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"Reward System Design and Group Creativity: an Experimental Investigation"

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Reward System Design and Group Creativity: An Experimental Investigation

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ABSTRACT

In an environment where three-person groups develop a creative solution to an important problem, we examine whether the efficacy of either individual or group-based creativity-contingent incentives depends on whether they take the piece-rate or tournament form. We predict and find that group (intergroup) tournament, relative to group piece-rate, pay increases group cohesion and collaborative efforts, which ultimately lead to a more creative group solution. While individual (intragroup) tournament pay increases individual efforts, it does not enhance the creativity of group solutions relative to individual piece-rate pay. Our results advance the burgeoning management accounting literature on creativity-contingent incentives by suggesting that reward systems are more likely to promote creativity through collaborative, rather than independent individual, efforts. We also provide important insights into when and why tournament pay can boost creativity in organizations. In doing so, we contribute to a better understanding of observations from practice suggesting that organizations valuing creativity often induce intergroup competition.

Keywords: *creativity-contingent incentives; reward system design; tournaments*

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I. INTRODUCTION

Organizations often look to employee groups to provide a creative solution to an important problem (Nussbaum 2005; Thompson and Choi 2006; Adler and Chen 2011). As such, a challenge for management accountants is designing performance evaluation and reward systems to promote group creativity (Kaplan and Norton 1996, Ch. 5). While a frequently proposed solution to this challenge is to reward either groups for the creativity of their solution or individuals for the creativity of their input to the group solution, prior research suggests creativity-contingent incentives often do not lead to the desired result. For example, consistent with theory suggesting that creativity is a dimension of performance that does not respond well to individuals' independent efforts (Amabile 1996), prior research demonstrates that reward systems motivating individuals to independently work harder at being creative often do not lead to more creative output (Kachelmeier et al. 2008; Kachelmeier and Williamson 2010). Tying rewards to a group-based measure of creativity can potentially enhance group creativity by increasing collaborative efforts (Toubia 2006). However, prior research highlights that groups often do not capitalize on these opportunities due to obstacles such as evaluation apprehension (i.e., anxieties that fellow group members will evaluate one's ideas unfavorably) and free riding which is exacerbated by the immense cognitive effort required to process, synthesize, and build on the diverse ideas of others (Paulus 2000; Paulus and Yang 2000).

These conclusions, however, are limited by the fact that prior research often only considers a single form of creativity-contingent incentive, most often a piece-rate where pay for either groups or individuals strictly increases in creativity (Sprinkle 2008). However, tournament pay, which can induce either intergroup or intragroup competition, is quite pervasive in

organizations (Lambert et al. 1993; McGregor 2006). Moreover, in environments where a measure of group (individual) creativity is available, the decision of whether to induce intergroup (intragroup) competition or make pay an increasing function of the creativity measure is often an important choice faced by managers. As such, we examine whether moving from the piece-rate to the tournament form of compensation better promotes group creativity across environments where individuals receive pay based on either (1) the creativity of the group's solution, or (2) the creativity of their individual input to the group's solution.

Drawing on theory from psychology, we develop a process model suggesting that group tournament, relative to group piece-rate, pay helps overcome obstacles that would otherwise limit the effectiveness of creativity-contingent incentives. When a group feels challenged or threatened by outsiders such as other groups fighting with it for an organization's scarce resources, members are posited to feel a greater sense of cohesion (solidarity) with one another. Members of cohesive groups feel stronger psychological bonds with each other and believe that other members are more open to their ideas, which enhances the ease at which group members share ideas (i.e., reducing evaluation apprehension). Moreover, members of cohesive groups feel more united in trying to achieve group objectives and, as such, work harder towards achieving them (i.e., decreasing free riding) (Brewer 1979; Tajfel and Turner 1986; van Knippenberg 2000; Bornstein 2003). Thus, to the extent intergroup competition enhances cohesion, we expect that group members will not only more freely share their ideas, but also exert the cognitive efforts necessary to process, synthesize, and build on each other's ideas, which can ultimately enhance the creativity of a group's solution (Tagger 2002; Van der Vegt and Bunderson 2005).

In addition to testing our process model which suggests that tournament pay increases the efficacy of group-based creativity-contingent incentives, we further validate our model by

examining whether tournament pay increases the efficacy of individual-based creativity-contingent incentives. Relative to individual piece-rate pay, research suggests that intragroup competition sparked by individual tournaments motivates more independent, individual efforts, to the detriment of collaboration (Drake et al. 1999). However, to the extent that (1) research suggesting that one cannot be more creative by simply independently working harder generalizes to a group setting, and (2) reward systems better motivate group creativity by increasing cohesion as our process model suggests, individual tournament pay will likely not increase the creativity of a group's solution relative to individual piece-rate pay. As such, we predict that, tournament, relative to piece-rate, pay increases the efficacy of group-based, but not individual-based, creativity-contingent incentives.

To test our predictions, we use a laboratory experiment where undergraduate students, in groups of three, developed a creative solution (i.e., a solution that is "original, innovative, and implementable within a reasonable budget") to an assigned campus problem. During the idea generation and development phase, groups utilized a computer program that organized inputs in trees (outlines) providing a forum to easily generate new (initial) ideas and develop (build on) others' and individuals' own ideas. Groups then selected one of the developed ideas to serve as their group solution.

We manipulated two factors between subjects at two levels each. First, we tied participant pay to a measure of either the creativity of the group's solution or the creativity of individual input to the group's solution, both as assessed by an independent panel of three raters. Second, participants received either a linear piece-rate based on their assigned measure or participated in a winner-take-all tournament. Here, either groups competed against two other groups in their session based on the creativity of the group's solution (an intergroup tournament)

or individuals competed against their other two group members based on the creativity of their individual input to the group solution (an intragroup tournament). Across all four conditions, we held average participant compensation constant.

Our results support our predictions. Group tournament, relative to group piece-rate, pay leads to more creative group solutions. We further show that group cohesion encompassing measures about group members' psychological bond, openness to each other's ideas, and the extent that group members feel united in achieving group objectives mediates the positive creativity effect of group tournament, relative to group piece-rate, pay. Individual tournament, relative to individual piece-rate, pay does not lead to more creative group solutions, neither in our initial experiment where we rewarded individuals based solely on the creativity of their inputs to the selected group solution nor in a supplemental experiment where we rewarded individuals based on the creativity of their input to all group ideas.

In addition to creativity ratings and self-reported measures, we also capture a rich set of data reflecting within-group interactions while the group members generated initial ideas, developed these ideas, and selected one of these ideas as the group solution. Consistent with our theoretical development, the primary difference between tournament and piece-rate conditions occurs while the group members developed ideas. Group tournament, relative to group piece-rate, pay increases the extent group members build on each other's ideas. By contrast, individual tournament pay increases the extent individuals build on their own ideas relative to the average of the other conditions.

Our results make important contributions. First, we illustrate that tournament pay inducing intergroup competition can help overcome obstacles identified by prior research that limit the effectiveness of creativity-contingent incentives. In doing so, we also shed light on the

process of idea generation, development, and selection that takes place within groups under various reward systems. We use a unique software program to capture a rich, objective dataset that reflects these within-group processes, and our analysis of this dataset yields valuable insights into how aspects of these creative processes differ under tournament relative to piece-rate incentive schemes. Although research from individual settings often suggests that creativity is invariant to reward system design, our results demonstrate that reward systems can play a vital role in promoting group creativity by encouraging individuals to collaborate and build on the diverse ideas of others.

Second, our results contribute more generally to research investigating the efficacy of tournament pay (e.g., see Young et al. 1993; Drake et al. 1999; Hannan et al. 2008). By simultaneously studying how group and individual tournaments affect group creativity as well as illustrating the processes through which intergroup competition promotes higher group performance, we gain a better understanding of when tournament pay can be effective (Luft and Shields 2003). For example, while Drake et al. (1999) suggest that tournament pay does not lead to higher group performance on a collaborative task, they focus solely on individual (intragroup) tournaments.

Our results also contribute to a better understanding of observations from practice. Case and field studies illustrate that, when desiring group creativity, organizations often induce intergroup competition (Amabile and Gryskiewiecz 1987; Arnold 1998; Simons 2000). We develop and test theory that can help explain why these practices have evolved in organizations.

We describe the background of our study and develop hypotheses in Section II. Section III explains our experimental method and design, Section IV presents results, and Section V concludes.

II. BACKGROUND, THEORY, AND HYPOTHESES

Background

In organizations, creative endeavors such as developing a proposal to address an important organizational problem often take place in group settings (Thompson and Choi 2006). In a group setting, creativity can arise not only from the individual creativity of group members, but also through collaborative efforts. Group members have the opportunity to observe, synthesize, and build on each other's ideas which can make them see the situation from multiple perspectives. This opportunity can increase the creativity of individual inputs to the group (Toubia 2006). Moreover, groups can coordinate their efforts to further develop (build on) the most creative individual inputs to transform them into a more creative group solution (Adler and Chen 2011).

In order to achieve this desired outcome, an oft-proposed management accounting solution is to tie employee pay to a measure of group creativity (e.g., the creativity of the group's solution to the organization's problem).[1] That said, prior research suggests that obstacles limit the effectiveness of group-based incentives. For example, evaluation apprehension can limit individual contributions in group creativity settings. That is, many individuals are anxious about sharing creative ideas, which by their nature are different, fearing others will evaluate them unfavorably (Paulus et al. 2006). Moreover, even to the extent individuals share their ideas, free-riding, a commonly observed by-product of group-based incentives, often prevents groups from reaping the benefits of the diverse ideas of its members (Paulus 2000). That is, individuals under

[1] In our setting, the group's objective is to develop a single creative solution. Throughout the remainder of the paper, we refer to the creativity of this solution as group creativity. We operationalize group creativity in this fashion for two primary reasons. First, given the amount of time we can reasonably keep participants in our laboratory setting, asking them to submit one solution (as opposed to many solutions) has a greater chance of encouraging collaboration among members (i.e., building on each other's inputs while developing solutions) which allows us to more powerfully test our theory. Second, because evaluating ideas is costly for management, organizations often require groups to put forth only their best (most creative) solution to the problem being addressed (Sutton and Hargedon 1996).

group-based creativity-contingent incentives are typically not willing to exert the immense cognitive efforts required to process, synthesize, and build on the diverse ideas of their group members (Paulus and Yang 2000).

To overcome these concerns, organizations may have the opportunity to measure and reward creativity at the individual rather than the group level. That is, organizations may tie rewards to the creativity of employee input to the group in order to motivate employees to independently work harder at being creative (Pirola-Merlo and Mann 2004). However, prior research suggests that obstacles may also limit the effectiveness of individual-based creativity incentives. For example, theory suggests that creativity does not arise simply from motivating individuals to independently work harder (Amabile 1996). Recent research in accounting supports this premise. For example, in settings without opportunities for collaboration, this research finds that reward systems motivating individuals to work harder at being creative do not lead to more creative output (Kachelmeier et. al 2008; Kachelmeier and Williamson 2010).

While prior research suggests that obstacles limit both individual and group-based creativity-contingent incentives, prior research typically only considers a single form of creativity-contingent incentive, something akin to piece-rate pay where better performance results in strictly higher rewards (Sprinkle 2008). Below, we develop a theory-based process model suggesting that tournament, relative to piece-rate, pay, if it induces competition at the group level, can help alleviate obstacles found to limit the effectiveness of creativity-contingent incentives and ultimately lead to a more creative group solution.[2] Figure 1 summarizes this process model.

[2] Given prior research suggests obstacles limit the effectiveness of both individual and group-based creativity-contingent incentives, we do not make a prediction as to the main effect of incentive level on group creativity. Rather, our focus is on the potential differential effect of incentive form on group relative to individual creativity-contingent incentives. That is, in environments where a measure of group (individual) creativity is available, we

(Figure 1)

Group Tournaments Relative to Group Piece-rates

In this section, we discuss the effects of moving from group piece-rate pay to tournament pay that induces intergroup competition. An example of a tournament scheme that induces intergroup competition is a competitive budgeting system that funds and provides higher pay to the most creative production teams (Kanter et al. 1997; Simons 2000; Nussbaum 2005). As another example, organizations such as Boeing and Dupont post pressing problems and request teams to submit proposals to address them. Each team is often only permitted to submit a single proposal, and it competes with other teams for a pre-specified cash reward (Brabham 2008). Below, we argue that, by inducing intergroup competition, organizations can help overcome obstacles identified by prior research that limit the effectiveness of group-based creativity-contingent incentives.

Theory in psychology posits that when a group is challenged or threatened by outsiders such as other groups fighting with it for an organization's scarce resources, its members feel a greater sense of cohesion (solidarity) with one another (Fiedler 1967; Friedkin 2004).[3] That is, intergroup competition, by making salient in-group and out-group categorizations, encourages group members to categorize themselves as a single group rather than a collection of individuals (Tajfel and Turner 1979; Turner et al. 1987). Supporting this theory, prior empirical research demonstrates that competition and rivalry among groups enhances group solidarity and the psychological bond among group members (e.g., Bornstein and Erev 1994; Mulvey and Ribbens 1999).

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examine the implications of either using the measure to induce intergroup (intragroup) competition or making pay an increasing function of this measure.

[3] As discussed below, the group cohesion construct encapsulates many pro-group attitudes such as beliefs about the strength of psychological bond among group members, the openness of group members to the ideas of others, and the extent group members are united in achieving group objectives.

To the extent that group tournament, relative to group piece-rate, pay enhances group cohesion, it can help mitigate obstacles identified by prior research that limit the effectiveness of group-based creativity incentives (i.e., evaluation apprehension and free-riding). That is, the group cohesion construct encapsulates members' attitudes about the group and its objectives that would make them more likely to share their own ideas and exert the efforts necessary to process and build on the ideas of others.

First, members of cohesive groups feel other group members are more open to their ideas and, thus, feel less anxious that group members will negatively evaluate their thoughts and ideas. Ultimately, these attitudes could lead members to more willingly share their ideas about problems faced by the group and comment on the thoughts and ideas of others.

Second, members of cohesive groups feel more united in trying to achieve group objectives. That is, individuals are more likely to adopt group goals as personal goals, thus blurring the distinction between self-interest and group interest (Borstein and Erev 1994; Kramer and Brewer 1984). This attitude could drive them to exert efforts to achieve collective goals, to focus on collective outcomes rather than individual rewards, and to maintain their commitment to the collective even when it does not benefit them individually (Brewer 1979; Chen et al. 1998; van Knippenberg 2000; Towry 2003; Ellemers et al. 2004). If so, individuals in a group creativity setting could be more willing to exert the cognitive efforts necessary to process, synthesize, and build on each other's ideas.

Ultimately, the more open exchange of ideas and efforts to synthesize and build on these ideas can enhance the effective integration of divergent perspectives and lead to more creative individual inputs (Paulus 2000; Van der Vegt and Bunderson 2005). Moreover, because group members are more in tune with each other's ideas, they can better coordinate efforts to further

develop (build on) the most creative individual inputs to transform them into more creative group solutions (Tagger 2002).

Individual Tournaments Relative to Individual Piece-rates

In this section, we discuss the effects of moving from individual piece-rate pay to tournament pay that induces intragroup competition. Examples of individual-based (intragroup) tournaments, where individuals compete against members of their own departments or teams, include competition for scarce promotion opportunities or a fixed bonus pool (Milgrom and Roberts 1992, Ch. 11). Relative to individual piece-rate pay, research suggests that intragroup competition sparked by individual tournaments motivates more independent individual efforts. For example, in a laboratory experiment where three-person groups each produced a subcomponent of a castle from toy blocks which can then be joined together, Drake et al. (1999) identified conditions where intragroup tournament pay increased independent individual efforts (i.e., individuals produced more units of their castle subcomponent to the detriment of completed castles).

These individual efforts, however, are unlikely to facilitate group cohesion and collaborative efforts among group members, which, as argued above, are essential for group creativity. As such, examining the effects of individual tournament pay in a group creativity setting provides the opportunity to further validate our theory-based process model. If motivating independent individual efforts does not enhance group creativity, then we provide further support for our model suggesting that reward systems better promote group creativity by fostering group cohesion. Ultimately, to the extent that (1) results from individual creativity settings suggesting that independent efforts do not enhance creativity generalize to a group creativity setting (Kachelmeier et. al 2008; Kachelmeier and Williamson 2010), and (2) our model suggesting that

reward systems spark group creativity by promoting group cohesion is descriptive, we do not expect individual-based tournaments to have a positive effect on group creativity relative to individual piece-rates.[4]

Hypotheses

The preceding discussion leads to the following expectations. First, group tournament, relative to group piece-rate, pay will lead to a more creative group solution. Second, individual tournament, relative to individual piece-rate, pay will not lead to a more creative group solution. Accordingly, we state the following two hypotheses:

H1: *Group tournament, relative to group piece-rate, pay will lead to a more creative group solution.*

H2: *Individual tournament, relative to individual piece-rate, pay will not lead to a more creative group solution.*

III. METHOD

Participants

We recruited 180 undergraduate student volunteers from upper-level business classes of a large state university to participate in one of ten 75-minute experimental sessions (nine to eighteen participants per session). Of the participants, 17 percent were sophomores, 73.5 percent were juniors, and 9.5 percent were seniors, with 48 percent of the participants being female. We randomly assigned participants to three-person groups and all group interaction occurred via computer. To ensure anonymity, we assigned each participant a code consisting of a group number and one of three letters (i.e., A, B, or C).

[4] Here, whether individual (intragroup) tournaments have no or a negative effect on group creativity depends on the influence of this incentive mechanism on group cohesion and the attitudes this construct encompasses. While prior research suggests that intragroup tournament pay leads individuals to sabotage the efforts of others, which would likely have a negative effect on these group processes (Drake et al. 1999), group members do not have clear opportunities to sabotage the individual efforts (e.g., disrupt the thoughts) of others in our group creativity setting. Thus, intragroup tournaments would not necessarily decrease these group attitudes relative to individual piece-rates.

Experimental Procedures

At the start of each session, participants read through a set of instructions on their computer screen. The Appendix provides the experimental instructions, including a screen shot summarizing the screen functions of the computer program that facilitated group-member interactions. After reading the instructions, individuals practiced using the software. No communication with group members took place during the practice session. Any questions and confusions regarding the functioning of the software were resolved during the practice session.

After the practice session, participants read about the incentive scheme they were assigned to, which was located on the top right corner of their computer screen. As a manipulation check, participants were asked to answer a pre-experimental question regarding the incentive scheme immediately following their reading of the incentive scheme. We checked every participant's answer to make sure that they understood their incentive scheme before we started the idea generation session.

In the idea generation session, each three-person group spent 30 minutes developing a specific proposal for a *creative use* for an abandoned house located on their college campus. Consistent with the psychology literature (e.g., see Amabile 1996), a *creative use* was defined as "a use that is original, innovative, and implementable within a reasonable budget." We provided each group with a brief history and a floor plan of the two-story house.

During the 30-minute proposal development phase, group members interacted via a collaborative "ideation program" (Toubia 2006). The ideation program organizes group member inputs in trees where initial thoughts or ideas ("parent-ideas") are placed far left of the screen and follow-up ideas ("child-ideas") are placed below, but slightly more indented, the existing ideas to which the child-idea relates. Participants, at any time during the experiment, could choose to

either contribute a new parent-idea or build on an existing parent or child idea. Each idea was labeled with the identification code of the group member providing the input.

For example, a group member initiated the parent-idea, “Experimental house for energy efficiency.” Under this parent-idea, a group member added the following child-idea, “Moreover, part of the project could be addressing how to modernize energy consumption while keeping historical significance intact.” While the group developed this proposal, another group member added another parent-idea, “historical museum for children,” which was also further developed with child-ideas.

Participants could also provide comments on any idea in a tree. Group members often used comments to coordinate group efforts. For example, participants used comments such as, “we need to discuss what to put in the [museum],” to focus the group’s efforts. Additionally, groups used the comment function for general discussion about the ideas such as one group member commenting, “there are already so many [restaurants] on campus, do you think it would work?” To which another group member responded, “that could work because [the house] is on the other side of campus where there aren’t many eating places.” Each comment was labeled with the identification code of the group member providing it.

After the 30-minute proposal development phase, the experimenter disabled the ideation program. Each group then selected one of the proposals it developed as the group solution. Specifically, each group selected a parent-idea with all its associated child-ideas as the group’s submitted solution. During the idea selection period, group members were only able to communicate via the comment function (i.e., no new parent or child-ideas could be added). Each group member had to come to an agreement as to the specific proposal to submit. To ensure that

the group members reached an agreement, the last comment of each group member had to be the (same) selected idea. All groups reached consensus.

Panels A and B of Figure 2 provide a submitted proposal from the group and individual tournament conditions respectively. Notice that, in the proposal from the group tournament condition, group members built extensively on each other's parent and child ideas. By contrast, in the proposal from the individual tournament condition, the group member initiating the idea performed the bulk of the idea development. As illustrated in the results section, these proposals are representative of their respective treatment conditions.

(Figure 2)

After selecting a proposal, each participant independently completed a post-experimental questionnaire asking for self-insights about aspects of group cohesion as well as requesting demographic and other information. Participants received a $5 show-up fee after the session. In addition to this show-up fee, as described below, participants also received performance-contingent compensation approximately four weeks after the experimental session, the nature of which depended on the experimental condition of the group.[5] The experiment used no deception of any kind.

Experimental Design

We randomly assigned each three-member group to one of four experimental conditions created by manipulating two dimensions of participants' reward system in a between-subjects design. We describe these two factors below.

Level of Creativity-Contingent Incentives

Our first manipulated factor is the level of the creativity-contingent incentive provided to participants. Half of the participant-groups received compensation based on the creativity of their

[5] We informed participants of this delay when recruiting them.

group's solution. The other half received compensation based on the creativity of their individual input to the group's solution.[6]

A panel of three graduate students from the same business school as our participants provided both creativity measures. Working independently and blind to our experimental manipulations, each rater read through the same set of instructions as our participants and the submitted solutions of all groups. They then rated the creativity of each group solution on a scale from 0 (lowest creativity) to 10 (highest creativity). They were asked to ensure the average rating across all solutions was a 5.

These raters also evaluated the creativity of each individual group member's input to the group's submitted solution. To facilitate these evaluations, each input to the solution was labeled with the code of the participant providing the input. Again, raters evaluated the creativity of each individual's input on a scale from 0 (lowest creativity) to 10 (highest creativity). They were asked to ensure the average rating across all individual ratings was a 5. Cronbach's alpha for the group and individual ratings was 0.89, indicating a reasonable level of consistency in the ratings. Thus, we averaged the three ratings to obtain our measure of group and individual creativity.[7]

[6] By rewarding participants for their individual contribution to the selected group solution, we attempt to give the individual conditions their best chance of increasing the creativity of the group solution. That is, since groups would most likely select one of their best ideas as the group solution, participants in the individual reward condition would have an incentive to creatively develop the group's best ideas in order to increase their assigned performance measure (i.e., the creativity of their individual input to the selected group solution). That said, as discussed later in the paper, we run a supplemental experiment where we measure and reward individuals based on the creativity of their input to all group ideas. Our results are robust to this alternative measure of individual creativity.

[7] We asked creativity raters to provide a justification for each of their ratings. Based on these justifications, proposals receiving a high creativity rating often developed either an original/innovative overall theme that was implementable or an ordinary overall theme with original/innovative aspects such as creative ways to interface with student groups on campus. Examples of creative proposals include: (1) a Civil War visitors center serving food and presenting theater/other entertainment consistent with the time period giving a creative outlet to student groups across campus, and (2) allowing student groups from each college to turn a room into an exhibit in order to introduce prospective students to each college's offering (each year, student groups with the best exhibit receive funding for their organizations). Proposals receiving lower creativity ratings developed a use typically associated with a college campus without original/innovative aspects such as (1) a coffee shop, or (2) a space that can be rented out by groups on campus.

To help validate the graduate student ratings, we also asked an expert to provide creativity ratings. Specifically, we asked a manager from the campus historic preservation office who is in charge of the abandoned house to rank order six group solutions. We pre-selected these solutions such that they were uniformly distributed across our entire range of creativity ratings. Expert rankings corresponded perfectly with the rank order of our average creativity ratings.

Form of Creativity-Contingent Incentives

Our second manipulated factor is the specific form of the creativity-contingent incentive. We paid half of our participant-groups a linear piece-rate based on their assigned performance measure. The other half of our participants received tournament pay where the participant or group performing best on their assigned performance measure, out of three competitors, received the highest compensation. Here, those rewarded based on group creativity competed against two other groups in their session (i.e., an intergroup tournament), and those rewarded based on individual creativity competed against their two other group members (i.e., an intragroup tournament).

Across all four conditions, we held average creativity-contingent compensation constant at $15 per participant.[8] In our individual piece-rate condition, participants received $3 multiplied by their individual input creativity rating where, as discussed above, the average rating was a 5.[9] In our group piece-rate condition, groups received $9 multiplied by their group creativity rating, where the average rating was a 5, and the three group members equally shared this piece-rate. In our individual (intragroup) tournament condition, the group member with the highest individual input creativity rating (out of the three group members) received $45 and the other two group

[8] Participants received an average compensation of $20 (i.e., $5 show-up fee + $15 average creativity-contingent compensation). They also received "extra credit" from the courses in which we recruited them for participating in the experiment.

[9] We communicated the creativity rating range and average in participant instructions.

members received $0. Finally, in the group (intergroup) tournament condition, the group with the highest group creativity rating (out of three groups) received $135, where the three group members equally shared this tournament pay, and the other two groups received $0.

IV. RESULTS

Test of Hypotheses – Creativity Ratings

Our hypotheses predict that group tournament pay will lead to a more creative group solution (H1) and individual tournament pay will not lead to a more creative group solution (H2) relative to group and individual piece-rate pay respectively. Panel A of Table 1 provides descriptive statistics for group creativity ratings. With group creativity ratings as our dependent measure, Panel B of Table 1 provides the results of an ANCOVA with form of incentives (piece-rate versus tournament pay) and level of incentives (individual-based versus group-based) as our independent variables. The sole covariate in our analyses is the percentage of females in each group.[10] Consistent with our hypotheses and as illustrated in Figure 3, this ANCOVA yields a significant form × level interaction ($F = 12.30$, $p = 0.04$).

(Table 1 & Figure 3)

Follow-up analyses on this interaction, reported in Panel C of Table 1, provide formal tests for our hypotheses. Consistent with H1, those with group tournament pay developed more creative group solutions than those with group piece-rate pay ($F = 2.34$; $p = 0.06$). Consistent

[10] For all analyses, we control for the percentage of females in each group because prior research suggests that females participate more in computer-mediated discussions (Hsi and Hoadley 1997) and, in our collaborative setting, this could lead to higher group creativity. Therefore, as discussed in Kinney (1986), we use the percentage of females as a covariate to increase the power of our statistical tests by removing variance suggested by prior research that is unrelated to our research question of interest. Consistent with this reasoning, this covariate is positively related with group creativity ratings and statistically significant in our analyses ($F = 14.14$; $p < 0.01$). However, controlling for the percentage of females does not contaminate our ability to isolate the effects of our manipulations insofar as a separate ANOVA with percentage of females as the dependent variable (untabulated) reveals no significant main or interaction effects (the average percentage of females by condition ranged from 51 percent in the individual piece-rate condition to 47 percent in the group tournament condition) ($F < 0.10$; $p > 0.50$). Without controlling for the percentage of females, we find that, relative to piece-rate pay, group tournaments increase group creativity ($F = 1.87$; $p = 0.086$) and individual-based tournaments have no effect on group creativity ($F = 1.33$; $p = 0.250$, two-tailed). Though slightly weaker, these results do not materially change our inferences.

with H2, those with individual tournament pay did not develop more creative group solutions than those with individual piece-rate pay ($F = 1.18$; $p = 0.28$, two-tailed). Moreover, while not statistically significant at conventional levels, the pattern of means suggests that, if anything, individual tournament pay is detrimental to group creativity. Collectively, these results fully support our two hypotheses. In the next two sections, we investigate the underlying processes contributing to these results.

Test of Process Model

In developing our first hypothesis, we argued that, relative to group piece-rates, group tournaments lead to more creative group solutions by promoting greater group cohesion, a construct encapsulating beliefs about the psychological bond among group members, the openness of group members to the ideas of others, and the extent members are united in trying to achieve the group objective. We capture judgments about group cohesion using eight post-experimental questions adapted from the Group Environment Questionnaire (GEQ) scale (Widmeyer et al. 1985). Panel A of Table 2 summarizes the specific statements used to capture group cohesion and the descriptive statistics by condition for participants' responses to each statement, which were elicited on an eleven-point Likert scale with "0" labeled "not at all" and "10" labeled "completely." As reported in Panel B of Table 2, factor analysis of individual responses indicates that all eight items load on one factor (all loadings > 0.50). Moreover, the Cronbach's alpha on these eight measures is 0.87, which exceeds typical reliability thresholds (Peterson 1994). Accordingly, we base the analyses in this section on the average of all eight items.

(Table 2)

Consistent with our theoretical model, we find that group tournament, relative to group piece-rate, pay increased group cohesion ($F = 2.88$; $p = 0.05$). We also find that individual tournament, relative to individual piece-rate, pay had no effect on group cohesion ($F = 0.02$; $p > 0.50$, two-tailed). Collectively, these results suggest that, relative to piece-rate pay, intergroup tournaments, but not intragroup tournaments, enhance group cohesion.

We further investigate whether group cohesion mediates the positive group creativity effect of group tournament, relative to group piece-rate, pay. We establish mediation if two additional conditions are met: (1) group cohesion is positively associated with group creativity, and (2) controlling for group cohesion reduces the significance of the group creativity effect of group tournament, relative to group piece-rate, pay (Baron and Kenny 1986). To test for these conditions, we re-estimate the ANCOVA and follow-up analyses used to test our hypotheses adding our measure of group cohesion as a covariate.[11] Untabulated results reveal that group cohesion is significantly associated with group creativity ($F = 4.38$; one-tailed $p = 0.02$), satisfying condition (1). Additionally, after controlling for group cohesion, the significance of the follow-up comparison between group piece-rate and group tournament pay is reduced ($F = 1.59$; one-tailed $p = 0.105$), satisfying condition (2). Collectively, these analyses are consistent with group cohesion at least partially mediating the positive group creativity effect of group tournament, relative to group piece-rate, pay. Thus, our results support our process model.

Supplemental Analyses on Idea Generation, Development, and Selection

Our group interaction software allowed us to capture a rich set of data reflecting within-group processes while the participant-groups generated potential ideas, developed these ideas, and selected a single idea as the group solution. Below, we explore how group and individual

[11] That is, with group creativity rating as our dependent measure, we estimate an ANCOVA with form of incentives (piece-rate versus tournament pay) and level of incentives (individual-based versus group-based) as our independent measures as well as the percentage of females in each group and group cohesion as covariates.

tournament, relative to piece-rate, pay affects these processes. In particular, we examine whether groups across conditions differed in any of the following: (1) the number and/or diversity of initial ideas generated (and thus, considered), (2) the extent to which group members build on each other's (vs. one's own) ideas, and (3) the propensity of group members to select the most creative idea generated. Table 3 contains descriptive statistics by experimental condition for measures discussed in this section.

(Table 3)

Initial Idea Generation

To investigate whether group and individual tournament, relative to piece-rate, pay affected the number and/or diversity of initial ideas generated, we report analyses on two measures. First, to examine the number of initial ideas generated, we count the number of parent ideas generated by each group. Recall, parent-ideas are the initial thoughts offered by a group member (e.g., "The house could be used as a museum.") from which group members have the opportunity to develop with child-ideas. Neither group nor individual tournament pay affected the number of initial ideas generated relative to group and individual piece-rate pay respectively (both comparisons $F < 0.75$; two-tailed $p > 0.39$).

Second, to examine the diversity of initial ideas generated, we asked a research assistant who was blind to the study's hypotheses to categorize all parent-ideas into common categories or themes. This exercise resulted in a total of ten categories such as the two most common categories: "history, museum, and gallery," and "academic support services." [12] We then counted the number of distinct categories covered by each set of group's initial ideas. Neither group nor individual tournament pay affected the number of distinct parent-idea categories relative to group

[12] The ten categories from most to least common include: (1) history, museum, and gallery; (2) academic support services; (3) dining and drinks; (4) hotel and related; (5) outreach services; (6) student lounge; (7) entertainment; (8) community related (e.g., church, community center); (9) store; and (10) experimental house for energy efficiency.

and individual piece-rate pay respectively (both comparisons $F < 0.01$; two-tailed $p > 0.94$). Collectively, our results suggest that tournament, relative to piece-rate, pay affects neither the number nor the diversity of initial ideas generated and, thus, considered by the group.[13]

Idea Development

This section investigates whether tournament, relative to piece-rate, pay influences the development of each group's initial ideas. We find that neither group nor individual tournament pay affected the number of child-ideas and comments under initial ideas relative to group and individual piece-rate pay respectively (both comparisons $F < 1.56$; two-tailed $p > 0.22$). However, theory suggests that tournament pay should affect the extent group members' idea development builds on others' (vs. one's own) ideas. Specifically, group tournament pay is posited to lead members to build on each other's thoughts and ideas to a greater extent relative to group piece-rate pay. Individual tournament pay, on the other hand, is posited to motivate individuals to build on their own ideas to a greater extent.

To capture the extent of building on group ideas, we examine the depth of idea development. We measure this construct as the maximum number of layers contained in a parent-idea. For example, a parent-idea with two child-ideas both building on the parent-idea has a depth of two, whereas a parent-idea with two child-ideas, one building on the parent-idea and the other building on the previous child-idea has a depth of three. The latter structure of idea development represents a higher degree of collaboration among group members and greater extent of elaboration on a particular idea. Consistent with our theoretical arguments, group tournament pay leads to greater idea depth relative to group piece-rate pay ($F = 3.51$; one-tailed

[13] When comparing across our group and individual reward conditions, we do not observe significant differences for either the number of parent ideas ($F = 0.95$; $p = 0.33$) or the number of distinct categories of parent ideas ($F = 1.07$; $p = 0.31$).

$p = 0.03$). Individual tournament pay did not lead to greater idea depth relative to individual piece-rate pay ($F = 0.01$; two-tailed $p = 0.92$).

To capture the extent individuals developed their own ideas, we take the sum of the number of words contained in parent-ideas (i.e., initial ideas) and the number of words in child-ideas that build on group members' own ideas. While the pattern of means suggests that those in the individual tournament condition developed their own ideas to a greater extent than those in the individual piece-rate condition (443.47 versus 419.60 words), this difference is not significant ($F = 0.20$; one-tailed $p = 0.33$). That said, this measure is higher in the individual tournament condition relative to the average of this measure across the other three conditions, providing at least some evidence that individual tournament pay, on average, increases independent individual efforts ($F = 4.87$, one-tailed $p = 0.02$).

Finally, we examine the impact of tournament pay on the creativity ratings of individual inputs to the group solution. Recall, our theoretical development posits that by synthesizing and building on the many perspectives of group members, individual participants can increase the creativity of their individual inputs. Since those in the group tournament condition appear to carry out these processes to a greater extent than those in the group piece-rate condition, we expect individual input creativity ratings to be higher in the group tournament condition than in the group piece-rate condition. Consistent with this argument, we find that group tournament pay leads to more creative individual inputs relative to group piece-rate pay ($F = 5.11$; two-tailed $p = 0.03$).[14] Thus, it appears that synthesizing and building on the ideas of other individuals not only enhances group creativity, but also individuals' own creativity. Consistent with prior management accounting research suggesting that independent efforts do not enhance creativity,

[14] To ensure low creativity scores of individuals who did not contribute to the selected group idea are not driving our results, we replicated our results using the maximum individual creativity rating for each group. Using this measure does not change the inferences we make.

we did not observe an effect of tournament pay on individual creativity across our individual-based incentive conditions ($F = 0.14$; two-tailed $p = 0.71$).

Idea Selection

The creativity of a group solution is a joint function of idea generation/development and idea selection. That is, group members must ultimately select which of their ideas to submit, and the idea selected could affect the group's creativity rating. The magnitude of verbiage in our group interaction transcripts makes any meaningful evaluation of unsubmitted thoughts and proposals difficult. However, to explore the effect of tournament pay on potential variations in idea selection across our experimental conditions, we asked a graduate student from the participants' university (not one of our original creativity raters) to read through the transcript of each group's interaction during the 30-minute proposal development phase and then select and rank the three most creative solutions of each group. Our rater was unaware of the idea selected by the group. We then compare the idea our rater identified as most creative with the idea actually selected by each group.

Across the fifteen groups in each of our four conditions, the idea our rater identified as most creative was actually selected by the group eleven times in the group tournament, eight times in the group piece-rate, eight times in the individual tournament, and seven times in the individual piece-rate conditions. These relative proportions did not statistically differ across our individual or group conditions (both comparisons $\chi^2 < 1.29$; $p > 0.26$). Moreover, one of the top two most creative ideas identified by our rater was selected by the group thirteen times in the group tournament, eleven times in the group piece-rate, twelve times in the individual tournament, and twelve times in the individual piece-rate conditions. Again, these relative

proportions did not differ across our individual or group conditions (both comparisons $\chi^2 < 0.83$; $p > 0.36$).

While tournament pay did not affect the propensity of groups to select their most creative idea, we also examine how long it took groups to reach consensus on the idea to select. After the idea generation and development phase, group members exchanged comments until all three members agreed on the idea to select. For each group, we tracked the number of minutes from the start of the idea selection phase until groups reached consensus. The less amount of time needed to reach consensus reflects, at least to some extent, how well-coordinated (calibrated) group members were as to the best ideas to develop and submit. Recall, our theoretical development argues that those in the group tournament condition can increase this coordination (calibration) because members would better process and synthesize group members' ideas. Consistent with this argument, we find that those in the group tournament condition required significantly less time to select their idea relative to those in the group piece-rate condition (F = 3.48; one-tailed p = 0.04). We did not observe an effect of tournament pay in our individual condition (F = 0.71; two-tailed p = 0.40).

Collectively, results from our examination of within-group processes during the experiment are consistent with our theoretical development. Group tournament pay motivates more collaborative, coordinated efforts among group members and encourages members to process, synthesize, and build on group ideas to a greater extent relative to group piece-rate pay. Ultimately, these more collaborative and coordinated efforts appear to promote higher creativity. Individual tournament pay, on the other hand, leads to more individual, independent efforts and motivates individuals to build off their own ideas to a greater extent relative to the average of the

other three conditions. Such independent efforts, however, do not translate into higher individual or group creativity.

Supplemental Experiment

Our results suggesting that individual tournament, relative to individual piece-rate, pay does not increase the creativity of the group solution are consistent with our theoretical development. However, we want to ensure that this finding is not merely an artifact of the way we measured and rewarded individual creativity in our original experiment. Specifically, while we chose to measure the creativity of individual input to only the selected group solution to encourage individuals to develop the group's best ideas, the resulting individual tournament scheme could be demotivating. For example, to the extent that individuals under the individual tournament scheme believed that the group member who offered the initial parent-idea of the selected solution would win the intragroup tournament, individuals under this contract may not have had a strong enough incentive to creatively develop the group's best or any other idea.

To explore this alternative explanation, we conducted a supplemental experiment replicating our two individual-based incentive treatments using a different performance measure, the creativity of each group member's input to the entire group discussion. Specifically, in the supplemental experiment, the participants were told that "each group member will receive a single rating based on the creativity of his/her input to both the group's selected idea and any ideas not selected by the group." With this one exception, we used the same set of instructions and experimental material as in our original experiment (see the Appendix).

We recruited an additional 90 undergraduate student volunteers from upper-level business classes of the same large state university as our initial experiment to participate in this supplemental experiment. We randomly assigned participants to three-person groups and

randomly assigned groups to our supplemental individual tournament and individual piece-rate conditions. Moreover, a new panel of three graduate students evaluated both the creativity of the selected group solution and the creativity of the input of each individual to all group ideas using the same protocol as our initial experiment. The participants in the individual piece-rate condition were told that "each individual will receive $3 multiplied by his/her individual rating". The participants in the individual tournament condition were told that "the individual from each group with the highest rating will receive $45 and the other two individuals will receive $0". Table 4 reports descriptive statistics of the resulting creativity ratings.

(Table 4)

Not only does the pattern of means suggest that individual tournament, relative to individual piece-rate, pay is detrimental to group creativity as in our original experiment, but also this decrease is statistically significant ($t = 2.72$; two-tailed $p < 0.01$). Moreover, as in our original experiment, the form of the individual reward did not affect individual creativity ($t = 1.22$; two-tailed $p = 0.23$). Collectively, results from our initial experiment suggesting that individual tournament, relative to individual piece-rate, pay does not increase creativity are robust to this alternative way of measuring and rewarding the creativity of individual input.

V. CONCLUSIONS

We report the results of an experiment where three-person groups develop, via computer interaction, a creative solution to an important problem. In this environment, we examine whether the efficacy of either individual or group-based creativity-contingent incentives depends on whether they take the piece-rate or tournament form. Consistent with our theory-based process model, we find that group (intergroup) tournament, relative to group piece-rate, pay increases group cohesion, which ultimately leads to more creative group solutions. We further

illustrate that group tournament, relative to group piece-rate, pay increases the extent group members build on each other's ideas, enhances the creativity of individual inputs, and promotes better coordination among group members as to the best ideas to develop and submit. Further validating our model, we find that, while individual (intragroup) tournament pay increases individual efforts, it does not enhance the creativity of group solutions relative to individual piece-rate pay.

Our results contribute to a better understanding of observations from practice suggesting that organizations desiring group creativity often induce intergroup competition. For example, innovative companies such as Johnson & Johnson and Procter & Gamble invest heavily in competitive budgeting systems rewarding members of the most innovative project teams with greater funding and pay (Simons 2000; Nussbaum 2005). Our findings also contribute to a better understanding of academic practices in that research teams and universities are becoming increasingly reliant on competitive grants for the funding of innovative projects (Geuna 2001). Beyond formal organizational practices, our results also contribute to a better understanding of the recent trend of "crowdsourcing." Here, organizations make open calls to groups of people requesting creative solutions to important problems and often pay groups with the most innovative solution. For example, InnoCentive (launched with funding from Eli Lilly) provides a platform where companies such as Boeing and Dupont post pressing R&D challenges to the scientific community and provide financial rewards to teams with the best solutions (Brabham 2008).

More generally, our results highlight the importance of gaining a better understanding of linkages between performance evaluation and reward system design and creativity in group settings. Our existing knowledge of these linkages comes predominantly from individual settings

where research often suggests creativity is invariant to reward system design. Consistent with this literature, our results suggest that simply encouraging individual group members to independently work harder at being creative may not lead to the desired result. However, by encouraging individuals to collaborate and build on the diverse ideas of others, our results suggest that performance evaluation and reward systems can play a vital role in promoting group creativity. These promising results will hopefully encourage future research in the area.

To this end, limitations of our study provide opportunities for future research. For example, we examined a setting where groups interact for only a single period. Whereas this design choice may be representative of some environments such as the reliance on cross-functional teams formed to creatively address a specific problem, it may not be representative of other environments such as when longstanding departments or teams must creatively address on-going problems and, thus, may already be a cohesive and collaborative unit. Therefore, future research could address the moderating role of multiple-period interactions on the link between performance evaluation and reward system design and group creativity. In addition, although our mediation analysis provides strong support for the process model proposed in our study, we cannot rule out other plausible process models given our data.

Appendix: Experimental Instructions

Ground rules

Before describing the experiment, it is important to establish two ground rules.

1. NO TALKING WITHIN OR COMMUNICATION BETWEEN SESSIONS

While we hope that you find this experiment to be fun, it is also serious research. Please help us maintain control over the experiment by refraining from verbal communication with your fellow participants in this session or any communication with other students who might be participating in future sessions. If you have any questions at any time during today's session, just raise your hand and we will assist you.

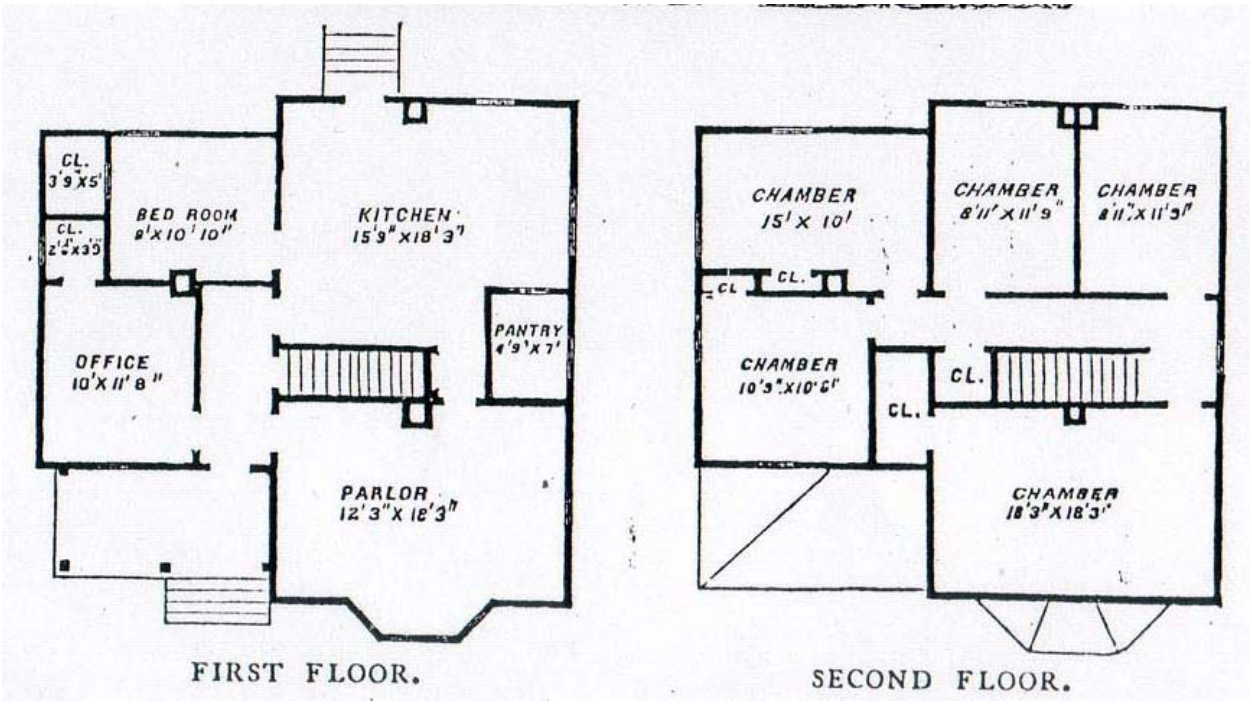
2. NO DECEPTION

We promise to carry out the experiment in the manner described in these instructions, with no deception of any form. You have already received a $5 show-up fee. As will be explained later, you can earn additional compensation from this experiment which will be paid at a later date (in about four weeks). We promise that your compensation will be determined exactly as described in the rules explained later for this session.

Experimental Task

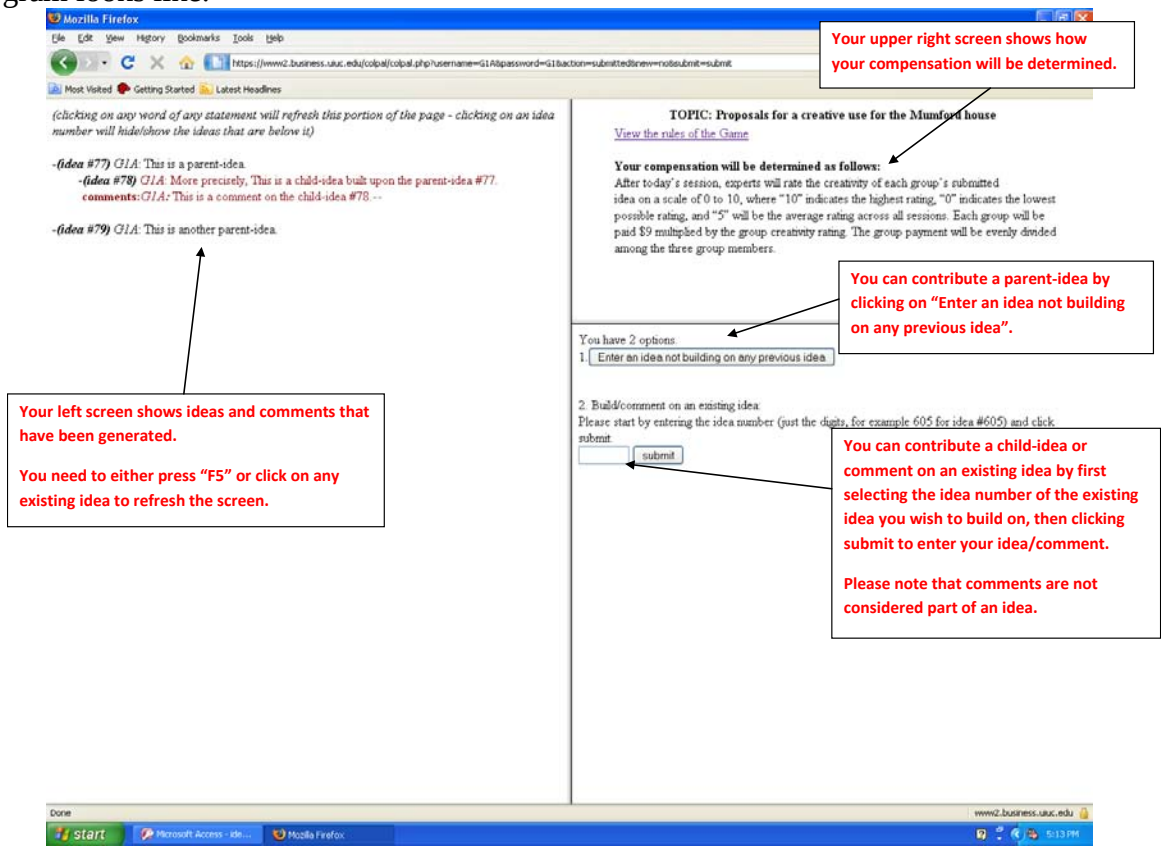
Participants in today's session have been randomly assigned into groups of three persons each. Each three-person group will spend 30 minutes developing specific proposals for a creative use for the Mumford house located in the South Quad (i.e., a use that is original, innovative, and implementable within a reasonable budget).

Built just after the Civil War in 1870, the Mumford House is the oldest building on our campus. Despite being listed on the National Register of Historic Places, the building has been poorly maintained and, as a result, is currently uninhabited. In order to renew interest in this historical landmark, groups from around the state want to develop a creative use for the building which will help secure money for its renovation.



Developing creative proposals for the Mumford House

For 30 minutes, each group will interact and develop their creative proposals electronically via an ideation program. The ideation program organizes group ideas in "trees" where the original ideas, "parent-ideas," are placed far left of the screen and the follow-up ideas, "child-ideas," are placed below the existing parent-ideas that the child-idea relates. Here is what the ideation program looks like:



Each group's idea-trees are recorded on the left-hand side of the screen. As seen in the image above, all child-ideas that build on a specific parent-idea have the same color and the same indentation.

At any time during the 30-minute interactive group session, group members can choose to either contribute a new parent-idea or build/comment upon an existing parent idea by clicking on either "Enter an idea not building on any previous idea" or "Enter an idea to react to or build on idea #" on the right-hand side of the screen. When building on ideas, you should generally use "conjunctive phrases" like 'More precisely', 'In particular.' These conjunctive phrases make sure that the ideas in a tree are linked not only verbally, but also conceptually.

Note: New ideas and comments won't appear automatically on the screen. To see new ideas, you have to refresh the page, either by pressing F5 or clicking on any previous idea.

Each group will only be able to observe the ideas and comments of its three members (i.e., not the ideas and comments of participants in other groups).

Submitting a creative proposal for the Mumford House

After the 30-minute interactive session, each group will have 5 minutes to select one idea from the idea(s) it developed. Specifically, each group will submit the number of the parent-idea where the discussion and development of its most creative idea began. **Recall:** Parent-ideas are the initial ideas at the far left of the screen.

During this 5-minute period, group members will only be able to communicate via the comment function (i.e., no new parent or child ideas can be added).

Remember, comments won't appear automatically on the screen. To see new comments, you have to refresh the page, either by pressing F5 or clicking on any previous comment.

The final comment of the group should indicate the number of the parent idea selected.

Your Compensation

<Group piece-rate>
After today's session, doctoral students will rate the creativity of each group's submitted idea on a scale of 0 to 10, where "10" indicates the highest rating, "0" indicates the lowest possible rating, and "5" will be the average rating across all sessions. Each group will be paid $9 multiplied by the group creativity rating. The group payment will be evenly divided among the three group members.

<Group tournament>
After today's session, doctoral students will rate the creativity of each group's submitted idea on a scale of 0 to 10, where "10" indicates the highest rating, "0" indicates the lowest possible rating, and "5" will be the average rating across all sessions. The group receiving the highest group creativity rating out of the three groups in today's session on your side of the lab will receive $135 and the other two groups with receive $0. The group payment will be evenly divided among the three group members.

<Individual piece-rate>
After today's session, doctoral students will rate the creativity of each group member's input to the group's submitted idea on a scale of 0 to 10, where "10" indicates the highest rating, "0" indicates the lowest possible rating, and "5" will be the average rating across all sessions. Each individual will receive $3 multiplied by his/her individual rating.

<Individual tournament>
After today's session, doctoral students will rate the creativity of each group member's input to the group's submitted idea on a scale of 0 to 10, where "10" indicates the highest rating, "0" indicates the lowest possible rating, and "5" will be the average rating across all sessions. The individual from each group with the highest rating will receive $45 and the other two individuals will receive $0.

<All Conditions>
We will pay you your compensation in about four weeks, after we receive the creativity ratings. We promise that you and all others with this version of the research will receive cash compensation as described above for participating today.

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TABLE 1
The Effects of Level and Form of Creativity-Contingent Incentives on Group Creativity Ratings

Panel A: Means (Standard Deviations) for Group Creativity Ratings[a]

	Individual-Based Incentive	Group-Based Incentive
Piece-Rate Incentive	5.47 (2.67) (n = 15)	5.09 (2.52) (n = 15)
Tournament Incentive	4.87 (2.53) (n = 15)	5.80 (1.91) (n = 15)

Panel B: Analysis of Variance

Factor	*df*	*Mean Square*	*F*	*p-value*[b]
FORM OF INCENTIVES[c]	1	0.55	0.29	.64
LEVEL OF INCENTIVES[d]	1	4.98	2.76	.24
FORM x LEVEL OF INCENTIVES	1	19.34	12.30	**.04**
PERCENT OF FEMALE GROUP MEMBERS	1	79.73	14.14	<.01
Error	167	5.64		

Panel C: Simple Effects

Effect of INCENTIVE FORM *within* GROUP-LEVEL INCENTIVES	1	2.34	**.06**
Effect of INCENTIVE FORM *within* INDIVIDUAL-LEVEL INCENTIVES	1	1.18	.28

[a] Both the creativity of group solutions and the creativity of individual input to the group solutions were assessed by an independent panel of three raters.
[b] Reported p-values are two-tailed unless testing a one-tailed prediction, as signified by bold face.
[c] We manipulated *Form of Incentives* between subjects at two levels. Participants received either linear piece-rate pay or participated in a winner-take-all tournament.

[d] We manipulated *Level of Incentives* between subjects at two levels. Participants received pay based on either the creativity of the group solution (Group-Based Incentive) or the creativity of their individual input to the group solution (Individual-Based Incentive).

TABLE 2
Descriptive Statistics of Group Cohesion Measure

Panel A: Descriptive Statistics of Statements Used to Capture Group Cohesion

	Group-Based Incentive *Mean (Standard Deviation)*		**Individual-Based Incentive** *Mean (Standard Deviation)*	
	Piece-rate	Tournament	Piece-rate	Tournament
(1) As a whole, I liked the members in my group.	7.51 (8.13)	8.13 (1.78)	7.02 (2.15)	7.04 (2.04)
(2) Our group was united in trying to generate a creative idea.	7.73 (2.44)	8.69 (1.41)	7.13 (2.79)	7.16 (2.36)
(3) My group did not give me enough opportunities to contribute my ideas. (R)	8.93 (1.78)	8.91 (1.82)	8.24 (2.16)	8.07 (2.40)
(4) I did not like the style of work in this group. (R)	6.87 (3.01)	7.87 (2.28)	7.07 (2.05)	7.27 (2.28)
(5) I feel attached to the group.	5.24 (3.18)	5.58 (2.79)	4.33 (3.19)	4.64 (2.99)
(6) I feel quite similar to others in my group in terms of general attitudes and opinions.	6.64 (1.98)	7.60 (1.44)	6.13 (2.12)	6.11 (1.91)
(7) I think my group was relatively more cohesive (united) compared to other groups in this study.	6.33 (2.42)	7.27 (1.53)	5.58 (2.20)	5.67 (2.33)
(8) My group members were open to the ideas of others.	7.89 (1.80)	8.02 (1.99)	7.51 (2.83)	7.27 (2.21)
Average	**7.14**	**7.76**	**6.63**	**6.65**

Panel B: Factor Analysis of Statements Used to Capture Group Cohesion

Statement	**Loading**
1	0.55
2	0.83
3	0.53
4	0.90
5	0.66
6	0.83
7	0.81
8	0.76

Adapted from the Group Environment Questionnaire (Widmeyer et al. 1985), Panel A of this table summarizes the statements used to capture group cohesion and the descriptive statistics of participant responses to these statements by condition. We elicited each statement using an eleven-point Likert scale with "0" labeled "not at all" and "10" labeled "completely". We averaged responses across each group such that n = 15 for each condition. Panel B of this table presents factor analysis for participants' responses to each statement.

TABLE 3
Descriptive Statistics of Process Variables

	Group-Based Incentive *Mean (Standard Deviation)*		**Individual-Based Incentive** *Mean (Standard Deviation)*	
	Piece-rate	Tournament	Piece-rate	Tournament
Idea Generation:				
Number of Parent Ideas	8.80 (4.28)	7.93 (3.79)	6.67 (2.58)	7.93 (4.99)
Number of Parent Idea Categories	5.87 (2.03)	5.93 (2.02)	6.53 (1.81)	6.47 (2.80)
Idea Development:				
Number of Child Ideas and Comments	36.53 (7.94)	42.07 (15.03)	41.60 (11.61)	37.53 (12.57)
Idea Depth	7.87 (4.31)	12.00 (10.26)	5.47 (2.42)	5.67 (3.87)
Individual Creativity Ratings	4.89 (2.28)	5.89 (1.71)	5.22 (2.48)	5.00 (2.40)
Number of Words Developing Own Ideas	330.87 (134.69)	278.27 (121.82)	419.60 (166.61)	443.47 (182.63)
Idea Selection:				
Minutes spent selecting idea	3.38 (2.13)	1.96 (1.37)	4.54 (2.47)	3.97 (2.26)

This table summarizes measures collected from transcripts of group interactions during our experiment and research assistant evaluations of these interactions. We averaged responses across each group such that n = 15 for each condition.

TABLE 4
Creativity Ratings in Supplemental Experiment[a]

	Piece-Rate Incentive[b]	Tournament Incentive[c]	*t*-statistic	2-tailed *p*-value
Creativity Rating of Group's Submitted Solution[d]	5.69 (1.25) (n = 15)	4.67 (0.74) (n = 15)	2.72	0.01
Creativity Rating of Individual Input to All Group Ideas	5.46 (1.02) (n = 15)	5.00 (1.05) (n = 15)	1.22	0.23

[a] This table summarizes creativity ratings for a supplemental experiment we conducted to replicate our two individual-based incentive treatments using a different performance measure, the creativity of individual input to all group ideas. With this one exception, we used the same set of instructions and experimental material as in our original experiment (see the Appendix).
[b] Participants in the Piece Rate condition received a linear piece-rate based on the creativity of their individual input to all group ideas.
[c] Participants in the Tournament condition received tournament pay where the participant who received the highest creativity rating, out of three competitors, for his/her individual input to all group ideas, received the highest compensation while the two other competing participants received nothing.
[d] Both the creativity of group's submitted solution and the creativity of individual input to all group ideas were assessed by an independent panel of three raters.

FIGURE 1
Process Model

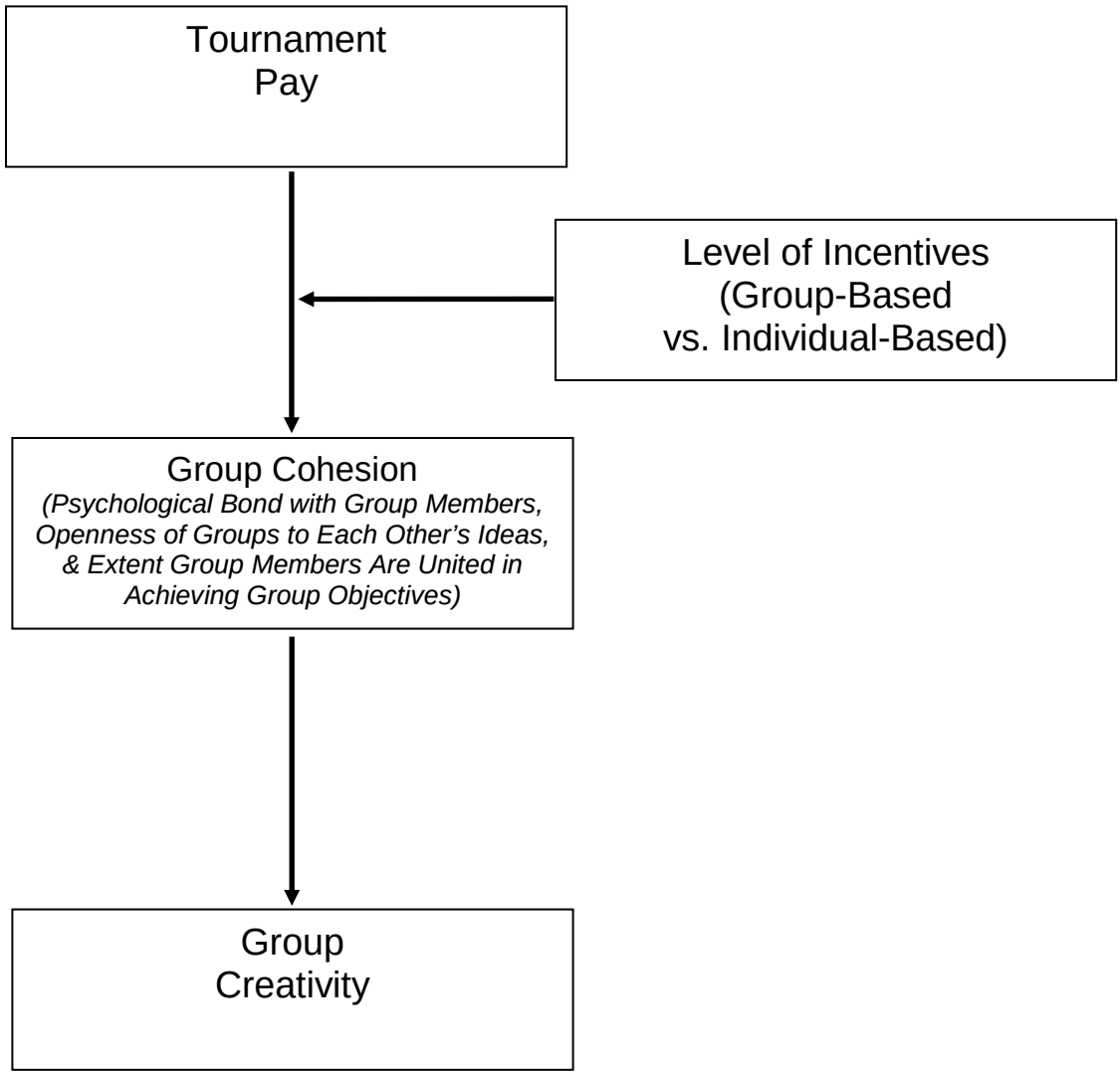


FIGURE 2
Submitted Group Proposals from the Group and Individual Tournament Conditions

Panel A: Example of a Group Proposal from the Group Tournament Condition

B: Bed & Breakfast

B: More precisely, we would have to hire some personnel to manage the B&B. this may be too costly considering staff, maids, person to do laundry

C: However, people would pay a lot to stay there, especially the elderly

B: On the other hand, would people pay a lot to stay in a run-down place?

C: On the other hand, it's gonna get fixed up

A: Indeed, people may pay more, but what is to say that the iHotel is does not offer more?

B: However, people may pay more for the more quaint experience, so maybe our target would be the elderly

C: More precisely, yes, old people have lots of money. Staying in the oldest building on campus would be more enjoyable than writing a check. Perhaps a contest that allows the winning donors to stay in the house for a weekend?

B: Indeed, having a contest for incentive is a good idea and we can advertise the house as very fixed up and comfortable to make the elderly feel more at home.

C: yep we have to think creativity here

A: Indeed, is keeping the integration of the museum and the bed n breakfast out of the question here?

C: well that is a great idea. Having the b and b themed like a museum for the old people. they would like that

A: In particular, need to discuss how and what to fill the house with artifacts, artwork, displays, holographic theaters, What is the underlying theme of the museum? University over the past 150 years, development of state over that time, or both?

A: Indeed, get school to pull things out of the archives or off the walls of libraries or something to put into it.

C: More precisely, I think we need to drop the robotic holographic talking theater idea. too futuristic, especially for the elderly. The theme of the museum would be the history of the university, with rotating displays

C: so are we leaning towards this for our creative pick. It is getting tricky to follow all of these threads

A: More precisely, I think since we have two creative ideas we should incorporate both. Unless anyone has a better idea. time is kind of limited

C: More precisely, could not agree more

A: Indeed, You could have all types of incentive and sponsoring events depending on the time of year to allow big donors to invite who every the like to stay there for the weekend or you could have large donors for the football stadium stay there at no char

A: Another way to look at this is what if we incorporate the bed n breakfast with the museum idea and have it be decorated with artwork and artifacts from around the state and University. Possible have an interactive room. It would incorporate the two lar

B: Indeed, nice, take two ideas and put it into one. It would be a good idea to decorate it with artwork and artifacts when renovating.

C: should we create a new thread for the combined art museum and b and b idea

B: In particular, we would also have to hire cooks to make the breakfast

A: Instead, Have the mangers who run the house cook like an actual bed n breakfast

B: On the other hand, i don't think it's a good idea to have managers be the cooks, because then who would manage the place and the staff?

C: Another way to look at this is a general manager of the property would

B: In particular, how much would we charge the guests? Would this be enough to cover all of the costs? How would we advertise the B&B?

A: More precisely, is the location of the house in proper city zone for it it be converted into a bed n breakfast for the public's use?

B: However, I'm sure location is fine considering it is on-campus. It would be ideal for grandparents visiting their grandchildren who attend the University because they would be on-campus

A: In particular, could we try an move the house to a better or more convenient location?

B: More precisely, so just to make it clear, this B&B would be renovated and decorated with historical artwork and artifacts to provide a comfortable and quaint experience to the elderly.

B: More precisely, what other details do we need to figure out? We figured out general labor expenses for personnel to maintain the place. We need to get washing and dryer machines to clean linens.

A: More precisely, I'm sure we could get a majority of this to get donated

B: In particular, we could also get donations from the university or alumni to support the continued renovation of this historical landmark

Panel B: Example of a Group Proposal from the Individual Tournament Condition

C: A coffee shop

C: More precisely, it could be themed as a university cafe

C: More precisely, This coffee shop idea would go hand-in-hand with 1799, because if it operated as a cafe, it would be a place for students and faculty to lounge and relax

C: More precisely, It could be themed as University Cafe- and host various significant University memorabilia on the walls/upstairs, while functioning as a cafe where students and faculty could relax. It could also feature a specialty dessert or coffee drink theme

A: One problem with this approach is Moreover, we can also maybe incorporate idea 1814 with the cafe feel.

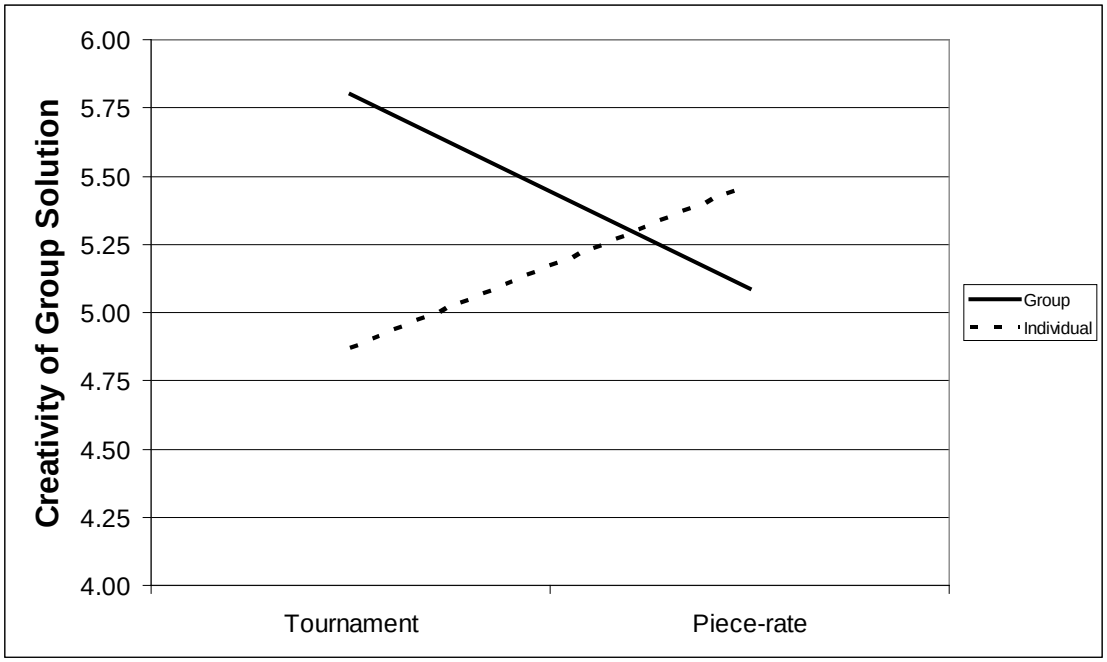
C: More precisely, To go along with the coffee shop idea, it is something that students and alumni alike could come to- enjoy the ambiance, and see the University memorabilia, the upstairs could feature an University museum paying homage to the school mascot.

C: More precisely, It would be a way to connect students- because not many might consider visiting a museum on a regular basis, however they might consider frequently visiting the Campus Café where they can relax, meet new friends, visit with alumni,

A: More precisely, it would also create a way for alumni to feel at home. A place that has so much history. Maybe it can even house all of the University sports pictures and etc.

C: More precisely, I agree, it would be such a great way to connect students to their heritage here at the University. Alumni would also love to come back and visit and gain the nostalgia of reliving the Big 4 basketball memories, the College Bowl Game.

FIGURE 3
Group Creativity Ratings by Condition



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Education

Doctor of Philosophy in Accounting, Indiana University (2005)
Master of Business, Indiana University (2003)
Master of Information Systems in Public Policy and Management, Carnegie Mellon University (1998)
Bachelor of Science in Accounting, Louisiana State University (1996)

Research and Teaching Interests

Research: Performance-Evaluation and Reward System Design
Teaching: Management Accounting and Behavioral Accounting Research

Relevant Teaching Experience

The University of Texas at Austin

Associate Professor	2011 – present
Assistant Professor	2005 – 2011

Fundamentals of Management Accounting in the Undergraduate Business Honors Program
International Accounting Policies and Procedures in the MPA program (taught in Prague)
Accounting Information for Managerial Decision Making in the MBA Program
Managerial Accounting in the Mexico City Executive MBA Program
Behavioral Research in Accounting in the Ph.D. Program

Indiana University

Assistant Instructor	2000-2005

Introduction to Management Accounting in Undergraduate Program

Professional Experience

Senior Consultant (Information Technology), Ernst & Young – Atlanta, GA (1998 – 2000)
Tax Consultant, Ernst & Young, Memphis, TN (1997)

Publications

Refereed Journal Articles

Balakrishnan, R., Sprinkle, G.B., and Williamson, M.G. (2011). Contracting Benefits of Corporate Giving: An Experimental Investigation. *The Accounting Review*, forthcoming.

Kachelmeier, S. J., and Williamson, M. G. (2010) Attracting Creativity: The Initial and Aggregate Effects of Contract Section on Creativity-Weighted Productivity. *The Accounting Review* (85): 1669 -1691.

Outstanding Management Accounting Paper Award at the 2008 AAA Annual Meeting

Hales, J. and Williamson, M. G. (2010). Implicit Employment Contracts: The Limits of Management Reputation for Promoting Firm Productivity. *Journal of Accounting Research* (48): 51-80.

Koonce, L., Williamson, M. G., and Winchel, J. (2010). Consensus Information and Nonprofessional Investors' Reaction to the Revelation of Estimate Inaccuracies. *The Accounting Review* (85): 979 - 1000.

Kachelmeier, S. J., Reichert, B., and Williamson, M. G. (2008). Measuring and Motivating Quantity, Creativity, or Both. *Journal of Accounting Research* (46): 341-373.

Best Paper Award, Management Accounting Stream at the 2007 AFAANZ Conference

Sprinkle, G. B., Williamson, M. G., & Upton, D. R. (2008). The Effort and Risk-Taking Effects of Budget-Based Contracts. *Accounting, Organizations, and Society* (33): 436-452.

Williamson, M. G. (2008). The Effects of Expanding Employee Decision Making on Contributions to Firm Value in an Informal Reward Setting. *Contemporary Accounting Research* (25): 1183-1209.

Sprinkle, G. B., & Williamson, M. G. (2004). The Evolution from Taylorism to Employee Gainsharing: A Case Study Examining John Deere's Continuous Improvement Pay Plan. *Issues in Accounting Education* (19): 487-503.

Book Chapter

Sprinkle, G. B., & Williamson, M. G. (2007). Experimental Research in Managerial Accounting. In *Handbook of Management Accounting Research*, edited by Chris Chapman, Anthony Hopwood, and Mike Shields. Elsevier Science.

This is an updated version of Sprinkle, G. B. (2003). Perspectives on Experimental Research in Managerial Accounting. *Accounting, Organizations and Society* (28): 287-318.

Working Papers

Chen, C. X., Williamson, M.G., and Zhou, F. H. (2011). Reward System Design and Group Creativity: An Experimental Investigation.

Outstanding Management Accounting Paper Award at the 2010 AAA Annual Meeting

Fisher, J. G., Peffer, S. A., Sprinkle, G. B., and Williamson, M. G. (2010). Reciprocity, repeated play, and budget-based contracts.

Kachelmeier, S. J., Majors, T. M., & Williamson, M. G. (2011). How Does Willful Intent Modify Risk-based Auditing?

Kachelmeier, S. J., Thornock, T. A., & Williamson, M. G. (2010). The Interactive Effect of Performance-Contingent Incentives and Organizational Values on Performance.

Webb, A., Williamson, M. G., and Zhang, Y. (2011). Productivity-Target Difficulty, Performance-Based Pay and Outside-the-Box Thinking.

Research Grants

McCombs School of Business Research Excellence Grant, 2006, 2008
University of Texas University Research Institute Grant, 2006

Invited Presentations

University of Illinois, April 2011
Texas Tech University, April 2011
Nanyang Technological University (Singapore), November 2010
University of Iowa, 2010
Catholic University of Leuven (Belgium), 2010
University of Washington, 2010
Purdue University, 2010
Nyenrode Business University (Netherlands), 2009
Northeastern University, 2009
University of Waterloo, 2009
University of South Carolina 2009
Tilburg University, 2008
University of Notre Dame, 2008
Georgia State University, 2007
Cornell University, 2007
Harvard University, 2007
Michigan State University, 2007
University of Pittsburgh, 2006
Emory University, 2005
University of Illinois, 2005
Louisiana State University, 2005
University of Utah, 2005
University of Washington, 2005
University of South Carolina, 2005

ABO Doctoral Consortium, 2009
ABO Research Conference (Panelist), 2009
Management Accounting Section Mid-year Meeting, 2007, 2008, 2009, 2010
Global Management Accounting Research Symposium, 2007, 2009
American Accounting Association Annual Meeting, 2008
Journal of Accounting Research Conference, 2007
Central Texas Compensation and Benefits Association, 2007
New Faculty Consortium (Panelist), 2007
Economic Science Association North American Meeting, 2006
Management Accounting Section Doctoral Colloquium, 2006

Service

The University of Texas at Austin

Accounting Department Executive Committee, 2011-2013
Second Summer Paper Co-Advisor, Tracie Majors
Dissertation Co-Chairperson, Todd Thornock, 2011 (Iowa State University)
Dissertation Co-Chairperson, Bernhard Reichert, 2010 (Drexel University)
Dissertation Committee, Margaret Christ, 2008 (University of Georgia)
McCombs School of Business Strategy Guidance Committee 2008
Accounting Doctoral Program Evaluation and Continuation Committee 2009-present
Accounting Department Spring Conference Co-chairperson 2010
Ad Hoc Committee on BBA Curriculum Reform 2010 – present
Teaching Awards Committee 2011
Accounting Department Executive Committee 2011 – present

Reviewing and Discussing

The Accounting Review – Editorial Board (2011 – present)
Behavioral Research in Accounting – Editorial Board (2008 – 2010)
Journal of Management Accounting Research – Editorial Board (2009 – present)
Management Science – Adhoc Reviewer
Accounting, Organizations and Society – Adhoc Reviewer
Journal of Information Systems – Adhoc Reviewer
Contemporary Accounting Research – Adhoc Reviewer
Managerial and Decision Economics – Adhoc Reviewer
Management Accounting Section Mid-year Meeting – Discussant and Reviewer
American Accounting Association Annual Meeting– Discussant and Reviewer
Global Management Accounting Research Symposium – Discussant

Professional Committees

Management Accounting Section Mid-year Meeting, Co-Organizer, 2011-2013
AAA Distinguished Contributions to Accounting Literature Award Selection Committee, 2010
Dissertation Committee (K.U.Leuven, Belgium), Stijn Masschelein
ABO Outstanding Dissertation Award Selection Committee 2007, 2009
Management Accounting Section Midyear Meeting Outstanding Paper Committee, 2009
Management Accounting Dissertation Award Committee, 2010

Teaching Honors and Awards

Regents' Outstanding Teaching Award, 2010
Mortar Board Preferred Professor, 2009
Outstanding Educator Award from the Texas Executive MBA at Mexico City Class of 2009
Trammell/ CBA Foundation Teaching Award for Assistant Professors, 2009
Texas Blazers Faculty Excellence Award, 2009
Honors Business Association Professor Award, 2007
Faculty Honor Roll for Excellence in Undergraduate Teaching, 2006, 2008, 2011

Research Honors and Awards

Best Early Career Researcher in Management Accounting Award 2010 (sponsored by AICPA, CIMA, & CMA)
Outstanding Management Accounting Paper Award at the 2010 AAA Annual Meeting
Outstanding Management Accounting Paper Award at the 2008 AAA Annual Meeting
Best Paper Award, Management Accounting Stream at the 2007 AFAANZ Conference