The Effect of Overconfidence, Engagement and Risk Attitude on Project Entrapment: Theory and Evidence

Li, Yuhao

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The Effect of Overconfidence, Engagement and Risk Attitude on Project Entrapment: Theory and Evidence

Yuhao Li

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Abstract

The research investigates the effect of overconfidence, engagement, and teamwork on project entrapment. The fundamental factors in the research include project entrapment (decision to continue or abandon a failing project), managerial overconfidence, engagement and team's coordination and conflicts. Little research has been conducted to analyse the combined effect of overconfidence and engagement on project entrapment, and there is lack of research on team's decision on project entrapment specifically. Therefore, my research adds to the literature by developing a game-theoretical model of an individual manager and a model of a team to analyse their project investment decisions.

By solving from backward induction, I discover that the manager's choice on continuing or abandoning the project depends on the different level of overconfidence and engagement. The model also reveals ambiguous effects of overconfidence on firm's value. A lower level of overconfidence can destroy firm's value while higher level of overconfidence increases firm's value. I extend the model to a team's decision, in which I find a team with one overconfident manager and a rational manager may have conflicting decisions and souring relationship depending on the manager's level of overconfidence.

I further implemented two real-effort experiments, one for an individual's decision and the other for a team's decision, to test the propositions in the theoretical models. The experiments demonstrate the analysis of effect of overconfidence, engagement, and teamwork in the model. The experiments also provide pilot support and bring a potential direction for future research.

The significance of this research is that it provides both theoretical and empirical evidence on the effect of overconfidence, engagement on individual manager's decision and team's decision. I close the analyse by discussing future research directions and the possibility of applying my research in practice.

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Chapter 1: Introduction

1.1 From Traditional Finance to Behavioural Corporate Finance

Traditional finance is based on an important assumption of rationality. Traditional finance theories assume that people are fully rational, self-interested, and utility maximizing in the market. However, an increasing number of market behaviours have shaken the conception. Research shows that in the financial market, investors' and managers' financial decision making violates traditional assumption of rationality. The researchers start observing that investors and managers do make mistakes when making investment decisions, which they find could be caused by psychological biases. As a result, behavioural finance was developed to explain the irrational behaviours in financial market by including the effect of psychological phenomena. Shefrin (2001) argues that psychological phenomena include three categories: biases (excessive optimism, overconfidence, confirmation bias and illustration of control), heuristics (representative ness, availability anchoring and affect), and framing effects (loss aversion, aversion to a sure loss). Much behavioural finance research has focused on investors' irrational investing and trading behaviours in the financial markets. Behavioural finance scholars recognize that such behavioural biases also exist in corporate financial decisions. As corporate managers are also human beings, they can make mistakes in corporate financial decisions. By applying behavioural finance theories to corporate finance, researchers developed a new branch of behavioural finance, behavioural corporate finance, which focuses on the effects of managers' psychological biases on corporate financial decisions. Researchers argue that corporate financial decisions, such as investment appraisal, capital structure, merger and acquisition activities, and financial contracts are significantly influenced by psychological biases (Baker et al., 2004). Such biased financial decisions have various effect on the firm, including destroying the firm value and decreasing shareholders' wealth. In my research, I am focusing on a specific decision bias which is common in behavioural corporate finance: project entrapment.

1.2 A Brief Introduction of Project Entrapment

Among all psychological pitfalls in corporate managers' financial decision making, one critical finding is project entrapment. The aim for a firm to investing in a project is usually to increase the firm's value. Before investing in a project, the project managers in the firm will evaluate the project by investment appraisal methods, such as payback periods, Internal Rate of Return (IRR), Net Present Value (NPV) and Real Options. Traditional finance shows that a rational

manager is always willing to invest in a project with a positive NPV because the project will add value to the firm and increase the payoff for the managers. Similarly, rational managers should abandon those projects immediately whenever they find the projects are damaging firm's value. In contrast, in the real world, some investors are still willing to throw money into projects with negative NPV, and they continue value-destroying projects. The irrational behaviour that manager continues a project which damages the firm's value is called project entrapment. Shefrin (2001) identifies the examples of project entrapment including Sony's Chromatron in 1960s and Syntex Corporation's drug Enprostil in late 1970s. In Sony' case, Sony's founders continued to throw money into a colour television screen Chromatron and produced despite the double cost. One of the founder Masaru Ibuka refused to terminate the project until the time Sony lost $8.5 billion and was close to ruin in over 5 years. Syntex Corporation is a pharmaceutical corporation. The company created a new drug Enprostil to treat stomach ulcers in 1978. The drug was found to have severe side effect on patients, but the company poured more than $100 million into the project before terminating it in the late 1980s.

Researchers believe that the key concept of entrapment is overcommitment. (McElhinney and Proctor, 2005). An entrapment in a project has been defined as an ineffective action of increasing commitment to a failed project. Recent examples have already shown detrimental outcome of escalation of commitment and project entrapment in various fields. One recent example in financial market is the investment of SoftBank into WeWork. From 2016 to 2019, SoftBank Group has spent more than $5 billion in restructuring and maintaining operations of WeWork, a company providing coworking spaces. However, a report by its former chief in 2019 warned SoftBank that they had 'put good money after bad' and that WeWork had a high probability of being worth 'zero for equity and debt'. (Aliaj and Edgecliffe-Johnson, 2019). Similarly, escalation of commitment in construction industry are also common. The Big Dig project, which involved the largest construction of highway and update of infrastructure in Boston in the United States, was estimated to cost $2.8 million and scheduled to complete in 1998. Surprisingly, the project finally costed $14.6 billion and did not finish until 2007. The unexpected costs and delay in the project resulted in various problems including health and safety threat, budgetary overruns, material issues, and lack of human resources. In some other fields, investing in a project with negative NPV is observed. Australia announced to terminate its development in COVID-19 vaccine development in 2020 after spending $750 million on the project. Abudu et al (2021) find that over more than a decade, the funding for cancer research has increased by $3 billion. Even though the financial cost and time cost for

developing an effective treatment is high unpredictable, the government and partners of the cancer research organizations are increasingly continuing their investment in the industry. The evidence from various industries has demonstrated that companies indeed invest in projects that has negative NPV. Therefore, it is important to understand why such investment behaviour appears frequently in the industry.

One of the fundamental factors for project entrapment is the failure of the project. The most common characteristic inherent to a project potentially causing entrapment is poor performance of financial features and economics of the project (Main and Rambo, 1998). A failing project that entraps investors and managers can be related to problems on financial decisions, including ambiguity outcomes, the size of investment left to finish the project, the opportunity cost of the project, the expected return on the investment, and so forth. Escalating the commitment to such projects can results in ineffective financial outcome from the project, adverse political and interpersonal consequences (Molden and Hui, 2010). In my research, the project involved in managerial and financial decisions possesses characteristic of failure to achieve existing cashflows and uncertainty of its future financial payoff, which can damage the payoff for the manager himself and the firm's value.

An increasing amount of research shows that various psychological biases, such as sunk cost fallacy, overconfidence, regret, and other psychological and emotional factors contribute to project entrapment. Sunk cost causes managers to continue throwing good money into bad projects (Statman and Caldwell, 1987). In traditional finance, it has been argued that sunk cost should be neglected when investors and managers make financial decisions. Sunk cost, representing the managers' previous decisions, can raise managers' commitment to a project even if it turns out to be a failure. Besides, according to prospect theory people prefer avoiding losses to pursuing due to loss aversion (Crumbaugh, 2015). In addition, managers cannot neglect their initial investment when they are deciding whether to continue or not due to the fear of loss and rejection of their previous investment decisions. Researchers have also expanded their studies on effects of overconfidence and regret on project entrapment. Many scholars divide overconfidence into two different types: overestimation, in which people believe the probability of success of projects to be higher than it actually is, and overplacement (better-than-average), which means that people claim their abilities to be better than others (Pikulina et al., 2014). Overconfident people would be less risk-averse when choosing investments compared to those who are less confident (Pan and Statman, 2012), i.e. they are over-optimistic about the future. Overconfidence makes people more strongly believe in their

own abilities, thus underestimating the risk of the investment and potential losses from the project in the future (Gervais, 2009). Managers who are overconfident are more likely to take excessive risks and make incorrect investment appraisal on investment projects. However, overconfidence also causes managers to exert excessive efforts in the project (Pikulina et al., 2014). Overconfident managers who overestimate their ability tend to believe in a higher marginal productivity of their own (Gervais et al., 2011). Consequently, the manager is more likely to perceive a higher payoff from the project and continue the project for so long.

Another possible factor that contributes to project entrapment is engagement. Studies in fair process has theoretically and empirically demonstrated that managers not only care about the outcomes of the project, but also pay attention to the process working on the projects (Wu et al., 2008). Fair process refers to the phenomenon that people also care about the fairness of the process or procedure through which the decision is made, and the outcome reached. Recent studies have shown that fair process can enhance managers' motivation and performance for the project. If managers are engaged and motivated in the project, they are more reluctant to abandon the project.

Studies in behavioural corporate finance not only focus on the individual project manager's decision but also consider a project management team's decision. Researchers find that the interaction between the team members affects the team's performance. An overconfident team member can increase the team's marginal productivity to avoid free-rider problem (Gervais and Goldstein, 2003). Additionally, the negative reciprocity in the team creates moral hazard problem which may cause souring relationship in the team, while the positive reciprocity in the team can enhance the team's performance on the project (Fairchild, 2012). The idea of team's coordination and conflicts brings more potential research directions in behavioural finance, especially combining with project entrapment.

1.3 Research Questions

In my study, the main focus is the manager's project entrapment. I concentrate on three factors: managerial overconfidence, engagement, and reciprocity in the team. I define managerial overconfidence as overestimation that managers think they have better-than average abilities and expand excessive efforts into the project. To distinguish from overconfidence (physical effort), I define engagement as how much passion and motivation the project managers would love to spend on investing and evaluating the project. I take engagement as a factor to illustrate psychological motivations, such as overcoming personal inconsistency and sense of personal

achievement. If managers get more psychological motivation, they could be much more engaged in the project and unwilling to abandon it.

To begin with, I develop a game theoretical model with an overconfident manager to explore the effect of overconfidence and engagement on project entrapment. Combining the effect of overconfidence and engagement, I can investigate how the project manager's decisions on whether to continue or abandon a failed project and the effect of manager's decision on firm's value. Based on the original model, I extend my model to a team with two managers, in which the coordination and conflicts in the team is included. As modern corporate decisions are usually made by a decision team, researchers are increasingly paying their attention to the interaction between team members and the inequality in the team. It inspires me to explore how team's investment decisions and the firm's value can be affected by overconfidence and team members' interactions simultaneously. In the thesis, I investigate the relationship between overconfidence, team's reciprocity, and project entrapment. Accordingly, my research investigate the following questions:

- What is the effect of managerial overconfidence and engagement on project manager's decision on the project?
- Are managerial overconfident and engagement good or bad for the manager's payoff from the project?
- Is firm's value affected by the manager's decision? If so, how will the shareholders react on the manager's decision?
- What effect the managerial overconfidence will have on the project continuation or termination decision in a team?
- Will the team member's interaction and reciprocity in the team affect the teammates estimation and change the team's decisions?
- What are the implications of the research? How can the research apply to the real world?

My research relates the overconfidence and engagement to both individual level and team level. I consider the effect of overconfidence and engagement in the same model simultaneously. The model gives a deeper insight into the effect of overconfidence and engagement on corporate manager's decision on the project. In addition, my research adds to the literature by establishing a game theoretical model of team's reciprocity and project entrapment. I also extend my analysis by including the uncertainty of the project and the shareholders' ex ante recruitment decision.

1.4 Structure of the Thesis

My thesis consists of 7 chapters. The thesis is organized in the following way.

Chapter 2 reviews relevant literature in the research. I start with the development of behavioural finance and behavioural corporate finance. Then I summarize the previous research of overconfidence and engagement on the investors and managers in corporate finance decision making and project entrapment. Through the literature review, I identify the research gap in where my research can fill in and the specific research areas on which my research can step further.

Chapter 3 introduces a game theoretical model of an overconfident manager's decision on whether to continue or abandon a failed project. In the model, I investigate how overconfidence and engagement can affect the manager's perceived payoff from the project, and how the manager makes decision on different level of overconfidence and engagement. Additionally, I outline both positive and negative effect of overconfidence on the firm's value for the shareholders.

In chapter 4, I present the behavioural finance experiment I implement to demonstrate the theoretical model in chapter 3. I test the effect of overconfidence and engagement on the manager's decision and the firm's value for shareholders from the project.

In chapter 5, a game theoretical of a team's decision in developed and presented. Following a similar outline of single manager model, I show the effect of overconfidence and team reciprocity on the team's decision. I analyse the coordination and the conflicts in the team and identify their impact on the managers' payoff from the project. I also extend the model by considering the uncertainty of the project and the shareholders' recruitment of the team.

Chapter 6 includes the design and findings of a behavioural finance experiment built on the teamwork game theoretical model in chapter 5. I test the hypotheses made from the model and demonstrate the relationship between the overconfidence, team's reciprocity, and the manager's payoff from the project.

Chapter 7 summarizes the conclusion from the model and the experiment in my research. I provide potential application of the research to the real world. I also discuss the limitations and the future research directions built on my research.

Chapter 2: Literature Review

2.1 From Traditional Finance to Behavioural Corporate Finance

Traditionally, financial theories were established based on the assumption of fully rational, value maximizing and self-interested investors and managers. However, with more research financial decision making, researchers realized that investors and managers were not always rational when they were making financial decisions. To explain people's irrational behaviours, researchers introduced behavioural finance, which argues that mistakes in decision making may result from investor's psychological biases and emotions. Behavioural finance initially focused on irrational behaviour of investors in financial markets. When researchers found that investors' behaviours were not consistent with the concepts in traditional finance, they created behavioural finance to explain financial market anomalies. In behavioural finance, the researchers are exploring how psychological factors are related with the irrational behaviours from investors.

Meanwhile, corporate finance focuses on financial contracts, investment decisions in organizations, capital budgeting, dividend policies between investors and managers. Companies raise funds in various ways such as borrowing on lines of credits, issuing equity, and selling bonds, while companies also seek to expand by investing in new projects, paying dividends, and so on (Shefrin, 2001). Corporate finance explains interactions between managers and shareholders. Traditional Corporate finance assumes that corporate managers are totally rational, self-interested and value-maximizing in financial decision making. Likewise, investors can take for granted that managers will act in their self-interest, respond quickly to the investment opportunities, and organize an optimal capital structure in the firm. Nevertheless, managers' behaviours do not necessarily fit in the theory of rational investors and managers. Instead, researchers found that managers also made mistakes on corporate finance decisions. Therefore, researchers try to apply behavioural finance framework to corporate finance. As a result, behavioural corporate finance has emerged to investigate managers' 'irrational' decision making by adopting behavioural finance theories.

2.2 Project Entrapment

2.2.1 Theoretical Research in Project Entrapment

Behavioural corporate finance researchers believe that managers with psychological biases make mistakes on financial decisions. One of the most common mistakes for corporate managers is project entrapment. Project entrapment refers to a situation where a decision maker

continues with a project that keeps sending out negative feedback. Project managers are often observed throwing too much money to bad projects or keeping a failed project for too long. Traditional finance argues that rational managers can terminate the project without hesitation as soon as they find the project no longer profitable. However, there are an increasing number of studies demonstrating that managers are more or less influenced by psychological biases. There is both theoretical and empirical evidence that project entrapment is common among corporate managers. In the real world, researchers find project entrapment in many prestigious companies. Recent examples such as SoftBank Group's investment in WeWork and The Big Dig project in Boston in The U.S. have demonstrated that companies are continuing throwing good money into bad projects. Similarly, the famous supersonic aircraft Concorde was produced by British and French companies together but turned out to be unprofitable due to its extremely high costs. However, managers still keep it alive mostly because of their huge prior investments and overconfidence that they will finally make profits (Crumbaugh, 2015).

Many scholars of behavioural corporate finance have extended their research in why managers still want to continue a failing project even if they are aware of the situation. Finance and psychology scholars believe that project entrapment results from various psychological biases such as self-justification, sunk cost fallacy, overconfidence, regret, hyperbolic discounting and so on. McElhinney and Proctor (2005) identifies several potential factors contributing to entrapment and escalation of commitment, including theory of anchoring, prospect theory, group thinking, concept of incrementalism, manager's motivation, social pressure, and organizational culture. In behavioural corporate finance, researchers concentrate on the psychological biases to explain project entrapment and escalation of commitment. Studies in behavioural corporate finance have analysed how various factors affect the escalation of commitment on a project for managers.

Firstly, researchers argue that theoretically, managers refused to abandon a failing project due to self-justification, which implies that managers with psychological biases are unwilling to admit misallocation of prior financial resources (Sivanathan et al., 2008; Lunenburg, 2010). Sivanathan et al (2008) argues that people are driven to stay in a positive situation in which they can take actions for self-achievement and satisfaction. For managers, they are self-interested in corporate decisions. They suffer from psychological discomfort whenever the results are not what they expect. Thus, the authors believe that managers are seeking to escalate their commitment to a project and eager to justify themselves, which triggers project entrapment. Similarly, Wieber et al. (2015) argue that self-justification escalates the

commitment to avoid the conflict between initial investment and the realization of a total mistake. One psychological determinant for self-justification is that people always avoid dissonance between their initial decisions and the realization that the decisions are mistakes. The cognitive dissonance could not be easily fixed as people may have invested so many resources into the project (effect of sunk cost, time) or feel uncomfortable and restless about negative feedback (regret, overconfidence, mental discounting). The authors did an experiment to demonstrate how self-regulation can affect managers' decision making by individuals and groups. They find in the experiment that a group effect can be significant in the decision making. The problem of project entrapment appears because managers lack self-regulation when they make investment decisions with psychological biases. Wilson and Zhang (1997) reviewed the existing research and concluded that decision maker tends to escalate their commitment to justify his previous choice of action, but self-justification cannot solely explain escalation of commitment.

Secondly, researchers believe that sunk cost is one of the crucial factors contributing to project entrapment. Research has shown that sunk cost, representing the mangers previous decisions, can raise managers' commitment to a project even if it turns out to be a failure. Sunk cost changes managers' risk attitudes and places a significant effect on managers' framing on a project. According to prospect theory, people tend to be risk aversion when they are confronted with losses. Because of loss averse, people are more likely to avoid losses prior to pursuing gains (Crumbaugh, 2015). Taking sunk cost into account may force people to make a trade-off between reducing losses and increasing gains. Besides, although sunk cost is independent of any activities in the future, the past action is rooted in managers' mind. Managers cannot neglect their initial investment when they are deciding whether to continue or not due to the fear of loss and rejection of their own opinion. Some studies have strengthened the effect of sunk cost fallacy by implementing either interviews (Statman and Caldwell, 1987; Lokhorst et al., 2006; Pan and Statman, 2012) or lab experiments (Haita, 2013; Haita-Falah, 2017) to capture the individual's feeling of sunk cost and their decision making. They discover that sunk cost fallacy exists among individuals, and that the feeling of sunk cost depends on the size of sunk cost.

When researchers discovered the relationship between sunk cost and project entrapment, they began to realize that sunk cost fallacy is related with regret aversion which also affects managers' decision making. Managers with higher propensity of regret feel much more painful when they have to terminate a project. Statman and Caldwell (1987) demonstrate the effect of

regret in their experiment, and they conclude that managers' commitment to a poorly performed project can be explained by the fear of regret and aspiration of putting off the pain. Pan and Statman (2012) also demonstrate the effect of regret by asking people's true feeling about terminating a project. Managers who are looking to maximize profits from projects tend to ask themselves if their choices are best and experience uncomfortable lingering doubt that they could have made a better choice. The level of project entrapment can be even worse especially for a manager who have ever abandoned a project before. They found that the feeling of regret makes people avoid doing the same choice again. Marcatto et al. (2015) argue that if managers have experienced feelings of regret by denying their own decisions, they will find it much harder to make identical abandonment decisions again just because of regret aversion, or resistance of feeling regret for a second time.

Thirdly, overconfidence has long been recognized as one of the major factors contributing to project entrapment. Behavioural researchers argue that overconfidence influences managers on biased recognition of their abilities and excessive optimism on the success of a project. On one hand, managerial overconfidence leads to underestimation of risks on certain investment opportunities. Overconfident managers tend to have higher risk tolerance and lower risk perception (Pan and Statman, 2012). Manager's underestimation on risks and high risk-tolerance enhances their expected probability of success for the project, thus making them throw money into riskier project that they otherwise wouldn't. In the survey implemented by Pan and Statman (2012), they asked about people's attitudes towards risks while they also measure people's level of overconfidence. The authors reveal that overconfidence plays a significant role in people's attitudes towards risks. Shefrin (2001) also argue that managerial overconfidence not only leads to higher perceived control, but also produces inadequate risk management. In addition, overconfident managers overestimate the knowledge they possess about the project and the quality of their project, which can lead to project entrapment.

On the other hand, researchers also pay attention to managerial overconfidence in ability. Managers who are overconfident about their abilities may possess useful knowledge about the project and may estimate the risk of the project. However, overconfident managers believe that they have better-than-average abilities than their peers, for example they have a unique skill allowing them to solve more problems and observe better information. Some researchers ascribe overconfidence to attribution bias, which means that people tend to attribute success to their own ability while blaming outside as factors for failures (Everett and Fairchild, 2015). Statman and Caldwell (1987) argue that overconfident managers feel 'more comfortable' in his

company and in his project so he will exert more effort in the project. Choosing effort as a proxy to investigate the effect of overconfidence has been widely accepted by researchers in behavioural corporate finance. It also has been theoretically assumed that there is a positive relationship between level of confidence and effort input in investment (R.J. Fairchild, 2011; Gervais et al., 2011; Pikulina et al., 2014; Everett and Fairchild, 2015). In their study in overconfidence, Pikulina et al. (2014) asked participants to answer 20 financial knowledge questions and assign probability that their choice is right. The average probability represented the level of overconfidence. Similarly, some researchers asked participants to complete a task containing certain number of questions and estimate how many correct answers they could get or how many participants they could beat in the task. In their experiment, they showed that participants' effort and investment choice were closely linked to their levels of overconfidence. The method not only enables the authors to measure the level of overconfidence from the participants, but also provide the authors with the participants true ability and perceived ability. Compared with self-reported level of overconfidence, the question-answering task is more precise in obtaining level of confidence. In addition, it also measures the participants' true abilities and perceived abilities, which cannot be obtained by the self-reported overconfidence. The empirical studies reveal that managers with higher overconfidence produce excessively higher level of effort and investment comparing with less overconfident ones.

After discovering and demonstrating the relationship between the level of overconfidence and effort for the managers, researchers expand their research on how overconfidence and excessive effort affect corporate managers' decision making. There are increasing theoretical and empirical studies showing that overconfidence affects managers' investment decision making in different fields such as asymmetric information, moral hazard (R.J. Fairchild, 2011), capital structure and investment policies (Gervas et al, 2011) and group thinking. What these studies have in common is that researchers build up theoretical models in which managers are considered overconfident about their abilities. By arguing that overconfident managers insert excessive efforts into the project, researchers believe that there is an optimal level of effort for value-maximizing and that the effect of overconfidence varies in terms of what sort of corporate finance decisions are made. Fairchild (2009) finds that in different stages of investment, overconfidence may have ambiguous effects on the debt decision. In the early stage with sufficient investment opportunities and free cash flows, overconfident managers may issue less debt, while in the later stage where only limited investment opportunities and free cash flow are available, managerial overconfidence results in higher level of debts. The author

believes that managerial overconfidence makes managers overestimate the probability of success and underestimate the probability of financial distress, so managers prefer issuing less debt in the early stage, while managers issue more debt in the later stage.

Extending the research of overconfidence on escalation of commitment, researchers argue that overconfident managers tend to overestimate their ability and the expected payoff from the project. An overconfident manager may feel unrealistically optimistic about the project than it should be in the future. It has been theoretically assumed that there is a positive relationship between level of confidence and effort input in investment (Fairchild, 2009; Gervais et al, 2011; Pikulina et al, 2014; Everett and Fairchild, 2015). Gervais et al. (2002) built a model to analyse the effect of overconfidence on investment policy. They argue that the overconfident manager tends to exert more effort into the project because he is overconfident about his ability. As a value-maximizing manager, the overconfident manager overestimates his marginal productivity transforming effort into the payoff from the project, so he will exert more effort into the project if he is more overconfident. In their model, the authors find positive side of overconfidence that the manager can work harder and increase the firm's value, but they also recognize that extremely high level of overconfidence is detrimental to the firm. Meyer (2014) defines that entrapment include continuing the project as previously planned and continuing the project by adding extra investment. Through experimental research he finds that overconfident manager in inclined to an optimism to believe that he can save a failed project and achieve better payoff from the project.

Lokhorst et al. (2006) argue that overconfidence is common in big companies as managers are experience and with high reputation. The authors find that those managers tend to overestimate their abilities and put excessive effort into the project, thus refusing to abandon it quickly. In Gervais et al's studies, they claim that a risk-averse manager's overconfidence makes him less conservative, resulting in motivation to pursue more risky projects (Gervais et al., 2002; Gervais et al., 2011). Gervais et al. (2011) argue that overconfidence is prevalent among managers in the real world, and overconfidence has ambiguous effects on investment appraisal decisions. Managerial overconfidence creates incentives for managers to pursue risk-taking behaviour, especially when managers are not highly skilful and the potential for the project is relatively large. An optimal level of overconfidence will help increase firm's value as the benefits from overconfidence dominate over detrimental effects. The opposite effects of overconfidence are also displayed in capital structure decisions. Under asymmetric information, moral hazard problems exist when overconfident managers have conflicts with shareholders in

decision making. Fairchild (2005) also argues that excessive efforts of overconfident managers can, on one hand, create value while, on the other hand, results in higher debt levels that may reduce firm's value. The author finds that overconfidence leads to higher managerial effort and harder work from managers, but it also leads managers overestimate the probability of good states and underestimate the risk of bankruptcy. The findings in their studies reveals that overconfidence may have ambiguous effect on the managers' decision. Built on their concepts of game theoretical models, I develop a model on managerial overconfidence and project termination decisions in which I demonstrate the positive and negative effect of overconfidence on firm's value. In addition, the model also discusses the moral hazard problems between shareholders and managers in terms of inefficient project continuation decisions.

Psychological research identifies that people are more likely to become overconfident or optimistic in their abilities especially when they are largely engaged in a project, when they believe they can control the project outcomes or when the project outcome is complex to realize (Fairchild, 2005). Particularly, even though the project is not profitable for outside observers, for overconfident managers they believe that their better-than-average abilities can make the projects beneficial to the company, therefore, hoping to keep the projects longer. In addition, experimental study also finds that overconfidence is not only related with the intrapersonal decisions, but also linked to interpersonal affairs (Gervais and Goldstein, 2003). Ronay et al. (2017) show that managers who escalate their commitment to a failed project are also socially motivated by enhancing their reputation. My research assumes that overconfidence leads to higher effort into the project, resulting in a higher perceived benefit for the managers which causes project entrapment. To explore the effect of overconfidence on project entrapment, I build a theoretical model based on previous overconfidence models from Gervais et al's (2011) analysis on overconfidence and capital budgeting and Fairchild's (2011) game theoretical model on choice of venture capitalist. Scholars in behavioural corporate finance modelled overconfidence using effort level as a proxy. Researchers conduct empirical analysis step by step in different dates and stages of investment decision making process. The game theory perspective and the application of utility function in existing overconfidence model acts as a guidance for us to establish and extend my overconfidence model.

Last but not the least, psychologists find strong evidence that exponential discounting analysis (e.g., Net Present Value) does not always accurately fit in managers' investment appraisal patterns. When making investment decisions, initial investment appraisal often requires predicting and discounting future cash flows. NPV method is an example of exponential

discounting, which assumes that people discount a future reward only depending on time gap and that discount rate remain constant regardless of different waiting time. However, recent studies and experiments show that hyperbolic discounting, instead of exponential discounting, is more fitted in to the result (Benhabib et al, 2004; Madon et al., 2012). Hyperbolic discounting refers to the increasing tendency for people to choose a sooner shorter reward rather than a larger later reward as the delay for sooner shorter reward becomes smaller (Redden, 2007). Green and Myerson (1996) argue that decrease in value reveals the relationship between delay and risk. Investment appraisal approaches using exponential discounting are developed with a fixed discounting factor while in hyperbolic discounting the discounting factor is not constant (Green and Myerson, 1996). In addition, Farmer and Geanakoplos (2011) argue that people discount future reward because people are impatient and naturally imagine future failure vividly in the present. The research above shows a strong influence of hyperbolic discounting on managers' investment appraisal. The biased mental discounting process will affect managers' valuation of the project, resulting in an incorrect estimation of project value and project entrapment.

So far, behavioural finance researchers have identified and analysed the effect of various psychological biases on corporate manager's decision. Researchers believes that manager's entrapment in the project affects not only the economic benefits for the manager but also the firm's value. Therefore, shareholders, who are concerned about increasing the firm's value, are also related to the manager's escalation of commitment. As researchers have found that entrapment in the project may have positive and negative effect on the firm's value, the manager's decision can create agency problems towards the shareholders. Studies on shareholders' engagement argue that shareholders do take actions when they have conflicts with the managers. Admati and Pfleiderer (2009) address that as the shareholders play a limited role in corporate financial decisions, they may choose a form of activism to improve the corporate performance, especially the manager's decision is acting 'in the best interest of the shareholders. They point out that exit could be an alternative in response to the manager's decision which is not favourable to the shareholders. Jahnke (2017) also points out that shareholders are sometimes acting between voice and exit. In recent years, shareholders are increasingly engaged into corporate performance and more active in expressing their voices to alert the failure in project management. Instead of exiting, shareholders are now more concentrated and involved in corporate strategies. Solomon (2017) reveals that the shareholders' involvement and engagement is efficient to avoid agency problems, lower agency costs and

strengthen capital markets for the firm. He believes that it is important for the shareholders' voice to be spoken out and heard in the firm. Similarly, Ferraro and Beunza (2013) emphasize the practice of shareholders' engagement and involvement. Shareholder resolutions have been massively growing in recent years, and shareholders engagement is effective in disclosing corporate governance issues and affects the firm's performance positively. Most studies focus on the relationship between shareholders' engagement and general corporate governance. There are few studies considering the specific situation where project entrapment occurs and how shareholders react to it. Under this conception, in the game theoretical model I consider an agency problem between project manager and shareholders. Shareholders' engagement on the project management decision and interaction with managers are analysed in the model. My model adds to the literature in the aspect of project entrapment, overconfidence, and shareholders' involvement.

2.2.2 Empirical Research on Behavioural Finance and Project Entrapment

Behavioural finance theories combine investors and managers behaviours with psychological factors. Behavioural finance researchers conduct both theoretical and empirical studies to explore the effect of various psychological factors on individual's financial decision making. Laboratory behavioural surveys and experiments has been widely carried out to reveal the empirical evidence.

Researchers has been testing the effect of overconfidence on investors and managers decisions. Studies on overconfidence adopt different approaches to measure level of overconfidence. Most commonly used method is to ask participants to perform a task and estimate the result. Some studies ask participants to answer a set of multiple-choice questions. The participants are required to estimate a probability that their choice is correct on every question they answer (Trinugroho and Sembel, 2011; Pikulina et al., 2014; McCannon et al., 2016; Michailova et al., 2017). A typical example is an experiment by Pikulina et al. In the experiment, they are investigating the relationship between the level of overconfidence and effort. To capture the participants level of overconfidence, the authors recruit finance students and ask them to answer 20 financial knowledge questions. Each question contains two alternatives, and after the participants make their choice on each question, they assign a probability between 50% to 100% that their answer is correct. The average probability reflects the participants perceived confidence level, and the proportion of actual correct answers represents the skill of the participants. An alternative to this method is to directly ask the participants to estimate how many questions they can answer correctly at the end of the task. By comparing the estimated

correct answers and actual answers from the participants, the researchers can observe the participants' level of overconfidence (Ifcher and Zarghamee, 2014; Michailova et al., 2017). Another approach to capture level of overconfidence is by confidence level. This approach also requires basis of question answering task. Instead of multiple-choice questions, the questions are not provided with any alternative answers. The participants need to give a range in which they believe the answer lies in a certain level of confidence interval (usually 90%). The researchers will examine the difference between the upper and lower limit and treat it as the level of overconfidence (Biais et al., 2005; Deaves et al., 2009; Fellner and Krügel, 2012; Menkhoff et al., 2013). Fellner and Krügel (2012) use this method to measure the level of overconfidence. In their experiment, subjects need to state a lower and an upper bound in which they are 90% sure that the correct answer lies in the interval. The level of overconfidence is indicated by broadness and narrowness of the range. Comparing each measurement, I find that estimating the number of correct answers fits best in the experimental design in my research. In the experiment, I need to collect participants true ability and perceived ability, and then I calculate the participants perceived payoff using the ability data. Therefore, the estimated and actual number of correct answers is more straightforward.

As researchers are getting better understanding on the relationship with overconfidence and effort, they increasingly seek to obtain the participants effort level for analysis in the experiment. There are diverse opinions on whether a real-effort task or a stated-effort method should be selected in the experiment. The experiments adopting stated effort method provides a chart with different effort levels, cost of effort and corresponding value created at each effort level. At the stage of exerting effort, the participants simply choose one effort level, and they can understand how much output they can achieve in the experiment. In some papers on the fairness and venture capitalist, the researchers are more inclined to the methods of choosing a work effort (Anderhub et al., 2001; Fehr et al., 2007; Karakostas et al., 2017; Fairchild et al., 2017). Fairchild et al. (2017) conduct an experiment to analyse venture capital/entrepreneurial contracting and performance. Theoretically, the authors argue that moral hazard problem may occur when venture capitalists and entrepreneurs negotiate on equity stake. To find how bargaining power and negotiation affect the effort motivation and the performance, they use stated effort chart to obtain the effort level of the participants.

On the other hand, some researchers design a real effort task to capture the participants' effort level. The real effort methods require the participants to take part in a task and complete several rounds. The researchers will treat the participants' performance in the task as the effort level.

These tasks usually include coding and grouping a series of numbers (Pikulina et al, 2014), judging a series of statements as being true or false (Bäker and Pull, 2017), clicking on points appearing all over the screen (Hammermann et al., 2012)counting a specific number in blocks of random different numbers (Vranceanu et al., 2015) etc. Vranceanu (2015) conduct an experiment including a real-effort task to investigate the effect of punishment in a team on the team's performance. The team's performance is measured by the effort exerted into the task, which requires participants to count 7s in blocks of random numbers. The real-effort experiment consists of a computer task in which subjects are asked to count the number of 7s in blocks of random numbers. The participants need to correctly identify how many 7s are there in each block formed of 30 columns and 6 rows. When the participants submit the answer for each block, a new one will be shown to them. The task lasts for 4 minutes. The effort and the performance are represented by the number of blocks correctly counted. What real effort methods have in common is that the participants need to spend effort into the project to achieve better results, which are linked with their rewards in the final stage. The participants can review their effort and the results at the end of the task. Inspired by Vranceanu (2015), I adopt the similar way of capturing level of effort. My experiment was built to test the effect of overconfidence on project termination decision and firm's value. In the experiment, one of the important steps was to test the relationship between the level of overconfidence and level of effort from the participants. Therefore, to obtain the level of effort, I included number counting task in my experiment.

As researchers debated on which effort methods can reflect the participants' effort more precisely, Charness et al. (2018) compares stated effort method and real effort methods, and they identify both pros and cons in each method respectively. The authors argue that the stated effort task eliminates the uncertainty from the participants but may not capture the participants effort related with the environment and psychological conditions. Meanwhile, real effort method is closer to the psychological states when the participants are involved in the experiment, but it is difficult for the researchers to find the cost of effort from the real effort method. According to their review on each method, they propose a general criterion on which method to choose from when designing behavioural experiment. When choosing between real effort method or stated effort methods, timing of the decisions, planned or actual action, and the interchangeability between the effort and the payoff should be considered.

Pikulina et al (2014) implemented a behavioural finance experiment in which they measured the level of confidence by question-answering task and the level of effort from participants by

real-effort test. The authors provided 20 financial knowledge questions to the student from finance background to answer and asked them to estimate how much percentage they believed each answer was correct. Then the participants performed a real-effort task requiring them to coding and grouping a series of numbers in a limited time. They demonstrated the positive relationship between the level of overconfidence and physical effort exerted in the experiment. The authors' approach to measure overconfidence inspired me on designing task to obtain the level of overconfidence for the participants. My experiment contained a question answering task to collect the participants true ability, perceived ability, and level of overconfidence for analysis. Mapping on Pikulina et al's experiment, I extended their analysis of overconfidence and effort further to project termination decision and moral hazard problems between project managers and shareholders.

With more research on overconfidence and effort accomplished, researchers have continued to carry out experimental work on project entrapment. In Schulz-Hardt et al.'s (2009) experiment, they demonstrate the individual's responsibility effect on project entrapment. They provide the participants with an economics case study. The participants read the information about the company and project and decide whether to reinvest the project using a Likert-type scale. The participants are allocated with different responsibility information ('responsibility' or 'no responsibility'). The data confirms that responsible participants make higher reinvestments in a failing project than non-responsible participants. Responsible participants tend to stick with their chosen alternative than the non-responsible participants. As this experiment reveals the responsibility effect on the project entrapment and reinvestment, other researchers go further by considering sole responsibility and joint responsibility. Chong and Wan (2014) implemented a lab experiment to investigate joint responsibility effect on project entrapment. Participants are required to act as project manager and calculate NPV of the project. Then they are randomly allocated to different treatments with joint or sole responsibility and with private and public information, and the participants express their preference on continuing or abandoning the project on a 10-point Likert-type scale. The authors discover that managers with private information tends to continue the project than others who only access public information, and that managers in the joint responsibility are more likely to continue the project than those in the sole responsibility.

Similar experiment has been conducted by Dension to explore the relationship between investment appraisal methods and project entrapment. Dension (2009) argues that incorporating real options with NPV analysis empirically makes managers less likely to keep

a failing project for too long. In her experiment, she divided participants into two groups. Participants in group 1 can only use NPV method to re-evaluate the project when it is underway. Group 2 combines NPV and real options to revisit the project. Both groups are facing the same cash flows from one project. Participants from both groups were asked their feelings about the project abandonment by marking a score from -5 to 5. She demonstrates the effect of adopting real options by comparing levels of project entrapment in two groups. She believes that managers who adopt various investment appraisal methods obtain higher cognitive accessibility to the possibility of abandoning the project, thus resulting in less project entrapment. By incorporating real options with NPV, managers are involved in valuing the option to abandon the project earlier.

Other experimental research on escalation of commitment and project entrapment includes factors such as sunk cost (Boehne and Paese, 2000), loss aversion, monitoring, alternative projects (Buxton and Rivers, 2014), project completion (He and Mittal, 2007) etc. My experiments on project entrapment contribute to the literature that I bring in real effort experiment to test the participants effort level and combine it with project entrapment. In addition, I introduce the effect of team reciprocity on project entrapment in the experiment. The team experiment include overconfidence, effort level, team interaction and individual team members' decision on the project.

2.3 Other Psychological biases in Financial Decision Making

2.3.1 Psychological biases in Behavioural Corporate Finance

Traditional corporate finance theories concern manager's investment and fund-raising decisions for value-maximizing in firms. However, behavioural corporate finance researchers argue that decision makers are not always rational, and their decisions are influenced by various psychological biases. When behavioural finance researchers are concerned about the investor's irrational behaviours, they are recognizing that corporate managers also suffer from psychological pitfalls when the managers are making corporate finance decisions (Shefrin, 2001). Researchers observe that corporate managers may sometimes make decisions that damages the firm's value. Generally, many scholars in behavioural corporate finance argue that managers behave irrationally in financial decisions because human beings are inevitably influenced by psychological factors, which includes sunk cost, overconfidence, regret, hyperbolic discounting etc.

Studies have shown that sunk cost, which should be neglected when making financial decisions as hypothesized in traditional finance, causes managers to continue throwing money into bad projects (Statman and Caldwell, 1987;Lokhorst et al., 2006; McRaney, 2011; Crumbaugh, 2015). This kind of psychological bias is referred to as framing effect, also known as sunk cost fallacy (McRaney, 2011). Without sunk cost, managers are facing a sure gain or a gamble in whether to continue the project or not, while, considering sunk cost, managers are switching their views on abandonment or continuation of the project. The effect of sunk cost can be related to prospect theory in that taking sunk cost into account may force people to make a trade-off between reducing losses and increasing gains. Prospect theory argues that people are more sensitive to losses than gains, and that people become loss averse in gains but risk seeking when they are facing losses (Kahneman and Tversky, 1979). Psychologically, taking sunk cost into consideration can change managers' attitudes to risks. The authors argues that people feel more pain when facing losses than joy when achieving gains. Therefore, taking sunk cost into consideration could make people perceive that they are suffering from losses if sunk cost is higher than gains. Therefore, managers are more motivated to cover the loss of sunk cost and more willing to take risks. Statman and Caldwell (1987) demonstrate the effect of sunk cost in their experiment. The result shows that when considering sunk cost, managers are more likely to be entrapped in the project, especially when the rewards for good news and penalties for bad news are relatively high. Similarly, a case study on SCA Company by by Lokhorst et al. (2006) reveals that sunk cost makes managers more risk-seeking. Managers surveyed in the study admit that they cannot ignore sunk cost and that they choose risks hoping to break even although the odds are against them.

In terms of psychological biases, behavioural corporate finance researchers have massively expanded their research on effects of psychological biases on corporate financial decisions, for example, investment appraisal methods, capital budgeting, equity and debt structure, and dividend policies. Among those psychological biases, overconfidence has been overwhelmingly paid attention to. Researchers believe that there are two different categories of overconfidence: overestimation, which refers to people believing the probability of success of projects to be higher than they actually are, and overplacement (better-than-average), which means that people claim their abilities are better than others (Pikulina et al., 2014). Researchers have also demonstrated that both these types of overconfidence have an impact on people's decision making.

Meanwhile, behavioural finance researchers have also allocated their studies on effect of other psychological biases such as regret. Many researchers who concentrate on regret theory focus on its effect on individual's utility. Based on prospect theory, Loomes and Sugden (1982) establish an alternative explanation which considers regret theory on the individual's irrational decisions. They claim theoretically that the investor feels sensations of regret and rejoicing because he anticipates his utility and sensations under uncertainty. The individual's experience of regret violates the conventional utility function which is related with the individual's ability to anticipate the regret feelings. Other scholars add more research combining the investors' regret and their utility function. Schran (2007) demonstrates that the feeling of regret leads to concavity in individual's utility function, which explains the fact that regret occurs if a better alternative appears after the investor makes a decision. In addition, apart from anticipating ex ante regret, the author argues that individuals also tend to compare what they have chosen with what they have abandoned retrospectively. Researchers also acknowledge that regret theory has been applied to explain financial activities including trade-off techniques, stock market participation, asset allocation, insurance policy, overbid etc. (Bleichrodt and Wakker, 2015).

Much research has been extended on managerial level. Researchers pay increasing attention to the effect of regret on corporate financial decisions, especially on project investment. Pan and Statman (2012) argue that people with higher propensity of regret feel more disappointed and emotionally painful when they have to deny their previous decisions, causing managers to terminate the failed project too late. Marcatto et al. (2015) find in his experiment that the feeling of regret makes people avoid doing the same choice again. People are less like to make the same choice that previously led to regret, and, in contrast, they will select other alternatives, especially when managers are facing the abandonment of a project. It is quite hard for managers to make the decision because of the painful experience of regret, which they call 'regret heuristic'.

So far, behavioural corporate finance researchers have conducted many studies on the effect of various psychological biases on financial decision making. There is strong evidence that psychological biases have influences on corporate managers' financial decision making. Scholars in behavioural corporate finance emphasize the effect of overconfidence to such problems as moral hazard, agency problems arisen in the real world. Much of the existing research on behavioural corporate finance focuses on psychological biases on capital budgeting, capital structure, firm's value, dividend policy etc. Various psychological factors have been identified to explain mistakes in decision making from the managers. These studies provide

deep analysis of effect of psychological biases on corporate financial decision and start incorporating the effect of biases with the effect of emotions to explain the manager's behaviour. One of the phenomena the research is escalation of commitment in project for firms, which is related to managerial capital budgeting and firm's value. Project managers' decisions are affected by psychological biases and emotions, which may lead to mistakes and damage firm's value. In the following sections, I will have an overview of existing research on project entrapment.

2.3.2 Research of Teamwork on Corporate Investment Decisions

Corporate financial decisions are often made by a team. In many cases, corporate wealth is achieved through teamwork instead of one manager. Thus, behavioural finance researchers are increasingly paying attention to team's coordination and conflicts in financial decision making. It has been acknowledged that the interaction between team members has significant effect on the team's output especially when there is diversity in the team members.

Studies in teamwork considers the effect of fairness and inequity on the team's productivity (Rey-Biel, 2008; Mohnen et al., 2008; Wei, 2009; Li, 2009; Gill and Stone, 2015). Researchers believe that managers are not only care about self-interested value maximizing but also their co-workers' welfare in the team. As a result, the team member may be aware of any inequity on welfare distribution. Researchers find that individuals in the team are usually inequity-averse and more or less hate unfair output distribution among team members. Mohnen et al (2008) argue team members have incentives to reduce the inequity by adjusting the effort exerted into the project. Those who contribute less effort tend to exert more in the next stage, and those who contributes less before are likely to add more effort. The author also emphasizes that such reaction to inequity in the team only appears when the contribution of each team member is transparent in the team. He attributes such behaviour to peer pressure. The team member who contributes more but dislikes inequity can punish the team member who contributes less by exerting less efficient efforts and reduce the team output. For fear of this, the team members are always trying to exert most efficient effort to the team. Li (2009) revisits the theory that self-interest can avoid free-riding problem in the team. As the team member concerns about his own welfare and his teammates payoff, the author claims that there is a balancing budgeting contract which can reach an equilibrium in effort. As everyone else exerts efficient efforts, any team member who chooses to shirk will make the team output lower than the equilibrium output, which discourages the team member to do so.

Theoretical models on team inequity considers team's cooperation and conflicts. Studies discover that social norm plays a considerate role in team's cooperation. Game theoretical model in social norm and teamwork finds that social norm and team inequity contributes to team cooperation (Wei, 2009). His analysis in the model reveals that team cooperation will be implemented on the condition that inequity aversion is strong and social norm anticipates teammate's cooperation. Scholars are wondering why team coordination is sometimes difficult to reach. The possible answer lies in the diversity of individual's characteristics. Various categories include cognitive factors, social category differences, status differences, and other factors (Mohammed and Harrison, 2013). The authors explore the relationship between team's performance and time-based individual difference. They observe that the team's performance is affected by the degree of diversity team members and the nature of the task. For a task requiring decision making and actions, team members with greater diversity in time urgency and time perspective will cooperate and perform better in the team. The authors' opinion on the diversity of cognitive factors are also supported by the experiment conducted by Curşeu et al. (2013). Curşeu et al (2013) implement an experiment on group cognitive synergies and team's decision making. They argue that collaborative decision rule in the team can achieve higher level of cognitive synergies, which is attributed to team member's interactions induced by decision rules. Collaborative decision-making helps emerging team's rationality. However, group rationality is lower than the highest individual rationality within the group when the cognitive synergy is relatively high in the group. This interesting finding can be related to my teamwork theoretical model where a team consisting of managers with different characteristics may make correct or wrong decisions depending on the interaction between teammates.

Recently, behavioural corporate researchers have begun to incorporate psychological biases and teamwork theories to explain team's corporate decisions. Capital budgeting strategies are crucial to a firm's growth and performance in the financial markets. Traditional finance assumes that managers estimate the monetary payoff and select the project with highest expected value. Behavioural corporate finance researchers believe that managers may consider the interpersonal relationships with their colleagues when making capital budgeting decisions in a team. Peters and Meilleur (2016) suggest that affective reactions, namely emotions and moods, have positive or negative effect on the team's decision-making process. These affective reactions can lead to irrational behaviours. Their experiment demonstrates that managers consider both affective reactions and financial rewards when making an investment decision. Specifically, managers tend to reject the investment opportunity that elicit negative emotions

even though the project is beneficial in value addition. In contrast, managers are also inclined to holding a project which brings positive affective reactions to them. The findings indicate that considering the combining effect of cognitive factors and financial information is necessary to understand the decision-making process in the team.

Gervais and Goldstein (2003) analyse relationship between overconfidence and team coordination. They identify that overconfidence affects the team's performance by increasing the effort exerted into the project for both the manager himself and his teammates. The overconfident manager overestimates his productivity works harder for the project, and, simultaneously, increases the marginal productivity for other team members. Therefore, all the team members will exert more effort and enhance the team output. The overconfident member's overinvestment creates a substantial synergy in the team, thus increasing the team's performance and making each team member better off. Based on Gervais and Goldstein's model, Fairchild (2011) introduce a game theoretical model considering the effect of overconfidence on team's performance, team member's negotiation on shares and fairness process in a team with one overconfident manager and one rational manager. The author discovers that as an overconfident manager exerts more effort into the project, he expects to take more share of the team's output, which in turn reduces the rational manager's incentives to exert effort. The level of overconfidence and the ability of rational manager also affects the optimal team composition. When the rational manager is relatively less capable, the overconfident is preferable to work for the project. However, if the rational manager's ability is high enough, the optimal team should consist of rational managers. According to the analysis, overconfidence has positive effect on the team's performance that higher team productivity and effort can be achieved. Following studies also reflect negative effect of overconfidence. Fairchild (2012) finds that in terms of project choice, the team could have coordination and conflicts when encountering alternative projects and potential project switching decision.

One step further, researchers have begun exploring whether a team can escalate commitment when making decisions. Implement an experiment, Curseu et al. (2016) reveal that compared with individual investors, groups are more likely to escalate monetary commitment in investment. They believe that interactions between the team members in a team with collaborative decision rules accentuate the team member's willingness to continue investing the project. Developed under the model and concepts mentioned before, my research adds to the literature that my model combines the effect of overconfidence, project entrapment (escalation of commitment) and team's reciprocity. I demonstrate both positive and negative

effect of overconfidence on the team's decision, especially when team is suffering negative reciprocity. In addition, my research makes a connection between team's performance and shareholder's engagement in project investment decisions.

2.4 Future Research Direction: Emotions in Corporate Finance

Behavioural corporate finance focuses on the effect of psychological biases and conscious emotions on financial decisions. Taffler and Tuckett (2005) introduce a new field of behavioural finance called emotional finance. Emotional finance analyses the effects of unconscious emotions on financial decisions. Previous research shows that emotions have various effects on people's investment decisions. Kida et al (2001) argue affective emotions such as frustration and anger affect people's capital budget decisions. In Taffler and Tuckett's (2005) emotional finance theory, investors first subconsciously treat an object as a phantasy which has a pleasant and successful image. In this stage, people tend to bury their negative feelings such as pain, frustration, and regret deep in the mind unconsciously. When reality (a tipping point) comes in, the negative emotions become conscious. Suddenly, panic occurs, and investors transform to hate the project. They will put effort on it, resulting in bad performance and value-destroying. Taffler and Tuckett (2010) apply concept of phantasy to stock market bubbles and crashes by arguing that the bubbles burst and the market crashes when reaching the tipping point where subconscious negative emotions dominate.

Recently researchers are extending the effect of emotions from individual's investment decisions to corporate finance decisions. Fairchild (2007) has introduced a new field of research, emotional corporate finance. Similar to behavioural corporate finance, corporate finance researchers aim to investigate financial contracts, investment decisions in organizations, capital budgeting, dividend policies and other investment decisions by adopting the perspective of phantasy. The author builds a theoretical framework incorporating the effects of emotions with overconfidence and regret on project entrapment. In his model, he argues that project entrapment results from not only the cognitive bias but also project phantasy. He demonstrates that phantasy and regret may worsen manager's refusal to abandon a failing project. However, if the failure of the project reaches the tipping point where managers switch to project-hatred, the emotions can induce managers to abandon the project. Scholars believe that emotions have a strong effect on managers' investment decisions in terms of investment appraisal and mental accounting. Geoffard and Luchini (2010) positive and negative emotions have opposite effects on managers' mental accounting. A positive emotion such as relief or joy induces impatience while a negative emotion such as grief and frustration triggers anxiety. With impatience

managers may feel a longer waiting time for the forthcoming event. In contrast, managers with anxiety get a feeling that time runs up fast. People may perform painful actions earlier than the pleasant ones.

Studies in fair process have also found that managers not only care about the outcomes of the project, but also pay attention to the process working on the projects (Wu et al., 2008). They argue that it has been empirically and analytically demonstrated managers' focus on payoffs of the projects and risk management. The manager feels engaged in the project when he undertakes project choice. Recent studies have shown that fair process can enhance managers' motivation and performance for the project. The authors point out that fair process and engagement motivates the manager to work harder and enhance performance in terms of private benefits. This study informs me that engagement probably has a significant effect on managers' decision making. If managers get more motivation and passion on the project, they can be much more engaged in the project and unwilling to abandon it. Hence, I take engagement into account to analyse how engagement can affect project entrapment. To distinguish from overconfidence (effort), I define engagement as how much project managers would love to spend on investing and evaluating the project. I take engagement as a factor to illustrate emotions and motivations, such as overcoming personal inconsistency and sense of personal achievement.

The introduction of emotional finance sets up a new field for researchers to investigate the effects of various emotions on investors' and managers' decision making. As the development of behavioural finance and emotional finance, scholars realize that indirect measurements of emotions and psychological biases cannot always provide accurate results. Psychological and financial researchers incorporate neural analysis with financial theories to get a better understanding of managers' investment decisions. Applying neural analysis to financial decision making is one of the potential new directions for corporate finance. So far, most neuroeconomics and neuro-finance studies focus on the effect of investors' emotions and cognitive biases on their investing and trading performance on financial markets. Neuroeconomics research can also be applied to analyse the effects of managers' emotions on corporate finance decisions, especially investment appraisal and project evaluation.

2.5 Conclusion

Behavioural finance and behavioural corporate finance have been developed incorporating with psychology to investigate investors' and managers' behaviours in financial market which could not be explained by traditional finance and corporate finance. Behavioural finance

research covers various psychological factors including sunk cost, overconfidence, regret, hyperbolic discounting etc. and their effects on individual's investment decisions. Extending behavioural finance concepts to corporate finance, scholars argue that managers, as human beings, are also influenced by psychological pitfalls which results in irrational corporate financial decisions. Research in behavioural finance has focused on the effect of psychological factors on corporate decisions such as capital budgeting strategies, capital structure, venture capital, dividend policy, mergers, and acquisitions. The literature in behavioural corporate finance provided both theoretical and empirical research on various managerial and corporate decisions. By extending emotional finance to corporate financial decisions, researchers were able to explain corporate managers investment appraisal, capital budgeting, dividend policies by unconscious emotions.

One of the psychological phenomena researchers paid attention is managers' escalating their commitment on a failed project (project entrapment). While research on project entrapment has largely empathized on the effect of sunk cost, overconfidence, regret on manager's decisions, there are less studies combining the effect of biases and emotions on managers' investment decision. My research is focusing on the integrated effect of overconfidence (physical effort, extrinsic motivations) and engagement (intrinsic motivation) on project continuation or termination decisions. In addition, although there are many studies on moral hazard problems between managers and shareholders, there is a lack of research on how project entrapment can lead to moral hazard problems and how shareholders are engaged with investment decisions. Built on Gervais et al's (2011) analysis on overconfidence and capital budgeting and Fairchild's (2011) game theoretical model on choice of venture capitalist, I developed game theoretical models to explore the relationship between overconfidence, engagement, and project entrapment.

As the research on behavioural corporate finance is increasingly focusing on team's decisions instead of individual's decision, scholars extended their studies on team's reciprocity and team's inequity. Some studies began to incorporate overconfidence with teamwork and interactions in the team. Few research mentioned project entrapment and its relevance with team's conflicts and coordination. Inspired by Gervais and Goldstein's teamwork model (2003) and Fairchild's game theoretical model (2011), my model on teamwork and project entrapment adds to the literature by discussing team's inequity and team's reciprocity when making project continuation and abandonment decisions.

As for empirical studies, behavioural finance experiments were widely implemented to explore psychological factors and decision making. Mapping on Pikulina et al (2014)'s design on overconfidence and Vranceanu (2015)'s real-effort task, I developed two experiments to demonstrate the theoretical model of individual manager's decision and team's decision respectively. The experiments provide practical evidence and strengthen the empirical analysis on project entrapment.

In summary, studies in behavioural finance and behavioural corporate finance have largely been focusing on escalation of commitment and project entrapment in both theoretical and empirical fields. There are still potential research areas combining biases and emotions on project entrapment, and more research can be conducted on teamwork and project entrapment. My research is aimed to cover the gap of combing the effect of overconfidence and emotions on project investment decisions, and to extend the research incorporating team's reciprocity and project entrapment.

Chapter 3: Game Theoretical Model: Investment Decision of One Manager

3.1 Introduction of Factors

3.1.1 Overview of the Factors

Behavioural corporate finance explains the effect of psychological factors on corporate finance decisions. In his book Behavioural Corporate Finance, Sherin (2009) propose that psychological factors can be divided into three categories: Psychological biases, Heuristics and Framing Effects. Psychological biases refer to a psychological disposition towards making a mistake. Psychological biases include excessive optimism, overconfidence, confirmation biases and illustration of control. Managers who are excessively optimistic overestimate the frequency of favourable outcomes but underestimate the frequency of disadvantageous results. Overconfidence refers to the facts that the manager believes in a higher skill and ability than he actual has. Confirmation bias describes the tendency that people ignore the information against the positions they are evaluating or put more importance on the information supporting the positions they are evaluating. Meanwhile, people overestimate their control over the outcome of a specific event are believed to have a bias called illustration of control.

Heuristics include representativeness, availability, anchoring effect. Representativeness refers to the principle that people make decisions based on their stereotype impression. They are more inclined to the ideas that are most representative to where it belongs. Availability is a simple decision rule where people overweight the information that is more readily available to them. Another mistake is that people may always stick to what they have in mind when they begin and make adjustments towards the opinion at the beginning. This phenomenon is called anchoring effect. Framing effects represent the act that people's decisions are affected by the description of the task they face. One of the most common framing effects is loss aversion, which has been explained by prospect theory, that people suffer more when facing loss than the pleasure from a gain of the same magnitude.

Over the development of behavioural corporate finance, researchers are trying to incorporate those psychological pitfalls with corporate finance decisions including capital budgeting, capital structure, merger and acquisition activities, dividend policies and financial contracts etc. My research is focusing on the corporate manager's project investment decision and project entrapment. In this chapter, I develop a game theoretical model to analyse the effect of

managerial overconfidence and engagement on the manager's decision on continuing or abandoning the project.

3.1.2 Factor: Overconfidence and Its Measurement

It is widely accepted that overconfident people overestimate their own skills and ability. A growing number of studies on overconfidence shows significant effect of overconfidence on corporate finance decisions such as asymmetric information, moral hazard (Fairchild, 2005), capital structure and investment policies (Gervas et al, 2011). Managerial overconfidence creates incentives for managers to pursue risk-taking behaviour. Researchers find that the manager who is more overconfident tends to exert more effort in his work (Fairchild, 2009; Gervais et al, 2011; Pikulina et al, 2014; Everett and Fairchild, 2015). Gervais et al (2011) point out that the positive relationship between overconfidence and effort results from increased marginal productivity. As the overconfident manager believes in a higher ability, he expects that he can convert his effort into monetary outcome from a project more efficiently. Therefore, as a self-interested value-maximizing manager, he tends to exert more effort into the project to achieve higher payoff.

The effect of overconfidence on the project investment and firm's value remains ambiguous. Some researchers finds both positive and negative effect of overconfidence on firm's value. On one hand, overconfidence causes manager to pursue risky-taking behaviours which could destroy firm's value. Fairchild (2005) argues that excessive efforts of overconfident managers can results in higher debt levels that may reduce firm's value. On the other hand, Gervais et al (2011) find that an optimal level of overconfidence can be beneficial to the firm as the additional value created by excessive effort can compensate for the detrimental effects of overconfidence. Therefore, it is an interesting topic to explore how overconfidence affects the manager's payoff from the project and the firm's value under the background of project entrapment.

Previous theoretical models address the effect of overconfidence on financial decisions by combing ability, effort, and end-of-period cash flows from the project. Some models have included individual's ability as a proxy to measure effect of overconfidence. In Gervais and Goldstein model (2003) on overconfidence and output of the project, the authors used the individual's ability to indicate the level of overconfidence. Their model assumes that the end-of-period payoff from the project is determined by the probability of the success of the project. Furthermore, the probability of success of the project is linearly related with the ability level

of the investor and the level of effort from the investor. The overconfidence of the investor is reflected by the difference between the actual ability and the perceived ability. The linear relationship between the effort, actual and perceived ability level implies the assumption that overconfident people overestimate their ability, and consequently, perceive a higher marginal productivity for the project. Therefore, to maximize their payoff from the project, the overconfident investor will exert more effort into the project. The similar modelling strategy was also adopted by Everett and Fairchild in their model of entrepreneur overconfidence, effort, and firm's value. Everett and Fairchild (2015) believe that overconfident manager overestimates the quality of the project and, as a result, overinvests in a value-destroying project. They argue that people who are overconfident in ability tend to attribute the success to their ability and failure to outside factors. Therefore, to model the level of ability and effort for the managers, the authors use a linear relationship to demonstrate the positive relationship between the level of overconfidence (true ability and perceived ability), the effort and the perceived payoff from the project. In addition, as most venture capital model assumes, there is an increasing marginal cost of effort as the manager exerts more effort into the project.

Gervais and Goldstein's model (2003) in overconfidence and teamwork, and Everret and Fairchild's model (2015) in entrepreneur overconfidence and firm's value inspired me in developing a game thoretical model of overconfidence and engagement on project entrapment. Based on the authors work, in my game theoretical model, overconfidence is defined as overestimation of manager's ability and the manager's overestimation on the outcome of the project, which is positively related the manager's perceived ability and effort exerted into the project. I assume that a player of project manager has a true ability which is observable by other players in the game, while his perceived ability himself is higher than his true ability. The difference between the true ability and the manager's perceived ability represents the level of overconfidence. The higher the manager perceives his ability, the more overconfident the project manager is in the model.

3.1.3 Factor: Engagement

Another factor I am considering in the model is engagement. Researchers find that when involving in a project, the managers are not only motivated by economic output from the project but also concern the process working on the project (Wu et al., 2008). Fair process also affects the manager's commitment to a project. The authors believe that fair process and engagement in the project enhance the manager's performance in the project because the manager gets private benefits from fair process which is exclusive for the manager himself. It is argued that

how hard the manager works for the project depends on both the economic outcomes of the project and the private benefit from engagement and motivation on the project.

Hence, I consider both overconfidence and engagement in the game theoretical. The model investigates the effect of engagement and motivation on project entrapment. The outcomes from the project for the manager is related with the level of overconfidence and engagement. I take engagement as a factor to illustrate psychological motivations, such as overcoming personal inconsistency and sense of personal achievement. To distinguish from overconfidence (effort), I define engagement as how much private benefits the manager expects to receive from getting engaged and motivated by the project. The model, therefore, includes both overconfidence in terms of physical effort and engagement in terms of private benefits to analyse the manager's perspective on the project and his decision on whether to continue or abandon the project.

3.2 Model

3.2.1 Background Information and Model Assumptions

3.2.1.1 Players in the Game Theoretical Model

In the game theoretical model, a manager and a board of shareholders are the players in the model. The project manager is a risk-neutral self-interested manager who works for the project and is always seeking to maximize his payoff from the project. In our model, the manager can decide whether to continue or abandon the project. If continuing the project, the manager will exert effort into the project and receive payoff from the project. If abandoning the project, the manager liquidates the project and claim the residual value. The project manager can be either rational or overconfident. The overconfident manager overestimates his ability, and he believe that he has higher ability than his actual ability. The rational manager is well-calibrated, and he knows his own ability. However, both overconfident and rational manager will make the decision from which he can receive the highest payoff.

Another important player in the game is a board of shareholders. The board of shareholders will also benefit from the project. The shareholders do not directly work for the project, but they estimate their optimal value from the project and state their preference on continuing or abandoning the project. I assume that the shareholders can observe the manager's true ability, which indicates that the shareholders know whether the project manager is rational or overconfident. In addition, the shareholders are also aiming to maximize the firm's value from the project. As the overconfident manager overestimates his payoff from the project and

continues the project, the shareholders may disagree with the manager's decision. When the conflicts happen, the shareholders can take actions to replace the overconfident manager with another rational manager.

In the game theoretical model, I focus on the overconfident manager's perceived payoff from the project and the actual firm's value from the project. I develop a model which illustrates the project manager's decision on whether continue or abandon a project under the effect of overconfidence and engagement. I also show the interaction between the manager and the board of shareholders in terms of their perceived payoff and actual payoff from the project.

3.2.1.2 Background: Project Investment

I base my theoretical model on the assumption that a project manager is currently running a project for the firm. The project manager shall work for the project and expect to receive payoff from the project. The project will also add value for the firm if the project succeeds. Originally, the manager made the initial investment decision for the project. The board of shareholders who are also concerned with the manager's decision making. The manager has a true ability level himself, which is observable to shareholders in the company. However, as he is overconfident about his ability, his perceived ability is higher than his actual ability. Meanwhile, shareholders are aware of managers' true ability and shareholders also seek to maximize their own benefits from the project.

I simulate the situation where the phenomenon of project entrapment occurs. I assume that the project is approaching a milestone where the managers must decide to continue or abandon the project. If the manager chooses to abandon the project, the liquidation value of the project is redeemed. If the manager continues the project, he will work the project and exert effort into the project, thus expecting a promising payoff from the project. The payoff from the project depends on the manager's effort and engagement to the project. The harder the manager work for the project, the more effort the manager will exert into the project, resulting in a higher perceived payoff from the project. The more motivated and passionate the manager feels for the project, the more reluctant he is to abandon the project. Consequently, the manager may escalate their commitment, and he is entrapped in the project.

For shareholders, as I mentioned before, they are also risk-neutral, and they always try to maximize the firm's value. The shareholders fully understand the manager's true ability level and make their estimation for the project based on their own knowledge on the manager and the project. Shareholders cannot make direct investment decisions on the project, but they can

involve in recruitment of the manager who works for the project. If the overconfident manager makes a decision that may damage firm's value, it is possible for the shareholders to replace the overconfident manager with a rational manager who can make a better decision for them. If the manager abandons the project, both the manager and the shareholders will receive an amount of residual value from the project based on equity stake.

Based on the analysis above, I therefore assume in the original model that 1) A rational manager will abandon a failed project and the shareholders agree with the manager's decision; 2) Overconfidence and engagement will make the manager more willing to continue the project; 3) The effect of overconfidence is contrary depending on the level of overconfidence. On one hand, a manager with a medium level of overconfidence will continue the project, which damages firm's value. The shareholders do not agree with the manager's decision and may replace the overconfident manager with a rational manager. On the other hand, a manager with a higher level of overconfidence will exert excessive effort into the project. The perceived payoff from the project and the firm's value is higher than the liquidation value from abandoning the project. Therefore, the shareholders are satisfied with the manager's decision. In the following sections, I will start with the timeline of the game, and introduce the mathematical framework of the model.

3.2.2 Model Timeline

In the game theoretical model, I will explore how a project manager make continuation or termination decision on a project. I develop a timeline of decision-making process and highlight a series of critical points which affects the manager's and the shareholders' decisions. The model starts with the situation where the manager is running a project which he believes will create value for him. At a critical point, the project fails, and the manager needs to decide on continuing or abandoning the project. The manager anticipates his payoff from the project and makes his decision. According to the decision, the manager receives the liquidation value (if abandon) or works for the project to achieve optimal payoff (if continue). Meanwhile, the shareholders also express their preference on the project, and they can replace the manager if they do not agree with the manager's decision. At the last stage, the payoff from the project is realized. The timeline of the game is shown below.

Time t_0: Background Setup

At time t_0, a risk-neutral self-interested manager is running a project. The manager believes that the project is beneficial, and the firm can also add value from the project. The manager

and the shareholders have already agreed on the equity stake. The manager has an equity stake of s and the shareholders oI an equity stake of $(1-s)$.

Time t_1: Project Failure

At time t_1, the manager and the shareholders realize that the project no longer makes profits for the company and starts damaging firm's value due to some disadvantageous conditions in the market. Therefore, the manager needs to deal with this situation by considering continuing or abandoning the project. The shareholders also have access to the information of the project, and they can observe the manager's true ability. The manager is overconfident about his ability, and he is also risk averse.

Time t_2: Overconfidence and Engagement Raised

At time t_2, the manager raises both extrinsic motivation (effort) and intrinsic motivation (engagement) for the project. The manager has a true ability level γ_e , which will be precisely observed by the shareholders. For manager himself, instead, he perceives that he has an ability level of $\hat{\gamma_e}$ ($\hat{\gamma_e} > \gamma_e$ for overconfidence). The overconfident manager overestimates his own ability so he will exert a level of effort e into the project as extrinsic motivation. In addition, the manager made the initial investment decision, so he has his own engagement and passion for the project, which is reflected as a private benefit b of the manager. If the project succeeds, it will provide an income of $R(R > 0)$ while if the project fails it will provide nothing. The performance of the project depends on the manager's effort in the project.

Time t_3: Payoff Expected and Decision Made

At time t_3, the manager and shareholders anticipate the payoffs of the project respectively. As the overconfident manager overestimates his ability, he believes that his ability is $\hat{\gamma_e}$ but his true ability is γ_e. The value added from the project depends on manager's extrinsic effort exerted in the project. In this model the project's value added with a multiplier p. The manager's decisions are influenced by overconfidence (extrinsic motivation) and engagement (intrinsic motivation). I have value creation partitioned into several parts: the level of overconfidence, which is related to how hard the manager is working for the project and engagement (intrinsic motivation/passion), which represents how passionate/motivated the manager feels for the project. At this point, the manager makes continuation or abandonment decision based on his perceived payoff from the project.

Time t_4: Effort Exerted or Liquidating the Project

At time t_4, the manager has already made the decision. If the manager chooses to abandon the project, he and the shareholders will claim the residual value from liquidating the project. If the manager chooses to continue the project, he will raise motivation and exert effort into the project. The manager will choose an optimal level of effort to work for the project, and he is trying to maximize his payoff from the project.

Time 5: Payoff Realized

This is the final stage of the game. After the manager continues the project and works for the project, the payoff from the project is achieved. The manager will receive his perceived optimal payoff from the project while the shareholders will also benefit from the project in terms of value addition for the firm. The game shall end after this stage.

I will develop my game theoretical model following the timeline above. In the next section, I will solve the game in a backward induction. First, I calculate the perceived payoff for manager and actual value for the shareholders. Then, I find the manager's optimal level of effort exerted into the project. Then I move back and calculate the optimal payoff for the manager and shareholders to examine the effect of overconfidence and engagement on project entrapment.

3.2.3 Payoff from the Project

3.2.3.1 How Payoff is modelled

According to the timeline of the model, the overconfident manager will estimate his payoff from the project based on his self-assessed ability. In this model, I assume that the overconfident manager has a true ability γ_e, and he believes that his own ability is $\hat{\gamma_e}$. Note that $\hat{\gamma_e}$ is larger than γ_e, and the difference between the manager's perceived ability and true ability represents the level of overconfidence. The shareholders know the manager's true ability γ_e. The setup of the effort is adapted from the model from Gervais and Goldstein (2003) and Everett and Fairchild (2015) in their modelling strategies of overconfidence based on the assumption that overconfident manager overestimates his ability. The overconfident manager makes his decision according to his perceived ability of himself $\hat{\gamma_e}$ while the shareholders can observe the manager's true ability γ_e. The manager raises certain level of motivation and engages in the project, reflected by a private benefit b from the project. If the manager continues the project, he will exert effort e into the project, which incurs a cost of θe^2 (θ measures the manager's cost of effort).

I extended the existing model of overconfidence and effort by considering the engagement, motivation as private benefits from the project. Theoretically, I assume that the manager shall exert effort and raise certain level of motivation for the project. The manager's payoff from the project depends on the manager's effort and motivation. For the manager, his expected payoff from the project consists of the cash flow from the physical effort and the private benefit of the manager himself. The private benefit indicates the manager's intrinsic motivation, his passion and engagement for the project, while the cash flow of the project depends on the effort manager exerts in the project (extrinsic motivation).

Overconfident manager claims that he has higher ability than others, and thus believes in an excessive marginal productivity. The ability of the manager represents the efficiency that the manager can transfer his effort into the monetary payoff from the project. Consequently, the overconfident manager also overestimates the expected payoff from the project. I multiply the manager's perceived ability $\hat{\gamma_e}$ and his effort exerted into the project e as a proxy to represent the effect of manager's overconfidence on his perceived payoff from the project. According to Gervais and Goldstein (2003) and Everett and Fairchild (2015), the expected payoff from the risky project is modelled as linearly related with the manager's perceived ability and effort. The harder the manager work for the project, the more payoff the manager will expected to receive from the project.

I now model the payoff for managers in the following way. In addition, it is costly for the manager to exert effort into the project, and the cost for the manager to exert effort is θe^2, which represents an increasing marginal cost of effort (Everett and Fairchild, 2015). The quadratic cost of effort enables me to calculate the equilibrium effort and payoff from the project for the overconfident manager, indicating a Nash Equilibrium for a game theoretical model. Therefore, the manager's profit from the project should be:

$$\Pi_m = \hat{\gamma_e} e(sR + b) - \theta e^2 \tag{3.1}$$

Note that $\hat{\gamma_e} e$ represents the payoff multiplier that is influenced by the level of overconfidence and the effort exerted into the project. It is consistent with my assumption that the payoff from the project is positively related with the manager's level of overconfidence and effort. The first term of the equation represents manager's expected payoff from the project, which includes the equity stake of the manager, payoff multiplier, the original payoff from the project and the private benefit from the manager. The term shows that the manager's expected payoff from the

project depends on the overconfidence, engagement, and the manager's effort. The second term represents manager's effort cost for the project. The payoff from the project is concave mathematically in terms of effort exerted. This allows us to solve the optimal level of effort the manager will choose to maximize his payoff from the project.

This model assumes that overconfidence (physical effort and extrinsic motivation) and engagement (intrinsic motivation) are independent element contributing to the payoff from the project. A possible relationship between overconfidence and engagement can be considered. For future research and extension on the model, the interaction between overconfidence and engagement can be considered as an element to affect the managers' decision. Whether there is a possible relationship between overconfidence and engagement or whether engagement can offset the negative effect of overconfidence can be considered as a positive or negative synergies contributing to the payoff from the project.

3.2.3.2 Perceived Payoff for Manager

Now that I know the manager's perceived payoff from the project, the manager will choose optimal level of effort and expect to received highest payoff from the project. Therefore, I solve the manager's optimal level of effort by finding the partial differential of effort e . As the manager seeks to maximize his payoff from the project, he will choose an optimal level of effort e^* to exert into the project. By solving $\frac{\partial \Pi_m}{\partial e} = 0$, I can obtain the manager's optimal effort level:

$$e^* = \frac{\hat{\gamma_e}(sR+b)}{2\theta} \tag{3.2}$$

Here I suppose that the manager can find the optimal effort based on the knowledge of their own ability. The manager is overconfident, and he believes that his ability is $\hat{\gamma_e}$ instead of his true ability γ_e. Then, I go back to the beginning to find the optimal payoff of the project. To maximize his payoff from the project, the manager will choose e^* to expend in this project, so I substitute optimal level of effort e^* into equation of manager's perceived ability Π_m, I can obtain the optimal payoff for the manager:

$$\Pi_m^* = \frac{\hat{\gamma_e}^2 (sR+b)^2}{4\theta} \tag{3.3}$$

Now I obtain the manager's perceived optimal payoff with variables 'overconfidence $\hat{\gamma_e}$' and 'engagement b'. To explore the effect of overconfidence and engagement, I know that if the

manager chooses to continue the project, based on his knowledge and ability, his perceived optimal payoff is Π_m^*, which is positively related with the manager's level of overconfidence and engagement. Suppose that if the manager chooses to abandon the project, he liquidates the project and receives sA from the project. Simply he will make continuation or abandonment decision by comparing Π_m^* and sA. If manager's expected payoff is larger than the compensation he obtains from abandonment, he will continue the project. Otherwise, he will terminate the project. I will discuss the manager's decision later.

3.2.3.3 Firm Value for Shareholders

In the model, I assume that the shareholders are also risk-neutral self-interested players. The shareholders are seeking to maximize the firm's value from the project. In addition, they can observe the manager's true ability despite the fact that the manager overestimates his true ability. They will estimate the value added from either continuing or abandoning the project by the manager's true ability. The shareholders are concerned about the value addition from the project so they can reveal their preference on the investment decision. As the shareholders does not work for the project, the firm's value from the project is influence by the original payoff from the project, the payoff multiplier, the manager's effort exerted and the manager's true ability from the project. The shareholders' payoff from the project shall be:

$$V = (1 - s)\gamma_e e\, R \tag{3.4}$$

Note that the shareholders will receive an equity stake of $(1 - s)$. The shareholders know that the manager's true ability is γ_e, so the multiplier for shareholder is $\gamma_e e$. The shareholders do not directly work for the project, so the private benefit and the cost is not included in the shareholders' value. The shareholders also observe that the manager will exert an optimal level of effort e^* into the project. By substituting $e^* = \frac{\hat{\gamma_e}(sR+b)}{2\theta}$ into equation of the shareholders' value V, I can find the optimal firm's value for shareholders V^* below.

$$V^* = \frac{(1-s)\gamma_e\hat{\gamma_e}(sR+b)R}{2\theta} \tag{3.5}$$

I suppose that the liquidation from the termination of the project will be paid to both the manager and the shareholders based on their equity stake. The shareholders will receive $(1 - s)A$ if the manager choose to abandon the project. The shareholders' preference on whether to continue or abandon the project depends on comparison between the optimal firm's value and

the liquidation value. If $V^* < (1-s)A$, the shareholders will recommend abandoning the project. If $V^* > (1-s)A$, the shareholders are willing to continue the project.

I have now obtained the perceived optimal payoff for the overconfident manager and the equilibrium firm's value for shareholders. In the next section, I will analyse how the level of overconfidence affects the manager's decision and the shareholders' preference as the level of overconfidence $\hat{\gamma_e}$ might have ambiguous effect on the manager's perceived ability. I observe both positive and negative impact of overconfidence on the firm's value, and model how shareholders take action to avoid negative effect of project entrapment.

3.2.4 Effect of Overconfidence on Project Termination Decision

In the previous section, I have already found the optimal perceived payoff for the overconfident manager and the equilibrium firm's value for the shareholders with level of overconfidence as the independent variable. The overconfident manager will always pursue best payoff for himself from the project, so he makes continuation or termination decision by comparing his perceived payoff and the liquidation value. I am able to find a critical level of overconfidence where the manager switch from abandoning the project to continuing the project.

Therefore, I know that the overconfident manager will continue the project if the payoff from continuing the project is larger than the liquidation value from abandoning the project, $\Pi_m^* < sA$. The manager will abandon the project if his perceived payoff is less than the value from abandoning the project, $\Pi_m^* > sA$. Then I substitute Π_m^* and find the critical value for the level of overconfidence $\hat{\gamma_e} = \frac{\sqrt{4\theta sA}}{sR+b}$. I can now conclude that the manager will choose to abandon the project if $\hat{\gamma_e} < \frac{\sqrt{4\theta sA}}{sR+b}$, and the manager will choose to continue the project if $\hat{\gamma_e} > \frac{\sqrt{4\theta sA}}{sR+b}$. This indicates that if the manager's perceived ability is less than $\frac{\sqrt{4\theta sA}}{sR+b}$, he believes that he is not capable enough to continue and work for the project and receive higher payoff from abandoning the project. If the manager's level of overconfidence is higher than $\frac{\sqrt{4\theta sA}}{sR+b}$, he is so overconfident that he will exert excessive effort into the project, increase the payoff multiplier, and expect an extremely high payoff from continuing the project. Depending on different levels of overconfidence, the manager may make opposite decisions towards a project. In summary, a rational manager or a manager with lower level of overconfidence will choose to abandon the project, while a manager with a higher level of overconfidence will continue the project.

Meanwhile, the shareholders who observe the manager's true ability also reveal their preference. The shareholders know that the manager exerts effort e^* into the project, and they will receive an equilibrium value V^* from the project. If $V^* < (1-s)A$, the shareholders will recommend abandoning the project. If $V^* > (1-s)A$, the shareholders are willing to continue the project. By solving the equations, I will find a critical level of overconfidence where the shareholders change their preference. The shareholders are willing to abandon the project if $\hat{\gamma_e} < \frac{2\theta A}{\gamma_e R(sR+b)}$, while the shareholders are willing to continue the project if $\hat{\gamma_e} > \frac{2\theta A}{\gamma_e R(sR+b)}$.

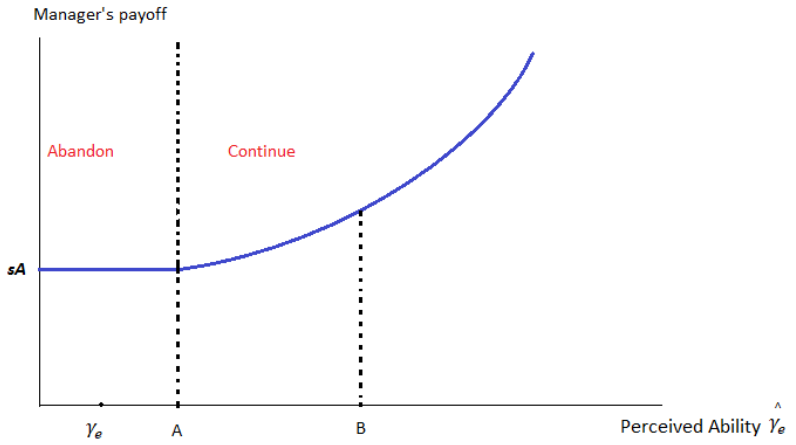
I notice that the critical levels of overconfidence for the manager and the shareholders to switch their decisions on abandoning to continuing the project are different. The critical levels of overconfidence for the manager and the shareholders create a moral hazard problem. As the manager overestimates his ability and the payoff from the project, he will exert more effort into the project. Shareholders observe the manager's true ability, so they will require higher effort to switch from abandoning the project to continuing the project than the manager under the same condition. I am, therefore, convinced that the critical level of overconfidence for the shareholders are higher than that for the overconfident manager ($\frac{\sqrt{4\theta sA}}{sR+b} < \frac{2\theta A}{\gamma_e R(sR+b)}$). Obviously, the overconfident manager and the shareholders will make contrary decisions upon the same project if the manager's perceived level of overconfidence lies in the range $\frac{\sqrt{4\theta sA}}{sR+b}$ and $\frac{2\theta A}{\gamma_e R(sR+b)}$.

At lower level of overconfidence ($\hat{\gamma_e} < \frac{\sqrt{4\theta sA}}{sR+b}$), the manager will abandon the project and the shareholders support the manager's decision, because both the manager and the shareholders estimate that they will receive higher payoff by liquidating the project. Likewise, on the higher level of overconfidence ($\hat{\gamma_e} > \frac{2\theta A}{\gamma_e R(sR+b)}$), the manager is so overconfident that he exerts excessive effort into the project. The manager and the shareholders both agree to continue the project as they can achieve higher payoff by working hard for the project.

However, at certain level of overconfidence ($\frac{\sqrt{4\theta sA}}{sR+b} < \hat{\gamma_e} < \frac{2\theta A}{\gamma_e R(sR+b)}$), the manager chooses to continue with the project while the shareholders are not happy with the manager's decision because they prefer abandoning the project. On one hand, the overconfident manager thinks that he makes a right choice to continue with the project and that the market is undervaluing his ability and the firm's value. He believes that the market will make a catch-up and will

realize his 'true' value later. The figure below shows the manager's perceived payoff from the project.

Figure 3.2.1 Overconfident Manager's Perceived Payoff

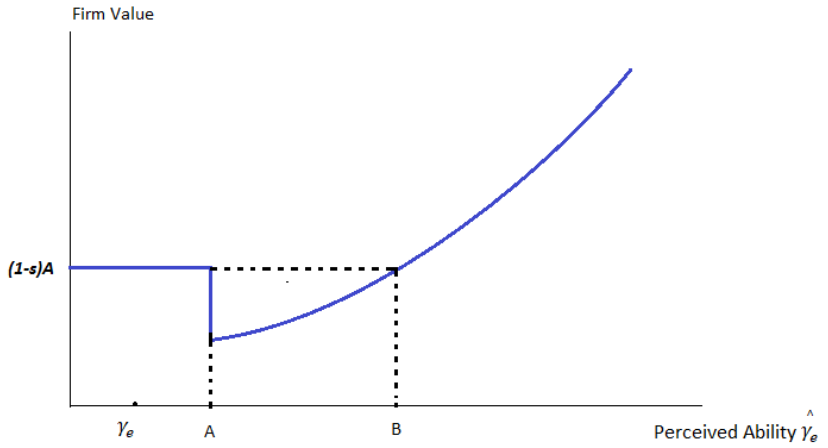


Note. The figure demonstrates the relationship between the overconfident manager's perceived ability and his perceived payoff from the project. The figure also shows the manager's actual ability and the manager's decision on the project.

In the figure, the manager will abandon the project if he has an overconfidence level $\hat{\gamma}_e < \frac{\sqrt{4\theta sA}}{sR+b}$, which is represented by A ($A = \frac{\sqrt{4\theta sA}}{sR+b}$). As the manager abandons the project, he will receive sA from the project. If the manager has a level of overconfidence $\hat{\gamma}_e > \frac{\sqrt{4\theta sA}}{sR+b}$, he will continue the project because he anticipates that he will receive more payoff from continuing the project than the payoff from abandoning the project. With the growing level of overconfidence, the manager will exert more effort into the project, thus increasing the manager's perceived payoff from the project. In the manager's view, he himself is rational and the market underestimates his ability, so he thinks he make the right choice to continue the project. In addition, as I assume that the true ability for the manager is constant, his true ability γ_e lies between 0 and A along the horizontal axis, indicating that the manager is overconfident.

On the other hand, the shareholders have their expectations on whether to continue or abandon the project based on their own understanding on the manager's true ability level. The firm's market value of the project and the manager's perceived payoff from the project is shown below.

Figure 3.2.2 Firm's Value



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability and the firm's value for the shareholders from the project. The figure also shows the ambiguous effect of manager's decision on the firm's value.

For shareholders they observe the manager's true ability and make their own investment decisions on the project. In the figure, A represents the critical value for the manager to switch from abandoning to continuing the project ($A = \frac{\sqrt{4\theta sA}}{sR+b}$). B represents the critical value for the shareholders to change their preference ($B = \frac{2\theta A}{\hat{\gamma}_e R(sR+b)}$). I argue that if the manager's overconfidence level $\hat{\gamma}_e > \frac{2\theta A}{\gamma_e R(sR+b)}$, the shareholders prefer continuing the project. Otherwise, they would like to abandon the project. If the manager's level of overconfidence lies between A and B ($\frac{\sqrt{4\theta sA}}{sR+b} < \hat{\gamma}_e < \frac{2\theta A}{\gamma_e R(sR+b)}$), the manager will continue the project, but the shareholders disagree with his decision. The manager continues the project that should have been abandoned, damaging the firm's value as a result of project entrapment. Therefore, the firm's value suddenly drops at A as the manager's decision decreases firm's value. As the manager exerts more effort into the project, the payoff from the project increases until it reaches B where both the manager and the shareholders agree to continue the project.

From the analysis above, I argue that the level of overconfidence has significant effect on the manager's decision on whether to continue or abandon the project, causing both positive and negative results of project entrapment. Firstly, if the manager is rational or less overconfidence, he will choose to abandon the project because he knows that continuing the project will damage his payoff. The board of shareholders agree with his decision. Secondly, if the manager raises

a moderate level of overconfidence, he will continue the project, but the shareholders want to abandon the project. Even though the manager exerts more effort than a rational manager and perceived a higher payoff, the shareholders know the true ability of the manager and confirm that he is not capable enough to continue the project. Instead, continuing the project will damage the firm's value since the manager continues a project which should have been abandoned. In this case, being entrapped in the project will deteriorate the firm's value. Overconfidence has a negative Impact. Lastly, extremely overconfident manager exerts excessive effort into the project. He works so hard for the project that the shareholders also believe that his effort will result in an increase in the firm's value. I conclude from my theoretical model that overconfidence has ambiguous effect that lower level of overconfidence will damage the firm's value while higher level of overconfidence will increase the firm's value.

3.2.5 Shareholders' Action

From previous section, I know that the moral hazard problem can occur if the overconfident manager decides to continue the project, but the shareholders are against the project manager's decision. I argue that the moral hazard problem only appears when the manager has a medium level of overconfidence. At lower level of overconfidence, the manager, and the shareholders both agree to abandon the project. At higher level of overconfidence, the manager continues the project and works hard for the project, increasing the firm's value. The shareholders are satisfied with his decision.

Nevertheless, if the manager has a medium level of overconfidence, he continues the project, but the shareholders are not satisfied with his decision. In my case, the manager makes an unsatisfying choice for shareholders that the manager continues with a project which should have been abandoned and damages firm's value. As the manager is hurting the shareholders' benefits from the project, the shareholders would not sit and watch the manager making the decision. I assume that even though shareholders do not directly exert effort into the project, they will take actions to avoid the loss from the project instead of doing nothing as the outside observers. To extend my original model, I suppose that the shareholders have the right to replace the overconfident manager with a rational one, who will abandon the project and avoid the loss from continuing the project. Meanwhile, it is costly for the shareholders to replace the manager and there is a probability that the shareholders can successfully replace the manager. The cost of replacing the manager and the probability of a successful replacement are exogenous variables only related with outside factors, such as the company's culture etc.

Now I consider whether the shareholders are willing to replace the current manager if his decision to continue with the project is damaging firm's value. As I discussed before, at lower level of overconfidence, both the manager and the shareholders are willing to abandon the project. At an extreme high level of overconfidence, the manager put so much effort into the project so that both the manager and the shareholders would love to continue with the project. However, at certain level of overconfidence, the manager is entrapped in the project and he thinks the market is undervaluing the project. He is continuing with a project which should have been abandoned. Thus, the shareholders who understand the manager's true ability level are not happy with the manager's decision. The shareholders then are considering replacing this overconfident manager with a rational manager who has the same ability level as the overconfident one but is fully rational. I denote that there is a probability q that the shareholders can successfully change the manager. The probability to replace the overconfident manager depends on the power of shareholders, the firm's culture, the manager's reputation etc. There is also a cost c_r for shareholders to replace the overconfident manager. If the shareholders can successfully replace the overconfident manager, at the moment, the rational manager will choose to abandon the project. The expected cost for the shareholders to replace the overconfident manager is qc_r. I then put the cost of replacement into analysis.

If the shareholders choose to replace the overconfident manager, the new rational manager will abandon the project. The project will be liquidated, so the shareholders will receive $(1-s)A$ from the project. In addition, the cost of successfully replacing the manager is qc_r. The payoff from the project for shareholders is $(1-s)A - qc_r$. As the manager increases its overconfidence level, the firm' value increases until C where the shareholders will receive the same payoff from both the overconfident manager and the rational manager. I now find the new critical level of overconfidence for shareholders to switch from abandoning the project to continuing the project. The critical level of overconfidence for C must meet the equation below:

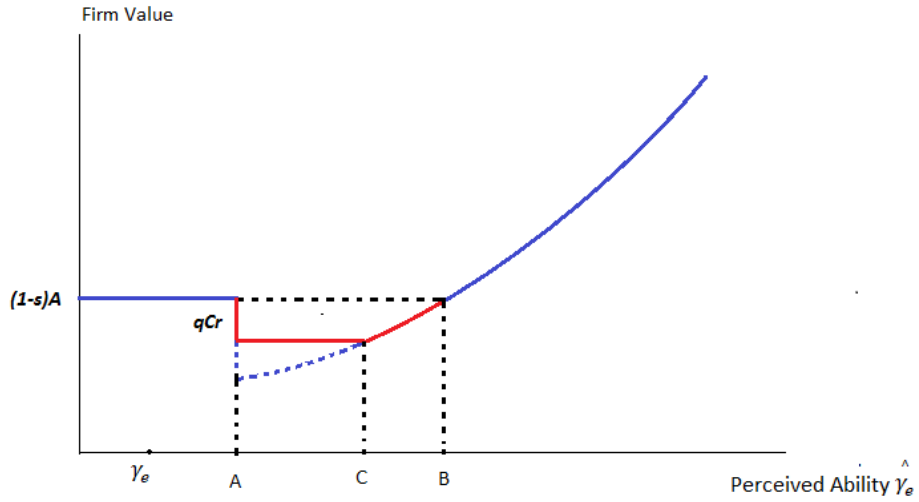
$$V^* = \frac{(1-s)\gamma_e \hat{\gamma_e}(sR+b)R}{2\theta} = (1-s)A - qc_r \tag{3.6}$$

Solving the equation above, I obtain the critical value

$$\hat{\gamma_e} = \frac{2\theta[(1-s)A - qc_r]}{(1-s)\gamma_e R(sR+b)}. \tag{3.7}$$

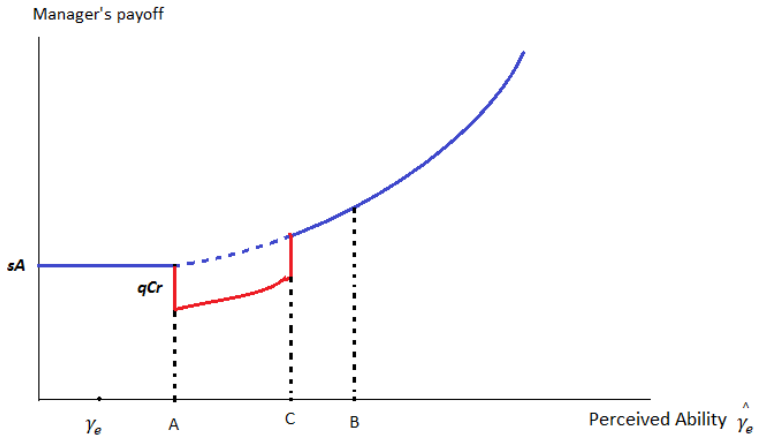
The figures below display the manager's perceived payoff and the firm's value for shareholders considering replacing the overconfident manager if his decision is damaging the firm's value.

Figure 3.2.3 Firm's Value with Cost of Replacement



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, the expected cost of replacing a rational manager and the firm's value for the shareholders from the project. The figure also shows the shareholders' replacement decisions and its effect on firm's value.

Figure 3.2.4 Overconfident Manager's Perceived Payoff with Cost of Replacement



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, the expected cost of replacing a rational manager and the firm's value for the shareholders from the project. The figure also shows the shareholders' replacement decisions and its effect on firm's value.

I notice that if the shareholders choose to replace the overconfident manager, a cost of qc_r occurs to reduce the total firm's value for shareholders. In the figure I can see that if the level

of overconfidence lies between A and C ($\frac{\sqrt{4\theta sA}}{sR+b} < \hat{\gamma_e} < \frac{2\theta[(1-s)A-qc_r]}{(1-s)\gamma_e R(sR+b)}$), the shareholders will choose to replace the overconfident manager with a rational one. Even if there is a cost for replacing the overconfident manager, the shareholders can still expect a higher firm's value from abandoning than continuing the project, which is represented by the red line parallel to the horizontal axis.

With the increase in the manager's level of overconfidence, the overconfident manager exerts more effort into the project and increase the payoff from the project. When the level of overconfidence is high enough and lies between points C and B ($\frac{2\theta[(1-s)A-qc_r]}{(1-s)\gamma_e R(sR+b)} < \hat{\gamma_e} < \frac{2\theta A}{\gamma_e R(sR+b)}$, even though the shareholders do not agree with the manager's decision, they still keep this overconfident manager because the cost of replacement is too high. If the shareholders replace the overconfident manager, they shall expect that the cost qc_r is higher than the decrease in the firm's value from continuing the project. Despite the fact that the manager's decision is damaging firm's value, the shareholders have to accept his investment decision.

To sum up, I argue that when the manager and the shareholders have conflicting decision, the moral hazard problem occurs. To avoid the loss in firm's value, the shareholders may choose to replace the overconfident manager with a rational manager. Depending on the cost of replacement and the level of overconfidence, the shareholders will replace the manager if they believe that liquidation value from abandoning the project including the cost of replacement is higher than the payoff from continuing the project. However, the shareholders will not replace the overconfident manager if the expected cost of replacement exceeds the damage in the firm's value if the project is continued.

3.2.6 Integrated Effect of Overconfidence and Engagement

So far, I analyse the positive and negative effect of overconfidence on the manager's project investment decision. The analysis assumes that the manager's engagement and motivation for the project, which is represented by private benefit for the project, is fixed. The manager has a constant level of engagement and private benefit or the project. In this section, I explore the integrated effect of overconfidence and engagement. We, therefore, assume that the level of overconfidence remains unchanged. I now analyse the effect of engagement in a similar way.

Recall that the manager will exert an optimal level of effort e^* into the project, the optimal level of effort is a variable dependent on the level of overconfidence and engagement ($e^* =$

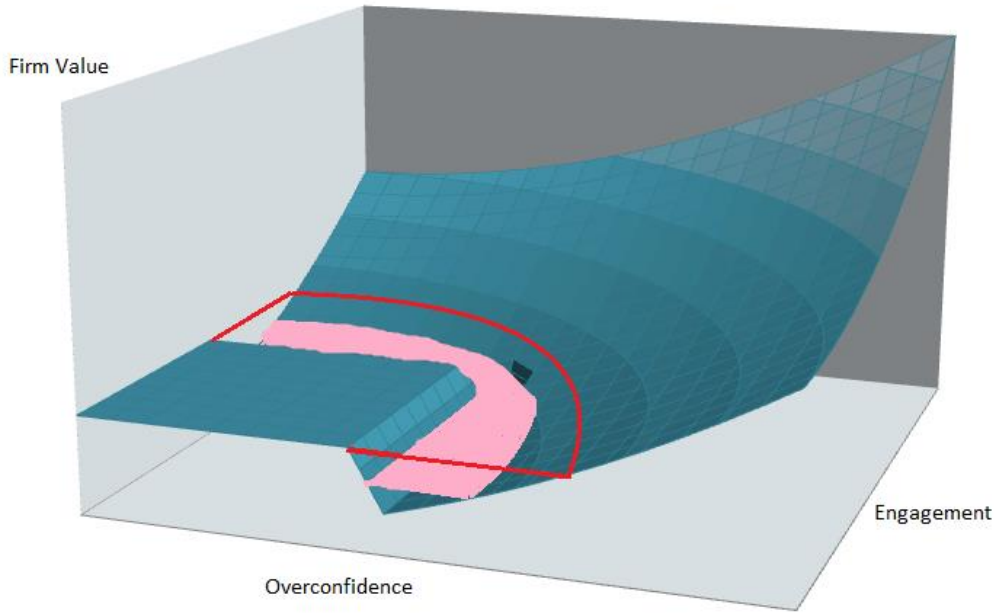
$\frac{\hat{\gamma_e}(sR+b)}{2\theta}$). By substituting e^* into the manager's perceived payoff, I obtain the manager's perceived optimal payoff from the project $\Pi_m^* = \frac{\hat{\gamma_e}^2(sR+b)^2}{4\theta}$ and the equilibrium firm's value is $V^* = \frac{(1-s)\gamma_e\hat{\gamma_e}(sR+b)R}{2\theta}$. By comparing the manager's optimal payoff from the project and the value from liquidating the project, I obtain the critical value of engagement for the manager to switch from abandoning the project to continuing the project. The critical level of engagement is $b = \frac{\sqrt{4\theta A}}{\hat{\gamma_e}} - sR$, so the manager will abandon the project if $b < \frac{\sqrt{4\theta A}}{\hat{\gamma_e}} - sR$, while the manager will continue the project if $b > \frac{\sqrt{4\theta A}}{\hat{\gamma_e}} - sR$.

As for shareholder, they also make their own estimation for the firm's value from the project. I also solve the critical level of engagement for shareholders $b = \frac{2\theta A}{\gamma_e\hat{\gamma_e}R} - sR$. The shareholders are willing to abandon the project if $b < \frac{2\theta A}{\gamma_e\hat{\gamma_e}R} - sR$, and the shareholders would like to continue the project if $b > \frac{2\theta A}{\gamma_e\hat{\gamma_e}R} - sR$.

It is interesting to observe that the level of engagement will also create a moral hazard problem between the project manager and the board of shareholders. If the project manager is not quite engaged and motivated in the project, he will choose to abandon the project as he believes that he will receive more payoff by liquidating the project. If the manager is extremely engaged into the project, which also increases his effort exerted into the project, he will continue the project, and the shareholders are happy with his decision. The problem occurs when the manager exerts not high enough effort and continues the project. When the manager feels motivated and engagement to the project to some extent and he estimates that continuing the project will produce more payoff for him, but the shareholders realize that continuing the project will damage the firm's value. Consequently, the manager continues a project which should have been abandoned in the shareholders' eyes and damages the firm's value.

Now I find the similar effect of overconfidence and engagement on the manager's decision and the firm's value. I consider both effects of overconfidence and engagement at the same time and combine the level of overconfidence and the level of engagement in one figure. I put the level of overconfidence and level of engagement in a 3-dimensional figure showing the effect of both overconfidence level and private benefit.

Figure 3.2.5 Integrated Effect of Overconfidence and Engagement



Note. The 3-dimensional figure demonstrates the relationship between level of overconfidence, engagement, and the firm's value for the shareholders from the project. The figure also shows the integrated positive and negative effect of overconfidence, engagement on firm's value.

The Figure above shows the integrated effect of overconfidence and engagement on project entrapment. The two horizontal axes represent the level of overconfidence and engagement (motivation) for the project as the independent variables, and the vertical axis represents the firm's value as the dependent variable. The manager raises a lower level of overconfidence and motivation for the project, so he is willing to abandon the project. At the beginning, an area which is parallel to the horizontal axes shows that the manager abandons the project, and the firm's value is $(1 - s)A$ paid to the shareholders. Then, when the manager raises higher level of overconfidence, he will continue the project which should have been abandoned in the shareholders' view. His decision is damaging firm's value so there is a sudden decrease in firm's value at certain level of overconfidence. When the manager raises higher value of overconfidence, he feels extremely engaged and motivated and puts so much effort into the project that the firm's value increases until it reaches the critical value that both the manager and the shareholders agree to continue the project. The critical value is represented by the red solid line in the figure above. If the level of overconfidence and engagement rises above the critical value, the manager continue with the project and the shareholders are happy with his decision.

Similarly, when the manager and the shareholders have opposite decisions on whether to continue or abandon the project, the shareholders have an opportunity to replace the overconfident manager with a rational one. If the shareholders successfully change the manager, the new manager will abandon the project, which is represented by the pink plane in the figure. Then the manager enhances his engagement and overconfidence level until the firm's value reaches $(1-s)A - qc_r$. Upon this tipping point, even though the manager makes irrational decisions, he survives in the firm because the cost of replacement is too high that the shareholders lose less by keeping him still in charge of the project.

3.3 A Numerical Example: Manager's True Ability Versus Perceived Ability

In my game theoretical model, I show how manager makes continuation or abandonment decision on the project, and how manager's decision affects the firm's value under different levels of overconfidence. I find the critical level of overconfidence for the manager where he switches from abandoning the project to continuing the project. My model shows that the manager's perceived payoff from the project only depends on his own perceived ability, regardless of the manager's true ability. In addition, I also obtain the critical level of overconfidence for the shareholders to change their mind. However, as shareholders can observe the manager's true ability level, the shareholders' payoff from the project depends not only on manager's perceived ability but also on manager's true ability. This results in a moral hazard problem that the manager continues the project that will damage firm's value from the project. In this section, I will investigate this relationship by setting up a numerical example and changing the values of manager's perceived ability and true ability.

3.3.1 Number Settings

I assume in the model that the independent variable for the manager is the manager's perceived ability, and the dependent variables are the manager's perceived payoff from the project and the equilibrium firm's value for the shareholders. I also treat other variables as exogenous and known to us. These variables include the manager's true ability, the manager's private benefits from the project, the projects' original payoff, cost of effort for the overconfident manager, the value redeemed from liquidating the project, and the equity stake.

To proceed my analysis, in the numerical example, the specific values for the exogenous variables are shown below. I consider the following condition where the manager has a true ability $\gamma_e = 2.5$, and he has an equity stake $s = 0.3$, which means that the shareholders equity stake is $(1-s) = 0.7$. In addition, the manager has a private benefit $b = 20$ for the project,

and the cost of effort $\theta = 5{,}000$ for the manager. The project has an original payoff of $R = 200$, and if the project is liquidated the total residual value for the project is $A = 120$.

3.3.2 Payoffs and Decisions

To maximize the payoff from the project, the overconfident manager will choose to exert an optimal level of effort $e^* = \frac{\hat{\gamma_e}(sR+b)}{2\theta}$ into the project. The=e manager's perceived optimal payoff from the project is $\Pi_m^* = \frac{\hat{\gamma_e}^2(sR+b)^2}{4\theta}$ and the equilibrium firm's value is $V^* = \frac{(1-s)\gamma_e\hat{\gamma_e}(sR+b)R}{2\theta}$. I substitute the variables into the manager's perceived payoff and the equilibrium and calculate the value of Π_m^* and V^* with the level of perceived ability $\hat{\gamma_e}$ ranging from 0 to 35. I draw the calculated perceived payoff for overconfidence, the firm's value for the shareholders in the axis. The results are shown in the figure below.

Figure 3.3.1 Numerical Example: Shareholders' and Manager's Payoff

Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, the manager's perceived payoff and the firm's value for shareholders. Calculated based on $\gamma_e = 2.5$, $s = 0.3$, $b = 20$, $\theta = 5{,}000$, $R = 200$, $A = 120$.

From the figure above, I find that for the manager, as he increases his perceived ability, he works harder and gets more payoff from the project, which is represented by the grey line. I calculate the critical level of perceived ability $\hat{\gamma_e} = \frac{\sqrt{4\theta sA}}{sR+b}$=10.6066. I can see in the figure that

if the manager's perceived ability is between 0 and 10.6066, the manager will abandon the project because by liquidating the project, he will receive higher payoff of 36, note that the amber line represents the residual value from abandoning the project. If the perceived ability is higher than 10.6066, the manager will continue the project. In addition, the manager's true ability γ_e=2.5, so when the manager is underconfident, rational or slightly overconfident, he will continue the project. If the manager is highly overconfident, he will abandon the project. For shareholders, I solve the critical value for shareholders $\hat{\gamma_e} = \frac{2\theta A}{\gamma_e R(sR+b)}$ =30. The shareholders would like to abandon the project if the manager's perceived ability is between 0 and 30, while the shareholders prefer continuing the project if the manager's perceived is higher than 30.

The positive and negative effect of overconfidence can be easily observed from the figure above. Firstly, I take a rational manager as an example. The rational manager has an ability level γ_e=2.5, and he knows his true ability. In this case, he expects that if he continues the project, he will exert an effort level of 0.05 into the project and estimates that he will receive a payoff of 2 from the project, which is less than the liquidating value of 36. Therefore, he will abandon the project. The shareholders also agree with the manager's decision. Secondly, at a medium level of overconfidence, in my example, $\hat{\gamma_e}$=20, the manager anticipates that he will exert an effort level of 0.16 into the project and expects that he will receive a payoff of 128 from the project, larger than liquidating value 36, so the manager will continue the project. However, the shareholders believe that the firm's value will become 56, lower than the liquidation value of 84. The shareholders would like to abandon the project. As the overconfident manager continues the project, he will damage the shareholders' value. This demonstrates the negative effect of overconfidence. Finally, if the manager is highly overconfident ($\hat{\gamma_e}$=35), the manager perceives that his payoff is 392, and the shareholders estimates the firm's value 98 exceeding the liquidation value 84. Both the manager and the shareholders are better off from continuing the project, which shows the positive effect of overconfidence.

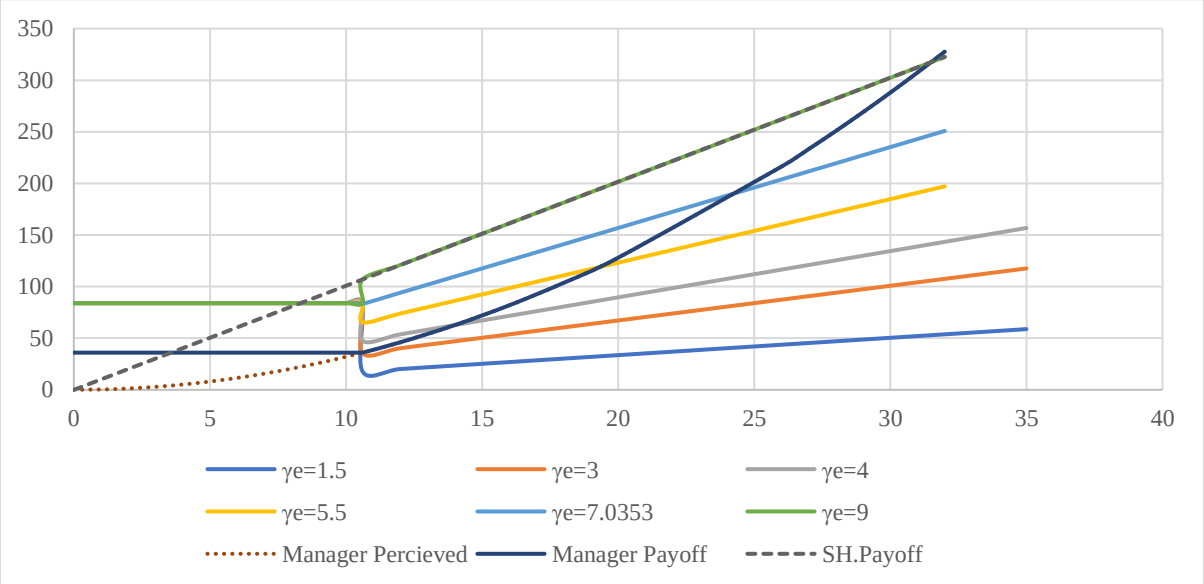
3.3.3 Different Levels of True Ability

If I revisit my theoretical model, I will find that the optimal level of effort exerted into the project ($e^* = \frac{\hat{\gamma_e}(sR+b)}{2\theta}$) and the perceived payoff for the manager ($\Pi_m^* = \frac{\hat{\gamma_e}^2(sR+b)^2}{4\theta}$) is related to his perceived ability only because the manager believes that his true ability is $\hat{\gamma_e}$. The

shareholders' optimal payoff from the project depends on both manager's true ability and perceived ability ($V^* = \frac{(1-s)\gamma_e \hat{\gamma_e}(sR+b)R}{2\theta}$). In the numerical example above, I assume the true ability of the manager is constant γ_e=2.5. In this section, I extend my analysis by comparing the payoffs for multiple true ability.

I keep all the example variables same as in the previous section and change the true ability γ_e. I notice that as the overconfident manager's perceived payoff only depends on the manager's perceived ability, so the figure for the manager's payoff remains identical no matter how the manager's true ability changes. As a result, the critical level of perceived ability for the manager remains $\hat{\gamma_e} = \frac{\sqrt{4\theta sA}}{sR+b}$=10.6066. I choose six different levels of true ability and draw the figure with the firm's value of each level of true ability respectively. The charts are shown below.

Figure 3.3.2 Shareholder Firm's Value with Different True Ability



Note. The figure demonstrates the change of the firm's value with different levels of true ability for the managers. Calculated based on γ_e = 1.5, 3, 4, 5.5, 7.0353, 9, s = 0.3, b = 20, θ = 5,000, R = 200, A = 120.

In the figure above I can observe the effect of manager's true ability on the shareholders' payoff from the project. For the manager, the brown dashed line shows the manager's perceived payoff and solid navy line represents manager's optimal payoff for the project. When I look at the shareholder's payoff, I notice that as the manager has higher true ability, the less shareholders will lose if the manager continues the project which should have been abandoned. The bottom blue line represents the payoff for shareholders in the situation that the manager has the lowest

true ability γ_e=1.5. The critical value for shareholders to change from abandoning to continuing the project decreases as the manager's true ability increases. When the manager has low true ability, he must be extremely high overconfident, and exert a large amount of effort to make the project profitable for shareholders. However, when the manager has higher ability, he can, somehow, make up for his mistake by exert some more effort. It can be observed from the figure that the shareholders' payoff line lifts upper and steeper. When the manager is capable enough where $\gamma_e = 7.0353$, the manager's critical value and the shareholder's critical value become identical. In this case, even though the manager is overconfident about his true ability. He works hard enough and continues the project so that the shareholders absolutely want him to do so. Both manager and shareholders will not lose from the manager's investment decisions.

Furthermore, if I increase the true ability level, the manager becomes more and more capable. As the critical value for the manager to switch from abandoning to continuing the project remain unchanged, but the critical value for the shareholders decreases. In my case when the true ability for the overconfident manager is $\gamma_e = 9$. The critical level of perceived ability for shareholders is less than the manager's critical level of perceived ability. Interestingly, I observe a reversed moral hazard problem where the manager is so cautious about any decisions he makes, so he abandons the project too early. The manager abandons the project which should have been continued. The shareholders are not satisfied with the manager's decision on abandoning the project, because continuing the project will produce more value for the firm. The manager damages the firm's value in an opposite way against my theoretical model. In the figure, the dashed black line shows the shareholder's estimated payoff, and the above green line shows their exact payoff from the project. I find that there is a small area where dashed black line intersects with the green line. The area indicates the negative effect of the manager abandoning the project. I argue that in this area the manager abandons the project, but the shareholders would get more payoff if the manager were to continue the project. The manager's decision is too conservative, and he abandons the project which should have been continues, resulting in shareholders' less payoff from the project.

Overall, I demonstrate the assumptions in my game theoretical model by a numerical example. I find the positive and negative effect of overconfidence. On the condition that the manager's true ability remain constant, rational, and less overconfident manager and the shareholders tends to abandon the project. At medium level of overconfidence, the manager continues the project and causes moral hazard problem. The manager's continuing the project will damage the shareholder's value from the project. If the manager is highly overconfident, he will spend

excessive amount of effort into the project and create more value for the firm. In addition, I also observe that with different true abilities, the shareholders' preference changes. The manager with lower true ability will damage the firm's value worse than the manager with higher true ability. The shareholders shall require the manager to exert more effort if the manager chooses to continue the project. When the manager has high true ability, he may create a moral hazard problem by abandoning the project. The shareholders believe that the manager has enough ability to continue and work for the project, but the manager abandons the project. The manager, therefore, damages the firm's value by abandoning the project and receiving the liquidating value that is lower than the payoff from continuing the project.

To summarize, in the original game theoretical model, I assume that the manager is running a project and he needs to decide on continuing or abandoning the project. The shareholders as outside observers also pursue optimal firm's value from the project and they have the right to replace the overconfident manager if the moral hazard problem occurs. In the next section, I will extend my model by considering the uncertainty of the project, the recruitment of the manager by shareholders at the beginning of the project investment.

3.4 Model Extension: Introduction of Uncertainty of the Project

3.4.1 Uncertainty of the Project and Model Assumption

The original model assumes that the manager is running a project, and the project fails so the manager needs to decide whether to continue or abandon the project. I am now extending and completing the model by adding the uncertainty of the project and the shareholders' recruitment of the project manager. To make the analyse simple, I assume that the overconfident manager and the rational manager has the same true ability. The only difference is that the overconfident manager overestimates his true ability, and the rational manager knows his true ability.

The shareholders are planning to invest in a project to increase the firm's value, and they are recruiting a manager to work for the project, who can decide whether to continue or abandon the project. Before investing in the project, the shareholders know the fact that the project is risky for investment. The project can be either a good project with a probability p or a bad project with a probability $(1-p)$. The ex-post property of the project will be revealed after the project has been invested. The uncertainty of the project leaves the shareholders to make a trade-off between maximizing the firm's value from a good project and avoiding the damage from a bad project. On one hand, the shareholders want to continue the project if the project is a good project. They are willing to recruit an overconfident manager because the overconfident

manager will continue the good project and works harder and exerts more effort into the project than a rational manager. However, if the project is a bad project, the overconfident manager will continue the bad project and damage the firm's value. On the other hand, the shareholders would like to abandon the bad project to avoid any loss. In this case, a rational manager will abandon the bad project, which meets the requirement from the shareholders. In the case of a good project, the rational manager will continue the good project and add value to the firm, but the shareholders will achieve less payoff from the project by the rational manager than the overconfident manager.

The shareholders, therefore, make ex-ante expected firm's value from the project on the basis of the probability of the project and the decision from either an overconfident manager or a rational manager. I assume that before the investment in the project, the shareholders will estimate the expected firm's values from the project considering the uncertainty of the project from an overconfident manager and a rational manager respectively. The shareholders compare the expected firm's value from the overconfident manager and the expected firm's value from the rational manager, and the shareholder will decide whom to recruit based on the ex-ante comparison. After the project has been investment, the nature of the project will eventually be revealed. If the project is a good project, the shareholders and the manager will continue the project. If the project is a bad project, the shareholders will abandon the bad project, and the rational manager will also abandon the project. In contrast, the overconfident manager continues the project and damages the firm's value, which ties in my original model. In the following sections, I will build a timeline of the investment procedure, and I analyse the ex-ante firm's value and the shareholders' recruitment decision.

3.4.2 Timeline

Based on the assumption above, I establish timeline of the extended model below.

Time t_0: Pre-investment Setup

At time t_0, the shareholders are looking to increase the firm's value by investing in a project. There is a probability for the project to be either a good project or a bad project. The good project will produce higher payoff than a bad project. The shareholders are recruiting a manager to invest and work for the project.

Time t_1: Project Milestone

At time t_1, the project reaches its milestone. As the manager is recruited and the project has already been invested in time t_0, the project now turns out to be a bad project or a good project. If the project is a good project, it will produce a payoff of R_G, and if the project is a bad project, it will produce R_B (Note that $R_G > R_B$).

Time t_2: Decision-Making

At time t_2, the manager needs to decide on whether to continue or abandon the project. In this stage, either rational manager or overconfident manager will anticipate the payoff from the project and make the decision.

Time t_3: Effort Exerted or Project Liquidated

At time t_3, the manager will take the corresponding action based on his decision in time t_2. If the manager chooses to abandon the project, he will liquidate the project and receive the residual value from the project. If the manager continues the project, the manager will exert effort and raise engagement for the project.

Time t_4: Payoff realized

At the last stage, the payoff from the project is realized if the project is continued.

The most important extension in the model is the shareholders' ex-ante expected payoff from the project. Due to the uncertainty of the project, the shareholders need to make a trade-off between recruiting a rational manager or an overconfident manager. I assume that the shareholders will recruit a project manager based on the manager's level of overconfidence and the probability of the project to be a good project. I will focus on the shareholders' ex-ante expected value and recruitment decision. After the shareholders recruit the manager and invest in the project, I can tie in my original theoretical in my extended model ex post when the project is a bad project.

3.4.3 Ex-ante Payoff from the Project

I keep my assumptions in the original model that the manager and the shareholders are risk neutral self-interested players. The manager tries to maximize his payoff from the project, and the shareholders also aim to achieve the optimal firm's value from the project. I assume that either the overconfident manager or the rational manager has a true ability γ_e. The rational manager is well-calibrated, and he knows his true ability. The overconfident manager perceives that his true ability is $\hat{\gamma}_e$. The manager is engaged in the project and has a private benefit b

from the project. The cost of effort for an overconfident manager or a rational manager is θ. To analyse the shareholders' recruitment strategy, I introduce the uncertainty of the project into the analysis. The project can either be a good project and a bad project. The payoff for a good project is R_G, and R_B for a bad project. The probability of a good project is p, and the probability of a bad project is $(1-p)$.

I note that the original payoff for the project is R_i $(i = G, B)$. For the overconfident manager, he believes that his ability is so his perceived payoff from the project is

$$\Pi_{m(OC)} = \hat{\gamma}_e e(sR_i + b) - \theta e^2. \tag{3.8}$$

For the rational manager, his payoff is

$$\Pi_{m(R)} = \gamma_e e(sR_i + b) - \theta e^2. \tag{3.9}$$

The difference is that the rational manager estimates his payoff using his true ability, but the overconfident manager's expected payoff depends on his perceived ability.

To maximize his payoff from the project, the manager will exert an optimal level of effort into the project. By solving $\frac{\partial \Pi_m}{\partial e} = 0$, I calculate the optimal level of effort for the overconfident manager

$$e_{oc}^* = \frac{\hat{\gamma}_e(sR_i+b)}{2\theta} \tag{3.10}$$

and the optimal level of effort for the rational manager

$$e_R^* = \frac{\gamma_e(sR_i+b)}{2\theta}. \tag{3.11}$$

I then substitute e_{oc}^* and e_R^* into the overconfident manager and the rational manager's payoff from the project, and I obtain the optimal perceived payoff for the overconfident manager

$$\hat{\Pi}_{m(OC)}^* = \frac{\hat{\gamma}_e^{\,2}(sR_i+b)^2}{4\theta} \tag{3.12}$$

and the optimal payoff for the rational manager

$$\Pi_{m(R)}^* = \frac{\gamma_e^{\,2}(sR_i+b)^2}{4\theta}. \tag{3.13}$$

If the shareholders recruit the overconfident manager, their equilibrium value from the project is

$$V^* = \frac{(1-s)\gamma_e \hat{\gamma}_e (sR_i + b)R_i}{2\theta}. \quad (3.14)$$

Now I consider the ex-post payoff for a good project and a bad project respectively. To make it simple, I assume that the equity stake $s = \frac{1}{2}$. In the case of a good project, the overconfident manager, the rational manager and the overconfident manager all prefer to continue the project. As the overconfident manager exerts more effort into the project, the perceived payoff for overconfident manager $\hat{\Pi}^*_{G(OC)}$ is larger than the payoff for the rational manager $\Pi^*_{G(R)}$. Therefore, I find a relationship of the managers' payoff and the shareholders' equilibrium value $\hat{\Pi}^*_{G(OC)} > V_G > \Pi^*_{G(R)} > \frac{A}{2}$. If the project is a good project, the payoff from continuing the project exceeds the liquidation value from abandoning the project, and the managers and the shareholders continue the project. In terms of the payoff, the overconfident manager works harder, so the shareholders will prefer recruiting the overconfident manager. In the case of a bad project, I assume that the overconfident manager tends to continue the project, but the shareholders and the rational manager want to abandon the project. I find the relationship between the managers' payoff and the shareholders equilibrium payoff $\hat{\Pi}^*_{B(OC)} > \frac{A}{2} > V_B > \Pi^*_{B(R)}$. The overconfident manager estimates that his payoff from the bad project is still higher than the residual value from abandoning the project, but the rational manager believes that abandoning the project will receive more payoff. The shareholders also anticipate that continuing the project will damage the firm's value, so they are willing to recruit a rational manager if the project is a bad project.

3.4.4 Shareholders' Recruitment Decisions

I argue that the shareholders do not know whether the project is a good project or a bad project before they invest the project. The shareholders need to recruit the manager before the property of the project is revealed. The shareholders shall estimate the ex-ante firm's value and recruit the manager that will bring them the optimal firm's value. I now consider the uncertainty of the project that there is a probability p that the project is a good project, and a probability $(1 - p)$ for a bad project. I also assume that the rational manager and the overconfident manager have same true ability. The true ability and the perceived ability for the overconfident manager is constant. I will analyse how the ex-ante recruitment strategy for the shareholders changes with the effect of the uncertainty of the project.

If the shareholders recruit a rational manager, the rational manager will continue a good project and abandon a bad project. If the project turns out to be a good project, the shareholders expect that the rational manager will exert $e_R^* = \frac{\gamma_e(sR_i+b)}{2\theta}$ into the project, and that they will achieve a firm' value of

$$V_{G(R)} = \frac{(1-s)\gamma_e{}^2(sR_G+b)R_G}{2\theta} \tag{3.15}$$

from the project. If the project is a bad project, the rational abandons the project and the shareholders receive a liquidation value $\frac{A}{2}$ from the project. Considering that the project has a probability p to be a good project, the shareholders' ex-ante expected payoff is

$$E(V_R) = pV_{G(R)} + (1-p)\frac{A}{2} \tag{3.16}$$

when recruiting a rational manager.

If the shareholders recruit an overconfident manager, the overconfident manager will continue both good and bad project. If the project is a good project, the shareholders know that the manager will exert $e_{oc}^* = \frac{\hat{\gamma}_e(sR_G+b)}{2\theta}$ into the project and that the firm's value will be

$$V_{G(OC)} = \frac{(1-s)\gamma_e\hat{\gamma}_e(sR_G+b)R_G}{2\theta} \tag{3.17}$$

If the project is a bad project, the manager will continue and exert $e_{oc}^* = \frac{\hat{\gamma}_e(sR_B+b)}{2\theta}$ into the project, and the shareholders observe the firm's value

$$V_{B(OC)} = \frac{(1-s)\gamma_e\hat{\gamma}_e(sR_B+b)R_B}{2\theta} \tag{3.18}$$

The shareholders' ex-ante expected firm's value is

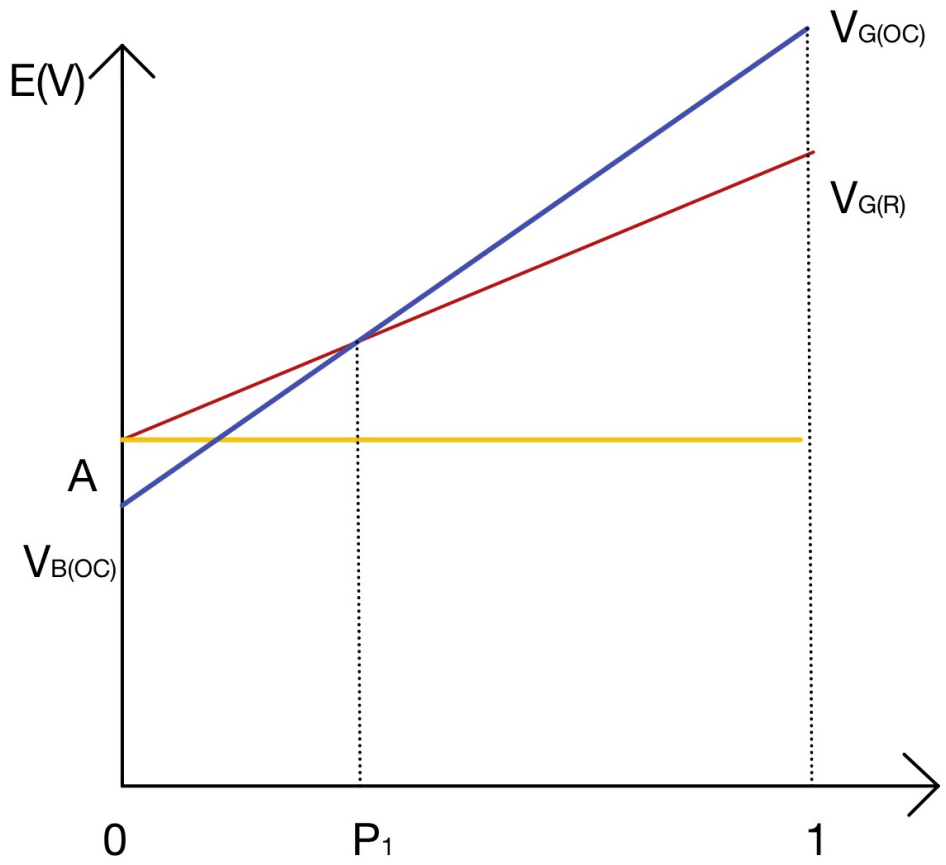
$$E(V_{OC}) = pV_{G(OC)} + (1-p)V_{B(OC)} \tag{3.19}$$

when recruiting an overconfident manager.

Remind the fact that on condition of a good project, the overconfident manager produces more payoff than the rational manager when continuing the project ($V_{G(OC)} > V_{G(R)}$). Nevertheless, when the project is bad project, the overconfident manager's decision on continuing the project will damage the firm's value so the shareholders will receive more from abandoning the project ($\frac{A}{2} > V_{B(OC)}$). By comparing the expected firm's values of recruiting the rational manager and

the overconfident manager, I can find a critical probability p where the shareholders change their recruitment strategy. Suppose that other variables remain constant, I am able to illustrate the relationship between the probability of a good project and the ex-ante expected firm's value below.

Figure 3.4.1 Shareholders' Expected Firm's Value with Different Managers



Note. The figure demonstrates relationship between the uncertainty of the project and the expected firm's value for the shareholders by recruiting a rational manager or an overconfident manager respectively. The figure also shows the shareholders' preference on the manager to recruit based on different probabilities of the project.

The figure above shows the expected value for shareholders from the project with different recruitment strategies. The blue line represents the expected value for shareholders recruiting an overconfident manager. The red line shows the expected value for shareholders recruiting a rational manager. The yellow line is the value from abandoning the project. Consistent with my analysis, I can see that when $p = 0$ where the project is for sure a bad project, the firm's value from abandoning the project is higher than the value from continuing the project, and

that when $p = 1$ where the project is for sure a good project, the overconfident manager will produce higher value from the project. It can be observed from the figure that with the uncertainty of the project $0 < p < 1$, the shareholders' recruitment decision depends on the probability of the project. I find a critical probability p_1 where the shareholders change their recruitment strategy. If the probability of a good project is between 0 and p_1 $(0 \leq p < p_1)$, the shareholders would like to recruit a rational manager for the project. The probability of a bad project is relatively high that the shareholders would like to recruit a rational manager that can make the right decision for them. If the probability of a good project is between p_1 and 1 $(p_1 \leq p \leq 1)$, the shareholders want to recruit an overconfident manager to work for the project. The probability of a good project is relatively high that the shareholders are willing to recruit an overconfident manager because the benefit from continuing a good project outweighs the risk of the decrease in firm's value from a bad project. In the next section, I will build a numerical example to show the exact effect the uncertainty of a project.

3.4.5 A Numerical Example

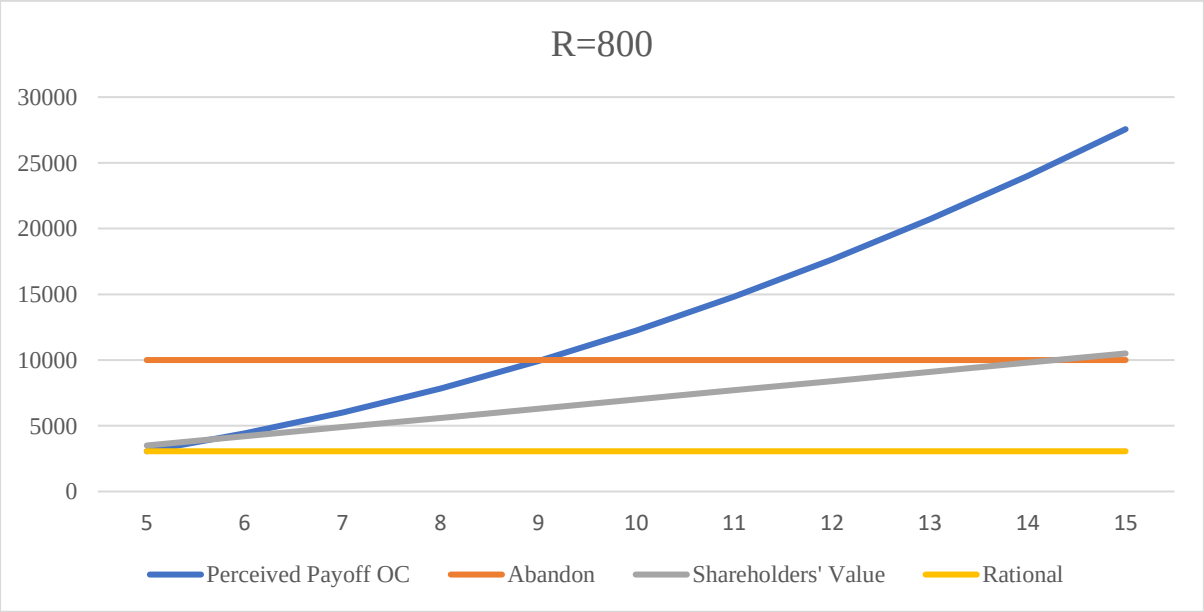
In this section, I will build a numerical example to demonstrate my model. I argue that if the probability of a bad project is relatively high, the shareholders are willing to recruit a rational manager. Otherwise, the shareholders will recruit an overconfident manager. In my example, I set the following numbers for analysis. The manager's true ability is $\gamma_e = 5$. The private benefit for the project is private benefit for the project $b = 300$. The cost of effort for the manager is $\theta = 1000$. I also assume that these variables apply to both the rational manager and the overconfident manager. The manager has an equity stake $s = 0.5$, and the shareholders receive the second half. The original payoff for a good project is $R_G = 2500$ and the original payoff for a bad project is $R_B = 800$. If the manager abandons and liquidate the project, the total value for the project is $A = 20000$.

3.4.5.1 The Cases of Good Project and Bad Project

According to the model, I calculate the perceived payoff for the overconfident manager $\hat{\Pi}^*_{m(OC)} = \frac{\hat{\gamma_e}^2 (sR_B+b)^2}{4\theta}$, the actual payoff for the rational manager $\Pi^*_{m(R)} = \frac{{\gamma_e}^2 (sR_B+b)^2}{4\theta}$, and the firm's value for the shareholders $V_{B(OC)} = \frac{(1-s)\gamma_e \hat{\gamma_e}(sR_B+b)R_B}{2\theta}$ with different perceived ability of the overconfident manager. The figures below show the overconfident manager's perceived payoff, the rational manager's actual payoff, the shareholders' value, and the liquidation value from the project with the level of perceived ability as the independent variable.

In the bad project case, the rational manager's payoff from the project, represented by the yellow line, is unrelated with the perceived ability of the overconfident manager. The value from abandoning the project, represented by the orange lie, is above the rational manager's actual payoff, so the manager would always abandon the bad project. For the overconfident manager, the perceived payoff for the overconfident manager is represented by the blue line. I believe that the overconfident manager chooses to continue the bad project only when he has a certain or a higher level of overconfident, in my case, higher than 9. The firm's value is represented by the grey line. It can be pointed out that the shareholders would like to continue the project only if the manager is extremely overconfident and exert highly excessive effort into the project ($\hat{\gamma_e} > 14$). At medium level of overconfidence, the shareholders want to abandon the project, but the manager continues the project, causing a decrease in the firm's value.

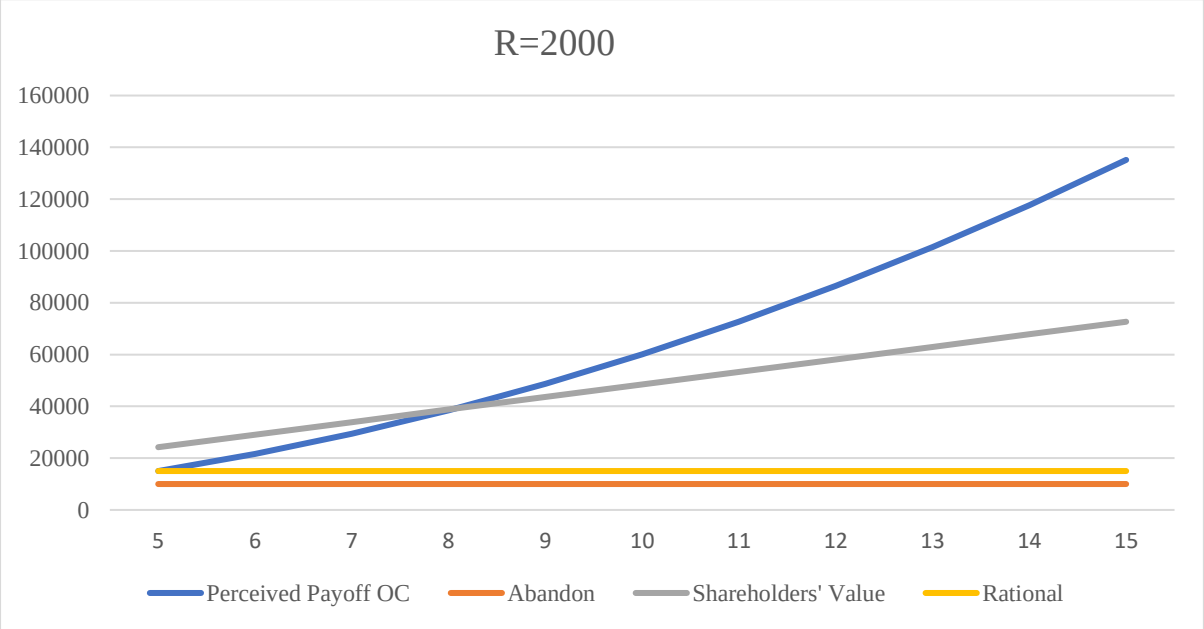
Figure 3.4.2 Payoff from A Bad Project



Note. The figure shows the perceived payoff for the overconfident manager, the actual payoff for the rational manager, and the firm's value for the shareholders from a bad project. Calculated from $\gamma_e = 5$, $b = 300$, $\theta = 1000$, $s = 0.5$, $R_B = 800$, $A = 20000$.

The figure below shows the results of the good project, I can see that the perceived payoff for the overconfident manager (blue line), the actual payoff for the rational managers (yellow line) and the firm's value (grey line) for shareholders are all higher than the value from abandoning the project (orange line). In the case of a good project, the overconfident manager, the rational manager, and the shareholders all agree to continue the project.

Figure 3.4.3 Payoff from A Good Project



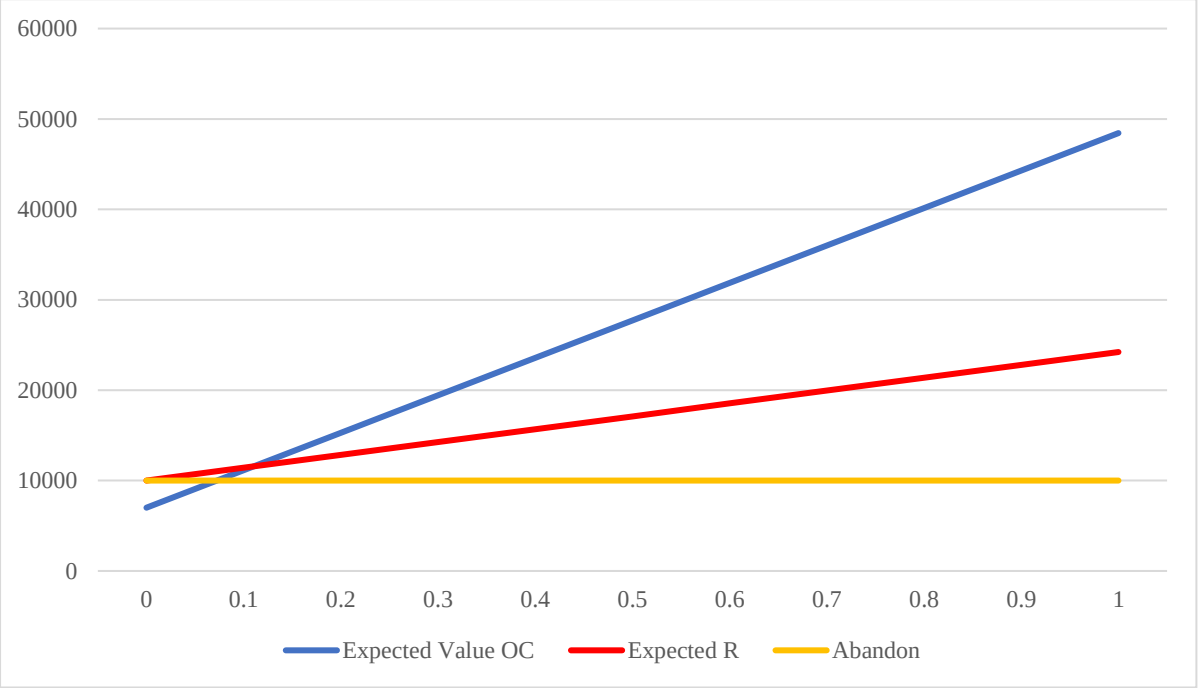
Note. The figure shows the perceived payoff for the overconfident manager, the actual payoff for the rational manager, and the firm's value for the shareholders from a good project. Calculated from $\gamma_e = 5$, $b = 300$, $\theta = 1000$, $s = 0.5$, $R_G = 2500$, $A = 20000$.

3.4.5.2 Ex-ante Expected Payoff for Shareholders and Recruitment Decision

To ties in with my theoretical model, I fix the overconfident manager's perceived ability to $\hat{\gamma_e} = 10$. For a bad project, when $\hat{\gamma_e} = 10$, the overconfident manager's perceived payoff is higher than the value of liquidating the project. The overconfident manager will continue the project. Meanwhile, the rational manager's payoff and the shareholders' value is lower than the liquidation value, so the shareholders prefer abandoning the project. For a good project, when $\hat{\gamma_e} = 10$, the rational manager, the overconfident manager and the shareholders all want to continue the project.

I then introduce the probability p of a good project and calculate the shareholder's ex-ante expected value from the project recruiting an overconfident manager or a rational manager respectively. If the shareholders recruit an overconfident manager, the shareholders' expected value is $E(V_{OC}) = pV_{G(OC)} + (1-p)V_{B(OC)}$. If the shareholders recruit a rational manager, the shareholders' expected value from the project is $E(V_R) = pV_{G(R)} + (1-p)A$. The results are shown in the chart below note that the probability of a good project is the independent variable.

Figure 3.4.4 Shareholders' Expected Value



Note. The figure shows the ex-ante expected firm's value for the shareholders based on recruiting a rational manager or an overconfident manager respectively.

In this figure, the blue line represents the shareholders' expected value when they choose to recruit overconfident manager. In this case I know that the overconfident manager always continues the project regardless of a good project or a bad project. The red line shows the shareholders' expected value when they recruit a rational manager. The rational manager will continue a good project and abandon a bad project. The yellow line is the value from abandoning the project. At lower probability where the project is highly likely to be a bad project, the shareholder's value is damaged because the overconfident manager continues the project. With the increase in the probability of a good project, the shareholder's expected value increases for the overconfident manager and the rational manager. The shareholders' value from a project of an overconfident manager increases more because the overconfident manager exerts more effort into the project than a rational manager, and the marginal productivity for the overconfident manager is higher than the rational manager. I observe that the expected value for the shareholder when recruiting the overconfident manager exceeds the expected value when recruiting the rational manager at a probability of $p = 0.1$. I know that if the probability of a good project is less than 0.1, the shareholders will recruit a rational manager to make the investment decision. If the probability of a good project is higher than 0.1, the shareholders are willing to recruit an overconfident manager.

3.4.6 Summary

In this section, I extend my model by considering the effect of uncertainty of the project. The project has a probability to be a good project or a bad project. The shareholders shall recruit a manager under the ex-ante expected firm's value resulting from the probability of a good project. Then the manager invests in the project and make his decision on whether to continue or abandon the project. I then combine my original model with the case of a bad project that continuing the project will damage the firm's value for an overconfident manager.

I find that the shareholders recruitment decision is affected by the ex-ante probability of a good project. If the probability of a good project is relatively low, which indicates that the project is more likely to be a bad project, the shareholders will recruit a rational manager because the rational manager will abandon the bad project to avoid decrease in the firm's value. If the project is highly likely to be a good project, the shareholders will recruit an overconfident manager. I also demonstrate my analysis through a numerical example.

3.5 Conclusion

In this chapter, I develop a game theoretical model to explore the effect of overconfidence and engagement on project entrapment. I suggest that the overconfident manager overestimates his ability and exerts more effort into the project than a rational manager. When the project fails, the manager needs to decide whether to continue or abandon the project. In the model, I find that the manager makes various decisions depending on the level of overconfidence and engagement. I argue that when the manager is rational or slightly overconfident, he will choose to abandon the project. If the manager is more overconfident, he will continue the project. I also find that different levels of overconfident manager have opposite effect of overconfidence on the firm's value for the shareholders. If the manager raises a medium level of overconfidence, he continues the project, but the shareholders want to abandon the project, which causes a moral hazard problem. The manager's decision on continuing the project damages the firm's value for shareholders. However, if the manager is highly overconfident, the manager and the shareholders are both willing to continue the project. The manager exerts excessive effort into the project and produce value addition to the firm. The shareholders will benefit from the manager's high level of overconfidence. In the original game theoretical model, I observe both positive and negative effect of overconfidence on the firm's value. When the moral hazard problem occurs, the shareholders can replace the overconfident manager with a rational manager with a cost of replacement.

Then, I extend my model by introducing the uncertainty of the project. The project can be either a good project or a bad project. The shareholders are recruiting a manager to invest in the project. Due to the uncertainty of the project, the shareholders need to make ex-ante estimation on the firm's value and decide which manager to recruit based on the probability of a good project and a bad project. We, therefore, find that with other factors, such as the manager's true ability, the manager's perceived ability, being constant, the shareholder will recruit a rational manager if the probability of a good project is low. As the probability of a good project increases until it reaches a critical value, the shareholders will start to recruit an overconfident manager.

To demonstrate my game theoretical model, I implemented a behavioural finance experiment, where I aim to find evidence on the effect of overconfidence on the manager's decision making. In the next chapter, I will introduce the design and the findings in the behavioural finance experiment.

Chapter 4: Behavioural Finance Experiment: A Manager's Decision

4.1 Theoretical Background

4.1.1 Theoretical Framework

In the previous chapter, I develop a game theoretical model of a manager's level of overconfidence, the level of engagement and his project termination decisions. In the game theoretical model, I argue that the manager's decision on whether to continue or abandon the project depends on the level of overconfidence and engagement. In addition, the manager's level of overconfidence has both positive and negative effect on the firm's value for the shareholders. The main propositions in the theoretical are summarized as follows.

- The manager's decision on whether to continue or abandon the project depends on the level of overconfidence and engagement. If the manager is rational or slightly overconfident, he will choose to abandon a failed project. At higher level of overconfidence, the manager will continue the project.
- The manager's decision is affected by his engagement on the project. The manager's level of engagement is reflected as a private benefit. The manager with higher level of engagement continues the project.
- The level of overconfidence has both positive and negative effect on the firm's value.
    - If the manager is underconfident, rational or slightly overconfident, he will choose to abandon the project, and the shareholders agree with the manager's decision.
    - At a medium level of overconfidence, the manager chooses to continue the project, but the shareholders prefer abandoning the project. The manager's continuing the project will create moral hazard problems in terms of destroying firm's value for shareholders.
    - At a higher level of overconfidence, the manager and the shareholders both agree to continue the project.

Based on the development of the theoretical model, I implemented a behavioural finance experiment to demonstrate the effect of overconfidence and engagement on manager's decision and firm value. In this chapter, I will introduce the design and the findings of the experiment.

4.1.2 Hypotheses

According to my game-theoretical model, I base my analysis on the assumption that higher level of overconfidence will make the manager work harder for the project. The first hypothesis I am going to test is the relationship between the level of overconfidence and the effort from the decision maker.

Hypothesis 1: Participants who are overconfident are significantly more likely to continue a failed project than those who are rational or underconfident.

Hypothesis 2: Participants who are more overconfident will significantly exert more effort into the project.

Hypothesis 3: There is a linear positive relationship between the participants' levels of overconfidence and the length the participants decision to continue the project.

The other important finding in the model is that the overconfidence has two-sided effect on the firm's value from the project. In the behavioural finance experiment, I will demonstrate the effect of overconfidence on the manager's decision and the firm's value.

Hypothesis 4: Overconfidence has both positive and negative effect on the firm's value. A Medium level of overconfidence will damage the firm's value. Higher level of overconfidence will create more value to the firm.

In addition, I also want to find the effect of engagement and passion on the manager's decision. As the engagement is represented as a private benefit from the project, I will obtain the engagement and motivation from the manager and test the relationship between engagement and project entrapment.

Hypothesis 5: Managers with higher engagement and motivation on the project will he more likely to continue the project than those with lower engagement and motivation.

4.2 Method

4.2.1 Participants

The experiment was conducted and distributed online via Qualtrics experimental platform. The experiment was distributed from October 2020 to January 2021. A mixture of undergraduate and postgraduate students from University of Bath were recruited to participate in the project. A total of 73 valid responses were recorded from the experiment. Table 4.2.1 below shows the composition and the characteristics of the participants.

Table 4.2.1 Composition of Experiment Participants

Gender		
Female	53	72.60%
Male	20	27.40%
Age		
18-24	54	74%
25-34	18	24.70%
35-44	1	1.40%
Total Participants	73	100%

Note. N=73. The table summarizes the number of the participants in terms of genders and age groups. Drawn from the data of all valid responses in the experiment.

4.2.2 Experient Materials

The experiment was implemented to explore the effect of overconfidence and engagement on the participants effort exerted into the project and their decision on continuing or abandoning the project. Therefore, the variables I obtain from the experiment or analysis include the participants' true ability, the participants' perceived ability, the participants' level of overconfidence, the participants' level of engagement, the effort exerted into the project.

Generally, behavioural finance researchers obtain participants' self-reported level of overconfidence in experiments. The researchers have done quite a substantial number of experiments to obtain the participants' overconfidence level. The most convenient way to obtain the level of overconfidence is to ask the participants self-reported level of overconfidence. Similar questions include 'how confident you think you are compared with others' etc. The participants choose a number from 1 to 10, which shows their level of overconfidence. Apart from the self-reported overconfidence, recently, most of the researchers adopt questions answering and estimation approach to observe the level of overconfidence. Typically, there are three ways the researchers treat the level of overconfidence. These methods start with a cluster of questions, either general knowledge questions or questions in a specific area. Then some researchers ask the participants to answer the question and give the probability of how confident they think the answer is correct for each question. They treat the difference between the average probability and the proportion of correct answers in all questions as the level of overconfidence (Trinugroho and Sembel, 2011; Pikulina et al, 2014; McCannon et al, 2016; Michailova et al, 2017). Some researchers ask the participants to give a range in which the answer lies at 90% confidence interval in the participants view. The researchers will examine the difference between the upper and lower limit and treat it as the level of overconfidence (Biais et al, 2005; Deaves et al, 2009; Fellner and Krügel, 2012; Menkhoff et

al, 2013). Other researchers adopt a more direct way by asking the participants to estimate how many correct questions they can get among all the questions. By comparing the estimated correct answers and actual answers from the participants, the researchers can observe the participants' level of overconfidence (Ifcher and Zarghamee, 2014; Michailova and Schmidt, 2016).

The task of question-answering and estimation has been widely adapted by laboratory experiment researchers to measure overconfidence. The most widely used question sets are consisting of general knowledge question. Such questions as 'Length of the Nile River (in miles)?', 'Weight of an empty Boeing 747 (kgs)?' (Biais et al, 2005), 'The United States shares the longest unguarded border in the world with what country?' (Ifcher and Zarghamee, 2014), 'What is the average diameter of the moon in km?' (Fellner and Krügel, 2012), 'What enterprise belongs to Bill Gates?', and 'How long does it take for a hen to hatch an egg?' (Michailova et al, 2017) were included in the general knowledge questions task. According to Michailova and Schmidt (2016), the questions are balanced from an easy level to a difficult level. Also, to avoid biases from question contents, the questions are not related with economics or finance and are gender neutral. Therefore, I got the inspiration from Pikulina et al (2014)'s design on the measurement of overconfidence. In their paper, they explored the relationship between level of overconfidence, effort, and investment through a behavioural finance experiment. The participants of business and economics background were asked to answer 20 financial knowledge questions. I adopt a few questions from Pikulina's experiment and created the rest of the questions in the form of examples from literature mentioned above using available information online.

In the task, I ask the participants to answer general knowledge questions and estimate the number of correct answers. I obtain the participants' perceived ability and actual ability from the general knowledge question task. Treating the actual correct answers as the true ability and the estimated correct answers as the perceived ability, it is more convenient for me to use the true ability and the perceived ability to calculate the payoff from the project in the later section.

Another important factor I consider in the experiment is engagement. Studies in fair process argue that the manager's feeling of engagement on the project enhances their motivation and performance on the project (Wu et al., 2008). The authors claim that manager's passion and motivation on the project is reflected in terms of private benefits for the manager. If the manager feels more engaged and passionate for the project, he could be reluctant to abandon a project. A manager who has been working for the project since the beginning and has been very dedicated to the project will have private benefit on the project. If the manager feels more

engaged and passionate for the project, he could be reluctant to abandon a project. To obtain the level of engagement for the project, I designed a project choice task and asked the participants to choose their favourite project to invest. Through this process, the participants could raise passion and motivation on the project they chose to investment. The level of engagement is measured by the participants' self-reported passion and motivation from 10-points Likert scale questions.

To observe the subject's effort into the project, I design a real effort task for the participants to complete and treat their performance in the task as the physical effort exerted into the project. Behavioural science researchers adopt real effort tasks to capture the effort for analysis, while others ask the participants to choose their effort from a provided effort chart (stated effort). The real effort methods require the participants to take part in a task and complete several rounds, which includes coding and grouping a series of numbers (Pikulina et al, 2014), judging a series of statements as being true or false (Bäker and Pull, 2017), clicking on points appearing all over the screen (Hammermann, 2011), counting a specific number in blocks of random different numbers (Vranceanu, 2015) etc. What these methods have in common is that the participants need to spend effort into the project to achieve better results, which are linked with their rewards in the final stage. The participants can review their effort and the results at the end of the task. In some papers on the fairness and venture capitalist, the researchers are more inclined to the methods of choosing a work effort (Anderhub, 2001; Fehr et al, 2008; Karakostas et al, 2015; Fairchild and Yao, 2017). They use the stated effort methods to obtain the participants self-reported effort level.

Studies comparing stated effort method and real effort methods find both pros and cons in each method respectively. The stated effort task eliminates the uncertainty from the participants but may not capture the participants effort related with the environment and psychological conditions. Meanwhile, real effort method is closer to the psychological states when the participants are involved in the experiment, but it is difficult for the researchers to find the cost of effort from the real effort method (Charness et al, 2018). According to Charness et all (2018) when choosing between real effort method or stated effort methods, timing of the decisions, planned or actual action, and the interchangeability between the effort and the payoff should be considered. When designing the experiment, I aim to find the relationship between the level of overconfidence, engagement, and effort based on the theoretical model. It is important for the participants to understand their role of project manager and make decisions under such environment. In addition, the participants' effort and performance in the experiment is affected

by the psychological and emotional states of themselves, so I believe that a real effort method is more suitable in my experiment. In addition, I am aiming to capture the participants actual behavioural action influenced by their level of overconfidence, so the real effort methods enable me to obtain the actual effort from the participants.

McGuire et al(2019) mentioned The Finger Tapping Tap as one of Performance Validity Test to measure the effort of participants. Therefore, w Hence, I adopt a tapping task for the participants to complete and capture their effort into the task. The participants tap the space bar on the keyboard as many as they can for 10 seconds and repeat twice. The total number of taps is treated as the actual effort from the participants. Then I am able to calculate the participants perceived payoff from the project and the shareholder firm's value.

4.2.3 Procedure

The experiment was distributed and operated via Qualtrics. I built the structure online and made several test experiments to make sure that the online experiment functioned well before starting to recruit participants. The participants received a unique link which enabled them to run the experiment on their computers. The participants could leave the experiment during the process of the experiment, and they could resume the experiment from where they left afterwards. The whole experiment took 20 to 30 minutes to complete. Any incomplete responses were rejected. The experiment consists of 3 sections. Section 1 contains the consent form and several questions on the basic information of the participants including gender, age, and ethnicity. Section 2 is a general knowledge question task to obtain level of overconfidence. Section 3 includes a project investment process in which the participants were required to make several investment decisions and performed an investment task. The detailed procedure of the experiment is described below.

At the beginning of the experiment, the participants were explicitly informed about the structure and the approximate duration of the experiment. The participants read the instructions carefully and familiarised themselves with the experiment before they started. Then, they were presented with a few consent statements on anonymity and access of the data. Following the consent forms were the questions on the participants' gender, age group and ethnicity.

Section 2 came after the participants finished the basic information questions. In Section 2, This section consisted of 20 general questions followed by a self-reported estimation question. First, the participants were required to answer the general knowledge questions without time limit. Each question was provided with two choices, and only one choice was the correct

answer for the question. The participants were told that they could search the answer from any source during the experiment, and that the number of correct answers would affect the outcome in project investment in section 3. The more correct answers they could provide in the task, the better results they might achieve in the next section. After the participants finished all questions, I asked them to estimate how many correct answers they believed they had just given in the task. When the participants made their estimation, they were told that section 2 was completed, and they were then moving to section 3.

In section 3, I established a project investment task for the participants to experience. Section 3 began with a potential project for investment. The participants were told that in this task they acted as a project manager for a firm aiming at maximizing value from the project. They were also seeking to achieve the best payoff from the project. Then I showed the detailed information of the project: a release of a new laptop. The participants were informed that the firm was considering launching a new laptop into the market, and they took the responsibility of the project choice and investment decisions. I provided the participants with four different versions of the laptop to choose from. The participants carefully read the introduction of the project which included a general description, the exclusive features, the target customers, and pros and cons of each laptop respectively. What the participants should do was choose only one version of laptop they believed was the best among all four versions to invest. When they made a choice on the laptop, I asked them several questions on their engagement and passion on the project, which included 'To what extend do you think you are passionate to invest in the project?', 'How excited do you feel if the laptop is about to release?', and 'To what extend do you think you are keen to make money from the project?'.

As the participants decided on their projects, they were then provided with the financial information of the project. The participants were given a positive net present value (NPV) project. Therefore, the participants believed that their investment into the project would create value for the firm. With the participants moving forward, they were confronted with a situation that the market performance of the laptop was not as good as expected. As a result, the project would not bring any cash flow to the firm at the end of the first year, so the project failed and was damaging firm's value. The participants should decide whether to continue or abandon the project. Their decisions on the project would lead them to different directions of the experiment. If the participants chose to abandon the project, the project would end immediately, and I showed the participants that the project would be liquidated, and they could claim some redemption from the project. The experiment ended whenever the participants chose to

abandon the project. If the participants chose to continue the project, they would be directed to a tapping task. I told the participants that the payoff from the project in the next year depended on their performance in the tapping task. The participants were shown with a platform where they tapped the space bar for 3 rounds, each lasted for 10 seconds. Before they started the task, they had a chance to practice the task for several times. Once they were familiar with the task, they could undertake the task formally. On their screen, first, the participants clicked 'Start' to perform the task. Then, the participants tapped the space bar on the keyboard for 10 seconds at any speed they wanted. Lastly, after 10 seconds, the task automatically ended. The participants' screen was redirected to the end page of this round. The participants were shown their total number of tapping on the screen. The subjects should record the number shown and repeat the task for 3 times. Then they added 3 numbers up and calculated the payoff for them from the project. They could see their payoff from the project calculated from the performance in the general knowledge questions and in the tapping task.

When the participants finished this task, they were informed that they were expecting the project to produce the payoff they calculated before in this 'year'. After the participants took a short break, which stood for a 'year' passing, they were told that the same problem occurred again, and the project failed again. If they continued with the project, they would again do the tapping task to simulate the effort exerted into the project. If they chose to abandon the project at the end of any time slot (end of the year for the project) in the experiment, the experiment came to an end. I assumed that the project lasted for 5 years, so the participants needed to make continue or abandon decisions up to 4 times depending on when they chose to abandon the project. For example, if one participant chose to continue the project for 2 years, and abandoned in year 3, he/she needed to perform the task twice. If one participant continued the project till the natural end of the project, he/she would repeat the task for 4 times.

At the end of the experiment, the participants were shown that they had completed all tasks in the experiment. Their data had been recorded and would only be used for my research and the participants may close the website and quit the experiment.

4.2.4 Statistical Analysis

To demonstrate the hypotheses, I use the following statistical data analysis methods. To begin with, an independent sample t-test is conducted to test whether there are different decisions on continuing or abandoning the project between underconfident & rational participants and overconfident participants. Then, to demonstrate the relationships between the participants'

level of overconfidence, engagement, and effort exerted into the project, I calculate the correlations between the variables and check whether the relationships are significant. In addition, the participants' perceived payoff and the shareholders' firm value are calculated, which are used to analyse the positive and negative effect of overconfidence on project entrapment. The results are shown in the next section.

4.3 Data and Findings

4.3.1 Level of Confidence from Participants

In the experiment, the subjects were required to answer 20 general knowledge questions and estimate the number of correct answers. I treat the actual number of correct answers from participants as their true abilities, and the estimates number of correct answers as their perceived abilities. The difference between a subject's actual ability and perceived ability reflects the subject's level of overconfidence.

Table 4.3.1 shows a summary of the overall performance from the participants. The subject with best performance answer 19 questions correctly out of 20 questions, while the subject with least number only gets 6 correct answers. On average, the participants score 14 correct answers among 20 questions. 15 participants answer 15 questions correctly which takes up to 20.5% of all subjects, covering the largest proportion of the participants.

Table 4.3.1 Distribution and Descriptive Statistics for Actual Answers in General Knowledge Questions

Actual Answer Distribution			
Correct Answers	Frequency	Percent	Cumulative Percent
6	1	1.4	1.4
8	1	1.4	2.7
9	1	1.4	4.1
10	6	8.2	12.3
11	5	6.8	19.2
12	4	5.5	24.7
13	7	9.6	34.2
14	8	11.0	45.2
15	15	20.5	65.8
16	9	12.3	78.1
17	9	12.3	90.4
18	6	8.2	98.6
19	1	1.4	100.0
Total	73	100	
Actual Correct Answers			
Min			6
Max			19
Mean			14.22

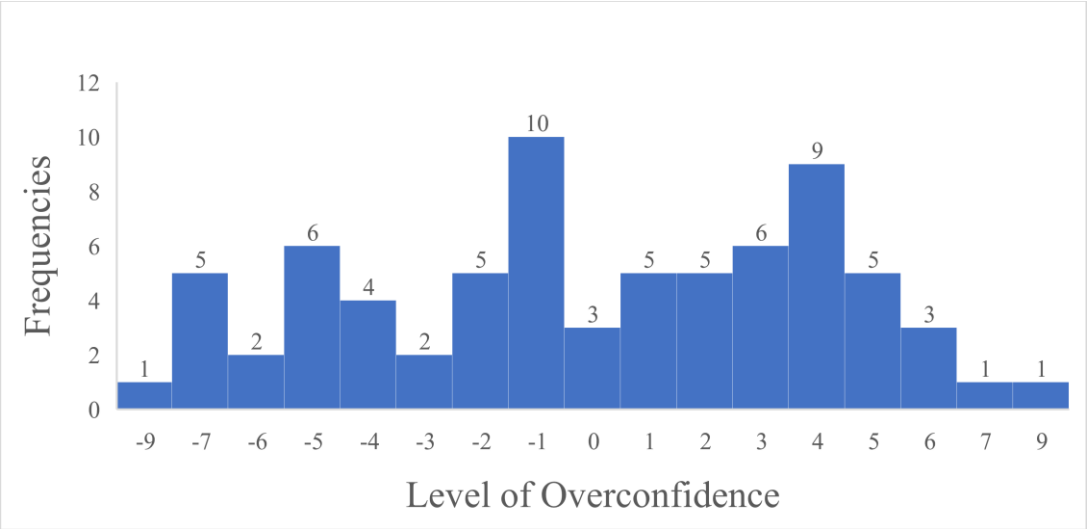
Note. N=73. The table summarizes the distribution of the participants' actual correct answers in the general knowledge question task.

Table 4.3.2 Distribution and Descriptive Statistics for Estimated Answers in General Knowledge Questions

Actual Answer Distribution			
Correct Answers	Frequency	Percent	Cumulative Percent
6	1	1.4	1.4
7	1	1.4	2.7
8	2	2.7	5.5
9	3	4.1	9.6
10	11	15.1	24.7
11	1	1.4	26.0
12	4	5.5	31.5
13	5	6.8	38.4
14	4	5.5	43.8
15	10	13.7	57.5
16	9	12.3	69.9
17	5	6.8	76.7
18	12	16.4	93.2
19	3	4.1	97.3
20	2	2.7	100
Total	73	100	100
Actual Correct Answers			
Min			6
Max			20
Mean			14.22

Note. N=73. The table summarizes the distribution of the participants' estimated correct answers in the general knowledge question task.

Figure 4.3.1 Distribution of Level of Overconfidence



Note. N=73. The figure summarizes the distribution of the participants' level of overconfidence in the general knowledge question task. Ranging from -9 to 9. Number of Overconfident subjects 35. Number of Rational and Underconfident Subjects 38.

I obtain the subjects' level of overconfidence by comparing the estimated and actual number of correct numbers (Individual Confidence=Estimated Correct Answers – Actual Correct Answers). I divide the participants into two groups, including a group of Overconfidence and a group of Rational & Underconfidence. Those with negative Individual level of overconfidence underestimate their ability, and those with 0 negative Individual level of Confidence knows their true abilities. They will be marked as Rational & Underconfidence. The subjects with positive Individual level of overconfidence overestimate their ability, and they will be marked as Overconfidence. My result shows that the subject with the lowest Individual Confidence (-9) is highly underconfident about his true ability, while the subject with highest Individual Confidence (9) excessively overestimates his true ability. Of all participants, 47.9% (35 of 73) are overconfident subjects with Individual Confidence larger than 0, and 52.1% (38 of 73) are rational or underconfident with Individual Confidence equal to or less than 0.

4.3.2 Overconfidence and Continuation of the Project

In the theory model, I argue that an overconfident manager is more willing to continue a project than a rational manager. The overconfident manager overestimates his ability and exerts more effort into the project. The reason why an overconfident manager tends to spend more effort is that he believes in a higher marginal productivity when working in the project. He, therefore, works harder and perceives a larger payoff from the project. On one hand, an overconfident manager's perceived payoff always exceeds the expected payoff of shareholders who can observe the manager's true ability. This could somehow trigger a problem that an overconfident manager overestimates the payoff of a project and keeps the project while the continuation of the project is not the best decision for shareholders. On the other hand, a rational manager is well-calibrated, and such problem shall not occur because the rational manager makes a decision in accordance with the shareholders' preference. As for underconfident managers, they are believed to be more conservative, and could make mistakes by abandoning a project which should have been continued. I am wondering whether my data support the statement that the overconfident subjects are more willing to continue the project than the rational and underconfident manager. I will use a t-test to compare the decisions from the overconfident subjects and the rational and underconfident subjects.

In the experiment I assume that the project lasts for 5 years, the participants shall make 'continue' or 'abandon' decisions at the end of every year, and the experiment ends whenever they choose to abandon the project. I manage to collect the data of which year the subject

chooses to abandon the project. For example, if the subject abandons the project at the end of year one, I record the year of continuation as 1, and if the subject continues to the end of year five, I note that his year of continuation is 5. In the experiment, I split the subjects into two groups: Overconfident group and Rational & Underconfident group. By comparing the average years of continuing the project in each group, I can observe whether the overconfident subjects are more likely to continue a project than the rational and underconfident ones. The result is shown in Table 4.3.2 below.

Table 4.3.3 Group Descriptive Statistics and Independent Samples T-Test

Group Statistics

	N	Mean Years	Std. Deviation	Std. Error Mean
Group Rational&Underconfidence	38	0.45	0.891	0.145
Group Overconfidence	35	3.43	0.948	0.160

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Continue Years	Equal variances assumed	1.225	0.272	-13.846	71	<0.001***
	Equal variances not assumed			-13.811	69.537	<0.001

Note. The table shows the result of an independent T-test comparing the mean years of continuing the project. The result of Levene's Test is insignificant (p=0.272) indicating equal variance assumed. The result of t-test is significant (p<0.001), indicating difference in means for two groups.

***. Correlation is significant at the 0.001 level (2-tailed).

I use an independent samples t-test to compare the means of each group. From Table 4.3.2 I can see that the average duration of continuing the project is 0.45 years for Rational & Underconfident group and 3.43 years for Overconfident Group. In Levene's test, the assumption of equal variance is not significant (P=0.272>0.05), so I accept the assumption of equal variance. Then I notice that under the assumption of equal variance, the t-test result is significant (P<0.001). It indicates that the mean years of continuing the project in Overconfident Group are significantly different from the mean years of continuing the project in Rational & Underconfident Group. On average, the years of continuing the project in group Overconfident is significantly larger than the years of continuing the project in group Rational & Underconfidence. Therefore, I can conclude from the result that the subjects in the group

Overconfidence are more willing to continue a failed project than the subjects in the group Rational & Underconfident. I demonstrate hypothesis 1 that an overconfident manager is more willing to continue a failed project than a rational manager.

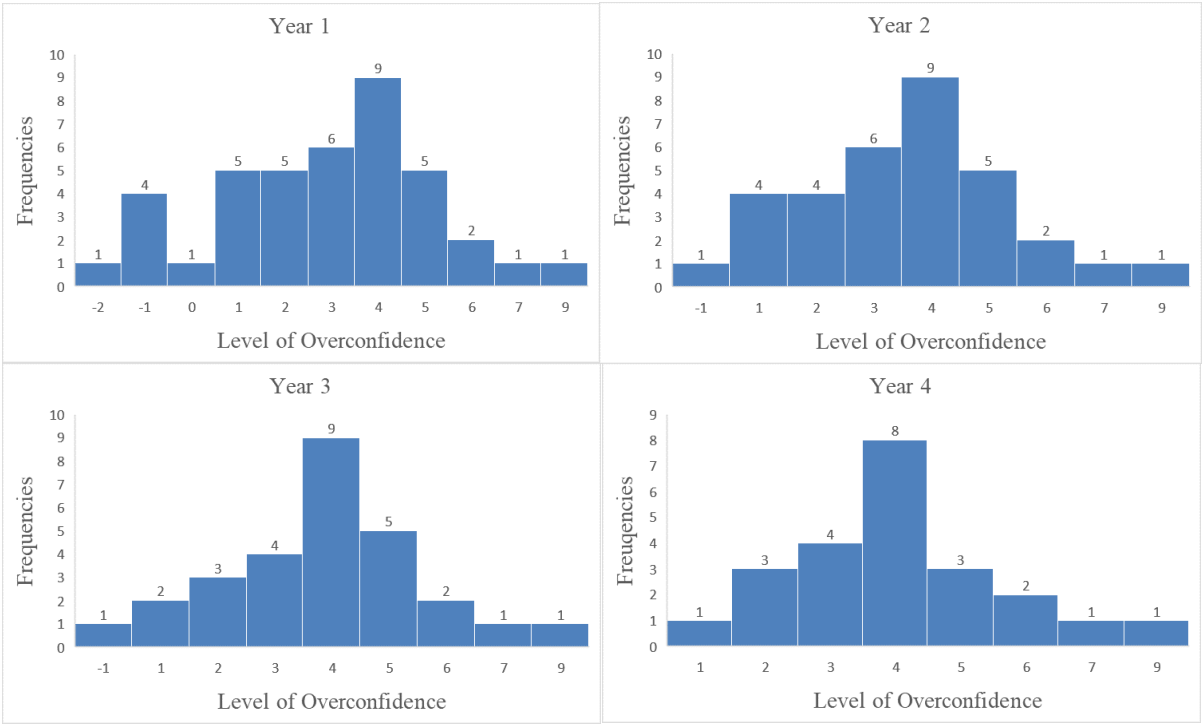
Result 1: When facing a same failed project, an overconfident manager is more willing to continue the failed project than a rational or an underconfident manager.

4.3.3 Level of Overconfidence and Length of Continuing

In the previous section, I find that the overconfident participants are significantly more intended to continue a project than the rational and underconfident participants. I am now going one step further to see how overconfidence affects the subject's decision. Within the group of overconfident subjects, I am wondering if there is a positive relationship between the level of overconfidence and how long the subject continues the project. It is reasonable to consider that the subject with higher level of overconfidence perceives more payoff from continuing the project are reluctant to abandon the project, causing him to continue the project longer than those with lower level of overconfidence. As the participants need to make decision up to 4 times based on a 5-year project, I obtained the data of how long the participants continued the project. Among all 73 valid responses, 40 participants chose to continue the project and 33 chose to abandon the project at the end of year 1. Then, 7 participants opted to drop out at the end of year 2 while 33 continued the project at the end of year 2. At the end of year 3, 28 continues the project, and 23 chose to exert effort until the termination of the project in year 5.

Within the subjects who continued the project in each different time steps, the subjects' levels of overconfidence also vary, which showing a positive relationship between the level of overconfidence and the length of continuing the project. The figure below summarizes the distribution of level of overconfidence for the subjects who choose to continue the project in each time step.

Figure 4.3.2 The Distribution of Level of Overconfidence for Participants Continuing the Project



Note. The figure summarizes the distribution of the level of overconfidence for participants who continue the project at the end of each year. N1=40; N2=33; N3=28; N4=23.

Specifically, the majority of the participants who continue the project are overconfident participants. At the end of the year 1, some underconfident, rational, and slightly overconfident participants opt to abandon the project, while participants with higher level of overconfidence choose to continue the project. Comparing year 2 and year 3, I notice that some participants with lower level of overconfidence (level of overconfidence=1, 2, and 3) choose to abandon the project at the end of year 2. Participants with higher level of overconfidence are still sticking to running the project. Participants with higher level of overconfidence begin to terminate the project. With one participant of overconfidence level 4 and two participants of overconfidence level 5 abandoning the project, a total of 23 participants decide to continue the project until the project's original termination time. The figure demonstrates that participants with higher level of overconfidence tend to continue the project for a longer period. From year 1 to year 4 at decision making time step, the participants who drop out early are among those with level of overconfidence at -2, -1, 0, and 1. Meanwhile, at later stage of the project, participants with medium level of overconfidence abandon the project. To demonstrate the relationship, I find the correlation between the level of overconfidence and the length of continuing the project.

The result shows that the correlation between the level of overconfidence and the year of continuing the project is 0.485 (p=0.003**). The correlation is significant at level of 0.01 (p=0.003<0.01). The significant correlation reflects that there is a strong positive relationship between the subject's level of overconfidence and the duration of continuing the project. As is stated in the hypothesis, in the experiment, I find that the subjects with higher level of overconfidence tends to continue the project longer than those with lower level of overconfidence. This is consistent with the corporate decision making in real world because an overconfident manager expect to create a higher value from a project despite the fact that the project failed before. The overestimation on the project pushes the manager work harder even if the project is damaging payoff for shareholders. The more overconfident the manager is, the more effort he will exert in the project and the more perceived payoff he is expecting to achieve from the project. Consequently, he is reluctant to abandon the project. In this part, I demonstrate the hypothesis 2 that managers with higher level of overconfidence continue the failed project significantly longer than those with lower level of overconfidence.

Result 2: The entrapment in a failed project increases with the manager's level of overconfidence. A more overconfident manager continues a failed project longer than those who are less overconfident.

4.3.4 The Relationship Between Overconfidence, Engagement and Effort

In the theoretical model, I argue that there is a close link between the level of overconfidence and the effort the manager exerted into the project. The level of overconfidence affects the manager's continuation or abandonment decision by affecting the manager's perceived payoff from the project. The overconfident manager believes in a higher ability than his true ability, so he expects a higher marginal productivity for himself. As the manager is self-interested and seeking to maximize his payoff from the project, his optimal effort exerted into the project increases with the manager's higher marginal productivity. I also assume that engagement has a positive effect on the payoff from the project in term of private benefits. If the manager feels more passionate and engaged on the project, the more willing he is to continue the project. In this part, I aim to explore the relationship between overconfidence, engagement and the effort the subjects exert in the project. Table 4.3.3 displays the correlations between the variables mentioned above.

Table 4.3.4 Correlations between Overconfidence, Engagement and Effort

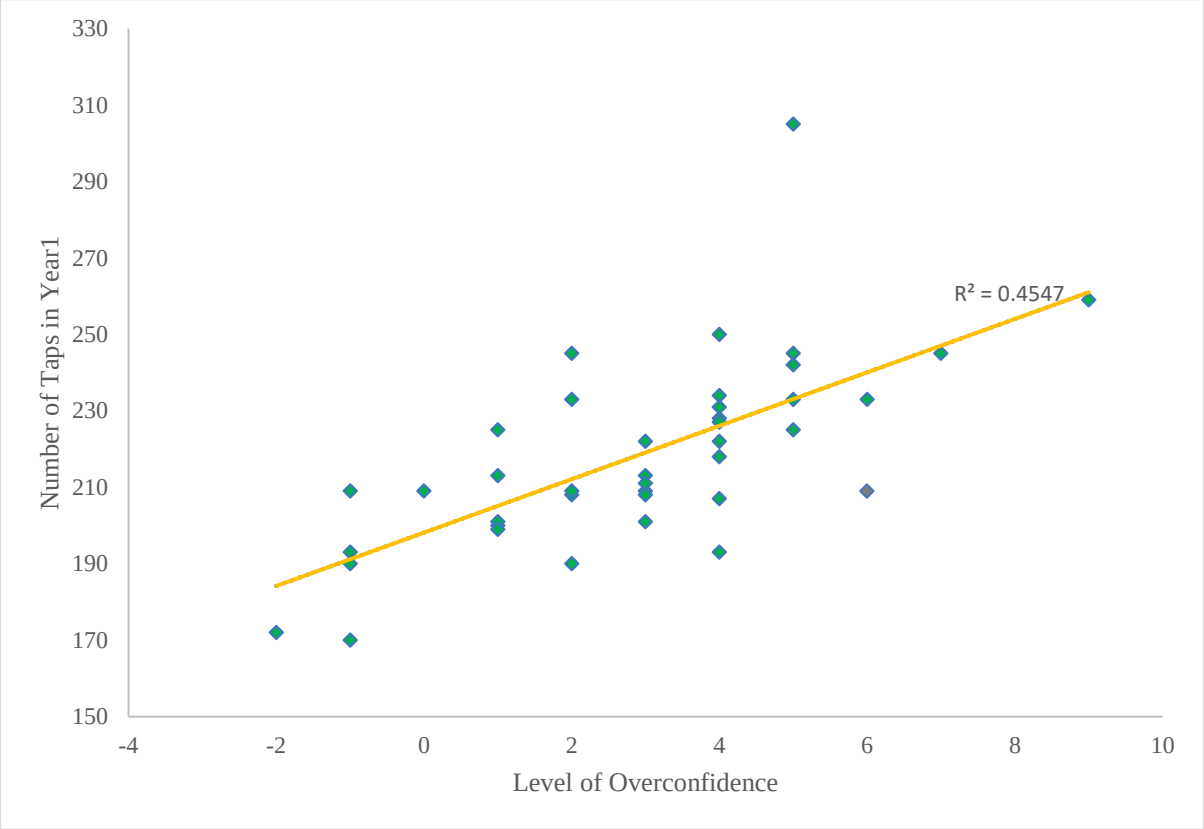
Correlations					
	Overconfidence	How Passionate	How Excited	Keen to Make Profit	Tapping
Overconfidence	1				
How Passionate	0.139	1			
	(0.242)				
How Excited	0.180	0.699***	1		
	(0.128)	(<0.000)			
Keen to Make Profit	0.130	0.359**	0.512***	1	
	(0.271)	(0.002)	(<0.000)		
Tapping	0.290*	0.008	0.023	-0.122	1
	(0.050)	(0.957)	(0.881)	(0.421)	

Note. The table shows the correlations between the level of overconfidence, three self-reported proxies for engagement and the number of taps the participants performed in the real-effort task. Drawn from the data of all valid responses in the experiment.
*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.1 level (2-tailed).
***. Correlation is significant at the 0.001 level (2-tailed).

In table 4.3.3 above, 'How Passionate', 'How Excited', 'Keen to Make Profit' are variables from the 3 engagement questions respectively. 'Tapping' is the number of the subjects' total taps in 3 rounds, which measures the effort exerted in the project from participants. I can see from table 4.3.3 that the correlation between overconfidence and the number of tapping is 0.290, significant at 0.05 level (p=0.05). It shows a positive relationship between overconfidence and the number of taps, representing the physical effort the subject exerted into the project. In the experiment, the participants who reported a higher level of overconfidence tend to get significantly more taps than those with lower level of overconfidence in a same limited time. The significant correlation indicates that the overconfident subjects believe in a higher marginal productivity works harder for the project. The result is consistent with my hypothesis that the more overconfident the subject is, the higher effort he will exert in the project.

Figure 4.3.1 below shows the relationship between level of overconfidence and the number of taps the subjects perform in the experiment on year 1. I can observe a positive relationship from figure 4.3.1, which matches the correlation displayed in Table 4.3.3. I can conclude that the subjects with higher level of overconfidence exert more effort into the project.

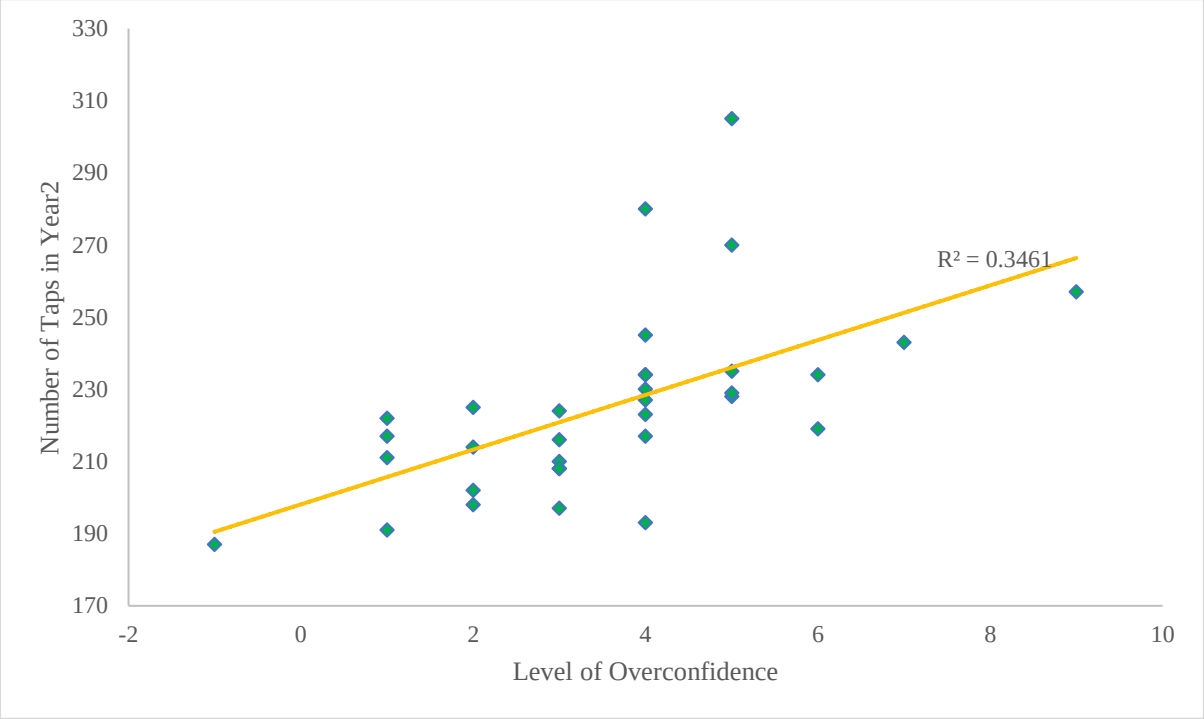
Figure 4.3.3 Relationship of Overconfidence and Number of Taps in Year 1



Note. N=40. The figure shows the scattered plots for participants level of overconfidence and number of taps in year 1. The figure also displays the linear regression between level of overconfidence and number of taps in year 1.

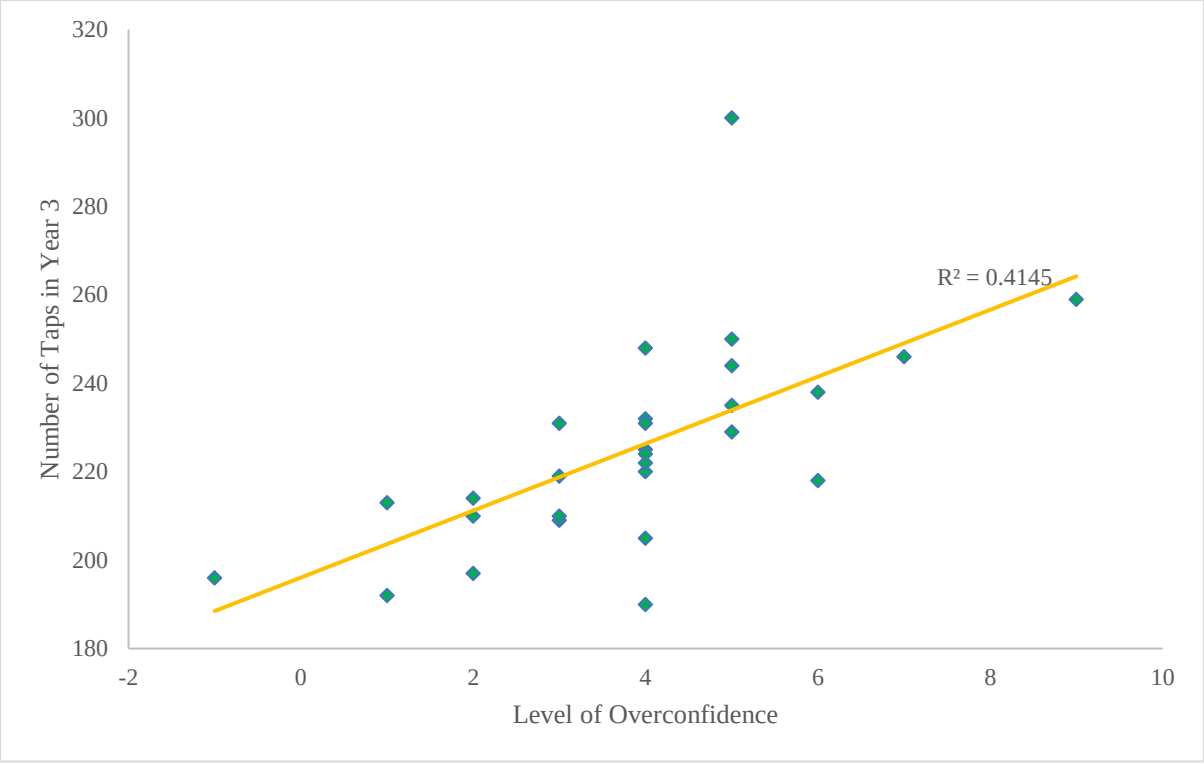
For those who continues the project in the end of year 2, year 3 and year 4, I also observe a positive relationship between the level of overconfidence and number of taps they achieved in the real-effort task. The figures below show the number of taps and the level of overconfidence from the participants who chose to continue the project.

Figure 4.3.4 Relationship of Overconfidence and Number of Taps in Year 2



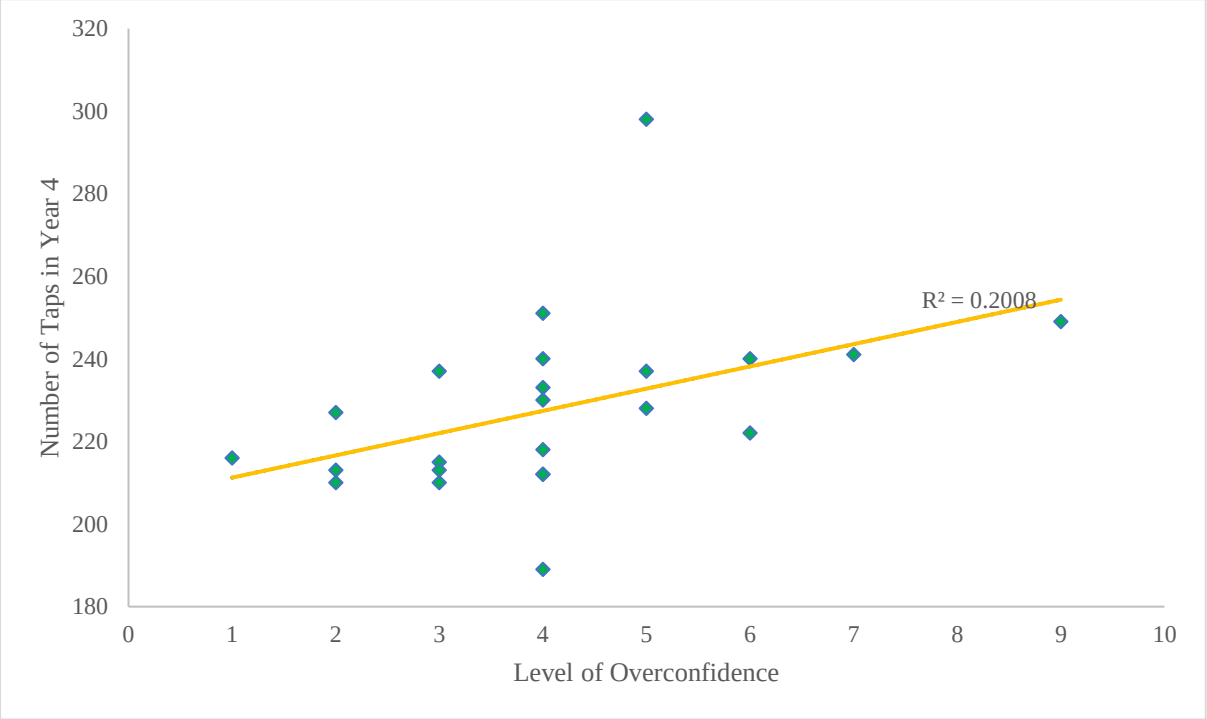
Note. N=33. The figure shows the scattered plots for participants level of overconfidence and number of taps in year 2. The figure also displays the linear regression between level of overconfidence and number of taps in year 2.

Figure 4.3.5 Relationship of Overconfidence and Number of Taps in Year 3



Note. N=30. The figure shows the scattered plots for participants level of overconfidence and number of taps in year 3. The figure also displays the linear regression between level of overconfidence and number of taps in year 3.

Figure 4.3.6 Relationship of Overconfidence and Number of Taps in Year 4



Note. N=25. The figure shows the scattered plots for participants level of overconfidence and number of taps in year 4. The figure also displays the linear regression between level of overconfidence and number of taps in year 4.

The figures demonstrate that the participants who continued the project and performed in the tapping task exerted more effort and achieved higher number of taps if they are more overconfident. The participants' performance in each year respectively displays a linear positive relationship between the level of overconfidence and the effort exerted into the project.

Result 4: The effort exerted in the project increases with the subjects' level of overconfidence. Managers with higher level of overconfidence are inclined to work harder and put more effort into the project than managers with lower level of overconfidence.

I am now looking at the relationship between the level of engagement and the effort exerted into the project. Table 6 lists the distribution and the frequencies of self-reported engagement from the subjects. The self-reported engagement is well spread from 1 to 10 for the three questions. Therefore, I believe that such self-reported engagement is precisely reflecting the subjects' passion and motivation on the project after they are informed of the characteristics of the project. I can rely on these data to analyse the relationship between the level of engagement and the effort.

Table 4.3.5 Frequencies on Self-Reported Engagement Questions

Self-Reported Engagement Distribution

How Passionate			Keen to Make Profit			How Excited		
	Frequency	Percent		Frequency	Percent		Frequency	Percent
1	1	1.4	3	2	2.7	2	3	4.1
2	2	2.7	4	2	2.7	3	4	5.5
3	1	1.4	5	3	4.1	4	6	8.2
4	5	6.8	6	6	8.2	5	7	9.6
5	11	15.1	7	13	17.8	6	13	17.8
6	11	15.1	8	16	21.9	7	17	23.3
7	20	27.4	9	15	20.5	8	12	16.4
8	17	23.3	10	16	21.9	9	8	11.0
9	4	5.5				10	3	4.1
10	1	1.4						
Total	73	100.0	Total	73	100.0	Total	73	100.0

Note. N=73. The table summarizes distributions of participants self-reported engagement from three questions 'How passionate do you think you are to invest in the project?', 'To what extend do you think you are keen to make money from the project?', and 'How excited do you feel if the laptop is about to release?' with a Likert-scale from 1 to 10.

Looking back to table 4.3.4, the correlations between the engagement questions and the effort exerted into the project show that there is no significant relationship between engagement and the effort exerted into the project ('How Passionate' p=0.957, 'How Excited' p=0.887, 'Keen to Make Profit p=0.421). In addition, the relationship between overconfidence and engagement are not significant ('How Passionate' p=0.242, 'How Excited' p=0.128, 'Keen to Make Profit p=0.271). Therefore, in my experiment, I cannot conclude that the subjects' self-reported engagement is positively related with the effort exerted into the project. There is no significant link between the level of overconfidence and the level of engagement. However, I notice that subject's self-reported engagement, passion and excitement are positively correlated with each other (p=0.000 for 'How Excited' and 'How Passionate', p=0.002 for 'How Excited' and 'Keen to Make Profit', p=0.000 for 'How Passionate' and 'Keen to Make Profit'). When the subjects read the information of the project and made the investment decision, the engagement and passion raised from the project are closely related. This implies that the subjects' passion, motivation, and engagement are consistent in the experiment.

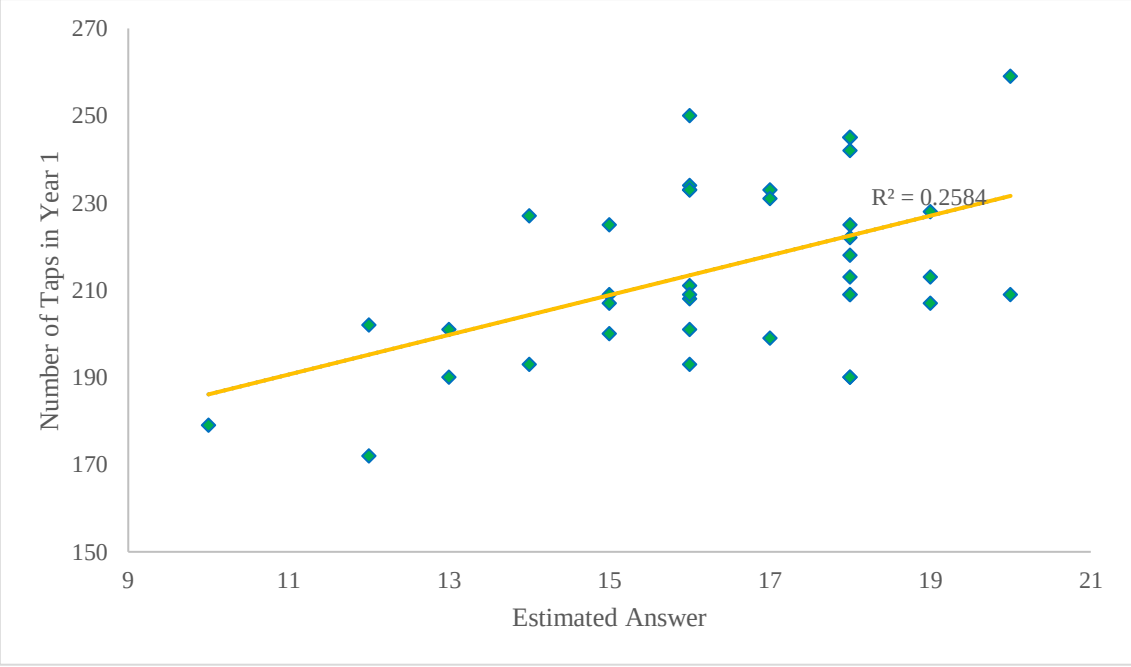
I assume in the theoretical model that engagement contributes to the value of the project in terms of private benefits. Physical effort exerted in the project and private benefits are independent variables affecting the value created from the project. The correlation between the level of overconfidence and engagement are insignificant at 0.05 level. Therefore, the result shows the independence of the variables as stated in the theoretical model.

Result 5: There is no clear relationship between the level of engagement and the effort exerted into the project. The level of overconfidence and the level of engagement is independent in one subject.

4.3.5 Payoff from the Project

From the analysis in the previous section, I find the positive relationship between overconfidence and effort. Based on this finding, I calculate the actual payoff and the perceived payoff for the subjects. In the theoretical model, I argue that for an overconfident manager, he always expects that continuing the project is a better choice for him because his perceived payoff from continuing the project is higher than the payoff from abandoning the project. However, the actual payoff from the project can be observed from outside shareholders who can observe true ability of the manager. At lower level of overconfidence, the continuation of the project will damage the value for shareholders, while at higher level of overconfidence, continuing the project will create value for shareholders. The model argues that the effort the manager exerts into the project and the perceived payoff from the project is only positively related the manager's perceived ability. Figure 4.3.5 below shows the relationship between the estimated answer, representing the perceived ability and the number of taps in the task, representing the level of effort.

Figure 4.3.7 The Relationship of Estimated Answer and Number of Taps in Year 1

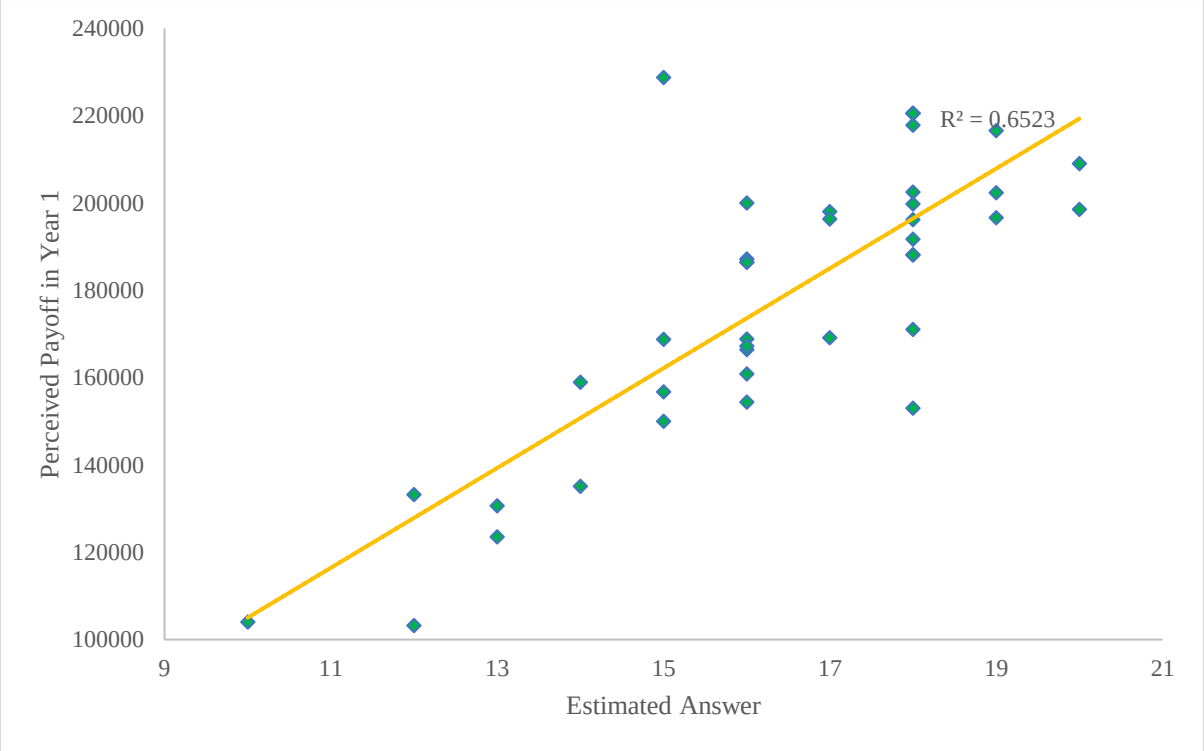


Note. N=40. The figure shows the scattered plots for participants' self-reported estimated number of correct answers and number of taps in year 1. The figure also displays the linear regression between estimated number of correct answers and number of taps in year 1.

The figure illustrates the linear relationship between the estimated answer and the number of taps for the participants, which demonstrates that the participants' effort exerted into the project increases with the participants' perceived ability. The result is consistent with the analysis in the theoretical model.

In the next step I explore how the participants' perceived ability and the actual ability is affected by different levels of overconfidence. I use the estimated correct answers and the effort exerted to calculate the perceived payoff from the project for the managers, noting that for rational manager, as his perceived payoff equals his actual payoff, the rational manager's perceived payoff and actual payoff are identical. As the shareholders observe the manager's true ability, I use the actual correct answers and the effort exerted to calculate the shareholders' value.

Figure 4.3.8 The relationship of Estimated Answer and Perceived Payoff



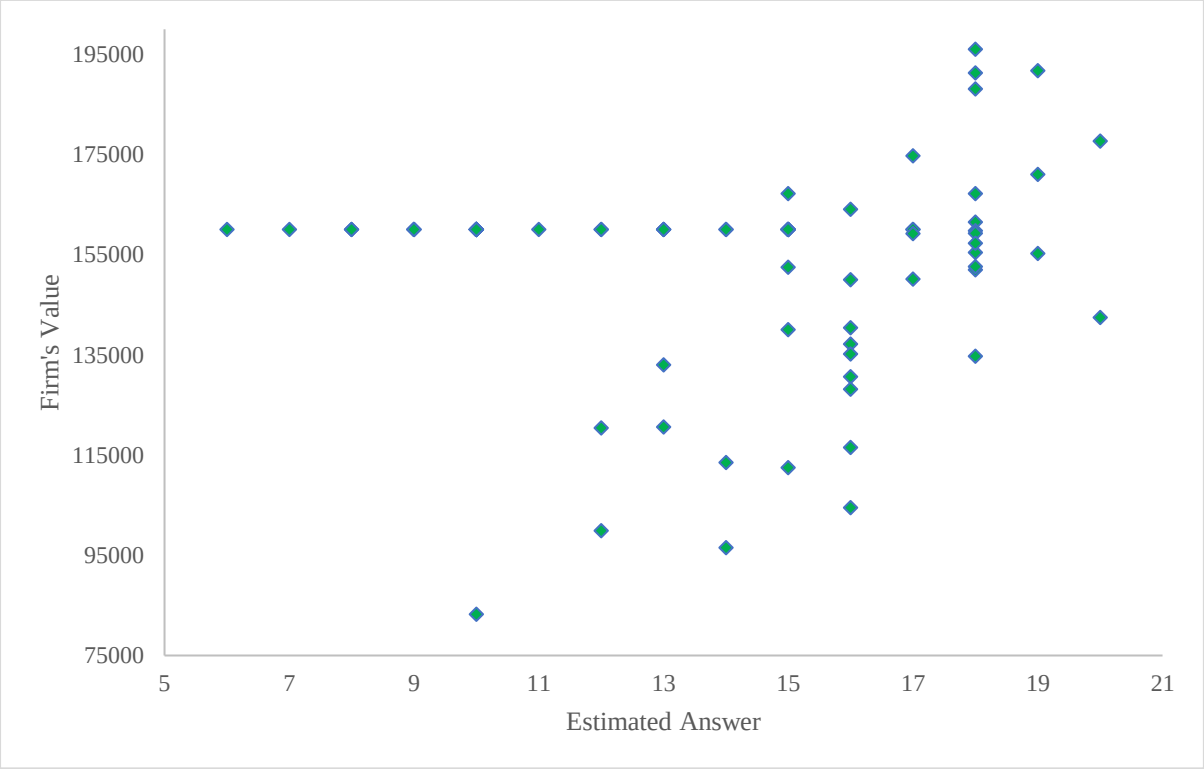
Note. N=40. The figure shows the scattered plots for participants' self-reported estimated number of correct answers and the participants perceived payoff from the project in year 1. The figure also displays the linear regression between estimated number of correct answers and perceived payoff in year 1.

Figure 4.3.6 displays a positive relationship between the subjects' estimated ability and their perceived payoff from the project. This is consistent with my model that an overconfident manager claims that continuing the project his payoff from the project. He overestimates his ability and, consequently, expects a higher marginal productivity of himself. Therefore, he works harder and exerts more effort into the project. As more effort has been put into the project,

he is expecting a larger payoff from the project, and therefore, willing to continue a failed project which should have been abandoned. The overconfident manager believes that he always makes the best decision even though shareholders who observe the manager's true ability think that the overconfident manager continues the project and damages the value for shareholders. This happens at lower level of overconfidence because in maximizes spite of excessive effort put into the project, the overconfident manager's true ability is not high enough to produce higher payoff than the redemption from abandoning the project. In other words, al lower level of overconfidence, the manager is not capable to produce adequate payoff to meet shareholders' expectations is he choose to continue the project.

In figure 4.3.6 I show that the with the enhance of perceived ability and level of overconfidence, the subjects' perceived payoff is increasing. It demonstrates the assumption that the overconfident manager overestimates his ability, works harder, and boosts the payoff from the project. Why shareholders think that overconfident managers make a mistake on continuing the project? The answer is shown in figure 4.3.7.

Figure 4.3.9 Relationship of Estimated Answer and Firm's Value



Note. N=73. The figure shows the scattered plots for participants' self-reported estimated number of correct answers and the actual firm's value for the shareholders from the project in year 1.

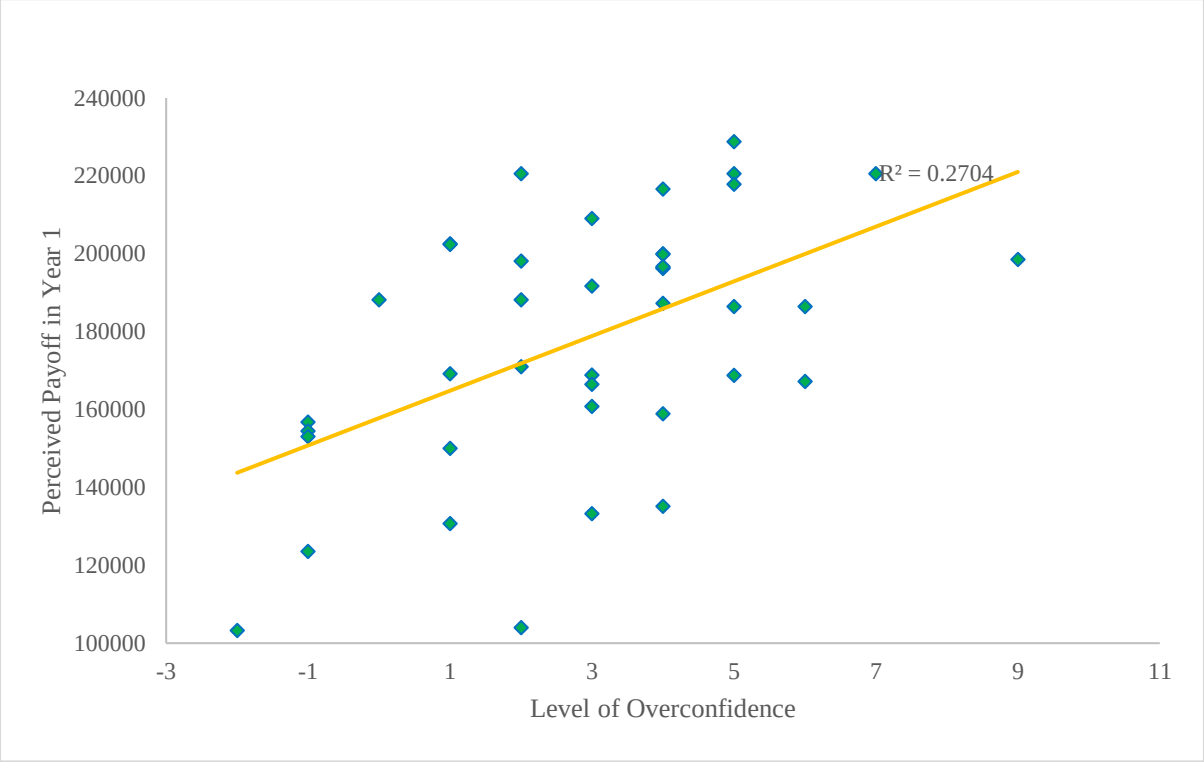
Figure 4.3.7 shows the actual payoff for shareholders in the experiment. I compare the actual value from continuing the project and the liquidation value from abandoning the project. On

the left, I notice that the actual payoff remains a constant which indicates when the manager is rational or underconfident, he chooses to abandon the project. On the right half of the figure, the payoff for shareholders goes upwards with the increase of estimated answer. The result is consistent with my model that with higher perceived ability, the manager exerts more effort into the project and the payoff from the project increases.

Between left and right, I observe a decrease in the value when the subjects' decisions changes from abandonment to continuation. This demonstrates my analysis in the theoretical model. I argue that rational managers tend to abandon the project because they observe their true ability. Rational managers believe that abandoning the project maximizes their payoff from the project since continuing exerting effort into the project will not produce higher payoff for them. Nevertheless, expected payoff from overconfident managers is higher than what the shareholders observe from the overconfident managers. In overconfident managers' view, the payoff from continuing the project is higher than the redemption from abandoning the project, so they continue the project. Meanwhile, in shareholders' point, the overconfident manager is not as capable as he believes in himself. Continuing the project will damage the value for the shareholders. Therefore, the actual payoff for shareholders suffers a sudden decrease when the overconfident manager chooses to continue the project as shown in figure 4.3.7. With the increased level of overconfidence, the manager put excessive effort into the project, which is high enough to generate an outstanding payoff for shareholders to agree on the continuation of the project.

I then change the independent variable 'Estimated Answer' with 'Overconfidence'. Figure 4.3.8 shows the relationship between the level of overconfidence of the participants and their perceived payoff from the project.

Figure 4.3.10 The Relationship of Overconfidence and Perceived Payoff



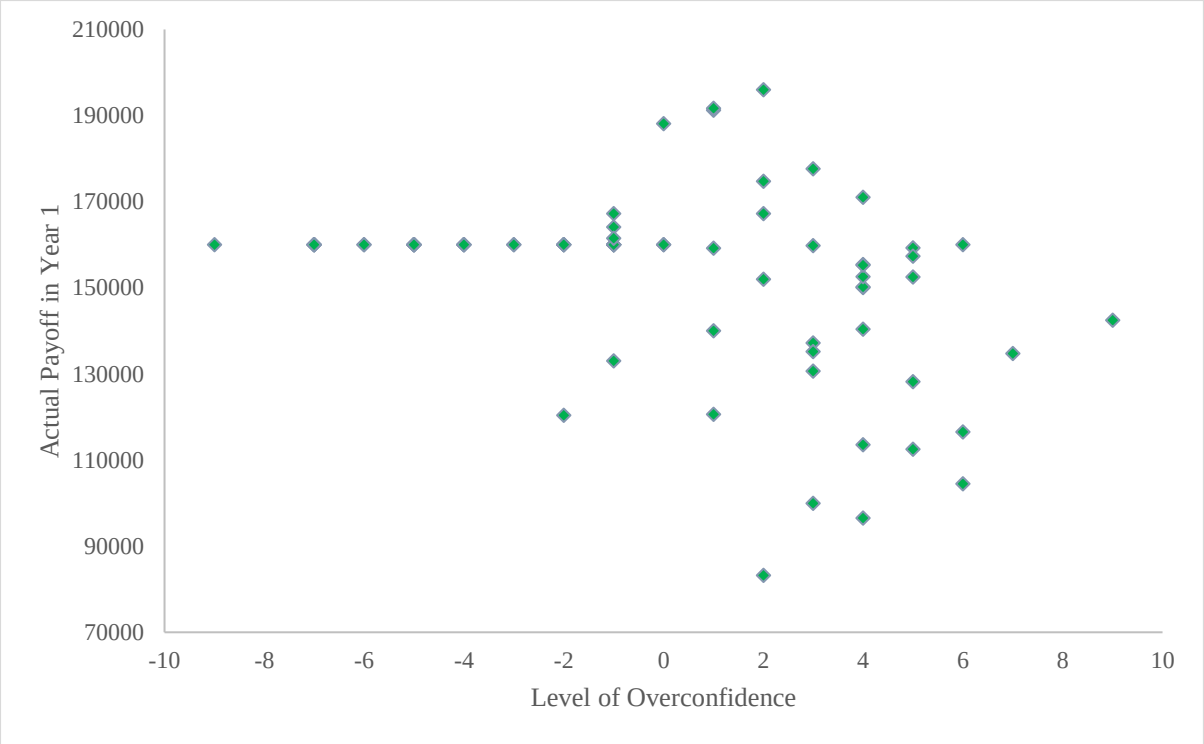
Note. N=73. The figure shows the scattered plots for participants' level of overconfidence and their perceived payoff from the project in year 1. The figure also displays the linear regression between the levels of overconfidence and perceived payoff in year 1.

From figure 4.3.8, I observe a positive relationship between the subjects' levels of overconfidence and their perceived payoff. The result indicates that with higher level of overconfidence, the subjects prefer continuing the project, increasing their effort exerted into the project, thus increasing perceived payoff from the project. Note that there is perceived payoff 0 from continuing the project which indicates that the subject chooses to abandon the project. This demonstrates the fact in the theoretical model that the manager's perceived payoff is related with their perceived ability and the level of overconfidence.

The figure 4.3.9 below displays the subjects' levels of overconfidence and the subjects' actual payoff from the project. In figure 4.3.9, I only notice that when subjects are rational and underconfident, they choose to abandon the project and received liquidation value A, which appears a parallel line with x-axis. When the subjects choose to continue the project at higher level of overconfidence, there is not a clear relationship between the actual payoff from the project and the level of overconfidence. This is because that in my theoretical model, I assume that the true ability for an overconfident manager is known to us and is a constant. In the numerical example for the theoretical model, I analyse the cases where the true ability of an

overconfident manager varies. The diagram in the numerical example shows a cluster of lines representing the managers' actual payoffs with different true abilities. Each manager with a different true ability, the actual payoff from the project differs in the diagram. Therefore, as has been indicated my findings in the numerical example, figure 4.3.9 only shows the actual payoff from abandoning the project. When considering the actual payoff for managers from the project, I cannot observe a significant relationship because the true ability from each subject is different.

Figure 4.3.11 The Relationship of Overconfidence and Actual payoff



Note. N=73. The figure shows the scattered plots for participants' level of overconfidence and the actual firm's value for the shareholders from the project in year 1.

Result 5: When making 'continue' or 'abandon' decisions on a failed project, the effect of overconfidence on the payoff are different given different levels of overconfidence. 1) Rational managers are inclined to abandon the failed project; 2) At lower level of overconfidence, overconfident manager continues the project which deteriorates the payoff from the project for shareholders; 3) At higher level of overconfidence, continuing the project will create more value for the shareholders.

In the analysis above, I demonstrate the relationship between overconfidence and the continuation decisions for managers. I manage to show that overconfident managers and rational managers take different actions on a failed project. Rational managers are more willing

to abandon the project, while overconfident managers tend to continue the project. The more overconfident the manager is, the longer he chooses to continue the project. The managers put more effort and work harder in the project with the increasing level of overconfidence. In addition, overconfidence has two-sided effects on the payoff from the project. Managers with lower level of overconfidence damages the shareholders' value from the project. Meanwhile, managers with higher level of overconfidence create excessive value from the project for shareholders.

4.4 Discussion

In this chapter, I implement an online behavioural finance experiment to explore how the level of overconfidence and engagement affects the manager's decision on whether to continue or abandon the project. Based on the theoretical model, I design the structure of the experiment. Theoretically, I assume that the perceived payoff of the overconfident manager is related with the manager's physical effort e exerted into the project, the engagement and motivation b for the project and the level of overconfidence $\hat{\gamma}_e$. The perceived payoff from the project is given by $\Pi_m = \hat{\gamma}_e e(sR + b) - \theta e^2$. The overconfident manager makes investment decision by comparing his perceived payoff from the project and the liquidation value from abandoning the project. Meanwhile, the shareholders can observe the manager's true ability γ_e and estimate their payoff from the project $V = (1 - s)\gamma_e e\, R$. I find that the overconfident manager's and the shareholders' preference on continuation or abandonment changes with the level of overconfidence. There is a tipping point for the overconfident manager and the shareholders respectively where he/they switch from abandoning to continuing the project. As the manager overestimates his true ability and the shareholders observe the true ability, the critical level of overconfident at the tipping point are different for the manager and the shareholders. As a result, the overconfident manager and the shareholders may make opposite decisions under certain level of overconfidence. I find that the overconfidence has both positive and negative effect on the firm's value. On one hand, lower level of overconfidence causes moral hazard problems in terms of inefficient value-destroying project continuation. The overconfident manager perceives that his payoff from the project is higher than the liquidation value, so he decides to continue the project. However, the shareholders who know the manager's true ability prefer abandoning the project. Meanwhile, the shareholders do not make decision on the project, so the overconfident manager's continuing the project will damage the firm's value, which indicates the negative effect of overconfidence and project entrapment. On the other hand, higher level of overconfidence can create more value for the firm in terms of higher effort level

on the project continuation. If level of overconfidence and level of effort is high enough, the overconfident manager and the shareholders both agree to continue the project.

My experiment stands on the analysis and results from Pikulina et al (2014) who implemented a behavioural experiment on overconfidence and investment of the investors. In their experiment, they designed a financial knowledge questions task to capture the level of overconfidence. They designed a real effort task in which they asked the participants to code and group a series of numbers to demonstrate the positive relationship between the effect of confidence, effort, and investment from investors. Pikulina found that different level of confidence including overconfidence and underconfidence had ambiguous effect on investment decisions. My experiment extends Pikulina et al's paper by including the effect of overconfidence and engagement on corporate investment decisions. In my experiment, I adopt same approach in which I ask the participants to answer general knowledge questions and estimate the number of correct answers. I obtain the participants' perceived ability and actual ability from the general knowledge question task. Treating the actual correct answers as the true ability and the estimated correct answers as the perceived ability, it is more convenient for me to use the true ability and the perceived ability to calculate the payoff from the project in the later section.

I find in the experiment that nearly half of the participants are overconfident, and the rest are rational and underconfident. It can also be found that the true abilities are ranging from 6 to 19, which shows a large variety of participants in the experiment. In the theoretical model, I find that the manager's perceived payoff is independent of the manager's true ability. Recall that the optimal payoff from the project is $\Pi_m^* = \frac{\hat{\gamma_e}^2 (sR+b)^2}{4\theta}$, the overconfident manager will make his decision based on his perceived payoff from the project, which is only related with his true ability. I calculate the manager's perceived payoff using his perceived ability and his effort exerted I obtain from the real effort task. I calculate the participants' perceived ability and find their decisions in the experiment. Therefore, the perceived ability and payoff is consistent with theoretical setup in the model.

The manager's true ability affects the shareholder's equilibrium firm's value from the project. The shareholders know the manager's true ability and their equilibrium firm's value is $V^* = \frac{(1-s)\gamma_e \hat{\gamma_e}(sR+b)R}{2\theta}$, which is calculated from the manager's true ability and perceived ability. In the model when I assume that the true ability for the managers is constant, I can find that the firm's value is damaged at lower level of overconfidence. What is difference between the

theoretical model and the experiment is that the true ability is assumed to be a constant in the model but in the experiment the true ability is various among the participants. In the numerical example in Chapter 3, I analyse the firm's value on different true abilities. The tipping point for the overconfident manager remains unchanged, which is reflected in figure 2. The manager with different true ability may have different level of overconfidence at the tipping point. I can observe a positive relationship between the manager's perceived ability and his estimated payoff, but there is no clear relationship between the perceived ability and the shareholder's firm's value as shown in figure 4.3.8 and figure 4.3.9. This is because what I illustrate in figure 4.3.9 is similar to the numerical example in Chapter 3 where I assume different true abilities. It has been argued that with lower level of true ability, the firm's value will be decreased more as the manager choose to continue the project. In Chapter 3, the firm's value is illustrated by a series of parallel curves each represented a level of true ability, and the only difference is the damaged value from the overconfident manager's continuing the project. Therefore, in the result of the experiment, the relationship between the firm's value and the perceived ability is not clear as the participants' true ability is widespread.

In the experiment, I find not only rational and overconfident participants, but also underconfident participants. In the model, I don't consider the case of an underconfident manager, but following the same analysis, I can outline the underconfident manager's decision. According to Pikulina et al (2014), they discovered that underconfident investors and managers tend to provide inadequate effort. Their experiment revealed that underconfidence resulted in underinvestment. The underconfident managers decreased their effort despite that the project was still beneficial to them. I also observe the same results in my experiment when observing the underconfident participants' decisions. The underconfident subjects underestimate their ability, so they perceive a lower marginal productivity and exert less effort into the project. Consequently, they are more conservative and abandon the project earlier than the rational and overconfident managers. In the experiment, I can see that the underconfident subjects will be located on the area where the subjects choose to abandon the project and receive the liquidation value. Including the underconfident manager will not affect my analysis on the effect of overconfidence on the subjects' decision.

Another important factor I consider in the experiment is engagement. I believe that the manager's engagement on the project includes their passion and motivation on the project. If the manager feels more engaged and passionate for the project, he could be reluctant to abandon a project. A manager who has been working for the project since the beginning and has been very dedicated to the project will have private benefit on the project. Therefore, to obtain the

level of engagement from the participants, I design a project which includes four potential products. When the participants read the detailed information on the project, they raise passion and motivation on the project they choose to investment. Then I ask the participants to report their level of engagement. I believe that unlike physical effort and overconfidence, the subjects who experience the investment procedure will precisely show express their engagement and passion on the project.

To observe the subject's effort into the project, I design a real effort task for the participants to complete and treat their performance in the task as the physical effort exerted into the project. As the participants true ability is not constant, in the experiment, I explore the relationship between the level of overconfidence and effort exerted into the project. By solving the correlation between the overconfidence and total number of taps, I find that the subjects with higher level of overconfidence are significantly achieve more taps in the real effort task. Then, I conclude that there is a positive relationship between the subject's level of overconfidence and the real effort exerted into the project, which demonstrates the hypothesis 3. I also find in the experiment that the overconfident manager's continuing the project will damage the firm's value at lower level of overconfidence, but it will add value to the firm when the level of overconfidence is high. The result replicates Pikulina et al's argument that the higher level of overconfidence, the more effort the manager tends to exert in investment. They believe that moderate level of overconfidence leads to accurate decisions. However, underconfidence triggers underinvestment, and excessive level of overconfidence leads to overinvestment and poor decision making. Interestingly, my experiment in project termination decision found opposite result, regarding to different level of overconfidence. I find in the experiment that moderate level of overconfidence leads to poor decision on continuing the project which destroys firm's value for the shareholders, but higher level of overconfidence increases the manager's perceived payoff and the firm's value for shareholders in terms of excessive effort exerted. My experiment distinguishes from Pikulina's research in the way that I focused on one specific investment decision: project continuation or abandonment decision. Consistent with their findings on positive relationship between level of overconfidence and effort in investment, the experiment shows both positive and negative effect of overconfidence on firm's value. Additionally, as has been stated in the model, my experiment demonstrates that the manager's effort and perceived payoff is positively related with the manager's perceived ability. The experiment reveals a strong positive linear relationship between the manager's perceived ability, the effort exerted and the perceived payoff from the project. The ambiguous effect of

overconfidence is related with the manager's true ability as the firm's value for the shareholders depends on both the perceived ability and the true ability for the managers.

Lastly, I test one hypothesis that the more overconfident the subject is, the longer he will continue the project. This assumption is not included in the model as the model is more focused on the interaction between the manager and the shareholders. In the pilot study, I did a survey among the participants as to how long they would continue a failed project and asked them their self-reported overconfidence. I found that the participants who claimed that they were more overconfident chose to continue the project longer than those who were less overconfident, rational or underconfident. Therefore, in the experiment, the participants are asked whether they would like to continue the project for 4 times. The participants shall continue the project and complete the task when they choose to continue, and the experiment ends whenever the participants decide to abandon the project. Since the participants experience the investment procedure and make their choice under such environment, the data shows that the participants with higher level of overconfident tend to continue the project longer. This brings me to the potential research direction to explore why overconfidence leads to longer project entrapment.

To summarize, I manage to implement a behavioural finance experiment to demonstrate my hypotheses in the model. I find a positive relationship between the manager's level of overconfidence and the effort exerted in the project. Meanwhile, I did not find any significant correlation between the level of engagement and the effort. I find the evidence on both positive and negative effect of overconfidence on the shareholder firm's value. Additionally, I also observe that higher level of overconfidence causes longer project entrapment for the managers.

4.5 Conclusion

In this chapter, I introduce the design and the findings from my behavioural finance experiment based on the game theoretical model in Chapter 3. I build my experiment on the hypothesis that the subject's level of overconfidence and engagement affects the subject's decision on continuing or abandoning the project. In the experiment, I demonstrate the positive a positive relationship between the manager's level of overconfidence and the effort exerted into the project. I also show both positive and negative effect of overconfidence on the managers decision. The rational and underconfident subjects and slightly overconfident subject are inclined to abandoning the project. The subjects with higher level of overconfidence are mostly continuing the project. At medium level of overconfidence, the subject's decision on continuing the project damages the firm's value for the shareholders. The results are consistent

with the proposition in the game theoretical model that lower level of overconfidence have a negative effect on the firm's value and higher level of overconfidence have a positive effect on the firm's value.

As for the level of engagement and passion, I do not find a significant relationship between the effort exerted and the subject's self-reported engagement. Nor do I observe the relationship between the subject's level of overconfidence and the level of engagement. The subjects' level of overconfidence is independent with the level of engagement and passion. Therefore, I cannot decide whether there is any link between the engagement and the manager's decision.

As the experiment demonstrates the effect of overconfidence on a project manager's decision, I start wondering what if there is overconfident manager in a team who is responsible to make investment decisions and how overconfidence can affect the team's decision. Considering that modern corporate investment decisions are increasingly made by a project management team; it is worth investigating the effect of both overconfidence and team's reciprocity on team's decision. In chapter 5 and chapter 6, I extend my theoretical and empirical research from an individual's view to a team's perspective.

Chapter 5: Game Theoretical Model: Investment Decision and Teamwork

5.1 Teamwork in Corporate Finance Decisions

In the previous chapters, I introduce the game theoretical model of one overconfident manager and the shareholders' engagement on the project manager's investment decision. The model shows both positive and negative effect of overconfidence on the manager's decision on the project. In real world, many work outputs are not assigned to an individual but a group of people or a team (Mohnen et al, 2008). In modern organizations, teams are central decision makers and plays a crucial part in creating economic wealth (Hollenbeck et al, 2012). Therefore, in this chapter, I extend my research from an individual decision making to a team's decision making.

Recent studies in teamwork find that individuals in the team not only care about their own payoff but also pay attention to their teammate's welfare. When there are more than one people in the team, inequity between the team members can appear inevitably. Researchers argue that self-interest and inequity aversion can alleviate free-rider problem. Every self-interested member's exerting efficient effort discourages any selfish team member who wants to shirk, because the team's output will be damaged and reduced lower than equilibrium output which satisfies all team members (Mohnen, 2008; Li, 2009).

Diversity in team members can also bring coordination and conflicts in the team, which may affect the team's decision and output. Corporate behavioural finance researchers incorporate overconfidence and team's interaction to analyse how team's performance can be influenced by the team members reciprocity. Gervais and Goldstein (2003) identify that overconfidence affects the team's performance by increasing the effort exerted into the project for both the manager himself and his teammates. Since the overconfident manager works harder, he can increase the team's marginal productivity, which in turn encourages the other teammates to exert more effort. Building on Gervais and Goldstein's model, Fairchild (2011) argues in a teamwork game theoretical model that overconfidence has positive effect on the team's performance to produce higher monetary outcomes. Following this study, he also finds both positive and negative effect of reciprocity on team's performance and firm's value in terms of project choice. A positive reciprocity in the team increases the firm's value in project investment, while a conflict and retaliation in the team will damage the firm's value.

Inspired by previous research on teamwork and team's decision, I develop a teamwork game theoretical model to analyse the effect of overconfidence and reciprocity on team's decision and firm's value. As an additional manager is added to the team, the level of confidence of the managers in the team and the team members' interaction are included in the model. The model begins with a discussion on the effect of overconfidence on team members' decision on continuing or abandoning the project, and possible interactions within the team of a rational manager and an overconfident manager. The model demonstrates that at lower level of overconfidence, the overconfident manager and the rational manager both agree to abandon the project, and at higher level of overconfidence, the overconfident manager and the rational manager both agree to continue the project. However, medium level of overconfidence triggers disagreement and conflicts in the team, which creates a moral hazard problem between the overconfident manager and the rational manager.

Scholars has increasingly investigated the effect of fairness, inequity, and reciprocity in teamwork and team's decision in terms of inequity aversion (for example, Rey-Biel, 2008; Mohnen et al, 2008; Wei, 2009; Li, 2009; Fairchild, 2012; Mohammed and Harrison, 2013; Gill and Stone, 2015; Baker and Zaby, 2019). Hart and Moore (2008) introduced a fairness contract where two members in the team negotiate and reach a 'reference point' favourable to both team members. An unexpected alternative project, which is only preferable to one team member, appears and causes conflicts in the team. Fairchild (2012) extended the model and the conflicts in the team by considering the conflicts of committing to the existing project for one teammate and switching to the alternative project by another. The author also defines that one team member's course of action violating the fair entitlement between the team members leads to 'souring relationship' in the team. Accordingly, inspired by his work on team's reciprocity, I apply coordination and conflicts to project continuation or abandonment decisions in a team. By analysing the effect of overconfidence on team member's decision, I also find that team members may have contradicted decisions on a project. When the one team member prefers continuing the project and the other abandoning the project, the domination of one team member over the other would create a 'souring relationship' in which the fairness is broken, and inequity appears. My game theoretical model o extends the analysis of team's negative reciprocity and 'souring relationship' on level of overconfidence, teamwork, and project entrapment.

Behavioural Economics researchers have argued that negative reciprocity is closely related with retaliation behaviour (Fehr and Gächter, 2000; Fon and Parisi, 2005; Asher et al, 2012).

Fehr and Gächter (2000) argue that if subjects expect a negative reciprocity and a hostile act, they can punish others by reducing the income of other subjects in the group. The authors believe that such behaviour is derived from the fact that subjects in the group are self-interested. Subjects who suffer from negative reciprocity and conflicts are willing to pay a price and use costly punishment to punish those who are acting against their interests and benefits. Fon and Parisi (2005) argue that 'an eye for an eye, a tooth for a tooth' is the most famous illustration for negative reciprocity and retaliation. To extend this into behaviour in economics, the authors show that retaliatory behaviour are triggered when individuals are interacting with each other. Harm suffered from the others' actions motivates and justifies a retaliatory response and punishment from the individual. Using an economic approach, the authors demonstrate that even though retaliation brings no monetary benefits and may be costly, Fairchild (2012) explains retaliation in terms of psychic benefits (for example, feeling frustrated, upset or even spiteful towards others in the team). Based on previous research on team's negative reciprocity, in my game theoretical, I also consider team's conflicts and the team members' retaliatory behaviour. Specifically, in a team of an overconfident manager and a rational manager, the rational manager's retaliation is triggered when the overconfident manager continues the project and damages the rational manager's payoff. As has been discussed above, even though it might be costly, the self-interested rational manager is motivated to punish the overconfident manager in terms of reducing the payoff from the project as a revenge or retaliatory response.

As team members with different confidence levels may change the team's decision and the outcome of the project, further extension on the model considers the effect of the team's composition on team's continuation or abandonment decisions on a project with uncertainty. The model considers the three team structures including a team of two rational managers, a team of one rational manager and an overconfident manager, and a team of two overconfident managers. The shareholders who want to maximize firm's value must estimate ex-ante payoff from the project and make trade of between avoid damaging firm's value from a bad project and achieving higher firm's value from a good project. The model argue that the shareholders' recruitment strategy and the optimal team composition depends on the uncertainty of the project. If the probability of a bad project is high, the shareholders best choice is to recruit a team of two rational managers. With a medium probability of good or bad project, the shareholders prefer a team of one rational manager and one overconfident manager. If the project is highly likely to be a good project, the shareholders will recruit a team of two overconfident managers.

The implications from the argument of team's interaction and the shareholders' recruitment decision are potential guidance for the companies in the real world in terms of selecting an optimal project management team. When considering maximizing firm's value from project investment, the shareholders should consider pros and cons of recruiting rational managers or overconfident managers and form a team with members that can create best output from the project.

5.2 Development of the Model

5.2.1 0Background Information and Model Assumptions

5.2.1.1 Players in the Game Theoretical Model

In the teamwork theoretical model, I assume that there are two players in the model, which include a project management team and a board of shareholders. There are two managers in the team, an overconfident manager, and a rational manager. The managers are risk-neutral self-interested managers who are trying to maximize their payoff from the project. The overconfident manager believes that his ability is higher than others, so his perceived ability is higher than his true ability. Meanwhile, the rational manager is aware of his true ability and he knows that his fellow colleague is overconfident. I also assume that the managers know each other's true ability. The overconfident manager and the rational manager shall work together as a team to make project investment decisions for the firm. The overconfident manager and the rational manager will estimate their payoff from the project and exert effort into the project to achieve an optimal payoff from the project individually. The team's effort will determine the totally payoff from the project. Additionally, if the team deicides to continue the project, the overconfident manager and the rational will exert effort into the project and work for the project together. If the team decides to abandon the project, the team will liquidate the project and redeem a residual value from the project.

The shareholders are also aiming to maximize the firm's value from the project. They recruit the team to make investment decisions on the project. The shareholders, as has been assumed in the model with one manager, will not directly work for the project, but they can estimate the optimal firm's value from the project. The shareholders can observe the overconfident manager's and the rational manager's true ability.

5.2.1.2 Background: Teamwork and Project Investment

In the original teamwork model, I remain the assumption that the team is running a project for the firm. Instead of one manager, I now have a team of two managers who will work together

for the firm and make continuation or abandonment decision on the project. The overconfident manager and the rational manager simultaneously exert effort into the project and expect a payoff from the project. The managers in the team and the shareholder are all focusing on maximizing the benefits from the project. The overconfident manager overestimates his true ability and perceives a higher payoff from the project while the rational manager knows his true ability and anticipates his true payoff from the project. In addition, either the overconfident manager or the rational manager knows the other manager's true ability, and the rational managers recognizes that his teammate is overconfident. The shareholders can observe the managers' true abilities.

What is different in the teamwork theoretical model is that the overconfident manager and the rational manager will exert effort and make the decision together. I will focus on the integrated effort from the team and the interaction between the team members. From the analysis from the model of one manager, I argue that the overconfident manager is more willing to continue a project than a rational manager under the same condition. Depending on the level of overconfidence, the overconfident manager may make different decisions on the project. It is reasonable to believe that the overconfident manager and the rational manager might have the same opinions towards the project, which creates a harmony relationship within the team. Meanwhile, the overconfident manager and the rational manager might have different decision on the project, specifically, that the overconfident manager wants to continue the project, but the rational manager intends to abandon the project, which causing a 'souring' relationship within the team.

Based on the analysis above, I therefore argue in the model that the team's decision depends on the overconfident manager's perceived ability and the interaction between the team members. I assume that at lower level of overconfident, the overconfident manager and the rational manager both agree to abandon the project, and the team will abandon the project. At a medium level of overconfident, the overconfident manager intends to continue the project, but the rational manager is inclined to abandoning the project which causes conflicting decisions on the project. I assume in that when the overconfident manager and the rational manager have disagreement, the overconfident manager dominates and forces the team to continue the project. At last, at a higher level of overconfident, the overconfident manager and the rational manager both agree to continue the project. The team's decision on whether to continue or abandon the project is influence by the level of overconfidence and the team's harmonious or conflicting relationship. IN the following sections, I will establish the timeline

of the model and calculate the perceived payoff from the team. I will investigate the effect of overconfidence and the interaction between the overconfident manager and the rational manager.

5.2.2 Model Timeline

According to the assumption, I start the model with the situation that the team invests in the project which is believed to add value to the firm. Then the project fails, and the team needs to decide whether to continue or abandon the project. The overconfident manager and the rational manager each estimate their payoff from the project and decides whether to continue or abandon the project. If the team continues the project, the managers will exert effort into the project and receive payoff from the project. If the team abandons the project, the project will be liquidated, and the team will claim a redemption value from the project. I develop the timeline of the model in the following way.

Time t_0: Background Setup

At time t_0, a team of an overconfident manager and a rational manager is considering investing in a project to increase firms' value. The managers estimate a positive NPV from the project, so they invest in the project. Both managers have already agreed on an ex-ante equity stake of $\frac{1}{2}$, which means that when the project's payoff is realized, they will be paid half of the total payoff from the project. If the project succeeds, it will provide an income of $R(R > 0)$ while if the project fails it will provide nothing. The performance of the project depends on the manager's effort in the project.

Time t_1: Project Failure

At time t_1, Unexpectedly, the project becomes a failure and no longer profitable for the firm. As I assume before that the project is risky, the project is unsuccessful because of the change of economics environment, the introduction of competitive substitutes, and other reasons. I do not consider what specific reasons cause the project's failure, but I am focusing on decisions from the team. After the project fails, managers now need to decide whether to continue or abandon the project.

Time t_2: Overconfidence Raised and Payoff Perceived

At time t_2, the managers will estimate their payoff from the project individually. To make it simple, I assume that the overconfident manager and the rational manager has the same

observable true ability γ_e. For the overconfident manage, he raises a level of overconfidence, and he perceives that he has an ability level of $\hat{\gamma_e}$ ($\hat{\gamma_e} > \gamma_e$ for overconfidence). In addition, he observes that his colleague, the rational manager has a true ability of γ_e. For the rational manager, he knows that his own ability and the overconfident manager's true ability are γ_e. Both the overconfident manager and the rational manager will estimate their payoff from the project. They are expecting to exert e_i $(i = 1,2)$ into the project. Here, I note that 1 stands for the overconfident manager and 2 for the rational manager.

Time t_3: Decision Made and Interaction

At time t_3, the overconfident manager and the rational manager exchange their preference on whether to continue or abandon the project. If both managers agree to abandon the project, they will abandon the project. If both managers agree to continue the project, they will start exerting effort and work for the project. If the overconfident manager chooses to continue the project but the rational manager abandons the project, the overconfident manager forces the team to continue the project. When the managers have conflicting ideas and the overconfident manager forces team to continue the project, the rational manager is angry and disappointed from this decision. Therefore, he takes retaliation action and deteriorates the situation with his attitudes and revenge on overconfident manager's decision. The effective of retaliation is given by λ and $\lambda \in [0,1]$. If the retaliation action is effective, λ is closer to 1, resulting in the payoff from the project decreased to $\frac{R}{2}(1-\lambda)$. Then the managers again take the optimal actions that maximize their payoffs from the project.

Time t_4: Effort Exerted or Liquidating the project

At time t_4, the team has already made the decision. If the team abandons the project, the project will be terminated and liquidated. The team will receive the corresponding payoff from liquidating the project. If the team chooses to continue the project, the overconfident manager and the rational manager will exert effort into the project respectively. The managers will choose optimal levels of effort to work for the project and maximize their payoff from the project.

Time 5: Payoff Realized

At the final stage of the game, the payoff from the project is achieved. The overconfident manager and the rational manager will receive their payoffs from the project. The game shall end after this stage.

In the next section, I will establish the teamwork game theoretical model following the timeline above. Firstly, I find out the perceived payoff for the overconfident manager and the actual payoff for the rational manager. Secondly, I solve the managers' optimal level of effort and the managers' optimal payoff from the project. Thirdly, I consider the critical value of overconfidence and the managers' decisions under different level of overconfidence. Lastly, I include the interaction between the overconfident manager and the rational manager and analyse how the decisions may change with the team's 'souring' relationship.

5.2.3 Payoff from the Project

According to the assumption in the model, I suppose that the team is investing in a project which has a positive NPV. The team expects that the project is profitable for the company. The team consists of an overconfident manager and a rational manager. I note that in the rest of the chapter, manager 1 stands for the overconfident manager and manager 2 stands for the rational manager. The overconfident manager and the rational manager work together, exert effort in the project, and receive payoff respectively from the project. Both managers seek to maximize their payoff from the project. The manager has a true ability $\gamma_i (i = 1,2)$ where γ_1 is the true ability for the overconfident manager and γ_2 the true ability for the rational manager. In addition, the overconfident manager's perceived ability is $\hat{\gamma_1}$ where $\hat{\gamma_1} > \gamma_1$ represents overconfidence. The manager will exert a level of effort e_i into the project if the project is continued, and the cost of effort for the manager is β_i.

5.2.3.1 How Payoff is modelled

Similar with the model with one manager, I assume that the team of an overconfident manager and a rational manager will work for the project simultaneously. Originally, the project will provide a payoff of R to the team. If the team continue the project, they will exert effort into the project, which creates a payoff multiplier and increase the payoff from the project. If they decide to abandon the project, they will receive a payoff of A from the project. Additionally, by exerting effort into the project, there occurs a cost when estimating the payoff from the project for the manager.

The team's total payoff from the project depends on both the overconfident manager and the rational manager's effort exerted. Therefore, if the team chooses to continue the project, the team will increase the payoff from the project by a payoff multiplier $(\gamma_1 e_1 + \gamma_2 e_2)$ as both managers exert effort and work hard for the project. For the overconfident manager, as he perceives that his ability is

$\hat{\gamma_1}$, his expected payoff from the project is given below:

$$\Pi_1 = \left(\hat{\gamma_1} e_1 + \gamma_2 e_2\right)\frac{R}{2} - \beta_1 e_1^2 \tag{5.1}$$

For the rational manager, his payoff from the project is:

$$\Pi_2 = (\gamma_1 e_1 + \gamma_2 e_2)\frac{R}{2} - \beta_2 e_2^2 \tag{5.2}$$

The payoff from the project for the overconfident manager and the rational manager is consistent with my assumption. The overconfident manager overestimates his true ability, and he knows the rational manager's true ability, so his perceived payoff from the project depends on his perceived ability and the rational manager's true ability. In contrast, the rational manager recognizes both his and his teammate's true ability, so the rational manager's actual payoff from the project is related with the true ability of the managers instead of the perceived ability. Note that $\beta_1 e_1^2$ represents the cost for the overconfident manager to exert effort into the project, and $\beta_2 e_2^2$ is the cost for the rational manager.

5.2.3.2 Perceived Payoff for Managers

The overconfident manager and the rational manager are both trying to maximize their payoff from the project. They will choose an optimal level of effort $e_i^*(i = 1,2)$ to exert into the project. By solving the partial differential equation for the manager's effort, I will obtain the optimal level of effort for the overconfident manager and the rational manager. For the overconfident manager, the optimal level of effort should be e_1^* that $\frac{\partial \Pi_1}{\partial e_1} = 0$. Similarly, for manager 2, the optimal effort is e_2^* in condition that $\frac{\partial \Pi_2}{\partial e_2} = 0$. The optimal payoff for manager 1 is

$$e_1^* = \frac{\hat{\gamma_1} R}{4\beta_1} \tag{5.3}$$

and for manager 2 is

$$e_2^* = \frac{\gamma_2 R}{4\beta_2} \tag{5.4}$$

Since the managers know each other's true ability, to maximize their own payoff from the project, the managers will exert optimal level of efforts into the project. I substitute e_1^* and e_2^* in the equation for their payoff Π_1 of the overconfident manager and Π_2 of the rational manager. Then I can find the optimal payoff for manager 1 and manager 2.

The overconfident manager's perceived optimal payoff from the project is

$$\Pi_1^* = \frac{\hat{\gamma_1}^2 R^2}{16\beta_1} + \frac{\gamma_2^2 R^2}{8\beta_2} \tag{5.5}$$

The rational manager's optimal payoff from the project is

$$\Pi_2^* = \frac{\hat{\gamma_1}\gamma_1 R^2}{8\beta_1} + \frac{\gamma_2^2 R^2}{16\beta_2} \tag{5.6}$$

From the results above, I notice that the optimal payoff from the project depends not only on the overconfident manager's and the rational manager's true abilities but also on the perceived ability from the overconfident manager. The more overconfident the manager is, the higher effort he will exert in the project, thus resulting in the higher payoff. This is different from the analysis from the theoretical model for one manager in which the rational manager's payoff is independent of the overconfident manager's perceived payoff. In a team of an overconfident manager and a rational manager, the rational manager's optimal payoff from the project is also related to the overconfident manager's perceived payoff. As I get the optimal payoff for the managers, I can find how the team makes decision on different level of overconfident.

5.2.3.3 Firm Value for Shareholders

In the teamwork model, the board of shareholders are also observers who do not work for the project. The shareholders are also self-interested and expect to add value to the firm through investing in the project. The shareholders can observe the team member's true ability and they will also estimate their optimal firm's value from the project. The shareholders observe that the overconfident manager has a true ability of γ_1 and the rational manager has a true ability of γ_2. The firm's value for the shareholders is

$$V = (\gamma_1 e_1 + \gamma_2 e_2)R \tag{5.7}$$

Note that the shareholders do not exert effort into the project, so there in no cost of effort in the shareholders' value.

If the team continues the project, the shareholders will be aware that the overconfident manager's and the rational manager's level of effort exerted into the project. Therefore, I substitute the overconfident manager's optimal level of effort are $e_1^* = \frac{\hat{\gamma_1}R}{4\beta_1}$ and the rational manager's optimal level of effort $e_2^* = \frac{\gamma_2 R}{4\beta_2}$ into the firm's value V, and I can obtain the equilibrium firm's value for the shareholders

$$V = \frac{\hat{\gamma_1}\gamma_1 R^2}{4\beta_1} + \frac{\gamma_2^2 R^2}{4\beta_2} \quad (5.8)$$

5.2.4 Team Decisions

In this section, I examine the effect of overconfidence and teamwork on project entrapment. From the previous section, I already know that if the team chooses to continue the project, the overconfident manager will exert e_1^* and the rational manager will exert e_2^* into the project to gain optimal payoffs from the project. If the team decides to abandon the project, both managers will receive a payoff $\frac{A}{2}$ from the project. By comparing the manager's optimal payoff from the project and the liquidation value, I can describe whether the manager will continue or abandon the project.

For either the overconfident manager or the rational manager, he is willing to abandon the project if $\Pi_i^* < \frac{A}{2}$, and he will choose to abandon the project if $\Pi_i^* \geqslant \frac{A}{2}$, where $i = 1,2$. Recall that the overconfident manager overestimates his ability and exerts more effort into the project, I can expect a higher perceived payoff from the overconfident manager compared with the rational manager, $\Pi_2^* < \Pi_1^*$. Specifically, the team will make different decisions under different perceived payoff for the project.

I figure that the team will abandon the project if $\Pi_2^* < \Pi_1^* < \frac{A}{2}$ where both the overconfident manager and the rational manager agree to abandon the project. If $\frac{A}{2} < \Pi_2^* < \Pi_1^*$, the overconfident manager and the rational manager choose to continue the project. However, I may encounter a situation where the overconfident manager and the rational manager reach a disagreement. If $\Pi_2^* < \frac{A}{2} < \Pi_1^*$, the overconfident manager will choose to continue the project, but the rational manager prefers to abandon the project. In this case, I assume that the overconfident manager dominates the team, and he can force the team to continue the project.

Consequently, the rational manager feels angry and frustrated with the decision, which causes him to retaliate. I call it a 'souring' relationship within the team. The rational manager's retaliation action will result in damaging the payoff for the managers and deteriorate the firm's value from the project.

To find the effect of overconfidence on the team's decision, I solve the critical value for the overconfident manager. As has been mentioned before, the overconfident manager's and the rational manager's payoff from the project is related with the overconfident manager's

perceived ability. There should be two critical values of the perceived ability where the overconfident manager and the rational manager change their decision from abandoning the project to continuing the project respectively.

Firstly, I solve the critical value of the perceived ability for the overconfident manager to change his decision

$$\hat{\gamma_{11}} = \frac{\sqrt{\left(\frac{A}{2} - \frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R} \tag{5.9}$$

This indicates that the overconfident manager is willing to abandon the project if his perceived ability is less than $\frac{\sqrt{\left(\frac{A}{2} - \frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}$, while manager 1 chooses to continue the project if his perceived ability if larger than $\frac{\sqrt{\left(\frac{A}{2} - \frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}$.

Secondly, even though the rational manager's effort exerted only depends on his true ability, his total payoff from the project is also related with the overconfident manager's perceived ability because they are working together as a team. I find the critical value of the perceived ability for the rational manager

$$\hat{\gamma_{12}} = \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2} \tag{5.10}$$

The rational manager prefers to abandon the project if the perceived ability of his teammate, the overconfident manager is less than $\frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$, and the rational manager prefers to continue the project if the overconfident manager's perceived ability is larger than $\frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$.Plus, I state that the critical value for the overconfident manager $\hat{\gamma_{11}}$ is smaller than the critical value for the rational manager $\hat{\gamma_{12}}$ because the overconfident manager overestimates his payoff from the project. As the overconfident manager works harder and exerts more effort into the project, he is more likely to switch from abandoning the project to continuing the project at a lower critical value of perceived ability than the rational manager.

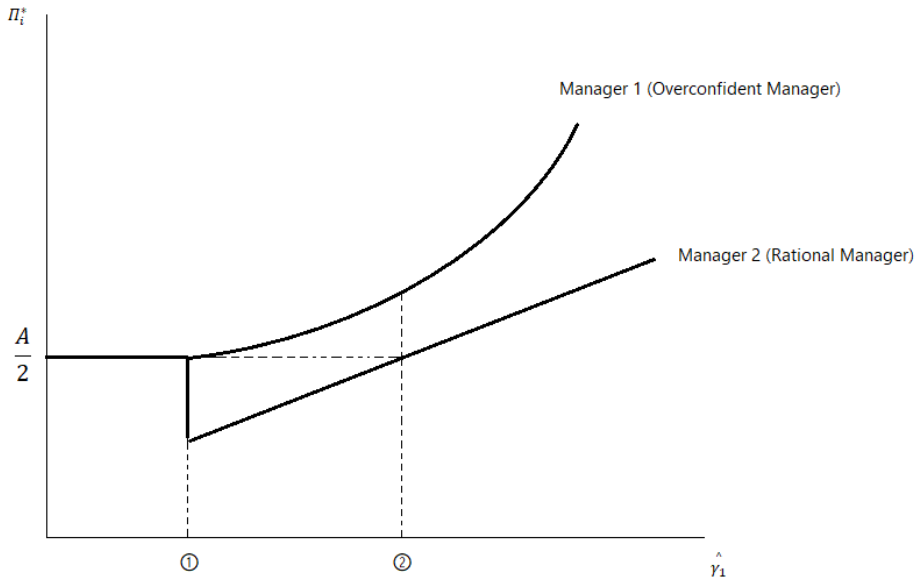
Lastly, I state the team's coordination and the 'souring' relationship between the teammates according to different levels of perceived ability. The team's decision on whether to continue or abandon the project is shown as follows:

If $\hat{\gamma_1} < \frac{\sqrt{\left(\frac{A}{2}-\frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}$, both the overconfident manager and the rational manager have a higher payoff if they abandon the project compared to the payoff from continuing the project. Both team members are happy with the decision. Therefore, the team decides to abandon the project.

If $\hat{\gamma_1} \geqslant \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$, both the overconfident manager and the rational manager are willing to continue the project since they will achieve higher payoff if they continue the project. Therefore, the team decides to continue the project.

If $\hat{\gamma_1} \in (\frac{\sqrt{\left(\frac{A}{2}-\frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}, \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2})$, the overconfident manager prefers to continue the project but the rational manager wants to abandon the project. Based on my assumption, if team members have conflicting ideas, the overconfident manager can force the team to continue the project. If this happens, the overconfident manager's decision on continuing the project is harming the relationship with his teammate, the rational manager. The rational manager will retaliate and worsen the situation. The figure below shows the perceived payoff for the overconfident and the actual payoff for the rational manager at different levels of overconfidence.

Figure 5.2.1 Managers' Payoff in the Team



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, his perceived payoff from the project and the rational manager's actual payoff from the project. The figure also shows the rational manager's decision and the overconfident manager's decision on the project.

In the figure above, I show the two critical values of the perceived ability for the overconfident manager. The critical value for the overconfident manager to switch from abandoning the project to continuing the project is $\hat{\gamma_{11}} = \frac{\sqrt{\left(\frac{A}{2} - \frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}$, which is denoted as ①. The critical value for the rational manager to change his decision is $\hat{\gamma_{12}} = \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$, denoted as ②. As I discussed before, both managers agree to abandon the project and they will get a payoff $\frac{A}{2}$ from the project. If the overconfident manager has an overconfidence level less than $\hat{\gamma_{11}}$, both managers agree to abandon the project and choose to receive the liquidation value $\frac{A}{2}$, which is shown on the left of point ①. If the overconfident manager has a perceived ability between $\hat{\gamma_{11}}$ and $\hat{\gamma_{12}}$, the overconfident manager is willing to continue the project while the rational manager wants to abandon the project. The overconfident manager believes that he will receive more payoff from continuing the project, but the rational manager observes that continuing the project will damage his payoff from the project. The overconfident manager and the rational manager have conflicting decisions. The overconfident manager can force the team to continue the project. This decision on continuing the project is also harming the payoff of manager 2 whose best choice is to abandon the project. This is shown between point ① and point ②. If the overconfident manager's level of overconfidence increases until $\hat{\gamma_{12}}$, where lies the critical value for manager 2 to switch from abandoning to continuing the project, both managers are willing to continue the project. I can find that on the right-hand side of point ②, the overconfident manager and the rational manager receive more payoff from continuing the project.

To summarize, it is obvious that if both managers prefer to continue or abandon the project, it is easy for them reach an agreement and create a harmonious atmosphere within the team. In the case abandonment, the overconfident manager has lower level of overconfidence, so he exerts less effort in the project together with the rational manager effort, which is not enough to achieve higher payoff from continuing the project. Thus, the team decides to terminate the project, and the managers will receive $\frac{A}{2}$ as the best option for them. In the case for continuation, the manager is so overconfident that he exerts extremely high effort into the project. With the rational manager's teamwork, the team is expected to achieve higher payoff if the managers continue the project. Therefore, the team members both are willing to continue the project. In

the next section, I will model the interaction between the overconfident manager and the rational manager if the team members have conflicts and the team is in a 'souring' relationship.

5.2.4.1 Conflicts and Souring Relationship

From the analysis above, when the overconfident manager wants to continue the project, but the rational manager tends to abandon the project. The overconfident manager can dominate the team and force the rational manager to continue the project, which causes a 'souring' relationship in the team. The rational manager feels angry and upset with the team's decision, and the rational manager's frustration will make him unwilling to cooperate with the overconfident manager. Instead, his negative attitude will worsen the situation.

I suppose that harming the relationship between team members will further decrease the payoff from the project by $(1-\lambda)$, where λ ($\lambda \in [0,1]$) measures how strong the effect of the rational manager's retaliation is on the payoff from the project. The closer λ is to 1, the more strongly his retaliation will affect the team's payoff. If $\lambda = 1$, manager 2 absolutely destroys the whole team, resulting in a breakup of the team and no payoff from the project. If $\lambda = 0$, manager 2's reaction does not have any impact on the team, thus not affecting the payoff at all. I then examine how the retaliation will affect the team's decision by analysing the amended payoff for the managers.

If the overconfident manager and the rational manager have conflicting decisions on whether to continue or abandon the project, the rational manager knows that the overconfident manager will force the team to continue the project. The rational manager starts to retaliate, which makes the overconfident manager's payoff and his own payoff decreased to $\frac{R}{2}(1-\lambda)$. Given the fact that the rational manager's action will break the coordination in the team, the overconfident manager's perceived payoff from the project is

$$\Pi_1' = (\hat{\gamma_1} e_1 + \gamma_2 e_2)\frac{R}{2}(1-\lambda) - \beta_1 e_1^2, \tag{5.11}$$

and the rational manager's payoff from the project is

$$\Pi_2' = (\gamma_1 e_1 + \gamma_2 e_2)\frac{R}{2}(1-\lambda) - \beta_2 e_2^2. \tag{5.12}$$

Remind that the managers know each other's true ability, and the overconfident manager is aware of the retaliation from the rational manager.

Following the same analysis, I find the optimal effort e_i' exerted into the project by solving the partial differential equations of Π_1' and Π_2'. Under the effect of retaliation, the overconfident manager's optimal level of effort exerted into the project is

$$e_1'^* = \frac{\hat{\gamma_1} R(1-\lambda)}{4\beta_1}, \tag{5.13}$$

and the rational manager's optimal level of effort is

$$e_2'^* = \frac{\gamma_2 R(1-\lambda)}{4\beta_2}. \tag{5.14}$$

I substitute the optima effort $e_1'^*$ and e_2^* into the payoff for the overconfident manager and the rational manager respectively. I can find the optimal payoff for the overconfident manager project is

$$\Pi_1'^* = \frac{\hat{\gamma_1}^2 R^2(1-\lambda)^2}{16\beta_1} + \frac{\gamma_2^2 R^2(1-\lambda)^2}{8\beta_2}, \tag{5.15}$$

and the rational manager's optimal payoff from the project is

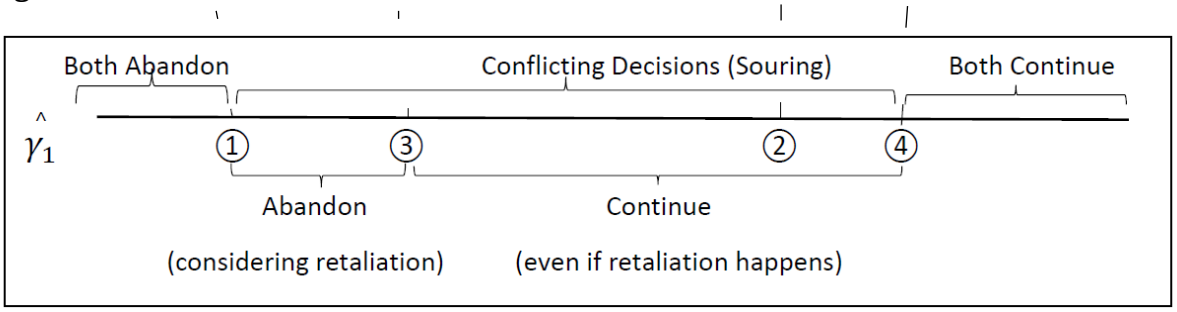
$$\Pi_2'^* = \frac{\hat{\gamma_1}\gamma_1 R^2(1-\lambda)^2}{8\beta_1} + \frac{\gamma_2^2 R^2(1-\lambda)^2}{16\beta_2}. \tag{5.16}$$

Comparing the optimal payoff from the project and the liquidation value from abandoning the project, I calculate the critical value of perceived ability for the overconfident manager and the rational manager. The critical value for the overconfident manager is $\hat{\gamma_1} = \frac{4}{R(1-\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)^2}{8\beta_2})}$ (noted as critical value ③). For the overconfident manager 1, if $\hat{\gamma_1} < \frac{4}{R(1-\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)^2}{8\beta_2})}$, he realizes that the rational manager's retaliation damages the payoff from the project so much. He makes concession and abandons the project. If $\hat{\gamma_1} \geqslant \frac{4}{R(1-\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)^2}{8\beta_2})}$, even though he totally understands that the rational manager's retaliation will damage the payoff, the payoff from continuation is still higher than the payoff from abandonment. Regardless of what the rational manager does, the team continues the project anyway. I also find the critical value for the rational manager $\hat{\gamma_1} = \frac{4A\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}$.

For the rational manager, if $\hat{\gamma_1} < \frac{4A\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}$ (Noted as critical value ④), he is willing to abandon the project. If $\hat{\gamma_1} \geqslant \frac{4A\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}$, he agrees to continue the project.

From the analysis above, I can find the effect of overconfidence and 'souring' team relationship on project entrapment. I the show how the team decision is made below.

Figure 5.2.2 Critical Level of Overconfidence and Team's Decision



Note. The figure demonstrates the critical values where the rational manager and the overconfident manager choose to continue or abandon the project. It also shows the moral hazard problems and the rational manager's retaliation in the team.

I can see that if manager 1 is not so overconfident, rational, or underconfident ($\hat{\gamma_1} <$ ①), the overconfident manager and the rational manager both want to abandon the project. They can easily reach the agreement that the team decides to abandon the project. If the overconfident manager is extremely overconfident ($\hat{\gamma_1} \geqslant$ ④), the team will put so much effort into the project that the expected payoff from the project is high enough. The managers cooperate and continue running the project.

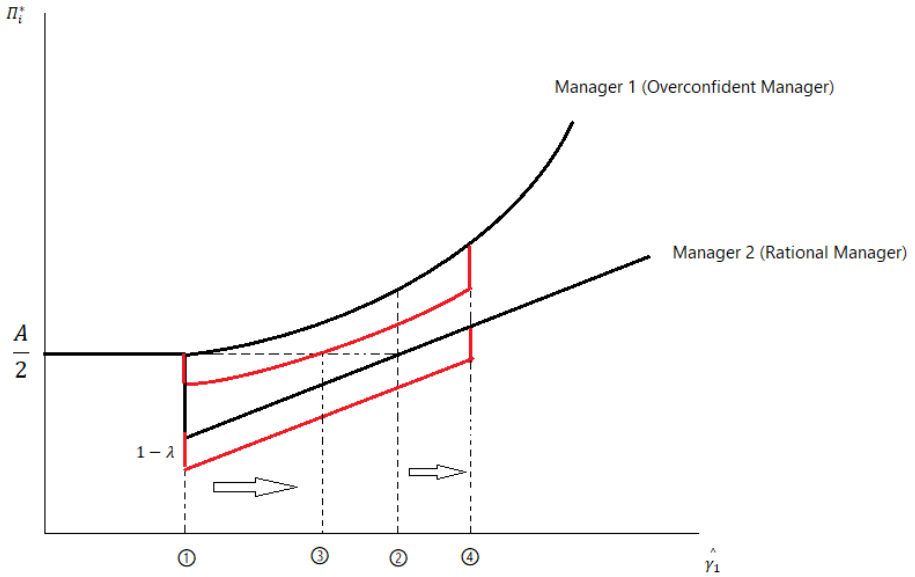
If the overconfident manager has a certain level of overconfidence (① $< \hat{\gamma_1} \leqslant$ ④), the overconfident manager wants to continue the project while the rational manager prefers abandoning the project. They have conflicting ideas and the overconfident manager, dominantly, forces the team to continue the project. However, the rational manager is upset about this decision and refuses to cooperate with the overconfident manager. The rational manager is so frustrated that the team's decision is harming his payoff from the project. Consequently, he reacts by retaliating and damaging the payoff from the project. The overconfident manager's forcing, and the rational manager's retaliation will sour the relationship between team members, causing a decrease in the payoff from the project for both managers, which means that the overconfident manager needs to be more overconfident and exerts more effort to make the project profitable again. Therefore, if ① $< \hat{\gamma_1} \leqslant$ ③, the retaliation from the rational manager worsens the situation so terribly that the overconfident

manager would abandon the project. Even though without retaliation the overconfident manager will continue the project, considering the damage from the rational manager's reaction, the payoff from abandoning the project exceeds the payoff from continuing the project, the overconfident manager has no other choice but to abandon the project. If ③ $\leqslant \hat{\gamma}_1 <$ ②, although the rational manager's retaliation is souring the relationship and deteriorating the project's value, continuing the project is still the better choice because the overconfident manager exerts enough effort into the project and the retaliation does not work so efficiently. The team still decides to continue the project despite the decrease in project value.

5.2.4.2 Effect of 'Souring' Relationship: Damaging Firm's Value

In this section, I will discuss how the payoff from the project changes for each manager and how overconfidence and teamwork influence managers' payoff. I know that at lower level of overconfidence, both managers abandon the project, and they achieve a payoff of $\frac{A}{2}$ from the project. At very high level of overconfidence, the team decides to continue the project, manager 1 will receive Π_1^* and manager 2 will receive Π_2^* from the project respectively. If manager 1 has certain level of overconfidence, the team decision depends on manager 1's overconfidence and manager 2's retaliation. I will show the effect of overconfidence on the managers' payoff in the figure below.

Figure 5.2.3 Managers' Payoff with Retaliation in the Team



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, his perceived payoff from the project and the rational manager's actual payoff from the project considering the effect of souring relationship and retaliation from the rational manager.

I base my analysis on the original model. The black line shows the overconfident manager's perceived payoff and the rational manager's actual payoff without considering retaliation. The team will abandon the project if the overconfident manager's perceived ability is less than critical value ① ($\hat{\gamma_1} < \frac{\sqrt{\left(\frac{A}{2}-\frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R}$), and team will continue the project if the overconfident manager's perceived ability is larger than the critical value ② ($\hat{\gamma_1} > \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$). The disagreement on the overconfident manager and the rational manager occur if the overconfident manager's perceived ability is between critical value ① and ② ($\frac{\sqrt{\left(\frac{A}{2}-\frac{\gamma_2^2 R^2}{8\beta_2}\right)16\beta_1}}{R} < \hat{\gamma_1} < \frac{4A\beta_1}{\gamma_1 R^2} - \frac{\gamma_2^2 \beta_1}{2\gamma_1 \beta_2}$). The overconfident manager overestimates his payoff from the project so he forces the rational manager to continue a project which should have been abandoned. The rational manager realizes that continuing the project damage his payoff from the project. The relationship in the team will be intense on this condition.

I can see from the figure that considering the effect of retaliation and souring relationship, the critical value for the managers to switch their decisions changes. I assume that manager 2's retaliation will sour the relationship and damage the payoff for both managers by $(1-\lambda)$. Therefore, if they have conflicting ideas, their payoff from the project will decrease by $(1-\lambda)$. Both the overconfident manager's payoff and the rational manager's payoff will be damaged, which is shown as the red line on the figure above. The severity of the decrease in payoff depends on how effectively the rational manager's retaliation works. The closer λ is to 1, the worse the situation becomes and, in my figure, the large the value drops downwards. The souring relationship and retaliation also result in the situation that the overconfident manager needs to exert more efforts to make the project profitable. As I calculated in the previous section, between ① and ③, even though the overconfident manager wants to continue the project, the rational manager's retaliation deteriorates the payoff so much that continuing the project is no longer the better option for him. Thus, to maximize his payoff, the rational manager decides to abandon the project, and the team now agrees to abandon the project. Nevertheless, when the rational manager has relatively higher level of overconfidence, despite the retaliation from the rational manager, the overconfident manager exerts more effort in the project and continues the project since he still achieves higher payoff from continuing the project including his loss from souring relation. When $\hat{\gamma_1}$ increases to ④, both managers are willing to continue the

project and the payoff for each manager moves back to the black line. It is shown in the figure above that the critical value for both the overconfident manager and the rational manager to switch from abandoning to continuing the project becomes larger (as the arrow towards right), requiring higher level of overconfidence and more effort in the project.

In this section, I analyse the effect of overconfidence and the effect of 'souring' relationship on the team's decisions on whether to continue or abandon a failed project. I discover from the analysis above that at lower level of overconfidence or at higher level of overconfidence, the overconfident manager and the rational manager work together reach agreement upon a decision on either abandoning or continuing the project. A medium level creates divergence and destroys the relationship between team members. The effect of 'souring' relationship on the project entrapment is that if retaliation happens in the team, the managers are more likely to abandon the project at lower level of overconfidence between they cannot afford the loss from retaliation. It also means that the overconfident manager must be more overconfident and must exert more effort into the project if he wants to continue the project. I consider that overconfidence can enhance managers' incentives to work harder for the project, but the detriment of payoff resulted from souring relationship requires more efforts from managers if they want to continue the project.

5.2.4.3 Extension on the Souring Relationship: Overconfident Manager's Understanding

In the previous section, I analyse the effect of overconfidence and the 'souring' relationship in the team on the team's decision. I assume that the overconfident manager knows that the rational manager will retaliate and damage the payoff from the project. As the manager is overconfident, he believes that he has higher ability than his higher ability than his fellow colleague. The overconfident manager is self-oriented and might not realize the rational manager's retaliation.

Therefore, I am thinking about extending my team-work model by considering whether the overconfident manager fully understands team's souring relationship. In my model, I assume that when the overconfident manager wants to continue the project and the rational manager prefers to abandon the project, the overconfident manager dominates and forces the team to continue the project. The rational manager, who disagrees with this decision, feels frustrated and retaliates by damaging the payoff from the project. I assume that if the rational manager retaliates, the payoff from the project will decrease by $(1-\lambda)$, which means that both managers will receive a payoff of $(1-\lambda)\frac{R}{2}$ if the team decide to continue the project. Now I

consider the overconfident manager's understanding on the souring relationship. When the rational manager disagrees with the team's decision on continuing the project, he is upset and does not want to spend much effort on the project. The conflicting decisions of the two team members creates 'souring' relationship in the team. It is assumed that the overconfident manager is sometimes not aware of the 'souring' relationship. Therefore, I introduce ϕ to measure how much overconfident manager is aware of the 'souring' relationship. I note that for the rational manager has a payoff of $(1-\lambda)\frac{R}{2}$ from the project because of the retaliation, while the overconfident manager's payoff from the project is $(1-\phi\lambda)\frac{R}{2}$, where $\phi \in [0,1]$. If $\phi = 1$, the overconfident manager fully understands the souring relationship and the decrease in payoff from the project. As ϕ reduces, the overconfident becomes less and less aware of the souring relationship. When $\phi = 0$, even though the rational manager retaliates, the overconfident manager does not realize the souring relationship at all and his perceived payoff from the project is still $\frac{R}{2}$. Then I can investigate the effect of the overconfident manager's understanding on the souring relationship.

I argue that the rational manager will retaliate when he disagrees with the overconfident manager's decision, so the rational manager's payoff from the project will decrease by $(1-\lambda)$, but the overconfident manager' perceived payoff from the project is reduced by $(1-\phi\lambda)$, depending on how effective the retaliation is and how the overconfident manage understands the retaliation.

Therefore, I find that the managers' payoff from the project is:

The overconfident manager's perceived payoff is

$$\Pi_1' = (\hat{\gamma_1} e_1 + \gamma_2 e_2)\frac{R}{2}(1-\phi\lambda) - \beta_1 e_1^2; \tag{5.17}$$

The rational manager's actual payoff is

$$\Pi_2' = (\gamma_1 e_1 + \gamma_2 e_2)\frac{R}{2}(1-\lambda) - \beta_2 e_2^2; \tag{5.18}$$

To find the optimal effort level, I solve the equations $\frac{\partial \Pi_1'}{\partial e_1} = 0$ and $\frac{\partial \Pi_2'}{\partial e_2} = 0$. Then I find the optimal effort for the managers: the overconfident manager's optimal level of effort: $e_1^* = \frac{\hat{\gamma_1} R(1-\phi\lambda)}{4\beta_1}$ and the rational manager's optimal level of effort: $e_2^* = \frac{\gamma_2 R(1-\lambda)}{4\beta_2}$. From the optimal effort, I can find the optimal payoff of the managers from the project:

The overconfident manager's optimal payoff: $\Pi_1' = \frac{\hat{\gamma_1}^2 R^2(1-\phi\lambda)^2}{16\beta_1} + \frac{\gamma_2^2 R^2(1-\lambda)(1-\phi\lambda)}{8\beta_2}$; (5.19)

The rational manager's optimal payoff: $\Pi_2' = \frac{\hat{\gamma_1}\gamma_1 R^2(1-\phi\lambda)(1-\lambda)}{8\beta_1} + \frac{\gamma_2^2 R^2(1-\lambda)^2}{16\beta_2}$. (5.20)

By comparing the optimal payoff from continuing the project and the liquidation value from abandoning the project, I can find the critical value of the perceived ability for the overconfident manager and the rational manager to change their decisions. For the overconfident manager, the critical value of the perceived ability is

$$\hat{\gamma_{11}} = \frac{4}{R(1-\phi\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)(1-\phi\lambda)}{8\beta_2})}. \quad (5.21)$$

Therefore, the overconfident manager will choose to abandon the project if $\hat{\gamma_{11}} < \frac{4}{R(1-\phi\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)(1-\phi\lambda)}{8\beta_2})}$, and he will choose to continue the project if $\hat{\gamma_{11}} \geqslant \frac{4}{R(1-\phi\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)(1-\phi\lambda)}{8\beta_2})}$. For the rational manager, his critical value is

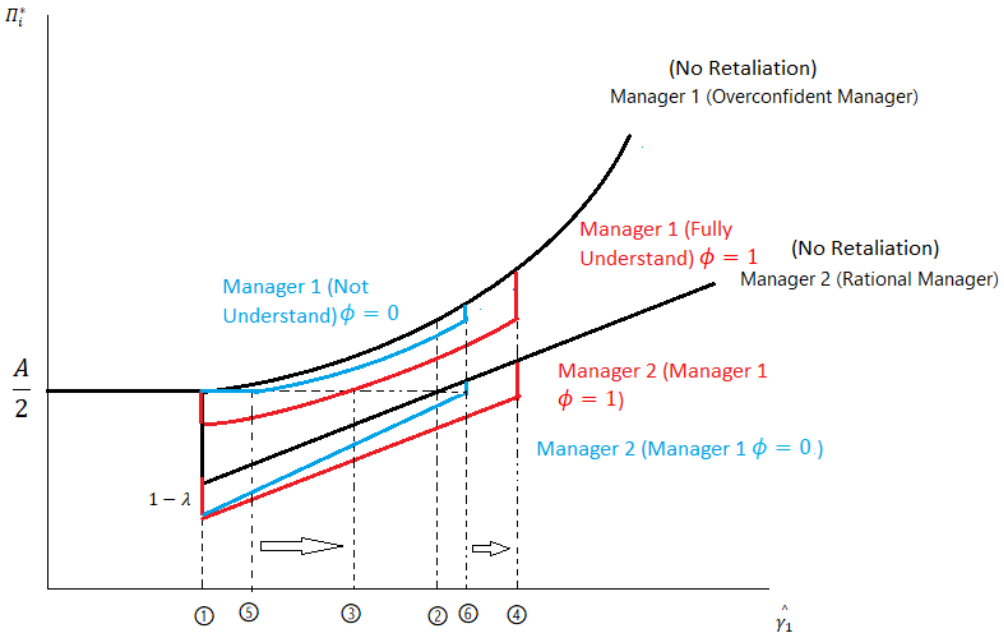
$$\hat{\gamma_{12}} = \frac{(1-\lambda)}{(1-\phi\lambda)}[\frac{4\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}]. \quad (5.22)$$

The rational manager prefers abandoning the project if $\hat{\gamma_{12}} < \frac{(1-\lambda)}{(1-\phi\lambda)}[\frac{4\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}]$, and he prefers continuing the project if $\hat{\gamma_{12}} \geqslant \frac{(1-\lambda)}{(1-\phi\lambda)}[\frac{4\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}]$.

From the critical value above, I notice that if the overconfident manager fully understands the souring relationship ($\phi = 1$), the critical value for the overconfident manager and the rational manager to change from abandoning the project to continuing the project is identical to my analysis before. As ϕ moves from 1 to 0, the critical value for manager 1 to change from abandoning to continuing the project $\hat{\gamma_1} = \frac{4}{R(1-\phi\lambda)}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)(1-\phi\lambda)}{8\beta_2})}$ become smaller, and the critical value for manager 2 $\hat{\gamma_1} = \frac{(1-\lambda)}{(1-\phi\lambda)}[\frac{4\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}]$ also becomes smaller. When $\phi = 0$ which means that the overconfident manager is not aware of the souring relationship at all, the critical values are $\hat{\gamma_1} = \frac{4}{R}\sqrt{\beta_1(\frac{A}{2} - \frac{\gamma_2^2 R^2(1-\lambda)}{8\beta_2})}$ (Note as critical value ⑤) for the overconfident manager and $\hat{\gamma_1} = (1-\lambda)[\frac{4\beta_1}{\gamma_1 R^2(1-\lambda)^2} - \frac{\gamma_2^2\beta_1}{2\beta_2\gamma_1}]$ (Note as critical value ⑥)

or the rational manager. Now, I am able to illustrate the overconfident manager's perceived payoff and the rational manager's payoff from the project in the figure below.

Figure 5.2.4 Managers' Payoff with Retaliation and Awareness of Retaliation



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, his perceived payoff from the project and the rational manager's actual payoff from the project considering the effect of souring relationship, retaliation from the rational manager, and the awareness of retaliation from the overconfident managers.

Firstly, I start with original model. Without any retaliation, I understand that the overconfident manager continuing the project will damage the rational manager's payoff from the project. The original payoffs for the overconfident manager and the rational manager are shown as the black line. I assume in the model that both the overconfident manager and the rational manager have same true ability. The actual ability level for manager 1 is γ_1.

Secondly, I consider the 'souring' relationship between the overconfident manager and the rational manager. I begin with the assumption that the overconfident manager fully understands the souring relationship where $\phi = 1$. The rational manager is frustrated with the rational manager's choice to continue with the project. He retaliates, and the overconfident manager totally realizes the retaliation from the rational manager. The redline shows how 'souring' relationship hurts the managers' outcome. Due to the retaliation, both managers' payoffs are decreased by $(1 - \lambda)$, which is shown by the red lines. With the increase in the level of overconfidence, both managers exert more effort into the project, and the payoff from the

project increases until it reaches the new critical value ④ where both managers agree to continue the project, and the effect of retaliation vanishes.

I also notice that as the overconfident manager realizes the retaliation, his perceived payoff decreases. As a result, he will need to exert more effort into the project to eliminate the influence brought by the retaliation. Instead of switching at critical value ①, he will continue the project if his perceived ability is higher than critical value ③. Accordingly, the rational manager's decision on continuing the project is also affected by the retaliation. He must spend more effort into the project to make it profitable to continue.

Lastly, I consider how much the overconfident manager is aware of the 'souring' relationship and the retaliation. The blue line shows the payoff for the overconfident manager and the rational manager in the case that the overconfident manager does not fully understand the rational manager's retaliation. As the rational manager decides to retaliate, he will damage the firm's value, but the overconfident manager is not aware not the retaliation. The rational manager's optimal effort level decreases, which requires more effort to exert in the project from the overconfident manager to continue the project. The critical value for the overconfident manager increases from ① to ⑤, but the overconfident manager's perceived ability does not decrease only because the overconfident manager is not aware of the retaliation. With the growing level of perceived ability, the overconfident manager exerts more effort into the project and the payoff for both managers increase. When the level of overconfidence reaches the critical value ⑥ and further, the overconfident manager and the rational manager agree to continue the project.

I know that as ϕ rises from 0 to 1, the overconfident manager increasingly understands the souring situation. When the overconfident manager is not aware of the retaliation from the rational manager at all, his perceived payoff from the project is represented by the blue line. If the overconfident manager become more aware of the retaliation, his perceived payoff from the project will shift downwards as he recognizes that the retaliation from the rational manager will damage his payoff from the project, and the critical value for him to switch from abandoning the project to continuing the project will become larger, which will move to the right on the horizontal axis in the figure. It indicates that since the overconfident manager notices the damage in his payoff from the retaliation, he needs to be more overconfident to exert higher effort to compensate for the loss from the retaliation if he in inclined to continuing the project.

In this section, I extend my model by lifting the limitation that the overconfident manager is fully aware of the rational manager's retaliation when they have 'souring' relationship. I argue that the overconfident might not totally realize that the rational manager will retaliate and damage the firm's value. I find that how the overconfident manager understands the retaliation will affect the optimal level of effort exerted in the project, and the manager is required to be more overconfident to continue the project. It is more difficult for the rational manager to agree to continue the project because he is asking for an increase in the effort exerted into the project. In the next section, I will discuss the case in which another manager joins the team and avoid 'souring' relationship.

5.3 Model Extension 1: One More Manager in the Team

In the original teamwork theoretical model, I assume that there are an overconfident manager and a rational manager in the team. The overconfident manager dominates the team when the rational manager and the overconfident manager have disagreement on whether to continue or abandon the project. The essential problem causing the 'souring' relationship and the retaliation is that the overconfident manager and the rational manager are taking equal responsibilities in the team. If I had not assumed the overconfident manager's domination, I could not have developed the model of disagreement and retaliation in the team.

To break the balanced positions in the team, I am considering adding another manager in the team. The additional manager can be either an overconfident manager or a rational manager. If I have a total of three managers in the team, when the rational manager(s) and the overconfident manager(s) have conflicting decisions, there is always a majority of managers (2 out of 3) who vote for the same decisions and dominate the team. As the majority wins, I can somehow avoid souring relationship and the retaliation problem.

5.3.1 An Additional Rational Manager

In this section, I discuss the case in which another rational manager joins the team. To simplify, I assume that newly joined rational manager (manager 3) has the same true ability γ_2 and cost of effort β_2 as the existing rational manager. The two rational manager and the overconfident manager will work together and exert effort into the project if they choose to continue the project. All managers will receive $\frac{R}{3}$ from the project, or $\frac{A}{3}$ if they choose to abandon the project. Then, I find the payoff from the project for the overconfident manager and the rational managers. The overconfident manager's payoff is

$$\Pi_1 = (\hat{\gamma_1} e_1 + 2\gamma_2 e_2)\frac{R}{3} - \beta_1 e_1^2, \tag{5.23}$$

and the rational manager's payoff is

$$\Pi_2 = \Pi_3 = (\gamma_1 e_1 + 2\gamma_2 e_2)\frac{R}{3} - \beta_2 e_2^2. \tag{5.24}$$

Following the same way in my original model, the optimal effort level for the overconfident manager is

$$e_1^* = \frac{\hat{\gamma_1} R}{6\beta_1}, \tag{5.25}$$

and the optimal effort level for the rational managers is

$$e_2^* = \frac{\gamma_2 R}{3\beta_2} \tag{5.26}$$

respectively. I know that as a team the overconfident manager and the rational managers will exert the optimal level of effort into the project. Then I substitute e_1^* and e_2^* into the payoff for the managers and find the optimal payoff for the overconfident manager and the rational managers. The overconfident manager optimal payoff is

$$\Pi_1^* = \frac{\hat{\gamma_1}^2 R^2}{18\beta_1} + \frac{2{\gamma_2}^2 R^2}{9\beta_2}. \tag{5.27}$$

The rational manager's optimal payoff from the project is

$$\Pi_2^* = \Pi_3^* = \frac{\gamma_1 \hat{\gamma_1} R^2}{18\beta_1} + \frac{{\gamma_2}^2 R^2}{9\beta_2}. \tag{5.28}$$

Comparing the optimal payoff from continuing the project and the liquidation value from abandoning the project, I obtain the critical value of the perceived ability for the overconfident manager $\hat{\gamma_{11}} = \frac{\sqrt{(6A - \frac{4\gamma_2^2 R^2}{\beta_2})\beta_1}}{R}$ (noted as critical value ⑦) and the critical value for the rational managers $\hat{\gamma_{12}} = \frac{2A\beta_1}{\gamma_1 R^2} - \frac{2\gamma_2^2 \beta_1}{3\gamma_1 \beta_2}$. The manager's decision on whether to continue or abandon the project is shown below.

For the overconfident manager:

If $\hat{\gamma_1} < \frac{\sqrt{(6A - \frac{4\gamma_2^2 R^2}{\beta_2})\beta_1}}{R}$, he would like to abandon the project.

If $\hat{\gamma_1} \geqslant \frac{\sqrt{(6A-\frac{4\gamma_2^2R^2}{\beta_2})\beta_1}}{R}$,he would like to continue the project.

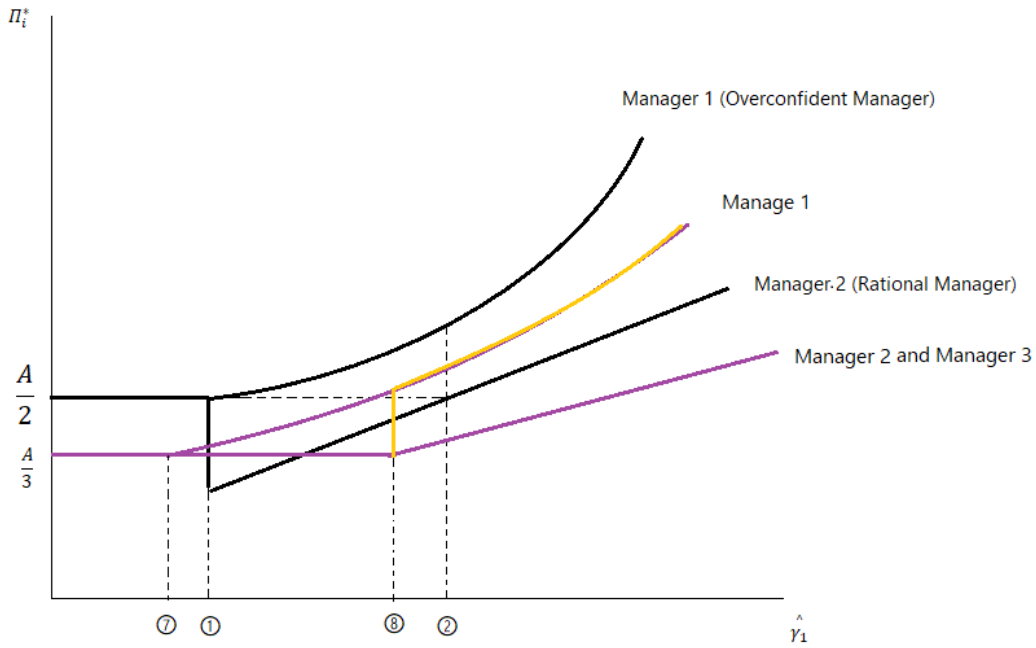
For the two rational managers:

If $\hat{\gamma_1} < \frac{2A\beta_1}{\gamma_1 R^2} - \frac{2\gamma_2^2\beta_1}{3\gamma_1\beta_2}$, they both agree to abandon the project.

If $\hat{\gamma_1} \geqslant \frac{2A\beta_1}{\gamma_1 R^2} - \frac{2\gamma_2^2\beta_1}{3\gamma_1\beta_2}$, they both agree to continue the project.

To show how the team makes the final decision, I show the overconfident manager's perceived ability, his actual payoff, and the rational managers' actual payoff in the figure. Also, remind that there are three members in the team, the team will follow the principle of majority. If the team members have conflicting decision, the team will follow the decision which most members vote for. The figure below shows the payoff for the overconfident manager and the rational manager respectively.

Figure 5.3.1 Managers' Payoff in a Team of One Overconfident and Two Rational



Note. The figure demonstrates the relationship between the overconfident manager's perceived ability, his perceived payoff from the project and the two rational managers' actual payoff from the project. It also shows the team's decision on the project with an additional rational manager.

The black line shows the original model in which there are an overconfident manager and a rational manager in the team and the overconfident manager dominates. The purple line shows

the overconfident manager's perceived payoff, and the rational manager's actual payoff. The yellow line represents the actual payoff for the overconfident manager considering the conflicts in the team.

I notice that on the left of critical value ⑦ ($\hat{\gamma_1} < \frac{\sqrt{(6A-\frac{4\gamma_2^2R^2}{\beta_2})\beta_1}}{R}$), where the overconfident manager has a perceived ability less than $\frac{\sqrt{(6A-\frac{4\gamma_2^2R^2}{\beta_2})\beta_1}}{R}$. All managers expected that abandoning the project will bring then higher payoff, so the team decides to abandon the project. If $\hat{\gamma_1} \in [\frac{\sqrt{\left(6A-\frac{4\gamma_2^2R^2}{\beta_2}\right)\beta_1}}{R}, \frac{2A\beta_1}{\gamma_1R^2} - \frac{2\gamma_2^2\beta_1}{3\gamma_1\beta_2}]$, where the overconfident manager has a medium level of perceived ability, only the overconfident wants to continue the project, both two rational managers agree to abandon the project. The whole team will abandon the project because the majority of the team vote for abandonment, and the overconfident manager has to follow. It is reflected in the figure that even though the perceived ability for the overconfident manager increases on the right of critical value ⑦, the actual payoff for the overconfident manager is still $\frac{A}{3}$ between critical value ⑦ and ⑧ because the team decide to abandon the project. On the right of ⑧ ($\hat{\gamma_1} \geqslant \frac{2A\beta_1}{\gamma_1R^2} - \frac{2\gamma_2^2\beta_1}{3\gamma_1\beta_2}$), where the overconfident manager has a perceived ability larger than $\frac{2A\beta_1}{\gamma_1R^2} - \frac{2\gamma_2^2\beta_1}{3\gamma_1\beta_2}$, all three members prefer continuing the project, and the team decides to continue the project. The actual payoff for overconfident manager will shift upwards to the original payoff. Compared with the case where I only have 2 members, the critical values for manager 1 and manager 2 shift to the left which means that all managers need less effort to exert into the project and make the project profitable for them as there is one more manager who works for the project.

5.3.2 An Addition Overconfident Manager

I now consider the case where there is another overconfident manager (manager 4) in the team. The team now consists of two overconfident managers and one rational manager. I assume that the additional overconfident manager has the same true ability γ_1 as the existing overconfident manager. To simplify, I also suppose that the additional overconfident manager has an identical level of overconfident $\hat{\gamma_1}$ and the cost of effort β_1 with the existing manager. The team will

cooperate and exert effort into the project if they decide to continue the project. The overconfident managers' perceived payoff from the project is

$$\Pi_1 = \Pi_4 = (2\hat{\gamma_1}e_1 + \gamma_2 e_2)\frac{R}{3} - \beta_1 e_1^2, \tag{5.29}$$

and the rational manager's payoff from the project is

$$\Pi_2 = (2\gamma_1 e_1 + \gamma_2 e_2)\frac{R}{3} - \beta_2 e_2^2. \tag{5.30}$$

I solve optimal level of effort for the overconfident managers effort level

$$e_1^* = \frac{\hat{\gamma_1}R}{3\beta_1} \tag{5.31}$$

and the optimal effort for the rational manager

$$e_2^* = \frac{\gamma_2 R}{6\beta_2}. \tag{5.32}$$

The overconfident managers will exert e_1^* and the rational manager will exert e_2^* into the project to maximize their payoff from the project. Therefore, I calculate that the overconfident managers' optimal payoff is

$$\Pi_1^* = \Pi_4^* = \frac{\hat{\gamma_1}^2 R^2}{9\beta_1} + \frac{{\gamma_2}^2 R^2}{18\beta_2}, \tag{5.33}$$

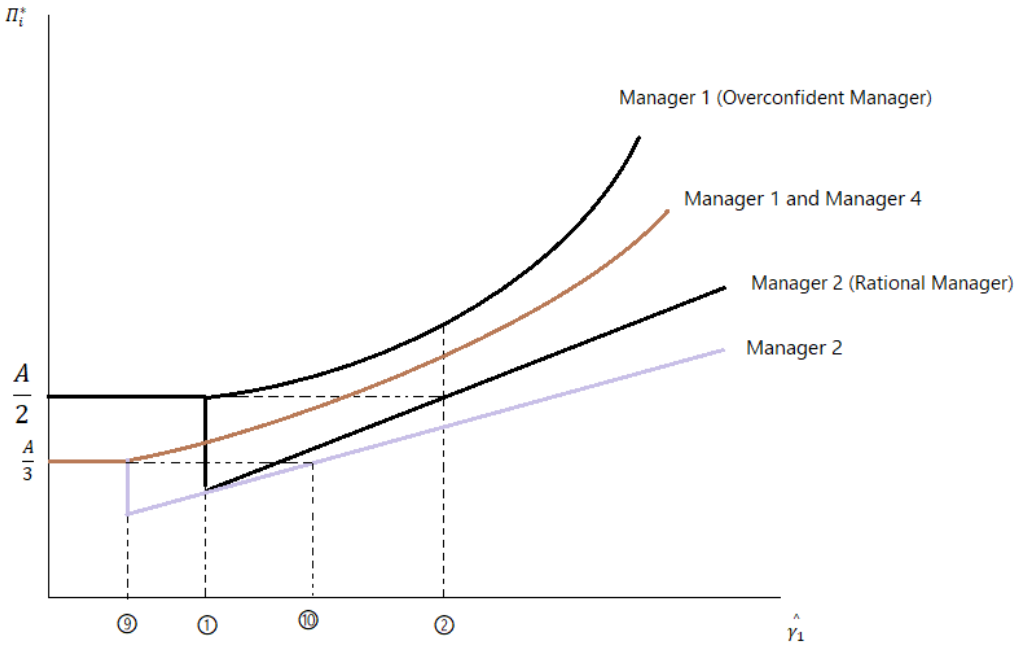
and the optimal payoff for the rational payoff is

$$\Pi_2^* = \frac{2\gamma_1\hat{\gamma_1}R^2}{9\beta_1} + \frac{{\gamma_2}^2 R^2}{36\beta_2}. \tag{5.34}$$

Next, I find the critical value of the overconfident manager's perceived ability. The critical value of perceived ability for the overconfident managers to change their decisions is $\hat{\gamma_1} = \frac{\sqrt{(3A - \frac{\gamma_2^2 R^2}{2\beta_2})\beta_1}}{R}$ (Noted as critical value ⑨). If the overconfident manager has a perceived ability $\hat{\gamma_1} < \frac{\sqrt{(3A - \frac{\gamma_2^2 R^2}{2\beta_2})\beta_1}}{R}$, they will choose to abandon the project. If $\hat{\gamma_1} \geqslant \frac{\sqrt{(3A - \frac{\gamma_2^2 R^2}{2\beta_2})\beta_1}}{R}$,the overconfident managers will choose to continue the project. The rational manager's critical value is $\hat{\gamma_1} = \frac{3A\beta_1}{2\gamma_1 R^2} - \frac{\gamma_2^2\beta_1}{8\gamma_1\beta_2}$ (Noted ass critical value ⑩). If the overconfident managers have a level of perceived ability $\hat{\gamma_1} < \frac{3A\beta_1}{2\gamma_1 R^2} - \frac{\gamma_2^2\beta_1}{8\gamma_1\beta_2}$, the rational manager would like to abandon the

project. If $\hat{\gamma}_1 \geqslant \frac{3A\beta_1}{2\gamma_1 R^2} - \frac{\gamma_2^2\beta_1}{8\gamma_1\beta_2}$, the rational manager agrees to continue the project. Depending on the different levels of overconfident, the team may make opposite decisions on the project. I reveal the relationship between the level of overconfidence, the overconfident managers' perceived payoff and the rational manager's actual payoff from the project in the figure below.

Figure 5.3.2 Managers' Payoff in a Team of Two Overconfident and One Rational



Note. The figure demonstrates the relationship between the two overconfident managers' perceived ability, their perceived payoff from the project and the rational manager's actual payoff from the project. It also shows the team's decision on the project with an additional overconfident manager.

The figure above illustrates the payoff for the managers in the team. The blackline represents the perceived payoff for the overconfident manager and the actual payoff for the rational manager in the original model of two managers. The brown line shows the perceived payoff for the overconfident managers in the team of three members, and the grey line reflects the actual payoff for the rational manager. I can observe from the figure that if $\hat{\gamma}_1 < \frac{\sqrt{(3A - \frac{\gamma_2^2 R^2}{2\beta_2})\beta_1}}{R}$ which lies on the left of critical value ⑨. The overconfident managers and the rational manager believe that they will receive more payoff from abandoning the project. The team will abandon the project, so each team member will receive a payoff of $\frac{A}{3}$ from the project. If the manager has a substantial level of overconfidence which is larger than the critical value of ⑩, all the team members agree to continue the project. If the manager has a medium level of

overconfidence between critical value of ⑨ and ⑩, the overconfident managers' perceived payoff is higher than $\frac{A}{3}$, so the overconfident managers prefer continuing the project. Nevertheless, the actual payoff for the rational manager is less than $\frac{A}{3}$, and the rational manager wants to abandon the project, because he believes that the overconfident managers are continuing the project which damages his payoff. Even though the overconfident manager disagrees with the team continuing the project, he must follow the team's decisions because majority of the team members want to continue the project and, as a result, harm his payoff.

5.3.3 Summary

In this section, I analyse how the team makes decision if there are three team members in the team. I argue that if there are three members in the team, the balance between the rational manager and the overconfident manager will break. An additional rational manager will make the team more likely to abandon the project because the rational managers are more conservative and more likely to abandon the project compared with the overconfident manager. In this case, when the two rational managers decide to abandon the project, but the overconfident manager wants to continue, the team will abandon the project under the principle of majority. On contrast, the team is more likely to continue the project if the team has two overconfident managers and one rational manager. When the overconfident managers and the rational managers have conflicted decisions, the team will continue the project because the majority of the team continues the project. By adding another manager in the team, I can avoid the problem of retaliation in the original teamwork model. In the next section, I will extend my model by considering the uncertainty of the project and bringing in the shareholders' role of recruiting the team.

5.4 Extension 2: Uncertainty of the Project

5.4.1 Background and Uncertainty of the Project

5.4.1.1 Uncertainty of the project

In the original model of a two-member team, I suppose that the project will fail, and the team need to decide whether to continue or abandon the failed project. I find in the model that at a medium level of overconfidence, the overconfident manager and the rational manager have different decisions on the project. I then assume that the overconfident manager wins and continues the project. Meanwhile, the rational manager will retaliate if the 'souring' relationship appears in the team.

Based on my theoretical model on a 2-member team, I extend my analysis by introducing uncertainty on the project. I apply the same assumption of the uncertainty of the project from the one-manager model. The shareholder in the firm is considering investing in a project. The shareholders do not know whether the project is either a good project or a bad project before they decide to invest in the project. There is a probability that the project is a good project or a bad project. Before investing in the project, the shareholders are looking to recruit a team of two managers to work for the project.

The shareholders shall estimate the ex-ante firm's value from the project and decide which team composition to recruit to maximize the firm's value from the project. Additionally, I lift the restriction that the overconfident manager always dominates the team. I reject the assumption of the overconfident manager's forcing to continue the project when there is conflict between team members. Instead, I assume that in the team the overconfident manager wins the negotiation with a probability if the team members have conflict.

Since the shareholders is recruiting a team of two managers to work for the project, I suppose that there are 3 possible team compositions which include 2 rational managers, 1 rational and 1 overconfident manager, and 2 overconfident managers. The shareholders will estimate and compare the firm's value from each team composition. Team composition is related with the uncertainty of the project. If the project is a good project for sure, the shareholders will recruit a team with all overconfident manager because they continue the project, work harder, and create more value for the firm than any rational managers. If the project is a bad project for sure, the shareholders will recruit a full rational team and make sure that they abandon the project. As a result, no shareholder will prefer a team of a mixture of overconfident and rational managers. The shareholders will recruit the team which produce the ex-ante optimal firm's value for them.

5.4.1.2 Players in the Game Theoretical Model

In the model of the teamwork with the uncertainty of the project, there are a board of shareholders and a project manager team in the game. The team consists of two managers, who are risk-neutral and self-interested managers seeking to maximize their payoff from the project. The managers can be rational or overconfident managers. The rational manager knows his true ability and the overconfident manager overestimates his ability. The two managers will work together and make continuation or abandonment decisions on the project.

The shareholders are also risk-neutral self-interested players in the game. The shareholders are always aiming to add value to the firm from the project. The shareholders can observe the managers' true ability, and they are aware of the rationality and the overconfidence of the project. Meanwhile, the shareholders can anticipate the value added to the firm from each team composition and recruit the team that brings them the maximum value.

In the following sections, I will establish the timeline of the teamwork model. Then I will analyse the perceived payoff for the overconfident manager and the actual payoff for the rational manager. Depending on the uncertainty of the project and the team composition, I will focus on team's decision on continuing or abandoning the project. Then, I calculate the shareholders' ex-ante expected value and discover which team composition the shareholders will recruit under the uncertainty of the project.

5.4.2 Timeline

Based on the assumption above, I establish the timeline of the model as follows.

Time t_0: Background Setup and Team Recruitment

At time t_0, a board of shareholders are considering investing a project to add value to the firm. The project can either be a good project or a bad project with a probability. I assume that the probability for a good project is p, and the probability of a bad project is $1-p$, which is known to the shareholders.

The board of shareholders is seeking to recruit a project management team to work for the project. The team consists of two members. The shareholders shall recruit a team with the three possible compositions: two overconfident managers, one rational manager and one overconfident manager, and two rational managers. After the shareholders decide the team composition, they will invest in the project.

Time t_1: Project Milestone

At time t_1, the project reaches its milestone. As the project management team is recruited and the project has already been invested in time t_0, the project now turns out to be a bad project or a good project. If the project is a good project, it will produce a payoff of R_G, and if the project is a bad project, it will produce R_B (Note that $R_G > R_B$).

Time t_2: Abandonment/Continuation Decision

At time t_2, the property of the project has been revealed (a good project or a bad project), and the team members will estimate the payoff from the project. The team will make decisions on whether to continue or abandon the project depending on the payoff for the overconfident manager and the rational manager respectively.

Time t_3: Continuation-Working on the Project/Abandonment-Realization of the Liquidation Value

If the team choose to abandon the project at time t_2, the managers will liquidate the project, and a total value of A will be realized from the project. If the team chooses to continue the project, the team members will exert an optimal level of effort into the project to maximize their payoff.

Time t_4: Payoff received from continuation.

At Time t_4, the payoff from the project is achieved if the team choose to continue the project. Both the team and the shareholders receive their payoff from the project, and the project terminates.

5.4.3 Payoff from the Project

I use the game theory approach to develop my model. There are a board of shareholders and a team of risk neutral managers who are recruited to work for the project. The shareholders can observe whether the managers are rational or overconfident. The manager's true ability is $\gamma_i (i = 1,2)$ for the two managers in the team respectively, and shareholders know if the manager is rational, he can observe his own true ability and he knows the true abilities of his fellow colleagues. The overconfident manager perceives that his ability is $\hat{\gamma_i}$, in which $\hat{\gamma_i} > \gamma_i$ for each manager in the team, showing that the overconfident manager overestimates his ability. The shareholders and the team agree that the equity stake is $\frac{1}{2}$.

I assume that I reach date 2, the uncertainty of the project is known to the shareholders. The probability for the project to be a good project is p, and the probability for a bad project is $1 - p$. The shareholders and the managers are all seeking to maximize their payoff from the project. If they continue the project, they will receive $\frac{R_j}{2} (j = G, B)$ from the project (note G for a good project and B for a bad project). The shareholders will receive the other half of the payment. If the team decide to abandon the project, they will receive $\frac{A}{2}$ by liquidating the project, and the shareholders will receive another $\frac{A}{2}$ from the project. In addition, I note that the shareholders prefer continuing a good project and abandoning a bad project.

I will solve the game in a backward direction of the timeline and find shareholders' ex ante preference on the team composition. First, I calculate the optimal payoff for the rational manager and the overconfident manager in the team, and I find the equilibrium value for shareholders from the project. Then I will identify the team's decision on whether to continue or abandon the project under three different team compositions respectively. Then I find the expected equilibrium value for shareholders based on the team's decisions and the probability of the property of the project. I will then see how the change of the probability affects the shareholders' ex ante recruitment decision at the beginning of the timeline.

5.4.3.1 Managers' Payoff from the Project

Consistent with my game theoretical model, the managers' perceived payoff from the project depends on the effort e_i $(i = 1,2)$ manager exerts into the project, the manager's perceived ability $\hat{\gamma_i}$ $(i = 1,2)$ and the payoff from the project $\frac{R_j}{2}$ $(j = G, B)$. Meanwhile, the shareholders' value from the project depends on the effort and the true ability γ_i $(i = 1,2)$ from the project. For managers, exerting effort into the project incurs cost of effort $\beta_i {e_i}^2$. I also assume that the two managers in the team will receive equally divided payoff from the project. Based on the assumption above, the perceived payoff from the project for each team member is given below.

The manager's perceived payoff from the project is

$$\Pi_i = \frac{1}{2}\sum_{i=1}^{2} \hat{\gamma_i} e_i \frac{R_j}{2} - \beta_i {e_i}^2. \tag{5.35}$$

(For rational manager $\hat{\gamma_i} = \gamma_i$, and for overconfident manager $\hat{\gamma_i} > \gamma_i$)

To simplify, I assume that all managers in the team have same true ability and they have same level of overconfidence. They also have the same cost of effort β. I now find the optimal payoff for managers in the team and the equilibrium value for shareholders in different team compositions.

5.4.3.1.1 Two Rational Managers

In this team, the two team members are rational, and they all have same true ability γ. For a rational manager 1, his payoff from the project is

$$\Pi_R = \frac{1}{2}\gamma(e_1 + e_2)\frac{R_j}{2} - \beta {e_1}^2. \tag{5.36}$$

As both managers are maximizing their payoff from the project, manager 1 will exert an optimal level of effort into the project. I shall obtain the optimal effort for manager 1 by solving $\frac{\partial \Pi_R}{\partial e_1} = 0$.

The optimal effort manager 1 will exert into the project is

$$e_1^* = \frac{\gamma R_j}{8\beta}. \tag{5.37}$$

Since both managers have same true ability, they will all exert e_1^* into the project. I substitute the optimal level of effort e_1^* into the rational manger's actual payoff Π_1 and I can get the optimal payoff for managers. The rational manager's optimal payoff

$$\Pi_R^* = \frac{3\gamma^2 {R_j}^2}{64\beta}. \tag{5.38}$$

5.4.3.1.2 One Rational Manager and One Overconfident Manager

There are 1 rational manager and 1 overconfident manager in the team. For the rational manager, he knows the true ability γ of the other team member. For the overconfident manager, he believes that his ability is $\hat{\gamma}$, and he knows the true ability of the rational manager. The overconfident manager will exert an effort of e_1 and the rational manager will exert an effort of e_2 in the project. The overconfident manager's perceived payoff and the rational manager's actual payoff from the project is shown below.

The rational manager's actual payoff is

$$\Pi_R = \frac{1}{2}\gamma(e_1 + e_2)\frac{R_j}{2} - \beta {e_2}^2. \tag{5.39}$$

The overconfident manager's perceived payoff

$$\Pi_{OC} = \frac{1}{2}(\hat{\gamma} e_1 + \gamma e_2)\frac{R_j}{2} - \beta {e_1}^2, \tag{5.40}$$

where I assume that manager 1 is overconfident and manager 2 is rational.

I calculate that the optimal effort for rational managers is

$$e_R^* = \frac{\gamma R_j}{8\beta}, \tag{5.41}$$

and the optimal effort for overconfident manager is

$$e_{OC}^* = \frac{\hat{\gamma} R_j}{8\beta}. \tag{5.42}$$

I then substitute e_R^* and e_{OC}^* into the actual payoff for rational manager Π_R and the perceived payoff for overconfident manager Π_{OC}. I can find the optimal payoff for the managers below.

The actual optimal payoff for the rational managers is

$$\Pi_R^* = \frac{\hat{\gamma}\gamma {R_j}^2}{32\beta} + \frac{\gamma^2 {R_j}^2}{64\beta}; \tag{5.43}$$

The perceived optimal payoff for the overconfident manager is

$$\hat{\Pi}_{OC} *= \frac{\hat{\gamma}^2 {R_j}^2}{64\beta} + \frac{\gamma^2 {R_j}^2}{32\beta}. \tag{5.44}$$

5.4.3.1.3 Two Overconfident Managers

In this team, the two managers are overconfident. As is assumed before, the two overconfident managers have the same perceived ability $\hat{\gamma}$ and the same level of overconfidence. Therefore, the overconfident manager's perceived ability from the project is

$$\Pi_{OC} = \frac{1}{2}\hat{\gamma}(e_1 + e_2)\frac{R_j}{2} - \beta {e_1}^2. \tag{5.45}$$

The optimal level of effort for managers is

$$e_{OC}^* = \frac{\hat{\gamma} R_j}{8\beta}. \tag{5.46}$$

The overconfident managers will exert an optimal effort e_{OC}^* into the project. I substitute the optimal level of effort e_{OC}^* into the rational manger's actual payoff $\hat{\Pi}_{OC}$ and I can get the optimal payoff for managers. The optimal perceived payoff for the overconfident managers

$$\hat{\Pi}_{OC} *= \frac{3\hat{\gamma}^2 {R_j}^2}{64\beta}. \tag{5.47}$$

5.4.3.2 Shareholders' Expected Value from the Project

I assume that the shareholders know the true ability γ for either the overconfident manager or the rational manager. The shareholders do not directly work for the project, but they will obverse the managers' effort exerted into the project. For shareholders, the firm's value from the project is

$$V = \sum_{i=1}^{2} \gamma_i e_i \frac{R_j}{2} \tag{5.48}$$

for all team compositions.

In the team of two rational managers, the shareholders know that the rational managers will exert a level of effort $e_{\mathrm{R}}^{*} = \frac{\gamma R_j}{8\beta}$ into the project. The equilibrium firm's value from the project is

$$V^{*} = \frac{\gamma^2 {R_j}^2}{8\beta}. \tag{5.49}$$

In the team of one rational manager and one overconfident manager, the shareholders know the optimal effort for the overconfident manager is $e_{OC}^{*} = \frac{\hat{\gamma} R_j}{8\beta}$ and the optimal effort for the rational manager is $e_{R}^{*} = \frac{\gamma R_j}{8\beta}$. The equilibrium value for shareholders

$$V^{*} = \frac{\hat{\gamma}\gamma {R_j}^2}{16\beta} + \frac{\gamma^2 {R_j}^2}{16\beta}. \tag{5.50}$$

In the team of two overconfident manager, the shareholders find the optimal effort $e_{OC}^{*} = \frac{\hat{\gamma} R_j}{8\beta}$, and the equilibrium value for the shareholders is

$$V^{*} = \frac{\hat{\gamma}\gamma {R_j}^2}{8\beta}. \tag{5.51}$$

5.4.4 Continue or Abandon? The Team and The Shareholders Decisions

From the previous section, I obtain the perceived payoff for overconfident managers, the actual payoff for rational managers, and the equilibrium value for shareholders. This will happen in time t_3 where the team decide to continue the project. Now I move one step back on time t_2 to analyse the team's and the shareholders' decisions on whether to continue or abandon the project. It has been assumed that a payoff of A will be paid if the project is liquidated. Managers in the team will receive equal payoff $\frac{A}{2}$ from the project. I assume that if both managers want to continue or abandon the project, they will immediately take the decision. In a team of two overconfident managers or two managers, the two managers will make identical decisions because I assume that the managers have same true ability and perceived ability. The conflicted decisions only occur in a team with one overconfident manager and one rational manager as discuss in the original teamwork model. Specifically, it is possible that the rational manager chooses to abandon the project and the overconfident manager opts to continue the project. Instead of assuming the overconfident manager's dominance in the team, I extend my analysis in such an approach that either the rational manager or the overconfident manager has a chance to win the negotiation if one member does not agree with the other. If the rational manager

chooses to abandon the project and the overconfident manager choose to continue the project, I assume that the overconfident manager can win the negotiation with a probability q and continues the project and that the rational manager wins with a probability $(1-q)$ to abandon the project.

Based on these assumptions, I see different decision scenarios in the three possible team compositions. In addition, I note that V_G^* and V_B^* represent the equilibrium payoff for shareholders from a good project and a bad project respectively. ${\Pi_{RB}}^*, {\Pi_{RG}}^*, {\Pi_{OCB}}^*, {\Pi_{OCG}}^*$ represent the payoff for the rational manager and the overconfident manager from either a good project or a bad project.

5.4.4.1 Two Rational managers

From previous analysis, I know that the actual payoff for rational managers in the team is $\Pi_R^* = \frac{3\gamma^2 {R_j}^2}{64\beta}$. The equilibrium payoff for shareholders is $V^* = \frac{\gamma^2 {R_j}^2}{8\beta}$. It is obvious that in this case $\frac{V^*}{2} > \Pi_R^*$. The possible decision scenario for a team with 2 rational managers is shown below. If the team decides to abandon the project, each team member will receive $\frac{A}{4}$ from the project, and the shareholders will receive $\frac{A}{2}$ from the project. Therefore, I can find the team's decision and the shareholders' preference on the project below.

If $\frac{V_G^*}{2} > \Pi_{RG}^* > \frac{A}{4} > \frac{V_B^*}{2} > \Pi_{RB}^*$, I notice that the payoff from continuing a good project for managers and for shareholders is higher than the value of abandoning the project, which is also higher than the payoff from continuing the project. Therefore, the team will continue a good project and abandon a bad project. Shareholders are also happy with the team's decision. They believe that the team makes a correct decision.

5.4.4.2 One Rational Manager and One Overconfident Manager

In a team with one rational manager and one overconfident manager, the perceived payoff for the overconfident manager is $\hat{\Pi}_{OC} *= \frac{\hat{\gamma}^2 {R_j}^2}{64\beta} + \frac{\gamma^2 {R_j}^2}{32\beta}$, and the actual payoff for the rational manager is $\Pi_R^* = \frac{\hat{\gamma}\gamma {R_j}^2}{32\beta} + \frac{\gamma^2 {R_j}^2}{64\beta}$. The equilibrium value for shareholders is $V^* = \frac{\hat{\gamma}\gamma {R_j}^2}{16\beta} + \frac{\gamma^2 {R_j}^2}{16\beta}$. For an overconfident manager $\hat{\gamma} > \gamma$, I find that $\hat{\Pi}_{OC}{}^* > \frac{V^*}{2} > \Pi_R^*$. The possible decision scenarios are shown below.

If $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2} > \Pi_{RG}^* > \frac{A}{2} > \hat{\Pi}_{OCB} *> \frac{V_B^*}{2} > \Pi_{RB}^*$, the team makes a correct decision by continuing a good project and abandoning a bad project. All team members and the shareholders agree with the decision.

If $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2} > \Pi_{RG}^* > \hat{\Pi}_{OCB} *> \frac{A}{2} > \frac{V_B^*}{2} > \Pi_{RB}^*$, the overconfident manager wants to continue the good project and the rational manager also wants to continue. In a good project case, the team is happy with continuing the project. In a bad project case, the overconfident manager prefers to continue but the rational manager tends to abandon. The conflict occurs and the probability of winning the negotiation will affect the team's decision. Meanwhile, the shareholders would want to continue the good project and abandon the bad project. The uncertainty of the project and the negotiation power will affect the shareholders' recruitment preference on the team composition.

5.4.4.3 Two Overconfident Managers

In a team full of overconfident manager, the overconfident managers' perceived payoff is $\hat{\Pi}_{OC} *= \frac{3\hat{\gamma}^2 {R_j}^2}{64\beta}$ and the shareholders' equilibrium payoff is $V^* = \frac{\hat{\gamma}\gamma {R_j}^2}{8\beta}$. I assume that $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2}$ in either the good-project scenario or the bad-project scenario.

If $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2} > \hat{\Pi}_{OCB} *> \frac{A}{2} > \frac{V_B^*}{2}$, the team will always continue the project no matter whether the project is good or bad, but shareholders only want to continue the good project and abandon the bad project. However, if I take an ex-post analysis, I notice that the shareholders prefer a team with overconfident manager if the project is good, because they work harder and create more value. If the project is bad, the shareholders will not recruit such team, because continuing the project will damage their value.

Now that I reveal the continuation or abandonment decisions from each team composition, I am concerning which team composition the shareholders would like to recruit. It is reasonable to infer that the shareholders prefer a team with two rational managers if the project turns out a bad project, because the team will abandon the bad project. Meanwhile, the shareholders want a team with two overconfident managers if the project turns out a good project since the overconfident manager will work harder and produce more payoff from the project.

The teams with different compositions make different decisions. The shareholders will recruit the team that maximize their payoff from the project based on each team' s decision. The

shareholders observe the managers' true abilities, and they know whether the team makes the right decisions on continuing or abandoning a project. The shareholders need to make trade-off between minimizing the damage from a bad project and maximizing the payoff from a good project. The uncertainty of the project brings in the possibility that all three team compositions could be recruited to achieve the optimal ex-ante firm's value for the shareholders. I now investigate the shareholders recruitment strategy based on the uncertainty of the project.

I begin with the team with two rational managers. I assume that a 2-rational-manager team will continue a good project and abandon a bad project, in which the relationship between the shareholders' value and the managers' payoff is $\frac{V_G^*}{2} > \Pi_{RG}^* > \frac{A}{2} > \frac{V_B^*}{2} > \Pi_{RB}^*$. In this case, the shareholders are happy with the team's decision when the project turns out bad ex post. Even though the rational managers also want to continue good project, the shareholders have better alternatives (2 overconfident managers), and this team composition is not the best choice when the project is a good project.

If I replace a rational manager with an overconfident manager, the team now consists of one rational manager and one rational manager. The overconfident manager will exert more effort into the project than the rational manager, which will increase the payoff for rational manager Π_{RG}^* and Π_{RB}^* and the value for shareholders $\frac{V_G^*}{2}$ and $\frac{V_B^*}{2}$. I assume that the team with one rational manager and one overconfident manager will have a payoff relationship $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2} > \Pi_{RG}^* > \hat{\Pi}_{OCB} *> \frac{A}{2} > \frac{V_B^*}{2} > \Pi_{RB}^*$. Note that the payoff for the rational manager and the value in shareholders increase, the liquidation value of the project $\frac{A}{2}$ shifts to the right. In this case, the overconfident manager prefers continuing the project regardless of a good project or a bad project. The rational manager wants to continue a good project and abandon a bad project. As I have assumed before, if there is a conflicted decision between the managers in the team, specifically, that the rational manager abandons the project and the overconfident manager continues the project, there is a probability q for the overconfident manager to win the negotiation and continue the project, and a probability $(1 - q)$ for the rational manager to win and abandon the project. The shareholders are happy with team's decisions on continuing the good project, but considering the ex post good project, the shareholders are willing to recruit more overconfident managers in the team because overconfident managers exert more effort and create more value for the firm. In the case of a bad project, the shareholders absolutely want the rational manager to win the negotiation and abandon the bad project.

I now move one step further by considering the team with two overconfident managers. The payoff for managers and the value for shareholders increases compared with the payoff in a team with one overconfident manager and one rational manager as one rational manager is replaced with one overconfident manager. The overconfident manager will exert more effort and work harder than the rational manager. Therefore, I have $\hat{\Pi}_{OCG} *> \frac{V_G^*}{2} > \hat{\Pi}_{OCB} *> \frac{A}{2} > \frac{V_B^*}{2}$. The team with two overconfident managers will continue both the good project and the bad project. In this case, the shareholders are happy with the team's decision on continuing a good project, but they do not want the team to continue a bad project.

From the analysis before, I know that shareholders' ex post preference on the team composition will be all rational managers if the project is a bad project and all overconfident managers if the project is a good project. The shareholders and managers are value maximizing, so all rational manager team will abandon the bad project for sure, and all overconfident team will continue the good project and create the highest value from the project. However, the shareholders will decide the team composition before the project's milestone. The shareholders shall estimate their expected firm's value under different team composition considering the uncertainty of the project. I now introduce the probability of the project to be a bad project or a good project into the analysis.

The probability for a good project is p and the probability for a bad project is $1 - p$. The expected value for shareholders on different team compositions are shown below.

For a team with two rational managers, they will continue a good project and abandon a bad project. Therefore, the expected firm's value for shareholders is

$$E(V_{2R}) = pV_G + (1-p)\frac{A}{2}. \tag{5.52}$$

For a team with one rational manager and one overconfident manager, the expected firm's value for shareholders will be

$$E(V_{1R1OC}) = pV_G + (1-p)[qV_B + (1-q)\frac{A}{2}]. \tag{5.53}$$

When the project is a good project, the team continues the project and exert effort into the project. When the project is a bad project, the team has a probability q to continue the bad project with a payoff V_B and a probability of $(1-q)$ to abandon the project and receives a payoff $\frac{A}{2}$.

If a team with two overconfident managers chooses to continue either a bad project or a good project, the shareholders' expected value is

$$E(V_{2OC}) = pV_G + (1-p)V_B. \tag{5.54}$$

I now compare the value for different team composition and find the critical value for the probability for shareholders to choose different team compositions.

I substitute $V^*_{G(2R)} = \frac{\gamma^2 {R_G}^2}{2\beta}$, $V^*_{B(1R1OC)} = \frac{\hat{\gamma}\gamma {R_B}^2}{4\beta} + \frac{\gamma^2 {R_B}^2}{4\beta}$, $V^*_{G(1R1OC)} = \frac{\hat{\gamma}\gamma {R_G}^2}{4\beta} + \frac{\gamma^2 {R_G}^2}{4\beta}$, and $V^*_{G(2OC)} = \frac{\hat{\gamma}\gamma {R_G}^2}{2\beta}$, and $V^*_{B(2OC)} = \frac{\hat{\gamma}\gamma {R_B}^2}{2\beta}$ into $E(V_{1R1OC})$ and $E(V_{2R})$ and $E(V_{2OC})$. I now find that the ex-ante expected value for shareholders are given below.

The expected value for shareholders from a team with two rational managers is

$$E(V_{2R}) = p\left(\frac{\gamma^2 {R_G}^2}{2\beta}\right) + (1-p)\frac{A}{2}. \tag{5.55}$$

The expected value for shareholder from a team with one rational manager and one overconfident manager is

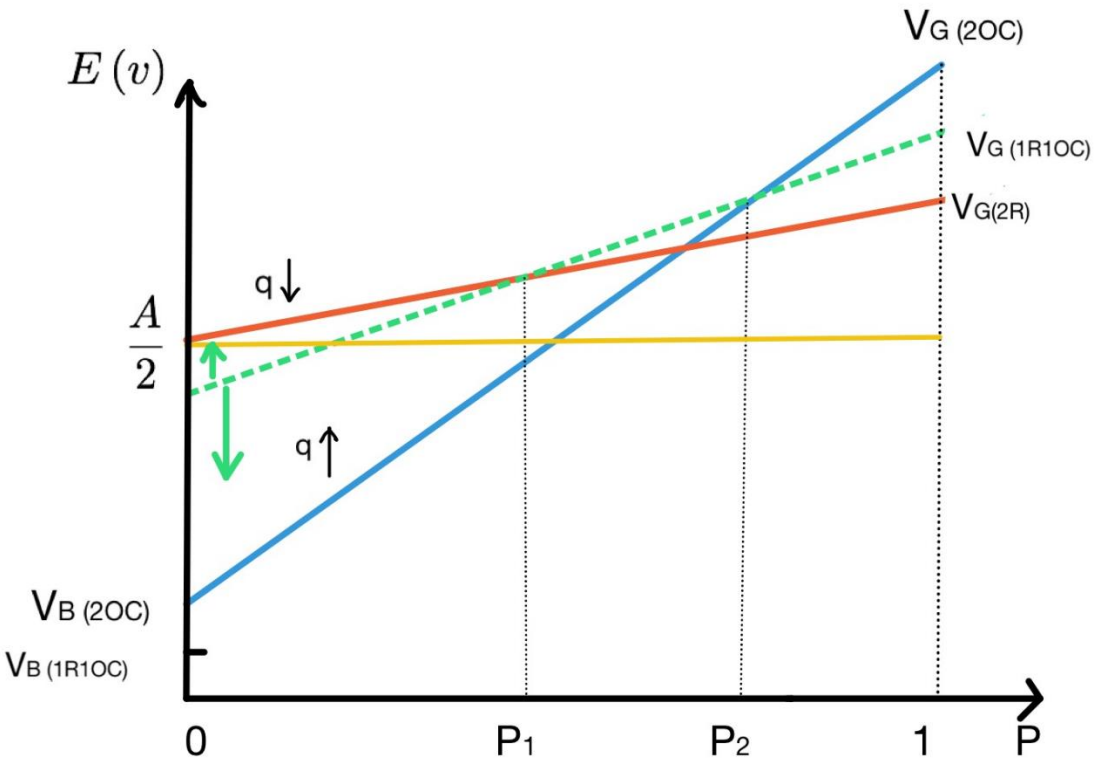
$$E(V_{1R1OC}) = p\left(\frac{\hat{\gamma}\gamma {R_G}^2}{4\beta} + \frac{\gamma^2 {R_G}^2}{4\beta}\right) + (1-p)[q\left(\frac{\hat{\gamma}\gamma {R_B}^2}{4\beta} + \frac{\gamma^2 {R_B}^2}{4\beta}\right) + (1-q)\frac{A}{2}]. \tag{5.56}$$

The expected value for shareholders from a team with 2 overconfident managers is

$$E(V_{2OC}) = p\frac{\hat{\gamma}\gamma {R_G}^2}{2\beta} + (1-p)\frac{\hat{\gamma}\gamma {R_B}^2}{2\beta}. \tag{5.57}$$

I put the shareholders' expected firm's value of different team compositions as dependent variable and the probability of a good project as an independent variable in the figure. The result below shows how probability of the project and the probability of winning the negotiation affect the team's decision and the shareholders' preference over team composition.

Figure 5.4.1 Shareholders' Expected Value with Different Team Compositions



Note. The figure demonstrates relationship between the uncertainty of the project and the ex-ante expected firm's value for the shareholders under different team compositions. The figure also shows the shareholders' preference on team's composition (two rational managers, one overconfident manager and one rational manager, and two overconfident managers) on different probabilities of the project.

The figure above illustrates that the team the expected value of the shareholders from the project is affected by the team composition and the probability of the nature of the project. The yellow line shows value from abandoning the project. The red line outlines the expected value of the shareholders with a team of two rational managers, and the blue line shows the expected value of the shareholders with a team of two overconfident managers. The green dash line represents the expected value of the shareholders with a team of one overconfident manager and one rational manager. At point $p = 0$, the project is 100% a bad project, the team with two rational managers will abandon the project and redeem the liquidation value $\frac{A}{2}$. For a team with two overconfident managers, they always want to continue the project. However, continuing a bad project will damage the firm's value, which is reflected as a point $V_{B(2OC)}$ lower than the liquidation value $\frac{A}{2}$. For a team with one rational manager and one overconfident manager, when they have conflicting decisions, I assume that the overconfident manager has a

probability q to win the negotiation and dominates the team. Otherwise, the rational manager has a probability of $(1-q)$ to dominate. In the case where $q=1$, meaning that the overconfident manager always forces the team to continue the project, the team's decision damages the value for shareholders, resulting in the point $V_{B(1R1OC)}$. I note that a team with two overconfident managers will exert more effort into the project than a team with one overconfident manager and one rational manager, so the point $V_{B(1R1OC)}$ is lower than $V_{B(2OC)}$ on the vertical axis. With q decreases from 1 to 0, the rational manager is more likely to win the negotiation and abandon the project, the green dashed line shifts clockward until it reaches $\frac{A}{2}$ on the vertical axis where the rational manager always wins, and the team will abandon the bad project.

When the probability of a good project increases, the ex-ante expected firm's value from the project goes up because the good project will bring higher payoff than the bad project, and the team is willing to continue a good project. I notice that the marginal growth of expected firm's value of a team of two overconfident manager is the highest among all three team compositions since the overconfident managers has higher marginal productivity than the rational managers. As the probability of a good project $p=1$ where the project is sure to be a good project, all three teams will continue the project, but as the overconfident managers exert the most amount of effort into the project, the expected firm's value for the shareholders is the highest of all three team compositions.

The figure above shows the effect of the uncertainty of the project on the manager's recruitment decision. If the conflict happens, the overconfident manager has a probability q to win to continue the project. and the rational manager has a probability $(1-q)$ chance to force the team to abandon the project. If the probability of a good project is relatively low $(0 \leq p < p_1)$, the shareholders will prefer recruiting a team with two rational managers because the ex-ante expected value for shareholders is the highest among three team compositions. If the probability of a good project is between p_1 and p_2 $(p_1 \leq p < p_2)$, the shareholders will recruit a team with one rational manager and one overconfident manager. On one hand, the shareholders would want the overconfident manager to increase the value created from continuing the project. On the other hand, in the case of a bad project, the shareholders are inclined to the rational manager to dominate and abandon the project. If the probability of a good project is relatively high $(p_2 \leq p \leq 1)$, the shareholders will recruit a team with over

overconfident managers as the shareholder are expecting a good project and seeking to maximize their payoff from the project with higher effort exerted into the project.

In this section, I extend my model by introducing the uncertainty of the project. I assume that the shareholders are investing in a project with the uncertainty of being either a good project or a bad project. To maximize the firm's value from the project, the shareholders must recruit a team that brings them the highest expected firm's value. I find in the model that the shareholders' recruitment decision is affected by the uncertainty of the project. If the project is highly likely to be a bad project, the shareholders are intended to recruit a team with two rational managers. If there is a medium probability that the project is a bad project, the shareholders prefer a team with one rational manager and one overconfident manager. If the project is more likely to be a good project, the manager will recruit a team with two overconfident managers. In addition, I also find that the probability of a rational or an overconfident manager winning the negotiation when they have opposite opinions also affect the team's decision and the shareholders' strategy. In the next section, I will establish a numerical example to demonstrate my model.

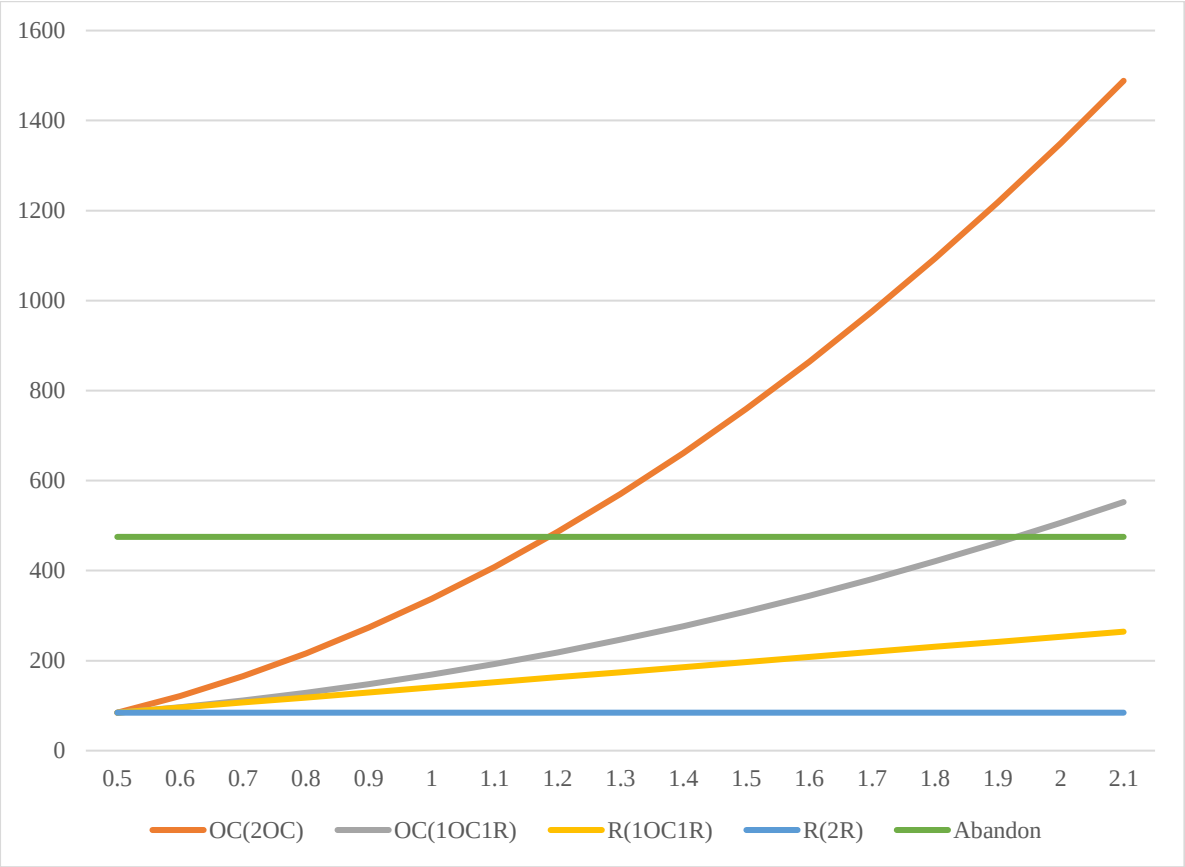
5.5 A Numerical Example of the Uncertainty of the Project

According to the model, I know that the ex-ante team composition the shareholders recruit depends not only on the probability of a good project or a bad project, but also on the probability of the overconfident manager winning the negotiation. In this section, I take a numerical example in the model to illustrate how the team's decisions on continuing and abandoning the project and what team composition the shareholders will recruit for the project. I will then calculate the payoff for the managers in each team composition for a bad project and a good project separately.

5.5.1 The Case of a Bad Project

In the numerical example, I suppose that the overconfident manager and the rational manager has a true ability of $\gamma = 0.5$, and the cost of effort $\beta = 50$. If the project is liquidated, the total redemption value is $A = 1900$. In the case of a bad project, I assume that the original payoff from the project is $R_B = 600$ if the project is continued. The figure below shows the value for shareholders and the payoff for managers with the change of level of overconfidence in different team compositions.

Figure 5.5.1 Managers' payoff from A Bad Project

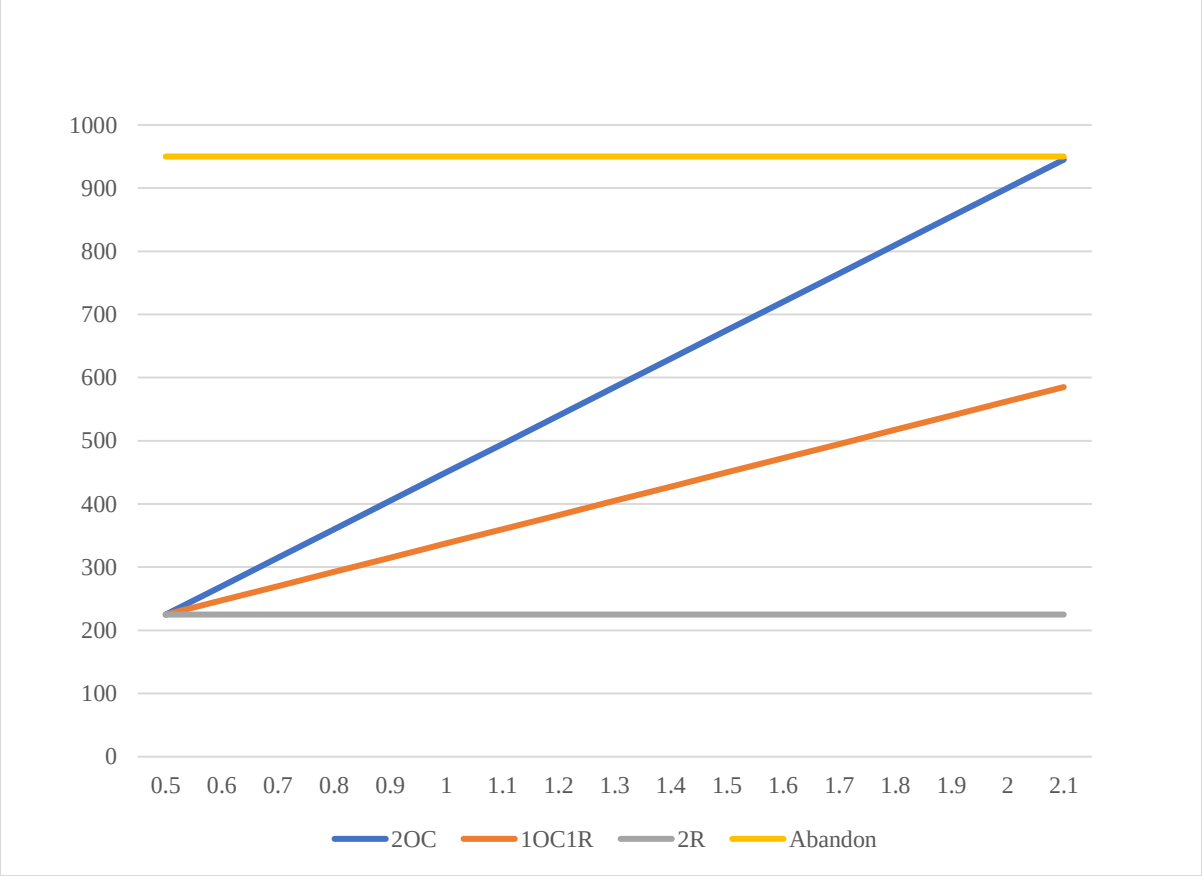


Note. The figure shows the perceived payoff for a team of two overconfident managers, the actual payoff for a team of one rational manager and one overconfident manager, and the actual payoff for a team of two overconfident managers from a bad project respectively. Calculated from $\gamma = 0.5,\ \beta = 50, A = 1900, R_B = 600$.

This figure shows individual's payoff from the project in different team compositions. The rational managers know his true ability and I show their actual payoff in the figure. The overconfident managers make decision based on their perceived ability and perceived payoff, so I put the managers' perceived payoff in the figure. The orange line shows the perceived payoff for the overconfident managers in a team of two overconfident managers. The grey line shows the perceived payoff for the overconfident manager in a team of one overconfident manager and one rational manager. The yellow line represents the actual payoff for the rational manager in the team of one overconfident manager and one rational manager, and the blue line the actual payoff for the rational managers in a team of two rational managers. To make my analysis consistent with the model assumption, I choose $\hat{\gamma} = 2$ in my analysis. For a team with two rational managers, they will abandon the project and receive liquidation value from the project, which is represented by a green line parallel to the horizontal axis. In the team with one rational manager and one overconfident manager, I observe that the overconfident

manager's perceived payoff is above the value from abandoning the project while the rational manager' payoff is lower than the value of abandoning the project. In this case, the rational manager wants to abandon the project, but the overconfident manager prefers continuing the project, from which the conflict between the team members occurs. For a team with two overconfident managers, the managers' perceived payoff is higher than the value from abandoning the project, so the team members both agree to continue the project.

Figure 5.5.2 Shareholders' Value from A Bad Project



Note. The figure shows the firm's value for shareholders with a team of two overconfident managers, a team of one rational manager and one overconfident manager, and a team of two overconfident managers from a bad project respectively. Calculated from $\gamma = 0.5,\ \beta = 50, A = 1900, R_B = 600$.

Next, I calculate the firm's value for the shareholders. This figure shows how the shareholders' value changes with the level of overconfidence. I notice that for a bad project, if the overconfident manager's perceived ability is $\hat{\gamma} = 2$, the shareholders will prefer abandoning the project in any team composition, because the figure above illustrate that the value for the shareholders from continuing the project is less than the value from liquidating the project. This consists with my theoretical model that the shareholders would like to abandon the project with all team compositions. I note that the team with over overconfident managers creates the

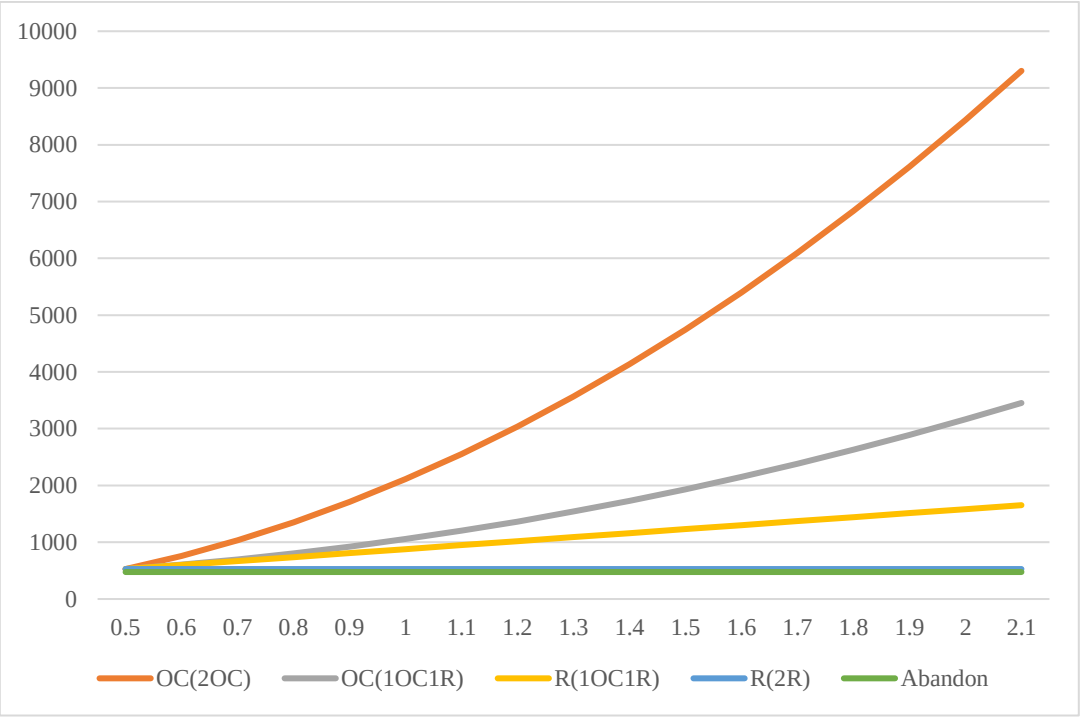
highest value from the project simple because the overconfident manager works harder for the project.

I now combine team's decision with the shareholder's preference. For a bad project, the shareholders believe that the team with two rational managers make the right decision by always abandoning the project, but the team with two overconfident managers damages their value by continuing the project. When the team consists of one rational manager and one overconfident manager, the team's decision depends on the probability of winning the negotiation.

5.5.2 The Case of a Good Project

I now discuss the condition that how the shareholders and the team's decisions on a good project. To find the effect of the probability of a good project on the shareholders' recruitment strategies, I keep the assumption that the true ability for the managers is $\gamma = 0.5$, the cost of effort $\beta = 50$, and the liquidation value for the project $A = 1900$, the overconfident manager's perceived ability to $\hat{\gamma} = 2$. The difference with the bad project is that the for a good project $R_G = 1500$. The figure below shows the individual's payoff from a good project.

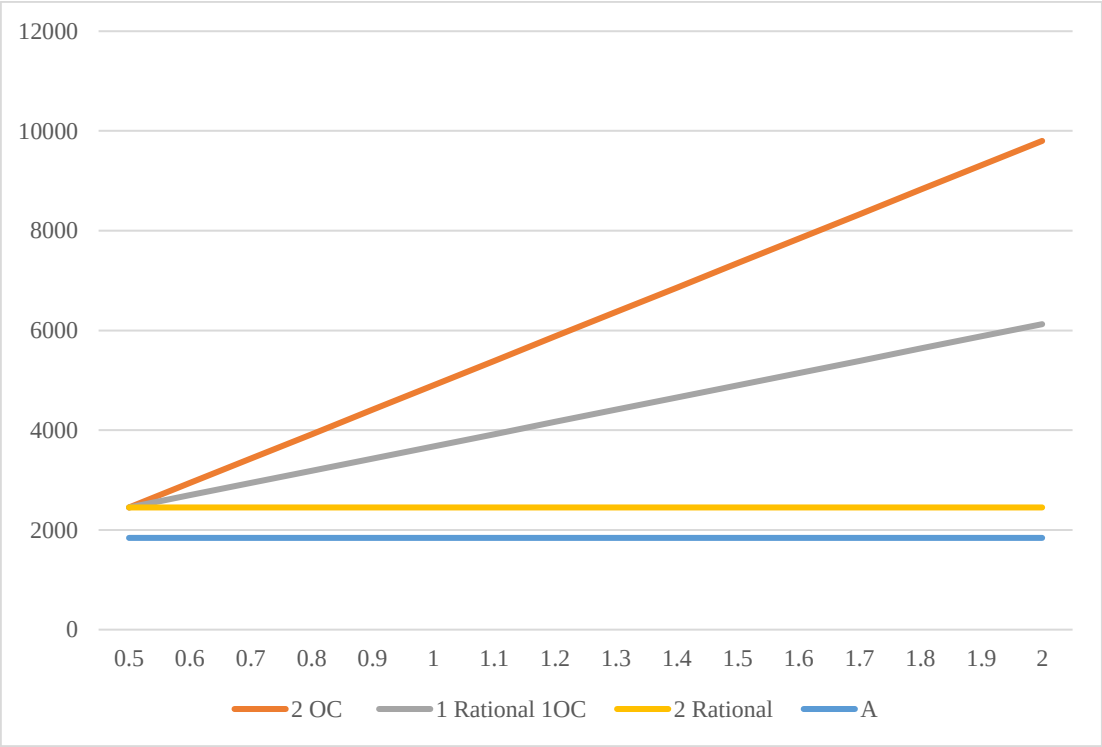
Figure 5.5.3 Managers' payoff from A Good Project



Note. The figure shows the perceived payoff for a team of two overconfident managers, the actual payoff for a team of one rational manager and one overconfident manager, and the actual payoff for a team of two overconfident managers from a good project respectively. Calculated from $\gamma = 0.5$, $\beta = 50$, $A = 1900$, $R_G = 1500$.

For the managers in the team, as I mentioned above, all team members are willing to continue the good project. The figure above illustrates the assumption in the model. The overconfident managers in a team of two overconfident managers, a team of one rational and one overconfident manager, and a team of two rational managers all agree to continue the project. The managers believe that their payoff from continuing the project is higher than the payoff they receive from liquidating the project.

Figure 5.5.4 Shareholders' Value from A Good Project



Note. The figure shows the firm's value for shareholders with a team of two overconfident managers, a team of one rational manager and one overconfident manager, and a team of two overconfident managers from a good project respectively. Calculated from $\gamma = 0.5,\ \beta = 50, A = 1900, R_B = 1500$.

In the good project case, I want it such that all team composition will continue the project and that the shareholders think it is the right decision to do so. The red line, grey line and yellow line represent the value for shareholders on a team with 2 overconfident managers, 1 overconfident manager and 1 rational manager, and 2 rational managers respectively. From the figure above I observe that the shareholders would like to continue the project on any team compositions given that the value from continuing the project is higher than the value from abandoning the project represented by the blue line.

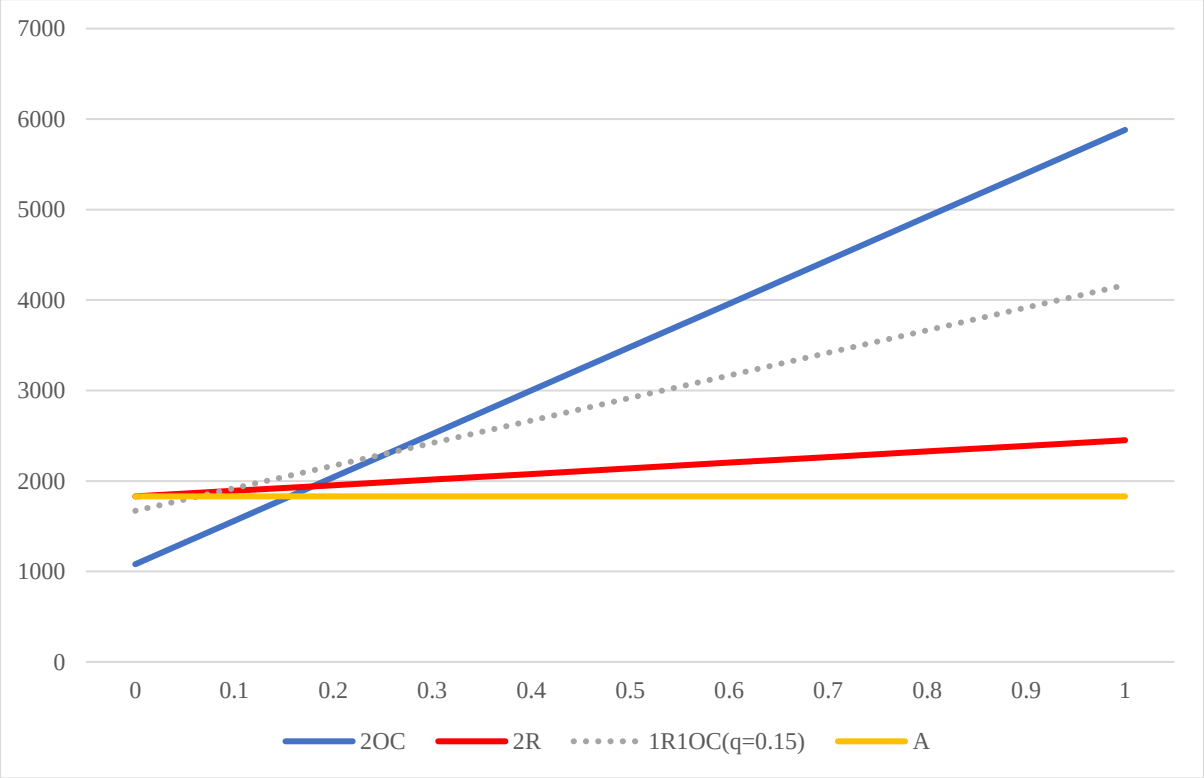
Combining the shareholders' preference and the team's decisions, I am convinced that for all the teams with different team compositions they are willing to continue the project, and the

shareholders agree with the right decision. The shareholders will, consequently, choose a team with 2 overconfident managers to recruit if they know for sure that the project is a good project, because this team will exert highest effort into the project and create most value among the 3 team compositions.

By introducing the uncertainty from the project, the shareholders ex-ante recruitment decisions will be affected by the probability of a good project or a bad project. Due to the uncertainty of the project, the shareholders need to recruit a team which will make the correct decision and create the optimal value for them. In addition, I assume that if the overconfident manager and the rational manager have conflicts, the probability for the overconfident manager to win the negotiation and continue the project is q.

Based on my analysis before, the expected value for shareholders with a team of two rational managers is $E(V_{2R}) = pV_G + (1-p)A$, noting that the team will continue a good project and abandon a bad project. For a team with one rational manager and one overconfident manager the expected value for shareholders will be $E(V_{1R1OC}) = pV_G + (1-p)[qV_B + (1-q)A]$, noting that the team continues a good project and negotiates on the decision upon a bad project with the existence of conflicting preferences from the team members. With a team of two overconfident managers who choose to continue either a bad project or a good project, the shareholders' expected value is $E(V_{2OC}) = pV_G + (1-p)V_B$. The perceived payoff for the overconfident manager is $\hat{\gamma} = 2$ and the true ability for the managers is $\gamma = 0.5$. The figure below shows the effect of the probability of the project on the shareholders' value from the project.

Figure 5.5.5 Shareholders' Expected Value with Different Team Compositions



Note. The figure shows the ex-ante expected firm's value for the shareholders based on recruiting a team with two rational managers, a team of one rational and one overconfident manager (with the probability of the rational manager's domination of the team $q = 0.15$), or a team of two overconfident managers respectively.

I assume that the shareholders would always want to continue a good project and abandon a bad project. The ex post optimal team composition would be two overconfident managers for a good project and one rational manager for a bad project. However, because of the uncertainty of the project and the negotiation outcomes, the shareholders will consider a mixture of overconfident managers and pursue expected optimal value from the project. In this figure, I choose the optimal value for the shareholders from the project when the level of overconfidence is $\hat{\gamma} = 2$ from 3 different team compositions.

The figure above illustrates how shareholders choose team composition to recruit. The blue line represents the shareholders' expected value from a team with two overconfident managers. The redline represents the shareholders' expected value from a team with two rational managers. The grey dashed line represents the shareholders' expected value from a team with one rational manager and one overconfident manager. The dashed line indicates that the expected value for shareholders varies with the change of probability for the overconfident manager to win the negotiation. The figure above shows the case where $q = 0.15$. With the

increase of q, which means that the overconfident manager is more powerful to win the negotiation, the grey line will rotate and shift anti-clockwise. Meanwhile, when q decreases, the power of the rational manager increases, and the grey line will rotate and shift clockwise.

How the shareholders recruit ex-ante team members for the project? The answer is displayed with different probability of the project. Remind that p is the probability of a good project, therefore, when the probability of a good project is relatively low, the shareholders want to recruit a team with two rational managers because they will abandon the project. With the increase of probability of the good project, at a certain probability where the grey line crosses the red line, the shareholders would like to recruit a team with one rational manager and one overconfident manager, because on one hand, the project is still likely to be a bad project, but on the other hand, it is possible enough to be a good project and the shareholders want to continue the project and the overconfident manager will do so. The shareholders know that an additional overconfident manager will increase the effort exerted into the project and create more value for them. As the probability of a good project grows to the point where the blue line crosses grey line, the shareholders are willing to recruit two overconfident managers to maximize their value form the project.

To conclude, from the numerical example, I argue that the shareholders' recruitment strategy is affected by the probability of a good project and the negotiation power of the team members over each other. If the project is highly likely to be a bad project, the shareholders will recruit a team with two rational managers. With a higher probability of a good project, the shareholders will recruit a team with one rational manager and one overconfident manager, they want to retain the potential of abandon the project as well as bringing a possible addition in the value of a good project. If the project is highly likely to be a good project, the shareholders will recruit a team with two overconfident managers. They want to ensure that the team can exert more effort into the project and achieve maximum payoff from the project.

5.6 Conclusion

In this chapter, I develop a game theoretical model to analyse the effect of overconfidence and teamwork on the project investment decisions. In the model, I argue that the team's decision depends on the corporation and the interaction between the team members. In a team with one rational manager and one overconfident manager, the team's decision is affected by the manager's level of overconfidence. I find that at lower level of overconfidence, the rational manager and the overconfident manager cooperate and agree to abandon the project. At a

medium level of overconfidence, the overconfident manager prefers continuing the project, but the rational manager wants to abandon the project. The overconfident manager can force the team to continue the project and create a souring relationship in the team. The rational manager may choose to retaliate over the overconfident manager's decision, which results in a damage in the payoff from the project. At a substantial level of overconfidence, the overconfident manager exerts excessively high level of effort into the project and the team both agree to continue the project. From the conflicting decisions in the team and the souring relationship, I extend my model in two ways: the overconfident manager's awareness of the retaliation and an extra manager in the team. I find that the less the overconfident manager's understanding of the retaliation, the more likely the team will continue the project at lower level of overconfidence. The addition manager will break the balance of the overconfident manager and the rational manager, when applying he principle of majority, I can avoid team's souring relationship and retaliation.

Furthermore, I extend my model by introducing the uncertainty of the project. I bring in the shareholders' role of recruiting a project management team to work for the project. The possible team compositions including two overconfident managers, one rational manager and one overconfident manager, and two rational managers. The team with two rational managers or two overconfident managers will always reach agreement when making continuation or abandonment decisions. The team with one rational manager and one overconfident manager can have conflicts but I assume that either the rational manager or the overconfident manager has a chance to win the negotiation. Based on the assumption, I find that the shareholders' recruitment strategy is related with the uncertainty of the project and the manager's power of negotiation in the team. If the project is highly likely to be a bad project, the shareholders will recruit a team with two rational managers. At a medium level of probability, the shareholders would like to recruit a team with one rational manager and one overconfident manager. If the project is more likely to be a good project, the shareholders shall recruit a team with two overconfident managers.

In the teamwork game theoretical model, I analyse the effect of the team members' reciprocity and interaction on the team's decision making. Based on the theoretical model, I implement a behavioural finance experiment to demonstrate my model. In the next chapter, I will introduce the procedure and the result of the experiment.

Chapter 6: Behavioural Finance Experiment: A Team's Decision

6.1 Theoretical Background

6.1.1 Theoretical Framework

In chapter 5, I extend the game theoretical model from a single manager's perspective to a team's perspective on the investment of a project. The model reveals that within a team with one rational manager and one overconfident manager, the team's decision on continuing or abandoning the project is related with the manager's level of overconfidence. In addition, the interaction between the team members also affects the managers' payoff from the project and the firm's value. The model raises the following propositions in terms of team members' decisions and reciprocity.

In a team of an overconfident manager and a rational manager, the team members work together and make decisions on whether to continue or abandon the project.

- At lower level of overconfidence, the rational manager and the overconfident manager both agree to abandon the project. The team members cooperate and abandon the project.
- At a medium level of overconfidence, the overconfident manager wants to continue the project, but the rational manager prefers abandoning the project. The rational manager and the overconfident manager have conflicting ideas. Assuming that the overconfident manager dominates the team and forces the team to continue the project, the rational manager feels frustrated and angry about the overconfident manager's decision, the souring relationship appears, and the rational manager retaliates.
    - The retaliation action from the rational manager will increase the critical level of overconfidence, making the overconfident manager work harder to be able to continue the project.
    - As the overconfident manager becomes increasingly aware of the retaliation from the rational manager, more effort is required for the overconfident to exert into the project if he wants to continue the project.
- If the manager is strongly overconfident, both the overconfident manager and the rational manager agree to continue the project.

According to the analysis in the theoretical model, I implemented a behavioural finance experiment to demonstrate the effect of overconfidence and team's reciprocity on the team member's payoff and the team's decision. In this chapter, I will discuss the development and the findings of the experiment.

6.1.2 Hypotheses to be Tested

In the teamwork game theoretical model, I keep my assumption that the managers are self-interested and seeking to maximize their payoff from the project. The manager will exert more effort into the project if he is more overconfident. The hypotheses to be tested in the experiment are based on the propositions in the teamwork theoretical model in chapter 5.

Hypothesis 1: Managers who are overconfident are more likely to continue a project than the rational and underconfident managers.

Hypothesis 2: Managers who are more overconfident will exert more effort into the project.

In chapter 5, I discover the positive and negative effect of overconfidence on team's decision. Lower level or higher level of overconfidence lead to agreement on termination or abandonment decision. However, medium level of overconfidence results in conflicted decisions on the project, which further causes souring relationship and damage in the payoff from the project. Therefore, in the experiment I make a few hypotheses on the reciprocity in the team.

Hypothesis 3: The team's decision on whether to continue or abandon the project depends on the overconfident manager's level of overconfidence

- At lower level of overconfidence, both managers agree to abandon the project.
- At medium level of overconfidence, the overconfident manager continues but the rational manager abandons the project.
- At higher level of overconfidence, both managers agree to continue the project.

Hypothesis 4: If the overconfident manager dominates the team and forces to continue the project, the rational manager will choose to retaliate the team, causing a decrease in the payoff from the project.

Hypothesis 5: When the team members have conflicts, the rational manager retaliates and damages the payoff from the project.

Hypothesis 6: When the team members have conflicts, there is a negative relationship between the overconfident manager's perceived payoff and his awareness of the rational manager's retaliation.

In the following sections, I will introduce the design of the experiment based on the theoretical background and the hypotheses and the findings from the data collected from the experiment. I aim to test the hypotheses above in the experiment.

6.2 Methods

6.2.1 Participants

The experiment was developed online on Gorilla.sc. The branch structure and the counting task were built via Gorilla.sc online experimental platform. Before I sent out invitations to the participants, I made several tests to make sure that the experiment worked well, and the participants with different levels of overconfidence were correctly assigned to the corresponding information and tasks. The experiment was distributed via a unique link from Qualtrics. The participants started the experiment on computer using the link provided from Qualtrics and were redirected to the experiment on Gorilla.sc. The experiment was implemented during February to May 2021. The participants were undergraduate students from University of Bath. A total of 88 valid responses were collected in the experiment. All responses were kept anonymous during the experiment and in the data analysis. Any incomplete responses were discarded and removed from the dataset. The composition and the characteristics of the participants are shown in table 6.2.1 below.

Table 6.2.1 Composition of Experiment Participants

Gender		
Female	77	87.50%
Male	9	10.20%
Prefer Not to Say	2	2.3%
Age		
18-24	88	100%
Total Participants	88	100%

Note. N=88. The table summarizes the number of the participants in terms of genders and age groups. Drawn from the data of all valid responses in the experiment.

6.2.2 Experient Materials

The experiment was implemented to test the effect of overconfidence and team's reciprocity on the team's decision based on the theoretical model in chapter 5. Based on the hypotheses in

the experiment, the variables I obtained from the experiment or analysis includes the participant's true ability, the participant's perceived ability, the participant's level of overconfidence, the effort exerted into the project, the overconfident subject's awareness of the souring relationship, the rational and the underconfident subject's degree of retaliation and the cost of effort for each participant. According to the hypothesis, I demonstrated the relationship between the level of overconfidence and the effort exerted into the project. I also analysed the team's reciprocity and team's decision on the project using the data I collected from the experiment

Similar to the single manager experiment, I adopt the general knowledge questions task to obtain the true ability, the perceived ability and the level of overconfidence from the participants. The general knowledge question task replicated the approach from Pikulina et al (2014) on their experiment of confidence, effort and investment. The participants she recruits are finance and management students, so she provides them with 20 financial knowledge questions. My participants are students from different divisions in the university, so I design a general knowledge question task for the participants. The actual number of correct answers is treated as the actual ability for the manager and the estimated number of correct answers as the perceived ability. On the online experiment platform, I was able to split the overconfident subjects and the rational and underconfident subjects into two directions based on the comparison between the true correct answers and the estimated correct answers. The participants who estimate more correct answers than the actual correct answer will be treated as overconfident subjects. The participants who are well-calibrated and know exactly how many correct answers they give are rational subjects. The participants who underestimate their number of correct answers are underconfident subjects. The difference between the perceived number of correct answer and the actual number of correct answers are the level of overconfidence. The experiment is divided into two branches which includes different investment information for the participants.

For the participants' effort level, I designed a real effort task to capture the effort exerted in the project, I adopt the method from Vranceanu et al (2015) from who designed a number-counting task to observe the effort level. In their experiment, they asked the participants to count a specific number in blocks of random numbers. The amount of correctly counted number represented the level of effort in the experiment, and the payoff for the participants are calculated based on their correct answers. Built on their design, my task requires the

participants to count the number of 7s in a chart of random numbers, and the number of correct counts are treated as the effort exerted into the project.

For investment decisions, I created a project investment background for the participants to experience before they make the termination or abandonment decision. The participants were paired with a virtual teammate depending on their level of overconfidence, and the rational individual's retaliation and the overconfident individual's awareness of retaliation were obtained from self-reported Likert scale from the participants.

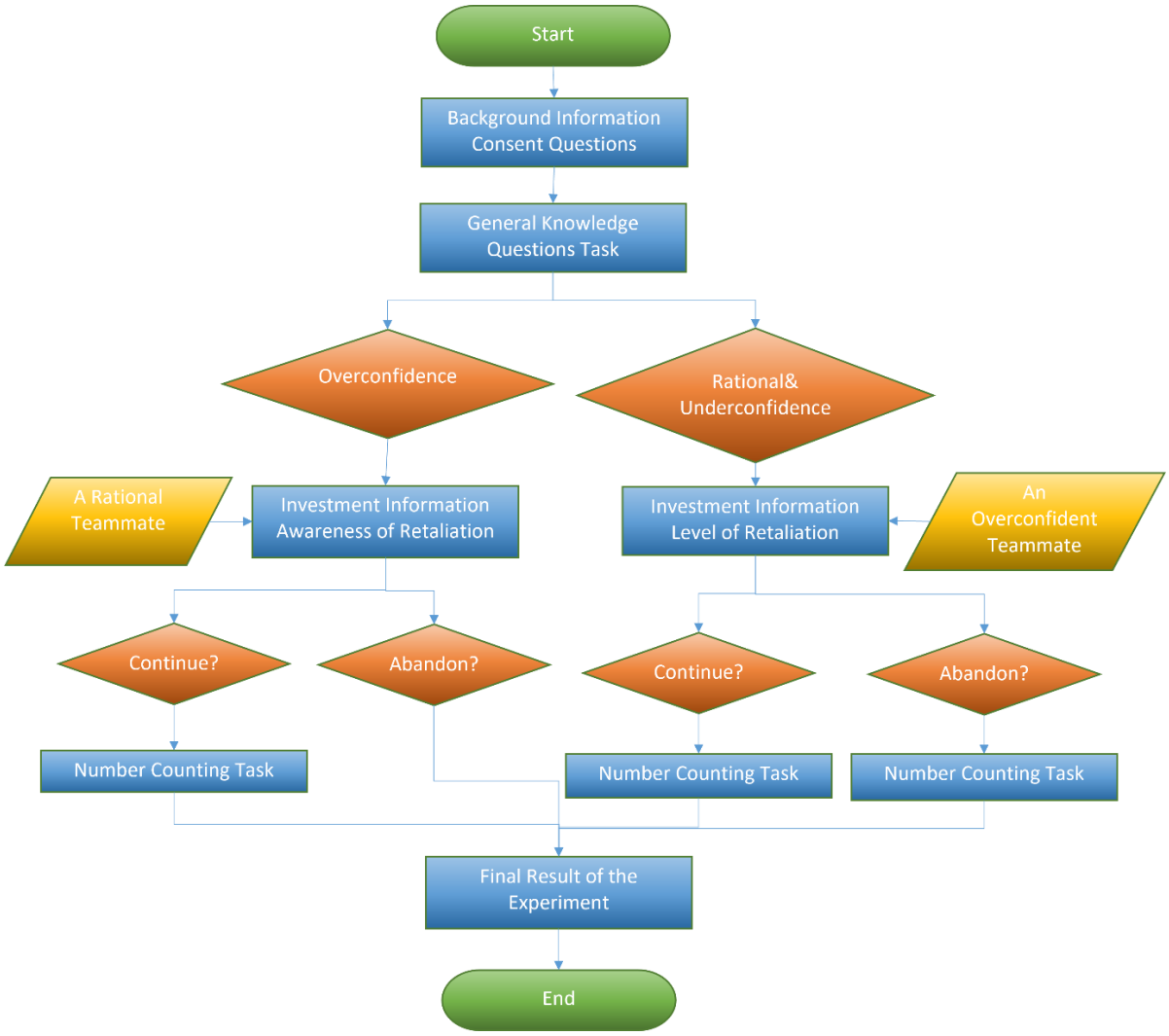
6.2.3 Procedure

The experiment consists of 3 sections. Section 1 contains consent questions and background information including age, gender and ethnicity. Section 2 is a question-answering task where I capture the subjects' levels of overconfidence. Based on their performance in section 2, I divide the participants into 2 groups, namely 'Overconfidence' and 'Rational&Underconfidence'. Section 3 contains an investment decision and a real effort task for the participants to complete. After the participants finished all the tasks, they were provided their results, and the experiment ended. The flow chart summarizes the procedure of the experiment.

The experimental design was driven by the theoretical evidence from the teamwork model in Chapter 5. Researchers in behavioural finance and negative reciprocity in team argue that retaliatory actions are triggered by individual's self-interest and his belief of being treated unfairly (Asher et al, 2012). The authors implemented a social game experiment to demonstrate the negative reciprocity and retaliation by creating a negative interaction between agents and participants and giving participants unfair treatment in games. Additionally, according to Fehr and Gächter (2000) and Fon and Parisi (2005), retaliation appears when subjects are suffering harm from violation of fairness process, and the subjects tend to punish those against their interests and benefits, even if it is costly to do so. Therefore, based on the theoretical background and inspired by empirical research on negative reciprocity and retaliation, I use the similar approach to manipulate negative reciprocity. As retaliation is mostly caused by unfairness and inequality in the team, in the experiment I create an asymmetric treatment for the rational and underconfident participants to experience the break of fairness in the decision-making process in the team. The underconfident and rational participants are confronted with a forced continuation by their overconfident teammate which may damage their benefits from the project. Then the participants are asked their feelings

towards their overconfident teammates' decisions and whether they would take any revenge to punish their teammates. The whole procedure of the experiment is shown in the figure below.

Figure 6.2.1 Procedure of the Experiment



Note. N=33. The figure shows the whole process of the experiment. It displays the conditions on different branches and the corresponding treatments on the branches.

At the beginning of the experiment, I provided the participants with a welcome page of the structure and the approximate duration of the experiment. The participants read the instructions carefully and familiarised themselves with the experiment before they started. In Section 1, the participants were presented with a few consent statements on anonymity and access of the data. Following the consent forms were the questions on the participants' gender, age group and ethnicity. They were also told that if they failed to complete the experiment, their responses would be discarded from the experiment.

Similar to the single manager experiment, in section 2, I presented a set of 20 general knowledge questions to the participants. I noted that these general knowledge questions were different from the questions in the single manager experiment. First, the participants were required to answer the general knowledge questions without time limit. Each question was provided with two choices, and only one choice was the correct answer for the question. The participants were told that they could not search the answer from any source during the experiment, and that the number of correct answers would affect the outcome in project investment in section 3. The more correct answers they could provide in the task, the better results they might achieve in the next section. After they finished all questions, they then estimated how many questions they answered correctly. Based on their correct answers and estimation, I divided the participants into two groups, 'Overconfident' and 'Rational & Underconfidence'. Each group was provided with different conditions and information in section 3.

For the participants in the group 'Overconfidence' participants, they were told that they were working with another rational teammate. The rationality was reflected by providing the participants with the information of identical estimated number and actual number of correct answers from the teammate. The overconfident subject was provided with the information of the project they were working on and the information of his teammate, including his partner's performance on the general knowledge tasks and the estimation of his performance. The participants were informed that they and their teammate worked together on a project.

The team was working for a motor corporation which launched a new model of sports utility vehicle (SUV). The firm was aiming to maximize the firm's value from the project. The participants were also seeking to obtain an optimal payoff from the project. The participants were informed that the project did not perform as it had been expected, and that it failed in the past year and the team should decide whether to continue or abandon the project. Before the overconfident participants made the decision, they were told that if they choses to abandon the project, the project would terminate, and that they would receive the liquidation value from the project. If they continued the project, they would be directed to a real effort task in which the better they performed, the more payoff from the project he could achieve. He was also noticed that his teammate wanted to abandon the project, but he could force his teammate to continue the project by simply clicking 'continue' button in the experiment. I also asked the participants 'From 0 (Not at all) to 10 (Absolutely will), to what extend do you think your teammate will retaliate over your decision to continue the project?'. After the participants understood the

investment background, the participants made their decision on whether to continue or abandon the project. If participants chose to abandon the project, they will be shown the result and liquidation value from the project, and the project ended. If participants chose to continue the project, the instruction of the real effort task was displayed. The participants were told that their teammates were working together with them, and they performed the real-effort task. After they finished the task, their performance and the payoff from the project were revealed to them, and the experiment ended.

For rational and underconfident subjects, they were informed with different instructions on performing the counting task. The rational and underconfident managers were denoted that they were working with an overconfident manager. The details of the project and their partners were shown to the participants before they made their decisions. The project information given to the rational and underconfident participants were the same as the information given to the overconfident participants. The rational and the underconfident participants were also informed that their teammate was an overconfident teammate, and I provided them with the actual number and the estimated number of correct answers for his teammate. Before the participants made the decision, they were told that if they had conflicted decisions with their teammate, the overconfident manager, they could retaliate by reducing the total payoff from the project. The subjects then needed to decide whether to continue or abandon the project. If they chose to continue the project, they were told that their teammate also wanted to continue the project. The participants were directed to starting page of the real effort task. If they chose to abandon the project, they were informed that their teammate, the overconfident partner, forced the team to continue the project. I then asked whether they felt angry and upset on the decisions and whether they retaliated. The participants reported their level of retaliation by answering 'From 0 (Not at all) to 10 (Definitely Yes), to what extend do you think you will take retaliation response to this situation?'. Then they undertook the counting task, acquired the result of the project, and finished the experiment.

In section 3, the most important part is the real effort task, in which I obtained the effort from the participants. The real effort task in the experiment was a number count task designed from the experiment implemented by Vranceanu et al (2015). The real effort task required the participants to correct count the number of 7s in tables filled with random numbers from 0 to 9. A typical table has 12 rows and 8 columns. The numbers of 7s in each table varied in random ranging from 2 to 17. I created a total of 100 tables for the experiment using the random number generated from Excel. All the tables were shown to the subjects in random order. The

participants had 3 minutes to count the numbers of 7. When the participants finished their counts for one table, they input the number they counted into the box I provided and clicked 'Next'. Then, a new table was shown to them for counting. The participants were kept counting until the time was up. Before the participants started counting the numbers, they were given a detailed instruction on how to perform the task. They were also remined that the payoff from the project for the participants depended on how many tables they could correctly count. The more correct tables they counted, the better outcome they might achieve in the final stage. When the time was up, they were automatically directed to the next page, where I asked the participants how hard they thought this experiment was for them to finish. After the self-reported question, the experiment ended, and the participants left the experiment.

6.2.4 Statistical Analysis

To demonstrate the hypotheses, I use the following statistical data analysis methods. Firstly, I demonstrate the relationship between participants level of overconfidence and effort exerted into the project by calculating the correlation. Secondly, I illustrate the relationship between the level of overconfidence and the perceived payoff from the project. Then, to analyse the effect of retaliation and the awareness of retaliation on the manager's decision, I computed the correlations between variables and calculated the firm's value. The results are shown in the next section.

6.3 Result and Analysis

6.3.1 Participants' Levels of Overconfidence

In this section, I will have an overview on the distribution of the level of overconfidence for the participants obtained from general knowledge questions task. Table 6.3.1 shows the overall performance of the subjects in the general knowledge questions task. The subject who has the highest score gets 19 questions correct out of 20 questions, while the least score is 7. The number of correct answers of all participants ranges from 7 to 19. On average, the participants answer 13 of 20 questions correctly. A relatively large proportion of participants answer 10, 14 and 15 questions correctly, in which 19 participants score 10, taking up to 21.6% of all participants, 16 participants score 14, 18.2% of the participants and 14 participants score 15, 15.9% of the participants.

Table 6.3.1 Distribution and Descriptive Statistics for General Knowledge Questions

Actual Correct Answer Distribution			
Correct Answers	Frequency	Percent	Cumulative Percent
7	4	4.5	4.5
9	3	3.4	8.0
10	19	21.6	29.5
11	7	8.0	37.5
12	9	10.2	47.7
13	7	8.0	55.7
14	16	18.2	73.9
15	14	15.9	89.8
16	4	4.5	94.3
17	2	2.3	96.6
18	2	2.3	98.9
19	1	1.1	100.0
Total	88	100	
Actual Correct Answers			
Min			7
Max			19
Mean			12.59

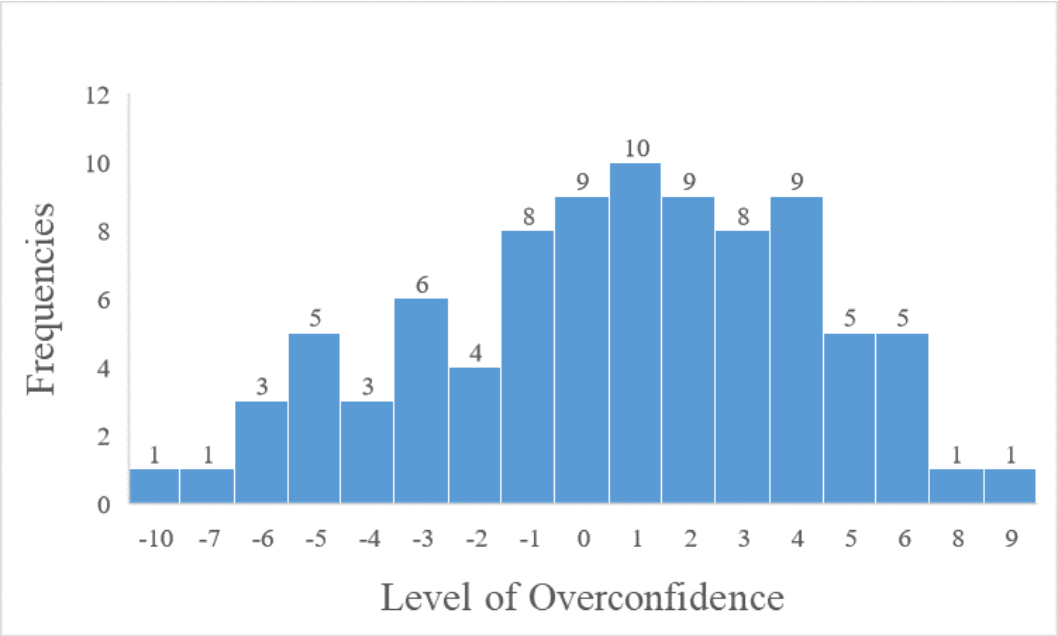
Note. N=88. The table summarizes the distribution of the participants' actual number of correct answers in the general knowledge question task.

Table 6.3.2 Distribution and Descriptive Statistics for Estimated Answers in General Knowledge Questions

Estimated Correct Answer Distribution			
Correct Answers	Frequency	Percent	Cumulative Percent
5	2	2.2	2.2
6	1	1.1	3.3
7	1	1.1	4.4
8	2	2.2	6.6
10	9	10.2	16.8
11	4	4.5	21.3
12	14	15.9	37.3
13	14	15.9	53.2
14	14	15.9	69.1
15	9	10.2	79.3
16	10	11.4	90.7
17	2	2.3	93.0
18	3	3.5	96.5
20	3	3.5	100
Total	88	100	100
Estimated Correct Answers			
Min			5
Max			20
Mean			13.20

Note. N=88. The table summarizes the distribution of the participants' estimated number of correct answers in the general knowledge question task.

Figure 6.3.1 Distribution of Level of Overconfidence



Note. N=88. The figure summarizes the distribution of the participants' level of overconfidence in the general knowledge question task. Ranging from -10 to 9. Number of Overconfident subjects 48. Number of Rational and Underconfident Subjects 40.

Using the formula: Individual Level of Overconfidence=Estimated Number of Correct Answers-Actual Number of Correct Answer, I calculate each subjects' level of confidence and divide them into two group, in which they will be presented with different investment information. The subjects with positive Level of Overconfidence enter the group 'Overconfidence', and those with 0 or negative level of overconfident are allocated to the group 'Rational and Underconfidence'. The data shows that the levels of confidence of the participants vary from -10 to 9. The subject with the lowest level of confidence is strongly underconfident about his ability on the general knowledge questions, while the subject with a level of confidence 9 is extremely overconfident about his own ability. Among all participants, 54.5% (48 of 88) are overconfident participants, and 45.5% (40 of 88) are rational or underconfident subjects.

6.3.2 The relationship between Overconfidence and Effort

In the game theoretical model of either a single manager or a team, the most crucial assumption I make is that higher level of overconfidence results in higher effort exerted into the project. The overconfident manager overestimates his ability and perceives a higher marginal productivity than he has, so he will naturally exert more effort into the project to achieve a higher optimal perceived from the project. In this experiment, I ask the participants to perform a number counting task, and the total rounds of correct counting are treated as the effort exerted into the project. To strengthen the result of the experiment, I check the relationship between overconfidence and effort exerted. Table 6.3.2 below shows the correlation between the subject's level of overconfidence and the numbers of correct counting in the real-effort task.

Table 6.3.3 Correlations Between Correct Counting and Level of Overconfidence

Correlations

	Level of Overconfidence	Correct Counting
Level of Overconfidence	1	
Correct Counting	.744*** (<0.001)	1

Note. N=48. The table shows the correlation between the level of overconfidence and the number of correct counting from the participants in the group 'Overconfidence'.

***. Correlation is significant at the 0.01 level (2-tailed).

I select the subjects in the group 'Overconfidence' for the analysis. In Table 6.3.2, the variable 'Correct Counting' is the number of tables correctly counted by the subjects in 3 minutes. The

correlation between level of overconfidence and correct counting is 0.774, which is significant at level of 0.05 ($p<0.001$). The result illustrates a positive relationship between the subjects' level of overconfidence and correct counting, which demonstrates that the subjects who is more overconfident about his own ability significantly exert more effort into the project. The results help me to reassure the assumption on the relationship between the level of overconfidence and the effort exerted into the project.

Table 6.3.4 Correlations Between Correct Counting and Level of Overconfidence for Other Participants

Correlations

	Level of Overconfidence	Correct Counting
Level of Overconfidence	1	
Correct Counting	.392***	1
	(0.012)	

Note. N=40. The table shows the correlation between the level of overconfidence and the number of correct counting from the participants in the group 'Rational&Underconfidence'.

***. Correlation is significant at the 0.05 level (2-tailed).

As I assume that the rational and underconfident managers are forced to continue the project when they are paired with an overconfident partner. They perform the task and exert effort into the project. From the table above, I also find a correlation of 0.392 (Significant at 0.05 level) between the level of overconfidence and the effort exerted into the task. This further confirms my finding that even when the manager is underconfident or rational, there is a linear positive relationship between the level of confidence and effort exerted into the project. The result indicates that as the manager is less underconfident, he is expecting a higher marginal productivity so he will exert more effort into the project even though he is still underconfident, exerts less effort and abandons the project earlier than the rational manager and the overconfident manager.

Result 1: There is a significant positive relationship between the subject's overconfidence and the effort. The subject with higher level of overconfidence will exert more effort into the project.

6.3.3 Will Forced Continuation Cause Retaliation?

I observe in the model that because the overconfident manager's perceived optimal payoff is higher than his actual payoff from the project and higher than the rational manager's actual payoff. Therefore, at a certain level of overconfidence, there is a situation where the

overconfident manager's perceived payoff is higher than the liquidation value of the project while the rational manager's actual payoff is lower than the liquidation value of the project. The overconfident manager prefers continuing the project, but the rational manager suggests abandoning the project. I assume in the theoretical model that the overconfident manager forces to continue the project if he and his rational teammates have conflicts. I believe that the forced continuation will make the rational manager feel upset and reluctant to work hard for the project. The rational manager may retaliate and create a souring relationship within the team. Consequently, the overall payoff for the managers from the project is damaged by the retaliation.

In the experiment, for rational and underconfident participants, I paired them with a virtual 'overconfident teammate'. The rational subjects and the underconfident are informed about their overconfident teammates' performance and estimation in the general knowledge task. When the participants choose to abandon the project, they are told that their teammates prefer continuing the project and they are forcing continuing the project. I create the souring relationship for the rational and underconfident subjects. I also tell the participants that if they choose to retaliate, they will damage the payoff from the project. They are asked whether they feel upset and angry, and to what extend they would retaliate from 0 (Not at all) to 10 (Definitely Yes). I obtain the subjects' retaliation from their self-reported feelings on forcing to continue the project. The distribution of the subject's self -reported is shown in Table 6.3.4 below.

Among the underconfident and rational subjects, 24 out of 40 subjects choose to abandon the project. The rest of the subjects opt to continue the project, and they are not asked the questions because they are told that their teammate also wants to continue the project. I can see in table 5 that Only 2 subjects reported that they were not angry or upset about continuing the project. 22 subjects claim that they feel frustrated and angry about the decision at different at a greater or lesser extent.

Table 6.3.5 Distribution for Retaliation

Retaliation Distribution			
Level of Retaliation	Frequency	Percent	Cumulative Percent
0	2	8.3	8.3
2	1	4.2	12.5
3	5	20.8	33.3
4	7	29.2	62.5
5	2	8.3	70.8
6	5	20.8	91.7
7	1	4.2	95.8
8	1	4.2	100.0
Total	24	100	

Note. N=24. The table summarizes the distribution of the participants' self-reported retaliation for participants who were forced to continue the project in terms of a Likert-scale from 0 to 10.

Table 6.3.4 displays that most rational and underconfident participants choose to retaliate when they are forced to continue the project. How much they retaliate ranges from 0 to 8. 50% of the participants choose a moderate level of retaliation (3 or 4). Only 2 participants felt extremely frustrated and retaliate at a higher level of 7 and 8. No participants choose to destroy the payoff (Level of retaliation 10). The result shows that when being forced to continue the project, the subject does not agree with the decision and somehow choose to retaliate and create a souring relationship.

Result 2: When the team members have conflicts, and the overconfident manager dominates the team. The rational and underconfident manager who prefers abandoning the project will retaliate and damage the payoff from the project.

Now I know that the rational and underconfident managers feel upset and angry about the overconfident manager's decision. I am also curious about whether there is a relationship between the level of retaliation and the level of underconfidence. Although I do not mention the case of underconfident managers in the game theoretical model, I can extend my analysis that the underconfident manager underestimates his ability and exerts less effort into the project. The underconfident manager' perceived payoff from the project is less than his actual payoff, so the underconfident manager is more willing to abandon the project than the rational manager under the same condition. If the overconfident manager forces the team to continue the project, the underconfident manager's payoff is damaged more severely than the rational manager. I am, therefore, wondering if the degree of retaliation is related with the level of underconfidence,

as the more underconfident manager is, the more reluctant the manager is to continue the project.

Based on the analysis above, I select all the underconfident subjects who are forced to continue the project. Comparing their self-reported retaliation and the level of underconfidence, I can reveal whether the relationship exists in the experiment. Table 6.3.5 shows the correlation between underconfidence and the level of retaliation.

Table 6.3.6 Correlations Between Underconfidence and Level of retaliation

Correlations		
	Underconfidence	Degree of retaliation
Underconfidence	1	
Degree of retaliation	-0.124	1
	(0.563)	

Note. N=24. The table shows the correlation between the level of confidence and self-reported retaliation from the participants in the group 'Rational&Underconfidence'.

***. Correlation is significant at the 0.05 level (2-tailed).

The data in Table 6.3.5 shows that the correlation between the degree of retaliation and the level of underconfidence is -0.124 (p=0.563), which is not significant at 0.05 level. Therefore, I can conclude that there is no relationship between the degree of retaliation and the level of underconfidence from the subjects. The underconfident subjects' self-reported retaliation is independent of the subjects' level of underconfidence. When I calculate the perceived payoff and the actual payoff for the underconfident, rational, and overconfident subjects respectively, I treat the level of overconfidence and the degree of retaliation as independent variables.

6.3.4 Are Overconfident Manager Aware of the Retaliation?

In the theoretical model, I argue that the rational manager will retaliate when he is forced by the overconfident manager to continue the project. The souring relationship in the team will damage the payoff for the managers. I assume that the overconfident manager can fully realize the retaliation action from the rational manager. Then I extend my analysis by considering that the overconfident manager may not be fully aware of the rational manager's retaliation as the overconfident manager is self-centred and highly believes in his own decision. Therefore, the effect of the retaliation on the overconfident manager's perceived payoff is determined by the degree of retaliation and the overconfident manager's understanding on the retaliation.

To find whether the subject is aware of the retaliation, I force on the subjects in the group of Overconfidence. I show them their rational teammates' actual correct answers and estimated correct answers in the general knowledge task. The overconfident subjects and their teammates exert effort in the project. For all overconfident subjects, they are informed in the experiment that if they and their teammates have conflicts, they can force the team to continue the project. Their rational teammates will retaliate and damage the firms value. When the participant chooses to continue the project, I show him the information that his teammate wants to abandon the project, but he can force his teammates to continue the project. Before the participant starts the counting task, I ask him 'to what extend do you think your teammate will retaliate over your decision to continue the project?', and they can choose from 0 (not at all) to 10 (absolutely will). I treat the participants answer as the awareness of retaliation for the overconfident subject. Table 6.3.6 shows the distribution of self-reported awareness of retaliation.

Table 6.3.7 Distribution for Awareness of Retaliation

Awareness of Retaliation Distribution			
Level of Awareness	Frequency	Percent	Cumulative Percent
1	2	4.8	4.8
2	7	16.7	21.4
3	11	26.2	47.6
4	6	14.3	61.9
5	8	19.0	81.0
6	3	7.1	88.1
7	5	11.9	100.0
Total	42	100.0	

Note. N=42. The table summarizes the distribution of the participants' self-reported awareness of retaliation for overconfident participants who can force their teammates to continue the project in terms of a Likert-scale from 0 to 10.

In table 6.3.6, I notice that the participants neither totally ignore nor fully realize the retaliation. Most participants claim that they are aware of the retaliation at a medium extent. 11 subjects believe that they are not very convinced that their teammate would retaliate over the decision to continue the project, which takes up to 26.2% of all overconfident subjects who continue the project, expressing the awareness at a level of 3. 81% of the participants claim that their teammate would retaliate at a relatively moderate the level no more than 5. The data in table 6.3.6 indicates that the overconfident subjects in the experiment are inclined to not fully realizing the retaliation from their rational teammate. Even though their teammates retaliate

and damage the payoff, the effect of the retaliation on the overconfident subject's perceived payoff from the project is limited by the overconfident subjects' awareness of the retaliation.

Result 3: If the team members have opposite decisions on the project, the overconfident manager dominates the team, and the rational manager retaliates. The overconfident manager is not always fully aware of the retaliation from the rational manager.

I go one step further by asking the question 'Is the subject with higher level of overconfident less aware of the retaliation from his rational teammate?'. I know that the overconfident manager overestimates his ability, and he believes that his ability is higher than his fellow colleague. With higher level of overconfidence, the manager is focusing more on his own estimation and decision. As the overconfident manager is dedicated to his own opinion, he tends to ignore the souring relationship in the team and, therefore, he might not realize that the rational manager retaliates. It could be considered that there is a positive relationship between awareness of retaliation and level of overconfidence. The more overconfident the manager is, the less the manager recognizes the retaliation. Accordingly, I find the correlation between the subjects' level of overconfidence and self-reported awareness of retaliation. Table 6.3.7 below displays the correlation.

Table 6.3.8 Correlations Between Overconfidence and Awareness of retaliation

Correlations

	Level of Overconfidence	Awareness of retaliation
Level of Overconfidence	1	
Awareness of Retaliation	-0.203	1
	(0.198)	

Note. N=42. The table shows the correlation between the level of overconfidence and self-reported awareness of retaliation from the participants in the group 'Overconfidence' who forced their teammates to continue the project.

***. Correlation is significant at the 0.001 level (2-tailed).

Table 6.3.7 reveals that the correlation between the level of overconfidence and the awareness of retaliation is -0.203, which is insignificant at 0.05 level (p=0.198). There is no significant relationship between overconfidence and awareness of retaliation. It demonstrates that the awareness of retaliation is independent of the level of overconfidence of the participants.

6.3.4 The Perceived Payoff and the Actual Payoff for the Team Members

In accordance with the game theoretical model, I establish a formula that the total payoff for a team member depends on his effort exerted, his level of overconfidence, his cost of effort, as well as his teammate's effort and level of overconfidence. As the overconfident manager overestimates his own ability and the underconfident manager underestimates his ability, they will make their decision based on their perceived payoff from the project. Meanwhile, the rational manager knows his true ability, so his actual ability equals his perceived ability. In the general knowledge questions task, I obtain the subjects' actual ability and perceived ability. In the number counting task, I acquire the effort exerted into the project. In addition, I ask the participants how hard the task is for them to complete under a scale from 1 (Very Easy) to 10 (Very Difficult). The subject's self-reported difficulty from the participants is treated as the cost of effort for them to work for the project. I calculate the participants' actual payoffs from the project and the overconfident and underconfident manager's perceived payoffs from the project.

First, I investigate the group with underconfident and rational subjects. In the theoretical model, I discuss that rational managers tend to abandon the project because they believe that their payoff from the project is less than the value from abandoning the project. Overconfident managers perceive that their payoff is higher than they payoff from abandoning the project. In the experiment, I inform the participants that their teammate also takes part in the general knowledge questions and answers 12 questions correctly, but he estimates that he achieves 17 correct answers. I also tell the participants that their teammate correctly counts 14 tables of random numbers in the counting task. Based on the information, the participants need to decide whether to continue or abandon the project.

6.3.4.1 Perceived Ability, Effort and Perceived Payoff

According to the game theoretical model, I argue that the perceived payoff for the overconfident managers is only related with their perceived ability regardless of their true ability. I calculate the overconfident participants' perceived payoff from the project and find the correlations between the level of overconfidence, the effort exerted into the project and the perceived payoff from the project. The results are shown in table 6.3.9.

Table 6.3.9 Correlations Between Perceived Ability, Effort, and Perceived Payoff

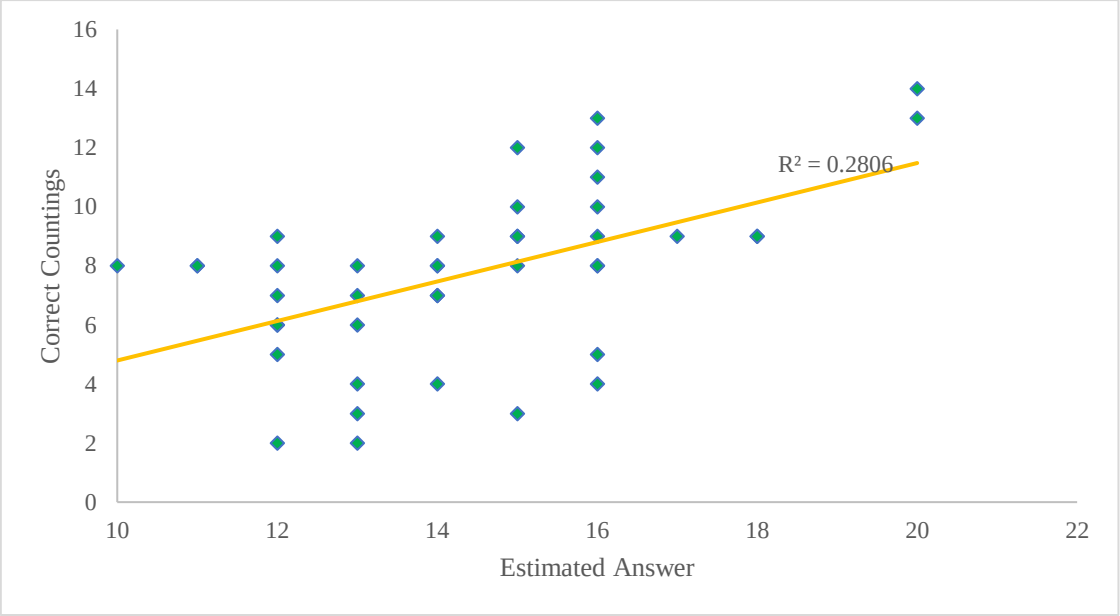
Correlations		
		Perceived Ability
Effort	Pearson Correlation	0.531***
	Sig. (2-tailed)	(<0.001)
Perceived Payoff	Pearson Correlation	0.514***
	Sig. (2-tailed)	(<0.001)

Note. N=42. The table shows the correlation between the participants' perceived ability and the number of correct counting, the correlation between the perceived ability and the perceived payoff from the project respectively in the group 'Overconfidence'.

***. Correlation is significant at the 0.001 level (2-tailed).

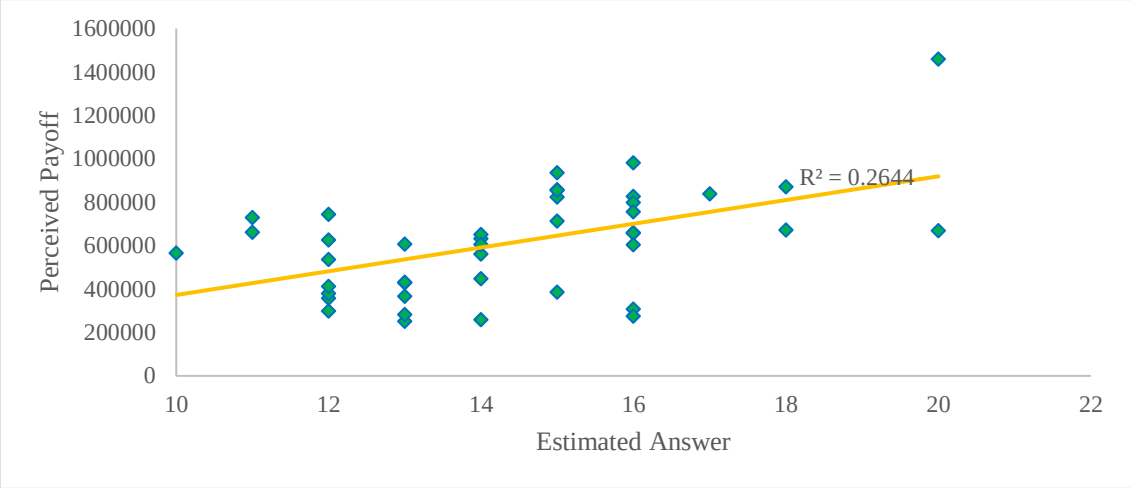
The results in table 6.3.9 demonstrate that there is a positive relationship between the participants perceived ability and effort exerted into the project. The correlation between the perceived ability and effort is 0.531, significant at 0.001 level ($p<0.001$) and the correlation between the perceived ability and the perceived payoff from the project is also significant. The results indicate that the participants who perceived higher ability exerted more effort into the project and expected a higher payoff from the project. The relationship of perceived ability and estimated answer and the relationship of perceived ability and perceived payoff are shown in the figures below.

Figure 6.3.2 The Relationship of Perceived Ability and Effort



Note. N=48. The figure shows the scattered plots for participants' estimated number of correct answers and the number of correct counting from the overconfident group. The figure also displays the linear regression between estimated number of correct answers and number of correct counting.

Figure 6.3.3 The Relationship of Perceived Ability and Perceived Payoff



Note. N=48. The figure shows the scattered plots for participants' estimated number of correct answers and perceived payoff from the project for the overconfident group. The figure also displays the linear regression between estimated number of correct answers and the perceived payoff from the project.

The figures above illustrate that the higher ability the participants perceived, the more effort they chose to exert into the project, and the higher payoff they expected to achieve from the project. The results are consistent with the assumptions in the theoretical model. The findings also strengthen the argument of positive relationship between perceived ability and effort in chapter 4.

6.3.4.2 Overconfidence and Perceived Payoff

In this section, I calculate the participants perceived payoff from the project using the participants' estimated correct answers, effort exerted into the project, cost of effort and the level of retaliation if applicable. I find that most of the underconfident and rational subjects' perceived payoff from continuing the project is less than the liquidation value, which indicates that most rational and underconfident subjects intend to abandon the project.

Table 6.3.10 Correlations Between Perceived Payoff and Underconfidence

Correlations		
	Level of Overconfidence	Perceived Payoff
Level of Overconfidence	1	
Perceived Payoff	0.392**	1
	(0.006)	

Note. N=24. The table shows the correlation between the level of overconfidence and the perceived payoff from the project from the participants in the group 'Rational&Underconfidence' who were forced to continue the project.

**. Correlation is significant at the 0.01 level (2-tailed).

I also check that for rational and underconfident participants, the manager's perceived payoff is positively related with the level of overconfidence. The correlation between level of confidence and the perceived payoff is 0.392, which is significant at 0.01 level (p=0.006). This indicates that the more confident the manager is, the more payoff he expects from continuing the project. As the rational and underconfident managers tend abandon the project, these managers are anticipating a liquidating value from abandoning the project. I will be focusing on the perceived payoff for overconfident managers. The result is shown below in Table 6.3.10.

Table 6.3.11 Correlations Between Perceived Payoff and Overconfidence

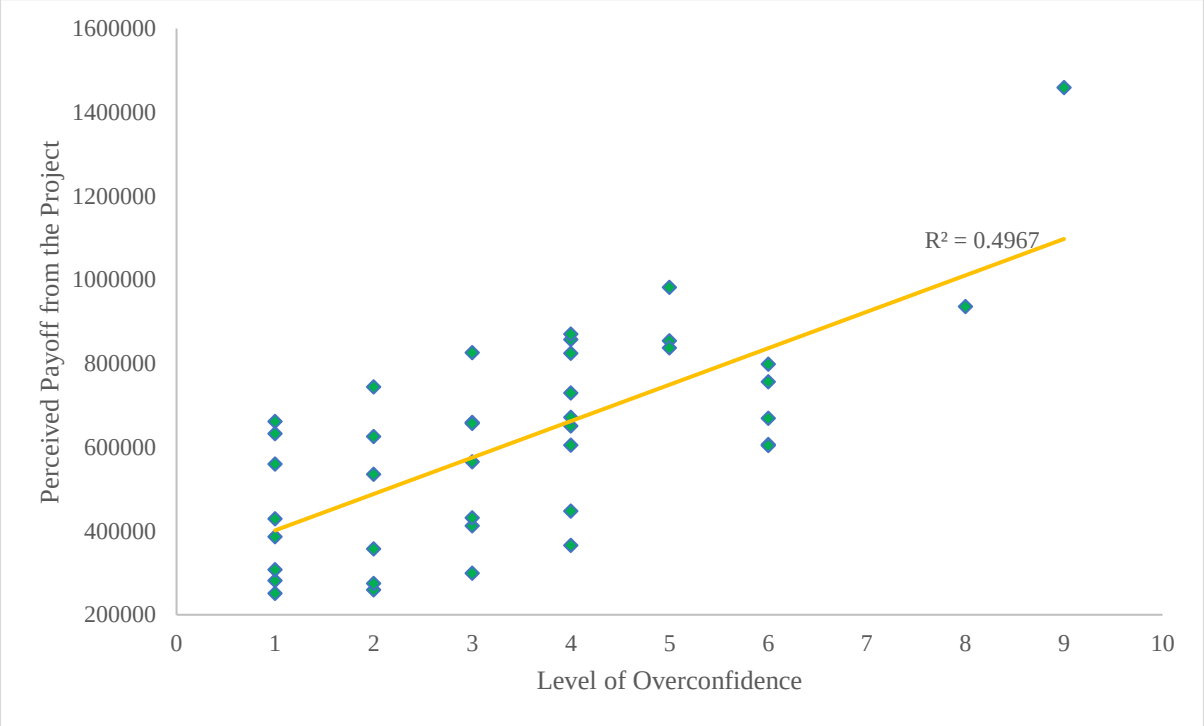
Correlations		
	Overconfidence	Perceived Payoff
Overconfidence	1	
Perceived Payoff	0.709***	1
	(0.001)	

Note. N=42. The table shows the correlation between the level of overconfidence and the perceived payoff from the project from the participants in the group 'Overconfidence' who chose to continue the project.

***. Correlation is significant at the 0.05 level (2-tailed).

For overconfident subjects, I find a positive correlation between level of overconfidence and the perceived payoff from the project. The correlation is 0.709 which is significant at 0.05 level (p=0.001). This makes me believe that if the manager is more overconfident, he exerts more effort into the project and expects higher payoff from continuing the project. To investigate the relationship between the level of overconfidence and the perceived payoff clearly, I put each subject's level of overconfidence and perceived payoff into the figure below.

Figure 6.3.4 The Relationship of Level of Overconfidence and Perceived Payoff



Note. N=48. The figure shows the scattered plots for participants' levels of overconfidence and perceived payoff from the project for the overconfident group. The figure also displays the linear regression between levels of overconfidence and the perceived payoff from the project.

The figure above illustrates the distribution of the overconfident participants' perceived payoff with level of overconfidence as an independent variable. The figure displays a positive relationship between level of overconfidence and the perceived payoff. If the manager is more overconfident, he tends to exert more effort and perceive a higher payoff from the project. This is consistent with my model that the overconfident manager's perceived payoff from the project increases with higher perceived ability. In addition, I assume that in the game theoretical model, the true ability for the manager is constant and remains unchanged. The level of perceived ability reveals the level of overconfidence for the manager. In my experiment, the participants have different true abilities, so I use the level of overconfidence for analysis.

Also, I notice that at the same level of overconfidence, the perceived payoff varies on individual, but overall, it shows an upward trend. The reason why the subjects with same level of overconfidence have the different perceived ability is that the subject differs in true ability and the cost of effort. In theoretical model, I assume that all managers have same cost effort. However, in the experiment I use the participants' self-reported cost of effort, which shall result in different perceived payoffs on the same level of overconfidence.

In addition, according to my model, the rational and underconfident manager tends to abandon the project but they will be forced to continue the project because their overconfident colleague dominates the team. The figure below shows the relationship between the level of underconfidence and the actual payoff from the project for the underconfident and rational participants.

Figure 6.3.5 The Relationship of Level of Confidence and Perceived Payoff for Underconfident and Rational

Note. N=40. The figure shows the scattered plots for participants' levels of confidence and perceived payoff from the project for the Rational&Underconfident group. The figure also displays the linear regression between levels of confidence and the perceived payoff from the project.

The figure shows a negative relationship between the level of underconfidence and the actual payoff from the underconfident participants. First, I notice different actual payoff at the same level of underconfidence, which results from different cost of effort and various true ability. I notice that the actual payoff from the project for these participants are less than the liquidation value from abandoning the project, which is 1,000,000 in the experiment, showing that the overconfident manager's forcing to continue the project will damage the other team member's payoff from continuing the project. The upward trending indicates an increasing actual payoff as the participants becomes less and less underconfident. I can also observe the fact the more underconfident the participant is, the more damage he will suffer from his payoff under the decision of continuing the project.

6.3.5 The Effect of Retaliation and Awareness of Retaliation

In the group of underconfident and rational subject, I ask them if they feel angry and upset about continuing the project and whether they would retaliate on the decision. Nearly all the participants choose to retaliate more or less on the overconfident manager's decision. The retaliation will reduce the payoff from the project for both team members as the rational manager tends to exert less payoff from the project. The table below shows the correlation between the level of retaliation reported by the underconfident and rational participants and his effort into the task.

Table 6.3.12 Correlations Between Retaliation and Effort

Correlations

	Correct Counts	Retaliation
Correct Counts	1	
Retaliation	-0.879***	1
	(0.017)	

Note. N=24. The table shows the correlation between the self-reported retaliation and the number of correct counts from the participants in the group 'Rational&Underconfidence' who were forced to continue the project.

***. Correlation is significant at the 0.05 level (2-tailed).

The correlation between the participants' self-reported level of retaliation and number of correct counts is -0.879, which is significant at 0.05 level (p=0.017). The correlation demonstrates a significant negative relationship between the level of retaliation and the effort exerted into the task. The result shows that if the participants in the experiment feel more frustrated on the decision on continuing the project, the less counts they perform in the real-effort task. This is consistent with my assumption in the model that the higher degree of retaliation will cause less effort exerted into the project and, consequently, harms the payoff from the project for the managers in the team. As the manager whose payoff is destroyed by the overconfident manager's domination in the team, he feels upset and angry about the decision. At higher degree the manager chooses to retaliate, the less effort he will exert into the project.

In the other group, the overconfident manager's reaction to the retaliation is also interesting. In the experiment, every overconfident manager who has a rational teammate abandoning the project reports that he understands his colleague's retaliation at some extend. The overconfident participants are fully convinced that their colleague tends to exert less effort and

damage the payoff from the project. To find the relationship between the awareness of the retaliation and the effort exerted into the project, I calculate the corelation shown in table below.

Table 6.3.13 Correlation Between Awareness of Retaliation and Effort

Correlations		
	Correct Counts	Retaliation
Correct Counts	1	
Awareness of Retaliation	-0.585***	1
	(0.002)	

Note. N=40. The table shows the correlation between the self-reported awareness of retaliation and the number of correct counts from the participants in the group 'Overconfidence' who forced their rational teammates to continue the project.
***. Correlation is significant at the 0.05 level (2-tailed).

Table 6.3.12 shows a negative relationship between the overconfident manager's awareness of the retaliation and the effort in the task. The correlation is -0.585 which is significant at the 0.05 level (p=0.002). Among the overconfident participants, those who reports less awareness of the retaliation are significantly performing better in the real effort task. The result shows that if the overconfident manager is less aware of the retaliation, the more effort he will exert into the project. The manager tends to perceive more payoff from the project if he understands less on the retaliation. Therefore, as a self-interested manager who aims to maximize the payoff from the project, he will exert more effort to achieve an optimal payoff for him.

Result 4: The rational manager's retaliation and the overconfident manager's awareness of the retaliation affects the manager's effort exerted into the project. The rational manager who retaliates more will exert less effort into the project and damages more on the payoff from the project. The overconfident manager who is less aware of the retaliation will exert more effort into the project.

6.4 Discussion

In this chapter, I implement an online behavioural finance experiment to explore the effect of overconfidence and team's reciprocity on a team's decision. The experiment is designed based on the teamwork game theoretical model in Chapter 5. I assume that a team consisting of an overconfident manager and a rational manager is running a project. The project fails and the team needs to decide whether to continue or abandon the project. The team's decision depends on the agreement between the team members. The overconfident manager perceives a higher ability $\hat{\gamma_1}$ and estimates larger payoff from the project. The rational manage observes his own

true ability γ_2 and the overconfident manager's true ability γ_1. The total payoff from the project for the team is determined by the effort from both managers in the team. The overconfident manager makes his decision according to his perceived payoff from the project. The overconfident manager perceives his payoff from the project and observe the rational manager's true ability, so he believes that his payoff from the project is $\Pi_1 = \left(\hat{\gamma_1} e_1 + \gamma_2 e_2\right)\frac{R}{2} - \beta_1 e_1^2$. The rational manager knows the overconfident manager's true ability, so his payoff from the project is $\Pi_2 = (\gamma_1 e_1 + \gamma_2 e_2)\frac{R}{2} - \beta_2 e_2^2$. Comparing the payoff from the project and the liquidation value, I find a tipping point in terms of a critical level of overconfidence where the manager changes his decision from abandoning to continuing the project for the rational manager and the overconfident manager respectively. As the overconfident perceives a higher ability, his critical level of overconfidence is lower than that of the rational manager, which means that as the level of overconfidence increases, the overconfident manager would continue the project earlier than the rational manager. The gap between the two critical values results in different team reciprocity and decisions. I show that the overconfident manager and the rational manager both agree to abandon the project at lower level of overconfidence, and that the overconfident manager and the rational manager both agree to continue the project at substantial level of overconfidence. However, at medium level of overconfidence, the overconfident manager wants to continue but the rational manager abandons. When the conflicts happen, the overconfident manager can force the team to continue the project, which damages the payoff for the rational manager, creating a souring relationship. I discuss the effect of rational manager's retaliation and the overconfident manager's understanding of the retaliation within the souring relationship.

Therefore, in accordance with the theoretical model, I designed a general knowledge question task to capture the participants level of overconfidence. Simultaneously, I obtained the true ability and the perceived ability for the managers for analysis. I divided the participants into two groups based on their level of overconfidence and give different investment information in different groups. To simulate the team composition, I paired each rational and underconfident participant with an overconfident partner, and each overconfident participant with a rational partner. In the experiment, I designed a real effort task to explore the team interaction and the participants' action responded to the conflicts.

Similar to the single manager experiment, I adopted the general knowledge questions task to obtain the true ability, the perceived ability, and the level of overconfidence from the

participants. Researchers in behavioural science adopt different methods to capture the participants' level of overconfidence, which includes self-reported stated overconfidence, estimated probability of correct answers, an answer range of 95% confidence interval, and estimated number of correct answers. Pikulina et al (2014) adopted question answering task to obtain the participants level of overconfidence. In my experiment, among 88 valid responses, 48 participants were overconfident, and 40 participants were rational and underconfident. There were slightly more overconfident participants than the rational and underconfident participants in the experiment. The experiment was divided into two branches which included different investment information for the participants.

Based on the nature of overconfidence from the participants, I divided the participants into two groups: 'Overconfidence' and 'Rational & Underconfidence'. To create the situation in the theoretical model, I gave the overconfident participants with a rational teammate, and I gave the rational and underconfident participants an overconfident teammate. The teammate I provided to them was a virtual teammate as the experiment is implemented online. Due to COVID-19 restrictions I was unable to carry out lab experiment. However, in the participants experimental pages, I added a few statements and manipulation to simulate the situation to make participants believe that they had a teammate working together with them.

In the scenario of overconfident participants, before they made the decision to continue or abandon the project, I told them about the true ability of his teammate, so they understood that their teammates were rational and that they observed their rational teammates' true ability, which was consistent with my assumption in the theoretical model. Before the participants chose to continue or abandon the project, they were informed that they could force the team to continue the project in the situation of conflicted decisions. Additionally, I also told them their teammate might retaliate and damage the payoff from the project, and the overconfident participants expressed their awareness of the retaliation. Then the participants chose whether to continue or abandon the project and performed the task if continuing. The whole process was developing a mental setup for the overconfident participants about the retaliation and their awareness of the retaliation. Therefore, the overconfident manager could make estimation about their payoff from the project and chose to continue or abandon the project. When the participants chose to abandon the project, they were shown that the rational teammate also abandoned the project, so they claimed the liquidation value, and the experiment ended. If they chose to continue the project, their teammates wanted to abandon, but they could force to continue. The result showed that 42 of 48 overconfident participants chose to continue the

project after knowing that their teammate might retaliate, and a majority (81%) of the participants believed that the rational manager would retaliate to an extend less that 5 (from 0 to 10). The results suggested that the overconfident participants did not fully realize the retaliation from his teammate. The overconfident managers were self-oriented and excessively optimistic about his own decision on the project.

The other group consisted of rational and underconfident participants. I put the rational and underconfident participants in a group because they would make decisions on abandoning a failed project. The rational managers know their true ability and anticipates a higher payoff from abandoning the project. Meanwhile, the underconfident managers underestimate his ability and believe in a lower marginal productivity. They exert less effort into the project and perceive a lower payoff from the project. The underconfident manager will, therefore, abandon the project earlier than the rational manager. In my model, even though I do not consider the case of an underconfident manager, the underconfident manager has similar decision with rational manager on abandoning the project when teamed up with an overconfident manager. In addition, they also suffer from a decrease in payoff from the project when the overconfident manager forces to continue the project. In the experiment, the rational and the underconfident participants were paired a virtual overconfident teammate whose true ability and perceived ability were available for them. The participants were asked about whether and how much they would retaliate on the condition of conflicted decisions and the overconfident manager's domination in the team. Among 24 participants in the group who were forced to continue the project, 22 participants claimed that they would retaliate the overconfident manager. The results suggest that the rational and underconfident managers whose payoff from the project was damaged by the overconfident manager's decision were absolutely feeling upset and frustrated. Hence, they exerted less effort into the project.

For the real effort task, I asked the participants to count the number of 7s in a chart of random numbers. I adopt this method from Vranceanu et al (2015) who design the task to capture the effort from the participants. In their paper, the typical bloc has 30 columns and six rows; across blocs, the numbers of 7s vary at random between 11 and 24, with an average of 18. My experiment reduces the numbers of 7s from 2 to 17, and the table has 12 rows and 8 columns. I treat the number of correct counts as the effort exerted into the project. When I choose between stated effort and real effort, I believe that it is important for the participants to show their effort under the specific situation (retaliation and awareness of retaliation). The participants' effort and performance in the experiment is affected by the psychological and

emotional states of themselves (Charness et al, 2018). Therefore, a real effort task is more precisely reflects the participants' effort.

I managed to test the relationship between the level of overconfidence and the effort exerted into the project in the teamwork experiment as well. In both group overconfidence and group rational& underconfident, I demonstrate that as the manager either reduces the level of underconfidence or increases the level of overconfidence, they tend to increase their effort exerted into the project. For the rational and underconfident manager, I find a significant relationship between the retaliation and effort exerted into the project. The data shows that the managers who claim a higher degree of retaliation exerts less effort into the project. A theoretical explanation on it is that the rational manager feels disappointed and frustrated about the team's decision are not willing to work hard for the project. In the theoretical model, I assume that when the rational manager chooses to retaliate, the manager's payoff is reduced by $(1-\lambda)$. Therefore, the rational manager's effort into the project is $e_2^{I*} = \frac{\gamma_2 R(1-\lambda)}{4\beta_2}$. When λ increases, the rational manager's retaliation has worse effect on the payoff from the project, and the effort decreases, which indicates that the rational manager will exert less effort into the project if he chooses to retaliate. As for the overconfident managers, I also find that the overconfident manager who is less aware of the retaliation will exert more effort into the project into the project. The overconfident manager's payoff from the project is damaged by $(1-\phi\lambda)$ in which ϕ represents the awareness of the retaliation. The effort the overconfident manager exerts into the project is $e_1^* = \frac{\hat{\gamma_1} R(1-\phi\lambda)}{4\beta_1}$, which shows a negative relationship between the awareness of retaliation and the effort. When the overconfident manager understands less on the retaliation action from his rational colleague, he perceives a higher payoff from the project, and he exerts more effort to maximize his payoff from the project. The data supports the argument that the overconfident participants who is less aware of the retaliation tends to score higher in the real effort task.

Even though the experiment data does not show a significant relationship between the level of confidence and degree of retaliation, theoretical and empirical research shows that subject tends to take revenge and retaliatory actions when facing unfairness treatment and inequality in the team. Research in negative reciprocity argues that retaliatory behavioural are motivated by a sense of fairness. Psychological research shows that people are 'in many ways better at solving problems that require cheater detection (deciding whether a social contract had been violated)' Fon and Parisi, 2005). When people are expecting or experiencing a sense of negative emotions

or monetary damage from a violation of fairness, they are highly likely to raise retaliatory attitudes towards their teammates. Researchers believe that the interaction and intrapersonal relationship between individuals are factors that evoke retaliation, and researchers begin to pay attention to the effect of negative emotions, such as upset, anger, frustration, on developing and evoking retaliation (Asher et al, 2012). Future research can potentially focus on the relationship between emotions and retaliation. With the help of neuroeconomics experiments, researchers can capture subjects' emotions and their actions when they are confronted with negative reciprocity, which can lead to further investigation on how emotions can affect the rise of retaliatory attitudes.

To sum up, I implement a behavioural finance experiment and test the hypotheses based on the teamwork game theoretical model. I manage to find the effect of overconfidence and the team's reciprocity in the team member's decision on the project. I also display in the model that the souring relationship in the team can change the rational manager's and the overconfident manager's effort exerted into the project, affecting the managers' payoff and their investment decisions.

6.5 Conclusion

In this chapter, I introduce the teamwork behavioural finance experiment based on the game theoretical model in Chapter 5. According to the hypotheses, I tested in the model that the level of overconfidence and the team's reciprocity affect the team's decision on whether to continue or abandon a failed project. I captured the participants' level of overconfidence with a design a general knowledge question task. The participants' effort was collected through the number counting real effort task. And I also obtained the level of retaliation and awareness of retaliation by self-reported Likert scale by the participants.

In the experiment I test the hypothesis that overconfident manager tends to exert more effort into the project. The data shows that the participants with higher level of overconfidence gets more counts correctly in the real effort task, which indicates that the participants exert more effort into the project. I also find that depending on the level of overconfidence, the team members may have different decisions. At lower level of overconfidence, the team members both agree to abandon the project, and at high level of overconfidence, they choose to continue the project. At medium level of overconfidence, the overconfident manager and the rational manager have conflicts. When the conflict occurs, most of the rational manager choose to abandon the project and the overconfident manager choose to continue the project. When the

overconfident participants dominate and force to continue the project, the rational participants would retaliate and reduce the total payoff from the project. According to the self-reported retaliation, I do not find any link between the level of underconfidence and the degree of retaliation. For the overconfident manager, I find that even though they are told that their continuation on the project may cause their teammate to retaliate and reduce the payoff from the project, the overconfident subjects are not always aware of the souring relationship and the retaliation by their rational colleague. However, I do not observe any relationship between the level of overconfidence and the awareness of the retaliation.

In addition, I observe that the rational manager's retaliation affects the manager's effort exerted into the project. The rational manager who feels more frustrated and retaliates harder in the team significantly spend less effort into the project, damaging the payoff more terribly from the project. The rational manager's teammate, the overconfident manager, are not fully aware of the retaliation. Instead, to a lower extend the overconfident manager realizes the retaliation, the more effort he exerts into the project, and the higher payoff he expects to receive from the project.

The experiment explores the relationship between the overconfidence, teamwork, and project entrapment in a team. The experiment contributes to the literature by demonstrating that A team with an overconfident manager and a rational manager may make different decisions influenced by the manager's level of overconfidence and the harmonious and souring relationship in the team. The experiment is also innovative to implement both overconfidence task and real effort task in exploring the relationship between overconfidence, effort and payoff from the project.

However, due to the restrictions when the experiment was distributed, the teammate in the experiment was a virtual one, and the participants were not working with a real partner. It allows potential future research to be considered mapping on the experiment I conducted. A laboratory experiment can be implemented in which participants are paired with each other and they can communicate to replicate a real teamwork scenario. It would be interesting to observe how an overconfident and a rational or underconfident manager negotiate and work together on the project.

Additionally, the experiment also inspires me to explore more team member's interaction and its effect on the team's decision. As the experiment is built on the basic teamwork theoretical model, I do not consider different team compositions, uncertainty of the project, shareholders

engagement on the project in the experiment. Future experiments can be conducted to cover more factors on team's project entrapment mentioned in the theoretical model.

Chapter 7: Conclusion

7.1 Theory

Behavioural corporate finance explains irrational corporate decisions using psychological factors. A firm's project investment strategies aim to add value to the firm. The project managers in the firm are also seeking to maximize their payoff from the project. Traditional finance argues that managers should invest the profitable project to achieve value addition and abandon the failing project to avoid reduce firm's value. However, researchers observe in real world that sometimes project managers tend to continue a failing project for too long and damage firm's value. Managers' escalating their commitment to a failed project is called project entrapment. Research in behavioural corporate finance shows that managers' mistakes in project investment may result from various psychological biases from the managers. Overconfidence has been identified as one of the most important biases contributing to project entrapment. In my research, I also consider engagement and teamwork as other two major factors to project entrapment.

Overconfidence refers to the cognitive bias that a manager perceives his ability higher than his actual ability. An overconfident manager who overestimates his true ability believes in a higher marginal productivity and exerts more effort into the project, thus expecting a higher payoff from the project than his actual payoff. Managers who are engaged in the project feels passionate and motivated on the project and gets private benefits from the project himself. Based on this assumption, I develop a game theoretical model to analyse the effect of overconfidence and engagement on project entrapment. In the model, I find that there are both positive and negative effect of overconfidence on the project entrapment and the firm's value. When the manager is rational or slightly overconfident, he will abandon the project and choose to receive liquidation value from the project which is also favourable to the shareholders. At medium level of overconfidence, the manager chooses to continue the project, but shareholders who observe the manager's true ability prefer abandoning the project. In this case, the manager's continuing the project will damage the firm's value, which indicates the negative effect of overconfidence. However, when the manager is extremely overconfidence, he will exert substantial effort into the project and increases the firm's value by hardworking, which shows the positive effect of overconfidence on firm's value. The shareholders are also pleasant with the managers' decision. The model shows that depending on different levels of

overconfidence, the managers' decision on continuing the project can be either detrimental or beneficial to the firm's value.

Then, I consider the shareholder's involvement and engagement on the manager's decision. At medium level of overconfidence where the manager's decision conflicts with the shareholders' preference, the shareholders have the chance to replace the overconfidence manager with a rational manager who will abandon the project. The model shows that as there is a probability of successfully replacing the manager and a cost of replacement if successful, the shareholders only take the action when the expected cost of replacement is lower than the damage in the firm's value by the overconfident manager's decision.

To develop a model of a complete progress of project investment, I add uncertainty of a project and consider the shareholders' ex ante recruitment for the project manager. At the beginning, the shareholders are considering investing in a project, and they expect the project to be value-adding for the firm. The project can either be a good project or a bad project with a probability known to the shareholders, but the quality of the project is only revealed after the investment is made. The shareholders need to make trade-off between avoid loss from a bad project by recruiting a rational manager and obtain higher payoff from a goof project by recruiting an overconfident manager. The model suggests that with other factors constant, the shareholder's ex ante recruitment decision is related with uncertainty of the project. If the project is relatively more likely to be a bad project, the optimal choice for the shareholders is to recruit a rational manager. At higher probability of a good project, the shareholders should recruit an overconfident manager. After the shareholder recruits the project manager, the project turns out to be a good project or bad project. If the project is a good project, the manager and the shareholders are happy to continue the project. If the project is a bad project, the original game theoretical model ties in.

The theoretical model of one manager reveals the effect of overconfidence on firm's value. Modern corporate decisions are often made by a project management team. With more research on project investment and corporate decisions, the researchers are paying more attention to teamwork in decision making. Therefore, I extend my model to a decision-making team with two managers. In the teamwork theoretical model, I investigate the relationship of overconfidence, team's reciprocity, and the firm's value.

I consider the team with one rational manager and one overconfident manager. The model shows that the team's reciprocity and team's decision is linked with the manager's level of

overconfidence. At lower level of overconfidence, the rational manager and the overconfident manager both agree to abandon the project. The team will terminate the project and receive liquidation value. At medium, level of overconfidence, the overconfident manager prefers continuing the project, but the rational manager expects a higher payoff from abandoning the project. The conflicts in the team occur. At higher level of overconfidence, the overconfident manager and the rational manager both agree to continue the project.

When the disagreement within the team members happens, I assume in the model that the overconfident manager can dominate the team and force the rational manager to continue the project. As a result, the model includes the negative reciprocity in the team by adding rational manager's retaliation and souring relationship in the team. As the rational manager is forced to continue the project, feeling angry and frustrated, he could choose to retaliate and damage the payoff from the project. The overconfident manager, meanwhile, might not fully realize the souring relationship and retaliation from the rational manager. The model shows that the team's effort and decision on the project is affected by the degree of retaliation and the awareness of the retaliation.

Following the analysis from the model of one manager, adding the uncertainty of the project enables us to reveal the recruitment strategy of a project management team. In this case, the project management team consists of two rational managers, one overconfident manager and one rational manager, and two rational managers. I also assume in the model that when the team of one overconfident manager and one rational manager have conflicts, either manager can win the negation with a probability. In the model, I find that at relatively high probability of a bad project, the shareholders prefer recruiting team full of rational managers. With the increase in the probability of a good project, the shareholders may turn to recruit a team with one rational manager and one overconfident manager. If the probability of a good project is relatively high, the shareholders would like to recruit a team with two overconfident managers. In addition, the tipping point of changing the recruitment strategy is affected by the negotiation power of the overconfident (rational) manager.

In my research, I develop a game theoretical model of one manager and a model of a management team. The framework introduces how an individual manager and a team make project continuation or termination decisions under the effect of overconfidence, engagement, and team's reciprocity. The model also addresses the shareholders' role on project investment decisions. They can engage in the corporate finance decisions by recruiting an optimal

manager/team to maximize the firm's value. For each model, I propose a numerical example to simply prove the model mathematically, and the results are consistent with the analysis. I also implement behavioural finance experiments to demonstrate the propositions in the model.

7.2 Experiment

The experiments are conducted to demonstrate the relationship between overconfidence, engagement, team's reciprocity, and individual manager's and team's project continuation or abandonment decisions. It is shown in the experiment that the effort exerted into the project is significantly positively related with the individual's level of overconfidence. The result demonstrates the assumption that managers who are more overconfident tend to exert more effort into the project. By comparing the decisions of participants in different confidence level, I find that overconfident managers are more willing to continue with a failing project than rational and underconfident people. Moreover, the higher level of overconfidence the manager has, the longer he is inclined to continuing the project. The experimental data also reflects both positive and negative effect of overconfidence on firm's value. I calculate the overconfident manager's perceived payoff and the firm's value for the shareholders. The results suggest that when rational or slightly overconfident, the manager choose to abandon the project; when the manager is at medium level of overconfidence, the manager opts to continue the project, which does harm to the firm's value; if the manager is highly overconfidence, both the manager's perceived payoff and the firm's value is higher than the liquidation value. However, I don't find any significant relationship between the self-reported engagement and the manager's payoff from the project.

For teamwork experiment, it reassures the relationship between the level of overconfidence and effort exerted into the project. The experiment also brings out the negative reciprocity and the souring relationship in the team. Nearly all rational participants who are forced to continue the project claims the retaliation for the overconfident manager's domination, and all overconfident participants acknowledge that they do not believe the rational manager will retaliate. By calculating the perceived payoff and the actual payoff, I discover that a team with an overconfident manager and a rational manager may make different decisions influenced by the manager's level of overconfidence and the harmonious and souring relationship in the team. The higher degree of retaliation the rational manager undertakes, the less effort he will exert into the project. In addition, if the overconfident is less aware of the retaliation, he will work harder for the project. Nevertheless, there is not significant relationship between the level of overconfidence and the awareness of retaliation for overconfident managers, and neither is

there any relationship between the level of underconfidence and the degree of retaliation for underconfident and rational managers.

7.3 Contributions

My Research contributes to the literature by combining the effect of overconfidence and engagement on project entrapment. Existing research has explored the effect of overconfidence on individuals' and managers' decision making. My research adds to the literature that I focus on the effect of overconfidence and engagement on project termination decisions in terms of effort, private benefits, and perceived payoff. In addition, I also consider the shareholder's engagement on the project when the moral hazard problem occurs (in my model: manager's continuing the project and damages the firm's value). In terms of teamwork game theoretical model, I develop my model based on the studies from Gervais and Goldstein (2003) and Fairchild (2011) who built a theoretical model to explore the team's coordination and conflicts. I extend the research to project entrapment and reveal the team's positive and negative reciprocity when the team needs to decide whether to continue or abandon a failing project. The experiment also demonstrates the analysis in the theoretical models. With real effort experiment, my research strengthens the existing findings of overconfidence on project entrapment. The experiment also adds to the literature with the link between team member's interaction and its effect on team's decision and firm's value.

Additionally, I introduce uncertainty of the project and suggest the shareholders' optimal recruitment strategy for the project. With the supplement of the shareholders' ex-ante recruitment decisions, the model is integrated and explains the full process of project investment in the firm. The model could shed light on how to recruit a project manager/team to achieve optimal value from project investment.

7.4 Limitations

The model is developed on individual level and team's level. Many restrictions are assumed for analysis, for example identical cost of effort for the managers, same level of overconfidence for overconfident managers. More complicated model can be established when the assumptions are lifted. I consider the effect of overconfidence and engagement on project entrapment in individual manager's model, and the effect of overconfidence and team's reciprocity in team's model. However, in the experiment, I did not find significant relationship between engagement and project entrapment. Future research can be conducted to revisit this factor. The behavioural finance experiment on individual level and team level are both distributed online via a unique

link. I intended to conduce lab experiment on teamwork level. However, due to the COVID-19 restrictions the experiment was implemented online, and the participants were paired with a virtual teammate in the experiment. Future experimental studies can add to the research by carrying out laboratory experiment and explore how participants with real teammates make investment decisions.

7.5 Future Research Directions

There exist other factors to consider in future research. For individual decision making, other psychological biases such as regret aversion, narcissism, myopic can be included in the model. On the opposite side of overconfidence, an underconfident manager's decision making is also worth studying in future research. In terms of project entrapment, in my model the manager's decision is simply continuing or abandoning the project. Reinvestment or partially liquidating the project is an option for the model in project entrapment because sometimes managers may not entirely abandon the project, or they would like to add extra investment to the project. As for team's decision making, a model with a team of more members would be interesting to develop. Moreover, the teamwork model can be extended to other corporate decisions incorporating with project entrapment, namely financial contracts, capital structures, and dividend policies. Applying the theories to the real word and helping decision makers in the companies are also a promising direction for future research.

Another interesting research direction is emotional finance. There is some existing research starting to combine emotions and investors' decision making. Recently, emotions in corporate managers are increasingly appealing to corporate finance researchers. Project entrapment can be potentially explained by emotions of project managers. Integrated with neuro-economics, more fascinating theoretical and empirical research can be carried out to 'add value' to the field of corporate finance.

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Appendix A: General Knowledge Questions in the Experiments

In the experiment of one manager's decision, I captured the participants' true ability and their perceived ability by a general knowledge question task. I developed 20 general knowledge questions adapted from 'Overconfidence and investment: An experimental approach' (Pikulina et al, 2014), and 'Betting on Own Knowledge: Experimental Test of Overconfidence (Blavatskyy, 2008)'. Each question was given two choices, and there was only one correct answer for each question. The participants were required to answer 20 questions first, then they estimated how many correct answers they could give. The number of correct answers was used as a proxy for true ability, and the estimated number of the correct answers was the perceived ability. I also measured the participants' level of overconfidence by calculating the difference between the actual correct answer. The general knowledge questions in the experiment of one manager are shown below (correct answers in bold).

1. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? **(i) 5 minutes**; (ii) 100 minutes
2. How many countries and regions are there in the world in total in 2019? **(i) 233**; (ii)278
3. How long is the earth equator around in kilometres? (i)20k; **(ii)40k**
4. Scientists find that a type of germ grows double in size every second. If it takes 48 seconds to reach its largest size, how many seconds would it take to grow to its half size? (i) 24 seconds; **(ii) 47 seconds**
5. In which year did Thomas Edison invent electric light bulb? (i)1908; **(ii)1879**
6. In 2019, where is the world's tallest building located, which stands 828 meters? **(i)Dubai;** (ii)New York
7. In which year, China exceeded Japan and became the second largest economy entity in GDP. **(i)2010**; (ii)2015
8. What is the highest temperature in the world in the history? **(i)56.7°C**; (ii)70.6 °C
9. Which aircraft can carry more passengers in its maximum capacity? (i) Airbus A350; **(ii) Airbus A380**

10. You should rather have $5,000 than a Euro cent doubled every day for a month. (i) True; **(ii) False.**
11. A bat and a ball cost £1.10 Euro in total. The bat cost £1 more than the ball. How much does the ball cost? (i) £0.10; **(ii) £0.05**
12. How many known planets does Solar System consist of? **(i)8**; (ii)9
13. What is the sum of angles in a triangle in degrees? **(i)180**; (ii)360
14. Jeanne Calment, who has the world's longest confirmed human lifespan, lived to the age of ( ) and passed away in 1997. (i)110; **(ii)122**
15. Which city has the longest metro (underground) system in the world? **(i)Tokyo**; (ii)London
16. How many rings are on the Olympic flag? **(i) 5**; (ii) 7
17. What is the capital of Canada? **(i) Ottawa**; (ii) Vancouver
18. Which country hosted the Summer Olympics in 2016? (i)United Kingdom; **(ii)Brazil**
19. Which city's landmarks include: The Pantheon, The Spanish Steps and Trevi Fountain? (i)Athens; **(ii)Rome**
20. Which of the following is NOT collected in British Museum? **(i) Venus de Milo**; (ii) Ancient Egyptian Mummy

In the experiment of team's decision, I developed a new set of questions. The questions are shown below (correct answers in bold).

1. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? **(i) 5 minutes**; (ii) 100 minutes
2. What is the most abundant metal on Earth? **(i)Aluminium**; (ii)Iron
3. What is the strongest sense in humans? **(i)Smell**; (ii)Taste
4. What enterprise belongs to Bill Gates? (i)Intel ; **(ii)Microsoft**
5. Scientists find that a type of germ grows double in size every second. If it takes 48 seconds to reach its largest size, how many seconds would it take to grow to its half size? (i) 24 seconds; **(ii) 47 seconds**.

6. How long does it take for a hen to hatch an egg? (i)14 days; **(ii)21 days**
7. What is a word to describe an uninformed person? **(i)Ignorant;** (ii)Ignatius
8. What is the smallest country in the world? **(i)Vatican City;** (ii)Luxemburg
9. How many bones in the adult human body? (i) 192; **(ii) 206**
10. You should rather have $5,000 than a Euro cent doubled every day for a month. (i) True; **(ii) False.**
11. A bat and a ball cost £1.10 Euro in total. The bat cost £1 more than the ball. How much does the ball cost? (i) £0.10; **(ii) £0.05**
12. There are McDonald's one every continent except one. **(i)True**; (ii)False
13. In Zootopia, what kind of animal is Flash? **(i)Sloth**; (ii)Leopard
14. Which US actor plays the title character in the movie franchise 'Deadpool'? (i) Chris Evans; **(ii) Ryan Reynolds**
15. What colour is found on 75% of the world's flags? **(i)Red**; (ii)Blue
16. How much of the human body is water? **(i) 60%**; (ii) 80%
17. To a single decimal point, how many kilometres are in a mile? **(i) 1.6km**; (ii) 2.0km
18. Which country is the origin of the cocktail Mojito? (i)Puerto Rico; **(ii)Cuba**
19. Who won the FIFA World Cup in 2019? (i)Croatia; **(ii)France**
20. What is the hottest continent on Earth? **(i) Africa**; (ii) Oceania

Appendix B: Instructions for Experiment of One Manager's Decision (General Instructions and Investment Information)

Starting Page of the Experiment

Welcome to the behavioural finance experiment!

Please take time to carefully read the following information about the experiment.

What is the experiment about?

The experiment will explore peoples' investment decision making and project management.

The experiment is being run by Yuhao Li, a PhD student from School of Management at University of Bath.

What does the experiment involve?

The experiment contains 2 sections

In section 1, you will be given 20 questions on general knowledge. You are required to choose the correct answer from two answers given. At the end of the task, you will be asked to estimate how many correct answers you believe that you gave.

In Section 2, you will take part in an investment task. You will be given 4 different products and you can only choose to invest in only one product. Then you need to make some financial decisions on your investment.

How long will the experiment take?

The experiment takes approximately 20 to 30 minutes.
The tasks will present you with text. It is important that you take your time and fully understand the text as you progress through the tasks

Please note that this survey can ONLY be completed on a COMPUTER.

→

Instructions for General Knowledge Questions

Section 1

In this section, you will be given 20 general knowledge questions. Please choose one of the two answers which you think is correct. To make the experiment result reliable, please answer the questions based on your own knowledge and do not search the answer online or in the textbook.

Please make sure that you read and answer the questions carefully because the number of correct answers you give will affect your performance in the next section. The more correct answer you give, the more better results you can achieve in the next section.

After answering the questions, you are required to estimate how many correct answers you think you can give.

Your choices are totally confidential and will only be used for data analysis after the experiment.

→

Instructions for Project Investment

Section 2

In this section, you are a project manager in an IT company V. You need to make some important investment decisions for the company.

V company has received a certain amount of profit from previous years and aims to gain competitive edge in the market by investing into a new project. V company is considering developing a new personal laptop to compete against other companies in IT field. The designers of the company introduce 4 different type of laptops for you to consider. After negotiating with the supplier and manufacturer, the company need to make an investment decision on only 1 of 4 versions of the laptops.

→

Information on Project Choice

As a project manager, you are in charge of this project. The following are the details of four laptop versions. Please read the descriptions below carefully and choose one of the four versions of the laptop. You cannot change your choice after this.

Gaming Laptop:

Features: Large Internal Memory, Faster Game Loading, Smoother Game Performance, Suitable for Most Popular Games

Target Customers: PC Game Lovers

Working Laptop:

Features: Largest Memory with latest CPU, Most Office Related Software Installed, Faster in Analysing and Data Processing;

Target Customers: Office Workers, Data Managers, Professional Businesspeople and Researchers

Family Laptop:

Features: Quick Internet Access, Advanced Video Player, Bluetooth Technology, High Performance Camera;

Target Customers: Family users

Convertible Laptop:

Features: Extreme Thin Screen, Detachable and Convertible Keyboard, Digital Pen, Fingerprint Reader, Smaller Size;

Target Customers: Frequent Travellers, Smart and Fashionable lifestyle customers

Please place the four versions of the laptop in the order of your preference (Top with most favourite to the bottom with least favourite) .

Version 1: Gaming Laptop 

Version 2: Working Laptop 

Version 3: Family Laptop 

Version 4: Convertible Laptop 

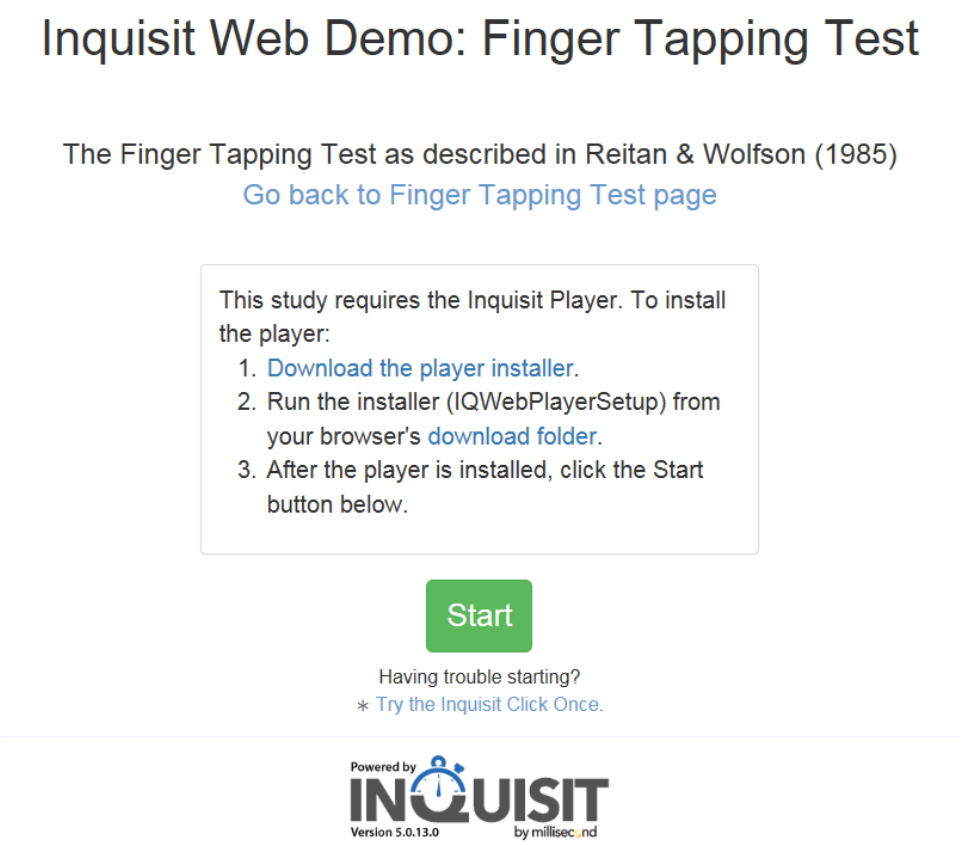
Appendix C: Instructions for Tapping Task

The tapping tsk was conducted using the link shown below:

https://www.millisecond.com/download/library/v5/fingertapping/fingertapping.web

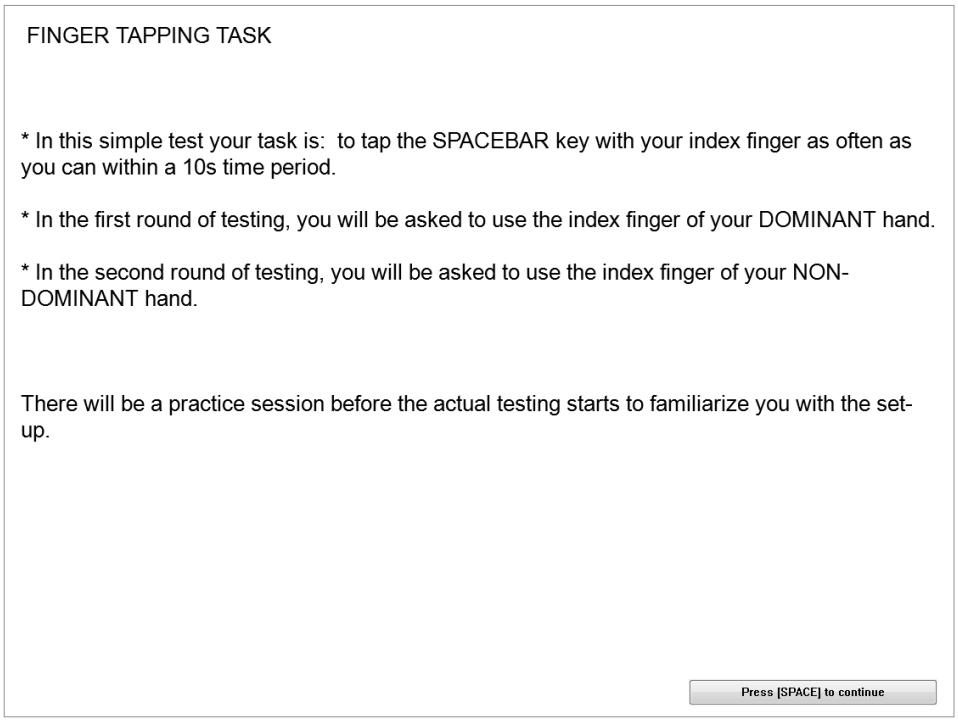
The task was performed in the following way:

1. Open the link in a new window. The web should be shown below:

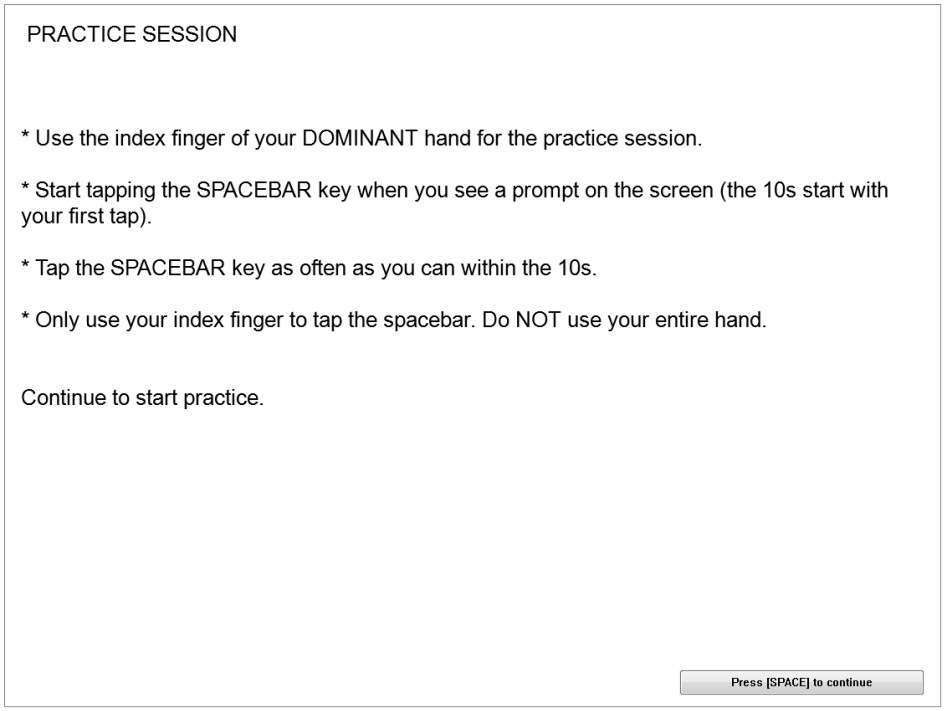


2. Click the 'Start' button, install the program for the tapping task and click the start button again.

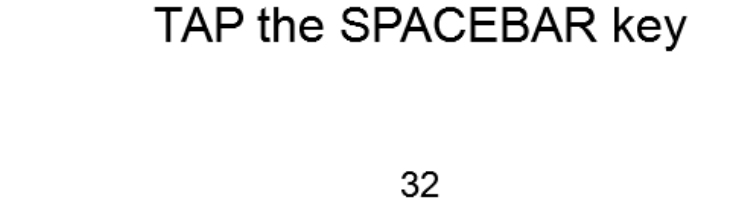
3. The program is shown below.



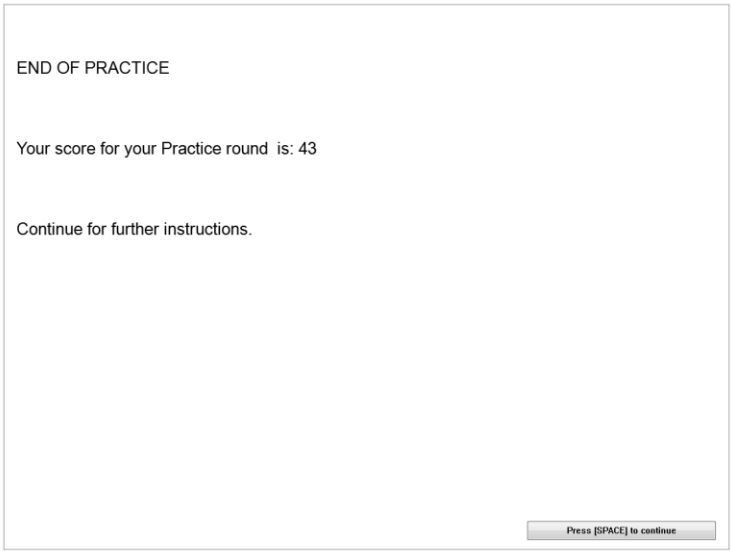
4. Press [SPACE] to continue until you see this below.



5. When you are ready, press [SPACE] to the next page. When you see the page below, start tapping the [SPACE] as soon as possible.



6. Until you see the page below, this is the end of the first session although it is shown as a practice, record the number in the first session. (As shown below ‘43’)



7. Press [SPACE] and complete the same tapping task twice, record the numbers from the result. Add the three numbers together, **Press [Ctrl]+[Q]** to quit the program and write down the result on the online experiment page. Then you can carry on with the experiment.

Appendix D: Instructions for Experiment of A Team's Decision (General Instructions and Investment Information)

Starting Page of the Experiment

Welcome to the behavioural finance experiment!

Please take time to carefully read the following information about the experiment.

What is the experiment about?

The experiment will explore peoples' investment decision making and project management.

The experiment is being run by Yuhao Li, a PhD student from School of Management at University of Bath.

What does the experiment involve?

The experiment contains 2 sections.

In section 1, you will be given 20 questions on general knowledge. You are required to choose the correct answer from two answers given. At the end of the task, you will be asked to estimate how many correct answers you believe that you gave. In Section 2, you will take part in an investment task. You act as a project manager in a management team for a firm. You will have ONE teammate working together. Your team will be running a project which can create value for your firm. Then you need to make some financial decisions on your investment.

How long will the experiment take?

The experiment takes approximately 15 to 20 minutes. The tasks will be presented you with detailed instructions. It is important that you take your time and fully understand the text as you progress through the tasks.

Next

Instructions for General Knowledge Questions

In this section, you will be given 20 general knowledge questions. Please choose one of the two answers which you think is **CORRECT**.

To make the experiment result reliable, please answer the questions based on your own knowledge and do not search the answer online or in the textbook. Please make sure that you read and answer the questions carefully because the number of correct answers you give will affect your performance in the next section. The more correct answer you give, the better results you can achieve in the next section.

After answering the questions, you are required to estimate how many correct answers you think you can give.

Your choices are totally confidential and will only be used for data analysis after the experiment.

Next

Information For Project and Team

Section 2

In this section, you will be working with another person in a team on a project. You and your teammate will be acting as project managers for a firm, which aims to maximize the payoffs from the project. You and your teammates are also seeking to receive optimal payoff from the project.

You and your teammate will be completing a simple task in this section respectively. The outcome of the project depends **ONLY** on your and your teammate's performance of the task. After you complete the task, you will be informed of your performance, your teammate's performance, and the payoff from the project. You can make your own investment decisions based on the results.

Information for a Rational Teammate and Project

Information of Your Teammate

You will be working with a manager Mr.R. You and Mr.R will work as a team to create optimal value for the firm. Mr.R scores **12** correct answers in the general knowledge quiz task. He also estimates that the number of correct answers he gives in the quiz task is **12**. Your team's output depends on your and Mr.R's performance in the following task.

Information of the Project

Your team is working for a motor corporation which launches a new model of sports utility vehicle (SUV). This SUV is equipped with a high efficient engine. It performs well in dynamic and fuel efficiency. It is also designed with autopilot and navigation system to provide a comfortable driving experience for drivers.

The project of the project has been run for a period. Due to an unexpected issue in the market, the project failed to achieve the expected value for the past year. Your team now needs to decide whether to continue or abandon the project.

Information for an Overconfident Teammate and Project

Information of Your Teammate

You will be working with a manager Mr.O. You and Mr.O will work as a team to create optimal value for the firm. Mr.O scores **12** correct answers in the general knowledge quiz task. He estimates that the number of correct answers he gives in the quiz task is **17**. Your team's output depends on your and Mr.O's performance in the following task.

Information of the Project

Your team is working for a motor corporation which launches a new model of sports utility vehicle (SUV). This SUV is equipped with a high efficient engine. It performs well in dynamic and fuel efficiency. It is also designed with autopilot and navigation system to provide a comfortable driving experience for drivers.

The project of the project has been run for a period. Due to an unexpected issue in the market, the project failed to achieve the expected value for the past year. Your team now needs to decide whether to continue or abandon the project.

Appendix E: Instructions for Number Counting Task

Starting Page of the Task

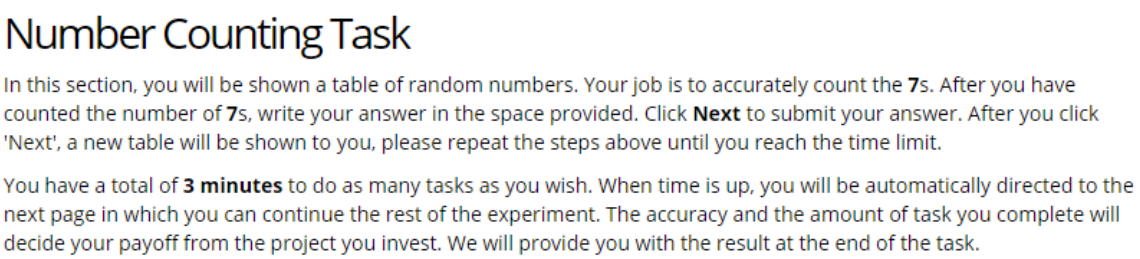
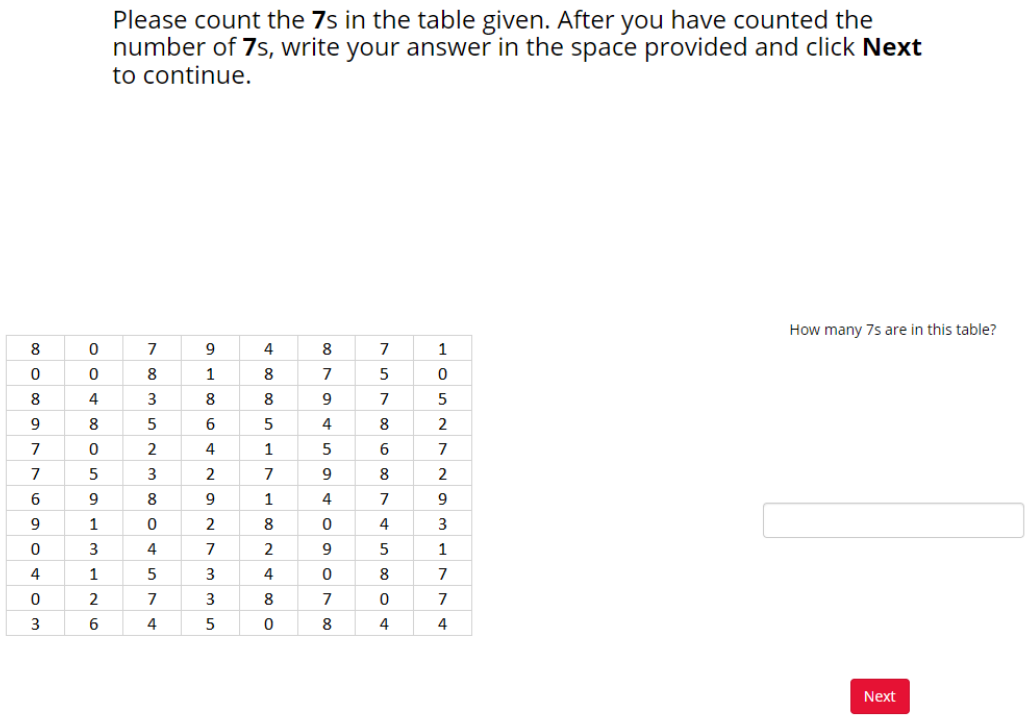


Table of Random Numbers and Task Page



When the participants finished counting, they submitted and clicked ‘Next’, and a new table was shown to them. The task was completed after 3 minutes.

Finishing Page of the Task

Thanks for taking the task. Your results will be shown on the next page.

Next

You got **0** counting correctly. Meanwhile, your teammate score **6** in the number counting task.

Combining your and your teammate's performance, your team will receive **£ 0** from the project and you will receive **£ 0** from the project.

Next