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The Effect of Prize Structure and Feedback Policy on Employee Effort: A Tournament Theory Approach

Wang Gang

Doctor of Management

Supervisors:
PhD Virginia Trigo, Professor Emeritus,
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PhD Chen Shuangying, Professor,
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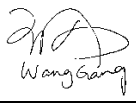
Signed 

Abstract

One of the main focus of management is on ways to motivate employees to improve their performance, initially at the level of individuals, and ultimately at the level of the organization (Denisi & Pritchard, 2006). So, it is critical to set effective performance appraisal systems to stimulate employees' efforts. Since tournament theory arose out of the labor economics literature (Lazear & Rosen, 1981), it has expanded to a wide range of other disciplines including management. Most of the previous studies on prize structure using this theory have focused on a two-level prize while, in real life, practitioners always adopt a multiple level prize structure. In addition, previous studies on feedback in a dynamic tournament have unveiled agents' reactions, however, there are few studies on feedback in multiple agents' tournaments with multiple level prize structure. These two gaps between theory and practice have motivated the research in this thesis.

Based on tournament theory, we study the effect of prize structure and feedback policy on employee efforts in a multi-person tournament. The experimental method is used to compare the efforts in four situations, including two-level prize structure with full feedback policy, multiple level prize structure with full feedback, two-level prize structure with no feedback, and multiple level prize structure with no feedback. After the experiment, six participants were invited to join a focus group interview for further insights on the experiment. As a supplement, a single case study of a factory in China is conducted and data collected through document analysis and a questionnaire distributed to employees.

The results show that the subjects' efforts in a multiple level prize structure is higher than that in a two-level prize structure in a multi-person tournament. Under both the policy of full feedback of own and relative performance information, and under no feedback policy, the effort in multiple level prize is also higher than that in two-level prize. These findings may contribute to develop the tournament theory in terms of prize structure in a multi-person tournament, and to bridge the gap between academia and industry since results could guide practitioners in the industry to apply a multiple level prize structure into employee performance management systems in order to maximize employee's efforts and the overall output.

Keywords: Tournament theory; Prize Structure; Feedback; employee efforts

JEL: D23; J33; L23

Resumo

A melhoria do desempenho dos trabalhadores é uma das principais preocupações da gestão quer a nível individual quer organizacional (Denisi & Pritchard, 2006), pelo que é necessário conceber sistemas de avaliação que promovam o esforço desenvolvido. A teoria dos torneios, proveniente da literatura da economia do trabalho (Lazear & Rosean, 1981), é precisamente um desses sistemas depois de se ter expandido para a gestão e para outras disciplinas. Contudo, muitos dos estudos sobre estruturas de prémios que utilizam esta teoria, têm-se concentrado em prémios com dois níveis enquanto na prática as organizações utilizam estruturas de múltiplos níveis. Além disso, embora existam trabalhos anteriores que têm revelado as reações dos agentes em torneios dinâmicos, são poucos os estudos sobre essas mesmas reações em estruturas de prémios de múltiplos níveis. Foi esta contradição entre a teoria e a prática que motivou esta tese.

Com base na teoria dos torneios, a tese estuda o efeito da estrutura de prémios e da política de *feedback* seguida pela organização sobre os esforços dos trabalhadores num torneio com vários sujeitos. Utilizou-se o método experimental para se compararem os esforços em quatro situações: estrutura de prémios de dois níveis e política com e sem *feedback*; estrutura de prémios de níveis múltiplos com e sem *feedback*. Finda a experiência, convidaram-se 6 participantes para um grupo de discussão a fim de se obterem mais esclarecimentos sobre a prova. Em complemento estudou-se o caso de uma empresa fabril na China através de análise documental e de um questionário distribuído aos empregados.

Os resultados demonstram que, num torneio com múltiplos sujeitos, os esforços são superiores quando é utilizada uma estrutura de prémios de níveis múltiplos. O mesmo acontece em caso de política de *feedback* integral ou mesmo quando não existe *feedback*. Estes resultados podem contribuir para ajudar a desenvolver a teoria dos torneios no que se refere à estrutura de prémios em torneios com múltiplos sujeitos e podem também aproximar a teoria da prática ajudando os gestores na implementação de sistemas que maximizem o desempenho dos trabalhadores.

Palavras chave: Teoria dos torneios; Estrutura de prémios; Esforços dos trabalhadores

JEL: D23; J33; L23

摘 要

管理的一个主要焦点是如何激励员工提高他们的绩效，最初是在个人层面，最终是在组织层面（Denisi & Pritchard，2006）。因此，建立有效的绩效考核体系，激发员工的积极性至关重要。自锦标赛理论产生于劳动经济学文献（Lazear & Rosen，1981）以来，它已经扩展到包括管理学在内的许多其他学科。以往这一理论的研究中，关于奖金结构的研究大多集中在两级奖金上，而在现实生活中，实践者往往采用多级奖金结构。此外，以往关于动态锦标赛中反馈的研究已经揭示了代理人的反应，但是对于具有多级奖金结构的动态锦标赛中的反馈研究却很少。这两个理论与实践的差距促使了本文的研究。

基于锦标赛理论，我们研究了多人锦标赛中奖金结构和反馈策略对员工努力度的影响。采用实验方法，比较了四种情形下被试者的努力程度，包括两级奖金结构和完全反馈、多级奖金结构和完全反馈、两级奖金结构和无反馈、多级奖金结构和无反馈。实验结束后，六名参与者被邀请参加焦点小组访谈，以进一步了解实验。作为补充，本文以中国某工厂为例，通过文件分析和问卷调查收集数据。

结果表明，在多人锦标赛中，多级奖金结构的被试者努力程度高于两级奖品结构。在完全反馈其个人和相关被试者绩效信息的策略下，以及在无反馈策略下，多级奖金结构下被试者的努力度都高于两级奖金结构。这些发现可能有助于从多人锦标赛的奖金结构方面发展锦标赛理论，并弥合学术界与行业之间的差距，因为研究结果可以指导行业从业者将多级奖金结构应用到员工绩效管理系统中，以最大限度地提高员工的努力程度和总体产出。

关键词：锦标赛理论；奖金结构；反馈；员工努力

JEL：D23；J33；L23

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Chapter 1: Introduction

1.1 Research background and significance

Since tournament theory arose out of labor economics literature (Lazear & Rosen, 1981), it has expanded to a wide range of other disciplines including management. Tournament is conceptualized as contest in which the 2 players compete for prize. Regardless their absolute outputs, the winner, whose relative rank is high, is rewarded a high prize, while the loser receives a low prize. The gap between high prize and low prize has a direct effect on the two players' effort. Another important variable is feedback policy during long-run tournament.

Starting from a real managerial problem, this thesis investigates the effect of prize structure and feedback policy on employee effort in a multi-person long-run tournament.

1.1.1 Research background

Lebas (1995) defines performance as follows: "Performance is about deploying and managing well the components of causal model(s) that lead to the timely attainment of stated objectives, within constraints specific to firm and to situation", while performance management is a process by which the company manages its performance in line with its corporate and functional strategies and objectives (Bititci, Carrie, & McDevitt, 1997). As a matter of fact, performance management is popularly applied at the organization, department and employee levels, to align resources, and motivate people to achieve the objectives of the organization.

As shown in Figure 1-1, the usual process of performance management in practice includes:

Performance planning is derived from decomposing organization strategies and goals into department and individual's objectives, followed by employees' tasks for the objective achievement, then by appraising performance results periodically, providing feedback, and then starting the next cycle.

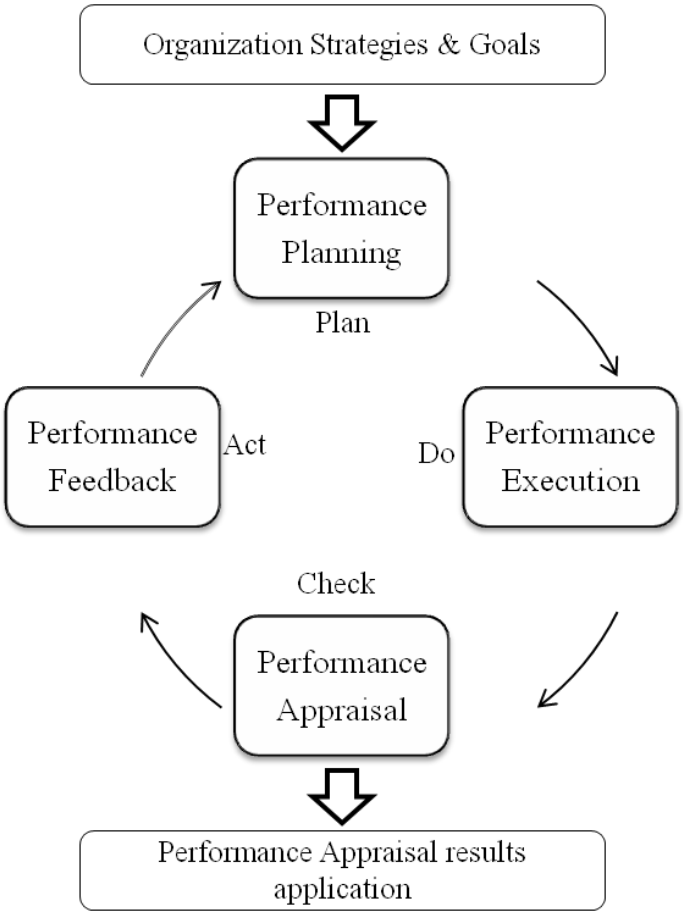

Figure 1-1 Performance Management Process

The performance appraisal results may be used for evaluative and (or) developmental purpose. Evaluation is defined as comparing an individual's performance to a set standard, to other organizational members, or to the individual's previous performance, and is used for salary administration, promotion or termination. Development is any effort concerned with enriching attitudes, experiences, and skills that improve the effectiveness of employees, as for example, assessing strengths and weaknesses of the employee, setting goals, and for identification of training needs (Boswell & Boudreau, 2002).

Performance management focuses on ways to motivate employees to improve their performance, initially at the level of the individual employees, and ultimately at the level of the organization (Denisi & Pritchard, 2006).

According to the Expectancy Theory, motivation is determined by combining expectancy and valence (Vroom, 1964). The expectancy includes the probability that the employee will accomplish the intended performance, labeled effect to performance (E→P) expectancy, and the probability that the performance will lead to a number of outcomes, labeled performance to outcomes (P→O) expectancy. The valence is the subjective attractiveness of the outcomes.

Vroom gave the formula of motivation:

$$\Sigma\ [(E \rightarrow P) \times\ \Sigma\ [(P \rightarrow O)\ (V)]\ ].$$

From the expectancy theory, we can see that valence is one of the important factors to motivate employees.

Among the application of performance appraisal results, monetary application is popular in practice as, for example, salary increment and monthly, quarterly or annual bonus according to performance results. Now let us image a situation in the real world: a manager leads 10 subordinates in a department, the manager sets objective goals for the subordinates, and then the subordinates put efforts for the goal. At the end of the year, the manager conducts performance appraisal for the 10 subordinates, and finds that the subordinates achieve different results, some are better, some are poor. The manager ranks the 10 subordinates by their performance results. If the manager has 10000 Yuan (approximately 1,290 euros) prize budget, how should he or she allocate the budget to each subordinates to maximize motivation of the 10 subordinates?

The optional prize allocation solutions are listed in Table 1-1. According to option 1, every subordinate is awarded 1000 Yuan, 10% of total prize equally. In option 2, the best half of the subordinates is awarded 2000 Yuan respectively, 20% of the total prize equally. The remaining half of the subordinates has no prize. In option 3, the top one subordinate is awarded all the 10000 Yuan while the remaining 9 subordinates have no prize. Finally, in option 4, the prize is a tolerance 222 arithmetic progression. The top one is awarded 2000 Yuan, the second one is awarded 1778 Yuan, the third one is awarded 1556 Yuan… the last one has no prize. How should the manager make the decision? How do the different decisions influence the subordinates to work hard in the following year? This is a real management problem in practice.

Table 1-1 Optional Prize Allocation Solutions

Subordinate	Rank	Prize Option 1	Prize Option 2	Prize Option 3	Prize Option 4
A	1	1000	2000	10000	2000
B	2	1000	2000	0	1778
C	3	1000	2000	0	1556
D	4	1000	2000	0	1333

E	5	1000	2000	0	1111
F	6	1000	0	0	889
G	7	1000	0	0	667
H	8	1000	0	0	444
I	9	1000	0	0	222
J	10	1000	0	0	0

One more question in the above situation: should the manager collect the output of all the subordinates, calculate the performance results and give feedback to the subordinates every month, like option 2 in Figure 1-2 below, or do it just once at the end of the year, like option 1 in Figure 1-2? If the manager decides to give monthly feedback to the subordinates about his/her performance, which item should he or she tell the subordinates, including subordinate's output, monthly rank, other subordinate's output, other subordinate's rank? Should the manager help every subordinate analyze the execution advantage and disadvantage in that month, and plan the countermeasure for the next month? Which feedback policy has the higher effect to motivate subordinates?

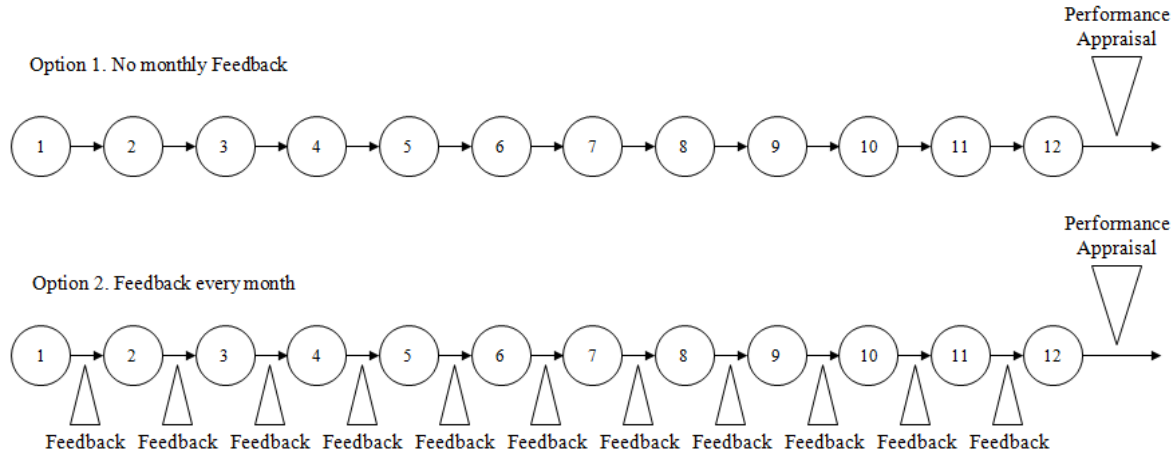

Figure 1-2 Feedback Policy Options

To address these real management problems, tournament theory (Lazear & Rosen, 1981) may provide solutions. Tournament is a special performance appraisal by comparing relative performance results. When the principal can monitor the agent's effort costless and reliably, the principal may determine the agent's salary by the marginal output and then the agent can put an optimal effort level, while the principal is able to obtain an optimal output. However, if the monitor cost is high and unreliable, tournament is an alternative solution. In tournament, employees' prize depends on their relative rank among all employees but does not depend on

absolute output. If the tasks of agents are related, tournament can remove uncertainty factors in the environment, therefore, the principal can judge the agent's effort level more accurately, and then tournament can enforce the agent's motivation.

When Lazear and Rosen (1981) compared compensation schemes of paying for individual's ordinal rank and paying for his output level, they created a simplified model whereby two agents compete for the prizes fixed in advance. The winner receives the higher prize W1, while the loser receives the lower prize W2. As long as the prize spread (W1-W2) gets larger, the productivity of agents gets higher. Many researchers (Harbring & Irlenbusch, 2003; Orrison, Schotter & Weigelt, 2004; Harbring & Irlenbusch, 2008) have analyzed the effect of prize structure on effort in a multi-person tournament by varying the portion of winners. For example 1/4, 1/3, 1/2, 2/3 or 3/4 agents receive a higher prize. These researchers have kept the two-level prize structure proposed by Lazear and Rosen (1981). However, a multiple level prize structure is widely used in practice, for example, for gold, silver and copper medals in sports competitions or first prize, second prize, third prize in assessments. During performance appraisal in a company, employees may be forcefully distributed into 5 grades according to their performance result rank, then the prizes and other rewards are issued according to employee's grade. In a multiple level prize structure, the total prize is split into 3 or more portions with different values, the higher the rank is, and the larger the portion is. Does the widely used multiple level prize structure in practice has higher motivation effect on the employees, comparing to a two-level prize structure?

Previous researchers (Ederer & Fehr, 2007; Ederer, 2010) have analyzed the effect of the feedback policy on effort of employees in tournament with two-level prize structure. They argue that the level of employees' effort is higher under full feedback policy than that under no feedback policy. Are these conclusions applicable for multi-person tournament with a multiple level prize structure?

These are the main issues that this thesis addresses by analyzing the effect of prize structure and feedback policy on effort in a multi-person tournament.

1.1.2 Research significance

The theoretical significance lies in the following three aspects. First of all, for a long time, the design of rank-order tournament and employee incentive mechanism was a hot topic for scholars. However, at present, some relevant research on prize structure only studies the prize gap between high prize and low prize and does not consider the prize structure into multiple

levels while others study the effect of different numbers and proportion of prizes on employee performance. There are few studies on the structure of multiple level prizes and no consistent conclusion has been reached. This thesis proposes to investigate both two-level prize and multiple level prize structures, which may be a useful supplement to the existing research.

Secondly, previous research has mainly interpreted the impact of prize structure or whether to win the prize or not on employees' efforts. However, this thesis adds two more situational mechanisms: supervisor feedback and employee risk preference. In the absence of supervisor feedback the effects of prize structure on employee effort and performance were examined as well as different risk preferences of employees. The analysis of different situations leads to more useful and novel conclusions.

Finally, the research of this thesis may also enrich the tournament theory. The research results of tournament theory in foreign countries are abundant and have been mainly used in the mature Western context. However, there are few studies on the relationship between different prize structures and employees' efforts in China. In addition, few scholars have compared the effect of multiple level prize structure and two-level prize structure on employees' efforts. Therefore, this study makes up for the shortcomings of the existing research through the experimental analysis and case study in terms of the impact of prize structure and supervisor feedback on employees' efforts.

1.2 Research framework and main contents

1.2.1 Research framework

The first step is to define the research problem extracted, for relevance, from real managerial practice, then introduce the dilemma managers meet when setting up a performance appraisal system under a rank-order tournament context.

The next step is literature review. The research on basic of tournament theory is reviewed, and its comparison with other incentive mechanisms and its extended research. Then the literature on previous research of prize structure on effort and feedback policy has been reviewed. Comments on previous studies, including the shortcomings and further study opportunities on this subject are also provided. After the literature review, hypotheses are raised, including prize structure effect on effort and feedback policy effect on effort.

Once the hypotheses are set, an experiment is designed and conducted to investigate the

influence of prize structure and feedback policy on effort. To understand the thought of subjects behind their behavior in the experiment, we conducted focus group interview with 6 subjects.

After conducting the experiment, the data collected from the experiment are analyzed using SPSS to validate the hypotheses.

According to the findings of the experiment, a case study is conducted and a questionnaire administered to clarify the findings. The last Chapter of the thesis is the discussion and conclusion. Figure 1-3 below presents the Research Framework.

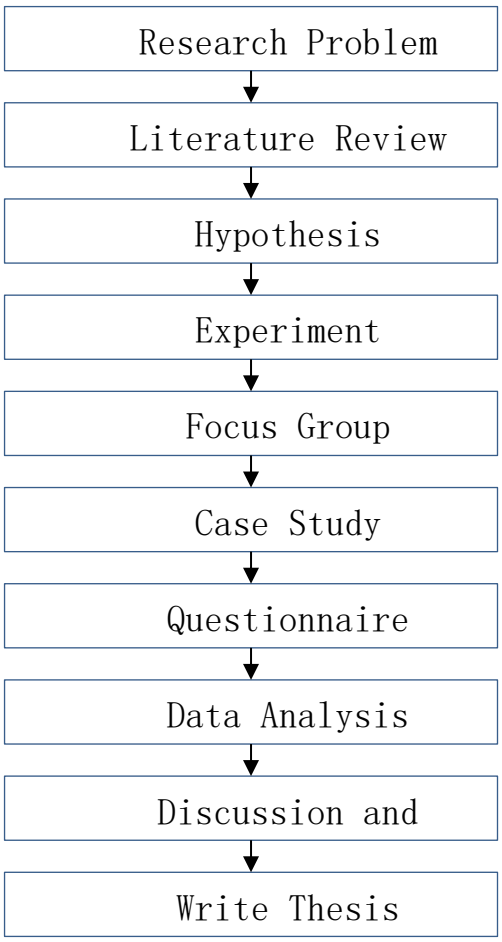

Figure 1-3 Research Framework

1.2.2 Main contents

In chapter 1, the research background and significance are introduced, followed by the research framework and main contents.

In chapter 2, the literature about tournament theory is reviewed, including the basics of tournament theory, comparison of tournament and other incentive mechanisms, tournament extended to research in management, labor economics, sport management and marketing. After

that, we review the literature about the effect of prize structure on effort, the effect of feedback policy on effort, risk-taking and effort exerting. Based on the literature review, the shortcomings and research opportunities are raised, then four hypotheses about prize structure and four hypotheses about feedback policy are proposed.

In chapter 3, the research methods of this thesis are introduced. In the section concerning the experiment, the tournament model with two scenarios will be presented first, then the experiment design will be introduced in detail, as well as the on-line program design and experiment implementation procedures. In the focus group interview section, the participant recruitment, preparation and implementation procedures will be presented. In the third section, quantitative data analysis methods will be explained, including statistical software, graph techniques and statistical test tools.

In chapter 4, the data from the experiment and focus group interview will be analyzed to validate the 8 hypotheses, including the test of prize structure effect on effort, test of feedback policy effect on effort and the result analysis of focus group interview.

In chapter 5, a case study of R factory in China is conducted to better understand the findings of the experiment. The levels of performance management in terms of prize structure and feedback are investigated: one level concerns the department managers, and the other level the workshop workers. Questionnaires are issued to the employees involved in the two levels of performance management, followed by data analysis.

Chapter 6 provides discussion, conclusions and limitation of this thesis, as well as proposal sfor further research.

1.3 Main contributions

When tournament was extended from the two-player model to multiple players model, researchers usually follow the simplified two-level prize structure in the two players model as per Lazear and Rosen (1981), examine prize differential increase with player number (McLaughlin, 1988) and the single prize structure in which the winner takes all prizes and the rest has no prize, or the proportion of winners in a multi-person tournament varies, for example 1/6, 1/3, 1/2, 2/3 or 5/6 agents win high prize (Harbring & Irlenbusch, 2003; Orrison, Schotter, & Weigelt, 2004; Harbring & Irlenbusch, 2008; Freeman & Alexander, 2010; Zeng & Yan, 2010). Few researchers have studied multiple level prize structure in multi-person tournament.

This thesis examines the effect of prize structure and feedback policy on effort in multi-

person and long-run tournament. Multiple level prize structure applies when the prize is split into 3 or more portions with different values, for example, in arithmetic progression. An example is when the prizes are set as 2.4, 1.8, 1.2 and 0.6 for 4-person tournament. The focus of this thesis is to investigate the effect of a multiple level prize structure on employees' effort compared to a two-level prize structure regardless whether there is feedback from agents on own and opponents' performance or not. This may contribute to the development of the tournament theory in terms of prize structure.

Chapter 2: Literature Review

In order to understand the research status of the effect of prize structure and feedback policy on employee effort, we reviewed the development of tournament theory in the past 39 years in China and all over the world, including its fundamentals, extensions, applications in management, labor economics, sports and marketing. After that, previous research of prize structure and employee effort, feedback policy and employee effort, risk-taking and effort exerting are discussed in detail.

2.1 Review of literature on tournament theory

2.1.1 The basics of tournament theory

Tournament theory is a theory on incentive mechanisms in the principal-agent relationship which is based on the comparison of individual relative performance. In the tournament mechanism, each employee's income depends only on his ranking among all agents, and has nothing to do with his absolute performance. Under the condition that the agent's performance is relevant, the tournament system can remove more uncertain factors, so that the principal's judgment of the agent's level of effort is more accurate, reducing the risk cost and strengthening the incentive mechanism.

Lazear and Rosen (1981) pioneered the research on relative performance with their seminal work on tournament theory, where they analyze the basic model of rank order tournament with two risk-neutral workers. Worker’s output (q) depends on his/her investment u and a random component (ε), $q = u + \varepsilon$. The employer may observe the worker’s output but cannot discover which one is due to worker’s investment and which one is due to good fortune, or both. The workers know their input and output. Besides piece rates, another payment scheme is to compare the output of two workers, and pay the winner a fixed prize W_1, pay the loser a fixed prize W_2, whereby $W_1 > W_2$. Their research proves that the agent's level of effort depends on the pay gap between the winner and the loser. The effort increases as the pay gap increases. In addition, by comparing the piece rate and tournament systems, they found that the wages based upon rank induce the same efficient allocation of resources as the one based on individual output levels. Under some circumstances, risk-averse employees are actually more willing to be paid on the basis of rank.

A key point behind the tournament theory is that there are clear winners and losers. The win percentage is a function of the actor's own willingness and the tournament size, which is determined by its breadth (the number of unique competitors) and its depth (the number of possible levels). The arguments for victory and defeat assume the existence of rational economic actors who pursue the maximization of personal utility, with reward as the main motivation. In addition to hard work, the probability of each actor winning is also an irreducible random factor, such as the weather in sports games, prejudice in legal games, and unexpected discoveries in innovative games.

Tournaments can be viewed as a competition in which players compete for a prize based on relative rank and are designed to stimulate an optimal level of effort. The prize is optimal when it maximizes the productive output of all participants in the tournament (Lazear & Rosen, 1981; Knoeber, 1989; Knoeber & Thurman, 1994). If the prize spread is too small, the participants will not be incentivized to compete, which results in a decline in the total output of the tournament.

Following the introduction of this basic model, the theory of tournaments has developed rapidly. Researchers have extended the two-player model in different directions, and there are five important ways in which the theory has developed beyond this basic formulation. First, a critical extension of the theory that received early attention involves joining multiple participants. A player in a tournament competing with multiple players slightly increases his or her effort, the probability of winning increases, but decreases as the number of players increases. Therefore, the prize differential must be increased with the player number. Second, tournament theorists have begun to consider many aspects of actor heterogeneity. Tournament designers may account for contestant heterogeneity by forming sub-contests, wherein contestants compete with a more homogeneous subgroup (Gomezmejia, Trevino, & Mixon, 2009) or by handicapping, which increases the win percentage for disadvantaged actors (Pfeifer, 2011). Third, some expressions of the tournament theory challenge simplified assumptions that contestants operate independently (Main, Reilly, & Wade, 1993). In an interdependent environment, contestants can not only benefit from improving their own efforts to increase output, but also benefit from setting obstacles to the success of others, but the sabotage requires a certain cost. Fourth, some research has raised concerns about the importance of the tournament’s environment. In an environment where random factors such as luck or external shocks play an important role, companies should use larger prize differential to offset the effort-reducing effects of randomness. Last, scholars have extended this model to examine how value

functions change in sequential tournaments (Rosen, 1986). The ratio of prizes in sequential tournaments increases by level because the value functions include not only the higher prize at that level, but also the value of the possibility to compete for larger prizes at higher levels.

Many scholars have researched the theory of tournaments from different perspectives. For example, some literature discusses the design of the tournament system, mainly focusing on the impact of pay levels and pay gaps on performance output. Meanwhile, the tournament model has gradually expanded from the individual level to the organizational team level, and the team tournament mechanism has gradually become a research hotspot. Lazear and other scholars have compared and analyzed the differences between tournament theory and traditional theories such as piece rate and contract theory and concluded for the superiority of the tournament system. Table 2-1 below summarizes some key definitions involving the concept of tournament.

Table 2-1 Primary Constructs

Construct	Description	Pertinent Citations
Tournament	A contest wherein actors compete for a prize that is awarded based on relative rank.	Lazear and Rosen, 1981 Rosen, 1986
Prize	Reward for tournament winner(s) designed to incent the effort of all contestants. This may be monetary or have monetary value attached to it, but it could also be about prestige, privilege, or the possibility of competing in successive tournaments.	Knoeber and Thurman, 1994 Moldovanu, Sela, 2001
Prize Structure	Including prize gap, the proportion of winners, the number of prize level and so on to set the prize in the tournament	Beaker and Huselid, 1992 Harbring and Irlenbusch, 2003
Feedback	In a dynamic tournament, the supervisor informs the employee of the performance of the previous stage	Ederer, 2010 Gürtler and Harbing, 2010
Tournament size	The combination of a tournament's breadth (number of unique competitors) and depth (number of possible levels).	Boudreau, Lacetera and Lakhani, 2011
Win percentage	The likelihood that any given actor will win a prize. This is an important predictor of motivation.	Chen, Ham, and Lim, 2011
Actor heterogeneity	Differences among actors that could influence tournament variables and their final relative rank.	Bothner, Kang and Stuart, 2007

Sheremeta (2016) summarized prior research on tournament in the workplace, and listed the pros and cons. The pros include:

(1) Tournaments can create powerful competitive incentives, motivating individuals to exert effort levels well above those predicted by the rational decision-making model.

(2) Tournaments provide non-monetary incentives in the form of recognition and winning. When compared to other compensation schemes, tournaments may require less information about individual performance. Common shocks, such as stock market fluctuations, have less of an effect on tournament-based incentives.

(3) Tournaments play an important function of matching better workers to better jobs. In contrary, workplace tournaments have cons including: The win-or-lose structure of tournaments creates some winners at the expense of many losers, leading to substantial payoff inequality. In addition, relative incentives create a "discouragement effect," causing lower-ability workers to cut back effort or withdraw entirely from competition. Workers view each other as competitors when using relative incentives, resulting in more selfish and less helpful behavior.

(4) Tournaments may encourage counterproductive behaviors such as cheating, sabotage, and collusion. Women may be discouraged from participating in tournaments, even when they are more capable and have better skills than men. Therefore, Sheremeta (2016) suggested managers should exercise caution when adopting completive compensation schemes due to potentially significant negative workplace effects by taking below questions into account: (i) Are the workplace conditions are appropriate for using tournaments? (ii) How such conditions can be adjusted to mitigate any negative consequences?

2.1.2 Comparison of tournament and other incentive mechanisms

An important factor in the design of organizational strategy is how to motivate employees to meet organizational goals. Before the tournament mechanism was proposed, the original literature on incentives and contract design focused on a situation where a principal hired only one agent and rewarded him based on absolute performance. Prendergast (1999) believes that the appropriate approach is to evaluate the gap between the actual performance of an agent and the set goals. Deciding the salary and promotion according to the agent's marginal contribution makes the principal's decision-making relatively simple. But it also depends on whether the principal's monitoring of the agent is credible and whether the cost is manageable. When the cost is high and not necessarily reliable, the principal-agent cannot reach the optimal equilibrium. Therefore, relative performance evaluation is an effective way to solve this problem, and the tournament mechanism offers the possibility of a typical relative performance evaluation. For example, Huawei and GE both use mandatory relative performance evaluation

to eliminate a certain number of bottom-level employees every year.

Since the theory of tournament was put forward, Green and Stockey (1983) and other scholars have compared the tournament mechanism with other incentive mechanisms to prove its superiority. Based on a series of simplified assumptions, tournament theorists have shown that relatively hierarchical rewards are better than performance-based rewards because they can motivate a wider range of employees for promotion, rather than focusing on just one person.

Green and Stockey (1983) first compared the tournament mechanism with contract theory. They extend the Lazear and Rosen (1981) model to compare the efficiency of tournaments and optimal independent contracts for any number of agents. Their research shows that the tournament system can eliminate common uncertainties faced by agents, and when the number of agents is large enough, the tournament system is superior to contracts where everyone's income depends only on their own performance. This conclusion affirmed the tournament and aroused people's interest in the tournament mechanism.

Nalebuff and Stiglitz (1983) analyze the role of competitive compensation schemes in which pay depends on relative performance. They found that when environmental uncertainty is large, such schemes are shown to be preferable to individualistic reward structures.

Bull, Schotter, and Weigelt (1987) implemented a comparative experimental study of the piece rate and the tournament mechanism. Ten experiments were run employing 225 paid undergraduate student volunteers. Their findings basically support the theory of tournaments. However, the level of effort that the disadvantaged subjects paid exceeded expectations. At the same time, they found that for the piece rate, the behavior of the participants showed a large fluctuation in the tournament experiment. In summation, while the results were supportive of the theory of tournaments, quite a number of puzzles were raised.

Kräkel (2005) also compared the tournament mechanism with the piece rate system and found that the tournament mechanism can eliminate certain risks and have a stronger incentive for agents. Even when the cost function is a convex function and the piece-rate system has a better incentive effect on the agent, from the overall effect, the incentive effect of the tournament is stronger and the agent's level of effort is higher.

Tsoulouhas and Marinakis (2007) conducted a more in-depth study following Kräkel’s. They first analyzed the tournament mechanism and piece rate theory under limited and unlimited liability conditions, and then compared the two with graphics. The result shows that the optimal choice is different in different situations: when the company's liquidation value is small, the use of the tournament system will increase the risk of bankruptcy; on the contrary,

when the company's liquidation value is large, the tournament system is still the best choice. Budde (2007) compared the tournament with a fixed salary system with a hierarchical structure. It was found that on the premise that the agent is risk neutral, the tournament system has an advantage.

Yan, Zhou, and Li (2015) examined the effect of two different incentive contracts, tournament contract and fixed performance contract, on the effort level and income of heterogeneous agents through experimental research, and came to the following conclusion: generally speaking, the tournament contract can increase the effort level of employees more than fixed performance contract. On the other hand, employees are paid more under fixed performance contracts than under tournament contracts. Therefore, from the perspective of employers, the tournament contract based on relative performance comparison is a more ideal incentive mechanism.

However the tournament theory also faces challenges. Dye (1984) argues that potential "collusion", mutual sabotage or other forms of non-cooperative behavior will offset the incentive value of excessive pay gap. So, the tournament mechanism is not necessarily superior to other contract mechanism. Levy and Vulina (2004), for example, compared the incentive effects of different incentive mechanisms with the field data observed in a roast chicken shop, and concluded that replacing the tournament contract with a fixed performance contract did not reduce the welfare level of employees. Steven Wu and Brian Roe (2005) found in their study that under the assumption of homogeneous agents, those under fixed contracts have higher efforts and gains than under tournament contracts.

Many scholars have compared tournaments with traditional theories from different perspectives. Although the tournament system does not have advantages in some circumstances, generally speaking, the championship system urges agents to make more efforts and has a better incentive effect.

Compared with incentive contracts based on marginal output, tournaments have four potential benefits. First, compensation is based on the ranking of the agent's marginal output, rather than the specific marginal output, which is easier to rank than an accurate measure of marginal output, thus reducing costs. Secondly, the pay gap can encourage grassroot employees to participate in ranking competitions, improve incentive validity and reduce monitoring costs since participants are more concerned with beating their opponents rather than with their own absolute performance. Third, the prize in the tournament is determined in advance, which can reduce the moral hazard or opportunistic behavior of principals or supervisors, and increase the

credibility of the enterprise incentive commitment. Fourth, relative performance comparison can effectively eliminate the influence of external interference factors, reduce the additional risk of agents, and improve the accuracy of performance evaluation.

2.1.3 Extended research on tournament theory

2.1.3.1 Tournament theory in management research

Different types of tournaments often involve their own unique research questions, methods, and examination of relationships. Therefore, we organize the management literature around the following substantive areas concerning tournament theory.

(a) Promotion Tournaments

In recent years, scholars have turned their attention to employee groups and based on the occupational concerns of employees, how to design the optimal incentive contract for low-level employees has become an important part of the incentive theory. Baker, Jensen, and Murphy (1988) pointed out that promotion serves two purposes: resource allocation and incentives. Resource allocation refers to the promotion of matching employees with different abilities and positions with different requirements. Research on incentives and productivity in internal promotion competitions is less ubiquitous than that which explores pay structures. This may be because it is difficult to obtain accurate data on individual performance in many jobs, which is the attraction of the tournaments as a reward mechanism in the first place.

When employee output is hard to measure, output-based compensation contracts are hard to work, internal promotion is equivalent to competition among employees and an effective alternative to employee motivation. The theory assumes that promotion is determined by the relative performance of employees at a given job level, measured by a combination of objective and subjective assessments, and that employees' efforts increase as the magnitude of rewards associated with winning a game increases.

Pfeifer (2011) studied promotion competitions involving mixed gender and found that although women's promotion opportunities were not lower than men's, there were some negative barriers that required women to meet higher standards in recruitment and promotion. Greenwood and Empson (2003) examined promotion competitions in the "promotion or out" career system. This is unique because losers do not have a chance to compete in later competitions, but these authors found that promotion incentives still prove to be a powerful motivator for actors to strive. In contrast, O’Neill and O’Reilly (2010) examined sequential

tournaments in the form of careers and found that heterogeneity among tournament participants (in this case, MBA graduates) led to the success of better-equipped actors in the first few rounds, but effort was the more important factor in determining the success in subsequent rounds.

Many Chinese scholars have discussed promotion tournaments to explain China's local economic miracle since the reform and opening up. Since local officials are all motivated to be promoted to higher positions, if the upper government takes higher positions as a reward for economic development performance, then local officials will strive to get promoted by improving economic performance within their jurisdiction (Zhou, 2004a, 2007b). In other words, the incentive compatibility mechanism provided by promotion championships can solve the existing principal-agent problem between central and local governments (Whiting, 2017).

However, due to the externality of technology spillover, it is difficult for enterprises to carry out innovation and technology diffusion under the condition of pure market economy. Therefore, government intervention is necessary and based on the theory of the tournament mechanism, when the government is the principal and each enterprise is the agent, if the government can formulate appropriate reward mechanisms, then the innovation and technology diffusion of enterprises will become a tournament among enterprises. Through the "tournament mechanism", incentives under the model of innovation diffusion of enterprises are built, and effective measures are taken to stimulate technological innovation diffusion, so as to maintain the overall sustainable innovation ability (Zhao, Ding, & Feng, 2008).

Tong and Song (2012) and other scholars question however this view and consider that if the promotion tournament theory of local officials attempts to study the effect of local government governance on economic development in the transformation and emphasizes the positive role played by local officials in China's economic development, then this theory becomes an incentive mechanism abstracted from corporate practice. As a hierarchical organization of government, despite the similarities with enterprises, the observability, multitasking, and incomparability of government performance determine a unique government governance mechanism that is more complicated than an enterprise. It is questionable whether the tournament theory used to explain the competition between agents can be directly applied to explain the competition among government officials (Tong & Song, 2012).

(b) Innovation Contests

In today's world, companies from all walks of life need to innovate and evolve faster than ever before to stay ahead of the competition. Tournament theory has also been an appropriate framework for explaining the structure, design, and outcomes of innovation contests (Terwiesch

& Xu, 2008). Ideas, much like job performance, can be difficult to measure in absolute terms, and the generation and development of ideas are certainly difficult to monitor. Innovation contests are often used in the public and private sectors to generate new ideas to solve problems, create designs, and improve products or processes. In such a contest, a firm or an organization (the seeker) outsources an ideation task online to a distributed population of independent agents (solvers) in the form of an open call. Solvers compete to exert efforts and the one with the best solution wins a bounty. It is often important that actors seeking creative solutions to problems operate independently, potential for instrumentalism, or based on preconceptions of others. Taken together, these factors suggest that tournament theory possesses a suitable conceptual lens for examining innovative contests (Frick, 2003).

Innovation can bring considerable value return, which makes the enterprise pursue diligently, but also makes the enterprise confused because of its high uncertainty. Terwiesch et al. (2008) proposed that enterprises could use the method of "innovation contest" to manage the process of innovation. Like sports, "innovation contest" is a filter for weeding out a large number of low-level innovation initiatives, with only the most promising winning. Because it does not need the client to formulate strict contract and post-supervision, the problem of incomplete contract can largely avoid innovation contest, which is widely applied to the research and development of high-tech products. For example, China has held the national youth science and technology innovation competition over the years.

Morgan and Wang (2010) proposed a framework for managers to organize tournaments for idea rankings. They examined the theoretical underpinnings of tournaments, and then linked that analysis to three recent popular concepts - the power of the network, the wisdom of crowds, and the power of love - that can boost the effectiveness of tournaments, and describe how to organize an innovation contest that best matches the company's problems and goals.

Contests are a historically important and increasingly widespread mechanism for encouraging innovation. A core concern in design innovation competitions is how many competitors to recruit. Tournaments can yield more creative solutions when the goal is to create revolutionary ideas in situations where solutions are highly uncertain, and when companies use large prize differentials for winners and increase the number of participants. Conversely, when goals are more evolutionary, greater competition is associated with less effort on the part of participants, even though it increases the likelihood that at least one participant will find a solution (Boudreau, Lacetera, & Lakhani, 2011).

Zhang (2009) argued that if an industry-benchmark innovation can bring a considerable

difference in value compared to an average level of innovation in the industry, it is worth raising more candidates at the beginning of the innovation competition, even if it leads to a significant increase in costs. Conversely, it is not necessary to go after the number of alternatives and it' is important to keep an eye on the projects that have raised significant objections from the judges. The best ideas are more likely to attract sharply opposing reviews than the mediocre ones.

Although scholars tend to believe that tournament theory can properly explain innovation competition and the behavior of its participants, others believe that this differs significantly from typical tournament theory principles. For example, some have pointed out that innovators are often motivated by non-monetary rewards, such as recognition and self-satisfaction (Murray & O'Mahony, 2007).Others explain that championship competitions may not always be the most effective way to solve innovation problems. For example, Lakhani, Lifshitz-Assaf, and Tushman (2012) suggest that innovation tournaments are best suited to scenarios where knowledge of potential solutions is widely distributed but knowledge of preferred solutions is concentrated, and vice versa.

(c) Franchising

The increasing popularity and influence of franchising in the business field has attracted the attention of various researchers from management academic backgrounds (Combs, Michael, & Castrogiovanni, 2004). Brickley & Dark (1987) examined companies that franchise some uits and centrally operate (own) others. In the study, the agency problems faced by these two organizational forms are analyzed. The empirical results support the notion that the cost of monitoring store managers appears to be especially important in the own/franchise decision. If franchisees cut corners, they receive the immediate benefits of cost savings but share the long-term burden of disgruntled customers with the umbrella organization. Tournament theory proposes a solution to this problem, tournaments in franchising operations allow for a higher level of information asymmetry, as rewards are based on results rather than on process, and allow for less monitoring, because some monitoring is pushed to the level of multi-unit franchising (Norton, 2003).

There is evidence that faster-growing franchisors use multiunit franchising as a reward in a tournament to reduce agency problems (Gillis, et al., 2011). Franchisors cannot assess and control opportunism absent comparative information provided by owning and operating some of their outlets and by franchising others. Identifying and monitoring franchisees is costly and difficult to implement, so large rewards for multiple units can serve as an effective mechanism for optimizing and ranking franchisee efforts (Kidwell & Nygaard, 2011).

2.1.3.2 Labor economics

Labor economists have provided new insights by bringing the tournament theory into the field. For example, some use tournament theory to help describe why productivity usually peaks after individual promotions within a hierarchical organization. This is sometimes called the Peter Principle. (Peter & Hull, 1969). The Peter Principle is a conclusion drawn by Lawrence Peter, an American scholar, after studying the phenomena related to personnel promotion in organizations. In organizations it is customary to promote people who are competent to a certain level after which employees tend to be promoted to positions where they are incompetent. The Peter Principle suggests that there is a fundamental inefficiency in the process of ascension, that is, tournament participants are one level higher than they should be. Many people believe that the performance decline after promotion is due to the fact that individuals encounter an incompetent task, which makes their performance worse (Dilger, 2004; Lazear, 2004). Others, however, suggest that this effect is not due to an inability to perform at the final level of promotion and, instead, offer a tournament theory explanation proposing that participants reduce their efforts at their last level because they are not encouraged to compete for the next higher level (Barmby, Eberth, & Ma, 2011).

Similar to research on management, labor economists have found empirical support for tournament theory predictions about wage differentials and participants' efforts. Bognanno (2001) conducted a longitudinal sample survey of CEOs of more than 600 U.S. companies and found conditions similar to those of the championship, including high internal promotion rates and a widening pay gap with the increase in rank. The study also shows that chief executives receive huge rewards for promotions and their pay is partly determined by the level of the position. Another study by Baker, Gibbs, and Holmstrom (1993) showed that the extension of tenure leads to a decline in the real compensation of senior executives. Instead, the rewards for promotion increase as the level increases.

2.1.3.3 Sport management

Ehrenberg and Bognanno (1990) analyzed the data from the 1987 European Men's Professional Golf Association Tour and found that players' performance appears to vary positively with both the total money prizes awarded in the tournament and the marginal return to effort in the final rout. Sports events are the natural environment for testing championship theory, and sports management scholars have come up with nuances of their own. For example, sports management studies reveal the selection of the tournaments that athletes choose to participate in (Rhoads, 2007).

Lynch and Zax (2000) make a clear comparison between incentive theory and ranking theory in road race performances. Regression analysis of the runners' abilities showed that the faster the runners recorded the greater the losses they suffered when they fell below the pre-race rankings. However, the relationship between bonus risk and completion time weakens or disappears with these controls. The results strongly suggest that lucrative races produce faster times because they attract faster runners, not because they encourage all runners to run faster. Participants with better identification skills are more likely to choose those tournaments with the greatest prize spread.

Maloney and McCormick (2000) investigated the labor supply using the responses of 1,426 athletes to prizes in open walking competitions. First, there is an entry effect, where higher wages attract more highly skilled runners. Second, the gap between the bonuses motivated individual athletes to work harder. The second effect was detected across the sample, and the average performance of individuals was affected. The authors also studied the elasticity of supply between the sexes. As a group, women are more responsive to higher wages than men, both in terms of entry and personal effort. In addition, the greater the concentration of gold in the competition, the higher the level of effort. The authors found that the tournament nature of competition has an important incentive effect. Other sports management researchers add that gender may mitigate the motivational effects of the spread of rewards. Some have found that men seem to be more tempted by the spoils of war than women (Lallemand, Plasman, and Rycx, 2008). So women may not respond as strongly to bonuses, which increases performance differences among men.

Sports management researchers have also added to our understanding of risk-taking or aggressive behavior by participants in tournaments. Groothius, Groothius, and Rotthoff (2011) show that, in addition to the spread of prize money, future goals may influence the risk bias in the competition.

Some studies using data from racing have found support for the risk hypothesis that nonlinear rewards may be associated with more risky behaviors (Depken & Wilson, 2004; Schwarts, Isaacs, & Carilli, 2007). Management researchers may ask whether non-linear reward structures also increase risky employee behavior. In addition, Hood (2008) found in a study of golfers on the PGA tour that the inconsistencies created by playing to win (a risky behavior) were more beneficial when the gap in prize money was larger. In other words, if a contestant's performance is erratic, even if it is slightly below average, he is more likely to win. Organizational academics might investigate whether this also applies to individuals competing

for promotion, who are more likely to win when they engage in less consistent (and riskier) behavior, even if it results in lower average performance.

2.1.3.4 Marketing

For marketing professionals, tournament offers an easy, practical, and economical way to leverage large online communities for creative and innovative solutions. For instance, during the annual "Crash the Super Bowl", the company Frito-Lay invited consumers to create commercials for Doritos, promising that at least one of the ads would air during the Super Bowl. From 2006 to 2016, Frito-Lay received more than 36,000 applications, which helped it win repeatedly on the USA Today Ad Meter Poll a number of times. AT&T, Coca-Cola, and American Express all sponsor online creative contests to find innovative ideas for companies (Rathi, 2014). As another example, Treadless (www.treadless.com) built its entire business model in the competition for ideas. Every week, it receives about a thousand designs from an online community of artists. Ten of the works are selected as winning designs and then used to make clothing and other products.

Sales contests are often used by companies as short-term incentives to increase the efforts of their salespeople. Conceptually, the difference between a sales competition and a piecework plan (such as salary, commission, or quota) is that in a sales competition, the salesperson is paid based on the relative sales level, not the absolute sales level. Specifically, the purpose is to look at how many salespeople should be rewarded and how the rewards are distributed among winners. Three commonly used sales competition forms are studied. In the first form, known as a ranking match, there are many winners and the amount awarded is based on the relative ranking, with a larger amount awarded to the higher ranking. Two special cases of ranked tournaments were examined: a multi-winner model, where the prize is split evenly, and a winner-takes-it-all model, in which a single winner gets all the prizes. The results show that when there are more participants or the uncertainty of sales is greater, the work efficiency of the sales staff is lower and that the format of the ranking match is superior to the format of the multi-winner match (Kalra & Shi, 2001).

One way marketing researchers have contributed to tournament theory is by focusing on tournaments where individuals compete as part of a group. If the territories have imbalanced sales potential, scholars have studied how the optimal sales, the efforts of the sales staff and the profit change with the regional imbalance in the sales competition and they found that in competitions between teams of uneven quality (such as sales areas), participants in stronger groups exert just enough effort to match others effort, because they assume that the strength of

the group will secure a win (Syam, Hess, & Yang, 2012).

Another study of sales competitions among life insurance salespeople has shown that the use of rank-order leads to better short-term performance (Garrett & Gopalakrishna, 2010). However, using the sales race also reduces the emphasis on building long-term customer relationships and correspondingly increases the use of customer manipulation. Repeated competition exacerbates the problem because they force salespeople to deceive customers' expectations of service (Oliver & Anderson, 1994). This series of studies suggests that tournaments reward short-term achievements at the expense of long-term goals (Poujol & Tanner, 2009), which may have an impact on management research of corporate governance. Principals have varied time horizons, some prefer short-term performance, while others prefer long-term performance.

The development of tournament theory provides basic assumptions for empirical research: the widening of the pay gap can motivate agents to make greater efforts since the pay gap increases as the number of agents increases and the level of the organization increases. Likewise, the relationship between the size of the salary gap in the tournament mechanism and the agent's hard work is also of concern to scholars. The collection of empirical data to support these studies ranges from the indirect use of officially published data to the direct acquisition and investigation of detailed company records of employee careers. The research objects include sports, scientific research, the public sector, and enterprises.

Lambert, Larcker, and Weigelt (1993) selected 303 U.S. listed companies from the food, paper, chemical, machinery, electronics, transportation, equipment, and other industries as a sample to test the principal-agent theory and tournament mechanism in formulating managers' role in pay contracts. The results of the regression analysis on the data show that the tournament mechanism plays an important role in explaining management compensation.

2.2 Prize structure and employee effort

To review previous research of the effect of prize structure on employee effort, we check the literature from four aspects: pay gap, single prize, two-level prize and multiple level prize. Pay gap is the amount differential between the higher prize and the lower prize. Single prize is when the highest ranked player takes the whole prize while the other players have no prize. Two-level prize is when the winner takes the higher prize and the loser takes the lower prize in a two-person tournament, or some winners take the higher prize and the remaining players take

the lower prize in a multi-person tournament. Multiple level prize is when the prize level is more than two in a multi-person tournament, for example, in 4 person tournament, the player ranked at 1 takes $2.4, the player ranked at 2 takes $1.8, the player ranked at 3 takes $1.2 and the player ranked at 4 takes $0.6. By this classification, a two-level prize is considered when 3 players take an equal higher prize and 3 take an equal lower prize in a six person tournament, even if there are multiple prizes. In addition, single prize is a special two-level prize when the top performer is rewarded a large prize and the others have zero award.

2.2.1 Pay gap

Each year, medial organizations focus their attention on the apparently exorbitant salaries of CEOs who are considered to be overpaid, with special attention to those who seem to enrich themselves at the expense of other employees in the organization (Connelly, et al., 2011). Many studies have examined the gap in pay between the CEO and other senior management team members, between executives and other employees, and among employees at different levels of the organization.

The agency theory generally believes that reasonable compensation level and its structure can have an incentive effect on senior executives, which is mainly reflected in that it can significantly inhibit senior executives' slacking and free-riding behaviors (Jensen & Murphy, 1990). Beaker and Huselid (1992) drew on a panel data set from auto racing, and showed that the tournament spread (prize gap) does have incentive effects on both individual performance and driver safety. Furthermore, the tournament theory suggests that "significantly" different pay levels and their structure may encourage executives to be more diligent and conscientious in their efforts to win the "prize", which in turn may help improve company performance (Lin et al., 2003). McLaughlin (1988) derives optimum prize differentials with n players (n>2), arguing that prize differential must increase with n, to marginally increase players’ effort.

Despite reasonably consistent support for the main predictions of tournament theory, management scholars have also proposed some important boundary conditions. For example, while tournaments with large prize differentials can inspire more effort, they may also promote counterproductive behavior (Henderson & Fredrickson, 2001). Others point out that in the final level of the tournament, excessive pay gaps can have adverse side effects, such as reduced teamwork and poor decision-making in the top management team (Hayward & Hambrick, 1997).

Audas et al. (2004) used the cross-sectional data of managers' remuneration of a British

financial company to study the promotion tournament and proved that the agent's effort level would increase with the increase of the pay gap, but this does not mean that the larger the pay gap, the better. Orrison, Schotter, and Weigelt (1997) proved that, in their sample, when the pay gap was too large, the participants' effort level would decrease instead suggesting that there should be an optimal pay gap that maximizes the agent's effort. Lin et al. (2013) studied the salary data of managers in some enterprises in Taiwan from 2002 to 2004 and found that there was indeed an optimal pay gap, and that it was different between non-high-tech and high-tech enterprises. The optimal pay gap of non-high-tech enterprises was higher than that of high-tech enterprises.

The rationalization of the pay gap between executives and employees can stimulate the enthusiasm of both, make them pay more efforts on their work, and then improve the performance of the enterprise (She & Cai，2017). Main et al. (1993) investigated more than 200 firms and over 2000 executives per year over a 5-year period and found that contestants may benefit not only from increasing their effort but also from reducing others' productivity which is called sabotage. In turn Lazear (1998) suggested that prize differentials should be reduced when players exhibit uncooperative behavior.

Humphreys and Frick (2019) tested the predictions of tournament theory by race-level data set from the National Association for Stock Car Racing. The empirical study result supports that the larger the spread in prizes paid in the race, the higher the average speed in the race.

In fact, an unreasonable salary gap will make employees feel unfairly treated thus failing to give play to the incentive function of the compensation system, which will have a negative impact on the company's performance. Therefore, enterprises should consider the nature of the company, the level of development in the region, as well as equity, to develop incentive systems and promotion policies. Only in this way can enterprises fully stimulate the incentive effect of the pay gap and effectively avoid its negative impact.

The tournament creates a competitive environment, and the pay gap is a motivation to provide incentives. Therefore, when designing the tournament, the pay gap needs to be designed to motivate agents to work hard. With the deepening of related research, the incentive effect of the pay gap has gradually attracted widespread attention in the academic community. The relationship between the design of the prize structure and the employee efforts has been a focus of attention.

In addition to the pay gap, there is another important factor to consider when designing the incentive mechanism of the tournament. The structure of the tournament refers to the

proportion of the winners in the contest. As detailed below, many scholars have studied the impact of different tournament structures on the level of agent effort, and their conclusions can be roughly divided into two camps.

2.2.2 Single prize

Krishna and Morgan (1998) analyzed the optimal prize structure in small tournaments through a mathematical model. Their analysis results show that the winner-take-all is optimal for 2 or 3 competing workers regardless of risk preferences. In a four workers tournament, the optimal prize structure is that the winner and the runner-up (ranked at 2) share the prize, and the winner's share should be greater than the runner up. In case the four workers are risk-neutral, an optimal tournament is the winner-take-all. Krishna and Morgan do not analyze further on prize structure if there are five, six or even more workers. In addition, their propositions need to be further studied by empirical research.

Shupp et al. (2013) designed a within-subject experiment to compare individuals' decisions across three resource allocation contests. In the single-prize contest, only one out of four subjects in the group receives a prize of $72. In the multiple prize contest, each subject could win one, two, or all three prizes, each worth $24. While in the proportional-prize contest, the subjects within a group receive a share of a $72 prize, the share of the prize received by each subject equaled the proportion of his/her tickets (effort) relative to those of the entire group. The results indicate that, in aggregate the single-prize contest generates lower expenditures (effort) than either the proportional-prize or the multi-prize contest. Individual level analysis indicates that the behavior in the single-prize contest is more similar to the behavior in the multi-prize contest than in the proportional-prize contest.

Büyükboyacı (2016) compared a designer's profits from a standard winner-take all tournament and two winner-take-all (parallel) tournaments. The mathematical model shows that the designer's profit is higher (lower) in the parallel tournament when contestants' abilities differ greatly (are similar). In addition, the experiment results show that the parallel tournament is more profitable under high heterogeneity, while when the contestants are under low heterogeneity, the single-prize tournament is optimal. His analysis focuses on designer's profit, but not contestants' effort.

Cason, Masters, and Sheremeta (2018) compared three types of contests by theoretical analysis and laboratory experiment: (i) the winner-take-all contest (we define it as single prize), (ii) the winner-take-all lotteries where the probability of success is proportional to performance,

and (iii) proportional-prize contests in which rewards are shared in proportion to performance. Equilibrium and observed efforts in experiment are the highest in winner-take-all contests. Lotteries and proportional-prize contests have the same Nash equilibrium but, empirically, lotteries induce higher efforts.

2.2.3 Two-level prize

More than one hundred years ago, Galton (1902) suggested to split a fixed prize into two separate prizes, the most suitable proportion between the value of first and second prizes is 3 to 1, in order to maximize the total effort in contest.

Harbring and Irlenbusch (2003) experimentally investigated the effort of the agent with different prize structure following six treatments: HL - High/Low - (tournament size is 2, 1 receives high prize of M=150 and 1 receives low prize of m=50), H2L, 2HL, 2H4L, 3H3L, 4H2L respectively. They found that the average effort varies systematically with the proportion of winner prizes and that the highest effort happens in treatment of 4H2L. In the case where the winning ratio is 1/2 and 2/3, the average effort of the agent is higher than that in the case where the winning ratio is 1/3. This also shows that a higher winning percentage can incentivize agents to put in more effort to some extent. However, there is a concern with this study. The total price budget in every treatment is different, for example, in the 2H4L treatment, the total prize budget is 500 (150*2+50*4), while it is 600 in 3H3L and 700 in 4H2L. Why is it the highest in the 4H2L treatment? Is this caused by prize structure setting, or by higher total prize budget, or mixed reasons?

In turn, Zeng and Yan (2010) compared the effort level through an experiment in China. In their case, the tournament size is four, 2 subjects receive a high prize and 2 receive a low prize in experiment 1, while 1 subject receives a high prize and 3 receive a low prize in experiment 3. The result shows that the subjects' average effort level is higher in experiment 1 than that in experiment 3, so the authors argue that the average effort increases with the higher proportion of winner prizes. However, the total prize budget in experiment 1 is 6.52 Yuan (2.4*2+0.86*2), 30% higher than that in experiment 3 at 4.98 Yuan (2.4+0.86*3), making it hard to distinguish if the effort is caused by a different prize structure or by a different total prize budget.

Other studies have reached the opposite conclusion. Fehr and Falk (2002), for example, found that the agent's behavior was more determined by the proportion of awards, that is: the smaller the proportion of awards, the more likely the agent was to increase his level of effort.

Orrison et al. (2004) performed a multi-person tournament experiment, but got different results from those presented by Harbring and Irlenbusch (2003). The average effort in experiment 3M-3m (tournament size is six, 3 subjects receive high prize at M=$2.04 and 3 subjects receive low prize at m=$0.86) is similar to the effort in experiment 2M-4m. Surprisingly, the average effort in experiment 4M-2m is considerably lower than that in 3M-3m and 2M-4m. The authors explain when there is a high percentage of large prizes, subjects tend to shirk, and speculate that some subjects may not sufficiently recognize the difference between the marginal and total probabilities of winning. Their research shows that, for an optimal tournament structure, the percentage of winners should be minimized, as long as the individual participation constraint is maintained, as long as the number of possible promotions does not lead the agent to withdraw from the tournament or provide no effort. In addition, a leaner organizational pyramid structure seems to better motivate agents. It is noticed that the effort deviation of experiment 4M-2m is about 3 times higher than that in the other two experiments, which may be due to the fact that some subjects choose very low effort numbers in experiment 4M-2m, thus causing the average effort to be lower. If this is the fact, this experiment corroborates the study result presented by Schmidt et al. (2001) according to which four basic elements affect the behavior in an experiment, including player types.

Harbring and Irlenbusch (2008) have also experimentally tested the predictive power of a tournament model. In tournaments with four subjects, the average effort of 2m2M (2 subjects receive low prize of m, and 2 receive high prize of M) is significantly higher than that of 1m3M, while average effort of 1m3M is higher than that of 3m1M. In tournaments with eight subjects, the result is the same regarding the fraction of winner prizes. Therefore, they suggest that a balanced fraction of winner and loser prizes seems to particularly enhance productive activities.

2.2.4 Multiple level prize

The aforementioned studies focus on prize structure with different winner fraction, like 1/4, 1/3, 1/2, 2/3, 3/4. There are only two prize levels, one is a high prize, and the other is a low prize. As a matter of fact, there are more prize levels in the real world like, for example, the gold medal, silver medal and copper medal in sports competition. If managers in organizations rank employees into 5 grades during annual performance appraisal, how about the agents' effort level in a multi-level prize structure versus a two-level prize structure? Freeman et al. (2010) examined behavior in a tournament with three prize structures by means of a real effort experiment. Within a fixed prize budget of $30, an equal prize treatment gave each participant

$5 regardless of performance; a single prize treatment gave $30 to the top scorer and nothing to the other 5 participants; a multiple prize treatment gave multiple and differentiated prizes by their performance rank, including $15, $7, $5, $2, $1 and 0. The results show that the output in a multiple prize treatment is higher than that in a single prize treatment. The output in equal prize treatment is the lowest one. Then the authors argue that multiple prizes elicited more effort than a single prize or equal prizes.

This study does not answer the above question (If managers in organization rank employees into 5 grades during annual performance appraisal, how about the agents' effort level in a multi-level prize structure versus two-level prize structure?) since the authors compared efforts in a multiple level prize structure and in a single prize structure that the top winner takes all prize. According to the studies of Harbring and Irlenbusch (2003), Harbring and Irlenbusch (2008), Zeng and Yan (2010), under the condition of a lower proportion of winner prizes, the average effort is lower, while a higher effort is associated with a higher winner proportion condition or balanced fraction of winner and loser prizes. Therefore, on top of existing studies, it is necessary to further study the behavior in multiple level prize structure tournament versus two-level prize structure tournament of balanced fraction of winner and loser prizes, which represents the best scheme in terms of effort maximization.

Kalra and Shi (2001) analyzed optimal sales contests design from a theoretical perspective. The contest includes three formats. In a rank-order tournament, there are many winners and the amount of the prize is based on relative rank, with larger amounts awarded to higher ranks. This format is the one we define as multiple level prize. In multiple-winners format, the prize is shared by the winners equally. This format is the one we define as two-level prize. The last one is winner-take-all format, where a single winner gets all the prize. This format is the one we define as single prize. They assume the sales revenue follow either a logistic or uniform distribution, and conclude that the optimal design is different between these 2 distributions. When the sales revenue is logistically distributed, the total number of winners should not exceed half the number of the contestants. The half salespeople who are ranked lower should not be given any prize. For the half salespeople who are ranked higher, the rank-order tournament format (multiple level prize) is superior to the multiple-winner format (two-level prize) for salesperson's effort maximization. When the sales revenue is normally distributed, the winner-take-all format (single prize) is optimal. If the winner-take-all format does not meet the participation constraint, they recommend offering a big reward to the top one and a small reward to many others to ensure that they participate. Kalra and Shi analyze this subject by using a

mathematical model analysis without an empirical study and their propositions need to be further studied.

Dutcher et al. (2015) compared the effect of prize structure on effort by means of a laboratory experiment. The experiment follows a 3 × 2 between-subjects design covering three tournament mechanisms: reward-only (REW), punishment-only (PUN) and reward and punishment (R&P), and two group sizes: n = 3 and n = 6. In the treatments of 3 subjects, prize amount of top, middle and bottom ranked subject in REW are 132, 44 and 44 respectively, in PUN are 102.67, 102.67 and 14.67 respectively, in R&P are 117.33, 73.33 and 29.33 respectively. In the treatment of 6 subjects, prize amount from top ranked to bottom ranked subjects in REW are respectively 146.67, 58.67 × 5 (the 5 lower ranked subjects receive the same prize at 58.67), in PUN are 88 × 5, 0, in R&P are 117.33, 73.33 × 4, 29.33. The experiment results show that the effort in punishment-only treatment is significantly higher than that in the reward-only treatment when the group size is 3, and the efforts in punishment-only and in reward-only treatments have no significant difference when the group size is 6. In the meanwhile, the effort in the reward and punishment treatment is significantly higher than that in the reward-only treatment and has no significant difference to the punishment-only treatment when the group size is 3. When the group size is 6, the effort in reward and punishment treatment is significantly higher than that in reward-only or punishment-only treatments.

We can interpret Dutcher et al.'s study from another view in terms of prize level. The prize structures in reward-only and punishment-only treatments are both two-level prize while the prize structure in the reward and punishment treatment is a special multiple level prize (specifically it is three level prize). Then their study result is that the effort in multiple level prize is higher than that in a two-level prize structure. However, this comparison between multiple level prize and two-level prize is not typical, because the multiple level prize is imperfect when group size is 6, at the 4 subjects ranked from 2 to 5 receive the same prize at 77.33. In addition, the two-level prize in their experiment is not balanced structure which elicits higher effort among all the two-level prize structure mixes according to Orrison et al.'s study (2004) and Harbring et al.'s (2008). Therefore, the comparison of efforts by multiple level prize and two-level prize structure needs to be studied further.

Balafoutas et al. (2017) analyzed the optimal allocation of prizes in tournaments of heterogeneous agents by mathematical model analysis. They show that while multiple prize allocation rules are equivalent when agents are symmetric in their ability, the equivalence is broken in the presence of heterogeneity. Under a wide range of conditions, loser-prize

tournaments, that is, tournaments that award a low prize to relatively few bottom performers, are optimal for the firm. The reason is that low-ability agents are discouraged less in such tournaments, as compared to winner-prize tournaments awarding a high prize to few top performers, and hence can be compensated less to meet their participation constraints. However, the propositions need to be further validated by empirical research.

Andersson, Holm, and Wengström (2020) conducted an experiment to study the degree of effort and the spread of effort in different prize structure conditions. They designed a tournament experiment with 3 subjects in each group. There are 4 prize schemes with the same total prize sum at 360 Danish crowns. In WTA (winner-take-all, we define it as single prize) scheme, the first prize is 360, and the second and third prize are both 0; In SL (single loser) scheme, the first and second prize are both 180, and the third prize is 0; In SFAS (something for all small differences, we define it as multiple level prize) scheme, the first, second and third prize are 150, 120 and 90 respectively; finally, in SFAL (something for all large differences, multiple level prize) scheme, the first, second and third prize are 210, 120 and 30 respectively. A total of 237 subjects have participated in 12 sessions (3 sessions for each of the 4 prize schemes). In each session type, the subjects play all the 4 schemes. There are 4 session types with different order of 4 schemes and the subjects play 5 rounds of each of the 4 prize schemes, so this is both a between-subject and a within-subject experiment. In each trial, each subject needs to choose both effort and spread of effort in the simulated game of firing an old cannon.

The experiment results show that there is no significant difference in terms of effort between WTA (winner-take-all), SL (single loser) and SFAL (something for all large differences) prize schemes, but the effort in SFAS (something for all small differences) prize scheme is significantly lower than in other schemes. They explain that either the prize structure gets too ‘flat’ in the SFAS scheme, or the subjects are satisfied with the fact that the loser’s payoff in SFAS is higher than in other schemes. The other finding from the experiment is that the spread of effort in WTA (winner-take-all, single prize) scheme is significantly higher than in other schemes. Therefore, the conclusion is that the employee effort in a multiple level prize structure is not higher than that in a single prize (WTA) or in a two-level prize structure (SL), or even lower (SFAS). This conclusion is different from the conclusion Freeman et al.’s (2010) conclusion that the effort in a multiple level scheme is higher. It is noticed that the tournament size is different between Andersson’s and Freeman’s experiments. The tournament size in Freeman’s experiment is 6, while it is 3 in Andersson’s experiment. We suspect that the

difference in tournaments causes different results and propose that this needs to be studied further.

2.3 Feedback policy and employee effort

Previous studies on tournament mechanisms have focused on static environments, where the interaction among participants is not obvious, because the level of effort is fixed and determined in advance. However, in reality, tournaments tend to be played over a long period of time, so tournament mechanisms have typical multi-stage dynamic characteristics in nature (Ederer, 2010). For example, it often takes years or more for employees to move up the corporate ladder, and sports competitions also have different stages. Moreover, in a dynamic tournament, the interaction among the subjects is more obvious, and the level of effort of the subjects will make appropriate adjustments according to the behaviors of the competitors.

In dynamic tournaments, the agent's game is not static, but a process of repeated games. Since the dynamic tournament has the characteristics of information sharing and happens at stages, at the end of each stage, agents will receive relevant performance ranking information about the tournament, so as to adjust their behaviors in the subsequent stages to increase the probability of winning.

Ederer (2010) studied a two-period dynamic tournament model with two scenarios, no-feedback and full-feedback. He proposes that when the output difference of the first period result is revealed, the expected effort in the second period is lower than when information is not revealed if the marginal cost of effort is convex, while the reverse inequality holds if the marginal cost of effort is concave. Through the analysis of the participants' mid-term strategy selection in the tournament, Ederer found that the experiment would be affected by the incentive effect and the evaluation effect. When the ability and effort of the subjects are complementary, information sharing can make the subjects clear about their relative performance ranking and relative output value. Therefore, if the ability of the subject is insufficient to improve the level of effort to affect the marginal benefit, the subject will adjust its subsequent strategy according to its effort cost.

Ederer and Fehr (2007) investigated the behavior of agents in a dynamic tournament under three conditions: no feedback, truthful feedback and when the principal has the opportunity to provide wrong feedback. The mathematical model analysis and experiment result show that both no feedback and truthful feedback are better for incentives than biased feedback. Denter

and Sisak (2015) also show that if marginal efforts are concave the effort may increase with revelation. Ederer (2009) further proposes that if the noise difference has a uniform distribution, then the first period efforts and expected outputs are higher under a feedback scenario than under a non-feedback scenario. The expected output sum of the two agents in the second period is higher when information is revealed than under a no-feedback scenario. He investigated this subject by means of a mathematical model analysis without an empirical study.

Gürtler and Harbing (2010) experimentally analyzed the principal and agents' behavior in the situation that one agent leads over the other before entering the tournament, that is the two agents respectively receive a start number $\theta \in \{-80, -60, -40, -20, 0, 20, 40, 60, 80\}$ to create possibly intermediate performance differences. In a creditable treatment, the principal always tells the agents true information of the difference while in a non-creditable treatment, the principal imposes. The experiment result shows that the average effort is highest when the start number is 0, while it is the lowest when the absolute value of the start number is 80. Then the authors summarized their findings: if intermediate information is revealed, the effort increases with the decreasing absolute value of the start number, while if the intermediate information is concealed, the effort is higher in the non-creditable treatment than in the creditable treatment. Therefore they suggest that the principal should reveal information if the asymmetry is not too large at the beginning of the tournament.

Berger and Pope (2011) conducted a real effort experiment to analyze the effort in the second period under three different feedback conditions after the first period: (i) the participants are informed that they are 1 point behind their competitor; (ii) they are informed that they are 1 point ahead; and (iii) they receive no feedback. The result shows that the effort increases significantly under the condition of participants being informed that they are 1 point behind. Efforts in the second period under the other two conditions also increase but less than under the slightly behind condition. Therefore, the authors argue that being slightly behind drives participants to exert more effort than those who are slightly ahead or who have received no feedback. This finding has important implications for incentive design. However, Berger and Pope limited the first period output at 1 point behind or 1 point ahead. If the difference is 2 points, 3 points, 4 points, or even larger in the first period tournament, what would the trend of effort in the second period be? In this area, existing studies leave space to study further.

Yan et al. (2015) analyzed agent's effort and sabotage in a dynamic tournament by real effort experiment in China. At the beginning of the experiment, a data relation sheet is issued to each subject. There are 10 groups of data including two variables and corresponding stock

prize in the sheet. In the experiment, the subjects are required to estimate the stock prize according to the value of two variables provided, as well as the data relation sheet. The assumption in the experiment is that the smaller the gap between estimated prize and standard prize, the more the effort the subject puts. Each treatment in the experiment consists of 10 rounds. There are 2 stages in each round, the final output in each round is the sum of the outputs in the 2 stages. In treatment 1, the results of own prize gap and the results of the opponent in stage 1 are not published. On the contrary, this information in stage 1 is published in treatment 2. According to the experiment result, the efforts in treatment 2 is significantly higher than that in treatment 1. Therefore the authors argue that publishing periodic performance information could exert agent's effort, and increase final output. However, the assumption of this study is that the subject's estimated prize gap to the standard prize has an absolute positive correlation with the subject's effort. Actually, according to the expectancy theory, the performance result is not only caused by effort, but also by other factors like individual ability, carefulness and mood. In addition, this between-subject experiment introduce another hidden factor of subject type in different groups.

Berger, Libby, and Webb (2018) examined the effects of a tournament horizon and the percentage of winners on efforts by means of a laboratory experiment. The tournament horizon means the duration of the tournament, including repeated and grand tournaments. Repeated tournaments tend to be short with no performance carry-over from one competition session to the next, while grand tournaments are longer with outcomes based on cumulative performance. They have set a low and a high percentage of winners at 20% and 50% respectively. They implement a 2 × 2 between experiments with a total of 400 undergraduate students working on an effort-sensitive decoding task. There are 10 subjects in each group competing for cash rewards. The total reward pool is held constant at $60 across conditions. The repeated tournament consists of 6 competitions with 4 minutes for each competition, while the grand tournament has only 1 competition lasting 24 minutes. The feedback interval in both repeated and grand tournaments is every 2 minutes. The feedback content in the repeated tournament is current period performance, rank and win/lose outcome, while the feedback content in the grand tournament is cumulative (total) performance and cumulative rank. The experiment showed that a higher percentage of winners results in a better performance than a lower percentage of winners. In turn, the grand tournament results in a better performance than the repeated tournament because the performance feedback provided to competitors is more indicative of the likelihood of future period outcomes. They have also introduced a social comparison into

the study model. The behavior in the tournament setting appears to be sensitive to the type of relative performance feedback provided. In their 20% win condition, when the relative performance feedback is provided, only for competition in a repeated tournament, the cumulative performance feedback provided in a grand tournament results in more social comparisons, which in turn has a positive effect on effort. Theauthors suggest that further research is needed to address this issue with various feedback types.

Jiang and Wang (2020) developed a game-theoretic model of feedback in unbind ideation contests, where solver's solutions and seeker's feedback are publicly visible by all. The results show that feedback plays an informative role in mitigating the information asymmetry between the seeker and solvers, thereby inducing solvers to exert more effort in the contest. The authors show that moderating feedback stimulates the intensity of participation. Through two longitudinal experiments using a commercial innovation tournament platform, Camacho et al. (2019) also show that moderating feedback stimulates participation intensity. They find that negative feedback increases participation intensity, as compared to both no feedback and positive feedback. Moreover, negative feedback, either provided in isolation or together with positive feedback, is more effective in the early stages of the tournament than in the later stages.

In addition, some scholars have found that feedback is not efficient at all times and it will be affected by some regulatory variables. Aoyagi (2010) studied the problem of information revelation in a multi-stage tournament and discovered that the optimal information policy is associated with the marginal cost of effort of the agent. When the marginal cost of an agent is strictly a convex function, it can achieve perfect Bayesian equilibrium when of a no information feedback. Conversely, when the agent's marginal cost of effort is a concave function, the optimal strategy is to provide the agent with complete information feedback. The principal controls the agent's efforts by using a feedback strategy that converts the agent's private information into public notice. The optimal feedback strategy is the strategy that maximizes the agent's expected effort.

Goltsman and Mukherjee (2011) argue that the optimal information feedback strategy is related to the general performance of employees. Although phased performance information feedback can improve the level of effort in the last stage, it may inhibit the effort level in the middle stage. Therefore, when the performance of employees is generally poor, information feedback can effectively improve the effort level of agents. When the performance of employees is good, it is better not to feedback information to agents.

Newman and Tafkov (2014) investigated the effect of relative performance information

feedback on performance in 2 different prize structures by a 2×2 experiment. They considered two variables, one is relative performance information feedback with 2 levels (present and absent), the other is prize structure with 2 levels (reward top performer only, reward top performer and punish bottom performer). They found that relative performance information has a negative effect on performance in the tournament that rewards the top performer only, but a positive effect in a tournament that both rewards the top performer and punishes the bottom performer. As a result, overall performance is greatest when relative performance information is present in a tournament that both rewards the top performer and punishes the bottom performer. In Newman and Tafkow's model, the tournament is not a typical one. When the subjects (act as production manager) choose a decision number from 1 to 20, the number does not represent effort, but production quantity decided by the production manager. There is no cost associated with the decision number. They introduce a term named economic condition from 1 to 20, representing a state of nature and serves as a source of common uncertainty for subjects. The higher the economic condition number is, the higher the certainty is. A profit point matrix is presented with two factors, production quantity chosen by the production manager and economic condition. Therefore, their study focus on the performance (profit) but not effort of the subjects, which is not typical tournament.

Yan et al. (2017) investigated the influence on agent behavior using a real effort experiment in China by varying three factors: prize structure, periodic performance information feedback and unconscious start. The result shows that periodic performance information feedback is unable to motivate an agent to work hard, but is able to reduce sabotage among agents, while the total output of agents is high.

Compared with static tournaments, the most important factor to be considered in designing dynamic tournament incentive mechanism is the control of staged performance information, that is, the organizer needs to make a strategic plan for the feedback of performance information, including when and how much feedback. In the process of agents repeatedly making multiple efforts to make decisions, by means of interim performance evaluation and other means, the principal can obtain information such as the agent's performance. In this case, the agent's performance information is the principal's private information, and the principal can control whether the feedback is given or not. For example, in the incentives for promotion tournament, agent performance is usually measured by some subjective standards, such as leadership ability, innovation ability or team work ability. The agent's performance is the personnel department managers or company proprietary information and managers can feedback the information to

agents as a kind of incentive. The ability to control whether and to which extent feedback should be given plays in itself an important role in the incentive mechanism. The principal should identify whether the no-feedback policy that reveals no information, or the full-feedback policy that reveals all the information should be used.

2.4 Risk-taking and effort exerting

In rank-order tournament, when agents choose their optimal effort, they have to trade off an increased winning probability against a higher disutility of work, so they do not only choose efforts but also decide risky actions. Kräkel and Sliwka (2004) analyzed agents' risk-taking in asymmetric tournaments model with endogenous risk choice by using a mathematical model. They found that if the abilities are sufficiently similar, the equilibrium effort decreases, while if abilities are sufficiently different, the equilibrium efforts increase. In addition, risk also affects winning probabilities.

Hvide (2002) assumed that agents can influence the spread of their distribution of output, in addition to the mean. He argues that under standard tournament rewards, the unique equilibrium will have a low level of effort and a high level of risk taking. Second, by modifying the tournament scheme to give the prize to the agent with the 'most moderate' output, a high level of effort can be implemented.

Kräkel (2008) analyzed the optimal choice of risk in a two-stage tournament game between two players who have different concave utility functions. They found that two effects are decisive for a player's risk choice: an effort effect (more risk strengthens or weakness effort incentives) and a likelihood effect (more risk increases or decreases effort incentives). Their analysis shows the asymmetry has important implications for players' risk taking since effort effect and likelihood effect are strictly interrelated.

Grund and Gürtler (2005) conducted an empirical study by examining data of 306 matches of the German Soccer Major League and found that risk taking matters. Coaches of teams leading during a match switch to less risky strategies, while the opposite is true for coaches of teams being behind. They demonstrate that switching to a riskier strategy for a coach is worse than maintaining the initial strategy in that it leads to a lower expected score and point advancement.

Nieken, and Sliwka (2010) studied risk-taking behavior in a simple two-person tournament in a theoretical model as well as in a laboratory experiment. They ran three different treatments

for each of which one session with 24 participants was conducted. In each of 23 periods two players were matched together randomly and anonymously. The analysis and experiment results show that the leading players choose the safe strategy more often than the trailing players if the outcomes are uncorrelated, but the contrary is true if the outcomes are perfectly correlated.

2.5 Summary of literature review

From the literature review on the tournament theory above, we can see that the previous research is mainly carried out from the aspects of the effectiveness of the tournament, the design of the tournament model and the application in various fields. After almost 40 years of development, many conclusions of this theory have been verified. These conclusions have important guiding significance for sports championship, enterprise employee motivation and promotion competition of government officials, and can also provide new ideas for the reform of the incentive system in China. As mentioned, some scholars in China have used the incentive theory to analyze practical problems, but compared to the needs in practice, the current research is far from enough. In addition, from the theoretical research itself, there are still some deficiencies in the tournament theory, which need to be further developed and improved.

Tournament is commonly applied in performance management systems in organizations. Because resources are always limited, bonuses, annual salary increase and promotion headcount are part of a budget and, within the hierarchical structure of the organization, prizes have to be allocated to the agents according to the rank of their performance result in order to motivate them to put forth their maximum effort. Then, the prize structure is one of the most important considerations in tournament design.

Most of the previous studies for prize structure have focused on a two-level prize, in which one is high, and the other is low. Even if there are more than two agents, there are only two levels, spread as 1H2L, 2H2L, 1H3L, and so on. However, practitioners always adopt multiple level prize structure, for example, 5 grades of bonus amount or 5 grades of salary increase percentage. In addition, in previous studies, the total prize budget is not fixed, the researchers compared the efforts with prize schemes of different portions of winners and losers, but the total prize budget in these schemes is different, which introduces a hidden variable of different total prize amount.

Considering that in a tournament with multiple agents, the total prize budget is fixed, how should the principal allocate the prize? There are three alternative prize structures, single prize,

two-level prize and multiple level prize. Which prize structure is optimal for agents' motivation? Which prize structure is optimal for output maximum? Freeman, et al. (2010) compared efforts in a single prize structure (e.g. give $30 to the top scorer and nothing to the remaining 5 participants) and multiple level structure. But few researchers have compared efforts in two-level prize structure and multiple level structure.

Therefore, on top of the existing studies in this area, it is necessary to study the efforts under a two-level prize structure and a multiple level prize structure within a fixed total prize budget.

Previous studies on feedback in a dynamic tournament have unveiled agents' reactions when they receive feedback of the first stage result or receive nothing about the first stage result. However, there are few studies on feedback in multiple agents' tournaments with multiple prize structure and it is doubtful whether the previous feedback study results also apply to a multiple prize structure situation. It is therefore necessary to analyze this subject, to explore the efforts under full feedback and no feedback in dynamic tournaments with multiple prize structure.

Now, let us assume a scenario where, in a dynamic tournament with multiple agents, the principal's target is to maximize the agents' effort and the overall output. There are two variables, prize structure and feedback policy. Each variable has two options, two-level prize structure and multiple level prize structure, full feedback policy and no feedback policy. Which prize structure is optimal? Which feedback policy is optimal? Which combination of prize structure and feedback is optimal? Next section will explore these questions.

2.6 Hypotheses

After reviewing previous related literatures, we worked out eight hypotheses in multi-person tournament situation, including four hypotheses of effects of prize structure on effort, and four hypotheses of feedback on effort.

2.6.1 Multi-person tournament situation

In a tournament with multiple employees, their supervisor's target is to maximize the agents' effort and the overall output. The total prize budget is fixed. The employee's target is to maximize his own utility by receiving a higher prize with a lower cost. There are two variables, one is prize structure setting, and another is feedback policy. There are two prize structure options: two-level prize and multiple level prize. There are also two feedback policy options:

full feedback and no feedback. Then there are four situations, including two-level prize structure and full Feedback (T-F), two-level prize structure and no feedback (T-N), multiple level prize structure and full feedback (M-F), multiple level prize structure and no feedback (M-N) as illustrated in Table 2-2 below.

Table 2-2 Four Situations

		Prize Structure	
		T. Two-level	M. Multiple Level
Feedback Policy	F. Full Feedback	**T-F**	**M-F**
	N. No Feedback	**T-N**	**M-N**

2.6.2 The effect of prize structure on effort

The employee incentive mechanism of enterprises has always been the focus of human resource management research, and the tournament incentive mechanism characterized by relative performance evaluation has also been the subject of wide concern and has been studied since it was put forward. Previous studies have shown that in the tournament system, the prize structure has a significant impact on employees' optimal efforts (Müller & Schotter, 2003; Nalbantian et al., 1997). In other words, when the scale of the tournament is constant, the prize structure in the tournament can affect the behavior of employees and it can also increase the average level of effort of employees in their daily work.

First of all, the intensity of employees' incentives depends on their cognition and expectation of their probability to win the prize (Vroom, 1964). Therefore different prize structure and earnings may affect their expectations. On the one hand, in the two-level prize structure, employees' expectations of getting a prize are low. Many ordinary employees may not get a high prize. Employee motivation is the process of motivating employees to strive to achieve corporate goals (Wang & Cui, 2011) and when employees think that the probability of getting a prize is low, their motivation is affected and they are likely to choose to give up their efforts (Orrison, 2004). Especially for the employees with lower ability, when they know that they have little chance to win a higher prize through more effort, the prize does not have any incentive effect on them (Richard, 2010), because in this situation they have a low expectation of the possibility of winning.

On the other hand, a multiple level prize structure can give more employees an incentive to try hard than a two-level prize (Moldovanu et al., 2001) thus producing a higher output since employees who are expected to receive a low prize in the two-level prize structure, are expected to make greater efforts when they have the opportunity to obtain the second, third or "nth" prize (Krishna et al., 1998). Employees with poor competence will also be encouraged to perform better in a multiple level prize distribution to obtain a higher level prizes. Under the condition that the effort cost function is convex enough, and under the condition of multiple level prize, the total effort of employees is the largest (Moldovanu et al., 2001). In addition, the amount of the prize in the multiple level prize structure is closely related to employees' personal efforts, and employees are more likely to obtain a prize and achieve goals through their efforts. Once the rank of employee increases, the expected increase of the prize amount can be expected; once the rank of employee decreases, the expected decrease of the prize amount can be expected. Therefore, the multiple level prize structure will provide more incentives than the two-level prize structure. When the multiple level prize is given to employees, their efforts are the highest and their performance is the best.

Secondly, the tournament system is a special form of relative performance evaluation, and the prize gap of different levels in the prize structure will affect the employees' effort behavior. Clark and Riis (1998) and Moldovanu and Sela (2001) believe that the compensation mechanism for determining prize distribution through relative performance is more effective, which shows the advantages of the tournament mechanism in prize distribution. In the two-level prize structure, the prize gap between the employees with high performance and the employees with poor performance is relatively large, but in the multiple level prize structure, the prize gap is more reasonable than in the two-level prize structure since employees at each level can get the prize brought by the performance of the corresponding level. Even if they do not do their best, they can still get a reasonable reward, which will significantly improve their satisfaction with the enterprise. The prize gap brought by multiple prize levels can encourage grassroots employees to participate in ranking competition, so as to provide incentives and reduce the necessity of supervisor monitoring since that employees in the competition are more concerned about whether they can beat their competitors rather than about their absolute performance (Zeng & Yan, 2010). Therefore, the multiple level prize structure can arouse the enthusiasm of employees and motivate them to work harder in comparison to the two-level prize structure. In conclusion, the following hypothesis is proposed:

Hypothesis 1. Employees' effort in a multiple level prize structure is higher than that in a

two-level prize structure.

In reality, tournaments are often held in a long period of time, and the promotion of employees often takes years or even longer. Therefore, in essence, the tournament mechanism has typical multi-stage dynamic characteristics (Ederer, 2010). Compared with static tournament, the most important factor to be considered in the design of dynamic tournament incentive mechanism is the control of stage performance information, that is, the organizer needs to make a strategic plan for the feedback of performance information, including when to give feedback and how much information to give back (Moldovanua et al., 2006). The main purpose of periodic information feedback from supervisor is to provide additional incentives for employees, which is another incentive for supervisor to set salary levels and salary gap (Yan et al., 2017).

However, there is no consensus in academia on whether staged information feedback can stimulate employees' performance and effort level, and the impact of supervisor feedback on employees' efforts in different prize structures (Cheng, 2013). On the one hand, feedback from supervisor may lead to more slack of backward employees, especially when one employee is significantly ahead of the others. In tournaments without information feedback, employees cannot know the result of their efforts and their exact ranking, so they will not give up (Harris & Vickers, 1985). From this point of view, in order to fully mobilize the enthusiasm of employees to work hard, we should choose not to disclose the results of the previous stage of performance appraisal (Ma, 2019). On the other hand, the information feedback in the tournament can make employees in different prize structures pay more attention to the business process and their own performance (Tong & Leung, 2002). Regardless of the prize structure, periodic information feedback may generate both pressure and incentives for employees who are temporarily behind (Berger & Pope, 2011) since it can let employees know the level of effort of their competitors, so that they can make more efforts. In their daily work, employees themselves are worried that they will be labeled as "losers" because of their low ranking, which will cause dissatisfaction among other members of the team. Therefore, even if the probability of winning is very low, backward employees may devote themselves to work, rather than abandon themselves. According to traditional economic analysis, feedback of performance evaluation results to employees will not affect the behavior of employees under different prize structures (Zhou, 2014). That is to say, the influence of information feedback on the level of employees' efforts under different incentive modes is not statistically significant. This may be because when the employee's effort level has reached a certain level, information feedback

cannot significantly improve their motivation level (Carpenter et al., 2010). At the same time, because of information disclosure, employees can know their own performance output and ranking in different prize structures, which leads to more rational efforts. From the perspective of incentive mechanism design, the amount of information mastered is a "double-edged sword", which may not only effectively motivate employees, but also become a fetter for employees to work hard.

Many studies only consider the incentive effect of the tournament mechanism, but there is no definite conclusion about the effect of supervisor feedback on employees in different prize structures (Ehrenberg, Ronald, & Bognanno, 1990). Therefore, this thesis argues that whether there is information feedback in the structure of the tournament has no significant difference o the impact of employees' efforts under different prize structures. In the situations of information feedback and no information feedback, employees' efforts under the multiple level prize structure are always higher than those under the two-level prize structure. In other words, when other conditions are the same, compared with the condition without periodic performance information feedback, the level of employees' efforts may remain unchanged when there is periodic performance information feedback. Based on the above analysis, two hypotheses are proposed:

Hypothesis 2a: Under full feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

Hypothesis 2b: Under no feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

Risk preference refers to an individual's psychological attitude to risk. Therefore, different individuals' attitudes to risk will be significantly affected by individual differences (Zhang & Li, 2009). Risk is in essence a kind of uncertainty. The attitude of individuals in front of this uncertainty is the representation of their personal risk preference. The task of each risk decision is affected by the subjective expectation of the decision maker. Employees with risk preference tend to overestimate their abilities and believe that they can get more benefits by making equal efforts (Ghosh et al., 2000).

This thesis holds that when the risk preference of employees is high, the expected value of employees in the multiple level prize structure is higher than that in the two-level prize structure, and the expected return is higher when they make some efforts. On the one hand, in the two-level prize structure, each employee ranking in the first half can get a high prize, while each employee ranking in the second half can get a low prize. Risk preference employees only need

to keep their performance at the upstream level to get high level prize. As a result, the employees who are already in the lead do not need to pay too much effort, but also have great expectations to maintain the upstream level and get high prize, which will make them slacker. Meanwhile the employees who are temporarily behind have little expectation of getting a high prize, and they tend to give up competition.

On the other hand, in the multiple level prize structure, risk preference employees want to make more efforts to reach the maximum prize, so their performance will not be satisfied even at the upstream level. The utility function of risk preference is increasing marginal utility. For those who prefer risk, with the increase of the prize amount, the marginal utility brought by the equal prize will be larger and larger (Tian et al., 2007). This encourages risk preference employees to make progress at a higher level in order to obtain a higher level prize. The risk-averse employees who had previously been at the downstream level are more likely to "go for it". They tend to put in more effort to keep moving up the rankings or to maximize returns. Therefore, in the case of paying the same cost, employees' efforts under the condition of multiple level prize are more than those under the condition of two-level prize. Based on the above analysis, this thesis proposes the following hypothesis:

Hypothesis 3. The higher the employee’s risk preference degree, the more the employee put effort in a multiple level prize than that in a two-level prize condition.

2.6.3 The effect of feedback policy on effort

In a number of studies, feedback is found to provide critical input for forming realistic self-assessments in the work setting (Sargeant et al., 2008; Ederer, 2010; Brown, Farrington, & Sprinkle, 2016) and is a key to maintaining high levels of work motivation (Murphy & Cleveland, 1995). Informational feedback mainly serves two important functions: evaluation and development (Cleveland, Murphy and Williams, 1987). The evaluation effect informs employees about their relative position and effort in the tournament, which makes it clear how far away the goal is. The development effect helps employees to do their jobs or plan their futures better by learning from prior performance information on which to base their decisions (Ederer, 2010), and focuses on what to do next to reach the goal. Information about others’ efforts can affect individual behavior in contests through several channels. Feedback primarily works by reducing the discrepancy between the current state and the desired state on the path to achieving a goal (Hattie & Timperley, 2007). Hence, we propose hypotheses based on the two functions (1) evolution and (2) development.

Firstly, at the evolution level, when given the performance evaluation, the employee knows about others' efforts and this may change the dynamics of individual behavior. Some scholars have argued that allowing people to observe each other's effort has a positive influence on an employee's performance although the payment is independent of other employees' performance (Falk & Ichino, 2006; Mas & Moretti, 2009). Specifically, losers may give rise to disappointment and regret missing a promotion opportunity by performing too low leading to feelings of shame, which can incentivize the employee's morale and motivation to work hard in the next period (Mago & Savikhin, 2012). Although the winner of the tournaments may regret paying too much effort in relation to the second highest worker, some experimental studies have found strong evidence for loser's and not winner's regret (Filizozbay & Ozbay, 2007). In contrast, winners of the first period will have feelings of pride, and choose higher levels to maintain a positive self-image and higher rewards. Additionally, winners are more motivated and have more confidence in their own ability, that is to say, they hold higher expectations about their own ability.

Secondly, at the development level, information feedback can facilitate faster learning of the incentives inherent in the contest structure. In particular, when information about all individual efforts is public knowledge, subjects may learn about profitable strategies more quickly from the experience of others, and thus additional information about others' productivity should help employees choose and develop their effort levels strategically so as to influence the content of the next performance appraisal. On the one hand, information feedback shows winners the positive feedback, which increases participants' confidence that they will be able to successfully develop and refine their ideas. Further, positive feedback also increases participants' goal commitment. Higher confidence and goal commitment, in turn, allow participants to internalize the goal of idea development and thus stay motivated to pursue their goal going forward (Fishbach et al., 2010). On the other hand, losers get the negative feedback which highlights weaknesses in the way a task is being performed, signaling the need for corrective action. Negative feedback signals that more effort is needed to accomplish the goal of idea development. Thus, according to this viewpoint, losers can be encouraged by prior negative performance (Camacho et al., 2019).

In the no-feedback scenario workers will still choose the same effort levels regardless of their actual abilities as effort choice only depends on expected ability. Under a full-feedback policy agents choose asymmetric effort levels in the second period as they tailor their effort choice to their posterior ability level so that on average output will be higher. Therefore, on

average, a full-feedback policy transmits positive or negative news to the employees so that the expected output is higher under a full-feedback policy than under a no-feedback rule.

Hypothesis 4: Employees' effort under full feedback policy is higher than that under no feedback policy.

Prior studies have assessed employees' behavior under different tournament prize structures, and especially noted that it is worth to explore the theoretical distinction between having several equal prizes and having several unequal prizes (Moldovanu & Sela, 2001). Most scholars (e.g. Freeman & Gelber, 2010), have showed that the aggregate effort of individuals in the tournament may be maximized by giving multiple level prizes (or several unequal prizes) rather than two-level prizes (or several equal prizes). The reason is that a two-level prize structure may produce low effort as participants see less return to effort. That is to say, multiple level prizes give more participants an incentive to try hard than two-level prizes, in which many participants may have little chance of winning.

According to our hypothesis 4, information feedback is also a key to impact on work motivation and effort levels of the participants in tournament. However, there is little empirical work examining how behavior responds to differing prize structures and to information feedback about participants' performance at the tournament task.

For our hypothesis, we rely on arguments from expectancy theory to predict the effect of feedback settings on effort with different prize structures. Expectancy theory suggests that individuals choose effort levels that maximize the expected outcome (Vroom, 1964), and mainly emphasizes that the employee's belief regarding whether increased effort will be affected by the probability of the achievement of a higher performance (Knauer et al., 2016). Under the setting of a two-level prize structure, information feedback about the prior performance informs higher performers that they have a greater probability of receiving the reward than their peers, for example, their marginal benefit of effort is higher as additional effort is likely to help them win the tournament. Compared with the multiple level prize structure, the two-level prize structure has a bigger gap of reward. Therefore, the relative winners remain motivated to increase performance via productive effort because they know that it is the best way to receive the higher reward in the next period. Meanwhile, information feedback informs the bottom performers that they take the least reward. The gap of reward can motivate the losers to improve their performance via effort.

Multiple level prize structure refers to several unequal prizes level for the employees. Compared with the two-level prize structure, the multiple level prize structure has a lower gap

of reward on different prize levels, and a relatively higher proportion of winning more rewards. Consequently, under the setting of multiple level prize structure, we argue that, when giving the information feedback, the losers in the previous period are likely to exert even more effort instead of giving up because the goal of winning appears attainable. More importantly, the higher proportion of winning more rewards reduces the lower performers' bonus concerns, namely, employees are concerned that expending effort will not result in them being awarded with the expected bonus (Knauer et al., 2016). When employees' bonus concerns are decreased, they will choose to exert a higher level of effort to win more in a multiple prize setting. As for the higher performers, when they are aware of their higher outputs than others', they are inclined to increase or maintain their effort level to consolidate the advantageous rank. Thus, we hypothesize that, within a multiple level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

In sum, our hypothesis focuses on how the effect of information feedback on individual effort varies across different tournament prize structures. Specifically, we explore the effect of feedback on performance under two-level prize structure rewarding the performers several equal prizes, and the effect of feedback under multiple level prize structure rewarding the performers several unequal prizes. Based on the expectancy theory and experimental findings related to prize structures, we hypothesize that information feedback increases individual efforts regardless of whether they are under a two or a multiple level prize structure as follows:

Hypothesis 5a. In a two-level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

Hypothesis 5b. In a multiple level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

Risk preference is commonly considered to be a personality trait, and greater risk taking is sometimes found to be associated with greater personal and corporate success (MacCrimmon & Wehrung, 1990). In a tournament, the participants' efforts level usually depends on their type of risk preference (Skaperdas & Gao, 1995). Specifically, the employees with high risk preference set higher goals and tend to exceed their goals; employees with low risk preference set lower goals and tend to underachieve (Krueger & Day, 2010). Put differently, participants of high-risk preference tend to choose the risk itself and be less fearful of the possibility of losing, whereas participants of low risk preference are more fearful of losing. Thinking of the effort expended on the tournament as a form of winning the top reward, we could then expect a higher risk preference participant to put more effort and thus have a higher probability of

success than a less risk preference participant would have. It is often considered, for instance, that successful entrepreneurs are those who are more willing to take risks.

Under a no-feedback setting where each employee has no idea about others' ability and performance, the employees with higher risk preference will choose higher effort levels. Since the exertion of effort by tournament participants could be thought of as a form of gambling, without performance feedback, the higher risk preference participant would be most willing to gamble, exert higher effort and have a higher probability of winning. Under a feedback setting, however, employees have clearly understood their relative position and efforts in the tournament, although equipped with higher risk preference, the top performers will prefer less risky actions to preserve their favorable positions, whereas low performers, who have nothing to lose, will prefer more risky actions and choose to more effort (Kräkel et al., 2004). Instead, low performers may choose conservative strategies and decrease the effort levels because they have little likelihood of winning. Therefore, we argue that, when having a higher risk preference degree, on average, the employee will put more effort under a no-feedback policy rather than under a full feedback policy and propose the following hypothesis:

Hypothesis 6. The higher the employee's risk preference degree, more effort will be put under no feedback policy rather than that under full feedback policy.

2.6.4 Summary of hypotheses

As per the above we have a total of eight hypotheses, four of which concern prize structure, including:

Hypothesis 1. Employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

Hypothesis 2a. Under full feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

Hypothesis 2b. Under no feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

Hypothesis 3. The higher employee's risk preference degree, the more employee put effort in a multiple level prize than that in a two-level prize condition.

The remaining four concern feedback policy, including:

Hypothesis 4. Employees' effort under full feedback policy is higher than that under no feedback policy.

Hypothesis 5a. In a two-level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

Hypothesis 5b. In a multiple level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

Hypothesis 6. The higher the employee's risk preference degree, more effort will be put under no feedback policy rather than that under full feedback policy.

Chapter 3: Research Methods

The research methods of this study include experiment and case study.

Data for empirical work can be drawn from several types of resources. Compared with field-happenstance data and laboratory-happenstance data, experimental data allow more reliable inferences (Friedman & Sunder, 1994). Experiment method is popularly used in tournament research to observe subjects' behavior by means of controlled variables in a laboratory environment. In our experiment, 7 groups of participants joined a series of experiments to observe their reactions to different treatments, simulating different performance management rules in terms of prize structure and feedback policy.

Focus group interview is designed to determine the responses of persons exposed to a situation previously analyzed by the researcher. One of its chief functions is to discover the processes involved in experimentally induced effects (Merton and Kendall, 1946). In order to understand subjects' thought behind their behavior, six subjects who joined our experiment, were invited to join the focus group interview.

As a supplement to the results from the experiment and focus group, we conducted a single case study with two-level performance management. The documents and historical data were studied. After that, a questionnaire was issued to the involved employees to collect more data.

After the data from the experiment is collected, the Wilcoxon signed rank test and correlation analysis were used to examine the results statistically.

3.1 Experiment design

In this section, a simple tournament mode is introduced first, followed by two scenarios and the key parameters setting in the experiment.

3.1.1 The tournament model

3.1.1.1 A Simple tournament mode

As introduced in section 2.2.3, Orrison et al. (2004) performed a multi-person tournament experiment. We refer to their experiment, considering n identical agents participating in a tournament. In this experiment, n=4, all the agents have the same technology and face an identical decision problem. The effort is not observable to anyone except to the agent and the

following formula may be derived.

$$y_i = e_i + \varepsilon_i \quad (3.1)$$

where

y_i: The output of agent i.

e_i: The agent's nonnegative effort level.

ε_i: A random or luck component. It is independent for each agent i from an identical and continuous density function.

Each agent has the same utility functions:

$$\mathbf{U(p, e) = p - e^2/c} \quad (3.2)$$

where

U(·): Agent's utility function.

p: Nonnegative prize payment to the agent.

e2/c: Agent's cost function, it is convex, in which c is a positive constant.

3.2.1.2 Scenario X: two-level prize structure

In this two-level prize structure scenario, after the outputs of all agents are determined, each agent ranking in the top half receive high prize M, while each agent ranking in the bottom half receive a low prize. The total prize budget is b = 2M + 2m. Agent i's expected payoff is

$$\mathbf{Ez_i(e_i, e_{-i}) = \pi(e_i, e_{-i})M + (1-\pi(e_i,e_{-i}))m - e_i^2/c} \quad (3.3)$$

or

$$\mathbf{Ez_i(e_i, e_{-i}) = m + \pi(e_i, e_{-i})(M-m) - e_i^2/c} \quad (3.4)$$

where

π(ei, e-i): The probability of winning a high prize for agent i given the effort ei.

In the experiment conducted for this thesis, the parameters are set as below,

M = 2.4 Yuan (Yuan is Chinese currency. 1 Yuan equals approximately Euro 0.13)

m = 0.6 Yuan

c = 10000

ε is normally distributed with mean at 0 and standard deviation at 5, N ~ (0, 5)

So the total prize budget per round is 6 Yuan (2.4 × 2 + 0.6 × 2).

3.1.1.3 Scenario Y: multiple level prize structure

In this multiple level prize structure scenario, after the output of all agents is determined, the agent with the lowest output receives prize L, the next agent with higher output receives prize 2L, the next higher one receive prize 3L, and the agent with the highest output receives prize 4L.

To keep the same total prize budget as that of scenario X for later comparison, the total prize budget in scenario Y is also 6 Yuan. In addition, the lowest and highest prizes are set the same as scenario X, 0.6 and 2.4 respectively. Prizes for the agents in scenario Y are as below,

Rank 4 (Bottom Rank): $L = (1/10) \times b = 0.6$ Yuan

Rank 3: $2L = (2/10) \times b = 1.2$ Yuan

Rank 2: $3L = (3/10) \times b = 1.8$ Yuan

Rank 1 (Top Rank): $4L = (4/10) \times b = 2.4$ Yuan

The parameter c is set at the same value as in Scenario X, c=10000.

ε is set the same as Scenario X, N ~ (0, 5)

3.1.1.4 Summary of experiment parameters

The experiment parameters are summarized in Table 3-1.

Table 3-1 Experiment Parameter Summary

		Scenario X	Scenario Y
Prize Structure	Ran 1	2.4	2.4
	Ran 2	2.4	1.8
	Ran 3	0.6	1.2
	Ran 4	0.6	0.6
Cost Constant	c	10000	
Random Number	ε	N~(0,5)	

3.1.2 Experiment design and procedure

3.1.2.1 Experiment design

In this thesis an effort-chosen experiment is used and four treatments to examine the efforts of the prize structure and feedback policy that have been designed as per Table 3-2 describing

the experiment parameters. Parameters of tournament size (subjects per group), decision number range, and cost function, random number distribution, total prize budget, round and number of subjects are the same across all four treatments. The only variables are prize structure and feedback policy.

Table 3-2 Experiment Parameters

Treatment	Tournament Size	Decision Number Range	Cost Function	Random Number	Rank 1 Prize (Yuan)	Rank 2 Prize (Yuan)	Rank 3 Prize (Yuan)	Rank 4 Prize (Yuan)	Feedback Policy	Round	Number of Subjects
A	4	(1-100)	e*e/10000	N~(0,5)	2.4	2.4	0.6	0.6	Full	6 + 6	4 × 7
B	4	(1-100)	e*e/10000	N~(0,5)	2.4	1.8	1.2	0.6	Full	6 + 6	4 × 7
C	4	(1-100)	e*e/10000	N~(0,5)	2.4	2.4	0.6	0.6	No	6 + 6	4 × 7
D	4	(1-100)	e*e/10000	N~(0,5)	2.4	1.8	1.2	0.6	No	6 + 6	4 × 7

According to experiment results obtained by different authors (e.g. Orrison et al. 2004; Harbring, 2010; Zeng & Yan, 2010), a balanced fraction of winning and losing particularly enhances subjects' efforts. Therefore in treatments A and C, the prize structure is set as two levels, including two high prizes at 2.4 Yuan and two low prizes at 0.6 Yuan. This prize structure represents the most effective approach to motivate employees' efforts among all two-level prize structure.

In treatment B and D, prize structure is set as multiple levels. The total prize budget is 6 Yuan respectively, the same as the total budget in treatment A or C. The highest prize (prize in Rank 1) is 2.4, the same as the highest prize in treatment A or C; the lowest prize (prize in Rank 4) is 0.6, the same as the lowest prize in treatment A or C. Therefore, the prizes from Rank 1 to Rank 4 are set at 2.4, 1.8, 1.2 and 0.6 Yuan.

In treatment A and B, the result information is respectively and individually feedbacked to the subject after all subjects having selected the effort number. Each subject receives his own output, rank, prize, utility (prize minus cost) in the current round, their own average output, rank, prize, utility of treatment-to-current-round, other subjects' output in the current round and other subjects' average output of treatment-to-current-round.

On the contrary, this information is not feedbacked to subjects in every round in treatments C and D. After subjects submit their effort value for all 6 rounds, the average output, rank, prize and utility of their own and other subjects is feedbacked to subjects together.

The decision number selected by each subject will not be revealed to any other subjects across this experiment.

Schmidt et al. (2001) investigated four basic elements related to the structure of the experimental setting that affect behavior, pecuniary benefits, player types, information about player types and linkages among players that occur in repeated game situations. They have found that the pecuniary benefits do not fully account for the subjects' ranking of the outcomes and subjects make decisions in the game based on their own internal valuation systems and beliefs concerning the likely actions of others and what these actions reveal about the intentions of others. In addition, subjects' decisions may be influenced by the kind of information that they obtain about those with whom they are paired, as well as their linkage to the subject they are paired with.

Some previous researchers have arranged between-subject experiment in which different groups of subjects participate in different treatments with given conditions and usually each group of subjects only participates in one treatment. However, such design brings one more variable into the experiment, which is player types. When researchers observe variance of outcomes, they check the experiment condition setting, and explain the outcomes variations by the experiment conditions. As a matter of fact, the variance of outcomes may be majorly caused by the types of different group of subjects or caused by mixed reasons and it is very difficult to separate the influence of experiment conditions and player types. One may argue that the variance of player types can be minimized by increasing the number of subjects or by random pairing, but few researchers have addressed this point in previous tournament studies.

To remove the influence of player types Box (1978) introduced the classic boys' shoes experiment where a randomized paired comparison design was adopted. In the current research we adopt within-subject experiments in which the same group of subjects was arranged to participate in different treatments allowing us to observe the same subject's behavior facing different conditions, and then analyze the result by hypothesis test, similar to Schmidt et al.'s (2001), who arranged the same group of subjects to participate in six treatments of the Prisoner's Dilemma game, as well as Shupp et al. (2013) who arranged the same group of subjects to participate in three treatments including single-prize, multiple-prize and proportional-prize conditions.

Friedman et al. (1994, p26) have also introduced other efficient designs for within-subject experiment. One is crossover design like ABA, and the other is dual trial like (b_L - b_S). These suggestions have been adopted in our experiment by arranging a trial sequence as ACAC. Twelve rounds of treatment A have been split in two phases then we ran the first six rounds of

A, followed by six rounds of C, then by the second six rounds of A and finally by six rounds of C. Likewise, treatments B and D were arranged as BDBD.

To introduce in detail in section 3.1.2.3, treatments A and B were conducted synchronously round-by-round. Each subject was required to select decision numbers for treatments A and B respectively in the same round at the same time slot, likewise, C and D. The purpose of this arrangement is to ensure that the subjects made their decision under the same situation except for the only variable of prize structure. Friedman et al., (1994) introduced a similar practice in a bidding experiment.

3.1.2.2 On-line program design

Table 3-3 Subject Interface (partial)

Role- Zhou

Scenario X	Testing Phase				Phase 1						
Round	1	2	3	Mean	4	5	6	7	8	9	Mean
Rank1 -Prize	2.4	2.4	2.4		2.4	2.4	2.4	2.4	2.4	2.4	
Rank2 -Prize	2.4	2.4	2.4		2.4	2.4	2.4	2.4	2.4	2.4	
Rank3 -Prize	0.6	0.6	0.6		0.6	0.6	0.6	0.6	0.6	0.6	
Rank4 -Prize	0.6	0.6	0.6		0.6	0.6	0.6	0.6	0.6	0.6	
Decision Number(1-100)	70	75	73		78	80	79	81			
Cost	0.49	0.56	0.53		0.61	0.64	0.62	0.66			
Output	70.1	78.5	73.1	73.9	78.2	77.4	87.3	84.4			81.8
Rank	2	2	3	2.3	2	4	1	1			2.0
Prize	2.4	2.4	0.6	1.8	2.4	0.6	2.4	2.4			2.0
Utility (Prize minus Cost)	1.91	1.84	0.07	1.3	1.79	-0.04	1.78	1.74			1.32
Role Wu's Output	67.9	71.4	83.0	74.1	77.6	82.7	77.9	82.5			80.2
Role Zheng's Output	78.3	79.9	82.5	80.2	76.3	78.1	67.4	71.9			73.4
Role Wang's Output	69.0	59.6	70.1	66.3	87.0	89.1	86.8	78.1			85.3
Scenario Y											
Rank1 -Prize	2.4	2.4	2.4		2.4	2.4	2.4	2.4	2.4	2.4	
Rank2 -Prize	1.8	1.8	1.8		1.8	1.8	1.8	1.8	1.8	1.8	
Rank3 -Prize	1.2	1.2	1.2		1.2	1.2	1.2	1.2	1.2	1.2	
Rank4 -Prize	0.6	0.6	0.6		0.6	0.6	0.6	0.6	0.6	0.6	
Decision Number(1-100)	76	87	74		81	80	77	87			
Cost	0.58	0.76	0.55		0.66	0.64	0.59	0.76			
Output	73.0	82.5	73.8	76.4	82.7	84.3	71.9	86.8			81.4
Rank	4	1	4	3.0	2	3	4	1			2.5
Prize	0.6	2.4	0.6	1.2	1.8	1.2	0.6	2.4			1.5
Utility (Prize minus Cost)	0.02	1.64	0.05	0.6	1.14	0.56	0.01	1.64			0.84
Role Wu's Output	79.6	76.8	82.0	79.5	84.3	86.0	90.0	77.8			84.5
Role Zheng's Output	75.1	73.0	79.3	75.8	81.2	85.7	84.1	78.2			82.3
Role Wang's Output	76.9	80.7	85.1	80.9	74.9	68.1	80.8	81.7			76.4

The sessions were computerized using on-line programmed WPS spreadsheet. WPS (Word Processing System) is an on-line software developed by a China local software company KingSoft. Then we programmed the needed close-loop software on the WPS platform, including 28 unique interface and 1 core spreadsheet. The data can be transferred between the interface and core spreadsheet automatically.

Table 3-4 Core Spreadsheet (Partial)

Scenario A	Testing Phase				Phase 1						
Round	1	2	3	Mean	4	5	6	7	8	9	Mean
Decision Number											
Role- Zhou	70	75	73		78	80	79	81	0	0	
Role- Wu	67	73	80		80	80	80	80	80	80	
Role- Zheng	81	81	81		76	76	76	76	76	76	
Role- Wang	67	67	67		87	87	87	87	87	87	
Random Number											
Role- Zhou	0.14	3.47	0.13		0.21	-2.58	8.29	3.38	-9.55	-3.19	
Role- Wu	0.88	-1.63	2.98		-2.40	2.73	-2.13	2.46	-6.21	2.61	
Role- Zheng	-2.75	-1.13	1.51		0.34	2.10	-8.59	-4.12	-12.18	-7.14	
Role- Wang	2.01	-7.38	3.13		0.02	2.06	-0.19	-8.85	4.98	9.79	
Output											
Role- Zhou	70.14	78.47	73.13		78.21	77.42	87.29	84.38			
Role- Wu	67.88	71.37	82.98		77.60	82.73	77.87	82.46			
Role- Zheng	78.25	79.87	82.51		76.34	78.10	67.41	71.88			
Role- Wang	69.01	59.62	70.13		87.02	89.06	86.81	78.15			
Rank											
Role- Zhou	2	2	3		2	4	1	1			
Role- Wu	4	3	1		3	2	3	2			
Role- Zheng	1	1	2		4	3	4	4			
Role- Wang	3	4	4		1	1	2	3			
Prize											
Role- Zhou	2.4	2.4	0.6		2.4	0.6	2.4	2.4			
Role- Wu	0.6	0.6	2.4		0.6	2.4	0.6	2.4			
Role- Zheng	2.4	2.4	2.4		0.6	0.6	0.6	0.6			
Role- Wang	0.6	0.6	0.6		2.4	2.4	2.4	0.6			
Cost											
Role- Zhou	0.49	0.56	0.53		0.61	0.64	0.62	0.66			
Role- Wu	0.45	0.53	0.64		0.64	0.64	0.64	0.64			
Role- Zheng	0.66	0.66	0.66		0.58	0.58	0.58	0.58			
Role- Wang	0.45	0.45	0.45		0.76	0.76	0.76	0.76			
Utility											
Role- Zhou	1.91	1.84	0.07		1.79	-0.04	1.78	1.74			
Role- Wu	0.15	0.07	1.76		-0.04	1.76	-0.04	1.76			
Role- Zheng	1.74	1.74	1.74		0.02	0.02	0.02	0.02			
Role- Wang	0.15	0.15	0.15		1.64	1.64	1.64	-0.16			

To identify each subject in a 4-person group, the subjects are named as Zhou, Wu, Zheng and Wang. The 4 subjects have exactly the same role, responsibility and right. A unique spreadsheet is designed in advance for each subject with different identification, but all calculation formulas are the same in the sheet. Then subjects input their unique URL (Uniform Resource Locator) into the web browser to enter in the participant interface as per Table 3-3 above. The prize numbers are listed at the top of each scenario and each subject is required to input an integer decision number in a range from 1 to 100 into the green cell to represent his or her effort degree. The cost of this effort degree is automatically calculated by the formula and displayed in the next cell immediately. The subject is able to alter his or her decision number

until he or she makes the final decision by entering Ctrl + S on the keyboard to save and submit the input.

Then the decision number is put into a summary sheet (as per Table 3-4) by formula linkage, to calculate the output automatically by adding a random number with normal distribution N ~ (0, 5). Once all four subjects submit their decision number, the ranks are calculated automatically, as well as the prize, cost, and utility for each subject. These results are displayed on the participant interface respectively, shown in Table 3-3. The subjects can only see their own interface as per Table 3-3 and are not able to see the summary sheet in order to avoid the any subject to know other subject's input.

3.1.2.3 Experiment implementation procedure

The experiment was conducted at the School of Management and Economics at the University of Electronic Science and Technology of China in 2019 and consists of nine steps, including participant hiring, randomly grouping onto seats, experiment introduction, conducting a pilot phase and four formal phases, questionnaire filling and paying the subject of show-up fee and a reward. The process is explained in Figure 3-1 below.

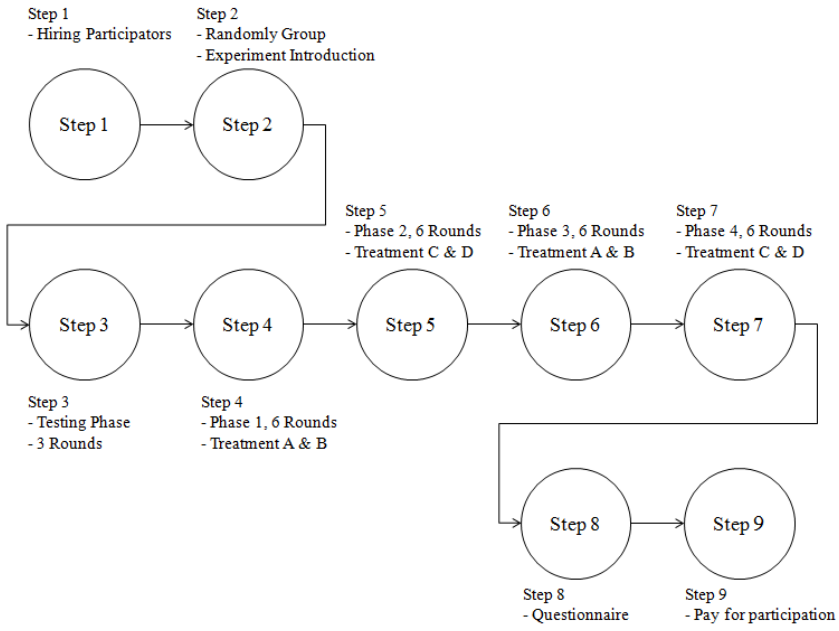

Figure 3-1 Experiment Procedure

The advertisement was made via Internet indicating that every participant would be paid a 100 Yuan show-up fee, plus a maximum 200 Yuan reward according to personal performance in the experiment. The experiment time took about 45 minutes. The participants were requested to bring their own notebook computers to the experiment room. More than 30 students applied

and 28 junior grade postgraduate students were hired to participate in the experiment according to the criterion of "first registered, first hired". The age of these students was within 21~23 years old. The demographics are shown in Table 3-5.

Table 3-5 Participant Demographics

Major	Male	Female	**Grand Total**
Business Administration	1	5	**6**
Management Science and Engineering	5	4	**9**
Finance	1	5	**6**
Applied Economics	3	4	**7**
Grand Total	**10**	**18**	**28**

The experiment was arranged in a classroom. Seat number labels were pasted on the desks in advance. The seats were arranged with enough distance in order to prevent subjects from communicating with each other, as per the layout shown in Figure 3-2. The good condition of Wi-Fi availability was tested and confirmed before the experiment.

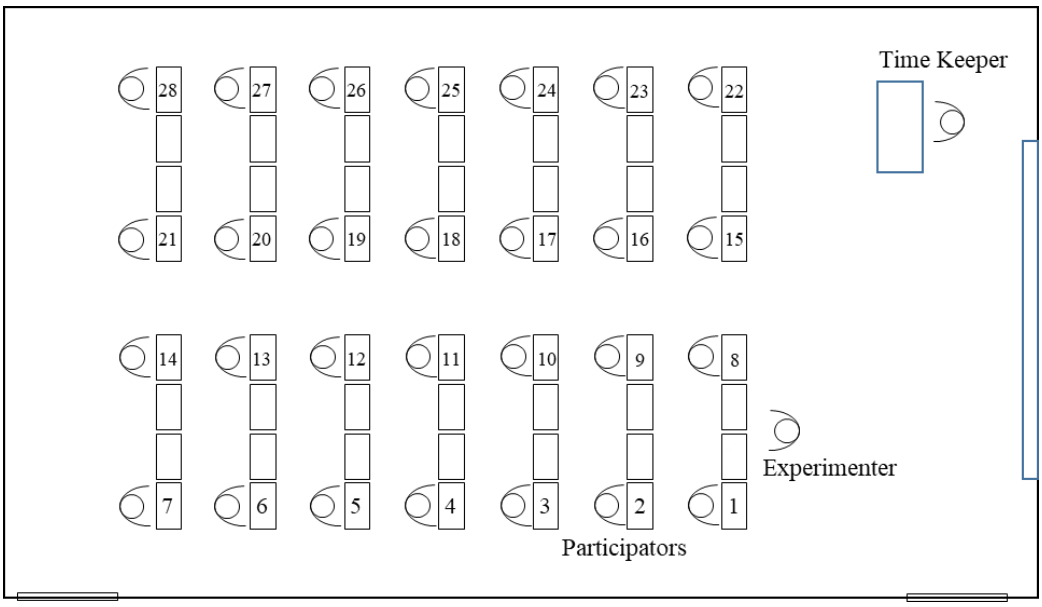

Figure 3-2 Experiment Room Layout

The 28 participants in the seats were randomly and in advance grouped into seven groups of four elements each as shown in Table 3-6 for cross-reference. The group information was not revealed and no participant knew who was in the same group.

Table 3-6 Cross-reference Table of Seat, Group, Role and URL

Seat Number	Group	Role	URL
1	3	Wang	https://kdocs.cn/l/sweKrxu4o
2	7	Wang	https://kdocs.cn/l/syCV9qiNw
3	1	Wang	https://kdocs.cn/l/sXnUmCoDS
4	4	Zheng	https://kdocs.cn/l/si4BxDIpM
5	1	Zheng	https://kdocs.cn/l/slGCZFIaS
6	3	Zhou	https://kdocs.cn/l/sp6VEgua7
7	7	Zheng	https://kdocs.cn/l/sryOA0DGx
8	3	Wu	https://kdocs.cn/l/sIsK9zXpD
9	5	Wu	https://kdocs.cn/l/sTbGh1jfe
10	7	Wu	https://kdocs.cn/l/s0zbcJmlf
11	4	Wang	https://kdocs.cn/l/sNWM5R7d6
12	5	Zheng	https://kdocs.cn/l/sW9LV9WmV
13	2	Zheng	https://kdocs.cn/l/sCLg33f8P
14	2	Wang	https://kdocs.cn/l/sKT5s4KLO
15	4	Zhou	https://kdocs.cn/l/srw16eGYD
16	3	Zheng	https://kdocs.cn/l/sIpRooEb0
17	6	Wu	https://kdocs.cn/l/sq1JUMRKQ
18	4	Wu	https://kdocs.cn/l/szc3KH5Pz
19	2	Zhou	https://kdocs.cn/l/sf8RNCLwb
20	6	Zheng	https://kdocs.cn/l/s0kpuVWWR
21	1	Zhou	https://kdocs.cn/l/sX80Vkgjr
22	6	Wang	https://kdocs.cn/l/ssUA7ZDE8
23	5	Wang	https://kdocs.cn/l/s5d9oBXgH
24	1	Wu	https://kdocs.cn/l/syVPtmKv5
25	5	Zhou	https://kdocs.cn/l/s4bHXTpOE
26	2	Wu	https://kdocs.cn/l/s0GXPv7IR
27	6	Zhou	https://kdocs.cn/l/sQJ3GJqz3
28	7	Zhou	https://kdocs.cn/l/sI42BG10B

After all the 28 subjects sat down, the experimenter issued an introduction sheet to every subject allowing them to read it in 5 minutes. The instruction sheet was in Chinese. To avoid potential suggestive influences a neutral language was used. Expressions like “tournament”, “effort” were not mentioned. In the introduction sheet, the subject was told that he or she had been grouped randomly, as well as the calculation formula between decision number, cost, random number, output, rank, prize and utility. It is emphasized that every subjects’ target in the experiment is to maximize his or her utility (prize minus cost) in each round. An identical cost table was attached to the introduction sheet. The introduction is shown as below. The cost table may be consulted as appendices to this thesis.

Introduction

This is a group of scientific research experiments on decision-making. The experiment operation is very simple. If you strictly abide by the experiment rules and make good decisions, you will not only get 100 yuan of participation reward, but also earn about 50-200 yuan of experiment bonus. The remuneration will be paid to you in the form of Wechat transfer.

Specific operation

You will be randomly assigned to three other participants. Four of you will be randomly assigned to one of the roles in the experiment: Zhou, Wu, Zheng and Wang. These four roles are equal and have equal rights and obligations in the experiment. The information about which roles you play will be kept confidential, and each participant will only know his or her role. The experiment will take about 45 minutes. During the whole experiment, please don't communicate with each other, especially don't say the numbers you filled in. To avoid other people waiting, try to avoid being interrupted or to interrupt.

The experiment will be carried out in four stages with 24 rounds. In each round, you need to select any integer from 1 to 100 to fill in the corresponding cell as the decision number E. The larger the input value is, the larger the output will be (the output is equal to the sum of the decision number you input and a random number of about ± 10). Of course, the higher the cost will be. The cost table is as follows. After you fill in the decision number, the next cell will automatically calculate the cost for you.

After all four participants in your group fill in and submit, the system will automatically calculate the ranking according to your output, and calculate the corresponding bonus according to the ranking (see the computer operation interface for the bonus table). The bonus minus your cost is your current round of income. Multiply the sum of all your rounds by 2, and you will get the experiment bonus. In this experiment, your goal is to find a way to get the most

profit and experiment bonus.

You can enter the corresponding link address (to be released later) in the address bar of the computer browser to enter the participant interface of this experiment. Only green cells are the areas you can fill in. Do not change the data in other cells. After you just entered, can't edit, and click the upper right corner to login, Wechat scan QR code will appear. At this time, do not use your own Wechat scanning. Wait for the experimenter to scan before you can enter the experiment smoothly.

In each round, you need to fill in two decision numbers of scenes AB in the same column within 30 seconds in the green cell (scenes a and B are independent of each other, the only difference is the amount of bonus). After confirmation, press control + s on the keyboard to save and submit. After all participants submit, the experimenter will verbally inform you to click the menu: formula → cross table reference → update the reference, and you will see the results of this round, including your own output, ranking, bonus and income, as well as the output of the other three participants in your group. (Note that after the results of the last round come out, the decision number of the last round can't be changed any more, which is invalid.) Then, you can start to fill in the next round of decisions. After 6 rounds of each stage, please stop and wait for the oral notice of the experimenter.

Before the formal experiment, we will carry out three rounds of practice to ensure that all of you fully understand. The income from the exercise round is not included in the experiment bonus.

After the participants have read the introduction, the experimenter introduced the interface by a projector screen, emphasizing the calculation logic inside. Then a slip of paper was distributed to each participant respectively containing the unique URL (Uniform Resource Locator) address for each one of them. The participants input the URL address into a web browser like Microsoft Internet Explorer to enter into the participant's interface.

The experiment was conducted by the order registered in Table 3-7. Firstly, three pilot rounds were implemented in order to help participants to understand the operation. In every round, all participants were requested to input two decision numbers into the green cells in spreadsheet within 60 seconds, then submit the numbers by saving the spreadsheet. The results were displayed on the participants' spreadsheet immediately. The participants reviewed the results and input the number for the next round. After the three rounds in the pilot phase were complete, there was a question and answer session. If any participant had questions related to this experiment, he may ask the experimenter and be answered in public.

Table 3-7 Experiment Implementation Order

	Testing			Phase 1						Phase 2						Phase 3						Phase 4					
Run Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Round	Trial Run			1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	7	8	9	10	11	12
Treatment	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C	A	A	A	A	A	A	C	C	C	C	C	C
Treatment	B	B	B	B	B	B	B	B	B	D	D	D	D	D	D	B	B	B	B	B	B	D	D	D	D	D	D

The formal experiment started from phase 1 of treatments A and B, round by round. The participants were required to fill two decision numbers and submit the input within 30 seconds for each round in phase 1 and following phases. A time keeper showed the countdown from 30 to 0 seconds on the projector screen by programmed slides.

After phase 1 was complete, the experimenter paused the experiment, and announced that no feedback in each round in phase 2 would be given. The final average results in phase 2 will be displayed until all six rounds were complete. Before starting phase 3, the experimenter announced that feedback would be given for each round. Following phase 4, the experimenter announced that no feedback would be given for each round until the six rounds were finished.

After all rounds were complete, a questionnaire was issued to every participant. The participants were asked to fill their basic profile and in addition, to score their risk preference on a scale in the questionnaire. The scale from Kramer and Weber (2012) was used and participants were required to select one of the 11 investment options from A to K. The questionnaire is shown as below.

Dear students:

Thank you very much for your participation in our scientific research experiment. Now we need you to fill out a questionnaire. This questionnaire is filled out anonymously. Please fill it truthfully. We guarantee that this information is only used for academic research and not for other purposes.

The first part

Please tick or fill in according to your actual situation.

1. Your seat number in the experiment is: ( )

2. Your gender: A. male B. female ( )

3. Your age: ( )

The second part

If you get 200 Yuan through a certain effort, there is a 1 / 2 chance that an investment

project will double your investment amount more (the return on investment is 110%). There is also a 1 / 2 possibility that your investment amount will not be recovered (return on investment is - 100%).

For example, if you invest all 200 Yuan (100%), you will have 1 / 2 chance to get 420 Yuan or 0 Yuan each. If you invest 100 Yuan out of 200 Yuan (50%), the 100 Yuan that is not used for investment in the first place can be reserved. Plus, each has 1 / 2 chance to get 210 Yuan or 0 Yuan. Your total income is 310 Yuan or 100 Yuan. If you do not participate in the investment, you will get a fixed 200 Yuan.

If I give you feedback immediately and get income, what percentage of 200 Yuan will you invest? (Single choice). ( )

A. 100% (half may get 420 Yuan, half may want to get 0 Yuan)

B. 90% (half may get 398 Yuan, half may want to get 20 Yuan)

C. 80% (half may get 376 Yuan, half may want to get 40 Yuan)

D. 70% (half may get 354 Yuan, half may want to get 60 Yuan)

E. 60% (half may get 332 Yuan, half may want to get 80 Yuan)

F. 50% (half may get 310 Yuan, half may want to get 100 Yuan)

G. 40% (half may get 288 Yuan, half may want to get 120 Yuan)

H. 30% (half may get 266 Yuan, half may want to get 140 Yuan)

I. 20% (half may get 244 Yuan, half may want to get 160 Yuan)

J. 10% (half may get 222 Yuan, half may want to get 180 Yuan)

K. 0% (no investment, 200 Yuan is determined)

According to each participant's overall utility, the total prize of every subject is calculated automatically by the spreadsheet. The actual payment is the calculated total prize times 2. According to the final result, the highest prize is 115 Yuan, the lowest prize is 25 Yuan, and the average is 68 Yuan. The prize added to 100 Yuan fixed show-up fee was the total reward for each subject. The rewards were paid to the participants respectively and anonymously via Wechat e-pay system within four hours after the completion of the experiment. A brief thank-you letter was sent to participants via Wechat.

3.1.3 Experiment summary

In summary, an effort-chosen experiment was designed and conducted to simulate a multiple person tournament. The two variables are prize structures and feedback policy. Prize structure has two levels: two-level prize structure and multiple level prize structure. Feedback policy has two levels: full feedback and no feedback. The experiment consists of four treatments, including two-level and full feedback, two-level and no feedback, multiple level and full feedback, multiple level and no feedback. A total of 28 subjects participated into the 4-phase experiment, arranged by seven groups. A total of 1344 effort data have been collected during the experiment. At the end of the experiment, subjects' risk preference was collected by means of a questionnaire.

3.2 Focus group interview

During the experiment, the subjects are only required to input numbers into the computer round-by-round but are not allowed to chat with each other, nor to communicate with researcher. The researcher does not know the subjects' perception, feelings and thinking in a particular situation, however this information is important for the researcher to understand the reason for the subjects' behavior, besides the numbers on the screen. How should the researcher collect this information effectively?

Merton and Kendall (1946) published a book named 'The Focused Interview'. They argued that the focused interview is designed to determine the responses of persons exposed to a situation previously analyzed by the investigator. One if its chief functions is to discover the processes involved in experimentally induced effects. Morgan (1996) defined focus groups as a research technique that collects data through group interaction on a topic determined by the researcher and that can be used as a follow-up that assists in interpreting survey results. Morgan (1993) argued that the advantages of focus groups for investigating complex behaviors and motivations were a direct result of the interaction in focus groups. Gibbs (1997) argued that the main purpose of focus group research is to draw upon respondents' attitudes, feelings, beliefs, experiences and reactions in a way in which would not be feasible using other methods. Therefore, we believe that focus group is useful to collect information from the subjects after the experiment.

Gibbs (1997) listed the key points in practical organization of focus groups. Following Gibbs' introduction, we designed the focus group as described below.

3.2.1 Participants recruitment

Eight candidates who joined the experiment were randomly selected and contacted via text message in Wechat online software. The proposed time, location and purpose of the focus group interview were listed in the invitation message. Finally, six accepted the invitation, including 4 male and 2 female students. Four out of 6 student's major is management science and engineering; the remaining 2 students' major is finance.

3.2.2 Preparation before focus group interview

The focus group interview location was a separate office in the School of Management and Economics at the University of Electronic Science and Technology of China. There was a meeting table with six chairs in the office. The atmosphere was made to put the participants at ease with snacks and coffee on the table in advance. A nameplate for every participant was prepared and placed on the table. Big white sheets were posted on the wall to record key points during the session. Audio recording software was available with the mobile phone.

As Gibbs (1997) emphasized, the role of the moderator or group facilitator becomes critical, especially in terms of providing clear explanations of the purpose of the group, helping people feel at ease, and facilitating interaction among group members. The moderator read several notes related to focus group in advance, explaining the key points of the focus group technique.

3.2.3 Implementation procedure of focus group

After all participants arrived and sat down, the moderator gave a comfortable opening speech including self-introduction. Then the moderator stated the purpose of the focus group interview, asking participants to express their opinion freely. After that, the moderator recalled the procedure of experiment conducted one week before, as well as the subject interface. Then the moderator raised the open questions below one by one.

1. How about your overall feeling regarding the experiment?
2. Between two-level prize structure and multiple level prize structure situation, in which did you input a higher decision number? Why?
3. Between full feedback and no feedback situation, under which did you input a higher decision number? Why?

4. In the risk preference questionnaire, which one did you selected? Is there any linkage between your risk preference and the effort number in the prize structure variance, and feedback policy variance?

5. If you were a human resource manager, how would you design a prize structure and feedback policy in a performance management system?

6. Do you have any additional idea about this experiment?

The moderator, as facilitator in the interview, encouraged participants to speak out freely, and controlled the discussion topic. The key points are written down on the white sheets on the wall. The session was audio recorded for further analysis.

3.2.4 Focus group interview summary

Six subjects, who participated the experiment, joined the focus group. The topics discussed included prize structure and feedback policy variance. The audio of the discussion was recorded for further analysis.

3.3 Case study

Experiment is a useful method to test hypotheses by controlling variables in a simulation environment. However, is the theory constructed in an experiment applicable in the real world? As a supplement, we have also conducted a case study to test hypothesis 1 **(**Employees' effort in a multiple level prize structure is higher than that in a two-level prize structure) and hypothesis 4 (Employees' effort under full feedback policy is higher than that under no feedback policy).

Case study is widely used by management researchers as it is a detailed description of management in a real life situation.

We examined two levels of performance management system in a single case, in terms of prize structure and feedback policy. The first level is department managers' performance appraisal by their direct supervisor, the plant manager. The second level is workshop workers' performance appraisal by their direct supervisors, the foremen. Multiple level prize structure and periodic full feedback policy are a usual practice in the factory.

Then we distributed questionnaires to the people involved in these two levels of the performance appraisal program, as well as to the third parties and to the human resource manager asking about their thinking on prize structure and feedback policy.

We received a total of 66 valid responses that are analysed in Chapter 5.

3.4 Quantitative data analysis method

After the data from the experiment and the questionnaire are collected, how can we analyze these quantitative data? The analysis software, graph technique and statistical test tools are introduced here.

3.4.1 Analysis software used in this research

Besides Microsoft Excel, IBM SPSS Statistics and Minitab are used to analyze the quantitative data as per Figure 3-3.

SPSS stands for statistical product and service solutions and is a widely used statistical software. SPSS was developed by three Stanford students in 1968 and acquired by IBM in 2009. It is the most popular statistical software in the academic world.

Minitab is a leading statistical software in quality management and in the Six Sigma area. Minitab was developed at Pennsylvania State University in 1972 and many global corporations use it.

Figure 3-3 Statistical Soft Used

3.4.2 Graph technique used in this research

In order to visualize the data from different views, the graph techniques below are used for data analysis.

(a) Box Plot Chart gives a quick look on the distribution of a set of data, making it easy to compare multiple data sets. From the box height capped by first quartile line and third quartile line, the centralization of dataset is displayed. The outliers represent the separate points far from the other data value.

(b) Histogram, also called frequency plot, evaluates the distribution of a set of data. The bar represents the count within different ranges of data. The shape of bars tells us the underlying distribution of the data.

(c) Scatter charts show the relationship or correlation between two factors or variables. It is easy to identify a positive or negative correlation from a scatter chart.

3.4.3 Statistical test tools used in this research

Wilcoxon signed rank test is used to analyze data from a paired two-sample design without assuming the normal distribution. It is one of the non-parametric tests developed by Wilcoxon in 1945. The Wilcoxon signed rank test should only be used in practice if the differences of the paired data are symmetric (Munzel, 1999).

Chi-square goodness of fit test is a non-parametric test to compare the observed sample distribution with the expected probability distribution.

Correlation is used to check if there is a relationship between two data sets. A positive correlation means that the higher values of one variable are associated with the higher value of the other variable. A negative correlation means that the higher value of one variable is associated with the lower value of another variable. In case one of the two variables is not continuous data, Spearman correlation analysis should be used.

Chapter 4: Data Analysis

In this Chapter, the data collected from the experiment is analyzed, to test the eight hypotheses. Firstly, the data overview is presented. Following is the test of the first 4 hypotheses in terms of the prize structure effect on employees' effort, then the test of 4 hypotheses in terms of feedback policy. Finally, the data analysis is summarized. Microsoft Excel, IBM SPSS and Minitab are used to analyze the data.

4.1 Overview of the data collected from the experiment

All 28 subjects participated in all the 4 treatments in a total of 24 rounds. In each round, the subject inputs 2 numbers between 1 and 100, representing effort degree in two-level prize and multiple level prize structure respectively. Inside the 24 rounds, 12 rounds have immediate full feedback, the remaining 12 rounds have no feedback. Therefore, each subject inputs total 48 effort numbers as detailed in Table 4-1.

Table 4-1 Dataset for Each Subject

	Phase 1 Round 1-6	Phase 3 Round 7-12	Phase 2 Round 1-6	Phase 4 Round 7-12	
Observed Data	Full Feedback		No Feedback		Sub-Total
Two-level Prize	12		12		24
Multi-Level Prize	12		12		24
Sub-Total	24		24		48

The total effort number is 1344 from all the 28 subjects and 24 rounds. The average effort number by round of each treatment is calculated, and presented by line chart with markers.

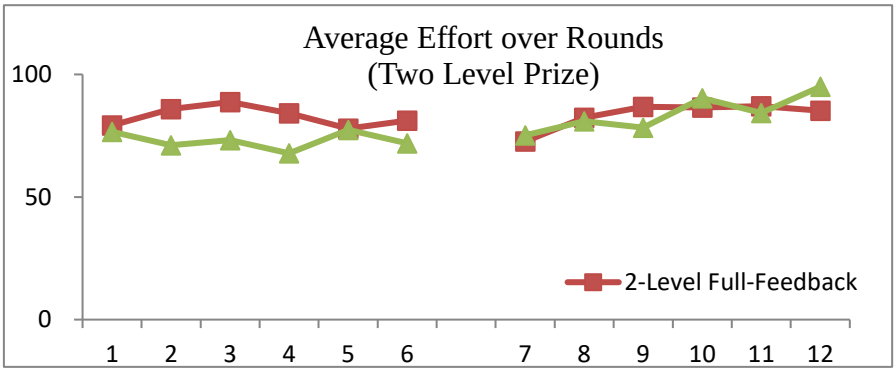

Figure 4-1 Average Effort over Rounds in Two-level Prize Structure

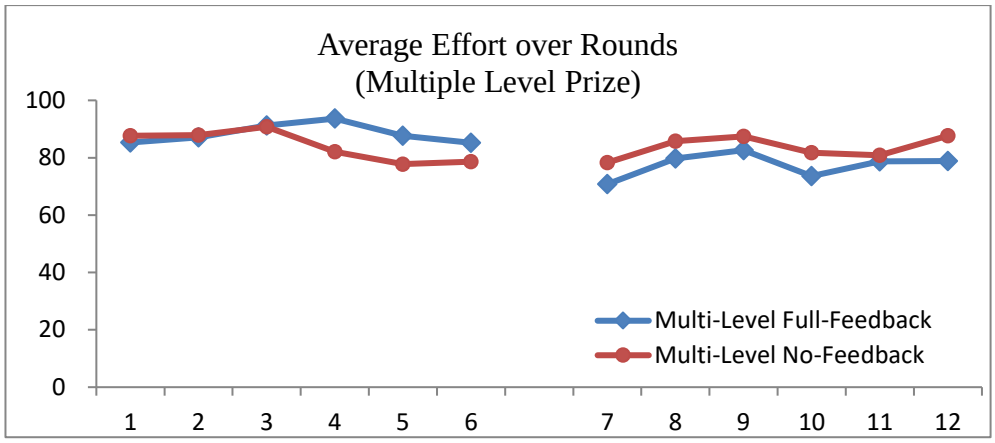

Figure 4-2 Average Effort over Rounds in Multiple Level Prize Structure

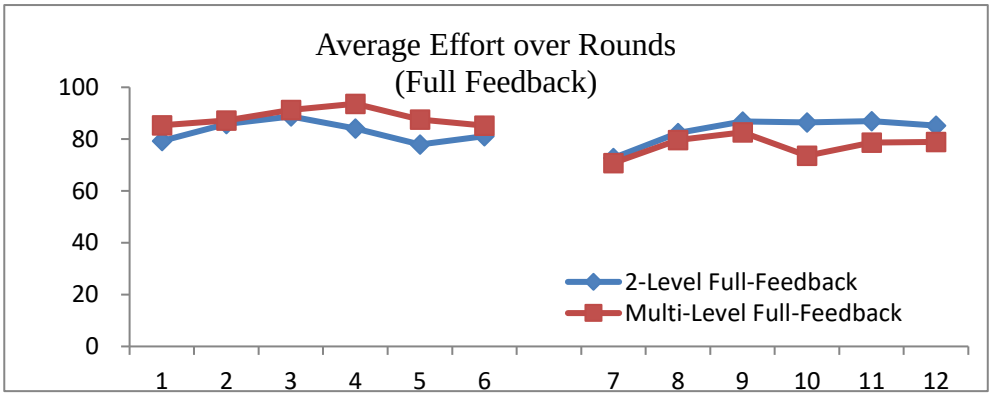

Figure 4-3 Average Effort over Rounds under Full Feedback Policy

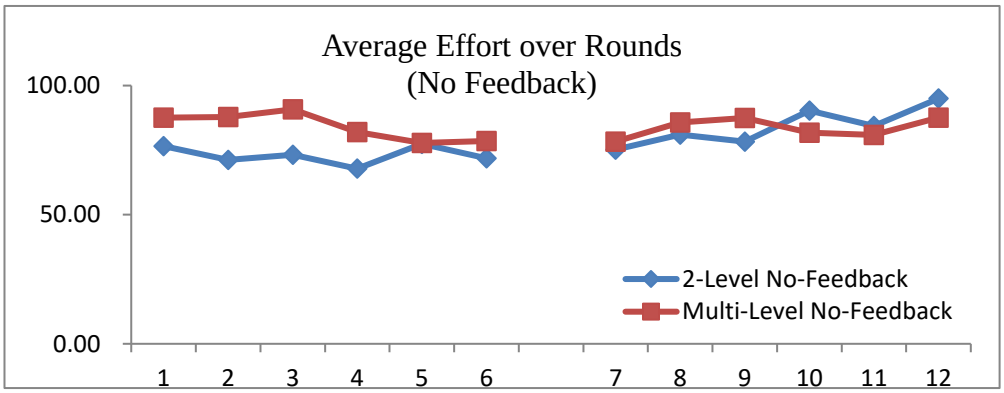

Figure 4-4 Average Effort over Rounds under No Feedback Policy

Figure 4-1 is the line chart of average effort over rounds in the two-level prize structure. Figure 4-2 is the average effort over rounds in a multiple level prize structure. Figure 4-3 is the average effort over rounds under full feedback policy. Figure 4-4 is average effort over rounds under no feedback policy.

Besides the 1344 effort numbers collected in the experiment, risk preference of each subject is investigated by means of a questionnaire. The one who selects option A has the highest risk preference, while the one who selects option K has the lowest risk preference. For

further analysis in SPSS, the selections are transformed into risk preference numbers, the larger the number is, the higher the risk preference is. Refer to Table 4-2 for details. The detailed cross-reference table is in appendix 4.

Table 4-2 Risk Preference Category

Choice	A	B	C	D	E	F	G	H	I	J	K
Risk Degree	11	10	9	8	7	6	5	4	3	2	1
Frequency	2	0	2	1	0	11	1	2	1	2	6

With these data, we can start to test the hypotheses.

4.2 Test of prize structure effect on effort

During the experiment, every subject inputs 2 numbers in every round, one is the effort number in a two-level prize structure, the other is the effort number in a multiple level prize structure. Because these 2 numbers are filled by the same subject in the same time slot, they are paired.

To test the effort difference between a two-level prize structure and a multiple level prize structure, the procedure is as below:

1. Set the data in columns.
2. Draw box-plot chart to visualize the two groups of data.
3. Conduct normality test of the difference value of the two groups of data.
4. Conduct descriptive statistics to understand the profile of the data.
5. If the difference value data distribute normally, conduct Paired-T test.
6. If the difference value data distribute abnormally, conduct Wilcoxon signed rank test.

Basically, when the hypothesis test is conducted, the significance level is set at 0.05.

4.2.1 Test of prize structure effect on effort in both feedback policies

This section is to test Hypothesis 1: Employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

To test the prize structure effect on employees' effort in both full feedback and no feedback policies, the data are set as formatted in Table 4-3. Effort numbers of two-level and multiple level prize structure are listed in two columns respectively in a total of 672 rows.

Table 4-3 Dataset of Two-level and Multiple Level

Group & Round & Subject	Two-level	Multiple Level
G1_Round1_Zhou	88	55
G1_Round1_Wu	93	89
G1_Round1_Zheng	78	73
G1_Round1_Wang	99	88
G1_Round2_Zhou	100	98
G1_Round2_Wu	93	83
G1_Round2_Zheng	88	92
G1_Round2_Wang	98	95
…	…	…
G7_Round24_Zhou	98	7
G7_Round24_Wu	97	7
G7_Round24_Zheng	96	7
G7_Round24_Wang	95	7

Firstly, a box plot chart is drawn to present the distribution of the 2 sets of data, as Figure 4-5. From this chart, we can see that three fourths of the data are within 80~100. The median of data for multiple level is a little bit higher than that for two-level. Some discrete points distribute with 1~60 in both two-level and multiple level prize structure.

In order to decide which hypothesis test tool should be adopted, the row-by-row difference value is calculated. Figure 4-6 shows the histogram of the difference value. The mean is only 2.55 but the standard deviation is 41.88. This means that some of the subjects have selected numbers with large deviation between situations of two-level and multiple level prize structure. From the two tails of the histogram, we can see that some subjects selected many higher effort numbers in the two-level prize structure, and some selected many higher numbers in the multiple level prize structure. The tests of normality show that the difference value data do not normally distribute as per Table 4-4. Therefore, Wilcoxon signed rank test should be used.

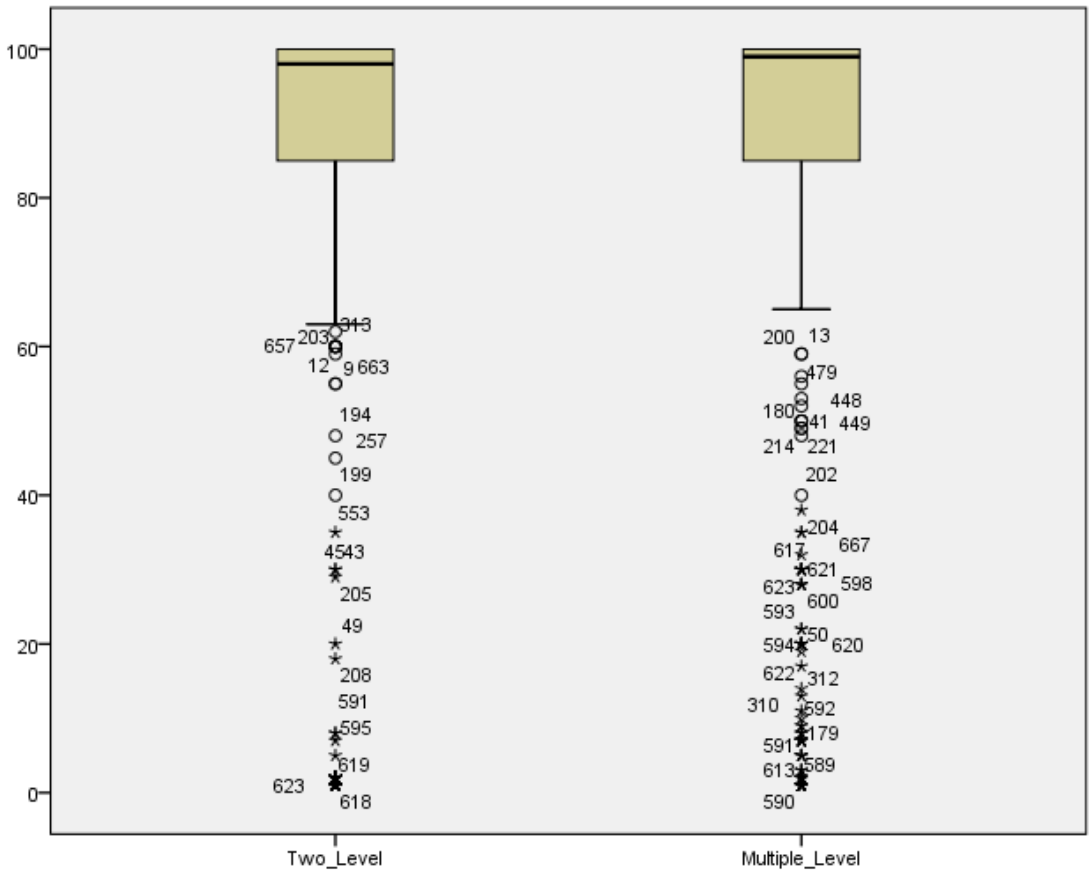

Figure 4-5 Box Plot Chart of the Effort Number in different Prize Structure

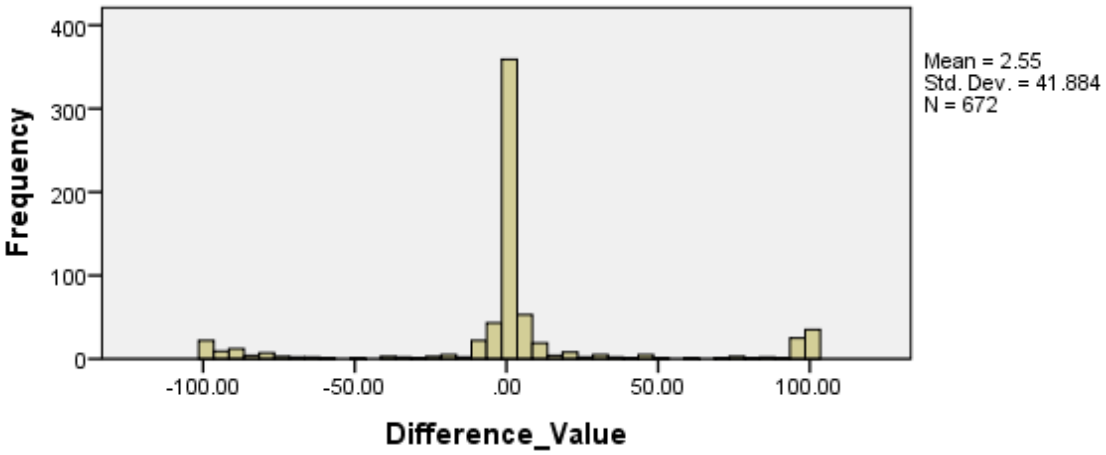

Figure 4-6 Histogram of Difference Value of 2 Prize Structures

Table 4-4 Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value	.276	672	.000	.736	672	.000

Descriptive statistics results show that the median of multiple level is 99, higher than that in the two-level structure at 98, refer to Table 4-5.

Table 4-5 Descriptive Statistics

	N	Range	Min	Max	Mean	Median	Std. Deviation
Two_Level	672	99	1	100	80.83	98	34.197
Multiple_Level	672	99	1	100	83.37	99	30.766
Valid N (listwise)	672						

From the Wilcoxon signed rank test result shown in Figure 4-7, there are 253 positive differences (multiple level > two-level) and 160 negative differences (multiple level < two-level). Hypothesis test summary shows that the p-value is 0.001 and the null hypothesis is rejected as per Table 4-8. That means the median difference between effort numbers in multiple level prize structure and that in two-level prize structure is significant. The median of multiple level is 99, higher than that of two-level at 98, refer to Table 4-5 for details.

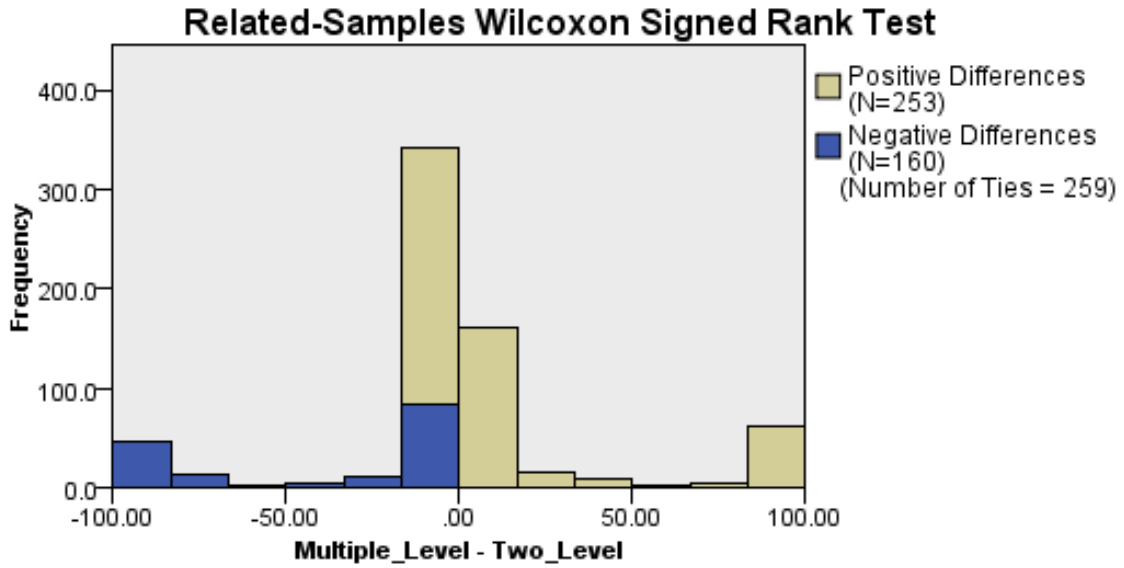

Figure 4-7 Wilcoxon Signed Rank Test Result

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Two_Level and Multiple_Level equals 0.	Related-Samples Wilcoxon Signed Rank Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-8 Hypothesis Test Summary Result

Table 4-6 Summary of Hypothesis Test Result of Hypothesis 1

Prize structure	Obs	Mean	Median	SD	P-value
Two-Level	672	80.83	98	34.197	0.001
Multi-Level	672	83.37	99	30.776	

Therefore, hypothesis 1 is not rejected: Employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

4.2.2 Test of prize structure effect on effort in full feedback policies

This section is to test Hypothesis 2a: Under full feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

To test the prize structure effect on employees' effort in the full feedback policy, the data are set as format in Table 4-3. Effort numbers of two-level and multiple level prize structure in phase 1 and phase 3 (full feedback) are listed in two columns respectively, total 336 rows.

Firstly, a box plot chart is drawn to present the distribution of the 2 sets of data, as per Figure 4-9. From this chart, we can see three fourths of the data are within 85~100. The median of data for multiple level is a little bit higher than that for two-level. Some discrete points distribute with 1~60 in both two-level and multiple level prize structure.

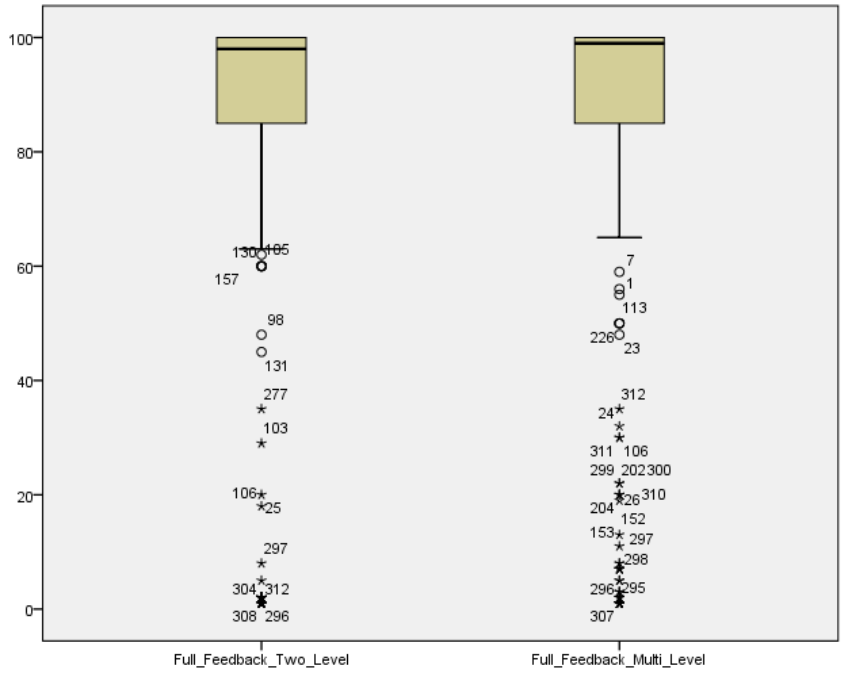

Figure 4-9 Box Plot Chart of the Effort Number in Full Feedback Policy

In order to decide which hypothesis test tool should be used, the row-by-row difference

value is calculated. Figure 4-10 shows the histogram of the difference value. The mean is only -0.26, the standard deviation is 38.045.

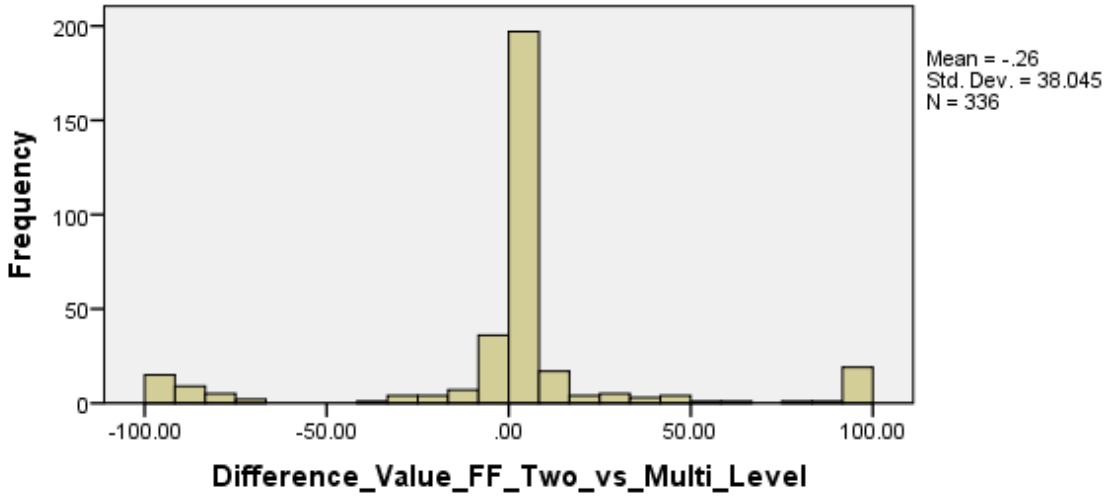

Figure 4-10 Histogram of Difference Value of 2 Prize Structures in Full Feedback

The tests of normality show that the difference value data do not normally distribute, refer to Table 4-7. Therefore, Wilcoxon signed rank test should be used.

Table 4-7 Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value_FF_Two_vs_Multi_Level	.302	336	.000	.721	336	.000

Descriptive statistics results show that the median of multiple level is 99, higher than that in the two-level structure at 98, refer to Table 4-8.

Table 4-8 Descriptive Statistics

	N	Min	Max	Mean	Median	Std. Deviation
Full_Feedback_Two_Level	336	1	100	83.13	98	30.630
Full_Feedback_Multi_Level	336	1	100	82.88	99	30.689
Valid N (listwise)	336					

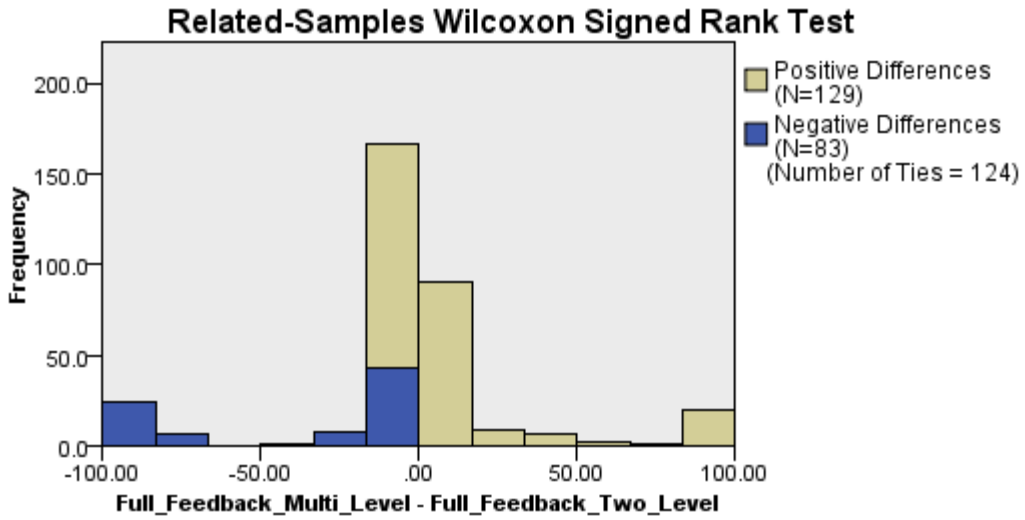

Figure 4-11 Wilcoxon Signed Rank Test Result

From Wilcoxon signed rank test result showing in Figure 4-11, there are 129 positive differences (multiple level > two-level) and 83 negative differences (multiple level < two-level). In other words, positive differences are 55% more than negative differences.

Hypothesis test summary shows that the p-value is 0.052, a little bit higher than 0.05. If we say that the significance level is 0.05, the null hypothesis is retained (Figure 4-12), while if we set a significance level at 0.1, the null hypothesis is rejected (Figure 4-13). Since the p-value is only 0.002 higher than 0.05, and that positive differences are 55% more than negative differences as per Figure 4-11, we conclude that the difference is marginally significant. That means the median difference between effort numbers in the multiple level prize structure and that in the two-level prize structure is marginally significant.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Full_Feedback_Two_Level and Full_Feedback_Multi_Level equals 0.	Related-Samples Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-12 Hypothesis Test with Significance Level at 0.05

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Full_Feedback_Two_Level and Full_Feedback_Multi_Level equals 0.	Related-Samples Wilcoxon Signed Rank Test	.052	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .10.

Figure 4-13 Hypothesis Test with Significance Level at 0.10

In Table 4-9, it is noted that the average effort in multiple level is 82.88, 0.25 lower than average effort in two-level at 83.13. Because Wilcoxon signed rank test addresses differences of median but not differences of mean, when the difference is significant, the median should be checked but not the mean. The median of multiple level is 99, higher than that of two-level at 98.

Table 4-9 Summary of Hypothesis Test Result of Hypothesis 2a

Prize structure	Obs	Mean	Median	SD	P-value
Two-Level	336	83.13	98	30.630	0.052
Multi-Level	336	82.88	99	30.689	

Therefore, Hypothesis 2a is not rejected: Under full feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

4.2.3 Test of prize structure effect on effort in no feedback policies

This section is to test Hypothesis 2b: Under no feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

In order to test the prize structure effect on employees' effort in no feedback policy, the data are set as presented in Table 4-3. Effort numbers of two-level and multiple level prize structure in phase 2 and phase 4 (no feedback) are listed in two columns respectively, in a total of 336 rows.

Firstly, a box plot chart is drawn to present the distribution of the 2 sets of data, as Figure 4-14. From this chart, we can see that three fourths of data are within 85~100. The median of the data for multiple level is a little bit higher than that for two-level. Some discrete points distribute with 1~60 in both two-level and multiple level prize structure, especially in multiple level prize situation.

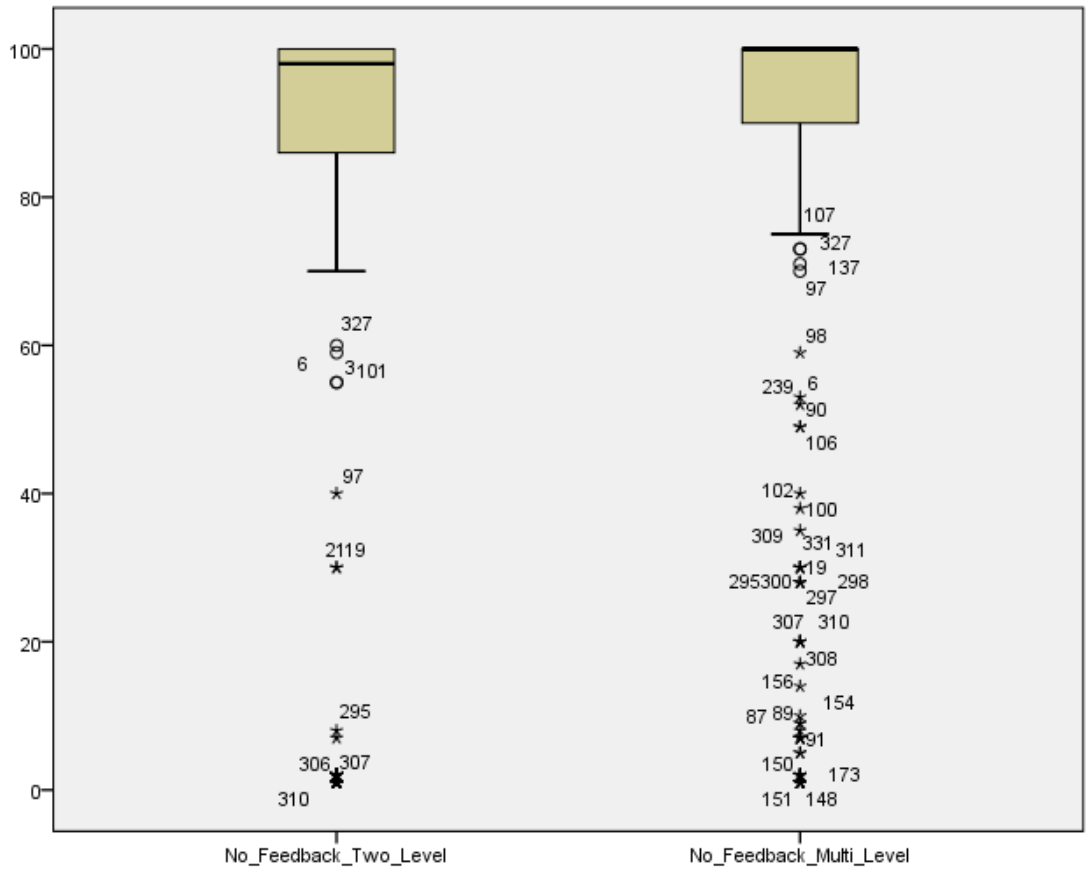

Figure 4-14 Box Plot Chart of the Effort Number in No Feedback Policy

In order to decide which hypothesis test tool should be used, the row-by-row difference value is calculated. Figure 4-15 shows the histogram of the difference value. The mean is 5.35 and the standard deviation is 45.284.

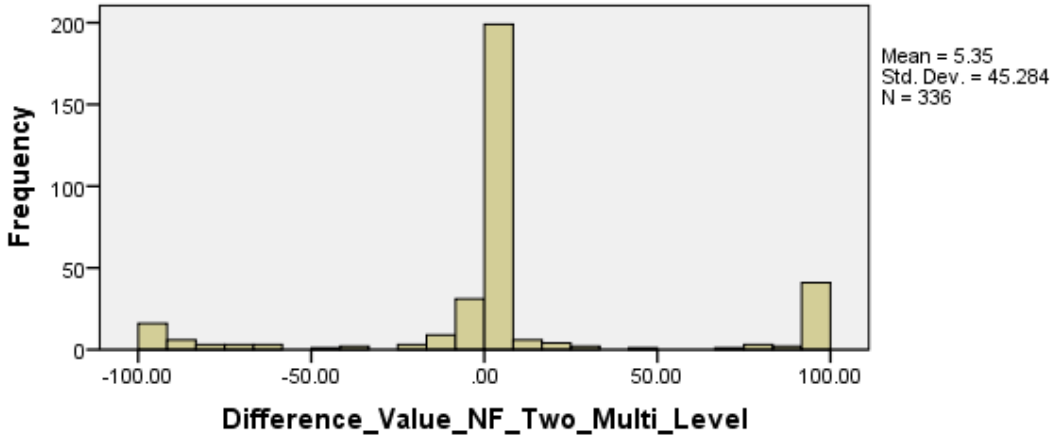

Figure 4-15 Histogram of Difference Value of 2 Prize Structures in No Feedback

The tests of normality shows that the difference value data do not normally distribute, refer to Table 4-10. Therefore, Wilcoxon signed rank test should be used.

Table 4-10 Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value_NF_Two_Multi_Level	.298	336	.000	.745	336	.000

Descriptive statistics results show that the median of multiple level is 100, higher than that in two-level structure at 98, refer to Table 4-11.

Table 4-11 Descriptive Statistics

	N	Min	Max	Mean	Median	Std. Deviation
No_Feedback_Two_Level	336	1	100	78.52	98	37.329
No_Feedback_Multi_Level	336	1	100	83.87	100	30.882
Valid N (listwise)	336					

From the Wilcoxon signed rank test result shown in Figure 4-16, there are 124 positive differences (multiple level > two-level) and 77 negative differences (multiple level < two-level). In other words, positive differences are 61% more than negative differences.

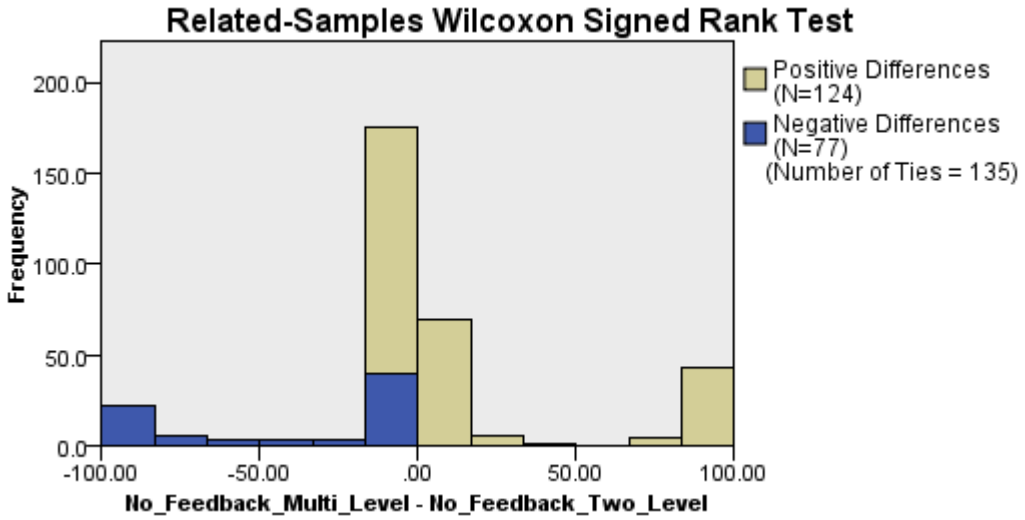

Figure 4-16 Wilcoxon Signed Rank Test Result

Hypothesis test summary shows that the p-value is 0.01, the null hypothesis is rejected (Figure 4-17). The median difference between effort numbers in multiple level prize structure and that in two-level prize structure in no feedback policy is significant.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between No_Feedback_Two_Level and No_Feedback_Multi_Level equals 0.	Related-Samples Wilcoxon Signed Rank Test	.010	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-17 Hypothesis Test Summary5

In Table 4-12, the median of multiple level is 100, higher than that of two-level at 98.

Table 4-12 Summary of Hypothesis Test Result of Hypothesis 2b

Prize structure	Obs	Mean	Median	SD	P-value
Two-Level	336	78.52	98	37.329	0.01
Multi-Level	336	83.87	100	30.882	

Therefore, hypothesis 2b is not rejected: Under no feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure.

4.2.4 Test of prize structure effect on effort with risk preferences consideration

This section is to test Hypothesis 3: The higher employee's risk preference degree, the more effort employees put in a multiple level prize rather than in a two-level prize condition.

Each subjects' risk preference is collected by a questionnaire just after the experiment. Risk preference is transformed to number 1~11. The larger the number, the higher the preference is. The effort numbers are set as presented in Table 4-13. In every row, the two effort numbers are input by the same subject in the same time slot and are paired. In the last column, the value difference between multiple level and two-level is calculated. There are total 672 rows in the table.

Table 4-13 Dataset with Risk Preference

Risk	Transformed-Risk	Two-level	Multiple Level	Difference (Multiple – Two)
K	1	88	55	-33
F	6	88	92	4
J	2	20	97	77
I	3	88	90	2
A	11	85	85	0
…	…	…	…	…

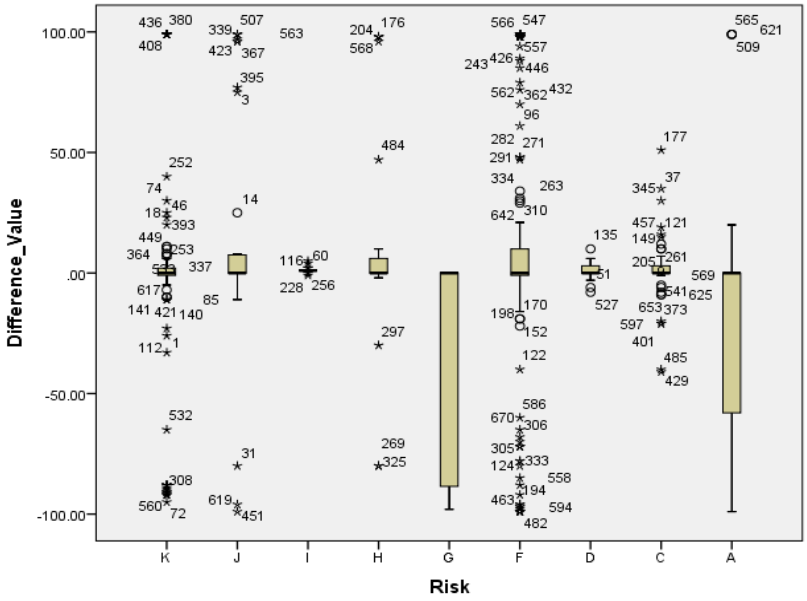

Figure 4-18 Box Plot Chart of Difference by Risk Preference

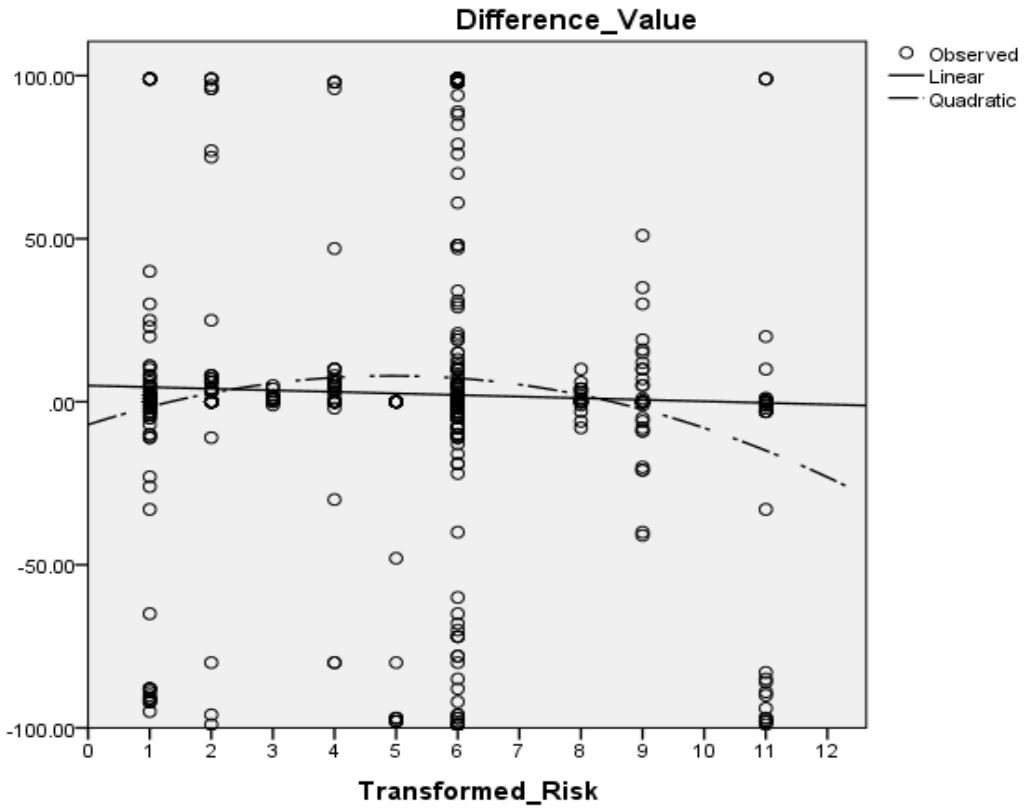

Figure 4-19 Scatter Chart of Difference with Fitting Lines

The value difference in the box plot chat is shown in Figure 4-18; there is no upward or downward trend from K (low risk reference) to A (high risk reference). In the scatter chart in Figure 4-19, the linear fitting line is flat, and the quadratic fitting line has a downward trend in high risk preference area.

Table 4-14 Spearman Correlations

			Transformed Risk	Difference Value
Spearman's rho	Transformed Risk	Correlation Coefficient	1.000	-.069
		Sig. (2-tailed)	.	.074
		N	672	672
	Difference Value	Correlation Coefficient	-.069	1.000
		Sig. (2-tailed)	.074	.
		N	672	672

Furthermore, correction analysis is conducted. Because transformed risk is ordinal data, the Spearman correlation is used. From the correlation result in Table 4-14, p-Value is 0.074, not significant and correlation coefficient is -0.069.

Therefore, hypothesis 3 is rejected.

4.3 Test of feedback policy effect on effort

During the experiment, every subject inputs effort numbers under two feedback policies, one is full feedback policy in phase 1 and phase 3, the other is no feedback policy in phase 2 and phase 4. We can calculate the average effort for each subject in the full feedback and no feedback policy respectively. Because these numbers are filled by the same subject, they are related and paired.

To test the effort difference between full feedback and no feedback policy, the procedure is detailed below:

1. Calculate average efforts, set the data in columns.
2. Draw Box Plot chart and line chart to visualize the two groups of data.
3. Conduct normality test of the difference value of the two groups of average data.
4. Conduct descriptive statistics to understand the profile of the data.
5. If the difference value data distribute normally, conduct Paired-T test.
6. If the difference value data distribute abnormally, conduct Wilcoxon signed rank test.

Basically, when the hypothesis test is conducted, the significance level is set at 0.05.

4.3.1 Test of feedback policy effect on effort in both prize structures

This section is to test Hypothesis 4: Employees' effort under full feedback policy is higher than that under no feedback policy. For each subject in each prize structure setting, the average effort numbers in full feedback and no feedback policy are calculated and put in the format showing in Table 4-15. The difference value is calculated in the right column. This data set has a total of 56 rows.

Table 4-15 Average Effort of Each Subject in Full and No Feedback

Role	Prize Structure	Mean of Full Feedback	Mean of No Feedback	Difference Value
Group1-Zhou	Two-level	90.4	85.2	5.3
Group1-Zhou	Multi-Level	84.5	88.3	-3.8
Group1-Wu	Two-level	81.7	85.7	-4.0
Group1-Wu	Multi-Level	85.0	92.2	-7.2
Group1-Zheng	Two-level	59.6	34.3	25.3
Group1-Zheng	Multi-Level	58.8	73.1	-14.3
…	…	…	…	…
Group7-Zheng	Two-level	99.9	98.0	1.9
Group7-Zheng	Multi-Level	99.8	98.0	1.8
Group7-Wang	Two-level	93.3	77.2	16.2
Group7-Wang	Multi-Level	54.8	36.3	18.5

In Figure 4-20 box plot chart, we can see some discrete points below 40.

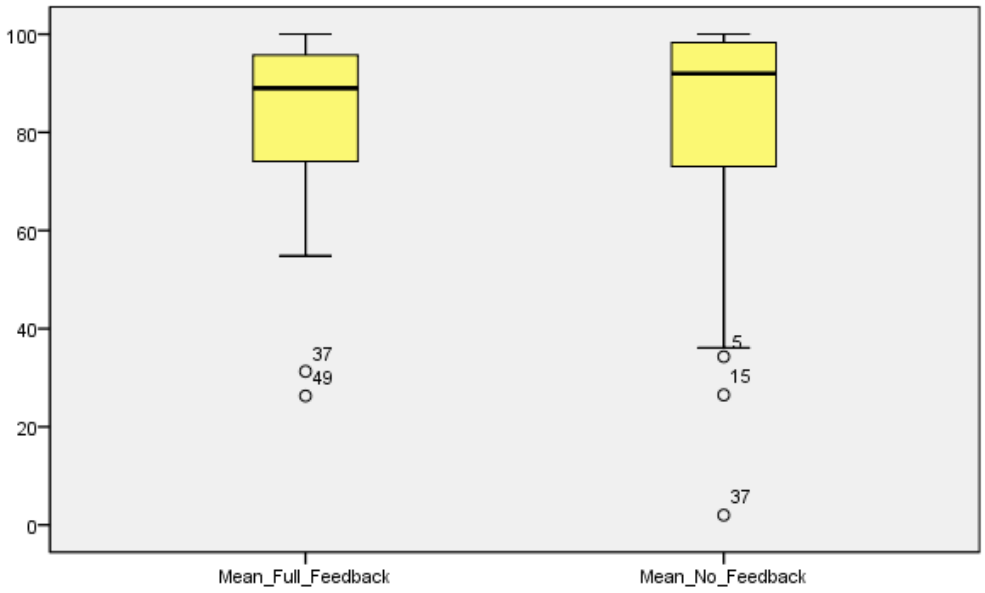

Figure 4-20 Box Plot Chart of Effort under Full Feedback and No Feedback

The line chart shows the difference between the average effort in full feedback policy and no feedback policy by each subject and by each prize structure. Some subjects select higher numbers in full feedback policy, and some select higher numbers in no feedback policy. There is no obvious trend that the overall effort in the full feedback is higher, as shown in Figure 4-21.

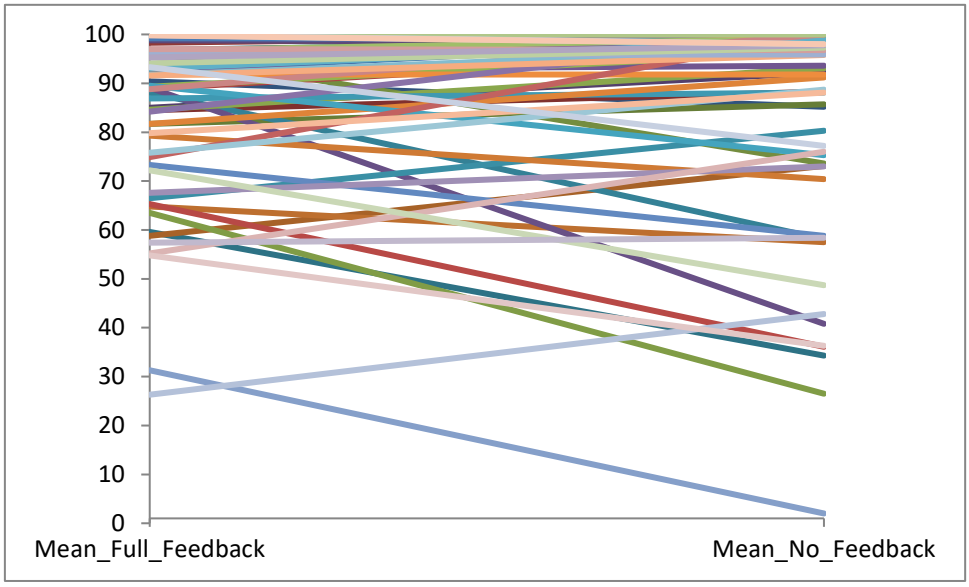

Figure 4-21 Line Chart of Average Effort

From the histogram in figure 4-22, the mean is 1.81 and the standard deviation is 14.728.

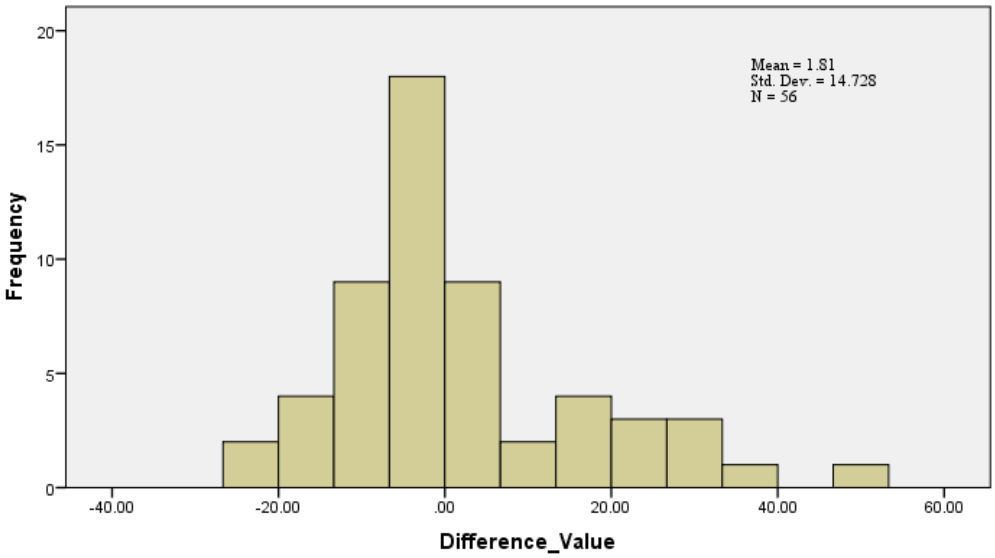

Figure 4-22 Histogram of Difference Value

Descriptive statistics results show that the average effort in full feedback is higher at 83.0196 and the median in no feedback is higher at 92, refer to Table 4-16.

Table 4-16 Descriptive Statistics

	N	Min	Max	Mean	Median	Std. Deviation
Mean_Full_Feedback	56	26.30	100.00	83.0196	89	16.97834
Mean_No_Feedback	56	2.00	100.00	81.2018	92	23.57336
Valid N (listwise)	56					

In Table 4-17, we can see that the value difference is not normally distributed because p-Value is 0. So Wilcoxon signed rank test should be used.

Table 4-17 Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value	.235	56	.000	.902	56	.000

From Wilcoxon signed rank test result showing in Figure 4-23, positive difference is 33 and negative differences is 20. The hypothesis test summary shows that the p-Value is 0.684 (Figure 4-24). The effort difference between full feedback and no feedback is not significant.

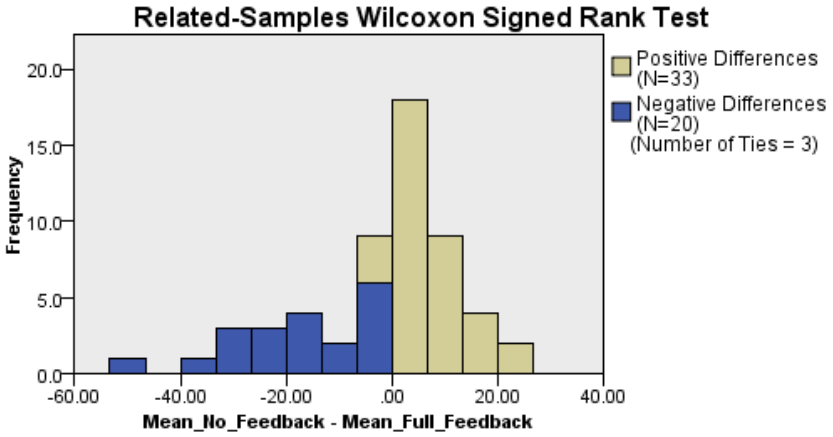

Figure 4-23 Wilcoxcn Signed Rank Test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Mean_Full_Feedback and Mean_No_Feedback equals 0.	Related-Samples Wilcoxon Signed Rank Test	.684	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-24 Hypothesis Test Summary

Therefore, hypothesis 4 is rejected.

4.3.2 Test of feedback policy effect on effort in two-level prize structure

This section is to test Hypothesis 5a: In a two-level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

The data is a subset of Table 4-15 by selecting only two-level situation. There are 28 rows. The box plot chart of average effort is in Figure 4-25.

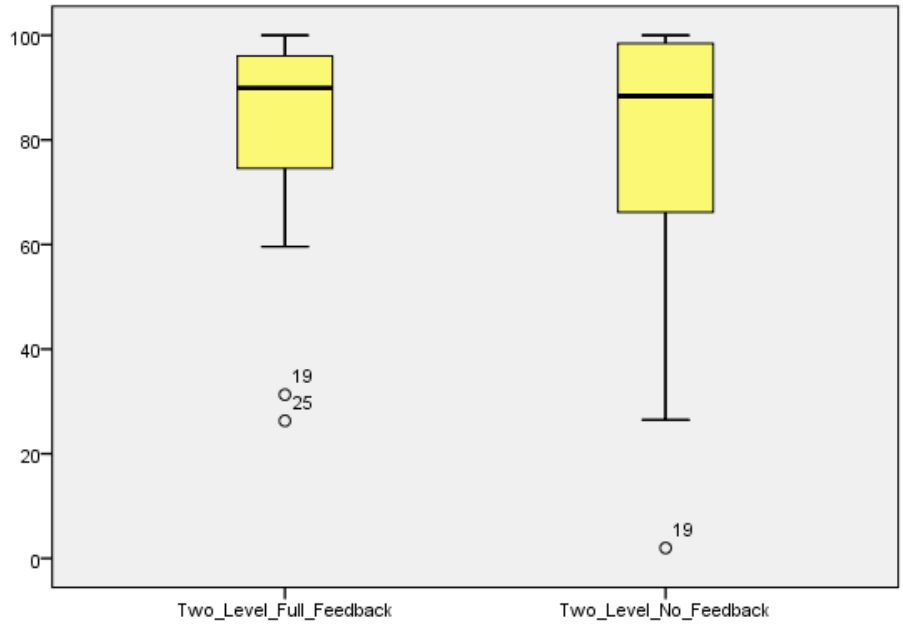

Figure 4-25 Box Plot Chart of Average Effort

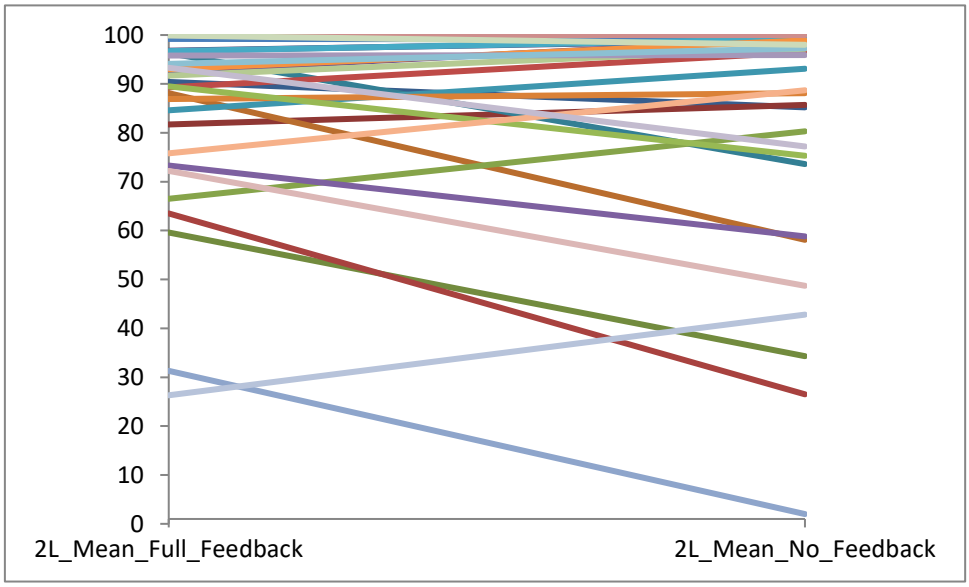

Figure 4-26 Line Chart of Average Effort

In Figure 4-26, the line chart shows there is no obvious trend that the average effort in full feedback is higher.

In Figure 4-27, the mean of difference value is 4.62 and standard deviation is 14.722.

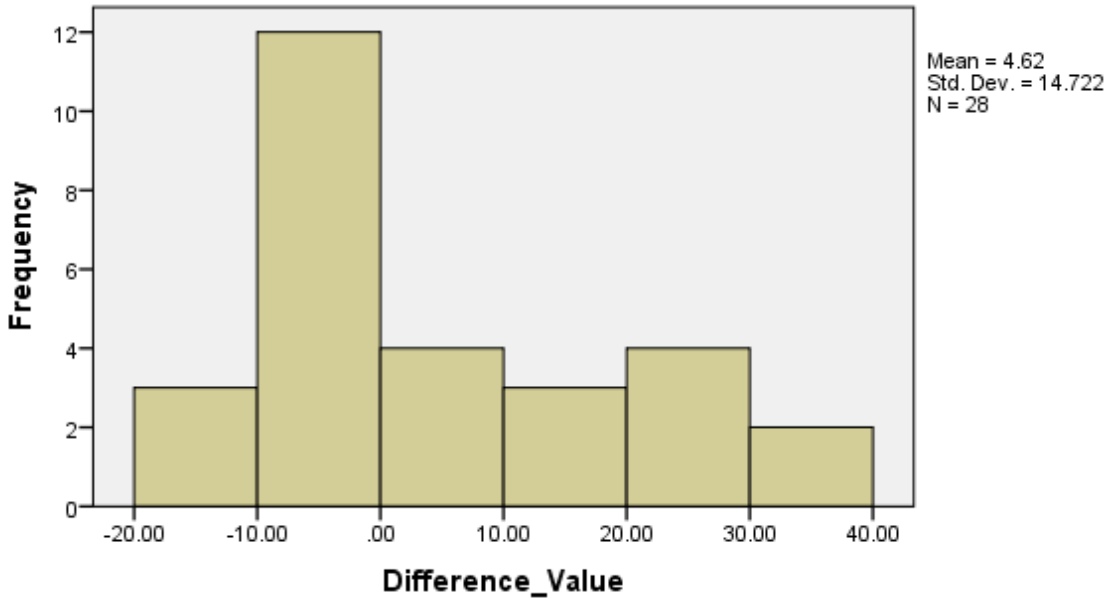

Figure 4-27 Histogram of Difference Value

In Table 4-18, descriptive statistics results show that the average effort under full feedback is higher at 83.1464, and the median is higher under full feedback at 90.

Table 4-18 Descriptive Statistics

	N	Min	Max	Mean	Median	Std. Deviation
Two_Level_Full_Feedback	28	26.30	100.00	83.1464	90	19.11502
Two_Level_No_Feedback	28	2.00	100.00	78.5286	88.4	26.37230
Valid N (listwise)	28					

By testing normality of difference, the p-Value is much less than 0.5, so Wilcoxon signed rank test should be used, refer to Table 4-19.

Table 4-19 Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value	.228	28	.001	.906	28	.016

In Figure 4-28, we can see that the Wilcoxon signed rank test results show that there are 15 positive differences and 12 negative differences.

In Figure 4-29, the p-Value is 0.449. The effort difference between full feedback and no feedback in two-level prize situation is not significant.

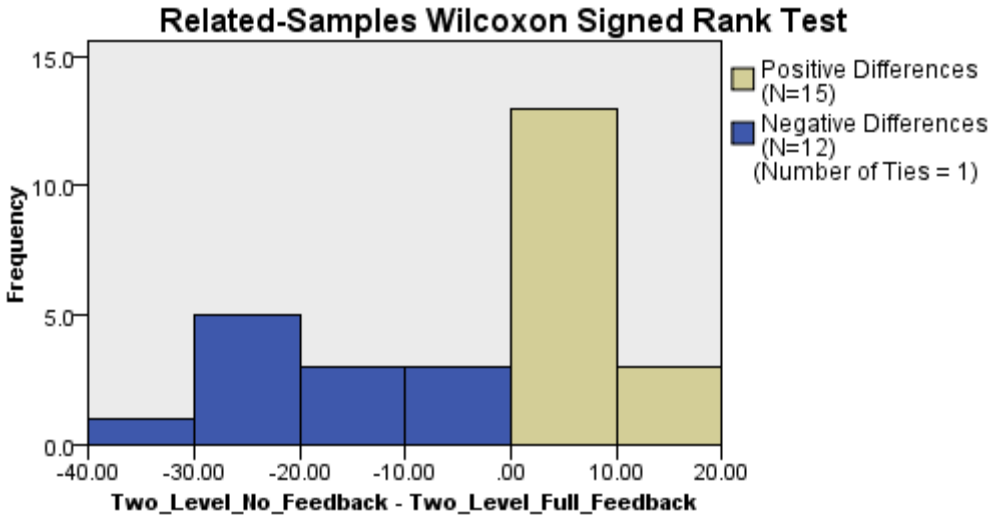

Figure 4-28 Wilcoxon Signed Rank Test Result

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Two_Level_Full_Feedback and Two_Level_No_Feedback equals 0.	Related-Samples Wilcoxon Signed Rank Test	.449	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-29 Hypothesis Test Summary

Therefore, hypothesis 5a is rejected.

4.3.3 Test of feedback policy effect on effort in multiple level prize structure

This section is to test hypothesis 5b. In a multiple level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy.

The data is a subset of Table 4-15 by selecting only a multiple level prize structure situation. There are 28 rows.

Figure 4-30 shows the box plot chart of the average effort under full and no feedback policy in the multiple level prize structure. The line chart in Figure 4-31 does not show any obvious trend.

Figure 4-32 shows that the average of the value difference is -0.99 and the standard deviation is 14.45.

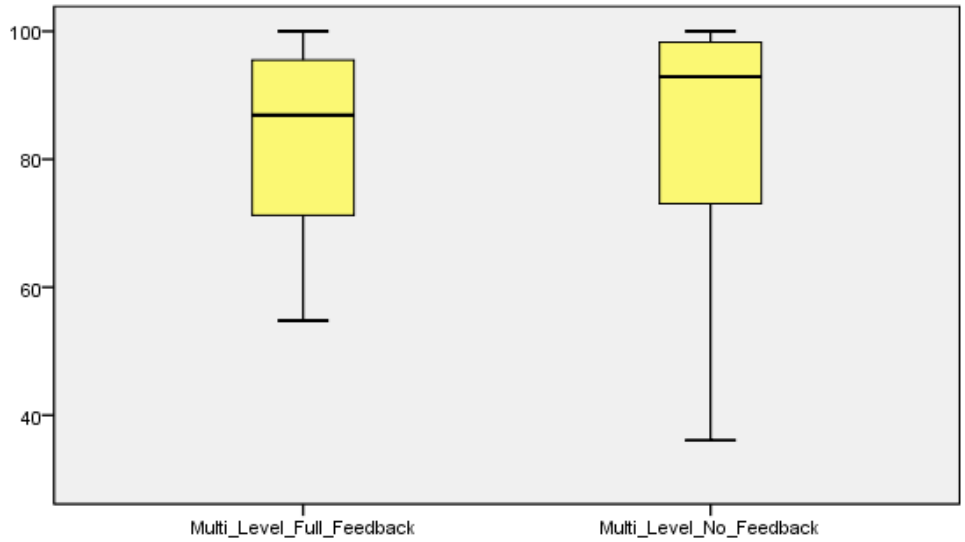

Figure 4-30 Box Plot Chart of Average Effort in Full and No feedback in Multiple Level Prize

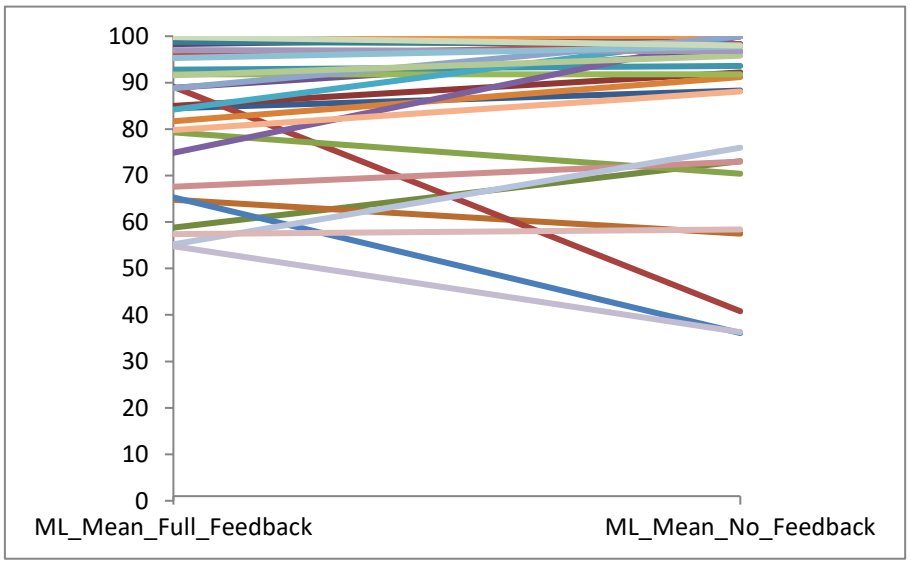

Figure 4-31 Line Chart of Average Effort

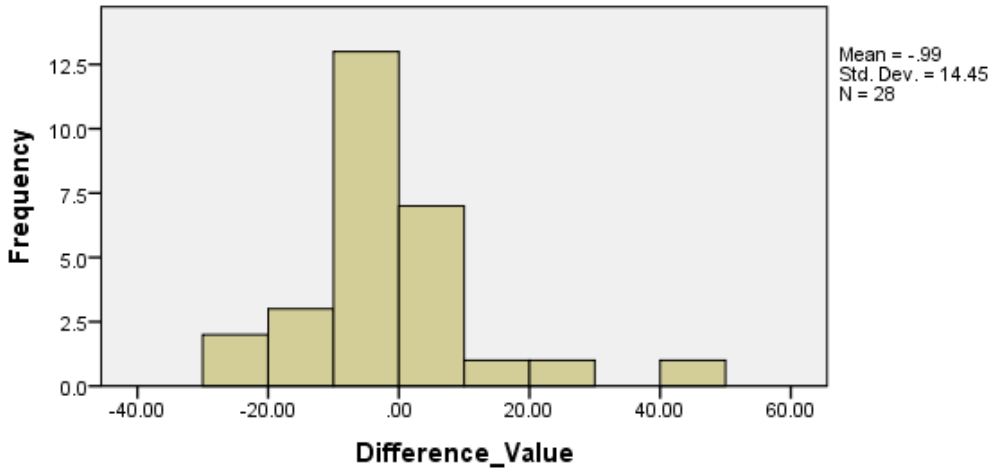

Figure 4-32 Histogram of Difference Value

Descriptive statistics show that both the mean and median in no feedback policy are higher, as shown in Table 4-20.

Table 4-20 Descriptive Statistics

	N	Min	Max	Mean	Median	Std. Deviation
Multi_Full_Feedback	28	54.80	100	82.8929	86.9	14.89253
Multi_No_Feedback	28	36.10	100	83.8750	92.9	20.53457
Valid N (listwise)	28					

The normality test result shows that the difference value is not normally distributed, as per Table 4-21, so Wilcoxon signed rank test should be used.

Table 4-21 Test of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference_Value	.247	28	.000	.849	28	.001

a. Lilliefors Significance Correction

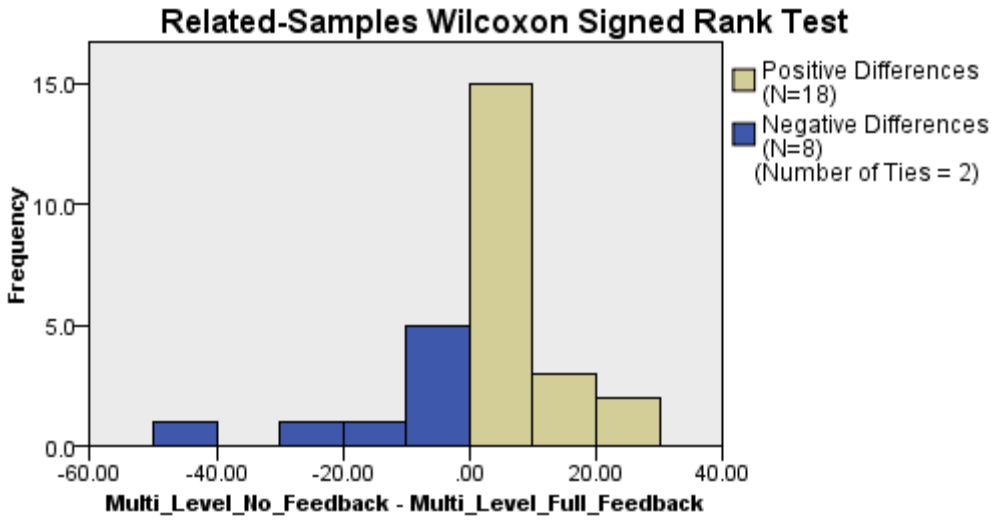

Figure 4-33 Wilcoxon Signed Rank Test

In Figure 4-33, the Wilcoxon signed rank test results show that there are 18 positive differences and 8 negative differences.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Multi_Level_Full_Feedback and Multi_Level_No_Feedback equals 0.	Related-Samples Wilcoxon Signed Rank Test	.128	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Figure 4-34 Hypothesis Test Summary

The hypothesis test summary show that the p-Value is 0.128 (Figure 4-34). The difference between full feedback and no feedback policies in the multiple level prize structure is not significant. Therefore, hypothesis 5b is not supported.

4.3.4 Test of feedback policy effect on effort with risk preferences consideration

This section is to test Hypothesis 6. The higher the employee's risk preference degree, more effort will be put under no feedback policy rather than under full feedback policy.

Two more columns are inserted in Table 4-17, to mark risk preference and transformed risk number. In every row, the two average effort numbers are input by the same subject and paired. There are total 56 rows, refer to Table 4-22.

Table 4-22 Average Effort with Risk Reference

Role	Prize Structure	Risk	Risk-T	Mean of Full Feedback	Mean of No Feedback	Difference Value
Group1-Zhou	Two-level	K	1	90.4	85.2	5.3
Group1-Zhou	Multi-Level	K	1	84.5	88.3	-3.8
Group1-Wu	Two-level	F	6	81.7	85.7	-4.0
Group1-Wu	Multi-Level	F	6	85.0	92.2	-7.2
Group1-Zheng	Two-level	J	2	59.6	34.3	25.3
Group1-Zheng	Multi-Level	J	2	58.8	73.1	-14.3
…	…			…	…	…
Group7-Zheng	Two-level	K	1	99.9	98.0	1.9
Group7-Zheng	Multi-Level	K	1	99.8	98.0	1.8
Group7-Wang	Two-level	K	1	93.3	77.2	16.2
Group7-Wang	Multi-Level	K	1	54.8	36.3	18.5

In Figure 4-35, box plot chart does not show obvious trend.

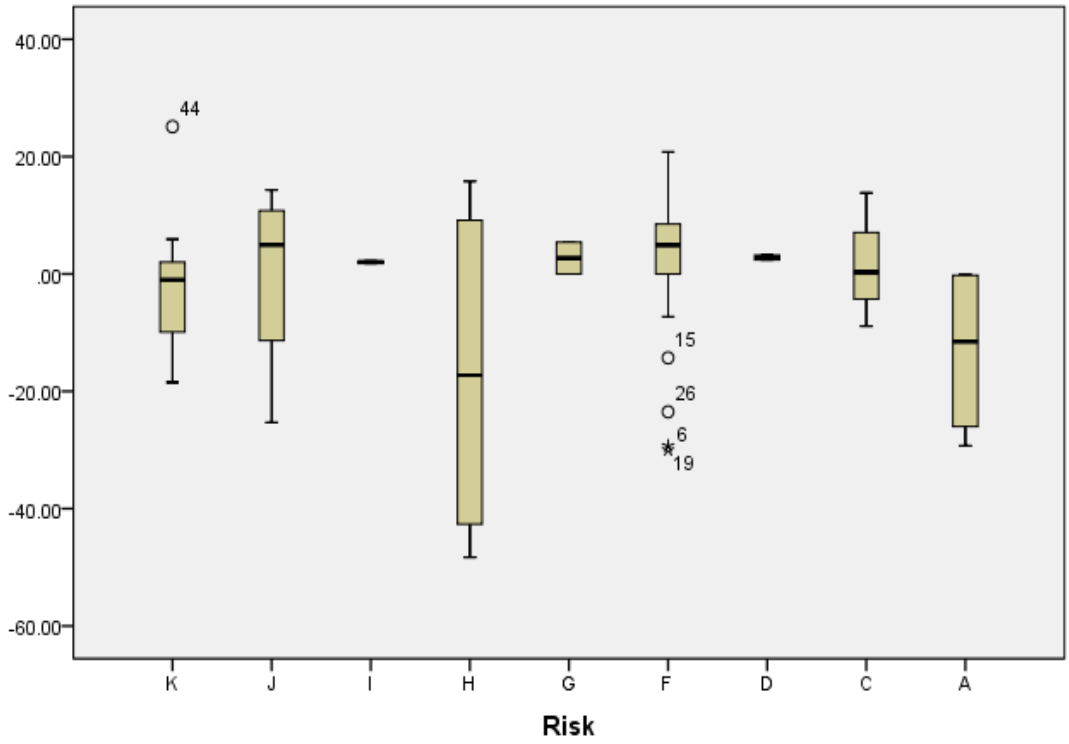

Figure 4-35 Box Plot Chart of Difference by Risk Preference

In the scatter chart in Figure 4-36, the linear fitting line is flat, and quadratic fitting line has a downward trend in high risk preference area.

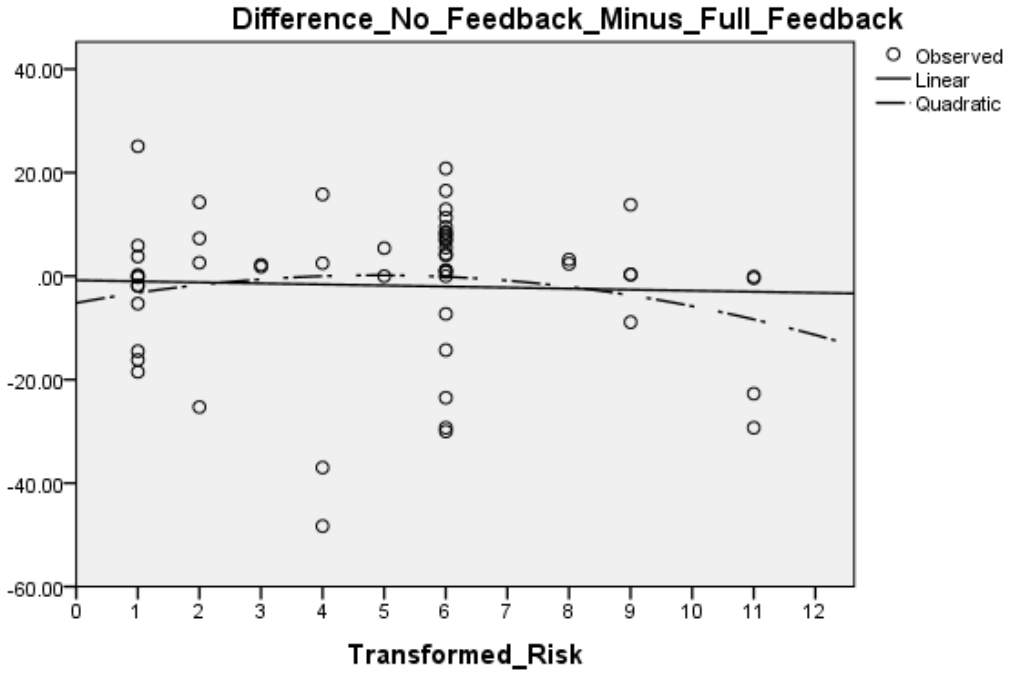

Figure 4-36 Scatter Chart with Fitting Line

Spearman correlations analysis result show the p-Value is 0.741, not significant.

Table 4-23 Correlations

			Transformed_Risk	Difference_No_Feedback_Minus_Full_Feedback
Spearman's rho	Transformed_Risk	Correlation Coefficient	1.000	.045
		Sig. (2-tailed)	.	.741
		N	56	56
	Difference_No_Feedback_Minus_Full_Feedback	Correlation Coefficient	.045	1.000
		Sig. (2-tailed)	.741	.
		N	56	56

Therefore, hypothesis 6 is not supported.

4.4 Summary of experiment data analysis

In summary, among the total 8 hypotheses, 3 are supported by experiment data analysis, 5 are not supported.

Regarding the effect of prize structure on employee effort, Hypothesis 1 is not rejected with a significance level at 0.001, employees' effort in multiple level prize structure is higher than that in two-level prize structure. Hypothesis 2a is not rejected with a significancet leve at 0.052, under full feedback policy, employees' effort in multiple level prize structure is higher than that in two-level prize structure. Hypothesis 2b is not rejected with asignificance level at 0.010, under no feedback policy, employees' effort in multiple level prize structure is higher than that in two-level prize structure. Hypothesis 3 is rejected with a significance level at 0.074 and correlation coefficient at -0.069. We cannot conclude that the higher employee's risk preference degree, the more effort employees will put in a multiple level prize rather than in a two-level prize condition.

Regarding the effect of the feedback policy on employee effort, hypothesis 4 is rejected with a significance level of 0.684, so we cannot conclude that employees' effort under full feedback policy is higher than that under no feedback policy. Hypothesis 5a is rejected with a significance level at 0.449, we cannot conclude that within a two-level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy. Hypothesis 5b is rejected with a significance level at 0.128, we cannot conclude that within multiple level prize structure, employees' effort under full feedback policy is higher than that under no feedback policy. Hypothesis 6 is rejected with a significance level of 0.741 and a correlation coefficient of -0.045, so we cannot conclude that the higher the employee's risk preference degree, the more effort the employee will put under no feedback policy than that

under full feedback policy.

For experiment data analysis, we confirmed that the effort in a multiple level prize is higher than that in a two-level prize structure in a multi-person tournament. When there is feedback, the effort in a multiple level prize is higher than that in a two-level prize structure. When there is no feedback, the effort in a multiple level prize is higher than that in a two-level prize structure. On the contrary, we cannot conclude the effect of feedback policy on effort, regardless in a two-level or multiple level prize structure. For risk preference, from the experiment ,we cannot conclude its effect on employee effort.

4.5 Result analysis of focus group interview with the subjects

The focus group interview with the 6 subjects lasted 100 minutes in a separate office in the School of Management and Economics at the University of Electronic Science and Technology of China. The atmosphere was lively throughout the discussion. The interview was implemented with a planned agenda, and the 6 questions are discussed one by one. The interview was audio recorded, and transcribed to text by software. We read the text carefully, and formulate the key points.

Generally speaking, the subjects felt the experiment is interesting and meaningful and were happy to join the experiment. They expressed that luck is one important factor in the experiment, including the random number generated in every round, and with whom they are grouped. The style and behavior of opponents in the group is a most important consideration to make decisions because this experiment looks like a multiple player game. The payoff not only depends on one's own strategy and effort but also on that of the opponents'. One of the subjects recalled he had filled the lowest decision number 1 in the first 3 rounds because he calculated that the overall payoff of 4 players would be the highest if the 4 players all filled 1. However, his opponents did not care about his 'sincerity' and filled high numbers. At last he had to give up filling the lowest decision number. They all felt it seemed like the typical prison's dilemma.

4.5.1 Focus group interview about prize structure

Moving to the second question, "between the two-level prize structure and the multiple level prize structure situation, in which did you input a higher decision number and why", one subject said he filled a higher decision number in the two-level prize structure situation because even if he got rank 2, the prize is also 2.4 Yuan, the same as rank 1. So, he feels it is wise to fill

a higher decision number in the two-level prize structure. Another subject argued she filled a lower decision number in the two-level prize structure situation and a higher number in the multiple level prize structure situation, because she guessed the two-level prize structure situation would be very competitive. Another subject thought it was wise to fill a higher number in the multiple prize structure, because when you fill the highest number like 100, the cost is 1.0 Yuan. In this case, if your rank is 3 in the two-level prize structure situation, you get only 0.6 Yuan prize, so your payoff is -0.4 Yuan, while if your rank is 3 in the multiple level prize structure situation, you will get 1.2 Yuan prize and your payoff is +0.2 Yuan. Some subjects filled a higher decision number in the two-level prize structure, others filled a higher one in the multiple level prize structure. This is in accordance with the data collected from experiment.

When we moved to question 5, "assuming you are a human resource manager, how would you design the prize structure in the performance management system", the participant jumped from the subject's role in the experiment to the manager's role in the simulated real world. Firstly, we contextualized that the function of a performance management system is to motivate employees to put more efforts in their work. On participant said it depends on the developing stage and the organization size. For a start-up firm, the two-level prize structure is better to motivate employees while the multiple level structure is better for a medium size firm. The other participants argued that the multiple prize structure is better for employee motivation, because the motivation is available for employees in every performance grade. For example, even for employees with the lowest performance grade in a 10 people tournament, he can work harder to catch up the second lowest one in order to receive the higher prize. But in the two-level prize structure situation, the employees in rank 10 and rank 9 may give up effort because it is too difficult for them to move to rank 5 with a higher prize. On the other hand, in the two-level prize structure, the employee in rank 1 may reduce his efforts because even if his rank drops to rank 5, he still can receive the higher prize the same as the one in rank 1. However, in the multiple level prize structure, the employee in rank 1 will continue to put effort because once his rank drops to rank 2, his prize will decrease. Most of the other participants agreed to this opinion.

In summary, for prize structure, the subjects have different points of view with various reasons, but most of them agree that in the multiple level structure the motivation power of employees will be higher.

4.5.2 Focus group interview about feedback policy

Moving to the third question, "between the full feedback and no feedback situation, under which did you input the higher decision number and why" the subjects expressed there is no obvious higher or lower trend under no feedback policy compared to full feedback policy. They mainly made the decision based on their own and the opponents' strategy in preview phases. Some subjects said they kept the same strategy in the no feedback phase, some said they have adjusted their strategy; one subject said she used one strategy for the first 3 rounds and the other strategy for the next 3 rounds. One subject said he had input higher decision numbers in the no feedback situation because he did not know whether the opponents' would act in time.

When we discussed question 5 from the human resource manager's perspective, one subject argued that frequent feedback can motivate employees stronger in the multiple level prize structure rather than in the two-level prize structure, because employees will adjust their own effort degree (usually higher) once they receive their own latest performance status. One subject said that in the two-level prize structure, maybe frequent feedback will reduce employees' effort, especially for those employees ranked at the top and bottom.

Concerning the feedback policy variable in the experiment, the subjects did not demonstrate a clear strategy to input a higher decision number under the full feedback or no feedback policy. We reason that this might be a shortcoming of arranging the same group of subjects to join multiple treatments in the experiment.

4.5.3 Focus group interview about risk preference

When we discussed the fourth question, "is there any linkage between your risk preference and effort number in the prize structure variance and the feedback policy variance", one subject said that her risk preference is low, therefore she prefers to input a relatively conservative decision number to avoid a negative payoff. One subject said the one with higher preference should prefer to fill a higher decision number like 100, to approach a higher prize, even if he may receive a negative payoff. Another subject argued that there is no direct linkage between risk preference and decision number, because they mainly focus on the opponents' strategy and selection.

At the end of the focus group, the subjects suggested to increase the cost of effect in the experiment, to prevent the ceiling effect pushing some subjects to select the highest decision number.

4.5.4 Result analysis summary of the focus group interview

By focus group interview, we understand subjects feeling, thinking and reaction in the experiment. For the prize structure, different subjects have different ideas with various reasons. Generally speaking, they prefer that the multiple level structure may enhance employee motivation. For feedback and risk preference, the subjects have no obvious direction in the experiment because they are mainly concerned with the opponents' selection.

Chapter 5: Case Study

Upon the laboratory experiment results, we conducted a case study on R factory in terms of prize structure and feedback policy, as a supplement to validate the hypotheses. Two levels of performance appraisal are investigated: (i) the department managers' performance appraised by the plant manager; and (ii) the workers' performance appraised by foremen.

5.1 R factory introduction

R Company is a printing company, established in the USA in 1864. The R Chengdu factory was invested by R Company in 2011, with 50,000 square meters space and a total investment of USD20 million. The annual sales revenue in R factory is about USD80 million and there are about 1200 employees.

There are four major departments in R factory, including Operations department, Finance department, Human Resource department and Sales department, refer to Figure 5-1. The Operations department is headed by the Plant Manager. Inside the Operations department, there are 6 departments, including Production Department, PMC (Production and Material Control) department, F&M (Facilities and Maintenance) department, PE&QC (Process Engineering and Quality Control) department, CI (Continued Improvement) department, QA (Quality Assurance) department. Each department is headed by a department manager.

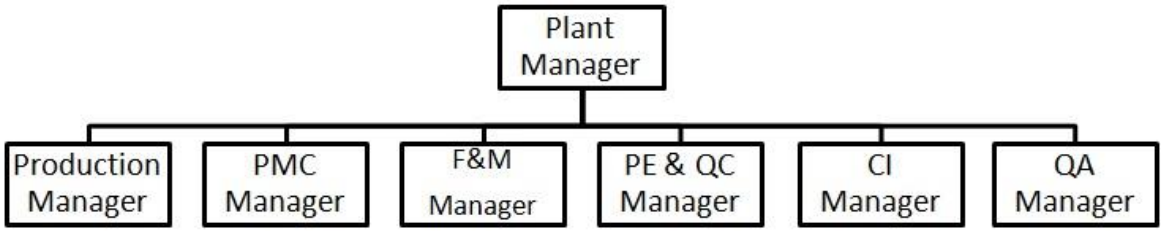

Figure 5-1 Organization Chart of the Factory

The Plant Manager is responsible for developing and implementing the manufacturing operation system to achieve P&L (profit and loss), safety, quality, delivery, and cost goals. The Production Manager leads the production team to produce products on time. The PMC Manager is to lead planning team to plan material and production to meet customer orders. The PE & QC Manager is to provide process engineering and quality control. The CI Manager is to deploy continues plant-wide improvement initiatives. The QA Manager is to control quality management system and incoming material quality control.

Under the Production Manager, there are 4 production supervisors. There are 24 production foremen under the supervisors. The 1000 first line workers are led by the foremen.

5.2 Performance management system introduction

5.2.1 Factory kpi setting (key performance indicator)

The KPIs of the factory are listed as Table 5-1. This is also the KPIs of Plant Manager.

Table 5-1 Factory Level Key Performance Indicator

No.	KPI	Weight	Breakdown Items	Sub-weight	UOM	KPI Base
1	Plant Gross Profit	30%	GP ($) - MTD	15%	US$K	MTD
			GP (%) - YTD	15%	%	YTD
2	Productivity	15%	Sales K$ / # of HC	15%	US$K	MTD
3	DIOH	15%	DIOH - Total	15%	Days	MTD
4	EHS	10%	Recordable Case Rate	10%	No.	YTD
5	Quality	15%	CoPQ%	15%	%	YTD
6	OTD	15%	Based on Promised Date	15%	%	MTD
	Overall	100%		100%		

1. Plant Gross Profit is a financial indicator reflecting the operating profit.

2. Productivity is measured by quotient of total sales revenue divided by total employee headcount.

3. DIOH stands for Days Inventory On Hand, which is an indicator for inventory level of raw materials, work-in-process and finished goods.

4. EHS stands for Environment, Health and Safety. This indicator is measured by recordable industrial injury case divided by total working hours during the duration.

5. Quality is measured by the cost of poor quality as a percentage of sales revenue.

6. OTD measures On Time Delivery of finished goods to customer upon orders.

The weight of each KPI item is listed in the table, as well as UOM (Unit of Measurement). In column of KPI base, MTD stands for Month to Date, which is the result of that month, while YTD stands for Year to Date, which is the accumulated result from January to that month.

5.2.2 Department manager KPI setting

Factory KPIs are broke down to 5 catalogs and 30 sub-KPI items. The 30 KPI items are assigned to 6 department managers according to given role and responsibility. The assigning principle is whether the items are related to the manager's responsibility, and the manager is able to control the result by efforts of his or her work at certain level. The more the KPI item is related and controllable, the higher the weight set to the manager.

All the KPI items are quantifiable in terms of goal and actual result, so the performance score can be calculated with the formula.

5.2.3 Worker KPI setting

The KPIs of workers in each production area are breakdown from their foreman respectively. The key items include output, quality, efficiency, safety, workplace housekeeping, and so on. The KPI within each production area is same.

5.3 Prize structure setting

5.3.1 Department manager prize structure

The annual performance score is equal to the average score of the 12 months.

According to the annual total performance score, the department managers are forcedly distributed into six grades. The annual bonus will be issued to the department manager according to his grade. 200% in the table means 200% of monthly base salary. Refer to Table 5-2.

Table 5-2 Prize Ratio of Each Grade of Department Manager

Rating Catalog	Ra	Allocatio	Individual
TP Top Performance	TP+		200%
	TP=	10%	190%
	TP-		180%
	VP+		170%

VP Very Strong Performance	VP=	20%	160%
	VP-		150%
SP Strong Performance	SP+	55%	130%
	SP=		100%
	SP-		70%
DP	DP	10%	40%
LP	LP	5%	0

5.3.2 Worker prize structure

Worker's prize is issued every month. According to each worker's monthly performance results, all the workers in each production area is forcedly distributed into five grades. The workers in each grade will receive the corresponding prize with different ratios. The prize equal to prize ratio multiply by average prize. Average prize in the month is calculated by factory performance and department performance score. For example, average prize is 400 Yuan in the month, the workers in grade 1 will receive 800 Yuan prize, while the workers in grade 2 will receive 340 Yuan prize. Refer to Table 5-3.

Table 5-3 Prize Ratio of Each Grade of Worker

Grade	Worker Percentage	Prize Ratio
1	5%	2.0
2	10%	1.7
3	60%	1.0
4	15%	0.4
5	10%	0.0

5.4 Performance feedback

5.4.1 Department manager monthly performance feedback

Usually, within 10 days after the month is closed, the Plant Manager Assistant calculates all KPI scores by collecting actual results. The monthly performance results are sent to all department managers via email, including goals, actual results and scores of each KPI items of all department managers. That means that every department manager is informed on his own monthly performance results, own year-to-month performance results, own monthly rank, own year-to-month rank, other peers' monthly performance results, year-to-month performance results, monthly rank and year-to-month rank.

Then the monthly review meeting of the factory will be conducted. All department managers attend the meeting, presenting KPI with PDCA (Plan-Do-Check-Act) approach for each of his or her KPI catalogs. In the "Plan" section, the manager introduces the goal and plan for the KPI. Then in the "Do" section, the key finished or ongoing actions are introduced. In the next "Check" section, the score by comparing actual results and goals of last month is presented, followed by the Act section to introduce the work plan for the KPIs in the next month. The Plant Manager and any department managers may provide advice to the manager during the presentation.

5.4.2 Worker weekly performance feedback

Worker performance results are weekly calculated by the foreman, printing out and pasting on the white board in public area like employee rest area, including actual results, goal and performance score of each KPI item. The workers are easy to read own month-to-week performance results, as well as other colleagues' performance results.

5.5 Questionnaire design and implementation

To investigate the effect of prize structure and feedback policy on employees' effort in R factory, we designed questionnaire to collect personal feedback. For department managers' performance appraisal, we investigated their direct supervisor, the plant manager and themselves. For workers' performance appraisal, we investigated their direct supervisor, the foremen, and the worker themselves. In addition, we investigated the third party, the human

resource manager. There are four questions to each group. The answer to each question is classified in five levels:

1. Completely disagree (scoring -2)
2. Disagree (scoring -1)
3. No comments of disagree or agree (scoring 0)
4. Agree (scoring 1)
5. Completely agree (scoring 2)

5.5.1 Questionnaire for plant manager, department manager, hr manager

There are 4 statements (questions) for the plant manager, department managers and human resource manager. Question 1 and question 2 address prize structure, question 3 and question 4 address feedback policy.

Q1. If possible, office employees are divided into two grades according to their year-end performance. Under the premise of maintaining the total amount of awards, half of the employees in the high performance grade receive the same high proportion of year-end awards, and half of the employees in the low performance grade receive the same low proportion of year-end awards. Compared with the current five grades, this two-level performance rating can promote employees to work harder at ordinary times.

Q2. According to the annual performance evaluation results of office employees, all office employees will be assigned to five grades, 1, 2, 3, 4 and 5. The year-end bonus of employees in each grade varies from high to low. Compared with the two grades, the five performance grades can promote employees to work harder at ordinary times.

Q3. For office employees, the way to publish their performance results and the performance results of colleagues in the same department every month can promote them to work harder than that without feedback every month.

Q4. The performance of each office employee and relevant colleagues of the same department will not be announced every month, and the department head will announce the annual total performance of each employee by the end of the year. This way, compared with monthly feedback, can promote employees to work harder at ordinary times.

5.5.2 Questionnaire for foremen

There are 4 statements (questions) for foremen. Question 1 and question 2 address prize

structure, question 3 and question 4 address feedback policy.

Q1. If possible, divide the monthly performance grade of employees into two grades. Under the premise of maintaining the total bonus amount, half of the employees in the high performance grade will get the same high proportion bonus range, and half of the employees in the low performance grade will get the same low proportion bonus range. Compared with the five grades, the two performance grades can promote employees to work harder at ordinary times.

Q2. According to the results of monthly performance evaluation of employees, all employees are assigned to five grades, 1, 2, 3, 4 and 5. The proportion of performance bonus in each grade varies from high to low. The five performance grades can promote employees to work harder at ordinary times.

Q3. For workshop employees, it can motivate them to work harder by publishing their performance scores and the performance scores of colleagues in the same department on the whiteboard every week.

Q4. If possible, do not publish the performance of workshop employees and their colleagues in the same department every week; instead, the supervisor will directly announce the total performance and ranking of the month after the end of the month. According to your experience and understanding, this kind of way of centralized feedback on performance after the end of each month without weekly feedback can promote more employees to work harder in normal times than weekly feedback.

5.5.3 Questionnaire for workers

There are 4 statements (questions) for workers. Question 1 and question 2 address prize structure, question 3 and question 4 address feedback policy.

Q1. If possible, I would like to classify the monthly performance level of workshop employees into two grades. Half of the employees in the high performance grade get the same high bonus, such as 400 Yuan; half of the employees in the low performance grade get the low bonus range, such as 100 Yuan. I think we will work harder in this way.

Q2. I am very concerned about my monthly performance evaluation results ranked in 1, 2, 3, 4 and 5, so as to affect my monthly bonus amount. I think this five grade ranking system can make us work harder.

Q3. For the performance results published on the whiteboard every week, I will basically

go to see and know the latest performance status. Regardless of performance, I will work harder to achieve better results and ranking at the end of the month.

Q4. If possible, I suggest that you do not publish workshop employee's performance every week. At the end of the current month, the supervisor directly announces their total performance and ranking of the current month. Compared with weekly announcement, I believe that we can work harder as a whole in the way of no announcement.

5.5.4 Implementation

We created an on-line questionnaire (www.wenjuan.com) for the above roles respectively, and send the URL (Uniform Resource Locator) address to target respondents respectively via Wechat by mobile phone. For plant manager, department managers and human resource manager, all of them were enquired. For foremen and workers, the URL was sent to their working Wechat group, asking for response.

After the respondents chose and submitted the questionnaire, we could find the responses on-line by accessing the website by account name and password. After two days, a total of 130 pieces of responses were received. The responses were checked carefully and invalid ones were removed. Actually, question 1 and question 2 are the opposite of one another; if the respondent chooses ‘agree’, the answer to question 2 shall not be ‘agree’ or ‘completely agree’. If the respondent chooses ‘agree’ (or ‘completely agree’) for both question 1 and question 2, we treat this response as invalid and all of his responses were removed from the data base. The same rule is for question 3 and question 4. The third type of invalid responses is that the respondent chooses ‘no comment’ for all the 4 questions. After removing invalid responses, we got a total of 66 pieces of valid responses, including 1 piece from the plant manager, 5 pieces from department managers, 21 pieces from foremen and 28 pieces from workers.

5.6 Data analysis from the answers of the questionnaire

Because question 1 and question 2 are opposite, and question 3 and question 4 are opposite, to avoid confusion, we score question 1 and question 4 reversely. For example, if the respondent chose ‘completely agree’ for question 1, the original score is 2, then we score it -2 for further analysis. After that, if the scores for first 2 questions is 1 or 2, that means the respondent supports that the employees’ effort will be higher in a multiple level prize structure. If the score for first 2 questions is -1 or -2, that means the respondent supports that the

employees' effort will be higher in a two-level prize structure. The similar logic exists in question 3 and 4.

5.6.1 Data analysis of prize structure

Question 1 and question 2 address prize structure. The individual value plot in Figure 5-2 shows that most plant manager, department managers, foremen and human resource manager state that employees' effort in a multiple level prize structure is higher.

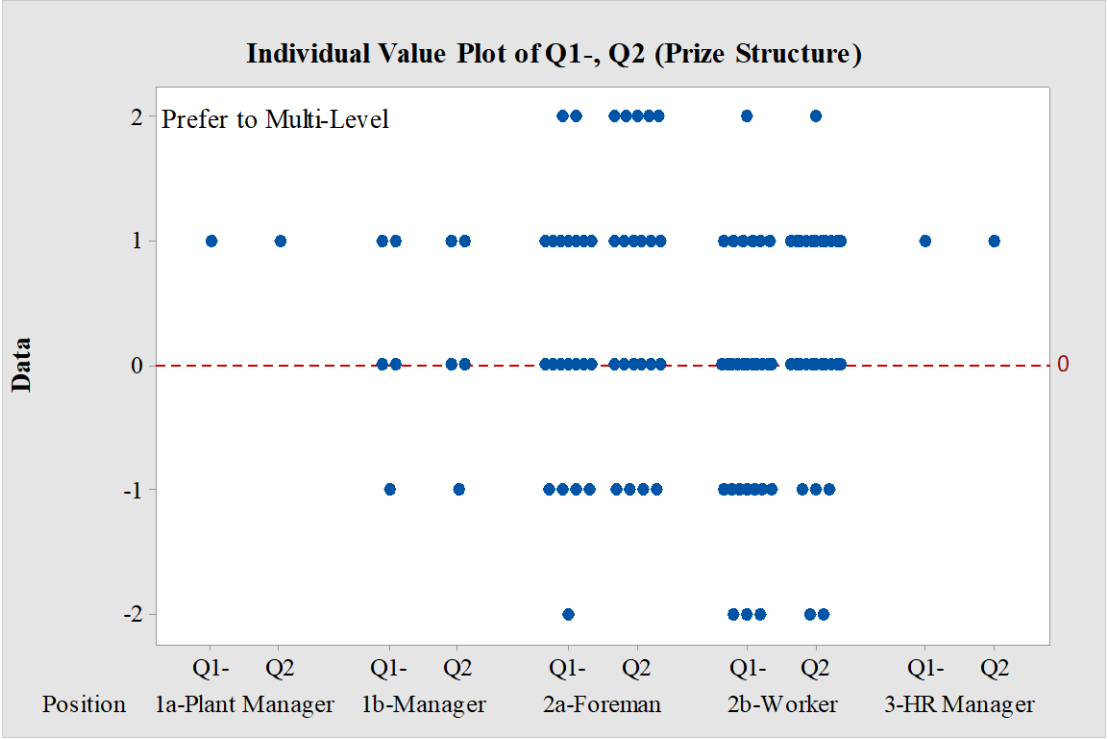

Figure 5-2 Individual Value Plot of Question 1 and 2

By adding the choice of question 1 and question 2 together, the choice summary for prize structure is shown in Table 5-4. Both the plant manager and the human resource manager prefer the multiple level prize structure, which is also preferred by 67% of department managers. For the foremen and workers, because our data is from sampling, we conduct ed a Chi-square goodness-of-fit test to test the difference significance. The p value for the foremen is 0.0041, which means that more foremen think that the employees' effort a in multiple level prize structure is higher. The p value of workers' responses is 0.366 and, although 56% workers in the sample prefer the multiple level prize structure, the difference is not statistically significant. Why do 31% workers prefer the two-level prize structure? We infer that the worker answers the questions from the first line employee perspective but not from factory perspective. They prefer the two-level prize structure because of the free-riding fluke mentality.

Table 5-4 Choice Summary for Prize Structure

Position	Observed	Multi-Level	Two Level	Multi-Level%	Two Level%	p value	Remark
Plant Manager	2	2	0	100%	0%	-	Population
Department Manager	6	4	2	67%	33%	-	Population
Foreman	29	20	9	69%	31%	0.041	Sample
Worker	34	19	15	56%	44%	0.366	Sample
HR Manager	2	2	0	100%	0%	-	Population
Total	73	47	26	64%	36%	-	

In summary, most of the people involved in the performance management program support that the employees' effort is higher in a multiple level prize structure rather than in a two-level prize structure. This result is in accordance with the experiment result, and in support of hypothesis 1.

5.6.2 Data analysis of feedback policy

Question 3 and question 4 address feedback policy. The individual value plot in Figure 5-3 shows that most of the plant manager, department managers, foremen, workers and human resource manager prefer that employees' effort under full feedback policy is higher.

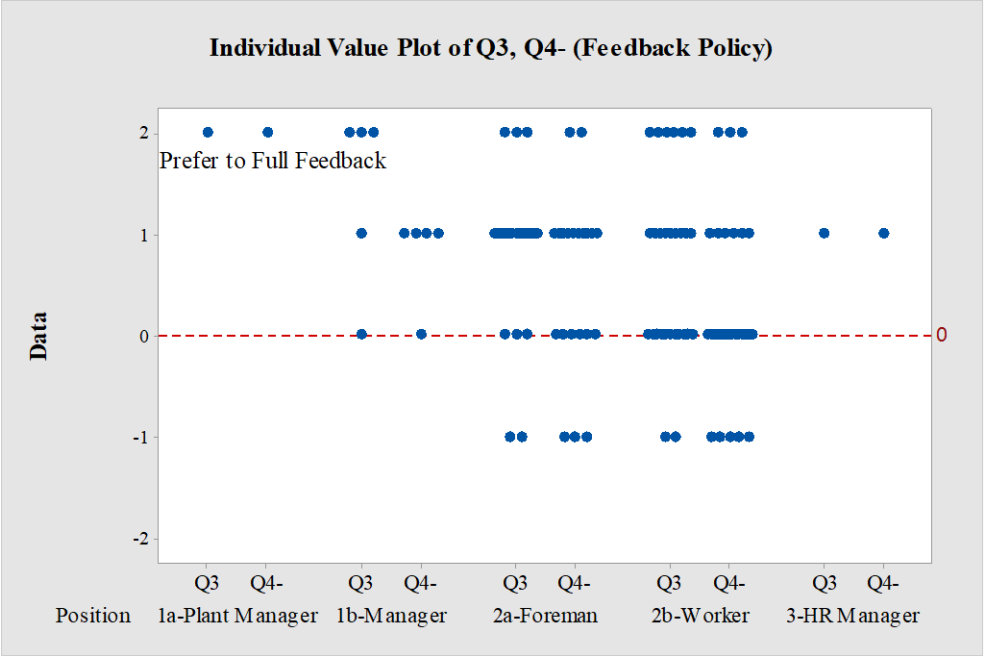

Figure 5-3 Individual Value Plot of Question 1 and 2

By adding question 3 and question 4 together, the choice summary for the feedback policy is showing in Table 5-5. The plant manager, department manager, human resource manager are all 100% in support that employees' effort in the full feedback policy is higher than that in no

feedback policy. The p value is much less than 0.05 in the Chi-square goodness-of-fitting test, so we conclude that most foremen and workers also support it.

Table 5-5 Choice Summary for Feedback Policy

Position	Size	Full Feedback	No Feedback	Full Feedback%	No Feedback%	p value	Remark
Plant Manager	2	2	0	100%	0%	-	Population
Department Manager	8	8	0	100%	0%	-	Population
Foreman	33	28	5	85%	15%	0.000	Sample
Worker	31	24	7	77%	23%	0.002	Sample
HR Manager	2	2	0	100%	0%	-	Population
Total	76	64	12	84%	16%	-	

In summary, most of the people involved in the performance management program support that employees' effort is higher under full feedback policy than under no feedback policy. This result is different from the experiment result, but supports hypothesis 4.

5.7 Summary of the case study

In this chapter, the performance management system of R factory is introduced at two levels. One level is the department manager level; the other level is the workshop worker level. This factory adopts the multiple level prize structure and periodic (monthly and weekly) full feedback policy for both department manager level and worker level.

We designed questionnaires for the people involved in the performance management system, including the plant manager and department managers, foremen and workers, plus the human resource manager as third party. Upon the responses received, most of the people support that employees' effort in the multiple level prize structure is higher than that in the two-level prize structure, and support that employee's effort under full feedback policy is higher than that in no feedback policy. Based on the research results from R factory, hypothesis 1 and hypothesis 4 in chapter 2 are both supported.

Chapter 6: Conclusion and Recommendation

In order to design an effective performance management system to maximize employees' effort, how should the manager decide the prize structure and feedback policy? In this thesis, this managerial problem is conceptualized as a multi-person long-run tournament. Multiple agents put their efforts for output; the prize for each agent is not based on their own absolute output, but on the relative rank of output among the agents. The total prize budget is fixed in advance. The target of each agent is to maximize his utility (prize minus cost), while the principal's target is to maximize the overall effort and output of agents. This research focuses on the effect of prize structure and feedback policy on effort in a multi-person tournament.

Most of the previous research on prize structure has focused on a two-level prize: one is high, and the other is low. However, practitioners always adopt multiple level prize structure, an obvious mismatch between research and practice. In addition, in previous studies, the total prize budget is not fixed, the researchers compared the efforts with prize schemes of different portions of winners and losers, but the total prize budget in these schemes is different, which introduces a hidden variable of different total prize amount.

Previous research on feedback in a dynamic tournament has unveiled agents' reactions when they receive feedback of the first stage result or receive nothing about the first stage result. However, there are few studies on feedback in multiple agents' tournaments with multiple level prize structure and it is doubtful whether the previous feedback study results apply to multiple prize structure situation also.

After reviewing previous related literatures, we worked out eight hypotheses in multi-person tournament situation, including four hypotheses of effects of prize structure on effort, and four hypotheses of effects of feedback policy on effort.

The research methods of experiment and case study have been adopted. In the experiment, seven groups of participants joined a series of experiments, bestowing reactions to different treatments and simulating different performance management rule in terms of prize structure and feedback policy. In order to understand subjects' thought behind their behavior, 6 subjects, who joined our experiment, were invited to join a focus group interview.

As a supplement to the results from the experiment and focus group, a single case study with two-level performance management was conducted by means of data collected from the subject company and by issuing a questionnaire to the involved employees to obtain more data.

The data from the experiment was quantitatively analyzed and qualitatively through the focus group. After the information from the case study was collected, qualitative analysis method was used. Then the conclusion is as follows.

6.1 Conclusion

According to the experiment and case study results, we find that employees' effort in a multiple level prize structure is higher than that in a two-level prize structure. Under full feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure. Under no feedback policy, employees' effort in a multiple level prize structure is higher than that in a two-level prize structure. The case study results also support that the effect of a multiple level prize structure on effort is higher than a two-level prize.

Previous studies of prize structure in a multi-person tournament have focused on the effect of pay gap between high prize and low prize on effort (Hayward & Hambrick, 1997; McLaughlin, 1988; Henderson & Fredrickson, 2001; Lin et al. 2003; Lin, 2013, She & Cai , 2017; Humphreys & Frick, 2019), or the effect of winner proportion on effort (Falk and Fehr, 2002; Harbring and Irlenbusch, 2003; Orrison et al. 2004; Harbring & Irlenbusch 2008; Zeng & Yan, 2010). Few researchers have studied multiple level prize structure in the past. Freeman et al. (2010) have compared equal prize, single prize and multiple level prize structure but research is scarce on comparing the effect of two-level prize and multiple level prize structure on employee efforts by experiment.

This research compared the effort in a two-level prize structure with a balanced fraction of winner (2 high prizes and 2 low prizes), and multiple level prize structure with arithmetic progression by laboratory experiment, and found that the effort in a multiple prize structure is higher than that in a two-level prize structure. This finding may contribute to the development of the tournament theory in terms of prize structure in multi-person tournament.

Furthermore, this research examined the combined effect of a multiple level prize structure under full feedback or no feedback policy, which, to our best knowledge is the first study of its kind in tournament theory development. According to this research, with or without periodic feedback, the effort in a multiple level prize structure is higher than that in a two-level prize structure. This finding also highlights the importance and effect of a multiple level prize structure in multi-person tournament.

This finding, in terms of prize structure, bridges the technology gap between academia and industry. Since Lazear and Rosen (1981) founded the ournament theory by a simplified model with 2 workers and 2 level prizes, the following researchers continued to study the two-level prize structure even if in multiple player tournament model. They have examined the effect of two-level prize structure on effort by varying the pay gap or varying the proportion of winners in a multi-person tournament. However, this research confuses practitioners because multiple level prize structure is widely used in the industry while there is few research on it. Is it because a two-level prize structure is better than a multiple level prize structure in a multi-person tournament? Should practitioners adopt the two-level prize structure? The findings of this thesis provide a clear answer that the effect of a multiple level prize structure on employee effort is higher than that in a two-level prize structure. On the other hand, going forward, the research on multi-person tournament could pay more attention on multiple level prize structure by investigating the practice in the industry. Therefore, the research results could guide practitioners in the industry to apply a multiple level prize structure into employee performance management system, in order to maximize employee's efforts and overall output.

The effect of feedback policy on effort is not significant from the experiment result, however, in the case study, both level appraisers and employees believe that employee effort under periodic full feedback is higher than that under no feedback policy. This result is not surprising. Actually, the effect of feedback policy on effort is inconsistent in previous researches. Some argue that full feedback could exert agent's effort (Ederer, 2009; Yan et al. 2015), some argue that full feedback or no feedback have a similar effect on effort (Ederer & Fehr, 2007; Yan et al. 2017), and some propose the the effect of feedback policy on effort is dependent on the marginal cost of effort (Ederer, 2010; Denter & Sisak, 2015) or on the general performance of employees (Goltsman & Mukherjee, 2011). In the industry, different practitioners have different practices. Some implement monthly feedback, some implement half-year feedback, and some give feedback only at year end.

6.2 Recommendation

This study has limitations. Our experiment consists of four phases. In phase 1 and phase 3, the performance results are feedback round-by-round. In phase 2 and phase 4, the performance results are not feedbacked until that phase is completed. Because we arrange the same group of subjects to participate in all the 4 phases, even if the variable of player type is removed, one more variable is brought in the experiment that is the learning effect. The subjects'

behavior in the later phase not only depends on the controlled variables like prize structure and feedback policy, but also on the subject's learning and reaction to previous phases. So our recommendation for researchers who conduct similar experiments is to separate it into two experiments. One is to examine the effort on a two-level and multiple level prize structure with full feedback policy; the other is to examine effort in two-level and multiple level prize structure with no feedback policy with another group of subjects. In addition, the experiment parameters could be optimized further. As feedback collected from focus group interview, the cost function in our experiment could be adjusted to raise the cost of effort, in order to avoid the ceiling effect. The ideal experiment parameters should let the subject select neither the highest nor the lowest numbers.

We have two more recommendations for further research direction in multi-person tournament theory.

In our experiment, we set the prizes with an arithmetic progression at 2.4, 1.8, 1.2 and 0.6 Yuan. The purpose of this setting is to keep the same total prize budget as two-level prize structure at 6.0 Yuan (2.4, 2.4, 0.6, 0.6 Yuan), and to keep the same highest prize and the same lowest prize as the multiple level prize structure, in order to compare the effect of the two prize structures. Now, after it is concluded that effort in a multiple prize is higher than that in two-level prize structure, what is the optimal prize differential and allocation in a multi-person tournament? Given a fixed total prize budget, how many levels of prize should be set? What is the optimal allocation percentage in each prize level? These real managerial questions in the industry have not been studied in the academia and could attract more research in the future.

Furthermore, the assumption of the tournament theory is that the total prize budget is fixed in advance. This is one of the advantages of tournament to avoid the principal's moral hazard problem. But, why is not the total prize budget set as a dynamic amount with a minimum in a multi-person tournament? When the total output of all agents is beyond a certain level, the total prize amount increases with the increase of total output. Under this situation, the agents do not share a fixed size amount, but the amount could be made bigger cake and shared. Then what is the effect on effort? Güth, Levínský, Pull and Weisel (2016) have introduced 'output-dependent prizes' and showed that tournaments with output-dependent prizes outperform fixed-prize tournaments and piece rates. Going further, how should the multiple level prize structure be set in a multi-person tournament with a dynamic total prize amount? This is an interesting research area in tournament theory, and it is closely linked to real managerial problem in the industry, thus deserving more attention in future research.

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Appendix 1: Experiment Effect Cost Table

Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost
1	0.000	21	0.044	41	0.168	61	0.372	81	0.656
2	0.000	22	0.048	42	0.176	62	0.384	82	0.672
3	0.001	23	0.053	43	0.185	63	0.397	83	0.689
4	0.002	24	0.058	44	0.194	64	0.410	84	0.706
5	0.003	25	0.063	45	0.203	65	0.423	85	0.723
6	0.004	26	0.068	46	0.212	66	0.436	86	0.740
7	0.005	27	0.073	47	0.221	67	0.449	87	0.757
8	0.006	28	0.078	48	0.230	68	0.462	88	0.774
9	0.008	29	0.084	49	0.240	69	0.476	89	0.792
10	0.010	30	0.090	50	0.250	70	0.490	90	0.810
11	0.012	31	0.096	51	0.260	71	0.504	91	0.828
12	0.014	32	0.102	52	0.270	72	0.518	92	0.846
13	0.017	33	0.109	53	0.281	73	0.533	93	0.865
14	0.020	34	0.116	54	0.292	74	0.548	94	0.884
15	0.023	35	0.123	55	0.303	75	0.563	95	0.903
16	0.026	36	0.130	56	0.314	76	0.578	96	0.922
17	0.029	37	0.137	57	0.325	77	0.593	97	0.941
18	0.032	38	0.144	58	0.336	78	0.608	98	0.960
19	0.036	39	0.152	59	0.348	79	0.624	99	0.980
20	0.040	40	0.160	60	0.360	80	0.640	100	1.000

Appendix 2: On-site Pictures of Experiment

Appendix 3: On-site Pictures of Focus Group

Appendix 4: Risk Preference Cross-Reference Table

Seat	Group & Role	Filled	Risk Number
1	Group3_Wang	F	6
2	Group7_Wang	K	1
3	Group1_Wang	I	3
4	Group4_Zheng	F	6
5	Group1_Zheng	J	2
6	Group3_Zhou	C	9
7	Group7_Zheng	K	1
8	Group3_Wu	F	6
9	Group5_Wu	K	1
10	Group7_Wu	F	6
11	Group4_Wang	K	1
12	Group5_Zheng	F	6
13	Group2_Zheng	C	9
14	Group2_Wang	H	4
15	Group4_Zhou	A	11
16	Group3_Zheng	F	6
17	Group6_Wu	K	1
18	Group4_Wu	J	2
19	Group2_Zhou	A	11
20	Group6_Zheng	D	8
21	Group1_Zhou	K	1
22	Group6_Wang	F	6
23	Group5_Wang	G	5
24	Group1_Wu	F	6
25	Group5_Zhou	H	4
26	Group2_Wu	F	6
27	Group6_Zhou	F	6
28	Group7_Zhou	F	6