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Incentives (Competition), Feedback, and Innovation Performance: Evidence from an Experimental Study

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Abstract

Research on innovation has shown incentives play an important role in shaping innovation performance. However, we have little knowledge about how incentives shape innovation activity and performance when the incentives induce competition. Nor do we know much about the role of performance feedback on individual's innovation performance and activity. In this study, we examine the effects of incentive structure and performance feedback on individual's innovation performance and activity. The results from our controlled experiment show that, compared to individuals with incentives that created inter- and intra-group competition, individuals had better innovation performance when the incentives only created inter-group competition. Knowing competing groups' performances moderated the relationship between incentive structures and individual's innovation performance. Finally, our results reveal the complicated effect of individual's prior performance on individual's innovation activity.

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Abstract

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Incentives (Competition), Feedback, and Innovation Performance: Evidence from an Experimental Study

Innovation is one of the important drivers for organizational performance and survival. Understanding how to manage innovation and ultimately increase innovation performance has received considerable attention from management scholars and practitioners in past decades. The innovation process begins with a creative idea that is novel and useful (Amabile, 1996). This creative idea is usually modified and realized, before it can be implemented. Such a process requires experiential learning, trial and error, risk taking, and coordination (Thamhain, 2003) and can benefit from multidisciplinary efforts from members of organizations and organizational support (Zhou & Hoever, 2014). However, due to its complex nature, two important challenges still remain for organizations: (1) knowing how to manage innovation and (2) how to enhance innovation performance (Ederer & Manso, 2013; Zhou & Hoever, 2014).

To understand how to manage innovation and enhance innovation performance, past research has made significant progress in understanding factors situated in individual differences, group dynamics, and organizational contexts that influence innovation performance (Shalley, Zhou, & Oldham, 2004; Zhou & Hoever, 2014). Despite significant contributions made by past studies, there are important limitations in these studies. Specifically, while recent studies have begun to attend to the effects of incentives and competition on individual's and group's innovation performance (e.g., Baer, Leenders, Oldham, & Vadera, 2010; Chen, Williamson, & Zhou, 2012; Ederer & Manson, 2013), the studies have yet to consider how incentives influence individual's innovation behavior and performance when the incentives induce competition among individuals. This is an important question to address because individuals often face the tension of competition and cooperation with others in organizations. Exploring the effect of such tension on

innovation behavior and performance shall provide us with better understanding of the relationship between incentives, competition and innovation in organizations.

Furthermore, prior studies have shown that receiving performance feedback can have a positive effect on individual's performance (De Stobbelier, Ashford, & Buyens, 2011; Harrison & Rouse, 2015; Zhou, 2003). Nevertheless, we still have limited knowledge as to how knowing competitors' performances affects individual's innovation behavior and performance. Relatedly, past research has suggested that individual's prior performance exerts great influence on individual's risk taking behavior (Kahneman & Taversky, 1979; Singh, 1986). Innovation processes often involve experimentation and risk-taking behaviors. Surprisingly, little attention has been devoted to understanding how an individual's prior performance affects the individual's innovation behavior. Examining these limitations is theoretically important as it can advance our understanding of an individual's innovation performance.

To address these limitations, we draw upon prior studies on incentives and performance feedback to examine their effects on individual's innovation performance. Our main hypothesis is that individuals faced with only inter-group competition and provided with information on competitor's performance will have better innovation performance than their counterparts. In a controlled experimental setting, in which participants performed a computer-stimulation task that involved making innovative solutions to generate profits, we show that individuals in the inter-group competition condition with group-based incentives reported higher profits than those in the inter-group competition with individual-based incentives. We further provide evidence that individuals who received information on competing groups' performance reported higher profits than those without such information. Finally, our results show an individual's prior performance

exerted great influence on individual's propensity to engage in risky innovation activity and such influence was moderated by incentive structure and knowing competing groups' performance.

The results from this study have a number of implications. To begin with, this study shows that group-based incentives led to better individual's innovation performance; however, such incentives made individuals less responsive to their poor performance. This suggests that when designing incentive plans to support innovation that they should be team based. As well, the findings of this research show that feedback (knowing other groups' performance) led to better individual's innovation performance. Our results show that correctly designed incentive systems and performance management programs can lead to better individual innovative performance. These findings are important for organizations because innovation is a 'competitive necessity', as identified in a recent PWC survey of executives (Shelton & Percival, 2013). Thus, a key competitive advantage for a company is to obtain the best value out of its incentive expenditure, by designing incentive systems that maximize innovative output.

THEORETICAL BACKGROUND

Innovation is often defined as the production of knowledge through experimentation (Arrow, 1969). To be effective, experimentation requires access to diverse knowledge and incorporates such knowledge to develop innovative solutions to organizational problems. Such experimentation often involves risks associated with exploring new knowledge and solutions (March, 1991). Such experimentation is also a process by which individuals engage in trials and errors to search for new combination of new and existing knowledge to respond to emerged problems in innovation (Arrow, 1969; Fleming, 2001). Due to its complex nature, innovation often takes place in group settings in which group members share, synthesize, and build on each other's ideas to engage in collaborative activities (Adler & Chen, 2011; Thompson & Choi, 2006;

Toubia, 2006). To that end, incentives to motivate individual group members to positively engage in experimentation are crucial for innovation performance.

Incentive structure and competition

Research on the relationship between incentives and innovation has suggested that incentive structure plays an important role in shaping innovation performance (Byron & Khazanchi, 2012). In group settings, individuals can be faced with the tension between cooperation and competition either within or between groups, which in turn affects their behaviors in collaborative activities with others. The incentive structures that promote/reduce such tension may affect both individuals and group's innovation behaviors and performances.

In his thesis on social interdependence theory of cooperation and competition, Deutsch (1949) depicts that people's beliefs about how their goals are interdependent of others' exert great influences on how they will interact with others, which in turn impacts their performance. Such interdependence can be either cooperative or competitive. Specifically, for the cooperative interdependence where individuals perceive that they are only able to attain their goals if others in their group are also able to do so, the individuals are more likely to communicate ideas with others and coordinate their efforts, and develop friendly interactions. Cooperative interdependence creates the perception of a shared fate and promotes supportive behavior, where the members of the group look out for the interests of the others (Beersma, Hollenbeck, Humphrey, Moon, Conlon & Ilgen, 2003). In contrast, for competitive interdependence where people perceive that their goal attainment is negatively related that of others, individuals tend to keep information proprietary, are less likely to support each other, and may impair the progress of others for their own positive advantage. These behaviors might be detrimental to the creative process when individuals are competing against others. Hence, the extent to which individual

group member's motivation to work with each other to engage in collaborative activities depends upon if the incentive structure promotes cooperative or competitive interdependence.

Recent studies have examined the effect of incentive structure on group's innovation performance by linking incentive structure with inter-group competition. For example, Chen and her colleagues (Chen et al., 2012) compared the effects of the tournament pay incentive structure (i.e., groups competing for a cash prize) with piece-rate pay incentive structure on group creativity performance. They found that groups with the tournament pay incentive reported higher group cohesion and had better creativity performance. Similarly, a study completed by Drake, Haka and Ravenscroft (1999) found that group-based incentives that induce competition among groups led to higher motivation to cooperate among group members, more innovative solutions, and higher group profits. These suggest that incentive structure that stimulates inter-group competition helps to promote collaborative efforts among group members and enhance innovation performance.

Incentive structure can be designed to stimulate not only inter-group competition but also intra-group competition. Prior studies on the effect of incentives on individual performance have suggested that an incentive that creates competition among individuals (i.e., the tournament pay based on individual performance) can promote individual's innovation performance (e.g., Ederer & Manso, 2013). However, we propose that individuals may have worse innovation performance when they are required to compete with their group members and other groups. While incentives based on an individual's innovation performance can motivate the individual to put more effort into experimentation (Ederer & Manso, 2013; Zhou & Hoever, 2014), the individual is faced with a greater tension between cooperation and competition with his/her group members. To promote group innovation performance, individuals are required to share information and knowledge and

engage in collaborative activities with others in the same groups (Thompson & Choi, 2006; Toubia, 2006). Yet, intra-group competition can diminish an individual's motivation to share proprietary information and knowledge with others in his/her group on the expense of group performance. The intra-group competition therefore decreases information sharing and collaborative activity within the group. While intra-group competition can motivate an individual to increase his/her efforts toward experimentation, the individual is less likely to benefit from information sharing and collaborative efforts from other individuals in the group. As such, compared to individuals in groups with inter-group competition, individuals faced with both inter-group and intra-group competition may experience lower innovation performance.

Formally, we hypothesize:

Hypothesis 1: Individuals in the condition of inter-group competition with group-based incentives will have better innovation performance than those in the condition of inter-group competition with individual-based incentives.

Feedback

Prior studies on the relationship between incentive structure and innovation performance in the group settings have not examined the role of feedback on performance in shaping the relationship. However, past studies have suggested that providing feedback to individuals can enhance their creativity. For example, Zhou (2003) found that employees displayed more creativity when they received development feedback from a supervisor and were in the presence of a creative co-worker. De Stobbeleir et al. (2011) found that employees can increase their creative performance by actively soliciting feedback on their work performance. Harrison and Rouse (2015) completed a study that examined how feedback was used in creative projects in two

contexts, modern dance and product development. They reported that feedback influenced how individuals changed their performance on a creative task.

We propose that performance feedback may have a positive effect on individual's innovation performance in the context of group-based competition. By performance feedback, we refer to individuals receiving information on their performance relative to others'. Specifically, feedback on performance can form a reference point that changes individual's motivation such that an individual who has received feedback on their performance will be more motivated to change their behavior than individuals that do not receive feedback on their performance. Faced with inter-group competition, feedback on performance (i.e., knowing competitor's performance) may increase individuals' efforts into experimentation and willingness to share information and engage in collaborative activities with others in their groups. The level of information sharing and collaborative activities may increase, which in turn benefit individual's innovation performance. This leads us to the following hypothesis.

Hypothesis 2a: Individuals in the condition of knowing competing groups' performances will have better innovation performance than those in the condition without knowing the groups' performances.

However, the effect of knowing competing groups' performances on individual's innovation performance in the context of inter-group competition will be disproportionately different between individuals faced with and without intra-group competition. While knowing competing groups' performances increases individual's efforts with experimentation and motivation to share information and engage in collaborative activities with others in the group, the intra-group competition may decrease the motivation. Therefore, we expect that the positive effect of knowing competing groups' performances on individual's innovation activity should be

higher for individuals in the inter-group competition condition with group-based incentives.

Formally, we propose:

Hypothesis 2b: The positive effect of knowing competing groups' performances will be weaker for individuals in the condition of inter-group competition with individual-based incentives.

Individual's prior performance and innovation behavior

Hypotheses 1, 2a and 2b examine the effects of incentive structure and knowing competing groups' performances on individual's innovation performance. It is important to explore their effects on individual's innovation behavior. Prior research has suggested that innovation is a process of experimentation associated with exploratory activity and risks (Arrow, 1969; Jalan & Kleiner, 1995; March, 1991; Simmons & Ren, 2009). Therefore, it is possible that factors that influence individual's risk taking propensity will affect the individual's innovation behavior. For example, Pfeffer and Sutton (2013) showed that when employees feel that innovative ideas that fail will result in punishment to the innovator, they are less likely to take risks. Indeed, prospect theory has long contended that when individuals believe that they are in a situation that might involve a risky decision they tend to weigh their options based upon a given reference point (Simmons & Ren, 2009; Kahneman & Tversky, 1979). Individuals then use the reference point to determine whether or not a situation may result in a gain or a loss (Simmons & Ren, 2009; Kahneman & Tversky, 1979). Whether the individual believes that the situation will result in gain or a loss will affect their behavior (Simmons & Ren, 2009; Kahneman & Tversky, 1979). This theory suggests that when individuals conceive that the situation may result in a loss they are less likely to exhibit risk taking behavior, whereas if they believe that the risk might result in a gain they are more likely to exhibit risk taking behavior.

We propose that individual's prior performance serves a reference point that may influence his/her innovation behavior (e.g., Baum, Rowley, Shipilov, & Chuang, 2005; Greve, 2003). More narrowly, when an individual enjoys good performance, the individual is less likely to explore new innovation activity that involves more risks. Exploring such risky activity might decrease his/her future performance. In contrast, when an individual experiences poor performance, the individual is more likely to engage in experimentation that is more risky. By engaging in more risky experimentation, the individual may be able to increase his/her future performance. Therefore, the prior performance may play an important role to influence an individual's innovation behavior. Accordingly, we hypothesize:

Hypothesis 3a: The greater the individual's performance above his/her prior performance, the less risky innovation activity the individual will explore.

Hypotheses 3b: The greater the individual's performance below his/her prior performance, the more risky innovation activity the individual will explore.

Moderating effects of incentive structure and feedback

Our Hypotheses 3a and 3b suggested that individuals modify their behaviors in innovation activity in response to their prior performance. However, incentive structure may exert great influence on such response. Specifically, when incentive structure induces inter-group competition, individuals in the group are more likely to share information and engage in collaborative activity (Chen et al, 2012; Johnson, Hollenbeck, Humphrey, Ilgen, Jundt, & Meyer, 2006). Through information sharing and collaboration, individuals may shift their attention from their own performance to the group performance. Information sharing and collaboration also increase the group cohesion. However, past research suggests that there is a tendency for members to conform to the group's position in order to maintain group cohesion when the group engages in problem solving activity (Whyte, 1989). The tendency to conform may decrease an

individual's incentive to explore risky innovation activity. As such, the effect of individual's prior performance on the individual's innovation activity may be weakened. In contrast, when incentive structure induces both inter-group and intra-group competition, individuals are more likely to attend to their prior performance. Faced with intra-group competition, individuals are less likely to be constrained by group decisions on innovation activity. Individuals are then more responsive to their prior performance by exploring new innovation activity on their own. Particularly, compared to other individuals in the inter-group competition condition, an individual in the condition with both inter-and intra-group competition, the individual is more likely to explore more risky innovation activity when his/her performance is below the prior performance. By taking on more risky activity, the individual may be able to improve future performance. Similarly, compared to other individuals in the inter-group competition condition, an individual in the condition with both inter-and intra-group competition, the individual is less likely to explore more risky innovation activity when his/her performance is above the prior performance. By not taking on more risky activity, the individual may be able to maintain the same performance level. Accordingly, we propose,

Hypothesis 4a: The negative effect of the individual's performance above his/her prior performance on exploring more risky innovation activity will be weaker for individuals in the condition of inter-group competition with group-based incentives.

Hypothesis 4b: The positive effect of the individual's performance below his/her prior performance on exploring more risky innovation activity will be weaker for individuals in the condition of inter-group competition with group-based incentives.

How individuals respond to their prior performance by modifying their innovation activity may also be dependent on information availability of competitor's performance. For example, Fafchamps, Kebede and Zizzo (2015) reported that individuals took more risky decisions when they observed their competitors had higher performances. Baum and his

colleagues (Baum et al., 2005) reported the interactive influence of individual's and others' performances on individual's risk taking behavior. We propose that knowing competitor's performance may moderate the effect of individual's prior performance on his/her innovation activity. Compared to individuals in the groups without knowing competing groups' performances, individuals in the groups with information on competing groups' performances may be more responsive to their performances in order to maintain competitive. Particularly, when individuals experience poor performance and know competing groups' performances, they may be inclined to taking more risky innovation activity in attempt to improve their performance and competitive position. In contrast, when individuals achieve good performance and know competing groups' performances, they may be less likely to take risky initiatives in their innovation activity. By taking such initiatives, they put themselves at risk to lose their competitive position and decrease future performance. This leads us to our last hypotheses.

Hypothesis 5a: The negative effect of the individual's performance above his/her prior performance on exploring innovative options will be stronger for individuals in the condition of knowing competing groups' performances.

Hypothesis 5b: The positive effect of the individual's performance above his/her prior performance on exploring innovative options will be weaker for individuals in the condition of knowing competing groups' performances.

METHODS

We conducted an experimental design to test our hypotheses. Specifically, we used a 2 X 2 randomized experiment that investigated the effects of incentive structure (group-based vs. individual-based) and feedback (knowing competing groups' performances vs. not knowing competing groups' performances) on individual's innovation behavior and performance.

Sample

Our sample consisted of 108 fourth-year undergraduate students with business administration major in a large university. The participants were on average 23 years of age and 54% of the participants were female and 46% were male. Participants were randomly assigned into a group of three and to one of four experimental conditions. In return to their participation, participants received class credit.

Experimental tasks

Each participant took on the role of operating a computer-simulation lemonade stand. The lemonade stand task has been utilized in the Ederer and Manso's (2013) study of the relationship between incentives and innovation performance. Each experimental session consisted of 10 periods. During each period each participant made decisions on how to run his/her lemonade stand based on five dimensions: the location of the stand, the lemonade color, the ingredient in lemonade, the sugar level, and the price. After each period each participant learned about the profits of his/her decisions and customer comments on these decisions.

Incentive structure and feedback manipulation

For incentive structure, we created two types of incentive structure – group-based and individual-based. In both types of incentive structure conditions, each group competed against other two groups for a cash prize of \$75 based on the total profits earned by all three group members. Therefore, both conditions created inter-group competition. For the group-based incentives, three members of the winning group shared the cash prize evenly (i.e., \$25 each). In contrast, for the individual-based incentives, three members of the winning group received the cash prize based on the profits they contributed to the group. The member who generated most profits received \$40. The member who generated the least profits received \$10. The other

member received \$25. Hence, the individual-based incentive structure in our design created both inter- and intra- group competition.

To manipulate feedback on competing groups' performances, we created two conditions – feedback and no feedback. In the feedback condition, in the beginning of each period, the information on the profits generated by each group was posted on the board of the experiment's room. No information on individual's and group's decisions were revealed publicly during the experiment. In the no feedback condition, no profit information was provided to participants.

Procedures

Before the formal experiment, we conducted a pilot study with 36 participants to examine if there were technical issues with all aspects of the experiment and resolved the issues accordingly. In the formal experiment, upon arrival for the experiment all participants were introduced to their group members and the facilitator. The groups were told that once the experiment began they could not communicate with their group members verbally and all communication had to occur through written messages on Skype. The groups were then given time to introduce themselves to each other over Skype before they were given the instructions for the experiment.

Prior to the beginning of the task, each participant was given a letter that outlined the strategy that was used by the previous Manager of the Lemonade stand. The letter explained the combination of choices that were used, including previous profits and customer feedback. Accompanying the letter each participant received information relevant to the experimental condition s/he was assigned.

The strategy that was given by the previous Manager was not the most profitable strategy. Thus each group was assessed on the ability to explore different innovative strategies. In each

period, each group member had the option to modify his/her strategy from the previous period by changing each of the five dimensions to discover the most profitable solutions. Group members were informed to communicate with other members freely on Skype.

Prior to the start of the experiment, participants were asked to complete a pre-session questionnaire that consisted of a consent form and demographic questions. Upon completion of the experiment participants were asked to complete a post-session questionnaire. Manipulation check was performed to examine if participants were fully aware of the conditions they participated and they were. Prior to leaving, the teams were instructed about when they would receive the debriefing information.

Measures

Innovation performance. Consistent with the approach used by Ederer & Manso (2013), we measured individual's innovation performance using the total profits generated by a participant by the end of the experiment s/he participated.

Risky innovation activity. In the simulation, a participant can decide how many changes s/he wants to make on the five dimensions. To capture the risky innovation activity a participant engaged, we counted the number of changes a participant made in each period, ranging from 0 to 5.

Prior performance. To examine the effect of an individual's prior performance on the individual's innovation activity, we measured prior performance by taking the difference between an individual's performance in period t-1 and that in period t-2 to examine its effect on the risky innovation activity the individual had in period t. Following the approach used in previous studies (Baum, et al., 2005; Greve, 2003), we constructed two measures, Performance above prior performance and Performance below prior performance. For Performance above prior

performance, we recorded the values of the difference between performance in period t-1 and that in period t-2 greater than 0. For the observations where the differences are smaller than 0, we recorded them as 0. For Performance below prior performance, we recorded the values of the difference between performance in period t-1 and that in period t-2 smaller than 0. For the observations where the differences are greater than 0, we recorded them as 0. For ease of interpretation, we further reversed the coding for Performance below prior performance. Accordingly, the greater the value of Performance below prior performance, the greater the individual's performance below his/her prior performance.

Competitiveness. We further measured individual's competitiveness to control for its effect on our dependent variables (i.e., innovation performance and risky innovation activity). We used the 9-item, 5-point Likert scale developed by Harris and Houston (2010). An example of these items is I am a competitive individual. Each participant answered these 9 items in the beginning of the experiment. The reliability of this scale in our sample was about .88.

Information sharing. We also measure the degree of information sharing an individual had with other group members by using the 4-item, 7-point Likert scale developed by Foss, Minbaeva, Pedersen and Reinholt and his colleagues (2009). Each participant answered these four items in the end of the experiment. The items capture knowledge inflow and outflow. Accordingly, we constructed two measures, Knowledge inflow and Knowledge outflow. Examples of items are - To what extent have you received knowledge from your team members? To what extent have you used knowledge from your team members? The reliability of the measures in our sample are about .87 for Knowledge inflow and .85 for Knowledge outflow.

Analysis

Our theoretical interests rest upon the effects of incentive structure, feedback on performance, and individual's prior performance on individual's innovation performance and activity. Accordingly, the level of analysis is at the individual. For Hypotheses 1, 2a and 2b, we used the OLS regression to test the effects of incentive structure and knowing competing groups' performances on individual's innovation performance (total profits). We created dummy variables, Group-based incentive and *Knowing competing groups' performances* to test the hypotheses. For Group-based incentive, individuals in the inter-group condition with group-based incentives were coded as 1; individuals in the inter-group condition with individual-based incentives were coded as 0. For *Knowing competing groups' performances*, individuals in the condition with information on competing groups' performances were coded as 1; individuals in the condition without such information were coded as 0.

For Hypotheses 3ab, 4ab, and 5ab, we used the GLS regression to test the effects of individual's prior performance, incentive structure and knowledge competing groups' performances on individual's risky innovation activity across 10 periods of the experiment an individual participated¹. We treated each period as a panel and performed panel data analysis to test the hypotheses. As our experiment was conducted in a group setting, it is important to control for the group effect. Accordingly, we clustered individual observations based on their group affiliation in both OLS and GLS analyses.

¹ Since our measure of risky innovation activity is a count measure, we also ran negative binomial regressions to test our hypotheses. The results from negative binomial regressions are similar to the ones reported in Table 2 here.

Results

Table 1 represents the results from OLS regression analysis to test our Hypotheses 1, 2a and 2b. Model 1 is the baseline. We entered our theoretical variables in order of our theoretical discussion and derived at the full model, Model 5. Hypothesis 1 suggested that individuals in the inter-group competition condition with group-based incentives would have better innovation performance compared to their counterparts. The coefficient estimates in Models 2 and 4 provide mixed support for the hypothesis. The coefficient estimate of Group-based incentives is not significant in Model 2 and becomes marginally significant after *Knowing competing groups'* performance was entered in Model 4 (158.356, $p < .10$). Hypothesis 2a proposed that knowing competing groups' performances would have a positive effect on individual's innovation performance. The coefficient estimates of *Knowing competing groups' performances* in Models 3 and 4 provide partial support for the hypothesis (182.79, ns in Model 3 and 207.96, $p < .05$ in Model 4).

<<Insert Table 1 and Figure 1 about here>>

Hypothesis 2b suggested that the positive effect of knowing competing groups' performances on individual's innovation performance would be weaker for individuals in the inter-group competition condition with individual-based incentives. The positive coefficient estimate in Model 5 provides support for the hypothesis (358.65, $p < .05$). To better appreciate the moderating effect of knowing competing groups' performances, we plotted the interaction graph by using the coefficients in Model 5 and the data range in our sample. The solid line represents the individual performance in the inter-group competition with group-based incentives. The dash line represents individual performance in the inter-group competition with individual-based incentives. As shown in the figure, the positive effect of knowing competing groups'

performance is greater for the solid line (i.e., individuals in the inter-group competition condition with group-based incentives). These suggest that group-based incentives, together with information on competing groups' performances positively influence individual's innovation performance.

<<Insert Table 2, Figures 2 and 3 about here>>

Regarding our hypotheses on risky innovation activity, Table 2 represents the results of GLS models. Model 1 is the baseline. Model 2 shows the effects of performance above and below prior performance on individual's innovation activity. The negative coefficient estimate for performance above prior performance provides support for Hypothesis 3a (-.005, $p < .01$). The positive coefficient estimate for performance below prior performance provides support Hypothesis 3b (.018, $p < .01$). We further tested if the coefficients were significantly different and they were ($p < .001$). These suggest that individuals were more likely to make changes on their lemonade stands when their performance was below prior performance. By making more changes, they might be able to improve their performance in the next period. In contrast, individuals who received better profits were less likely to make more changes. By making more changes, the individuals might not be able to receive the same profits they have been receiving.

Turning to the moderating effects of incentive structure and knowing competing groups' performance, the coefficient estimates for interaction terms provide mixed support for our hypotheses. Specifically, Hypotheses 4a and 4b suggested that individuals in the inter-group competition condition with individual-based incentives would be more responsive to their prior performance. Only Hypothesis 4b is supported (-.016, $p < .05$). Hypotheses 5a and 5b proposed that knowing competing groups' performances would moderate the effect of prior performance on individual's risky innovation activity. The non-significant coefficient estimate for

Performance above prior performance x Knowing competing groups' performances provides no support for Hypothesis 5a. Yet, the positive coefficient estimate for *Performance below prior performance x Knowing competing groups' performances* provides support for Hypothesis 5b. These suggest that participants in our experiment were less likely to modify their strategies when they had received higher profits. While they were more likely to modify their choices in running the lemonade stand when their profits were declining, their propensity to make changes depended upon incentive structures and knowing competing groups' performance.

To better appreciate the interaction effects in Models 3 and 4, we again plotted the interaction graphs using the correspondent coefficients in the models. Figure 2 shows the moderating effect of incentive structure on the relationship between individual's prior performance and risky innovation activity. As shown in Figure 2, participants in the inter-group condition with group-based incentives, compared to those in the individual-based incentives, were less likely to make adjustments on their strategy. This suggests that individuals with individual-based incentives were more responsive to their poor performance.

Figure 3 shows the effect of knowing competing groups' performances on how individuals respond to poor performance. The solid line (knowing competing groups' performances) is steeper than the dash line. This suggests that knowing competitor's performance motivated participants who had received poor profits to make more adjustments on their strategy about running the lemonade stands.

DISCUSSION AND CONCLUSION

In this paper, we began with the question suggesting that incentive structure and performance feedback influence innovation activity and performance. We found that incentive structure played an important role in both individual's innovation performance and activity.

Performance feedback at both individual and group levels exerted great influence on individual's innovation activity and performance. In particular, we saw an interesting and complicated pattern in how the individual's prior performance influences the individual's innovation activity.

Accordingly, there is much to take away from our study.

Prior studies on the effect of incentives on innovation performance have shown that incentives significantly influence how group members interact with each other (Chen et al., 2012; Johnson, et al., 2006). Particularly, incentives that induce inter-group competition can enhance group cohesion and therefore enhance group creativity (Chen, et al., 2012). Such effect can be moderated by the turnover of group members (Baer, et al., 2010). Our study builds upon this line of research by showing that incentives that induce both inter- and intra- group competition have detrimental effects on individual's innovation performance. Importantly, our findings here offer valuable implications for the effective design of incentive structures. Drawing upon the notion of social interdependence theory (Deutsch, 1949), our findings provide further evidence that the incentives that foster cooperative behaviors among group members should be emphasized in the context of innovation activity. Furthermore, our results on the effect of performance feedback on individual's innovation performance shed light on another contingent factor to enhance innovation performance. Baer and his colleagues (2010) documented the moderating effect of group memberships on the relationship between incentives and innovation performance. We show the importance of information on competitor's performance in shaping innovation performance.

Turning to our results on the role the prior performance plays in shaping innovation activity, our results are consistent with what prospect theory would have predicted in main – whether individuals are going to engage in risky innovation activity is in part dependent on their

prior performance. Furthermore, our results show that incentive structures and performance feedback at the group level had little effect on how individuals responded to their own performance when they enjoyed good performance. In contrast, incentive structures and performance feedback at the group level exerted great influence on individual's exploration of risky innovation activity when they experienced poor performance. Particularly, individuals with the group-based incentives were less likely to engage in risky innovation activity when they had poor performance. It is possible that group-based incentives shift the individual's attention from individual performance to group performance. As such, they were less responsive to their poor performance. It is also possible that individuals who experienced poor performance might have had a lower motivation to improve their performance as other group members also account for group performance (Pearsall, Christian & Ellis, 2010). To that end, our results here call the effectiveness of team-based incentives in question.

Limitations

One of the limitations of this study is whether or not the shared \$75 incentive successfully motivated participants to complete the task. In order for one to generalize this study to a work environment the incentive that must be used should simulate that of an individual's variable compensation. The shared \$75 incentive might not generate the same amount of motivation in an undergraduate student as a variable incentive might in that of an employee. As well, this brings up the concern of the studies' external validity. The study utilized teams of undergraduate students in a lab study. The dynamics in these short term teams may not approximate a workplace team that might be brought together for a long duration of time to work on a task. A possibility for future research would be to study the effects of reward structures and environmental factors (no competition, competition and within team competition) in teams over a longer duration of

time. As well, these teams were created quickly and lasted for a short amount of time. It is plausible that the effect of team members may influence the performance on a task. Additionally, team self-efficacy could influence a team's performance on a task.

Practical Implications

The findings of this study also provide some managerial implications for business practitioners. One of the key findings from this study is that group-based incentives led to better individual innovation performance; however, group-based incentives also made individuals less responsive to their poor performance. Subsequently, these findings suggest that if managers want to encourage innovation then incentives that foster cooperation should be used i.e. team based incentives. Managers should be aware in these situations that when teams are not performing well individuals will be less responsive to their poor performance. Future research should investigate whether or not hybrid reward systems, that focus the motivation of team members not only on the performance of the team but on their individual contribution, are able to address this issues (Pearsall, Christian, & Ellis, 2010).

As well, the findings of this research show that feedback (knowing other groups' performance) led to better innovation performance by individuals. This is important for management as it suggests that mechanisms that give teams the ability to track their performance against other teams will lead to better innovative performance. This study has shown that the effective design of rewards and feedback systems can help increase individual innovation performance in a team.

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Table 1. The effects of incentive structure and knowing competing groups' performances on individual's innovation performance

	Model 1	Model 2	Model 3	Model 4	Model 5
Control variables					
Competitiveness	-41.611 (71.939)	-23.993 (61.221)	-50.836 (72.271)	-30.456 (57.499)	-13.816 (57.323)
Knowledge inflow	-3.609 (33.847)	-4.259 (32.437)	-21.073 (37.502)	-24.276 (35.784)	-14.180 (36.170)
Knowledge outflow	92.619** (31.072)	87.238** (27.341)	105.388** (31.267)	100.533** (26.211)	97.593** (28.642)
Theoretical variables					
H1 (+)					
Group-based incentives		128.861 (95.690)		158.356+ (84.521)	46.297 (93.185)
H2a (+)					
Knowing competing groups' performance			182.792 (110.943)	207.964* (98.730)	67.261 (124.208)
H2b (+)					
Group-based incentive x Knowing competing groups' performance					358.658* (165.037)
Constant	821.625** (261.886)	739.811** (227.405)	821.231** (259.205)	720.636** (208.634)	677.934** (226.919)
Observations	80	80	80	80	80
R-squared	0.144	0.195	0.235	0.311	0.393

Robust standard errors in parentheses; clustered by group

** p<0.01, * p<0.05, + p<0.1

Table 2. GLS models of the effects of prior performance on individual's risky innovation activity

	Model 1	Model 2	Model 3	Model 4
Control variables				
Competitiveness	-0.001 (0.137)	-0.028 (0.156)	-0.029 (0.156)	-0.032 (0.159)
Knowledge inflow	-0.045 (0.047)	-0.038 (0.054)	-0.035 (0.054)	-0.039 (0.053)
Knowledge outflow	-0.134** (0.043)	-0.119* (0.047)	-0.116* (0.047)	-0.123** (0.046)
Group-based incentive	-0.021 (0.121)	-0.036 (0.125)	0.032 (0.174)	-0.031 (0.124)
Knowing competing groups' performance	-0.080 (0.139)	-0.064 (0.139)	-0.073 (0.141)	-0.150 (0.167)
Theoretical variables				
H3a (-)				
Performance above prior performance		-0.005** (0.002)	-0.006+ (0.003)	-0.006* (0.002)
H3b (+)				
Performance below prior performance		0.018** (0.005)	0.027** (0.006)	0.014* (0.006)
H4a (-)				
Performance above prior performance x Group-based incentive			0.001 (0.004)	
H4b (-)				
Performance below prior performance x Group-based incentive			-0.016* (0.008)	
H5a (+)				
Performance above prior performance x Knowing competing groups' performance				0.001 (0.003)
H5b (+)				
Performance below prior performance x Knowing competing groups' performance				0.012+ (0.007)
Constant	3.718** (0.469)	3.370** (0.556)	3.292** (0.597)	3.430** (0.569)
Observations	640	640	640	640
rmse	1.446	1.200	1.193	1.197
Number of newid	80	80	80	80
Waid chi-square	22.04	83.49	312.6	169.4

Robust standard errors in parentheses

** p<0.01, * p<0.05, + p<0.1

Figure 1. The interaction effect of incentive structure and knowing competing groups' performances on individual's innovation performance.

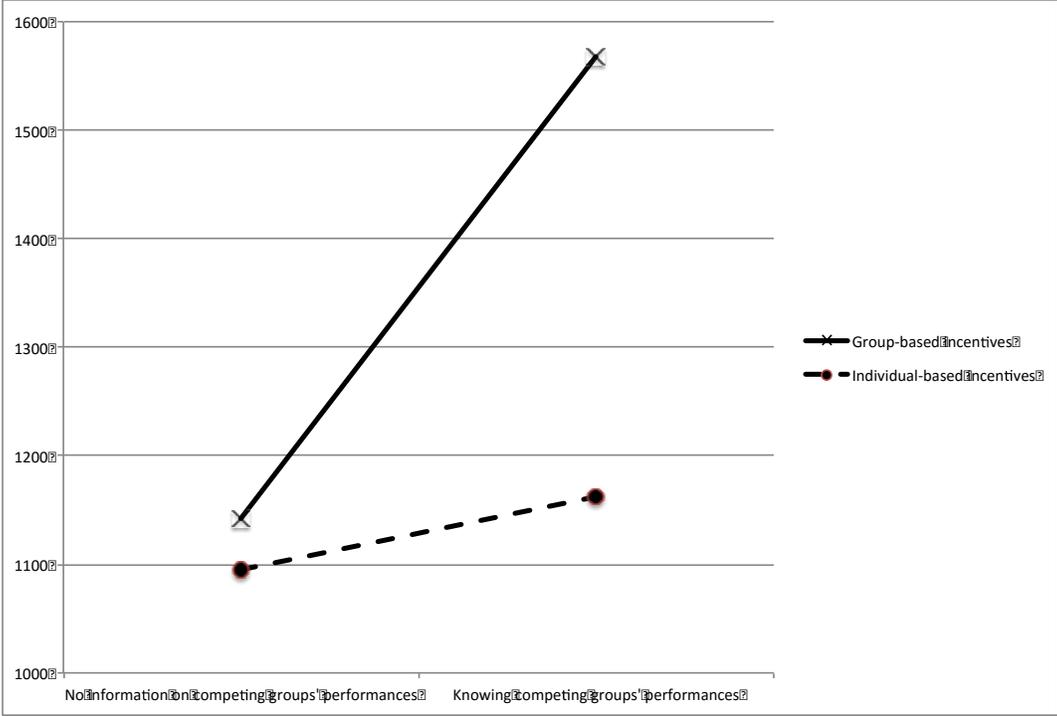


Figure 2. The moderating effect of incentive structure on the relationship between performance below prior performance and risky innovation activity.

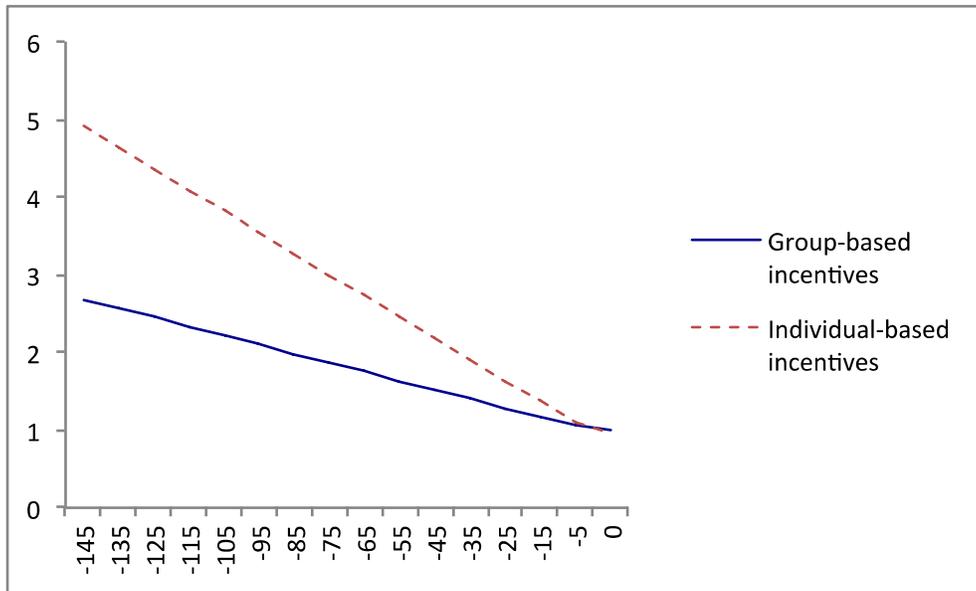


Figure 3. The moderating effect of knowing competing groups' performances on the relationship between performance below prior performance and risky innovation activity.

