The Governance of Long-Term Investing in Knowledge Creation

Novel Control Mechanisms for Reducing Managerial Myopia and Increasing Growth in Organizations

Antti Niemi

The Governance of Long-Term Investing in Knowledge Creation

Novel Control Mechanisms for Reducing Managerial Myopia and Increasing Growth in Organizations

Antti Niemi

A doctoral dissertation completed for the degree of Doctor of Science (Technology) to be defended, with the permission of the Aalto University School of Science, at a public examination held at the lecture hall AS1 of the school on 15 November 2013 at 12.

Aalto University
School of Science
Department of Industrial Engineering and Management
Strategic Management

Supervising professor
Professor Markku Maula

Thesis advisor
Professor Thomas Keil

Preliminary examiners
Professor Søren Salomo, Technical University of Denmark , Denmark
Professor Yuval Deutsch, York University, Canada

Opponent
Professor Maurizio Sobrero, University of Bologna, Italy

NORDIC ECOLABEL

441   697
Printed matter

Author
Antti Niemi

Name of the doctoral dissertation
The governance of long-term investing in knowledge creation: Novel control mechanisms for reducing managerial myopia and increasing growth in organizations

Publisher School of Science

Unit Department of Industrial Engineering and Management

Series Aalto University publication series DOCTORAL DISSERTATIONS 150/2013

Field of research Strategic Management

Manuscript submitted 11 June 2013   **Date of the defence** 15 November 2013

Permission to publish granted (date) 20 August 2013   **Language** English

☒ **Monograph**   ☐ **Article dissertation (summary + original articles)**

Abstract

Investments in learning are central to the sustained growth and competiveness of corporations. However, a corporation's ability to invest in learning is restrained by managerial preferences for low-risk and short-term investments. Such managerial myopia can be induced by excessive reliance on the short-term financial control of management that is based on the comparison of actual income relative to annual or shorter-term targets. Previous research on corporate governance and corporate internal controls has identified the balancing controls for reducing managerial myopia, but it has focused on top management. There is a lack of understanding of how managerial myopia can be curbed at lower organizational levels.

This dissertation makes a contribution by filling the gap in the understanding of the mechanisms that reduce managerial myopia at lower organizational levels to increase investments in learning new knowledge that is likely to take a long time to generate income. This dissertation extends mechanisms such as strategic controls and boards of directors, which have been examined in previous research on corporate governance and corporate internal controls, to lower organizational levels. Agency theory, organizational control theory, and resource dependence theory are the key theories applied in this dissertation, following the tradition of previous research on corporate governance and corporate internal controls.

This dissertation proposes the use of written ex ante reasoning and reviewers as possible controls against managerial myopia. In addition, the issues of attention, income decrease and the time it takes for an investment to generate income are proposed as potential influences on investments in long-term learning. The hypotheses were tested empirically using a regression analysis on a longitudinal sample of 2,147 research and development projects in a large industrial corporation. Most of the hypotheses received empirical support.

This dissertation contributes to the extant literature by extending previous applications of agency theory to lower organizational levels. In addition, the findings of this dissertation contribute to the literature on managerial myopia and organizational learning. The findings have practical implications for managers and shareholders who consider investments that involve learning and are likely to require long periods of time to generate income.

Tiivistelmä

Investoinnit oppimiseen ovat keskeisiä yritysten kestävän kasvun ja kilpailukyvyn osalta. Yrityksen kykyä investoida oppimiseen rajoittaa kuitenkin johdon taipumus suosia investointeja, joilla on alhainen riski ja lyhyt takaisinmaksuaika. Tällaista lyhytnäköisyyttä voi aiheuttaa liiallinen turvautuminen lyhyen aikavälin taloudelliseen tulokseen perustuvaan ohjaukseen, jolloin yritystä ohjataan vertaamalla toteutunutta taloudellista tulosta vuosittaisiin tai lyhyemmän aikavälin tavoitteisiin. Aiempi tutkimus yritysten hallinnointitavoista ja yritysten sisäisistä ohjaustavoista on tunnistanut mekanismeja, joilla lyhytnäköisyyttä voidaan vähentää, mutta aiempi tutkimus on keskittynyt yritysten ylimpään johtoon. Ymmärrys lyhytnäköisyyden rajoittamisesta alemmilla organisaatiotasoilla on puutteellista.

Väitöskirja täydentää puuttuvaa ymmärrystä mekanismeista, joilla lyhytnäköisyyttä voidaan rajoittaa alemmilla organisaatiotasoilla ja näin kasvattaa investointeja sellaisen uuden tiedon oppiseen, jonka pohjalta syntyvän taloudellisen tuloksen toteutuminen voi kestää pitkän ajan. Aiempi tutkimus yritysten hallinnointitavoista ja sisäisistä ohjaustavoista on tarkastellut hallituksen ja strategisen ohjauksen käyttöä yritysten johtamisessa ja tässä väitöskirjassa näiden mekanismien soveltamista laajennetaan johtamiseen alemmilla organisaatiotasoilla. Kuten aikaisemmassa tutkimuksessa yritysten hallinnointitavoista ja sisäisistä ohjaustavoista, tärkeimmät väitöskirjan pohjana olevat teoriat ovat agenttiteoria, organisatorinen ohjausteoria, ja resurssi-riippuvuusteoria.

Väitöskirjassa ehdotetaan lyhytnäköisyyden rajoittamiseen mahdollisina ohjauskeinoina investoinnin potentiaalisen tuoton ennaltakuvaavan kirjallisen päättelyn ja erityisten tarkastajien käyttöä. Lisäksi ehdotetaan, että investoinnit pitkäaikaiseen oppimiseen riippuvat johdon huomiota ohjaavista tekijöistä, taloudellisen tuloksen heikentymisestä, ja investoinneista taloudellisen tuloksen toteutumiseen kuluvasta ajasta. Väitöskirjan hypoteesit tutkittiin empiirisesti regressioanalyysillä tarkastelemalla suuren teollisuusyrityksen 2147 tuotekehitysprojektista koostuvaa pitkittäisotosta. Empiiriset tulokset tukivat suurinta osaa hypoteeseistä.

Väitöskirja täydentää olemassa olevaa kirjallisuutta laajentamalla agenttiteorian aikaisempia sovelluksia alemmille organisaatiotasoille. Lisäksi väitöskirjan löydökset täydentävät aikaisempaa johdon lyhytnäkösyyteen ja organisaatioiden oppimiseen liityvää tutkimusta. Löydökset tarjoavat käytännön johtopäätöksiä johtajille ja sijoittajille, jotka harkitsevat investointeja sellaisen uuden tiedon tuottamiseen, jonka pohjalta syntyvän

Acknowledgements

Many individuals have supported me over the years in the research that has culminated in this dissertation. Thoughts and constructive criticism from both researchers and practitioners have helped me to improve the quality of the research and have made the research endeavor an exciting experience.

First of all, I would like to thank my supervisors. Professor Tomi Laamanen led me into this sphere of research and encouraged me to learn about and delve deeper into the existing body of knowledge. I continued my research under the supervision of Professor Thomas Keil, who provided me with invaluable insights into structuring the research into this dissertation and who tirelessly supported me through the process. I also wish to thank Professor Markku Maula for increasing the rigor of the empirical analysis of this research.

I am grateful for Professor Søren Salomo of Technical University of Denmark and Yuval Deutsch of York University, who acted as my external examiners. I also want to thank Professor Maurizio Sobrero of University of Bologna for acting as my opponent.

I am indebted to the case organization for allowing me access to the valuable data source that made this dissertation possible. A number of managers from the case organization offered me their support and constructive feedback. For the sake of confidentiality, I cannot name any of them here, but I am nevertheless most thankful for every one of them.

I did not request or receive any external funding for this research. Nevertheless, I want to express my gratitude to Aalto University and to the citizens of Finland, who have provided me with tuition and access to the research infrastructure for the entirety of my education and research.

Table of contents

1. Introduction

1.1 Background

The past research on managerial myopia suggests that an excessive preference for low risk and short-term investments restrains an organization's ability to allocate resources to learning new knowledge that is likely to take a long time to generate income (e.g., Hayes and Abernathy, 1980; Hill, 1985; Porter, 1992; Hoskisson et al., 1993; Jensen, 1993; Levinthal and March, 1993; Laverty, 1996; Zahra, 1996; Miller, 2002; Marginson and McAulay, 2008: Barrett, 2010). Managerial myopia can be induced by an excessive reliance on the short-term financial control of management, which is based on the comparison of actual income relative to annual or shorter-term targets. Such a short-term focus can reduce investments in learning new knowledge that is likely to take a long time to generate income and may eventually erode an organization's ability to remain competitive in a changing environment over time (Leonard-Barton, 1992; Levinthal and March, 1993; Utterback, 1994; Christensen and Bower, 1996). Managerial myopia has been observed to be a common dilemma faced by numerous organizations that limits wealth creation. A common indication of the prevalence of managerial myopia is incessant discussions in the public media about degrading competitiveness and calls for innovation to improve competitiveness.

Previous research on corporate governance and organizational control has addressed the dilemma of managerial myopia. Such research has contributed to an understanding of how corporate governance and organizational controls can be employed to curb managerial myopia within organizations. The literature on corporate governance is based on agency theory, which suggests that equity-based incentives such as stock and stock options can be applied to avoid excessive managerial myopia (Jensen and Meckling, 1976; Holmström, 1979; Fama, 1980; Fama and Jensen, 1983a, 1983b). Agency theory further contends that equity-based incentives do not provide a perfect solution and can be complemented by monitoring. Corporate governance regards boards of directors as the main monitoring

mechanism. In its monitoring role, a board assesses management's ability and effort and the external factors that influence shareholder return. If a board of directors perceives a need for improvement by management to increase shareholder return, the board can adjust the management of the organization by modifying incentives or changing the management personnel.

Whereas corporate governance focuses on the apex of an organization by investigating the role of incentives and the board of directors in controlling the CEO, the research on corporate internal controls focuses on studying the next level down in the organizational hierarchy. In particular, it investigates how the corporate management of a multidivisional firm controls the divisional management that reports to the corporate CEO (e.g., Gupta, 1987; Hill and Hoskisson, 1987; Baysinger and Hoskisson, 1989, 1990; Hitt et al., 1990; Goold and Quinn, 1990; Hoskisson et al., 1991, 1993; Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn, 1999). Corporate management can apply strategic controls to evaluate the strategies by division management. As a consequence, division management can also be evaluated based on its longer-term strategic decisions rather than by its short-term financial performance. This method of evaluation is expected to motivate division management to pay more attention to sustaining longer-term competitiveness.

In summary, previous research on corporate governance and strategic controls provides a number of controls against managerial myopia, but that research focused on boards, CEOs and division management. Board monitoring and strategic controls are not as applicable to control beneath the upper echelons. In addition, the effectiveness of equity-based incentives is reduced considerably at lower organizational levels because the decisions of an individual manager can only have a marginal effect on the total organizational income, which determines the outcomes of equity-based incentives (Baker et al., 1988; Baker, 1992, Balkin, et al., 2000; Zenger and Marshall, 2000).

In conclusion, there is a lack of understanding about the controls that can be used against managerial myopia at lower organizational levels. However, most individuals who are employed by large organizations work at lower organizational levels. Additionally, the bulk of the decisions that determine organizational income are made at lower organizational levels. Therefore, the difficulty of controlling managerial myopia at lower levels is expected to impose a substantial limitation on an organization's ability to invest in learning new knowledge that is likely to take a long time to generate income. An improved understanding of how to curb managerial myopia at

lower organizational levels could help organizations to better sustain their long-term competitiveness.

1.2   Research problem and objectives

This research aims to fill the gap in the understanding of the controls that can be used against managerial myopia at the lower organizational levels. This research problem is addressed with the following main research question:

How can large organizations better control against managerial myopia at lower organizational levels to increase investments in learning new knowledge that is likely to take a long time to generate income?

This main research question is addressed in three stages and guided by three further questions. The existing knowledge about controls against managerial myopia is used as a starting point to search for answers to the main research question. This first stage is driven by the following question:

1.   *How can the known control mechanisms be extended for application at lower organizational levels?*

This question is addressed by an overview of the extant research on boards of directors and corporate internal controls. Based on this review, a number of controls against managerial myopia at the upper echelons are identified and then modified for use at lower organizational levels. As a result, a model of the control mechanisms at lower organizational levels is developed. In the next phase, this study investigates how such control mechanisms can actually curb managerial myopia. This investigation is guided by the second question:

2.   *How do investments in learning new knowledge that is likely to take a long time to generate income depend on the use of controls against managerial myopia at lower organizational levels?*

This question is examined to determine how the identified controls can both encourage and impede the ability and motivation of decision makers at lower organizational levels to invest in the learning that is needed to support an organization's long-term competitiveness. The theory is formulated as a number hypotheses for empirical testing. In addition to the control mechanisms themselves, the extant literature on corporate

governance and organizational learning is also reviewed to identify other factors that can influence managerial myopia and the effect of control mechanisms in curbing managerial myopia and increasing investments in learning new knowledge that is likely to take a long time to generate income. This issue is addressed by the following third question:

3.   *What other factors can influence managerial myopia and the effect of control mechanisms in increasing investments in learning new knowledge that is likely to take a long time to generate income?*

The objective of this study is to identify the controls against managerial myopia at the lower organizational levels of large organizations. In particular, this study aims to conceptualize the mechanisms for how these controls against managerial myopia influence investments in learning new knowledge that is likely to take a long time to generate income. This study also aims to formulate a theory of empirically testable hypotheses and to actually test those hypotheses. Finally, this study seeks to provide tangible recommendations to practitioners for reducing managerial myopia in large organizations.

1.3   Research approach and methods

The construction of the theoretical model is guided by the research problem and question. The basis is an overview of the extant body of knowledge that is related to the research problem. In particular, the past research on corporate governance, corporate internal controls, investment in learning, and managerial myopia are reviewed. The known control mechanisms that are applicable to the organizational upper echelons are utilized as the basis for a theory of controls against managerial myopia at lower organizational levels. The theory of this study is formulated as a number of hypotheses that can be tested empirically.

The hypotheses of this study are tested on the data of research and development projects in a large industrial corporation. When the interest of research regards managers at the lower levels of an organization, a detailed focus on a single firm provides certain gains. Organizational processes are usually complex and rich in subtlety. Organizational phenomena tend to have a temporal dimension of dynamism that can be best captured by longitudinal data (e.g., Pettigrew, 1992). A focus on one organization helps to provide a more comprehensive and longitudinal understanding of the details that are related to the phenomena that influence decisions by

individuals (e.g., Siggelkow, 2007). The methods that were used in this study are discussed in more detail in chapter 4.

The data on the research and development projects were obtained from the corporation's management information systems. The sample consisted of the over 260 million euros invested in 2,147 research and development projects over a thirteen-year period between 1997 and 2009. The hypotheses were tested empirically with quantitative statistical methods using a regression analysis. Finally, based on the empirical findings, conclusions are drawn for both theoretical and practical implications.

1.4 Scope

The theoretical scope of this study focuses on large organizations that have several organizational levels. In small companies, in which most of the decisions that influence long-term competiveness are made by the management team, the controls against managerial myopia, which focus on upper echelons and have been identified by previous research, are likely to be effective.

The empirical findings of this study are based on a single large industrial company. When the focus is on the managers at the lower levels of an organization, the focus on a single firm provides certain gains. Organizational processes are usually complex and rich in subtlety. Organizational phenomena tend to have a temporal dimension of dynamism that can be best captured by longitudinal data (e.g., Pettigrew, 1992). The focus on one organization helps to provide a more comprehensive and longitudinal understanding of the details that are related to the phenomena that influences the decisions that are made by individuals (e.g., Siggelkow, 2007).

The generalizability of the findings from a study that is based on the investigation of only one organization is inherently suspect. Any finding can be due to something that is idiosyncratic to the organization, and similar phenomena may not exist in most other organizations. This risk can be minimized by sampling an organization that is a typical representative of many similar organizations and does not have idiosyncratic characteristics that would be critical to the findings. To address the potential limitation of the generalizability of the findings, a typical industrial corporation was chosen for investigation. To further minimize the risk of any idiosyncratic characteristics, the corporation and the processes within the organization are analyzed and described in detail. This description suggests that the activities within the organization closely match the findings of previous literature on corporations, and no idiosyncratic characteristics that are

critical to the findings are observed. Therefore, the findings from this study are assumed to be generalizable to a broader population of similar corporations.

The empirical data consist of research and development projects. Research and development expenditure has been widely used in the past research to measure the activities that are related to long-term learning in firms (e.g., Hoskisson and Hitt, 1988; Hitt et al, 1991; Hoskisson et al., 1993; Helfat, 1994a, 1994b; Hitt et al, 1996; Hundley et al., 1996; Palmer and Wiseman, 1999; Greve, 2003; Lee and O'Neill, 2003; Chen and Miller, 2007; Sanders and Hambrick, 2007; Chen, 2008; Kim et al., 2008). Research and development projects are expected to effectively represent the general investments in learning new knowledge that is likely to take a long time to generate income, but adequate caution is nevertheless warranted in generalizing the results to different types of long-term learning.

1.5   The structure of the dissertation

Following this introduction, chapter 2 provides a literature review. Chapter 3 formulates the theory and hypotheses. Methods, including the empirical research context and operational variables, are described in chapter 4. The empirical results are presented in chapter 5. Finally, chapter 6 discusses the conclusions of the research, including the practical implications and avenues for future research.

2. Literature review

This chapter reviews the theories and literature that are relevant for the theory and hypotheses developed in chapter 3. The review of the theories and literature is driven by the research question that asks how large organizations can improve controls against managerial myopia at lower organizational levels to increase investments in learning new knowledge that is likely to take a long time to generate income. To address this research question, the literature on corporate governance, corporate internal controls, investment in learning, and managerial myopia are reviewed. Before the review of this literature, the relevant theoretical perspectives are introduced. These perspectives include agency theory, organizational control theory, and resource dependence theory.

The literature on corporate governance and corporate internal controls is reviewed to provide an understanding of how large organizations can be controlled. The literature on board of directors focuses on the very apex of an organization, investigating the shareholder-board and board-CEO dyads. On the other hand, the literature on corporate internal controls focuses on the next level of organizational hierarchy, the relationship between CEOs and division managers.

The literature on investment in learning is reviewed to provide an understanding of the factors that influence the amount of resources that are invested in learning. Once the literature on corporate governance, corporate internal controls, and investment in learning are reviewed, the literature on managerial myopia is reviewed to provide an understanding of how investments in learning can be bounded by the limitations of organizational controls. This review provides the basis for the following chapter, which examines how known organizational controls can be extended to reduce the managerial myopia that limits investments in learning.

2.1 Relevant theoretical perspectives

2.1.1 Agency theory

Agency theory explains how a firm can be organized with separate owners and management (Ross, 1973; Jensen and Meckling, 1976; Harris and Raviv, 1978, 1979; Holmström, 1979; Fama, 1980; Fama and Jensen, 1983a, 1983b). Agency theory and related research is discussed in detail in many reviews (e.g., Eisenhardt, 1989; Shleifer and Vishny, 1997; Dalton et al., 2007).

Jensen and Meckling (1976, p. 308) define an agency relationship as "a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf which involves delegating some decision making authority to the agent." For example, in a corporate context, agency theory is applied by regarding shareholders as principals and a CEO as an agent. Agency theory has its roots in economics and is deduced from a number of assumptions through mathematical analysis. The main assumptions of agency theory are related to self-interest, asymmetric information, and the risk aversion of a principal and agent.

Agency theory assumes that both a principal and agent maximize their self-interest. Because the desires and goals of the principal and the agent are usually different, an agency creates a conflict of interests. In particular, the agent can take actions that benefit the agent at the cost of the principal. The self-interest of the agent is neither hypothetical nor marginal but has been found in many empirical studies. For example, Shleifer and Vishny (1997) provide several examples of how agents have benefited at the cost of principals. As an example, they illustrate how in some cases, management has made decisions to buy corporate assets from firms that were owned by management at a 99 percent discount, thereby practically appropriating the wealth of the shareholders. In conclusion, a principal has reason to be concerned about the self-interest and mischief of an agent. A principal is even unlikely to hire an agent in the first place unless the principal can somehow curb the agent's actions. Agency theory seeks to determine how a principal can best motivate an agent to take actions that benefit the principal.

If a principal can directly observe the actions that are taken by an agent and their outcomes without any uncertainty, it is straightforward for the principal to motivate the agent simply by compensating the agent based on the actions that were taken by the agent. The principal and agent can make a contract that defines how much the principal will pay for the agent once

the agent has taken each action. The principal then observes the actions of the agent and pays the agent according to the contract.

However, the principal usually cannot fully observe the agent's actions or their influence on outcomes directly. This is the assumption of asymmetric information. In this case, the principal cannot compensate the agent based on observed actions. If the principal would just hire the agent without being able to observe what the agent does, the principal would expect the agent to take actions with self-interest, which could be quite harmful for the principal. Thus, the principal would not hire the agent in the first place. However, agency theory suggests that a principal can solve this problem by making an agent's compensation contingent on the principal's income. For example, a principal and an agent can make a contract that specifies that the agent gets a certain percentage of the principal's income. When the agent's income depends on the principal's income, the agent is motivated to take actions that increase the principal's income.

Agency theory further shows that even when an agent's income depends on a principal's income, the agent still may not take the actions preferred by the principal because the principal and agent can have different risk preferences. The risk preferences can differ because the principal and agent have different levels of wealth. In addition, the principal can diversify his or her wealth among many agencies, and one agency influences only a minor part of the principal's wealth. On the other hand, the agent is likely to get most of his or her income from only one agency. Therefore, the variation in the income from one agency has a much larger impact on the agent's than on the principal's total wealth. The agent is likely to take actions to adjust the variation of the agency's income to optimize personal risk, but such variation is likely to be less than preferred by the principal. Agency theory notes that because of this dilemma of risk aversion by an agent, a principal cannot fully align the agent's actions with the principal's preferences by making the agent's compensation contingent on the principal's income.

Agency theory suggests that a principal can improve an agent's motivation to take actions that are in line with the principal's preferences by complementing the agent's income-based compensation with the monitoring of the agent's actions. Holmström (1979) showed that any additional information about an agent's actions, however imperfect, can be used to improve the agent's incentives. A principal can monitor an agent with information systems such as auditing, formal control systems, budgeting systems, reporting systems, additional layers of management and boards of directors (e.g., Eisenhardt, 1989). The role of a board of

directors has been the most studied mechanism for the monitoring of agents.

A principal's decisions are not limited solely to choosing an agent and the agent's compensation, but, in addition, the principal can also make decisions on choosing which actions are to be implemented (Fama and Jensen, 1983a; Aghion and Bolton, 1992; Aghion and Tirole, 1997). Usually a principal delegates most of the decisions to be taken by an agent but retains rights to make certain key decisions that can have a major impact on the principal's income.

In addition to income-based compensation and monitoring, the market for corporate control provides a third control mechanism for an agency (Jensen and Meckling, 1976; Fama, 1980; Fama and Jensen, 1983a, 1983b). The market for corporate control is usually regarded as a "last resort" control for cases in which both income-based compensation and monitoring fail to motivate the agent adequately. If management acts with self-interest against a principal, the principal's income from the agency is likely to be relatively low. As a result, the potential for increasing a principal's income by changing the management becomes an attractive opportunity. The market for corporate control means that if management acts with self-interest against a principal, the agency, such as a firm, can be taken over by other principals who can then replace the management with other individuals.

In summary, agency theory suggests that a principal can motivate an agent to take actions that are in line with the principal's interests through a combination of financial incentives and the monitoring of the agent's actions. The market for corporate control works as a third, last-resort type of control. The theoretical predictions of agency theory have been widely tested, and many of the empirical results tend to support the theory. As a result, agency theory has been adopted as the dominant theoretical basis for corporate governance. The following chapters briefly review the past research on the details and empirical findings that are related to financial incentives and monitoring by boards of directors. Because this study focuses more on monitoring than on financial incentives, the past research on boards of directors is reviewed in greater detail than the research on financial incentives.

Equity-based incentives

Stock ownership and stock options are the two most widely applied types of equity-based financial incentives in firms (e.g., Jensen and Murphy, 1990). They can also be applied in combination. Equity-based incentives

are usually complemented by fixed-base salaries and variable bonuses that are contingent on short-term performance such as a firm's annual operating profit.

When stock ownership is applied, the principal grants or sells the agent part of a firm's equity. According to agency theory, such ownership share is expected to motivate the agent to take actions that maximize the firm's future income. On the other hand, stock options give an agent the right to buy stock at a specified price during some time period in the future. As a result, if the stock price increases above the specified price in the future, the agent can benefit by buying stock at a discount. Stock options motivate the agent to maximize the stock price by the time that the agent can exercise the stock options. Such an increase in stock price will also benefit the principal.

Agency theory posits that neither stock ownership nor stock options align an agent's preferences perfectly with a principal's. As discussed above, an agent may prefer less risk than a principal, even when the agent owns stock. On the other hand, stock options can motivate an agent to prefer more risk than a principal (e.g., Deutsch et al., 2010). This motivation arises because stock options provide the agent with income only if the stock price exceeds a certain limit, and the agent receives no income if the stock price remains lower. As a result, the agent has an incentive to choose actions that maximize the expected value of the stock price above the limit price, whereas shareholders prefer actions that maximize the expected value of the stock price overall. In practice, stock options can motivate an agent to take risky actions that have an increased probability of losses, which decreases the expected value of the stock price overall (Burns and Kedia, 2006; Harris and Bromiley, 2007). Stock options even create a temptation for the agent to influence the stock price through fraudulent activities such as concealing information that could have a negative impact on the stock price, such as the size and probability of losses due to the agent's actions. In conclusion, a principal can motivate an agent through a combination of stock ownership and stock options to attune the agent's preference for risk, but, in practice, setting the right balance can be challenging.

The past research has paid considerable empirical attention to trying to determine how a principal's income depends on an agent's equity-based incentives. Jensen and Murphy (1990) studied a sample of over 1,000 corporations and found that CEO wealth changed S3.25 for every S1000 change in shareholder wealth. The result suggests that an agent's income is contingent on a principal's income. In testing the effects on equity-based incentives on performance, Morck et al. (1988) studied Fortune 500 firms and found that when management owns up to 5% or more than 25% of a

firm's shares, management ownership increases the firm's market valuation. The relationship was negative between 5% and 25%. Morck et al. interpreted the result so that both small and large ownership shares motivate managers, but, in the middle range, management tends to have incentives to act with self-interest and has the adequate power to do so. McConnell and Servaes (1990) repeated a similar study with a larger sample of firms and found that managerial ownership increased firm value up to approximately 50% ownership and then sloped slightly downward. Hermalin and Weisbach (1991) found that market value increases when management ownership is below 1% or between 5% and 20%, and it decreases in the other ranges. Holderness et al. (1999) found results that were quite similar to Morck et al. (1988). Himmelberg et al. (1999) investigated the same relationships with panel data, but they did not find significant effects.

Recent overviews of the empirical studies on equity-based incentives include meta-analyses by Tosi et al. (2000) and Dalton et al. (2003). Tosi et al. investigated the results from 42 empirical studies on equity-based compensation, whereas Dalton et al. included 229 studies. These two meta-analyses found only weak support for agency theory's propositions that equity-based compensation helps the principal to motivate an agent to take actions that are in line with a principal's preferences. However, Nyberg et al. (2010) identified a number of weaknesses in the two meta-analyses. In particular, Nyberg et al. noted that there is a large variety in how the different studies that were included in the meta-analyses defined the variables for measuring a principal's income and an agent's equity-based incentives. Further, many of the variables that were used in the earlier studies do not adequately take into account the timing differences between incentives and performance. The variety of the variables complicates the interpretation of the findings from the past research. Nyberg et al. provided their own empirical investigation on the primary data to address these shortcomings.

Nyberg et al. (2010) tried to address the shortcomings that are related to the variables that measure a principal's income and an agent's equity-based incentives with an empirical test on a sample of Standard and Poor's 1500 firms. They measured a principal's income as the fiscal-year return for shareholders, including the stock price change and the dividends that were reinvested. An agent's equity-based incentives included a one-year change in the values of the CEO's in-the-money options, restricted stock, other equity, and the net proceeds that were accumulated throughout the fiscal year from sales in any of these equity types. They also included other agent incentives such as annual salary, other annual compensation, long-term

incentive payouts, and other miscellaneous non-equity payouts. Nyberg et al. found that CEO return and shareholder return had a significant positive relationship, suggesting that an agent's income is contingent on a principal's income as predicted by agency theory. Further, they estimated a regression coefficient of CEO return on shareholder return over a three-year period for each firm to indicate alignment. They then found that shareholder return over the subsequent three-year period was positively related to the alignment. This result suggests that a principal can increase income by setting equity-based incentives for an agent.

Empirical studies on stock options have found that management stock options tend to increase the volatility of firm performance and stock price (e.g., Coles et al., 2006; Williams and Rao, 2006; Wright et al., 2007; Sanders and Hambrick, 2007). These findings are in line with the theoretical predictions that stock options motivate managers to take riskier actions.

In summary, a principal can use equity-based incentives such as stock ownership and stock options to motivate an agent to take actions that increase the principal's income. The topic has attracted a large number of empirical studies that investigated the topic using a variety of variables. While not all of the empirical studies agree with each other, many of the studies tend to support the basic predictions of agency theory. The empirical research also finds support for the prediction that stock options increase risk taking.

2.1.2 Organizational control theory

Organizational control theory studies how the actions of individuals can be aligned with the interests of the firm that employs them (Thompson, 1967; Ouchi 1977, 1979, 1980; Eisenhardt, 1985; Snell, 1992). Organizational control theory identifies a number of control mechanisms and antecedents that determine the appropriate control mechanism. Major control mechanisms include behavior control, output control, and clan control, and key antecedents consist of task programmability and outcome measurability. Eisenhardt (1989) noted that the control mechanisms of organizational control theory mirror the mechanisms that are proposed by agency theory.

If a supervisor knows exactly how a task should be performed, task programmability is high. In this case, the supervisor can define the task in detail to a worker and then simply monitor the behavior of the worker to control that he or she performs the task as defined. This type of action is referred to as behavior control. The supervisor can control the worker

adequately by specifying the behavior and the related pay, monitoring the behavior, and then paying the worker as agreed.

However, if the supervisor cannot clearly specify a task, task programmability is lower. Thus, it is more difficult to control a worker by simply observing the worker's behavior. However, if the supervisor can still measure the output of the worker's behavior, the outcome measurability is regarded to be high. When the supervisor can measure the worker's output, the supervisor can base the worker's pay on the measured output. This process is referred to as output control. The supervisor can control the worker adequately by specifying the output and the related pay, measuring the output, and then paying the worker as agreed. A typical outcome measure that is used for outcome control is the financial performance that is related to a worker's tasks.

Both behavior and output controls rely on performance evaluations. A performance evaluation means that a specific aspect of a worker's activities is measured. For behavior control, the behavior of a worker is measured, and for output control, the output of a worker is measured. When a performance evaluation is used, a worker's pay depends on performance evaluation.

If a supervisor can both specify the task clearly and measure output, the supervisor can use either behavior or output control, or both in combination. The decision about a choice of controls can depend on the relative strengths and weaknesses of the two controls. Behavior control has several weaknesses. First, the monitoring of behavior takes supervisory time and possibly other monitoring systems to observe behavior, which is costly. Second, a detailed definition of tasks reduces workers' discretion and can lead to rigid and overly cautious behavior. Third, behavior control may still be used when tasks are not perfectly programmed or when behavior is not completely monitored, which can create conflicts of interpretation.

One advantage of output control is that it allows for some discretion by workers who can adapt their behavior to best improve the output, without requiring the supervisor to determine the behavior. However, output control also has some weaknesses. First, measuring output can require information systems that can be costly. Second, output control is reactive, having been referred to as "ex post control." As a result, output control provides no means for preventing mistakes before they happen. Third, if some critical goals are not included in the output definition, workers are motivated to pursue only the measured output, and they tend to ignore any other goals even if they might be critical to the organization. Fourth, Eisenhardt (1985) integrated organizational control theory with agency theory and concluded that, like equity-based incentives in agency theory,

output control also has the weakness of increasing a worker's exposure to financial risk. When output depends on uncertain external factors that are beyond the control of a worker, the worker is subject to increased risk, which can decrease the effectiveness of output control.

Finally, sometimes both task programmability and output measurability are low. In this case, performance evaluation is difficult. As a result, neither behavior nor output control is effective. Organizational control theory suggests that in this case, the supervisor can resort to clan control. In clan control, the supervisor tries to align a worker's preferences as closely as possible with the preferences of the organization. This alignment can be achieved by selecting workers that share the organization's preferences and then training and socializing them deeply to internalize the organization's preferences. The disadvantage of clan control is that the intended internalization efforts may fail, and it can be difficult to quickly identify such a failure.

In summary, organizational control theory identifies different types of control mechanisms, mainly behavior control, output control, and clan control. Each control has specific requirements, strengths and weaknesses. Sometimes, these controls can be used in combination. Part of organizational control theory is similar to agency theory, and the two theories have been integrated in past research. Organizational control theory has focused on supervisor-worker relationships at the lower organizational levels, but it has also been extended to the higher organizational levels. These extensions are discussed below.

2.1.3   Resource dependence theory

Resource dependence theory (Pfeffer and Salancik, 1978) proposes that an organization's performance and survival depends on its ability to gain control over resources that are owned by others. Organizations need a multitude of different resources, and they do not own all such resources. Thus, organizations are dependent on others who own the needed resources. In other words, organizations are dependent on their environment for resources. This dependence on resources makes organizational performance dependent on actions that are taken by others in the environment, which increases the uncertainty that is faced by an organization.

Resource dependence theory posits that organizations try to reduce their dependence on their environment. As a result, an understanding of an organization's environment is needed to understand the organization's actions. Organizations can reduce their dependence on their environments

by trying to gain control over their resources by applying a variety of strategies. In addition to reducing their dependence on the environment, organizations can apply resource dependence strategies to gain power over others in their environments. Together, dependence and power can make organizations interdependent with others in their environments. Resource dependence theory also argues that an organization's relationship with its environment is dynamic. Organizations need to adapt to changes in their environments by applying various resource dependence strategies to acquire additional access or control over resources they need. Finally, an organization's performance depends on how the organization can manage its control over the needed resources.

Resource dependence theory introduces a number of strategies for managing dependence on the environment. Some strategies are introduced for illustration here, but these examples do not constitute an exhaustive list of potential strategies. For example, an organization can decide to own resources to limit its dependence on its environment. Accordingly, organizations tend to own their most critical resources. This approach can result in the acquisition of critical suppliers to establish vertical integration. Another strategy to gain control over resources is to avoid reliance on a single supplier by maintaining a number of alternative suppliers. Yet another strategy to limit dependence on the environment is to seek control of the resources that are critical to others to increase their dependence on an organization. In other words, an organization can use resources to gain power over others in its environment. For example, horizontal mergers and acquisitions help organizations to gain more power over their suppliers and customers.

Resource dependence theory has been used in numerous applications. Resource dependence theory is relevant for this study because it provides an important basis for previous research on corporate governance and particularly for boards of directors. Resource dependence theory suggests that board members' roles in other organizations provide the board members with the knowledge and resources that can help them monitor and counsel management and facilitate inter-organizational relationships (Pfeffer and Salancik, 1978). The application of resource dependence theory on corporate governance is discussed in more detail in the following review of the literature on boards of directors.

2.2 Board of directors

Corporate governance describes the structures and processes that determine how resource allocation decisions are made among different corporate stakeholders. Corporate governance has attracted substantial interest from scholars. Previous research has studied corporate governance from multiple disciplinary perspectives including economics, management, law, political science, and sociology. Given the wide variety of previous research, there is no clear and universal definition of corporate governance. An overview of the past literature and the definitions of corporate governance are available in a number of recent reviews of corporate governance (e.g., Shleifer and Vishny, 1997; Daily et al., 2003; Davis, 2005; Dalton et al., 2007; Aguilera and Jackson, 2010).

A board of directors is a corporate governance mechanism that has been studied extensively in the past. This chapter provides an overview of the roles and characteristics of boards of directors.

2.2.1 The roles of a board of directors

Monitoring

Agency theory suggests that equity-based incentives can be complemented by the monitoring of an agent by a principal. A board of directors is the main mechanism for monitoring management in firms (e.g., Fama, 1980). The function of a board of directors is to design a management compensation mechanism that is contingent on both equity-based incentives and managerial actions that are monitored by the board. Typically, such a compensation mechanism also includes the possibility of management dismissal. Unlike agency theory, which is built upon a formal theory with a mathematical basis, the function of a board of directors still lacks a similar formal theory (Hermalin and Weisbach, 2003). This lack of formal theory implies that, as yet, there are no clear answers for questions such as why boards exist in the first place or if they are optimal governance mechanisms. Hermalin and Weisbach note that boards exist because the law requires them in most countries. As an additional idea of why boards may benefit shareholders, they suggest that making several individuals responsible for overseeing a firm reduces the risk that they will jointly pursue interests that are in conflict with the shareholders because each board member has less to gain from such actions and is still subject to

possible personal penalties, such as lost income or reputation, or legal sanctions. Despite the lack of a formal theoretical basis, past research has brought much insight into the function of boards of directors that is based on empirical studies of the functions of existing boards of directors. Walsh and Seward (1990) provide a detailed overview of the function of boards of directors, and the following discussion is based to a large extent on their study.

In monitoring management, a board of directors needs to determine what actions management takes and how those actions influence shareholder return. The board of directors can then reward management based on the observed actions. However, in practice, it is difficult to determine both the actions that have been taken by management and the impact of those actions on shareholder return. Shareholder return depends on both managerial actions and the external effects that are beyond managerial control. Management typically has little control over external factors such as new technologies that have been developed by outsiders, actions by competing firms, or regulations. Nevertheless, such factors can have a major positive or negative impact on shareholder return. To determine how well managerial actions contribute to shareholder return, the board of directors needs to understand also how shareholder return depends on such external factors. This determination can be very difficult because the number of external factors can be high and therefore require time to assess.

Walsh and Seward argue that, in assessing how well the actions that are taken by management contribute to shareholder return, a board of directors needs to assess both the ability and the efforts of management However, this assessment is not easy. The difficulty is reflected by the fact that Walsh and Seward do not provide details on how either can be assessed in practice. Despite the vast amount of research on management ability, there is no universal definition for it, and it can include abilities that are related to following areas: (a) product, firm, and industry knowledge; (b) emotional maturity; (c) entrepreneurial abilities; (d) intellectual abilities; (e) interpersonal abilities; and (f) leadership skills. Effort is also a vaguely defined construct. Typically, research on boards of directors and on monitoring in general tends to assume that the directors make their assessments of management's ability or effort in some way, even if the details are not specified.

Whatever the actual methods by which a board of directors assesses management's ability and effort, the board of directors combines the results of its assessment with an understanding of external factors to determine if shareholder return can be improved by adjusting the mechanisms for controlling management. If the board of directors is satisfied with

management's actions and sees no room for improvement, management control will remain unchanged. If the board of directors perceives a need for improvement, it can adjust management controls by modifying incentives or changing management. Walsh and Seward suggest that if a board of directors assesses a need for improving management efforts, incentives are modified to motivate for more effort. Incentives can also be modified when the board of directors observes that management's ability and effort is adequate, but incentives can mislead managerial efforts. On the other hand, ability is less amenable to change than effort. If ability needs to be improved, management is dismissed and replaced with new individuals. However, rather than outright dismissing the management, the board of directors is likely to first modify incentives to test how managerial actions change and thereby clarify their understanding of the managerial ability. Usually the dismissal of management is combined with a prior poor financial performance. In particular, weak financial performance relative to peer firms typically increases the probability of management turnover.

In summary, the function of a board of directors is to monitor managerial actions and external factors. Based on this monitoring, a board can then determine the ability and effort of management. If the board perceives an opportunity for increased shareholder return, it can adjust management incentives or change management. However, the quality and effectiveness of monitoring depends on how much related knowledge and time the board members have invested. In practice, monitoring is always limited and far from perfect. In addition, the benefits of monitoring are further challenged because management has a built-in motivation to meddle with monitoring.

Walsh and Seward note that management is expected to be aware of the fact that their career and related income are strongly dependent on monitoring by a board of directors. Therefore, they have an incentive to tamper with the board's ability to monitor and control them. Walsh and Seward list a number of tactics that management can use to influence the board of directors. Managers can promote their positive abilities and conform to the generally accepted norms of good management behavior such as following correct decision-making procedures. They can also hide negative attributes or information from the board. Or, when managers realize that they have made an error, they can promptly admit it and propose a corrective action plan to be given a second chance. Management may also try to exaggerate the impact of external factors and try to scare the board into believing that the firm is at the mercy of powerful and dominating market trends that mostly determine the firm's performance. Management can also try to influence the board to approve mediocre performance expectations that can be easily met. Managers can also try to

become expensive to substitute by gathering personal publicity by personifying the firm and thereby tying customer commitment to themselves. The board of directors is likely to think twice before dismissing a manager who is trusted personally by customers.

Mizruchi (1996) and Zajac and Westphal (1996) identify a number of approaches that management can take to compromise the monitoring incentives of a board of directors. Often board members are managers of other firms. If a firm's managers also have board appointments in outside firms, they can act as board members in the firms that are managed by their own board members or in firms that are managed by the board members of firms that are managed by their board members. Such board interlocks provide a reason for board members with management positions in other firms to avoid aggressive monitoring because it can result in retaliation from their own boards. For similar reasons, when board members with management positions in other firms have an opportunity to influence the selection of other board members, they are motivated to give preference to their own kind and candidates that have track records of past directorships without aggressive monitoring. Additionally, whenever a board of directors has adequate representation of interlocked directors, they are likely to listen more positively to management, which may even create an opportunity to influence board nominations. When management is powerful enough to influence the selection of the directors in a firm's own board, it can gain increasing power over the board as board members are replaced over time. Once management has adequate power over the board, management can influence monitoring by the board to reduce the risk of dismissal and to improve compensation.

In conclusion, the function of a board of directors is to monitor managerial actions and external factors and to determine management compensation and the changes that are based on such monitoring. However, the monitoring is far from perfect because the board members have limited knowledge and time for monitoring. In addition, management is motivated to apply a number of influencing tactics to tamper with monitoring. On the other hand, the prevalence of boards of directors suggests that their total contribution to shareholder return is perceived as adequate for them to remain as an accepted corporate mechanism. In particular, previous research has observed a number of mechanisms that can improve the supervision and contributions provided by boards of directors. These mechanisms are discussed in more detail in following chapters.

Resource dependence theory argues that in addition to monitoring, a board of directors can provide expert advice and counseling to management (Pfeffer, 1972; Pfeffer and Salancik, 1978). In particular, board members typically have current or past management or director assignments in external organizations. Such external experience provides board members with knowledge that is not available within the firm. Directors can use this knowledge to provide valuable advice to management. This valuable knowledge is expected to help management to make better decisions and thereby to increase shareholder returns.

In particular, counseling from a board of directors can assist management in strategy making (e.g., Zahra and Pearce, 1989; Judge and Zeithaml, 1992; Westphal, 1999; Stiles, 2001). Fresh perspectives and new information that is provided by board members can help management to identify promising strategic opportunities, articulate a firm's mission, develop the firm's strategy and effectively control and evaluate the implementation of the chosen strategy. Board involvement in strategy making helps to improve strategy by reducing problems due to narrow thinking, escalating commitment, and weak analysis. The board of directors helps and forces management to check their assumptions that underlie their strategies. The board can be involved in strategy making to varying extents. At very least, the board can ratify strategic proposals and review the evaluations of strategy implementation that are provided by management. The board can also ask pointed questions about a strategy, and such questions can even result in the revision of the strategy. A more active approach can involve the board in actually formulating the strategy together with management. At the other extreme, the board can make strategic decisions separately from management and collect its own information about the progress of strategy implementation. Empirical studies have found that board involvement in strategy making can improve firm performance (Judge and Zeithaml, 1992; Westphal, 1999; Stiles, 2001).

Westphal (1999) and Adams and Ferreira (2007) suggest that counseling can also support the monitoring role of boards of directors. When a board of directors is involved in counseling, also it learns to better understand management's actions and the factors that influence firm performance. This involvement helps the board to better monitor management. In particular, when the board has knowledge that is valuable for management, management will be inclined to ask for advice. However, asking for advice from the board also forces management to disclose more information about

their actions and the firm's problems. This additional information helps the board to better monitor management, which would be difficult for them to do without the counseling process.

Other board roles

Agency theory also suggests that a principal can retain some rights to some decisions rather than delegate them to an agent. A board of directors has the ultimate control over all of the decisions that are made by management, but it usually delegates most of the decision-making to management (Fama and Jensen, 1983a; Zahra and Pearce, 1989). The board usually retains some critical decision rights in addition to the choice of management and its compensation. Management cannot make such decisions without the approval of the board. For example, the board typically makes decisions that are related to major policy initiatives and strategies.

In addition to a board's monitoring and counseling roles, resource dependence theory identifies additional roles for the board of directors. The board can also provide a firm with access to commitments or support from external organizations and improve the legitimacy of the firm (Pfeffer and Salancik, 1978; Hillman and Dalziel. 2003). Board members with assignments in external organizations can help to facilitate cooperation between the firm and the external organizations. For example, the firm may be able to identify the potential for mutually beneficial business opportunities and successfully negotiate the implementation with customers or suppliers with which the board members are affiliated. In particular, board members that represent prestigious or legitimate persons or organizations can improve the legitimacy of the firm and thereby convince others to cooperate with the firm.

2.2.2   Board characteristics

The effectiveness of a board of directors in monitoring and its other roles is influenced by a number of board characteristics. This chapter reviews the key characteristics of boards of directors.

Outside directors

Board directors can be grouped into three categories: (a) inside directors, (b) affiliated directors, and (c) outside directors (Pearce and Zahra, 1992).

Inside directors are current members of the management team or other employees of a firm. Affiliated directors are neither managers nor employees of the firm, but they have close links with the firm. Affiliated directors can, for example, be former managers of the firm or consultants or suppliers of the firm. Outside directors are neither insiders nor affiliated with the firm. Unlike inside or affiliated directors, the outside directors are not under the direct control of management. In particular, management can directly influence the career or income of the inside and affiliated directors. As a result, these directors have strong incentives to act as instructed by management, which compromises their function of monitoring management. On the other hand, management cannot influence the outside directors as directly, which provides the outside directors with more independence for monitoring management. Outside directors are sometimes referred to as independent directors, but the past research tends to maintain that such independence is rarely completely genuine because management can use several tactics to influence the directors, as discussed above. Even if the outside directors are not completely independent, they are considerably more independent than the inside or affiliated directors. Therefore, the proportion of outside directors is expected to be an important board characteristic that can improve monitoring by the board.

Past empirical studies have investigated the effect of the proportion of outside directors on monitoring by a board of directors. Instead of measuring monitoring directly, scholars have studied the effect on outcomes that are related to monitoring such as management compensation, management turnover, and decisions that decrease shareholder return such as paying greenmail and the adoption of poison pills. Such studies tend to support the view that outside directors help to improve the monitoring of management.

Conyon and Peck (1998) found that the proportion of outside directors had no effect on the size of management compensation, but it had a significant effect in making management compensation contingent on shareholder return. Ryan and Wiggins (2004) found that the proportion of outside directors increased equity-based incentives for management. Both of the empirical results support the notion that outside directors improve monitoring because compensation alignment is expected to be a result of effective monitoring.

Mizruchi (1983) proposed that the proportion of outside directors increases management turnover due to improved monitoring. The empirical studies have confirmed this proposition. Weisbach (1988) found a stronger association between prior poor performance and the probability of management turnover in firms with boards that are dominated by

outsiders. In addition, Weisbach found positive stock returns that were related to turnover announcements, suggesting that the turnovers increased shareholder return. Haleblian and Rajagopalan (2006) also found that a higher proportion of outside directors increased the likelihood of management turnover. Boeker and Goodstein (1993) found that poorly performing firms were more likely to choose management from outside a firm when the proportion of outside directors increased.

Kosnik (1987) suggested that the payment of greenmail reflects ineffective monitoring by a board of directors. The payment of greenmail is the practice of repurchasing stock at a premium above the market price from a shareholder who threatens to take over a firm. This practice decreases shareholder return because shareholders would expect to receive a premium themselves if the takeover would be completed. On the other hand, the payment of greenmail benefits management personnel who wish to avoid the risk of dismissal after a takeover. Kosnik found that the decision to pay greenmail was lower in firms with more outside directors. This finding suggests that outside directors improve monitoring by preventing management from paying greenmail.

Mallette and Fowler (1992) suggested that the adoption of a "poison pill" takeover defense provision indicates ineffective monitoring by a board of directors. A poison pill provision usually makes the takeover of a firm more difficult by making it excessively expensive. A poison pill provision benefits management by decreasing the risk of dismissal after a takeover but decreases shareholder return because they lose potential gains from takeover premiums. Mallette and Fowler found that a higher proportion of outside directors decreased the adoption of poison pill provisions, thereby indicating improved monitoring by the board.

A number of studies have investigated how the proportion of outside directors influences research and development (R&D) investments by a firm. Hill and Snell (1988) and Baysinger et al. (1991) found that a higher proportion of outside directors decreased R&D expenditure by a firm. Similarly, Zahra (1996) found that outside directors decreased corporate entrepreneurship. Additionally, Hoskisson et al. (2002) and Kor (2006) tested the effect of outside directors on R&D investments, but they did not find significant effects. Instead, Hoskisson et al. (2002) found that outsider directors increased a firm's acquisitions. Hill and Snell (1988) suggested that endogeneity may explain the negative effect of outside directors on R&D. Firms that rely on strategies that focus on diversification both invest less in R&D and prefer outside directors because they can provide valuable information for diversification. Baysinger et al. (1991) further suggested that firms with such a diversification strategy are likely to rely more on

financial control systems, which discourages management from investing in R&D, which is difficult to measure with financial controls alone.

In addition to monitoring, a large number of studies have investigated how outside directors influence firm performance. Many studies found that outside directors improve performance, but some studies have also raised opposite concerns.

Hill and Snell (1988) found that firms with a higher proportion of outsider directors also had higher returns on assets. Additionally, Pearce and Zahra (1992) found that firms with a higher proportion of outside directors also had a higher return on assets, returns on equity, and earnings per share. Daily and Dalton (1993) studied a sample of smaller firms and found results that were similar to Pearce and Zahra. Daily and Dalton (1994a, 1994b) also found that a higher proportion of outside directors decreased the risk of bankruptcy. Kroll et al. (2008) found that the number of outside directors increased shareholder returns from acquisitions. On the other hand, Hermalin and Weisbach (1991) did not find any significant effect of the proportion of outside directors on a firm's market value. Further, a meta-analysis of Dalton et al. (1998) does not find significant aggregate evidence for performance improvement.

Hermalin and Weisbach (1998) and Denis and Sarin (1999) noted a potential endogeneity problem when testing the causal relationship between outside directors and performance. This problem is because the number of outside directors can increase during periods of poor firm performance as a control to improve performance. As a result, a lagged empirical design is needed to properly test the causal relationships, but most of the past studies have failed to use this design. In conclusion, there is some evidence that suggests that outsider directors can not only improve monitoring but also firm performance, but the findings are still subject to some concerns.

A number of studies have investigated how outside directors influence investments in R&D. Baysinger and Hoskisson (1990) proposed that outside directors based management compensation more on objective financial criteria and less on subjective assessments. Such an emphasis on financial criteria is expected to decrease management's motivation to invest in R&D. Empirical studies by Hill and Snell (1988), Baysinger et al. (1991) and Hoskisson et al. (2002) have confirmed this proposition by finding that the R&D expenditure is negatively related to a higher proportion of outside directors. Additionally, Zahra (1996) found that a higher proportion of outside directors decreases corporate entrepreneurship as measured by survey items.

Duality

Duality refers to a situation in which a CEO also chairs a board of directors (Rechner and Dalton, 1991). The alternative situation would involve the roles of the chairperson and the CEO being held by different individuals. Because the chairperson of the board can have a large influence on setting the board's agenda and the choice of directors, duality is expected to compromise the monitoring effectiveness of the board. Kor (2006) found that duality decreased a firm's R&D investments. Rechner and Dalton (1991) found that firms with duality demonstrated lower performance as measured by returns on assets, returns on equity, and profit margins. Daily and Dalton (1994a, 1994b) found that duality increased the risk of bankruptcy.

On the other hand, a number of studies provide contrary results. In studying smaller firms, Daily and Dalton (1993) did not find a significant effect of duality on performance. Baliga et al. (1996) and Coles et al. (2001) did not find any significant effects either. Boyd (1995) found no general significant effect of duality on performance but found a positive effect in firms that operate in industries that were growing slowly or had a large number of firms with relatively different market shares.

Dalton et al. (2007) concluded that the effect of duality on firm performance remains unsettled. They noted that most firms still had duality, with CEOs that also chaired the board. Further, they noted that even in most of the firms that did not have duality, the board was chaired not by an outside director but an affiliated director such as a former CEO. Such an arrangement with an affiliated chairperson may be even worse of a situation than duality because the chairperson is not independent, but, further, there can be additional uncertainty about the division of power between the CEO and the chairperson.

Board size

Resource dependence theory suggests that board members have expertise that helps them to monitor and counsel management and to provide access to external resources. Increasing the size of a board is likely to increase such gains as each additional board member adds to the pool of available expertise and resources (e.g., Pfeffer, 1972; Pfeffer and Salancik, 1978; Goodstein et al., 1994; Dalton et al., 1999). Larger boards can have more diverse occupational and industrial experience that provide multiple perspectives on strategy and operations, which can improve performance.

Further, larger boards can represent more diverse stakeholders and help a firm to better take its interests into account.

On the other hand, past research has identified many problems with increasing board size such as free riding and the difficulty of consensus due to diverse opinions and coalitions. As the number of directors increases, each director can have less influence on a board's decisions, which decreases the reputational gains or costs of the board's performance for each individual director (Golden and Zajac, 2001; Hermalin and Weisbach, 2003). As a result, directors are more likely to commit free riding, which decreases the effectiveness of the board. Increasing board size also increases the number of opinions on the board, which makes it more difficult for the board to find the adequate consensus that is needed to reach decisions (Goodstein et al., 1994). An increase in the number of directors also increases the risk that the board will develop different coalitions that increase conflict and make it even more difficult to establish consensus (Goodstein et al., 1994; Tuggle et al., 2010a). The problems of free riding and lower consensus can hamper the board's ability for strategy making (Goodstein et al., 1994). This can become especially harmful when a firm's environment is changing fast, and strategic decisions are critical for survival.

Increasing board size can influence the monitoring of management, but the past research provides two opposing views on this effect (Pearce and Zahra, 1992; Alexander et al., 1993; Goodstein et al., 1994; Dalton et al., 1999). Basically, it is more difficult to get decisions done by a larger board, and this issue can have both a negative and positive impact on monitoring. On one hand, it is more difficult for management to get the board to make decisions that benefit management at the cost of the shareholders. Large boards make it more difficult for management to persuade more numerous interests represented by board members. It is also more difficult for management to hide information from a board with more varied knowledge. On the other hand, it is easier for management to prevent the board from making decisions that limit actions that benefit management at the cost of the shareholders. It is easier for management to manage coalitions within larger boards to prevent them from achieving the consensus that is needed for such decisions.

The results from the empirical studies on the effect of board size on firm actions and performance support the existence of both benefits and costs of increasing board size. Goodstein et al. (1994) did not find any effect of board size on firm strategic change in the form of product scope changes, whereas Golden and Zajac (2001) found that increased board size first increases strategic change but then begins to decrease with larger boards.

As for firm performance, Pearce and Zahra (1992) found that board size is positively related to firm performance. However, a number of other studies have found that board size decreases performance (Chaganti et al., 1985; Boyd, 1990; Judge and Zeithaml, 1992; Yermack, 1996; Eisenberg et al., 1998). Cheng (2008) found that firms with larger boards have a lower variability of performance, indicating that it takes more compromises to reach a consensus, which reduces more extreme decisions. Cheng (2008) also found that larger board size decreased firm R&D expenditures.

Occupational diversity

The occupational diversity of a board of directors has been identified as a characteristic that can reflect the expertise and resources that are available from the board members (e.g., Pfeffer, 1972; Kosnik, 1990; Goodstein et al. 1994; Forbes and Milliken, 1999; Hillman et al., 2000; Golden and Zajac, 2001; Haynes and Hillman, 2010). Previous research has typically investigated occupational diversity by grouping the occupations of board members into different categories. Examples of different categories include executives, lawyers, bankers, consultants, accountants, academicians, government officials, and politicians. Sometimes executive experience is divided further into general management, finance, accounting, sales and marketing, information systems, operations, engineering, and human resources.

Board members' current and past occupational experience provides them with knowledge that is related to particular occupations. Typically, different occupations rely on different knowledge. The more diverse the occupational experience of a board, the wider the knowledge that is available for the board to monitor and counsel management. Occupational diversity can help to identify and express different perspectives and reduce complacency and the risk of groupthink by a board. In conclusion, occupational diversity can improve the effectiveness of a board and a firm's performance. On the other hand, the occupation diversity of board members can also create problems, limiting the effectiveness of the board. Board members with different occupational experience can have difficulty in developing a shared understanding, which may hinder consensus and even create conflict (Goodstein et al. 1994; Forbes and Milliken, 1999; Golden and Zajac, 2001). This type of problem can decrease a board's ability to make decisions effectively.

Empirical research has also investigated the effects of occupational diversity. Kosnik (1990) found that occupational diversity decreased monitoring by boards as expressed by a resistance to greenmail. Goodstein

et al. (1994) found that occupational diversity decreased strategic change. On the other hand, Haynes and Hillman (2010) found that occupational diversity increased strategic change. Golden and Zajac (2001) found that occupational diversity first increased strategic change, but it began to decrease when the level of diversity reached a certain height.

Interlocks

An interlocking directorate occurs when a person who is affiliated with one organization sits on the board of directors of another organization (Mizruchi, 1996). Interlocks can provide a firm with valuable information, facilitate cooperation with other firms, increase the legitimacy of the firm, and spread management's reputation. Resource dependence theory suggests that a board with interlocks can help a firm to obtain information that can improve strategy making and cooperation with other organizations (Pfeffer and Salancik, 1978). Through interlock ties, board members have access to information that is available in the other firms for which they serve as directors. However, in addition, when directors communicate with other directors in other firms, they are also exposed to information from those other firms (Carpenter and Westphal, 2001). Information from interlocks is also typically more up-to-date than information from secondary sources. In addition, in contrast to information that is available through other channels, interlocks can provide especially influential information because they are inexpensive, trustworthy, and credible information sources (Davis, 1991; Haunschild, 1993; Haunschild and Beckman, 1998).

Interlocks provide information that can support strategy making in a firm. When working in other firms through interlocks, directors are exposed to information that can help a firm in strategy formulation and evaluation (Carpenter and Westphal, 2001). Such information can help the firm to notice and respond to environmental changes more rapidly (Davis, 1991). Geletkanycz and Hambrick (1997) suggest that external interlock ties can provide information that shapes management's views on the environment and adds ideas for strategic choices.

Interlocks between similar and dissimilar firms are expected to provide different types of information (Geletkanycz and Hambrick, 1997; Haunschild and Beckman, 1998; Carpenter and Westphal, 2001). Similar firms refer to firms that follow similar strategies or operate in similar product-market contexts. Interlock ties to such firms can provide experience and information that leads to development of knowledge that is related to implementing a firm's strategy. On the other hand, firms that

follow different strategies and operate in different business environments are referred to as dissimilar firms. Interlock ties to dissimilar firms provide directors with more novel information and exposure to diverse strategies. Such interlocks lead to greater knowledge and insight about a broad range of potential strategic alternatives. Geletkanycz and Hambrick (1997) found that interlocks to similar firms were related to strategic conformity and that interlocks to dissimilar firms were associated with the adoption of deviant strategies.

However, Carpenter and Westphal (2001) proposed that interlock ties between similar and dissimilar firms also have potential weaknesses for strategy making. If the interlocks of a board are dominated by similar firms, information from the interlocks may reinforce management's commitment to the current strategy and lead management to ignore the environmental changes that threaten a firm's long-term viability. On the other hand, if a board's ties are dominated by dissimilar firms, the board may lack sufficient expertise to evaluate the firm's current strategy or to assess the implications of abandoning the strategy. Carpenter and Westphal suggested that it is optimal for a board of directors to have a heterogeneous mix of ties to strategically similar and dissimilar firms. With such a combination, the board has knowledge for understanding both the current strategy and possible alternative strategies, which can help the firm to choose the optimal strategy.

The imitation of practices and strategies between firms has attracted research on interlocks. Haunschild (1993) suggests that directors can learn through their interlocks how various practices are implemented and how efficient they are. The experience of a practice in one firm tends to encourage directors to imitate the practice in other firms. The past empirical research has found support for the imitation hypothesis by showing that interlocks increase the adoption of poison pills (Davis, 1991), acquisitions (Haunschild, 1993), alliances (Gulati and Westphal, 1999), and even the practice of imitation itself (Westphal et al., 2001).

In addition to being a source of information for strategy making and for imitating practices in other firms, interlocks can also provide resources to facilitate cooperation with other firms as suggested by resource dependence theory (e.g., Pfeffer and Salancik, 1978; Burt, 1980). For example, Bazerman and Schoorman (1983) suggested that interlocks can provide the information and trust that is needed to establish cooperation with suppliers and customers. In the past, interlocks were even used to facilitate cooperation with competitors, but such interlocks are now typically illegal due to anti-trust concerns. Gulati and Westphal (1999) argued that board ties can also help firms to initiate alliances because the ties provide

firsthand knowledge about another firm's capabilities and activities. Haunschild (1993) suggested that interlocks can also provide firms with more accurate information about potential acquisition targets and thereby improve the chances for acquisitions.

Interlocks can also increase the legitimacy of a firm (Bazerman and Schoorman, 1983; Mizruchi, 1996). When investors evaluate a firm as an investment opportunity, they consider the ability of the firm's board as an indication of its potential value. By appointing individuals with ties to other important organizations, a firm can signal to potential investors that it is a legitimate organization.

Interlocks can also spread the reputation of a firm's management. Gulati and Westphal (1999) note how interlocks can be used to spread knowledge about the ability and effort of the involved individuals. As an example, they consider the information flow between three individuals. If A is cheated by its relationship with partner B, and A has third-party ties to B through C, A can impose reputational costs on B by spreading the word to C that B cannot be trusted. Gulati and Westphal applied this logic by suggesting that managers can have access to indirect information about directors through their appointments on other boards. However, the same general mechanism can also be applied to analyzing how information about the ability and efforts of managers can spread through interlocks to external directors and managers.

Board tenure

It has been proposed that the effectiveness of a board of directors depends on both the average tenure of board members and the distribution of tenure among board members (Kosnik, 1990). Increasing the average tenure has been suggested to have both benefits and costs. On the one hand, a board with a low average tenure has less knowledge of the strategy and operations of the firm, which is likely to limit the effectiveness of the board (Kesner, 1988; Singh and Harianto, 1989; Kosnik, 1990; Golden and Zajac, 2001). A board with a low tenure that is just learning about the firm is more prone to management tactics that are aimed at compromising its monitoring function (Mallette and Fowler, 1992). Westphal and Zajac (1995) suggest that when management has some influence on choosing board members, boards with low tenure are likely to include directors that were chosen by management, which further limits its effectiveness in monitoring. On the other hand, a board with a higher tenure can be familiar with the firm's resources, strategy, and operations (Singh and Harianto, 1989). Senior board members can provide the board and the management with deep

insight about the firm that is needed when management changes (Kosnik, 1990). Hillman et al. (2008) propose that directors with long tenures may start to identify strongly with the firm, which improves their commitment to monitoring and counseling management. On the other hand, Dalton et al. (2007) propose that board members with long tenure are more likely to have become friendly with management, compromising their effectiveness in monitoring.

Previous research proposes that board tenure homogeneity can have both positive and negative implications. On the one hand, boards that consist of many members with long tenures have acquired a high level of firm-specific knowledge and skills and also higher levels of cohesiveness, which allows them to utilize their skills (Alderfer, 1986; Singh and Harianto, 1989; Forbes and Milliken, 1999). On the other hand, past research contends that boards with homogeneous tenures suffer from various problems (Kosnik, 1990; Mallette and Fowler, 1992; Johnson et al., 1993; Golden and Zajac, 2001; Tuggle et al., 2010a). Long-tenured boards develop pressures for conformity, which can reinforce compliance and commitment to the status quo and impede the search for multiple alternatives. Board members with similar tenures share the same board experience, which can create biased perceptions and increase groupthink. The increased rigidity of homogeneous tenure is likely to limit the board's ability to make strategic changes when needed.

In contrast, boards with heterogeneous tenures can rely on a greater diversity of experience and knowledge (Johnson et al., 1993; Forbes and Milliken, 1999; Golden and Zajac, 2001; Tuggle et al., 2010a). Directors with low tenures can draw more strongly on the knowledge that they bring from their external experiences. Such knowledge helps to raise the number of different perspectives and cognitive diversity that is available to a board. A board's effectiveness in monitoring and counseling is likely to increase as a result. The board is also more likely to make decisions on strategic changes when needed. However, Kosnik (1990) suggests that the heterogeneity of board tenures may also impede a board's work because board members with diverse experiences may have more difficulty understanding each other and developing frequent and open communication.

The effect of board tenure also depends on management tenure and on CEO tenure in particular (Alderfer, 1986; Singh and Harianto, 1989; Sundaramurthy, 1996; Shen, 2003; Kor, 2006). In their early tenure, CEOs typically have little influence in shaping board knowledge and membership, and a board can more effectively monitor the CEO and focus on counseling. As the CEO's tenure increases, both in absolute terms and relative to the

board's tenure, the influence of the CEO increases at the cost of the board. This process decreases the effectiveness of monitoring by the board.

A number of empirical studies have investigated the effects of board tenure. An investigation by Kosnik (1990) found that an average board tenure increased boards' resistance to greenmail, indicating improved monitoring by boards. Singh and Harianto (1989) found that the longer the average board tenure relative to that of the CEO, the better the board could resist actions that were regarded harmful to shareholder return. Carpenter and Westphal (2001) found that the average board tenure was positively related to both monitoring and counseling in stable environments but only for counseling and not for monitoring in unstable environments. Mallette and Fowler (1992) proposed a curvilinear relationship between average board tenure and a firm's resistance to poison pills, but they found neither significant curvilinear nor linear effects. Golden and Zajac (2001) proposed a curvilinear effect of average board tenure on strategic change that is based on the argument that tenure brings both benefits and costs. They found support for the curvilinear relationship.

Attention

An attention-based view of a firm refers to how "decision-makers focus their attention on a limited set of issues and answers and the issues and answers they attend to and enact determines what they do" (Ocasio, 1997). Focused attention also implies that decision makers allocate their attention away from certain issues and answers. A selective focus of attention is necessitated by the fact that bounded rationality does not allow for effective attention to all possible stimuli. An attention-based view of a firm also proposes that attention is affected by the decision-making context, including a firm's procedural and communication channels. The context is further dependent on the rules, resources, players, and social positions of the firm.

The attention of a board of directors is also subject to the mechanisms that are proposed by the attention-based view of the firm (e.g., Golden and Zajac, 2001; Tuggle et al., 2010b). In case of a board, the issues and answers are related to the role of the board in the monitoring, counseling, and provision of resources. A firm's context and structures determine the issues and answers that draw the attention of the board members. Tuggle et al. (2010b) studied how a board's attention depends on the context that is defined by a firm's performance and the structures that are related to the board's composition, particularly duality. Golden and Zajac (2001) investigated how the differences in boards' attention to strategic and non-

strategic issues influenced strategic change by firms. They suggested that boards that pay more attention to, that is, spend more time on strategic issues, are more familiar with such issues and therefore are more inclined to make strategic changes as a result. They found empirical support that attention to strategic issues relative to non-strategic issues promoted strategic change.

Board incentives

Even if shareholders nominate a board of directors to monitor and counsel management, board members can be regarded as agents who act with self-interest (e.g., Deutsch et al., 2010). As a result, the effectiveness of the board also depends on what type of incentives that the board members have to act in line with the shareholders' interests. Boards of directors are given incentives that include various financial incentives, extended tenure, and the opportunity to obtain other directorships (Yermack, 2004).

Firms typically compensate their board members with a fixed annual compensation and fixed fees for each board meeting. However, agency theory suggests that because such fixed compensation does not align the incentives of board members with those of shareholders, fixed compensation can cause board passivity and ineffectiveness (Kosnik, 1987, 1990; Mallette and Fowler, 1992; Johnson et al., 1993). According to agency theory, equity-based incentives can motivate the agent to act more towards the interests of shareholders. Accordingly, equity-based incentives have also been proposed for boards of directors. In addition to stock, a board can also be granted stock options as equity-based incentives (Yermack, 2004; Deutsch et al, 2007, 2010). Yermack (2004) studied Fortune 500 firms and found that compensation of boards was contingent on shareholder return. On average, outside directors' pay changed 11 cents for each $1,000 of change in shareholder wealth. Yermack further found that more than half of this change came from stock and stock options. The rest of the change was due to alterations in the likelihood of obtaining new directorships in other firms or losing a board seat in the current firm.

A number of studies have investigated how the effectiveness of boards depends on the equity-based incentives of the board. Mallette and Fowler (1992) studied whether stock holdings by a board improve monitoring by the board by decreasing the adoption of poison pill provisions, but they did not find a significant effect. Johnson et al. (1993) found that stock ownership by outside directors increased restructuring by firms, suggesting improved monitoring. Hoskisson et al. (1994) found similar evidence. Deutsch et al. (2007) found that stock and stock option pay for outside

directors had a curvilinear effect on a firm's acquisition rate. They suggested that the decreasing effect at higher ownership levels is due to directors starting to focus on preserving their accumulated stock wealth. Deutsch et al. (2010) found that the stock option compensation of outside directors increased firm-level risk taking. Hambrick and Jackson (2000) studied how outside director stock holdings influence subsequent firm performance and found that high performing firms tended to have much higher ownership by the board than poorly performing firms.

Kosnik (1990) suggested that the effect of a board's equity-based incentives depend on management's equity-based incentives. Kosnik argued that when management has weak equity-based incentives, it is more likely to take actions that are less aligned with the shareholders' preferences, and the board's monitoring plays a more critical role. As monitoring by a board can be improved with equity-based incentives to the board, such incentives have a stronger effect when management has weak equity-based incentives. Kosnik found empirical support that in firms whose management's equity interests were small, corporate resistance to greenmail was most likely when the outside directors' equity interests were high relative to their total compensation. Also Deutsch et al. (2010) found that outside director compensation and CEO compensation are mutually substituting. Studying stock option pay, they found that if both the outside directors and the CEO are provided with stock options, the outside directors' incentives weaken the effect of the CEO's incentives on firm-level risk taking.

In addition to equity-based incentives, board members have also career incentives. Yermack (2004) noted that even if the fixed and equity-based compensation of a board are typically neither the sole or main source of director income, they can still be high enough to have some significance. As a result, board members have an incentive to retain their board appointments and to obtain new ones in other firms. Gilson (1990) found that directors who had to resign due to poor performance later had fewer seats on other boards, implying a loss of income opportunities. On the other hand, Yermack showed that strong firm performance helped board members to obtain new appointments, and the related income change was also considerable. Because firm performance has an effect on the career of board members, it provides the board with an incentive to perform its role effectively.

2.3   Corporate internal controls

Whereas the literature on boards of directors focuses on the apex of an organization by examining the shareholder-board and the board-CEO dyads, the literature on corporate internal controls focuses on the next hierarchical level in an organization, that is, the dyad between the CEO and division management.

The past research on corporate internal controls focuses on how the corporate management of a multidivisional firm controls the divisional management that reports to the corporate CEO (e.g., Gupta, 1987; Hill and Hoskisson, 1987; Baysinger and Hoskisson, 1989, 1990; Hitt et al., 1990; Goold and Quinn, 1990; Hoskisson et al., 1991, 1993; Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn, 1999). Corporate internal controls consist of financial controls and strategic controls.

Financial controls base their performance evaluations on objective financial criteria such as return on investment, return on equity, or net income. Managerial rewards are contingent on the achievement of such financial objectives. In essence, financial controls are similar to outcome controls in organizational control theory. Financial controls are generally based on annual or shorter-term financial performance. Performance targets are established at the start of a performance period, at the start of a year, for example. Actual results are then monitored, and managers are judged according to their actual performance relative to the targets. Actual performance relative to the targets influences both management's direct income and its career opportunities. If a manager exceeds a performance target, the manager can be awarded with a bonus. If a manager fails to reach the target, the manager faces an increased risk of being dismissed or demoted. Financial controls have certain weaknesses. First, a focus on short-term performance reduces managerial incentive to make long-term investments. Second, financial controls hinder cooperation between corporate divisions when the divisions are interdependent with each other. Cooperation between divisions becomes difficult because each division manager tries to maximize his or her own performance at the cost of other divisions.

Strategic controls are based on the evaluation of the strategic actions of division management. Hitt et al. (1996) describe strategic controls as the evaluation of "the strategies business-level managers formulate and the strategic actions they take rather than their outcomes." Baysinger and Hoskisson (1990) also include the outcomes by noting that "[u]nder a system of strategic controls, division (SBU) managers are evaluated on the basis of how strategically desirable their decisions were before

implementation (ex ante) and on the basis of the financial performance of the firm after the decisions were implemented (ex post)." Strategic controls can be regarded as a monitoring mechanism in terms of agency theory, but they are nevertheless different from any other controls that are discussed in the corporate governance or organizational control literature. The characteristic element of strategic controls is that division management is evaluated based on the quality of the strategic plan ex ante, that is, before the strategy is actually even implemented. This ex ante evaluation is a unique control mechanism that is not included in any other controls discussed in corporate governance or organizational control literature.

Strategic controls provide several advantages over financial controls. Strategic controls help division managers to take risky strategies because they feel that corporate management understands such strategies. Strategic controls allow for a focus on long-term performance because division managers expect to be evaluated based on their strategies rather than on short-term financial performance only. The motivation for risky and long-term strategies also encourages division managers to commit to innovation. The main weakness of strategic controls is that their use requires that corporate management has an adequate understanding of the operations and markets that are related to the division strategies. Establishing and maintaining the knowledge required for strategic controls can take a substantial amount of time from corporate management, thereby adding a cost to strategic controls.

Previous research on corporate internal controls has studied how the degree of corporate diversification influences the balance between financial and strategic controls. The main finding is that when a corporation is a conglomerate that consists of independent divisions that operate in unrelated businesses, the cost of obtaining the detailed information that is needed for strategic controls is high and limits the use of these controls. As a result, only financial controls are available in practice for use in such firms. On the other hand, when divisions that operate in the same market and need to coordinate strategies with each other, strategic controls are more useful because there is relatively less information to be obtained, and obtaining such information not only supports strategic controls but also helps corporate management in the coordination that it needs between the divisions.

Previous research has also investigated how corporate governance and corporate internal controls interact with each other. Baysinger and Hoskisson (1990) proposed that outside directors would prefer financial controls over strategic controls because outside directors have less knowledge of a firm and its markets than inside directors. Inside directors,

on the contrary, would be in a better position to use strategic controls. Baysinger and Hoskisson did not test their propositions, however. Johnson et al. (1993) found empirical evidence that the use of strategic controls improves the alignment between the interests of management and shareholders and thereby lessens the need for monitoring by a board.

In addition to Johnson et al. (1993), a number of empirical studies have investigated corporate internal controls. Gupta (1987) found that subjectivity in the performance evaluations of divisions was positively associated with the effectiveness of pursuing strategies that are based on differentiation. The association was negative for strategies based on low-cost leadership. Gupta argued that subjective performance evaluation encourages paying attention to the identification of unfilled customer needs and the design of unique new products, which is useful for a differentiation strategy. Johnson et al. (1993) provided the first empirical measure for strategic controls. They used three survey items to measure the emphasis on strategic controls, including the use of (a) face-to-face meetings, (b) informal meetings, and (c) subjective criteria. In addition, Hitt et al. (1996) used three similar survey items to test how corporate headquarters control divisions. In addition, Hitt et al. developed three survey items to measure the emphasis on financial controls, including the use of (a) return criteria such as return on assets or return on invested capital, (b) cash flows, (c) objective strategic criteria such as return on investments, and (d) formal reports from financial management information systems by corporate management. Hitt et al. found that strategic controls increased research and development expenditures and new product introductions. Financial controls, on the other hand, decreased R&D and new product intensity but increased acquisition intensity. They also found that both acquisition and divestiture intensity decreased the use of strategic controls but increased the use of financial controls. Further, Barringer and Bluedorn (1999) used similar measures for financial and strategic controls. They found that strategic controls increased corporate entrepreneurship, which was defined as a firm's tendency toward innovation, risk-taking, and proactiveness. Financial controls did not have any effect on corporate entrepreneurship.

2.4 Investment in learning

Cyert and March (1963) suggested that, provided that an organization does not change, environmental changes tend to degrade the organization's productivity below a satisfying level, creating pressure to seek new solutions through intentional learning. To address the pressure for learning, individuals and firms alike need to invest some of their resources into the pursuit and acquisition of new knowledge and to the adaptation to environmental changes. On the other hand, an excessive allocation of resources to learning can also pose a threat to survival (March, 1991). As a result, there are both benefits and costs of investments in learning, and the level of investments in learning is determined by their balance. This chapter reviews previous research to identify the factors that determine the level of investments in learning.

Because the body of knowledge about learning is broad, this chapter reviews the past research with a limited focus on certain definitions of resources to be invested and learning. Resources that can be invested in learning include money and equivalents, personal time, the operating time of any equipment, or any other assets that are needed for learning. Learning refers to the acquisition of knowledge that is new to the person or firm that is engaged in the learning process. Such knowledge can already be possessed by someone else, or it can be entirely novel to the world, not known to anyone. In addition, learning includes any effort that is made to acquire knowledge, and it does not distinguish between the various types of learning. If the existing resources are not allocated to learning, they are assumed to be allocated to alternatives including consumption, saving, production or operations that rely solely on the use of knowledge that is already known by an individual or a firm.

The focus on any learning is different from the influential stream of research about exploration and exploitation in learning that was initiated by March (1991), which focused on the balance between two types of learning. The literature on exploration and exploitation is interested in the balance between exploration and exploitation. March defines exploration as including "things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation." On the other hand, exploitation "includes such things as refinement, choice, production, efficiency, selection, implementation, execution." Other scholars have usually used the March's definitions, but they have also provided their own characterizations. For example, Levinthal and March (1993) portray exploration as "the pursuit of knowledge, of things that might come to be known" and exploitation as "the use and development of things already

known." Fang et al. (2010) state that "exploration refers to the search for new, useful adaptations, and exploitation refers to the use and propagation of known adaptations."

Although this study is interested in investigating learning in organizations, it is first examined from the perspective of an individual rather than that of an organization. That is, this study first identifies the factors that determine an individual's motivation to invest in learning. This approach is chosen because it is useful for an understanding of organizational phenomena, and such phenomena are later discussed from the perspective of a principal-agent dyad. Because a principal and an agent are individuals, organizational learning can be understood by how the principal and the agent prefer learning as individuals and how the agency mechanism influences these preferences.

2.4.1   The variations in learning preferences between individuals

Just as different individuals have different production resources, some individuals can allocate more resources to learning than others. However, there are also other reasons that cause some individuals to be more attracted to learning than others.

Differences in knowledge

An individual's past experience may help him or her to identify an opportunity that has the attractive potential for profits because others lack the same past experience that is needed to identify the opportunity in time. Others may lack the required experience because each individual has unique past experiences and knowledge that determines the choice of factors to which an individual pays attention (Hambrick and Mason, 1984; Sitkin and Pablo, 1992; Ocasio, 1997; Grégoire et al., 2010). Further, if others cannot perceive an opportunity as early as an informed individual, the income potential from the opportunity is likely to be improved for that individual due to limited competition. As an illustration of individual differences in perceiving opportunities, Shane (2000) showed how a technical invention was communicated to thousands of individuals, but only a few with the appropriate knowledge could identify the new opportunities that the invention presented. Further, the identified opportunities were unique in the case of each of those few individuals.

Cohen and Levithal (1990) suggested that knowledge that has been acquired in the past can help an individual to develop an absorptive

capacity that provides an edge over others in knowledge acquisition. Others may not be able to learn new knowledge that is built on the individual's unique knowledge base, which provides the individual with a source of competitive advantage over an extended period of time. The resource-based theory of firms (e.g., Wernerfelt, 1984; Henderson and Cockburn, 1994; Newbert, 2008) suggests that a similar type of knowledge advantage can exist also for firms.

Differences in risk preferences

Levitt and March (1988) and Levinthal and March (1993) noted that learning involves uncertainty about success or failure. As individuals differ in their preferences for risk regarding their income (e.g., Glimcher and Rustichini, 2004; Wolf et al., 2007; Cesarini et al. 2009), the higher the uncertainty of the success of an investment in learning, the fewer individuals find the investment attractive. In particular, an effort to learn novel knowledge that was not known to anyone else is likely to involve a high uncertainty of success, screening out most individuals and making the endeavor attractive only to individuals with high risk tolerance. Empirical evidence seems to support the notion that uncertain investments offer attractive returns to those who can tolerate uncertainty. Lundblad (2007) studied almost two centuries of equity market returns and found that higher uncertainty investments indeed offered a higher return.

Differences in patience

Competition for learning some knowledge is also limited if the learning is expected to take a relatively long time, postponing the potential gains from the learning. Montague and Berns (2002) and Glimcher et al. (2007) suggested that individuals discount future gains. Such behavior has its origin in the mechanisms of the human brain, but the strength of the discounting varies among individuals, making long-term learning more attractive to some individuals than others. The limited competition for investments in learning that are expected to take a long time may make such learning attractive to individuals with patience. The past research on investors has also found that certain types of investors tend to be more attracted than others to investing in a firm that is involved in long-term learning (Zahra, 1996; Kochhar, 1996; Hoskisson et al., 2002; Connelly et al., 2010).

Prelec and Loewenstein (1991) suggested that learning that is expected to take a long time to generate income is also likely to involve high uncertainty. The longer time that is needed for learning increases the likelihood of unexpected incidents. On the other hand, learning that involves uncertainty is also likely to require time to complete as the uncertainties need to be resolved. Thus, investments that are uncertain tend to take a long time to generate income, and investments that tend to take a long time to generate income tend to be uncertain.

Differences in intrinsic motivations for learning

An individual may also be attracted to learning because of an intrinsic motivation for learning. Amabile (1993) suggested that an individual is intrinsically motivated when he or she seeks enjoyment, interest, satisfaction of curiosity, self-expression, or personal challenge in an activity. Researchers have shown that some individuals have an intrinsic motivation to work on complex and novel tasks that involving learning (e.g., Maslow, 1968; Oldham and Cummings, 1996; Osterloh and Frey, 2000; Kim and Oh, 2002; Katz, 2005; Eisenberger et al., 2005; Sauerman and Cohen, 2010). Tierney et al. (1999), Dewett (2007) and Zhang and Bartol (2010) suggested that intrinsic motivation increases an individual's creativity in learning new knowledge. Eisenberger and Aselage (2008) showed that an individual can be simultaneously motivated both intrinsically and by the potential for future income through learning.

The synthesis of variation of learning preferences between individuals

In summary, there are several possible reasons for an individual to allocate resources such as time to learning. Some individuals have unique knowledge that helps them to identify new opportunities for learning. A high tolerance for learning failures and the patience to wait for learning gains can increase the attractiveness of learning. An individual may also be intrinsically motivated by learning. Such reasons for learning are not exclusive, but they may reinforce each other in making learning an inviting investment for an individual. Such individual differences are also reflected in the differences between firms. For example, Helfat (1994a, 1994b) studied firms and found that the balance between investments in existing production and the learning of new knowledge is firm-specific and varies even between firms in the same industry.

In particular, some individuals may be more attracted than others to invest in learning new knowledge that is likely to take a long time to generate income. New knowledge tends to have a relatively high probability of failure, to take a long time to generate income, and to present intrinsically motivating challenges. Additionally, if new knowledge is expected to take a long time to learn, the length of time toward completion is likely to increase the uncertainty of success because the environment is more likely to change during the course of the learning. An individual with a high tolerance for learning failure, the patience to wait for learning gains, and an intrinsic motivation for learning is more likely than others to find it attractive to learn new knowledge that is likely to take a long time to generate income.

2.4.2 The variation of learning preferences over time

Mansfield (1964) and Grabowski and Baxter (1973) suggested that resources are allocated to both learning and existing production, depending on the attractiveness of the potential income from each alternative. Often an individual has found a certain approach of arranging resources for production that is attractive and can be repeated over and over again. However, if the marginal expected income from adding more resources into the existing production is decreasing, the individual may find it more attractive to invest part of the resources in some other alternatives, possibly learning new knowledge. On the other hand, Nohria and Gulati (1996) found that alternative long-term investments also have decreasing marginal expected income. Thus, an individual is likely to retain a balance between investments in learning and existing production. For example, Collins and Porras (1994) found that successful firms allocated resources persistently to both learning and existing production. Helfat (1994a) and Chen and Miller (2007) also found that investments in learning in a firm vary over time, but it is nevertheless positively related to the past level of investments in learning. That is, the balance between investments in learning and existing production is likely to have somewhat limited variance over time. The past research has identified several reasons for the temporal variation of the balance between existing production and learning.

Effect of changes in knowledge

Herriott et al. (1985) suggested that as an individual learns new knowledge over time, the estimates of the expected income of alternative

investments can change, also changing the allocation of resources between production and learning. In particular, the resources that are allocated to learning can both increase and decrease over time as an individual learns new knowledge.

An individual may learn new knowledge about the future productivity of existing production and adjust the allocation of resources accordingly. A long tradition of research has identified that discontent with the status quo prompts learning. Schumpeter (1934) proposed that environmental changes can cause a creative destruction that undermines the productivity gains from existing knowledge and resources. Cyert and March (1963) suggested that environmental changes tend to degrade productivity below a satisfying level, creating pressure to seek new solutions through intentional learning. Grabowski and Baxter (1973) suggested that learning efforts by competitors may provoke learning to retain competitiveness. Porter (1980) portrayed a wide range of mechanisms for how actions by others may erode the profitability of existing production and generate pressure for learning. Lant et al. (1992) and Mone et al. (1998) suggested that if an individual learns that the expected income from existing production decreases permanently, the individual may find it more attractive to allocate some resources to other investments, possibly learning. Zahra and George (2002) noted that triggers such as performance decline, radical external innovations, and government policy changes can induce learning for the acquisition of new knowledge. Montague et al. (2006) even suggested that the learning response to discontent with the status quo has its origin in the human brain, which seems to have evolved with mechanisms for stimulating exploration in cases when the environment has been depleted of sources for exploitation.

However, an individual may also learn new knowledge that suggests that the expected income from existing production increases. In this case, the individual may find it more attractive to cancel some learning investments and to allocate more resources to expand the existing production.

The balance between existing production and learning can also change independently of existing production. Dosi (1988) suggested that an individual may perceive learning as an attractive opportunity, even when the productivity of existing resources is not threatened, although Knott and Posen (2009) found that learning in response to a threat is more prevalent. Huber (1991) suggested that an individual may discover an opportunity for learning new knowledge by accident. Greve (1998) and Greve and Taylor (2000) also suggested that innovations by others may help an individual to perceive new opportunities. As an individual discovers new opportunities with attractive future income potential, the individual may then allocate

resources from existing production to a new opportunity if the expected income from the opportunity is more attractive than the income from the existing production.

On the other hand, Green et al. (2003) suggested that as an individual learns new knowledge, the estimated expected income from a learning investment can also decrease, thereby decreasing the relative attractiveness of the learning investment. Moreover, if an individual invests in learning, the individual is likely to complete the learning at some point. If an individual has completed or cancelled learning investments and lacks the knowledge of another, equally attractive, learning investment, the individual will allocate resources to expand existing production instead.

The effect of changes in available income and resources for investing

A change in income from existing resources can affect an individual's estimate of the expected income from alternative investments. If the income from existing resources is less than in the past, one reason for the decrease may be a permanent external change that decreases the productivity of the existing resources. Cyert and March (1963) suggested that if an individual experiences a decrease in income, he or she tends to invest in learning to increase the income back to a satisfactory level. Mone et al. (1998) suggested that an individual estimates the probability of a permanent change based on personal knowledge of production. If the estimate of the likelihood of a permanent change is high enough, an individual may find it attractive to allocate some resources to learning. Thus, a decrease in income relative to the past can increase investment in learning but need not increase it.

On the other hand, if income from existing resources increases, one reason for the increase relative to the past may be an increased productivity of existing resources in a changed environment. In this case, an individual may increase the estimate of the expected income from existing resources and therefore allocate some resources for learning to expand existing production. Thus, an increase in income relative to past may decrease investment in learning but need not decrease it.

A change in the amount of resources that are available for investing can also cause changes in the amount of resources that are allocated for learning. If past investments succeed in increasing resources available for investing, an individual allocates such additional resources to the next best investment opportunities that can be either an expansion of the individual's existing production or an initiation of new learning initiatives. Thus, an

48

increase in resources can but need not necessarily increase investments in learning.

Similarly, if past investments fail, and as a result, an individual has fewer resources available for investing than in the past, the individual will cut the least attractive investments. The least attractive investments can be either a part of the individual's existing production or learning. Thus, a decrease in resources can but need not necessarily decrease investments in learning.

In summary, if income from past investments exceeds resources that are needed for the past investments, an individual can invest more, which can, but need not, increase investments in learning. On the other hand, if the income from past investments is less than the resources that were needed in the past, the individual must cut investing, which can, but need not, decrease investments in learning.

A change in the amount of resources that are available for investing can also affect investments in learning through changes in the likelihood of survival. Cyert and March (1963) and Singh (1986) suggested that the more resources that an individual has, the lower the risks to survival. As an individual always has limited resources, a decrease in the available resources implies not only that the individual can invest less, but it may also cut the individual's resources that are available for consumption, or at least increase the risk of lowering consumption in the future. As some level of consumption is eventually required for survival, a decrease in resources also increases the threat to survival, perhaps only a little, but in any case somewhat.

To minimize increasing the threat to survival after an income decrease, an individual can choose an investment that has a lower probability of threatening survival but has also somewhat lower expected value than the investments that were made prior to the income decrease. Even if an individual prefers an investment with a certain probability of failure at some point, the individual may start to prefer an investment with an even lower probability of failure and lower expected income if the resources that are available to the individual decrease for some reason. In other words, an individual becomes more risk averse (Pratt, 1964) if the individual's resources decrease. Such risk aversion is likely to decrease the preference for learning investments. In contrast, an increase in resources decreases an individual's risk aversion and increases the preference for learning investments.

If an individual's resources decrease to a very low level, the individual's behavior can become risk-seeking, and the individual may prefer investments with negative expected values (Cyert and March, 1963; Singh, 1986). If an individual's resources decrease low enough to threaten survival,

the individual will choose investments that maximize the probability of survival, regardless of their expected value (Cyert and March, 1963; Singh, 1986). As a result, an individual can invest in gambles with a negative expected income but with a higher probability of survival than any alternative investments. For example, an individual could face a situation where an investment has a positive expected value, but it is still less than is needed for survival. In this case, a higher positive gain is needed for survival. The individual is then motivated to prefer an investment with the highest probability that the income generated by the investment will exceed the income that is needed for survival. Such an investment is attractive to the individual even if it has a negative expected value, thereby motivating risk-seeking by the individual. As some learning investments may have potential for very high income but a negative expected value that is due to a high probability of failure, they can become attractive for individuals who have become risk-seeking. Investments with a negative expected value are likely to further deplete resources, and the individual must find gambles with increasingly higher potential income to provide some probability of survival. Thus, the individual is likely to become increasingly risk seeking. If the individual succeeds in increasing his or her resources, the individual will return to choosing less risky investments.

However, Kahneman and Tversky (1979) found that some individuals became increasingly risk seeking after they experienced negative income that decreased their resources regardless of their absolute amount of resources. Smith et al. (2002) found that risk seeking in the case of losses was reflected in the human brain. Montague and Berns (2002) suggested that the brain has evolved to include decision making mechanisms that support survival. Thus, even if a risk-seeking response to negative income when the threat to survival is low may not always seem rational, it is possible that evolution has favored such a behavioral trait. Based on few assumptions, Rayo and Becker (2007) suggested how evolution may have favored such a risk-seeking response.

The responses of risk preferences to income changes have been studied extensively, and there seems to be a wide variety of preferences among individuals (e.g., Glimcher and Rustichini, 2004; Wolf et al., 2007; Cesarini et al. 2009). For example, Pennings and Smidts (2003) studied farmers and found that some (39%) were always risk averse, and some were always risk-seeking (27%), while some were risk averse for income increases but risk-seeking for income decreases (30%). A minority (4%) was even risk averse for income decreases but risk-seeking for income increases.

Summary

In summary, an individual retains a certain balance between the resources that are allocated to existing production and learning new knowledge. The individual adjusts learning based on new knowledge, income from existing resources, and changes in resources that are available for investment. As a result, the individual may choose to both increase and decrease resources allocated to learning at different points over time.

As income changes can influence both resources that are available for investment and the estimates of expected incomes from alternative investment opportunities, income changes also influence investments in learning through these two mechanisms. An income decrease can both encourage and discourage investments in learning through several different mechanisms.

An income decrease increases the probability that the productivity of existing resources has decreased permanently, which increases the relative attraction of learning. An income decrease may also provoke a behavioral response of risk-seeking that may make some learning investments attractive. On the other hand, an income decrease can decrease the resources that are available for investing, thereby decreasing investments in learning. A decrease in the available resources also increases the threat to survival and thereby increases risk aversion, which can decrease the attraction of learning investments because of their higher probability of failure.

These same mechanisms can also encourage and discourage investments in learning after an income increase. An income increase increases the probability that the productivity of existing resources has increased permanently, which decreases the relative attraction to learning. An income increase may also decrease risk tolerance if an individual has recently responded to a performance decrease with risk-seeking. On the other hand, an income increase can increase the resources that are available for investing, thereby increasing investments in learning. An increase in the available resources also decreases the threat to survival and thereby decreases risk aversion, which can increase the attraction to learning investments.

2.5 Managerial myopia

2.5.1 The dilemma of managerial myopia

A number of scholars have observed that organizations suffer from managerial myopia, which is defined as an excessive preference for low-risk and short-term investments in firms (e.g., Hayes and Abernathy, 1980; Hill, 1985; Porter, 1992; Hoskisson et al., 1993; Jensen, 1993; Levinthal and March, 1993; Laverty, 1996; Zahra, 1996; Miller, 2002; Marginson and McAulay, 2008: Barrett, 2010; Souder and Shaver, 2010). This preference restrains a firm's ability to allocate resources to learning new knowledge that is likely to take a long time to generate income. Eventually, the firm's ability to sustain competitiveness in a changing environment erodes over time (Leonard-Barton, 1992; Levinthal and March, 1993; Utterback, 1994; Christensen and Bower, 1996). In essence, managerial myopia reflects the ineffectiveness of a principal in controlling an agent.

Previous research on managerial myopia suggests that myopia can be induced by short-term financial control. Hoskisson and Hitt (1988) and Hoskisson et al. (1993) suggested that short-term financial control is widely used by principals to control agents. Additionally, the output controls described by organization control theory are similar to short-term financial controls (Ouchi, 1977, 1979; Eisenhardt, 1985; Jaeger and Baliga, 1985; Snell, 1992; Kirsch, 1996). In short-term financial control, a principal reviews the past income from the production based on the resources allocated to an agent and sets an income target for the agent for the next period. The eventual performance relative to the target influences the agent's immediate and future income by shaping the agent's career opportunities (Fama, 1980; Narayanan, 1985; Gibbons and Murphy, 1992; Holmström, 1999).

If the agent exceeds the target, the principal awards the agent with bonus compensation, a promotion, or the promise of an increased probability of such awards in the future if the agent continues to exceed the target in the subsequent period of time. On the other hand, if the agent fails to reach the target, the principal sanctions the agent, for example by demoting, dismissing, or threatening the agent with an increased risk of such actions unless the agent can improve his or her performance in the next period (Walsh and Seward, 1990). For example, Tuggle et al. (2010b) found that boards their increased monitoring of firm management after an income decrease. Moreover, several studies have found evidence that poor financial performance indeed increases the risk of agent turnover (Schwartz and Menon, 1985; Morck et al., 1989; Grinyer and McKiernan, 1990; Gilson and

Vetsuypens, 1993; Daily and Dalton, 1995; Chevalier and Ellison, 1999; McNeil et al., 2004).

Hoskisson and Hitt (1988) suggested that short-term financial control provokes the agent to prefer investments with relatively low uncertainty and a short time to generate income, also in case of investments in learning. Uncertainty about the income of an investment implies uncertainty about an agent's personal income as performance below the target that was set by a principal may cause low income for the agent. The agent may prefer to avoid uncertainty more than the principal if the agent's total income depends more on the performance than the principal's total income. This is often the case because a principal's income may be diversified across many other resources that are not delegated to an agent. The agent is also likely to prefer investments that require shorter periods of time to produce income than the principal because an investment with a payback beyond the following few time periods of time decreases short-term performance, which may result in dismissal of the agent prior to the eventual potential future income increase from the investment. For example, Mishina et al. (2004) found that firms that are trying to develop new products had lower sales growth in the short term. Thus, trying to avoid a dismissal, an agent may avoid investments that require a long period of time to generate income to maximize short-term performance, anticipating a bonus or an earlier promotion as a result (Narayanan, 1985, Stein, 1989).

Laverty (1996) and Marginson and McAulay (2008) noted that an individual can have a natural preference for low risk and short-term investments, even without short-term financial control. If a principal prefers low risk and short-term investments, short-term financial control enables the principal to motivate an agent to allocate resources according to the principal's preferences. However, if a principal prefers investing in learning new knowledge that is likely to take a long time to generate income, short-term financial control may not provide the principal with the means to control an agent.

As short-term financial control encourages an agent to prefer investments with relatively low uncertainty and a short period of time to generate income, it is not likely to enable a principal to motivate the agent to allocate the delegated resources to learning new knowledge that is likely to take a long time to generate income even if the principal prefers such learning. In a case in which the principal delegates the agent resources that are allocated only for repeating production with existing knowledge, short-term financial control enables the principal to control the agent as long as the environment does not change and poses a threat that would require learning that takes a long time to generate income. However, even in this

case, the principal loses the ability to invest in learning opportunities that are based on further developing the potentially rare resources and knowledge that are embedded in existing production. Moreover, the environment tends to change continuously, and short-term investments in learning tend not to sufficiently improve productivity, resulting in decreasing income at some point in time (Leonard-Barton, 1992; Levinthal and March, 1993; Utterback, 1994; Christensen and Bower, 1996; Uotila et al., 2009). Thus, under short-term financial control, an agent may invest less in learning than a principal prefers, even when the agent manages resources that are allocated only to repeating production with existing knowledge.

2.5.2 The limitations of equity-based incentives against myopia

Even if a share of future dividends and stock options can help an agent to benefit from investments that take a long time to generate income, the agent typically has only a limited tenure and cannot influence resource allocation decisions beyond the tenure. If the agent allocates resources for an investment that takes a long time to generate income, it is possible that the successor will have different preferences and therefore will allocate resources differently. If the successor does not complete the long-term investments that were started by the agent, the agent will not achieve the intended future dividends. At worst, once the agent leaves, the principal may even transfer some of the resources and knowledge to a new firm without the appropriate compensation, leaving fewer dividends for the agent (Burkart et al., 1997; Shleifer and Vishny, 1997; Baker et al., 1999; Foss, 2003; Masulis et al. 2009). The legal system provides the agent with some security against such appropriation if the resources that were delegated to the agent are structured as a firm, but even a court has bounded rationality and may not be able to judge the appropriation of complex resources and knowledge correctly. Limited tenure and the possibility of post-tenure changes in resource allocation can decrease the agent's motivation to invest in long-term learning even if the agent is compensated with equity-based incentives.

Moreover, the ability to control the agent with a share of future dividends and stock options is also limited in firms that employ several agents. When a firm employs thousands of agents, equity-based incentives depend on the resource allocation decisions made by all of the agents. Resource allocation decisions by one agent have only a marginal effect on the agent's share of the firm's total income and dividends (Baker et al., 1988; Baker, 1992; Balkin, et al., 2000; Zenger and Marshall, 2000). Only a few agents at the

upper echelons are able to allocate resources with a significant effect on the income and dividends. As the resource allocation decisions that are made by the remaining majority of the agents can have only a marginal effect on the income and dividends, the effect of the decisions on the shareholder return is not likely to have much effect on the choices that are made by these agents. The choice is likely to be based to a large extent on whatever other controls the principal has set in place.

Finally, short-term financial control typically exists to some extent even in cases in which an agent has long-term financial incentives such as a share of future dividends or stock options. Even if an agent is motivated by long-term financial incentives, a principal can set a certain short-term income target. If the agent fails to reach the target, the principal may choose to sanction the agent. Thus, long-term financial control does not exclude simultaneous short-term financial control.

2.5.3 The limitations of other control mechanisms against myopia

In organizational control theory, behavior control provides little control against managerial myopia because most managerial actions have low task programmability. Output control is based on the evaluation of past output, and because long delays between actions and output make the control ineffective, it is based on short-term performance. Thus, it is not a cure against managerial myopia but, on the contrary, output control is rather a cause of managerial myopia. When task programmability and output measurability are low, clan control is recommended by organizational control theory. Clan control has the potential to reduce managerial myopia, but as discussed above, verifying the effectiveness of clan control is difficult.

In corporate governance, monitoring by a board of directors is intended to be the main control mechanism in addition to equity-based incentives. However, the board members have bounded rationality and can monitor only few of the most critical actions by the CEO and perhaps a number of key executives. However, the bulk of the decisions that determine the shareholder return of a firm are made at the lower organizational levels, and it is likely to be difficult for the board to directly monitor such decisions. As a result, direct monitoring by the board is unlikely to control managerial myopia at lower organizational levels. On the other hand, information of short-term financial performance can be presented in a concise format, and the board is likely to use short-term financial control for many organizational levels, if it so wishes. Thus, potential visibility of

short-term financial performance to the board may actually strengthen motives for managerial myopia.

In the corporate internal controls literature, strategic controls are specifically intended to reduce managerial myopia. Hitt et al. (1996) contend that "[b]usiness-level managers are more likely to undertake risky projects because they feel that corporate managers understand their strategic proposals. Additionally, business-level managers believe they will be rewarded for the quality of their strategies rather than for short-term financial outcomes." Even if strategic controls seem promising, the related past research has focused on investigating how a CEO can apply them to control the division managers who report to the CEO. Therefore, strategic controls may not control the bulk of the managers at the lower organizational levels and the decisions that are made by them. Moreover, even if the strategies tend to focus on key resource allocation opportunities, they are likely to cover only a minor part of the resource allocation decisions that are taken by all of the managers in large organizations.

In summary, known control mechanisms provide some support for reducing managerial myopia, but each also has considerable limitations. Long-term financial control suffers from difficulties in aligning risk preferences, limited tenure, and in particular, a low effectiveness on the bulk of lower management echelons. Moreover, short-term financial control is often used in addition to long-term financial control and creates myopic pressure. The effectiveness of clan control is difficult to verify. Monitoring by a board and strategic control are limited to a subset of resource allocation decisions. Finally, the past research on strategic controls has focused on the dyad between the CEO and division managers rather than the bulk of the managers at the lower organizational levels.

In conclusion, the past research has observed the dilemma of managerial myopia to be a widespread problem, which over time erodes the ability of firms to make investments that are needed to sustain competitiveness in a changing environment. The empirical evidence on managerial myopia suggests that organizational control mechanisms fail to adequately address managerial myopia. The review of corporate governance and corporate internal control mechanisms confirms this problem because all of the known controls have limitations in effectively guarding against managerial myopia. However, despite their weaknesses, some control mechanisms help organizations to avoid even worse levels of managerial myopia. Thus, managerial myopia is not an insurmountable dilemma, and other control mechanisms for better curbing managerial myopia may yet be discovered.

3. Theory and hypotheses

The past research in managerial myopia suggests that an excessive preference for low risk and short-term investments restrains an organization's ability to allocate resources for learning new knowledge that is likely to take a long time to generate income (e.g., Hayes and Abernathy, 1980; Hill, 1985; Porter, 1992; Hoskisson et al., 1993; Jensen, 1993; Levinthal and March, 1993; Laverty, 1996; Zahra, 1996; Miller, 2002; Marginson and McAulay, 2008: Barrett, 2010). Eventually, the organization's ability to sustain competitiveness in a changing environment erodes (Leonard-Barton, 1992; Levinthal and March, 1993; Utterback, 1994; Christensen and Bower, 1996). This chapter investigates how various control mechanisms in a firm can curb managerial myopia and thereby increase its preference for investments in learning new knowledge that is likely to take a long time to generate income.

Previous research on corporate governance and corporate internal controls tends to focus on one principal-agent dyad at some organizational level. Corporate governance focuses on the shareholder-board and board-CEO dyads at the very apex of an organization. Corporate internal control focuses on the next level dyad between a CEO and a division manager. On the other hand, the emphasis of organizational control theory focuses on the lowest organizational level between a supervisor and a worker.

The literature on corporate governance and corporate internal controls has addressed the dilemma of managerial myopia and has developed a basic understanding of how corporate governance and corporate internal controls can be applied in combination to curb managerial myopia by a division manager. However, the past research lacks an understanding of how controls on managerial myopia can be extended below division management. Because a typical corporation consists of several layers of management below division management and the bulk of decisions are made by lower level managers, there is a lack of understanding of how managerial myopia can be controlled in an organization.

This chapter aims to investigate how the control mechanisms that have been identified by the literature on corporate governance and corporate

internal controls can be extended to address the problem of managerial myopia at the lower organizational levels and thereby increase the preference for investments in learning new knowledge that is likely to take a long time to generate income. As in the literature on corporate governance and corporate internal controls, the hypotheses that are developed in this chapter are based on the key theories that underlie the literature on corporate governance and corporate internal controls: agency theory, organizational control theory, and resource dependence theory.

The following section first discusses how decisions on investment in long-term learning are typically made in large organizations and how such decisions can be influenced by myopic behavior. The rest of this chapter investigates how the control mechanisms that have been identified by the literature on corporate governance and organizational control can be extended to curb managerial myopia for such investments at the lower organizational levels. The effect of each control mechanism is examined from the perspective of both a principal and an agent by addressing the following two questions:

1. *Does the control mechanism help a principal to motivate an agent to increase investments in learning new knowledge that is likely to take a long time to generate income?*

2. *Does the control mechanism help a principal to increase investments in learning new knowledge that is likely to take a long time to generate income?*

3.1 Decisions on investments in learning in organizations

3.1.1 Investment decisions

Agency theory suggests that a principal has the ultimate control over all of the decisions in an agency, but he or she usually delegates most of the decisions to one or more agents (Fama and Jensen, 1983a; Aghion and Bolton, 1992; Aghion and Tirole, 1997). Large organizations are structured as vertical hierarchies with several successive layers of principal-agent dyads. Decision rights are delegated to different levels of hierarchy. Each principal has certain rights to make some decisions that are related to some resources. The principal can further delegate some of these rights to an agent. On the other hand, some decisions require the principal to ask for approval from a higher level in the hierarchy.

In particular, each principal has rights to allocate certain resources. Such resources can include money and equivalents, personal time, the operating time of equipment, or any other assets (e.g., Wernerfelt, 1984). The principal employs several agents and delegates specific rights to each agent to determine how certain resources are allocated.

Monetary resources are typically managed through budgeting (e.g., Chandler, 1962; Cyert and March, 1963; Bower, 1970). In budgeting, the board of directors retains the ultimate right to allocate all of a firm's income. The board decides what share of the income is distributed as dividends to the shareholders. The rest of the income is used for the firm's investments and operations. The board delegates rights to the CEO to allocate a certain maximum amount of money. This amount is defined as budget. The budget is usually defined for one year, but it can be frequently updated based on the actual income of the firm. The CEO delegates the firm's budget further and determines the budget for each division manager. Such delegations of budget repeat down the management hierarchy. Each principal can delegate the budget resources further to the lower levels or use a part of budget directly for expenditures. The lowest level of the organization cannot delegate the budget further, but rather it is used for expenditures. As a result, the budget is eventually spent for expenditures.

Typically, a principal does not delegate a budget to an agent by one decision per year. Instead, the principal asks the agent to specify a list of alternative activities for which the budget is requested. The principal then decides which activities are to be implemented and delegates the agent a budget for each activity (e.g., Chandler, 1962; Bower, 1970). The agent can then further allocate the budget for each activity. The budget of an activity is usually defined for some period of time, and the agent needs to ask the

principal for a decision on a new budget for each period. Typically, the maximum period for budgeting is one year, but the period can be much shorter for some activities. In conclusion, a principal allocates a budget to an agent through many separate decisions over time. Moreover, a principal's decision to allocate a certain budget for some purpose to an agent is in essence an investment decision.

3.1.2 Learning investments

As discussed in an earlier chapter, resources can be invested in either production and are based on either repeating existing knowledge or learning new knowledge. A principal can determine which part of the resources, if any, to invest in learning new knowledge that is likely to take a long time to generate income. Such learning is based on the following definitions. Learning refers to the acquisition of knowledge that is new to a person or firm (e.g., Cohen and Levinthal, 1990; Huber, 1991; March, 1991). Such knowledge can be already possessed by someone else, or it can be entirely novel to the world and not known to anyone. If the existing resources are not allocated to learning, it is assumed that they will be allocated to alternatives including consumption, saving, or production or operations that rely solely on the use of knowledge that is already possessed by an individual or a firm. The long period of time to generate income relates to managerial myopia, which can be caused by short-term financial control (Hoskisson and Hitt, 1988; Hoskisson et al., 1993). Typically, the maximum target period for short-term financial control is one year. Investments in learning that take longer to generate income cause only a cost for short-term financial performance. Thus, short-term financial control provides a weak incentive for investments in such learning. In this study, long periods of time to generate income refer to periods of time that are longer than the maximum periods that are used for short-term financial control, and those periods typically last for more than one year.

In learning new knowledge, it is typically difficult to predict perfectly what needs to be done to succeed in learning or how much time such learning will take (e.g., Levitt and March, 1988; Levinthal and March, 1993). Learning is typically initiated based on a number of assumptions and probability estimates on the relationships between the factors that are related to the learning. As the learning progresses, the relationships between the factors become more accurate and new factors are identified, both of which create a need for deciding in detail the next steps that should be taken to allocate the resources among a number of learning alternatives. Moreover, such decisions emerge frequently, and they are numerous. Thus,

many investment decisions of various sizes need to be made during the process of learning, and they all influence the amount of eventual expected income and its probability distribution.

If a principal makes learning investments directly without delegating any to an agent, the principal's investments in learning are determined by a number of factors that were reviewed above in the chapter on investments in learning. However, the principal usually delegates some decisions on a learning investment to the agent. In this case, the principal can use budgeting for investments in learning. When the principal identifies an opportunity to generate future income through learning new knowledge, the principal delegates a certain budget and other resources so the agent can take advantage of the opportunity. In essence, the principal makes an investment in learning by such resource allocation. As the learning progresses, the principal can make new investments by allocating more resources to the agent. When the principal delegates some decisions about a learning investment to the agent, the principal's income from the learning depends on how the agent makes decisions to choose between various alternatives.

In large organizations, the lower levels also experience the most direct exposure to the market. Such exposure helps to identify new opportunities for learning, for example, ideas for new products or new production techniques. The lower levels of an organization also include most of the employees in large organizations. Thus, the lower levels of an organization have the potential to identify a large number of opportunities for learning new knowledge to generate future income. On the other hand, employees at the lower levels of an organization usually have limited budgets and need to request additional budgeting o make investments in learning. As a result, in addition to initiating learning investments that are based on a principal's own ideas, the principal can receive proposals for learning investments from an agent. Because the income a principal derives from learning investments depends on the amount of proposals for learning that are submitted by agents, the principal's income from learning investments depends on how able and motivated the agents are to present such proposals.

3.1.3 The limitations that are caused by managerial myopia

As discussed above, a principal's investments in learning depend on an agent's actions. In particular, it depends on how many proposals an agent makes for learning investments and how the agent allocates the budget delegated by the principal. When choosing investments to propose to the

principal, or to implement with the budget that was delegated by the principal, the agent can choose between investments that are expected to take different amounts of time to generate income. Some investments have the potential to produce income in shorter time periods than others. The agent's preference for different investment alternatives with different time horizons depends on how the principal controls the agent. If the agent is mainly directed by financial control, the agent's evaluated performance can be decreased by investments in learning new knowledge that is likely to take a long time to generate income. If the agent is under short-term pressure, the agent may respond with myopic behavior.

An agent has several means of avoiding investments in learning new knowledge that is likely to take a long time to generate income. When the agent identifies an opportunity for learning new knowledge that has the potential of generating income or addressing a threat to the competitiveness of existing production, the agent can ignore the opportunity and never request any budget for such learning. Because such a budget would just add a cost to the agent's short-term financial performance, the agent is better off not requesting such a budget. Second, when a principal delegates an agent with some resources for learning, the agent can either minimize actual expenditures or direct learning for projects that will produce income as quickly as possible. The agent can minimize actual expenditures, for example, by quickly concluding that a learning opportunity is less attractive than initially estimated and proposing a discontinuation of the learning. To accelerate the production of income from a learning investment, the agent can direct the learning towards quick wins that sacrifice higher income in the longer term. For example, the agent can address the pressure from competitors through low-cost incremental improvements to support sales in the short-term, when a more substantial investment in developing new technology is needed (e.g., Christensen and Bower, 1996). In conclusion, if an agent is subject to managerial myopia, the agent can limit investments in learning new knowledge that is likely to take a long time to generate income. Because the principal has delegated most of the resources to the agent, the principal's investments in learning are also limited if the agent experiences pressures that are caused by managerial myopia.

As discussed above, the principal can resort to a number of control mechanisms, such as equity-based incentives, board monitoring, or strategic controls, to limit managerial myopia if the principal is a shareholder or a CEO. However, if the principal is a manager whose position is lower in the organization, the principal has much fewer tools for

controlling managerial myopia, which limits the investments in learning new knowledge that is likely to take a long time to generate income.

3.1.4 The determinants of investments in leaning

A principal is expected to have little reason to invest in anything unless he or she understands how the invested resources can provide an attractive income relative to the other opportunities to which the resources could be allocated. To be able to understand the income potential of a learning investment, a principal needs to understand both the related learning opportunity and the competence and motivation of an agent to manage the delegated resources. If the principal does not have adequate information for such an understanding, the principal is unlikely to invest in the opportunity. Thus, any information that can help the principal to better understand the learning opportunity and the agent's competence and motivations are likely to increase the probability that the principal makes investments in learning new knowledge that is likely to take a long time to generate income.

In addition, improved control against managerial myopia is expected to increase the principal's investments in learning new knowledge that is likely to take a long time to generate income. Such improved control encourages the agent to request resources for learning investments. Improved control against managerial myopia also motivates the agent to allocate the resources that have been delegated to the agent in investments in learning new knowledge that is likely to take a long time to generate income.

In conclusion, a principal's investment in learning new knowledge that is likely to take a long time to generate income is increased by (1) any information that can help the principal to better understand the learning opportunity and an agent's competence and motivations, and (2) improved control against managerial myopia.

3.2 Written ex ante reasoning as a control mechanism

3.2.1 Strategic controls

The past research on corporate internal controls has investigated how the corporate management of a multidivisional firm can apply strategic controls for the divisional management that reports to the corporate CEO (e.g., Gupta, 1987; Hill and Hoskisson, 1987; Baysinger and Hoskisson, 1989, 1990; Hitt et al., 1990; Goold and Quinn, 1990; Hoskisson et al., 1991, 1993; Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn, 1999). The research on strategic controls contends that strategic controls help division managers to take on risky strategies because they feel that corporate management understands such strategies. Strategic controls allow for a focus on long-term performance because division managers expect to be evaluated based on the quality of their strategies rather than on short-term financial performance alone. In conclusion, strategic controls are an effective control mechanism for curbing managerial myopia by division managers and thereby to help a CEO increase a divisions' investments in learning new knowledge that is likely to take a long time to generate income.

Strategic controls can be regarded as one monitoring mechanism in terms of agency theory, but they involve a unique element that is not included in any of the other controls that are discussed in the corporate governance or organizational control literature. This unique element of strategic control is that division management is evaluated based on the quality of a strategic plan before the strategy is actually implemented. Despite the eminence of strategic controls for curbing managerial myopia, the research on strategic controls has focused on strategy making and the apex of the firm. In this study, the concept of strategic controls is extended beyond such past focus by examining how similar mechanisms can be applied for controlling activities other than strategy making at the lower organizational levels.

3.2.2 The definition of written ex ante reasoning

In making a decision on delegating the agent's decision rights to allocate resources, a principal can ask an agent to write a plan that describes and reasons income potential from the resources before the plan is actually implemented. Such a plan is defined as a *written ex ante reasoning* of an investment's income potential. A written ex ante reasoning can outline the cause-and-effect relationships that exist between future income and the

factors that influence it. Examples of such plans include, but are not limited to, a strategic plan that is used for strategic controls or a business plan that is written for an entrepreneurial venture (e.g., MacMillan and Narasimha, 1987; Hormozi et al., 2002; Martens et al., 2007; Kirsch et al., 2009). A written ex ante reasoning is a control mechanism that can be applied for any type of investment at any organizational level.

To experience the full benefit of a written ex ante reasoning as a control mechanism, the principal needs to (1) evaluate the written ex ante reasoning that was prepared by the agent, (2) monitor ex post the realization of the learning relative to the written ex ante reasoning, and (3) ask the agent to revise the written ex ante reasoning frequently.

3.2.3   Improved knowledge of investment and agent competence

Asking an agent to prepare a written ex ante reasoning allows a principal to use it to evaluate both the investment opportunity and the competence of the agent. As discussed above, any information that helps the principal to better understand how an investment can generate income increases the probability that the principal will make the investment. As with strategic and business plans, any other type of written ex ante reasoning helps the principal to understand the various factors and causal relationships that are related to a learning investment and then to estimate the potential income that is to be gained from the learning investment. Therefore, a written ex ante reasoning is expected to increase the probability that the principal will make an investment. However, the principal also needs to be convinced that managerial myopia by the agent can be adequately curbed.

The research on strategic controls contends that strategic controls help division managers to take on risky strategies because the division managers feel that corporate management understands such strategies and evaluates the division managers based on the strategies (Baysinger and Hoskisson, 1990; Hitt et al., 1996). Similarly, a principal can use a written ex ante reasoning to evaluate an agent's competence in generating income for the principal. To use a written ex ante reasoning to evaluate the competence of the agent, the principal needs to (1) evaluate the written ex ante reasoning for the competence of the agent, (2) monitor ex post the realization of the learning process relative to the written ex ante reasoning, and (3) ask the agent to revise the written ex ante reasoning frequently. Each step of this process is outlined in detail below.

A principal can use a written ex ante reasoning to evaluate the competence of an agent. The factors and causal relationships and related assumptions that are identified in the written ex ante reasoning reflect the

knowledge and competence of the agent. The past research has found that individuals can identify others who can contribute novel insights, and they tend to return for more advice from such contributors (Sutton and Hargadon, 1996; Hendry, 2002; Cross and Sproull, 2004). A written ex ante reasoning that includes information that is novel to the principal indicates that the agent has knowledge that is valuable to the principal. This evidence of novel knowledge is a possible reason for the principal to hire the agent. On the other hand, if an agent ignores or omits certain factors or causal relationships of which a principal is aware and expects to influence the income from an investment, the principal has a reason to doubt whether the agent can make decisions that can maximize potential income. This evidence of faulty or missing knowledge reduces the value of the agent and decreases the principal's reasons to delegate resources to that agent and possibly even the need to hire the agent. By identifying both the contribution and the weaknesses of a written ex ante reasoning that was prepared by an agent, a principal can better evaluate the competence of the agent and how the competence influences potential income from learning investments. This process helps the principal to decide whether to hire the agent and to delegate resources to the agent or invest resources in other alternatives. The more detail that an agent provides through a written ex ante reasoning, the more likely it is that it will contain information that is novel to a principal. Thus, the quantity of the written ex ante reasoning is expected to increase the likelihood that the principal evaluates the agent to be competent and to delegate resources to the agent.

The principal needs to follow an analysis of the written ex ante reasoning with the monitoring of the actual learning actions for several reasons (Schreyögg and Steinmann, 1987; Goold and Quinn, 1990). First, monitoring the realization of learning relative to the written ex ante reasoning helps a principal to increase his or her own knowledge, which can help the principal to identify new opportunities. Second, the principal can compare the realization against the earlier estimates of an agent to evaluate the competence of the agent in identifying the factors that are critical to the learning investment. The third benefit from monitoring the realization of the learning investment relative to the written ex ante reasoning is related to ensuring that the agent does not mislead the principal. If a principal asks only for a written ex ante reasoning from an agent but does not check the agent's actual ex post actions, the agent may be tempted to deceive the principal by allocating resources for improving short-term income rather than allocating them in accordance with the written ex ante reasoning. To avoid this problem, the principal can check the agent's actual resource allocation against the written ex ante reasoning at some point. However,

the agent may have good reasons to act against the ex ante plan, but the principal can take such differences into account, as explained below.

Unforeseen factors are common in learning new knowledge that is likely to take a long time to generate income (e.g., Levitt and March, 1988; Levinthal and March, 1993). Mintzberg (1994) suggested that such an approach of sticking with an original plan was widely used in strategic planning in the past but the success rates of learning investments were low because all of the relevant factors in complex environments could not be easily identified. Instead, learning investment success can be improved by planning learning investments in successive steps (Ruefli and Sarrazin, 1981; Cooper and Kleinschmidt, 1986; Schreyögg and Steinmann, 1987; Cooper, 1990; Block and Macmillan, 1993; McGrath and MacMillan, 1995; Mosakowski, 1997; McGrath and MacMillan, 2000a).

In line with such learning in phases, a principal can ask an agent to revise a written ex ante reasoning frequently based on the experiences and resolutions of uncertainty from the learning process. This revision of the written ex ante reasoning can be combined with the monitoring of the realization of the written ex ante reasoning in each phase. In particular, such monitoring also provides the agent an opportunity to explain possible deviations from the plan based on experiences and resolutions of uncertainty from the learning process. Such explanations can help the principal to better evaluate if any of the deviations suggest the possibility of managerial myopia by the agent to minimize investments in learning new knowledge that is likely to take a long time to generate income. In addition, asking the agent to revise the written ex ante reasoning adds to the quantity of written ex ante reasoning, which can improve the principal's evaluation of the agent's competence by providing more information that is novel to the principal.

In summary, a written ex ante reasoning provides a principal with the means to evaluate an agent's competence. A written ex ante reasoning is always related to a specific investment opportunity. However, the past research suggests that an individual who demonstrates the competence to learn valuable knowledge is likely to be able to also learn valuable knowledge in the future (e.g., Sutton and Hargadon, 1996; Hendry, 2002; Cross and Sproull, 2004; Nebus, 2006; Gompers et al., 2010). Therefore, even if a principal can evaluate an agent's competence only in ways that are related to the specific investment for which the written ex ante reasoning was prepared, it is also likely to help the principal to estimate how the agent is likely to manage other types of investments. In conclusion, a written ex ante reasoning helps a principal to better determine what type of resources to delegate to an agent in the future.

3.2.4 Controlling against managerial myopia

The research on strategic controls contends that strategic controls help division managers to take on risky strategies because division managers feel that corporate management evaluates the division managers based on the strategies they present (Baysinger and Hoskisson, 1990; Hitt et al., 1996). Similarly, a written ex ante reasoning provides a principal with a mechanism to limit managerial myopia in an agent and to motivate the agent to invest resources in learning new knowledge that is likely to take a long time to generate income. This gain is possible because the written ex ante reasoning helps the principal to better evaluate the agent's competence to take actions that improve the principal's income according to the principal's preferences. This evaluation of the agent's competence helps the principal to improve upon the evaluation of the agent's competence based on financial control. As a result, the agent can also demonstrate value to the principal by means other than simply maximizing short-term financial performance. Therefore, the agent need not avoid investments that burden short-term financial performance.

An agent can actually benefit from making investments in learning new knowledge that is likely to take a long time to generate income when such investments most improve a principal's expected income. By making such investments and preparing related a written ex ante reasoning, the agent can demonstrate that he or she is valuable to the principal. Being regarded as a valuable agent to the principal, the agent can expect the principal to have a reason to hire the agent to manage resources in the future. The principal may even increase the agent's wage or promote the agent to manage additional resources that are delegated by the principal. In conclusion, a written ex ante reasoning provides the principal with a control mechanism to curb managerial myopia by the agent and to motivate the agent to invest resources in learning new knowledge that is likely to take a long time to generate income.

Because both the quantity of a written ex ante reasoning and the frequency of its revision increase the likelihood that a principal will find an agent to be competent, they are also expected to improve an agent's motivation to invest in learning new knowledge that is likely to take a long time to generate income.

3.2.5 Effects on investment in learning

In summary, asking an agent to prepare a written ex ante reasoning provides a principal with information that helps him or her to better understand the learning opportunity and the agent's competence. This increases the principal's investments in learning new knowledge that is likely to take a long time to generate income in several ways. First, because the principal understands the investment opportunity better, the principal is more likely to allocate the needed budget and to delegate it to the agent who wrote the specific ex ante reasoning. Second, because the principal can control better managerial myopia, the agent is likely to better manage the delegated resources according to the principal's interests and to invest a larger proportion of those resources into learning new knowledge that is likely to take a long time to generate income. Third, the reduction in managerial myopia increases the likelihood that the agent will propose requests for additional resources for new opportunities for investments in learning new knowledge that is likely to take a long time to generate income. Fourth, because the principal has a better understanding of the competence of the agent, the principal can better evaluate new resource requests from the agent, which increases the probability that the principal will approve the agent's new proposals for investments in learning new knowledge that is likely to take a long time to generate income.

In conclusion, the quantity of written ex ante reasoning and the frequency of revisions are expected to increase both an agent's and eventually a principal's investments in learning new knowledge that is likely to take a long time to generate income. Moreover, because a principal typically employs several agents, the principal's investments in learning depend on the quantity of written ex ante reasoning and the frequency of revisions by all of the agents who are employed by the principal. The effect of the written ex ante reasoning on the investments by the principal and the agent can be summarized in following hypotheses.

Hypothesis 1: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to the quantity of written ex ante reasoning of an investment's income potential.

Hypothesis 2: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to the frequency of

revisions of written ex ante reasoning of an investment's income potential.

3.3 Reviewers as control mechanism

3.3.1 The board of directors as a basis

The corporate governance literature identifies the board of directors as the main mechanism for monitoring management in firms (Pfeffer, 1972; Pfeffer and Salancik, 1978; Fama, 1980; Fama 1983a, 1983b; Zahra and Pearce, 1989). The board of directors also counsels management, makes critical decisions about a firm's strategy and operations, provides the firm with access to commitments from external organizations, and improves the legitimacy of the firm. Such activities by the board can limit managerial myopia of the firm's top management together with equity-based incentives. However, the literature on corporate governance and the board of directors has focused on the apex of the firm. The literature on organizational control at lower organizational levels does not identify control mechanisms that are similar to the board of directors. Instead, it assumes that the agents at lower levels of organizations are monitored by the one principal who controls each agent.

On the other hand, Fama and Jensen (1983a) suggest that when lower level agents "interact to produce outputs, they acquire low-cost information about colleagues, information not directly available to higher level agents." They continue by arguing that "if agents perceive that evaluation of their performance is unbiased ... then they value the fine tuning of the reward system that results from mutual monitoring information, because it lowers the uncertainty of payoffs from effort and skill." However, Fama and Jensen do not develop this idea further and provide no details on how such mutual monitoring works. Nevertheless, the idea suggests that perhaps it is not only the principal at the apex of a firm but also the principals at the lower organizational levels who can benefit from others monitoring the agent. This study extends the past research by investigating how principals at the lower organizational levels can benefit from others to curb managerial myopia in their organizations.

3.3.2 The definition of reviewers

Just as the shareholders of a firm can hire several board members to monitor the CEO, a principal at any organizational level can hire one or several individuals to monitor an agent. Such individuals are defined as *reviewers*. The principal can ask the reviewers to take on most of the roles that are held by a board of directors. Reviewers can monitor the agent. In

monitoring the agent, the principal can ask the reviewers to give their opinions, supporting the principal in the evaluation of income potential from resources that have been delegated to the agent and the agent's competence in managing such resources. In particular, the principal can ask the reviewers to analyze any ex ante reasoning that has been prepared by the agent.

In addition to the monitoring, the principal can ask the reviewers to counsel the agent. This is similar to the board members roles of counseling management. Reviewers are likely to have different knowledge sets than the principal, and the agent can utilize their knowledge in helping the agent to manage the resources that have been delegated to him or her. As with board members, reviewers can also utilize their contacts to facilitate cooperation between the agent and the contacts. Moreover, as with board members, reviewers can be hired only as part part-time resources.

As with board members, reviewers can be characterized by their quantity and qualities such as tenure and social ties. Such characteristics are discussed in detail in the following section. However, a number of differences between reviewers and board members are first discussed in the present section.

The relationship between the reviewers and the principal differs from the relationship between the board of directors and shareholders in one critical respect. Whereas board members are accountable to a group of shareholders, reviewers are accountable not to a group but only to one individual, the principal. This difference can result in a number of differences between reviewers and the board of directors.

A group of shareholders can suffer from the free rider problem, which makes it more difficult for shareholders to control a board of directors. In contrast, when the principal is only one individual, such a free rider problem does not exist. Thus, the principal is expected to be able to control the reviewers better than shareholders can control the board of directors. In other words, it is expected to be easier for the principal to motivate reviewers to take actions that are aligned with the principal's preferences than it is for shareholders to motivate the board members to actions that are aligned with the shareholders' preferences. In essence, reviewers have an agent relationship to the principal, and the principal can control reviewers in the ways that he or she can control agents.

Because, unlike board members, reviewers report only to one principal, reviewers may be given fewer delegation rights than board members. Shareholders typically delegate a board of directors with rights to many critical decisions because the alternative of a large group of shareholders making such numerous decisions is difficult in practice. On the other hand,

because the principal is one individual, the principal does not suffer from such a difficulty in making decisions. Thus, the principal has less of a need to delegate formal decision rights to the reviewers over the agent who they are reviewing. In particular, the principal can, but need not, keep all of the decision rights over the agent and delegate none of them to reviewers.

3.3.3 The number of reviewers

The past research on boards has identified board size as a determinant of a board's effectiveness in its role. Increasing the size of a board is likely to increase gains such that each additional board member adds to a pool of available expertise and resources (e.g., Pfeffer, 1972; Pfeffer and Salancik, 1978; Goodstein et al., 1994; Dalton et al., 1999). Further, larger boards can represent more diverse stakeholders and help a firm to cooperate with more stakeholders. On the other hand, the past research has identified many problems with increasing board size such as free riding and the difficulty of reaching a consensus due to diverse opinions and coalitions. As the number of directors increases, each director can have less of an influence on the board's decisions, which decreases the reputational gains or costs of the board performance on each individual director (Golden and Zajac, 2001; Hermalin and Weisbach, 2003). As a result, board members are more likely to commit free riding, which decreases the effectiveness of the board. Increasing board size also increases the number of opinions that are expressed on the board, which makes it more difficult for the board to arrive at an adequate consensus that is needed to reach decisions (Goodstein et al., 1994).

The results from the empirical studies on the effect of board size on activities related to learning new knowledge support the existence of both benefits and costs of increasing board size. Goodstein et al. (1994) did not find any effect of board size on a firm's strategic change in the form of product scope changes, whereas Golden and Zajac (2001) found that board size first increases strategic change, but it begins to decrease for larger boards. Cheng (2008) found that larger board size decreased firm R&D expenditures.

As with the number of board members, the number of reviewers can also increase the combined expertise and contacts that are available from the reviewers. As discussed above, any information that helps a principal to better understand how an investment can generate income increases the probability that the principal will make an investment. Because reviewers have different experiences than the principal and the agent, they are likely to identify new factors and causal relationships that are related to learning

opportunities. This gain can help the principal to better understand an investment and its potential income and also the competence of the agent. As discussed above, the improved evaluation of an agent's competence can limit managerial myopia by the agent and motivate the agent to allocate resources to learning new knowledge that is likely to take a long time to generate income.

In addition to helping the principal to better understand the investment and the agent's competence, reviewers can make suggestions to change learning plans to improve expected income from learning. Reviewers' experience and knowledge allow them to counsel the agent with new insight into improving learning plans. In addition, reviewers may have contacts to other principals who control resources that can contribute to the learning that is managed by the agent. In this case, reviewers can facilitate the cooperation between the agent and other resource owners, which can further improve the expected income that is derived from the learning. In conclusion, reviewers can improve the expected income that is derived from learning through counseling and the facilitation of cooperation with other resource owners. Such an increase in expected income makes the investment more attractive to the principal and the agent and thereby increases the probability that the principal and the agent will invest in learning new knowledge that is likely to take a long time to generate income.

On the other hand, the increasing number of reviewers is expected to cause fewer problems from free riding and the difficulty of consensus due to diverse opinions and coalitions than the increasing number of board members. There are several reasons for this difference. First, as discussed above, the principal is an individual who can better control the reviewers than a group of shareholders can control a board of directors. The principal can ask for each reviewer's contribution and evaluate the benefits from each reviewer's separate evaluation rather than evaluating a joint conclusion by a group of reviewers. Thus, the principal can better motivate individual reviewers to make substantive contributions through more in-depth reviews. Second, if the reviewers cannot make decisions due to a lack of consensus, it is relatively easy for the principal to make the decision instead. This is in contrast to shareholders, for whom it is typically difficult to make decisions when a board of directors cannot make them. Moreover, as discussed above, the principal is likely to delegate fewer decision rights to reviewers than shareholders typically delegate to boards of directors. Thus, there are likely to be fewer decisions for which the reviewers need to find consensus.

In conclusion, like the increasing number of board members, an increasing number of reviewers can improve the reviewers' role. On the other hand, the effectiveness of the reviewers is expected to be more immune to the problems of free riding and difficulty of consensus. As a result, the number of reviewers is expected to increase investments in learning new knowledge that is likely to take a long time to generate income. This process is summarized as the following hypothesis.

Hypothesis 3: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to the number of reviewers.

3.3.4   A reviewer's mutual reviewing tenure

Previous research on boards of directors has investigated how board tenure homogeneity influences the effectiveness of the board. On the one hand, boards that consist of many members with long mutual tenures possess a high level of firm-specific knowledge and skills and they maintain higher levels of cohesiveness through which to utilize their skills (Alderfer, 1986; Singh and Harianto, 1989; Forbes and Milliken, 1999). On the other hand, the past research contends that boards with long mutual tenures suffer from various problems (Kosnik, 1990; Mallette and Fowler, 1992; Johnson et al., 1993; Golden and Zajac, 2001; Tuggle et al., 2010a). Long-tenured boards develop pressures for conformity, which can reinforce compliance and commitment to the status quo and impede the search for multiple alternatives. Board members with similar tenures share the same board experience, which can create biased perceptions and increase groupthink. The increased rigidity of homogeneous tenure is likely to limit a board's ability to make strategic changes when needed.

An investigation by Kosnik (1990) found that average board tenure increased the boards' resistance to greenmail, indicating improved monitoring by boards. Carpenter and Westphal (2001) found that board average tenure was positively related to both monitoring and counseling in stable environments but only for counseling and not monitoring in unstable environments. Mallette and Fowler (1992) proposed a curvilinear relationship between the average board tenure and a firm's resistance to poison pills, but they found neither significant curvilinear nor linear effects. Golden and Zajac (2001) proposed a curvilinear effect of average board

tenure on strategic change based on the argument that tenure brings both benefits and costs. They found support for the curvilinear relationship.

As in the case of board members, mutual tenure between reviewers is expected to help them to achieve higher levels of cohesiveness to allow them to utilize their different knowledge and skills. With increased mutual tenure, reviewers may learn how to best utilize their varying knowledge in evaluating the investments that are proposed by an agent and the competence of the agent. Similarly, as reviewers learn to work together and to utilize each other's strengths, they are also likely to be more capable of developing new insights into improving learning plans and opportunities for facilitating cooperation with external resource owners. In summary, such gains are expected to increase a principal's and an agent's investments in learning new knowledge that is likely to take a long time to generate income.

However, similar to board members, reviewers with long mutual tenure can begin to suffer from problems that can reduce their effectiveness. As reviewers work together, their knowledge starts to increasingly overlap, and they may benefit less from the variety in their individual knowledge sets. As a result, reviewers have fewer benefits that are related to their combined knowledge in evaluating investments and agents. This process can reduce the reviewers' contributions to the principal and the agent. The reviewers may even develop groupthink, which can reinforce compliance and commitment to the status quo and impede the search for multiple alternatives. Therefore, the positive effect from mutual tenure may begin to decrease above some limit.

The possible effects of the average tenure of reviewers are summarized as the following two alternative hypotheses.

Hypothesis 4a: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income is positively related to reviewers' mutual reviewing tenure.

Hypothesis 4b: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income have an inverted U relationship with reviewers' mutual reviewing tenure.

3.3.5 Reviewers' reviewing tenure with the agent

Previous research on boards of directors has investigated how board members' tenure with a CEO influences the effectiveness of the board (Alderfer, 1986; Singh and Harianto, 1989; Sundaramurthy, 1996; Shen, 2003; Kor, 2006; Dalton et al., 2007). This research argues that board members with long tenure are more likely to have become friendly with management, compromising their effectiveness in monitoring.

Similarly to boards, reviewers are also likely to develop deeper social ties over time with the agent whom they are reviewing. Therefore, their ability to objectively evaluate the competence of the agent can suffer. As a result, a principal is expected to be less able to rely on the reviewers for evaluating the competence of an agent. Additionally, the agent is likely to be aware of this lack of credibility of the reviewers. Because the principal can depend less on the reviewers for evaluating the competence of the agent, the agent cannot be as confident that the principal can properly evaluate him or her. This situation can make the agent more hesitant about making investments in learning new knowledge that is likely to take a long time to generate income. Similarly, in such cases, the principal is less likely to make such investments by allocating resources to the agent. In summary, reviewers' reviewing tenure with an agent is likely to reduce the value of the reviewers in curbing managerial myopia and decrease investments in learning new knowledge that is likely to take a long time to generate income.

On the other hand, as reviewers learn to know an agent better, they are likely to develop a better sense of the agent's competence. If the reviewers also have an ability to convincingly justify the competence of the agent to the principal, the reviewers may be able to improve the principal's evaluation of the agent's competence. In addition, becoming more familiar with the agent is likely to improve the reviewers' ability to counsel the agent, which can help the agent to improve learning opportunities and the potential income they can generate. Reviewers that are more familiar with an agent can also better support the agent by utilizing their contacts to cooperate with the agent and thereby improve income potential from learning investments. The improved income potential from learning investments increases their attractiveness to the agent and the principal, and thus, this situation is likely to increase the probability that such investments a made. In summary, reviewers' reviewing tenure with an agent can also increase investments in learning new knowledge that is likely to take a long time to generate income.

In conclusion, reviewers' reviewing tenure with an agent can have two opposing effects on investments in learning new knowledge that is likely to

take a long time to generate income. These effects are summarized as the following alternative hypotheses.

Hypothesis 5a: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to reviewers' reviewing tenure with the agent.

Hypothesis 5b: Investments by (i) a principal and (ii) an agent in learning new knowledge that is likely to take a long time to generate income are negatively related to reviewers' reviewing tenure with the agent.

3.3.6 Reviewers' ties to external reviewers

The research on interlocks by boards of directors suggests that board members can have appointments on boards at multiple firms (Pfeffer and Salancik, 1978; Burt, 1980). Through their various directorships, board members have access to information that is available in other firms. Each appointment exposes the director to different information and, consequently, the amount of knowledge that is possessed by a board director is positively related to the number of his or her board appointments. However, in addition, when directors communicate with other directors on the boards of other firms, they are also exposed to knowledge that is possessed by such external directors. Through such interlocking contacts to external directors in other firms, the board members have access to the knowledge of those external directors. Board members' ties to external directors expand their sources of information to include those of the other firms to which the external directors are affiliated, for example, through their boards or managerial roles at the other firms (Carpenter and Westphal, 2001).

The information from board members and their ties to external firms and directors has several advantages over the information that is acquired from other public or more formal sources. The information that is acquired through interlocks is typically more up-to-date than the information that is acquired from secondary sources. In addition, in contrast to the information that is made available through other channels, interlocks can provide especially influential information because they are inexpensive, trustworthy, and credible information sources (Davis, 1991; Haunschild, 1993; Haunschild and Beckman, 1998).

78

The information that is acquired from interlocks benefits a firm in several ways. The information from interlocks can help the firm to notice and respond to environmental changes more rapidly (Davis, 1991). Geletkanycz and Hambrick (1997) suggest that external interlock ties can provide information that shapes management's views on the environment and adds ideas for strategic choices. In addition to being a source of information for strategy making and for imitating the practices of other firms, interlocks can also provide resources to facilitate cooperation with other firms (e.g., Pfeffer and Salancik, 1978; Burt, 1980). Finally, interlocks can also spread the reputation of the firm's management. Gulati and Westphal (1999) note how interlocks can be used to spread knowledge about the abilities and efforts of the individuals who are involved in the interlock. In conclusion, the increasing number of ties to external directors through other board appointments increases the knowledge that possessed by board members. Such information provides multiple gains for the firm.

Like board members, reviewers can also establish ties to other reviewers through their various reviewer appointments. Principals can hire different reviewers for the evaluation of different investments and agents. As a result, an organization with multiple principals has a large number of review tasks with differing compositions of reviewers. Because different types of tasks have different combinations of reviewers and reviewers can be involved in several review tasks, a rich network of ties between the reviewers can develop over time. In particular, the reviewers who are nominated by the principal for a certain current review task can each have experiences of other reviewer tasks. Further, such experiences of other review tasks provide the reviewers with ties to other reviewers who are not involved in the current review task. Such other reviewers are defined as external reviewers for this study. In other words, each reviewer of a given review task has also a number of ties to external reviewers from other review tasks. Each reviewer can have a number of ties, and in total, the reviewers for a given task may have ties to a number of external reviewers. The number of the combined ties of the reviewers of a given review task is defined as the number of reviewers' ties to external reviewers.

Reviewers' ties to external reviewers provide benefits similar to board members' ties to other directors through multiple interlocks. In particular, reviewers' ties to external reviewers increase the amount of information available to the reviewers. The increased amount of information helps the principal to better understand an investment and the competence of the agent. In addition, reviewers can make better suggestions to change learning plans to improve expected income from learning. Moreover, as with board interlocks, reviewers' ties to external reviewers can also help the

reviewers to facilitate the cooperation between an agent and other resource owners, which can further improve the expected income from the learning. As discussed above, these types of information benefits can increase both a principal's and an agent's motivation to invest in learning new knowledge that is likely to take a long time to generate income.

In conclusion, a greater number of reviewers' ties to external reviewers can provide information benefits that can increase investments in learning new knowledge that is likely to take a long time to generate income. This effect is summarized as the following hypothesis.

Hypothesis 6: Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to reviewers' ties to external reviewers.

3.4 Other factors that reduce managerial myopia

3.4.1 Attention to investments in learning

The literature on corporate governance proposes that the attention of a board of directors is subject to the mechanisms that are proposed by an attention-based view of a firm (e.g., Golden and Zajac, 2001; Tuggle et al., 2010b). In the case of a board, the issues and answers are related to the role of the board in monitoring, counseling, and providing resources. The firm context and structures determine the issues and answers that draw the attention of the board members. Tuggle et al. (2010b) studied how a board's attention depends on the context that is defined by a firm's performance and the structures that are related to the board's composition, in particular, duality. Golden and Zajac (2001) investigated how the differences in a board's attention to strategic and non-strategic issues influences strategic change by a firm. They suggested that boards that pay more attention to, that is, spend more time addressing strategic issues, are more familiar with such issues and more inclined to make strategic changes as a result. They found empirical support that attention to strategic issues relative to non-strategic issues promoted strategic change.

In addition to board members, other principals in general are also subject to the mechanisms that are proposed by the attention-based view of a firm. Ocasio (1997) proposed that decision makers are more likely attend to issues with greater value and relevance to an organization. A principal's attention is divided among a number of resource allocation decisions. A principal is expected to pay most of his or her attention to the largest investments that are the most critical in determining income (e.g., Chandler, 1962; Bower, 1970). A principal's largest investments are likely to raise even some attention from other principals at the higher organizational levels. Such attention by higher organizational levels is likely to increase the principal's motivation to pay attention to relatively large investments. In conclusion, the increased size of an investment is likely to increase the attention that a principal gives to an investment.

The increased attention of a principal is expected to improve the principal's understanding of an investment. When the principal pays more attention to an investment, the principal can better evaluate the income potential of an investment. Such attention also makes the principal is also better equipped to evaluate the competence of an agent, which encourages the agent to invest in learning new knowledge that is likely to take a long time to generate income. Additionally, the principal's motivation to invest in such learning is improved by his or her enhanced understanding of an

investment's income potential and a reduced risk of managerial myopia by the agent. In conclusion, the increasing attention by a principal increases his or her investments in learning new knowledge that is likely to take a long time to generate income. This concept is summarized as the following hypothesis.

Hypothesis 7: An investment by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income is positively related to the principal's attention to the investment.

3.4.2 Income decrease

Previous literature on learning suggests that an investment in learning is influenced by a decrease in income from existing resources (e.g., Cyert and March, 1963; Kahneman and Tversky, 1979; Staw et al., 1981; Singh, 1986; Hundley et al., 1996; Mone at al., 1998; Greve, 2003, Chen and Miller, 2007; Chen, 2008). The effect of the income decrease on a learning investment is not unequivocal, even in case of an autonomous principal who is independent of any agency relationship. As concluded in section 2.4.2.3 above, there are conflicting pressures that can either increase or decrease learning after an income decrease. An income decrease increases the probability that the productivity of existing resources has decreased permanently, which increases the relative attractiveness of a learning investment. An income decrease may also provoke a behavioral response of risk-seeking, which may make some learning investments attractive. On the other hand, an income decrease can decrease the resources that are available for investing, thereby decreasing investments in learning. A decrease in the available resources also increases the threat to survival and thereby increases risk aversion, which can decrease the attraction of learning investments because of their higher probability of failure. In conclusion, depending on the context, an autonomous principal who is independent of any agency relationship can either increase or decrease investments in learning when income decreases.

The effect of an income decrease on learning is affected further by the existence of an agency relationship. If a principal controls an agent based on short-term financial control, a decrease in the agent's income implies a decreased performance-contingent payment to the agent (Hoskisson and Hitt, 1988; Walsh and Seward, 1990; Hoskisson et al., 1993). However, the agent's future income can be further decreased because a decrease in income can be interpreted to indicate that the agent has inadequate

competence. As a result, an income decrease can decrease an agent's future career opportunities (Fama, 1980; Narayanan, 1985; Gibbons and Murphy, 1992; Holmström, 1999). A number of empirical studies have found evidence that poor financial performance indeed increases the risk of agent turnover (Schwartz and Menon, 1985; Morck et al., 1989; Grinyer and McKiernan, 1990; Gilson and Vetsuypens, 1993; Daily and Dalton, 1995; Chevalier and Ellison, 1999; McNeil et al., 2004).

Because an income decrease has a detrimental effect on an agent's competence evaluation and future career when a short-term financial control is used, an income decrease strengthens the agent's managerial myopia. In other words, an income decrease decreases an agent's motivation to invest in learning new knowledge that is likely to take a long time to generate income. When income decreases, an agent can offset the decrease in his or her competence evaluation by increasing financial performance over the subsequent period. The pressure for the necessity of increasing income after an income decrease is intensified by the fact that it is typical for control based on short-term financial performance that the risk of dismissal of the agent increases considerable by any subsequent income decreases. To keep his or her job, the agent is under pressure to increase income after an income decrease.

To increase income, it is usually easier for an agent to decide to decrease his or her own investments rather than to try to increase sales, which are dependent on decisions by external players such as customers and competitors. On the other hand, short-term sales usually require certain expenditures and investments, and decreasing such costs can also reduce sales, thereby making it more difficult to increase income. Therefore, an attractive alternative to increasing income after an income decrease is to decrease any investments that do not also decrease income in the short term. As a result, after an income decrease, an agent is motivated to decrease investments in learning new knowledge that is likely to take a long time to generate income.

In conclusion, a decrease in income increases managerial myopia and thereby decreases an agent's investments in learning new knowledge that is likely to take a long time to generate income. However, this study focuses on examining how income decrease moderates the effects of control mechanisms as hypothesized above in this study.

In this study, income decrease is expected to positively moderate the positive effects of the control mechanisms hypothesized above. That is, the use of written ex ante reasoning and reviewers can curb managerial myopia increasingly after income decrease. This is because written ex ante reasoning and reviewers help principals to better evaluate the competence

of agents on attributes other than short-term financial performance. As a principal can evaluate an agent's competence based on attributes other than short-term financial performance, income decrease is likely to have a relatively lesser impact on the evaluation of the agent's competence. In particular, the agent's future career is less dependent on the agent's ability to increase income over the subsequent period. Thus, the agent has less pressure to increase income by resorting to cutting investments in learning. Therefore, managerial myopia is not increased as much after an income decrease. In conclusion, the use of written ex ante reasoning and reviewers reduces the increase in managerial myopia after an income decrease. In other words, the effect of written ex ante reasoning and reviewers in reducing managerial myopia is higher when income decreases rather than when income increases.

Both the quantity of written ex ante reasoning and the frequency of revisions improve a principal's ability to evaluate the competence of an agent for generating income from learning investments. Thus, the effects of written ex ante reasoning and the frequency of revisions are increased when income decreases. As discussed earlier, the number of reviewers improves a principal's evaluation of an agent's competence. Similarly, reviewers' mutual reviewing tenure helps them to better evaluate an agent's competence, which can help the principal's evaluation, too. Also reviewers' mutual tenure with an agent helps the reviewers to become more familiar with the agent, which supports the evaluation by the principal. Finally, reviewers' ties to external reviewers also improve the reviewers' ability to contribute to the principal's competence evaluation. In summary, all of the mechanisms related to the reviewers help a principal better evaluate the competence of an agent. Therefore, their effects are expected to increase when income decreases. In addition, the principal's attention to the investment improves the principal's ability to evaluate the agent, and this effect is expected to be stronger when income decreases. In conclusion, these effects can be summarized as the following hypothesis.

Hypothesis 8: The positive effects predicted by hypotheses H1 through H7 are expected to be amplified when income decreases.

3.4.3 The time required to generate income from learning investment

Previous research suggests that the time that it takes for a learning investment to produce income varies between learning investments. March (1991) identified two types of learning, exploration and exploitation: (a)

exploration includes "things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation," and (b) exploitation includes "such things as refinement, choice, production, efficiency, selection, implementation, execution." March further noted that exploration is more remote in time than exploitation but did not specify such difference in more detail. Levinthal and March (1993) noted that some learning is more distant in time than other. Additionally, the research on technological changes has found that some learning investments take much longer to generate income than others (e.g., Tushman and Anderson, 1986; Christensen and Bower, 1996). A firm can make parallel learning investments that require different lengths of time to generate income and that aim to create successive generations of solutions. In other words, a firm can simultaneously develop both a new next generation solution and a solution that will later replaced the next generation solution. In conclusion, different learning investments can require substantially different times to generate income.

In this study, the long periods of time required to generate income refers to periods of time that are longer than the maximum period used for short-term financial control, which is typically more than one year. However, there can be considerable variation in the amounts of time that are required to generate income, even among investments that take more than one year to generate income. For example, some investments in learning can aim at generating income in two years, whereas others may be expected to take longer than five years to generate any income.

An agent is expected to have different preferences for long-term learning investments that require different lengths of time in generating income. The longer the period of time that it takes for the potential income from an investment to be produced, the less likely it is that an agent's income will be impacted by the learning. This is because a longer period of time will increase the probability that the agent will experience a career move due to promotion, dismissal, or other career event. As a result, the agent is unlikely to be in a position in which income is significantly affected by the outcome of learning new knowledge that is likely to take a long time to generate income. Therefore, if an agent is evaluated based on financial performance, the agent's motivation to make a learning investment decreases as the investment's time to generate potential income increases.

However, the controls that are based on the use of written ex ante reasoning and reviewers can curb such decreasing motivation as a function of the time that is required for potential income to be produced by an investment. This is because the use of written ex ante reasoning and reviewers help a principal to evaluate an agent's competence in terms of

attributes that extend beyond financial performance. As the principal can also evaluate the agent's competence based on other attributes than financial performance, income decrease is likely to have a relatively lesser impact on the evaluation of the agent's competence. Thus, the agent has fewer reasons to excessively determine the preference of investments based on the time that is required for them to generate potential income. Consequently, a principal's capacity to evaluate an agent's competence beyond financial performance increases both the agent's and the principal's investments in learning new knowledge that is likely to take a long time to generate income. In addition, the principal's investments are further increased because the principal can better rely on the agent to manage delegated resources adequately, which encourages the principal to delegate more resources for learning to the agent.

In conclusion, the use of written ex ante reasoning and reviewers can make learning investments that require increased time to produce income more attractive to the principal and agent. The increasing attractiveness of such investments is expected to increase a principal's and an agent's total investments in learning new knowledge that is likely to take a long time to generate income. Therefore, it can be hypothesized that the positive effects predicted by hypotheses 1 through 7 are expected to be increased as an investment's required time to generate income increases. However, this hypothesis can be further extended to include hypothesis 8.

It was discussed above how an income decrease heightens managerial myopia because the pressure for an agent to increase income in the next period increases. In particular, when income decreases, an agent is tempted to cut investments that require long periods of time to generate potential income. In choosing to cut such long-term investments, the agent is likely to have more reason to first cut investments that require the longest periods of time to produce income because cutting such investments has the lowest probability of affecting the agent's future income. Therefore, when the principal controls the agent with short-term financial control, an income decrease is likely to most heavily reduce learning investments that require the longest periods of time to generate income. On the other hand, the use of written ex ante reasoning and reviewers can diminish such reductions. In other words, the use of written ex ante reasoning and reviewers can increase investments in learning when income decreases and such an effect is expected to increase as the learning investment's required time to generate income increases.

In summary, the effect of an investment's time to generate income can be encapsulated in the following hypothesis.

Hypothesis 9: The positive effects predicted by hypotheses H1 through H8 are expected to be amplified as an investment's time horizon increases.

3.5 Summary of hypotheses

The hypotheses of this study are summarized in Table 3-1.

Table 3-1 Summary of hypotheses

Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to the	
H1	Quantity of written ex ante reasoning of an investment's income potential
H2	Frequency of revision of written ex ante reasoning of an investment's income potential
H3	Number of reviewers
H4	(a) Reviewers' mutual reviewing tenure, or alternatively, (b) Have an inverted U relationship with reviewers' mutual reviewing tenure
H5	(a) Reviewers' reviewing tenure with the agent, or alternatively, (b) Are negatively related to reviewers' reviewing tenure with the agent
H6	Reviewers' ties to external reviewers
H7	Principal's attention to the investment
The positive effects predicted by	
H8	H1 through H7 are expected to be amplified when income decreases
H9	H1 through H8 are expected to be amplified as an investment's time horizon increases

4. Methods

4.1 Empirical research context

4.1.1 Research approach

The hypotheses of this study are tested on data of principal-agent dyads that are involved in research and development (R&D) projects in a large industrial corporation. Previous research on corporate governance and corporate internal controls has relied on large samples of firms. Such an approach is warranted when the focus is limited to few decision makers at the apex of each firm. On the other hand, when the focus is on managers at the lower levels of an organization, a focus on a single firm provides certain gains. Organizational processes are usually complex and rich in subtlety. Organizational phenomena tend to have a temporal dimension of dynamism that can be best captured by longitudinal data (e.g., Pettigrew, 1992). A focus on one organization helps to provide a more comprehensive and longitudinal understanding of the details that are related to the phenomena that influence the decisions that are made by individuals (e.g., Siggelkow, 2007).

A number of past empirical studies have focused on single firms to investigate behavior at the lower organizational levels. This study follows the tradition of several past empirical studies that have investigated behavior in R&D projects focusing on a single firm. Katz (1982) studied how communication behaviors and project characteristics influenced performance in R&D project groups in a single firm. Hansen (1999) investigated how ties between units in a single large firm influenced the completion times of R&D projects. Hansen et al. (2005) also focused on one large firm to investigate how a search for knowledge in R&D projects depended on the contacts of R&D project team members.

The research on social networks provides another example of how behavior at the lower organizational levels has been examined by studies

that have focused in detail on single firms. Many previous empirical studies on social network theory are based on an investigation of activities within a single firm. Typically, the managers or other professionals of a single firm have been approached with surveys asking questions on mutual ties and performance attributes. Many of these studies have only investigated a single large industrial corporation, usually focusing on one division or other part of the corporation (Tsai and Ghoshal, 1998; Gargiulo and Benassi, 2000; Rodan and Galunic, 2004; Obstfeld, 2005; Zhang and Bartol, 2010). Additionally, single companies that operate in the professional services such as banking or consulting have been the focus of several studies (Ibarra, 1993; Mizruchi and Brewster Stearns, 2001; Morrison, 2002; Cross and Sproull, 2004; Mehra et al., 2006; Biais and Weber, 2009; Mors, 2010). Instead of acquiring survey data, a number of past studies that focused on a single organization have relied on secondary data from information systems that were related to the organization (Nerkar and Paruchuri, 2005; Reagans et al., 2005; Gargiulo et al., 2009; Palomeras and Melero, 2010; Briscoe and Tsai, 2011).

The generalizability of findings is a weakness of studies that focus on a single company. The generalizability of findings from a study that is based on the investigation of only one organization is inherently suspect. Any finding can be due to something that is idiosyncratic to the organization, and similar phenomena may not exist in most other organizations. This risk can be minimized by sampling an organization that is a typical representative of many similar organizations and which does not have idiosyncratic characteristics that would be critical to the findings.

Ideally, an optimal research design would include detailed and longitudinal data from several organizations. However, such an approach is limited because detailed data are usually confidential, and it is difficult to acquire a permit for adequate access. In addition, a detailed investigation of an organization requires considerable resources. Thus, a scarcity of resources can further limit opportunities to conduct intensive investigations of multiple organizations.

This study follows the past tradition of investigating behavior at the lower organizational levels, R&D projects in particular, by focusing in detail on a single firm. To address the potential limitation of generalizability of the findings, a typical industrial corporation was chosen for investigation. To further minimize the risk of any idiosyncratic characteristics, the case organization and processes within the organization are analyzed and described in detail. This description of the case organization is provided below, and it suggests that activities within the organization closely match the findings of the past literature on corporations, and no idiosyncratic

characteristics that could be critical to the findings were observed. Therefore, the findings from this study are assumed to be generalizable to a broader population of similar corporations.

4.1.2 Corporate organizational structure

The case organization was a division of an industrial corporation. The division was a large global operation, exceeding one billion euros in sales during the investigation period from 1999 to 2009. The corporation and the processes within it are described in detail below; however, for reasons of confidentiality, some data have been disguised, and names are not used.

The corporation and the division were organized much like the typical large industrial global corporations that have been discussed extensively in the past research (e.g., Barnard, 1938; Simon, 1947; Chandler, 1962; Bower, 1970; Rumelt, 1974). The parent corporation was publicly traded with a diverse ownership and no single dominating owner. The corporation had thousands of owners, including mutual funds, pension funds and individual investors. The corporation employed tens of thousands of employees and was structured in a vertical hierarchy sometimes spanning close to ten management levels. The corporation was managed by a board of directors and a CEO.

All of the board's directors were outsiders for most of the investigation period. In the early years of the sample period, the CEO and a representative of an employee union were members of the board, but the board had a clear majority of outsiders even at that time. The board was never chaired by the CEO.

Several divisions with profit and loss responsibilities reported to the CEO. Further, case division consisted of smaller units with profit and loss responsibilities. Such units were further divided into smaller units with profit and loss responsibilities. The organizational structure of the division evolved over the years, but typically there were two levels of hierarchy with a profit and loss responsibility below the division level, referred to as the business line and profit center levels. Profit centers were the lowest management levels with profit and loss responsibilities. Each profit center was typically responsible for the operations that were required to design, produce, and sell a number of products. Sometimes manufacturing or sales operations were organized as entities that reported directly to some management level above the profit centers, but they were nevertheless controlled by the profit centers through a matrix relationship. The management levels under each profit center were typically organized according to functional structure. Operating profit was not usually

measured for these functional structures, but only sales or cost were measured.

Table 4-1 describes how the organizational structure evolved from 1999 to 2009. Different individuals in the positions of chairman of the board, corporate CEO, and division manager are described by a serial number for each position. The serial numbers increase by one whenever a new individual was nominated for each position. All of the eleven individuals in these positions were different persons. None of the division presidents was promoted to the position of CEO, and none of the CEOs served as chairman of the board. The number of business lines and profit centers identifies the number of each per each year.

Each profit center with a unique name is indicated by a profit center identification number. The number of R&D projects that were managed by a profit center is listed for each year when the profit center was active. The profit center structure highlights that the organization changed frequently, and while some of the profit centers existed for several years, many others were short-lived. Some of the profit centers disappeared as a result of divestments, and some emerged as the result of acquisitions, but most of the changes were due to internal reorganizations.

Table 4-1 Profit center organization structure and number of R&D projects in 1999-2009

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Chairman of board	1	1	1	1	2	2	2	2	2	2	3
Corporate CEO	1	2	3	3	3	4	4	4	4	4	4
Division manager	1	1	1	1	2	2	3	3	4	4	4
Number of business lines	5	10	9	8	8	8	5	8	4	5	5
Number of profit centers	17	22	27	18	19	17	14	15	12	14	16
Profit center ID	**Number of R&D projects**										
1	3	5	5	9	10	2	5	5	1	6	3
2	12	16	17	13	11	14	11	11			5
3	12	11	21	8	11	11	11	6			
4	9	11	13	10	13	18	9	11			
5	22	10	16	22	12	6	4	4			
6	9	2	3	4	5						
7	17		11	3	4						
8	5	6	10	9							
9	8	7	4								
10	7	6	6								
11	8										
12	4										
13	17										
14	9										
15	16										
16	9										
17	45										
18		12	11	8	5	4	4	7	4	14	7
19		9	9	8	12	8	5	5	7	9	7
20		18	24	25	21	1					
21		4	5								
22		10	7								
23		4	3								
24		11	1								
25		27									
26		8									
27		7									
28		45	43	36	54	61	63	35			
29		13	25	16	11						
30		7	8	4	5						
31			9	12	5	8	9	12	10		
32			4	6	5						
33			2								
34			8								
35			3								
36			4								
37			1								
38				11	10						
39				7	5	5	8	8	7	9	9
40					9						
41					2						
42						11	21	19	8	11	4
43						6	12	3	7	15	7
44						4			1	1	2
45						4	3				
46						2					
47						1					
48							1				
49								11	18	24	17
50								6	50	44	35
51								2			
52									5	11	4
53									5	25	13
54										1	2
55										64	29
56										17	6
57											1

4.1.3 R&D investment process

Origins of R&D projects

The division's R&D expenditures consisted of the costs of activities in hundreds of separate R&D projects. Prior to starting an R&D project, an idea for improving some product or customer production process emerged from various sources such as market surveys, customer feedback, internal experience with previous products, or suppliers promoting new component technologies. Sometimes an idea was a concrete technical solution that just needed to be tested for technical and economical feasibility. At other times, an idea was less concrete, such as a customer's need for which no technical solution was yet identified, or the development of a new technology that had not yet been applied in existing products. These types of ideas required additional work to be developed into concrete solutions.

An idea could be identified by an individual employee or evolve as the result of joint discussions by several employees. If an idea could be investigated further with the investment of minimal time and resources, an employee could develop the idea somewhat further without starting a formal R&D project. However, once the resources that were required to develop an idea further exceeded the resources that were available without a formal R&D project or within certain cost limits, it was required that a formal R&D project be initiated to continue the development, and a proposal for such an R&D project needed to be prepared.

The initiation of R&D projects

Investments in R&D projects were determined according to a typical corporate resource allocation process (e.g., Bower, 1970). Profit center managers gathered a pool of proposals for R&D projects and invested in a set of those R&D projects with income potential and which best aligned with their preferences. Even if a profit center manager made the final decisions on choosing R&D projects, the proposal preparation was usually coordinated by a functional manager who reported to the profit center manager, such as an R&D manager, together with other functional managers who reported to the profit center manager, such as sales and production managers. In practice, this preparation work was often organized as an R&D committee that was chaired by a profit center manager, with an R&D manager working as a secretary. Such an R&D

committee tended to meet repeatedly to discuss different choices before making its final decisions about starting R&D projects.

Usually, the R&D project proposals that were presented for a profit center manager or an R&D committee were screened by an R&D manager who gathered proposals from the organization and made some pre-selections. However, the proposals could also bypass an R&D manager through another route and end up as proposals to be considered by a profit center manager.

Sometimes a profit center manager wanted or was required to submit a project proposal for final approval to higher level management. Typically, strategic projects with links to other profit centers or with very large budgets were submitted to higher level management for decisions. On the other hand, a profit center manager could typically increase a profit center's total R&D budget for smaller projects without needing to acquire a permit from the higher management levels. Thus, to a large extent, a profit center manager could control the profit center's total R&D budget. Moreover, all of a profit center's projects needed to be approved by the profit center manager. It was unusual for higher level management to force profit center managers to invest in something that was not proposed, or even opposed, by a profit center manager. In summary, a profit center's total R&D budget was determined by the profit center manager, even if higher management levels could reject certain strategic or otherwise larger projects.

The information expectations for R&D project approval

Profit center managers chose R&D projects based on preferences that were influenced by their strategic and financial goals and targets. A profit center manager needed some information about each R&D project proposal to be able to determine the best match with those goals and targets. Therefore, profit center managers needed some information on R&D project proposals and typically defined certain questions that each project proposal needed to answer. The scope and details of information that were required for R&D project proposals varied from year to year. Often there were some division-wide templates, and even then, individual profit center managers could add specific requirements for their part. Thus, a detailed description of the requirements was not always possible, but some common issues were nevertheless identified and tended to be repeated from year to year.

Common questions for R&D project proposals over the years included estimates of future income potential, including both cost and sales, and some reasoning justifying such estimates. The accuracy and detail of such

estimates tended to depend on a project's type and, in particular, on the time that was needed to generate income. R&D projects were categorized into three types that had different time horizons. Projects with modestly long time horizon were typically expected to generate income in one to three years. Such projects focused on product development. Projects that required medium long time horizon were typically expected to generate income in three to five years. Such projects focused on developing technologies and components that were to be used as the basis for product development projects later. Finally, projects with very long time horizons were typically not expected to generate income until sometime after five years. Such projects usually focused on applied research. The estimates for projects at the very early stages with very long time horizons were allowed to be somewhat vague, whereas projects with only modestly long time horizon required relatively accurate and well-justified estimates.

The financial estimates and reasoning were typically accompanied by a reasoning of how a project supported the qualitative strategic goals of a profit center manager. Additionally, project budget and schedule estimates were common and important topics in project proposals because determining how much to invest in an R&D project had a direct impact on short-term cost and the income of a profit center manager.

In evaluating R&D project proposals, profit center managers relied on both written and oral sources. All of the written material on the project proposals were stored in an R&D project reporting information system. In addition, it was typical that profit center managers met formally or informally with their R&D managers, other members of an R&D committee, and other employees who were involved in preparing a proposal or who possessed knowledge that was critical to a project proposal. Such discussions were not always based on written documentation, and their content was not documented. Moreover, it was possible that sometimes verbal discussions partly substituted for written material and thereby reduced the amount of written material. However, the most critical reasoning that was needed to justify a project was usually documented and stored in the R&D project reporting information system.

An R&D project's budgeting

Rather than just approving or rejecting a proposal as such, a key element of a decision that was made by a profit center manager was to determine the size of the budget of an R&D project. Profit center managers often analyzed budgeted tasks and their costs in detail and challenged proposals. As explained above, choosing a set of R&D projects from proposals was

usually an iterative process. A profit center manager could return a proposal for further adjustments on the proposal content, including tasks and budget. Sometimes a profit center manager even dictated such details.

As in the traditional corporate resource allocation processes described by Bower (1970), investments in R&D projects followed an annual cycle. The corporate strategy process usually started in the spring, and once a strategy was chosen in the fall, the budgeting for the following full year began. The choice and budgeting of R&D projects were part of the overall budgeting in the last quarter of each calendar year. Each fall, the profit center managers reviewed the proposals for R&D projects for the following year and chose R&D projects and defined a budget for each, as described above.

However, it tended to take several years of R&D work to develop a solution that could be sold to generate income. To minimize risks, profit center managers were not willing to approve resources for an R&D project for several years. As a result, not only the new R&D projects that were based on new ideas but also R&D projects that had been started earlier needed to go through the approval and budgeting process at the end of each year. Only a minority of R&D project proposals during budgeting were proposals for new R&D projects based on new ideas. In summary, at the end of each year, the profit center managers picked a set of R&D project investments for the following year from a pool of proposals for continuing R&D projects that had been initiated earlier and new R&D projects that were based on new ideas.

For projects that continued from the past, the justification for the investment was mainly based on past reasoning and related documentation. Still, the past documentation needed to be updated to revise a task plan based on past experiences and to include new tasks. Additionally, the estimates and justifications related to income and strategic benefits needed to be updated to match any changes that had occurred since the previous version. The information needed to justify a project to a profit center manager was prepared from scratch only for entirely new R&D projects based on new ideas.

Even if the overall budgeting for the following year was completed only once a year, profit center managers wanted to limit risks by actually reviewing the progress of projects more frequently and also changing budgets, if needed. A profit center manager could review projects for changing tasks and budget any time of year if a reason for such changes was identified. However, in addition to reviews based on ad hoc needs, a number of reviews were already scheduled when a project was approved during the annual budgeting process. Both planned and unplanned reviews were referred to as "milestones." As a result of the milestones, a budget that

was defined during the annual budgeting at the end of each year was only a guideline, and it could be and often was adjusted at the milestones that took place during the year. Whenever a budget was adjusted, the adjusted budget became the formal project budget, which was documented and tracked in the R&D project management information system. Budget adjustments typically also required some updating of the information on justifying a project.

A profit center manager could also decide to stop an R&D project completely at any milestone if the project was no longer justified based on new information that was learned about the project or due to other changes that were external to the project. The flexibility in adjusting R&D investments during the year also went in the opposite direction, as profit center managers could initiate new R&D projects at any time during a year. Most of the new projects were initiated based on the annual budgeting at the end of each year, but if an attractive idea for a new project emerged during the year, profit center managers could approve budgets for them. In practice, the management of milestones and new project proposals was typically arranged so that a profit center manager met with an R&D committee at regular intervals during the year, and they made decisions on milestones and new projects in such meetings.

Milestones and the stage-gate model

The practice of defining milestones for projects changed in 2004. Until 2003, projects typically had one milestone per each quarter of a year, or four milestones per year in total. Four was the maximum amount of milestones and sometimes milestones were omitted for certain quarters.

The number of milestones changed in 2004. Starting from the beginning of 2004, a revised R&D process was implemented in the entire division. The revised R&D process was similar to a typical stage-gate R&D process, as discussed extensively by past researchers (e.g., Cooper and Kleinschmidt, 1986; Cooper, 1990). The key change of the new R&D process was the introduction of minimum required standard tasks to be included for each project. The change was intended to increase the quality of the R&D projects by making sure that none of the tasks found to be critical to a project's success were ignored in any project. The definition of critical tasks was based on a benchmarking of the literature on stage-gate processes (e.g., Cooper and Kleinschmidt, 1986; Cooper, 1990; Cooper at al. 2002a, 2002b), discussions with other companies, and best practices that were identified internally. Standard tasks were further divided into standard

phases. Each project was divided into similar phases with the same minimum tasks defined for each phase.

Standard phases with standard tasks for each phase were separated by standard stage-gates with defined standard minimum requirements to be completed for each gate. The stage-gate model presented by Cooper (1990) includes five phases that are preceded by five gates. Stages include preliminary assessment, detailed investigation (and business case preparations), development, testing and validation, and full production and market launch. The R&D process in the case division had similar phases with the exception that the first two phases were combined into only one phase. The division had five gates, but the second gate, defined by Cooper between the first two gates, was omitted, and the fifth gate was a new one that was added after the last phase to ensure that a developed new solution was adequately integrated into ongoing operations in all the functional areas before closing the R&D project. Moreover, the last two phases and gates that were related to testing and validation and full production and market launch were omitted for projects that only focused on applied research.

The introduction of the stage-gate process changed the number of milestones per project. Prior to 2004, projects tended to have quarterly milestones, but from 2004 on, the milestones were defined by gates between the project phases. On the other hand, the standard gates only set the minimum requirements, and profit center managers could still add any number of additional milestones between the gates. The basic function of the milestones did not change, and the gates and other milestones were still points at which profit center managers reviewed a project's progress and updated budgets. Gates and other milestone decisions were often made by profit center managers in regular R&D committee meetings. Additionally, the annual budgeting process remained in place. The annual budgeting and stage-gate models did not conflict with each other much. Gates with standard criteria added the number of tasks in projects in general but otherwise acted like additional milestones, as before.

As a result of the stage-gate process, profit center managers were required to make sure that all of the gate requirements were completed, and they were not supposed to approve projects to pass a gate unless all of the requirements were met. However, the requirements for standard tasks and gate criteria were mostly presented in the form of checklists, and a relatively high degree of variety remained for how each profit center manager interpreted the requirements in practice. Thus, even if the information requirements for projects were more aligned than prior to 2004, there was plenty of variety that remained in the actual project

documentation between different profit center managers and even between projects within a profit center.

Project manager

By approving an R&D project, a profit center manager also nominated an R&D project manager, either full-time or part-time in addition to other responsibilities. Usually, someone was needed to prepare a project plan and budget for approval before an R&D project manager was formally nominated. Often the person who prepared a project plan was chosen with the intention of being nominated as the R&D project manager later. An R&D project manager was responsible for implementing the project plan, which had been approved as the basis of the project's budget. Usually an R&D project manager also nominated an R&D project team and organization to help with implementing the project.

However, when creating new knowledge, it is typically difficult to predict with high accuracy what actually needs to be done to succeed in learning or how much time it will take (Ruefli and Sarrazin, 1981; Cooper and Kleinschmidt, 1986; Schreyögg and Steinmann, 1987; Cooper, 1990; Block and Macmillan, 1993; Mintzberg, 1994; McGrath and MacMillan, 1995). This was also typical of R&D projects in the case division. A project plan and budget were based on the best estimate of needed tasks at the time of budgeting, but rigidly following the plan was not usually the preferred approach as new knowledge would be discovered during the development of the project. The amount of changes and detailed task definitions was usually so high that a profit center manager could not have had enough time to approve each change. As a result, many of the decisions on how to react to changes and how to define tasks in detail was left to be decided by an R&D project manager. A profit center manager could review and revise a project plan and budget at milestones. Some milestones were included in the project plan, but additional milestones could also be added on an ad hoc basis if the R&D project manager identified a need for major changes that required decisions by the profit center manager.

Reviewers

In addition to a project manager, a profit center manager could also nominate reviewers for each R&D project. Up to 13 reviewers were nominated per R&D project. Some projects did not have any reviewers. Reviewing projects was rarely a full-time task, and the reviewers were

typically heads of various functions who reported to a profit center manager, but other managers also reported to other profit center managers. The reviewers were distinct from an R&D project team that reported to an R&D project manager.

R&D project reviewers reported to a profit center manager, and they were responsible for helping the profit center manager in making decisions that were related to the project but which could also support an R&D project manager. The reviewers who were heads of various functions helped the profit center managers to evaluate the attractiveness of an R&D project from the perspective of each function. They also supported the R&D project manager by ensuring that the project manager got access to the resources that were available within their function, as needed. For example, they could allow employees from their functions to participate as members of a project team and to report to the project manager. The support in functional expertise and resourcing was similar to what Cooper (1990) described as the role of a group that was used to make gate decisions in certain stage-gate processes.

In the case division, reviewers were not limited to functional heads who reported to the profit center manager, but they could also be other employees from the organization that were overseen by the profit center manager or employees who worked for other profit center managers, including other profit center managers themselves. Anyone that a profit center manager regarded as being useful in supporting the profit center manager with an R&D project could be nominated as a reviewer.

One critical support that reviewers could provide was to help a profit center manager to evaluate how well an R&D project manager was managing a project. The reviewers provided the profit center manager with additional expertise and time that was spent in evaluating an R&D project manager. The reviewers with specific functional expertise could advise a profit center manager about how well an R&D project manager was able to take into account the related functional factors that could potentially have a critical impact on a project's cost or sales goals. The reviewers who had worked with a profit center manager previously had likely learned the preferences of the profit center manager, such as how the profit center manager preferred to set a balance between short-term cost pressures and future income potential. Such reviewers could act as additional eyes to help evaluate how decisions that were made by an R&D project manager were aligned with those preferences.

The reviewers could also occasionally help a profit center manager to communicate the investments in R&D projects to managers who were higher in the organization. Because the organization of the division changed

frequently, higher level managers also typically had extensive previous contacts within the organization, including other organizations that were managed by profit center managers. If higher level managers respected the opinions of such contacts, they could serve as useful reviewers to help to justify an R&D project for higher level managers.

The primary role of the reviewers was to advise profit center managers, but it was still the profit center managers themselves who approved the project plans and budgets. The reviewers were not similar to typical company boards that actually make decisions and vote for them. A profit center manager was the decision maker and could make decisions against the opinion of the reviewers, if needed. However, if the profit center managers trusted the reviewers adequately, they could delegate decisions to the reviewers. Such delegation could be conditioned up on certain rules. For example, a profit center manager could allow the reviewers to make a decision only if they all agreed, but otherwise it was required that the decision be brought back to the profit center manager. If the profit center managers delegated decisions, the delegation was usually limited to milestones that did not include major changes in budgets or tasks. The profit center managers usually wanted to make decisions with a major impact on short-term cost or potential income from an R&D project.

4.1.4 Incentives for balancing short-term and long-term financial performance

Formal financial incentives

The corporate board members were only granted fixed annual and meeting fees and did not receive any bonuses or other remuneration. All of the managers in the corporation had a fixed based salary. In addition to fixed base salary, most of the managers had short-term financial incentives in the form of annual performance bonuses that were tied to annual financial performance and other development objectives that were central to the operations managed by each manager. The emphasis was on annual financial performance, which determined at least 80% of short-term financial incentives. Annual financial performance was divided into corporate performance, division performance, and performance in the lower organizational units. For the managers at levels that were below the division manager, the corporate and division performance were the major part of the annual financial performance that determined the short-term financial incentives. The short-term financial incentives were typically half of the annual base salary at a maximum for the CEO and the division

president. The maximum percentage relative to the base salary decreased at the lower management levels and was typically not more than 20% of the base salary for profit center managers.

Additionally, different types of dividend-based long-term incentives were used over the years in which this study was conducted. These incentives were similar to the instruments that are widely used in other firms and which are discussed in the past literature, such as options and share-based incentives (e.g., Jensen and Meckling, 1976; Coles et al., 2006; Sanders and Hambrick, 2007; Deutsch et al., 2010). Before 2006, the direct share holdings of the CEO and the division manager were usually less than their annual base salaries. Instead, options were the basis for their dividend-based long-term incentives. The options were granted to all of the management levels down to most of the profit center managers, mainly in 2000 and 2001. The subscription period was from 2003 to 2005, which provided incentives for a few of the upcoming years. It is not known how the amount of options that were granted to each manager was determined, but most likely, as with the annual performance bonus, the options were a reward that was based on past annual financial performance or base salary. Additionally, the exact amount of the options that were granted to the managers below the division manager is not known. Based on the total number of options that were granted, it can be roughly estimated that, on average, each manager could have doubled his or her annual base salary if the share price would have doubled during the subscription period. Eventually the share price did not increase that much, and the gains were equal to a few month's base salary, at the maximum. Between 2002 and 2005, most of the managers, except for the CEO, did not receive any additional options.

From 2006 on, the options as incentives were replaced by a share ownership plan. The board intended the share ownership plan to support the meeting of the financial targets set for the following years and to commit managers to staying with the corporation. Unlike the earlier options, the profit center managers were not covered by the share ownership plan between 2006 and 2008 because the plan was typically limited to the three highest management levels. The managers who were covered by the share ownership plan received a number of shares each year that were based on the same type of triggers as annual performance bonuses. Once the managers received some of the shares, they needed to own the shares for at least three years before being able to sell them. In addition, they needed to remain employees of the corporation for the three-year period. In 2008, the corporate board set a new rule that limited the amount of shares granted each year to no more than annual base salary.

A different share ownership plan was adopted for 2009. It extended the coverage of the plan to include most of the profit center managers as the lowest level of managers. Rather than just granting shares as was done earlier, the new plan required each manager to purchase the shares before being granted any as an incentive. Typically, the managers could be granted a maximum that was four to six times the amount of the shares that they had first bought themselves. However, the multiplier was dependent on how the share price and annual operating profits developed over the coming three years and could eventually be much less. In addition, the gain from the share ownership plan for each year was limited to not more than 1.5 times the annual base salary of each manager. As earlier, the managers also needed to remain employed by the corporation for the following three years to be granted any additional shares. After having been granted shares after three years, the managers were not able to sell them for an additional year. In summary, the incentive was based on financial performance for four years in future. Approximately 90% of the managers that were offered the plan participated in it.

CEO and division president

The CEO, and to some extent the division manager, had the authority to make decisions that could potentially have sufficient impact to influence the share price. Thus, the CEO and the division manager could influence the gains from the options or share rewards that they were granted. As the gains from the options and shares depended on financial performance over several years, they were likely to be effective, to some extent, in motivating the CEO and the division manager to make investments that took several years to generate income.

However, the CEO and the division manager also had several reasons to prioritize short-term financial performance over long-term financial performance. The annual base salary and bonuses based on annual financial performance usually exceeded potential gains from dividend-based long-term incentives. Thus, the CEO and the division manager maximized their personal income by staying in their positions for as long as possible. Moreover, the CEO and the division manager needed to avoid being dismissed to benefit from their dividend-based long-term incentives. This increased the incentive for the CEO and the division manager to avoid being dismissed.

High annual financial performance was the key for the CEO and division manager to avoid being dismissed. Top management changes and the related financial performance of operating profit per sales are listed in

Table 4-2. The threat of being dismissed due to a weak annual financial performance was real because two of the CEOs were actually dismissed before retirement. In both cases, the corporate operating profit per sales had been decreasing for two consecutive years prior to their dismissal, and the board communicated the changes to have been mainly due to weak annual financial performance. Similarly, one of the division presidents was dismissed after two consecutive years of decreasing division operating profit per sales. In conclusion, even if the corporate CEO and the division manager had dividend-based long-term financial incentives, their priority was nevertheless to guarantee adequate short-term financial performance, and, in particular, to avoid a decrease in operating profit per sales.

Table 4-2 Top management changes in 1998-2009

Year	1998	2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Chairman of board	1	1	1	1	1	2	2	2	2	2	2	3
Corporate CEO	1	1*	2	3	3	3*	4	4	4	4	4	4
Annual change in corporate operating profit per sales	-1%	-7%	5%	1%	-2%	-9%	8%	2%	1%	0.1%	1%	-4%
Division manager	1	1	1	1	1	2	2*	3	3	4	4	4
Annual change in division operating profit per sales	-1%	-10%	9%	2%	-1%	-5%	-1%	2%	0.3%	0.4%	1%	-6%

A serial number of manager in each position.

* Manager dismissed. Other changes due to retirement.

Profit center managers

Only the CEO, and to some extent the division manager, could make decisions that could potentially have a large enough impact to influence the share price. Thus, the options and shares were likely to be to some extent effective in motivating the CEO and the division manager to make investments that took several years to generate income. However, the options and shares were not likely to be as effective for motivating profit center managers. Even if every manager from the CEO down to the profit center managers received some dividend-based long-term incentives, the managers below the division manager could influence the corporate share price to a very limited degree because each profit center contributed just a small part of the total corporate dividends. In practice, the most that the profit center managers could do to influence the benefits from the dividend-based long-term incentives was to keep their annual operating profit as high as possible to maximize the number of shares granted to them, to not leave the corporation, and to try to avoid being dismissed for three years. Keeping their annual operating profit high was also essential for the latter objective of avoiding being dismissed. In conclusion, for profit center managers, the options and share ownership plan were mostly about committing them to not leaving the company and keeping their operating profits at a satisfactory level for four years.

Even the incentive for keeping operating profits at a satisfactory level for four years did not necessarily imply that the profit center managers had a

reason to prefer investments that took several years to generate income. As discussed above and highlighted by Table 4-1, many of the profit centers did not exist for four years, but rather for much shorter periods. A change in the profit center structure also usually reset financial performance indicators, and the monitoring of financial performance started to be tracked only from beginning of the new structure. Thus, a profit center manager could sacrifice long-term competitiveness and income by cutting R&D investments with a good chance that the resulting decrease in income would never become visible because the financial performance indicators were likely to be reset before the decrease could be observed. This process was likely to increase the temptation to keep R&D investments to a minimum, even if it threatened competitiveness over the coming years.

In addition to the financial incentives that motivated profit center managers to keep R&D investments to a minimum, the incentives for the higher level managers created similar pressures. It was difficult for the division manager to achieve adequate annual financial performance and avoid a decrease in operating profits per sales unless all of the management levels below contributed accordingly. Thus, the pressure for annual financial performance and avoiding a decrease in operating profits per sales cascaded down the management levels to the profit center managers. Each profit center manager usually had personal annual financial performance expectations, and if he or she failed to meet the expectations, the potential negative consequences were more than just a lower annual performance bonus. Additionally, the career of profit center managers depended on meeting annual financial performance expectations and career was a determinant of personal income for profit center managers. A fixed base salary increased considerably at each higher management level. Thus, promotion, demotion, and dismissal had considerable influence on a manager's personal income.

As discussed above, annual financial performance was a critical career determinant for the CEO and the division manager. Unlike the dismissals of a CEO and a division manager, the direct evidence of the career determinants of the profit center managers was not available. The organization of the division changed constantly, and most of the details of organizational structure were not archived. Table 4-1 illustrates how the structure of the profit centers changed over the years and demonstrates how regularly the organization was changing. The names of the profit centers were archived but not the names of their managers or their financial performance. Thus, it is not possible to analyze the careers of individual profit center managers or how financial performance was related to

organizational changes. Each manager chose their subordinates, and the reasons for the choices were not communicated or documented.

Despite the lack of documented evidence on career determinants, it is assumed that annual financial performance relative to expectations was a major career determinant for profit center managers, even if it was not the only one. On one hand, the assumption is based on the evidence that was found on the career of the CEO and the division manager, which can likely be generalized to the lower level managers. On the other hand, informal discussions with managers at different levels seemed to support the assumption based on how the managers had chosen their organizations and perceived others' choices as well.

Based on this assumption, it is expected that successful annual financial performance improved the chances for promotion and decreased the risks of demotion or dismissal and thereby increased a manager's personal potential future income considerably. On the other hand, a weak annual financial performance decreased a manager's chances for promotion and substantially increased the risk of demotion or dismissal and thereby decreased a manager's personal potential future income considerably. In summary, the profit center managers had strong motivations to maximize annual operating profits.

The profit center managers could meet the expectation for annual financial performance by increasing sales, increasing costs less than sales, and decreasing costs. All of the profit centers mostly operated in the same market, which was growing relatively slowly. As a result, it was not easy to increase sales, and tight cost control was critical for profit center managers to achieve adequate annual financial performance. As R&D investments usually could increase income only in later years, keeping R&D investments to a minimum could contribute to the goal of tight cost control.

Despite the cost pressures, there were also some balancing pressures supporting investments in R&D. Stopping R&D investments completely was not an attractive alternative because competition was active in R&D. If a profit center manager stopped investing in R&D, sales could have been decreased somewhat even in the short term, and there would have been potential for a major decrease in a few years' time. Higher management would have noticed such a decrease in R&D investments and as the CEO and the division manager had some effective dividend-based long-term incentives, they had motivation to invest in R&D if it could help to avoid a major decrease in sales in few years. Additionally, if a large scale reduction in R&D investments would have been noticed outside of the corporation, the share price would likely have decreased immediately. Thus, the profit center managers had to strike a balance between pressures to minimize

costs and R&D investments and to avoid the potential for an excessive decrease in sales in coming years due to not having developed solutions that remained sufficiently competitive. The corporation had no explicit universal rules for determining such a balance, and the profit center managers needed to find a balance for each specific situation.

Because some level of R&D was desirable to management at the levels above the profit center managers, R&D investments may have also played some positive role as career determinants. Even if annual financial performance was a major determinant of annual bonuses and share ownership plans, another determinant included other development objectives that were central to the operations overseen by each manager. It is likely that such other objectives also played some role in how managers were chosen for different positions. Because the CEO and the division president had effective dividend-based long-term incentives, their total income could be improved if the managers that reported to them could both meet short-term financial expectations and, in addition, create opportunities for future income through R&D investments. Thus, it is possible that some profit center managers who were experiencing good sales or otherwise strong short-term financial performance could improve their career chances by also demonstrating R&D investments beyond the minimum. Such behavior may have offered a profit center manager an opportunity to distinguish him- or herself from other competing managers with strong short-term financial performances. However, there was no documented evidence to confirm if R&D investments also had a positive effect on the profit center managers' careers.

In summary, profit center managers were subject to various pressures for minimizing R&D investments and some balancing pressures for making R&D investments. Annual performance bonuses motivated them to minimize R&D investments. The options and share ownership plan were not effective in motivating long-term investments because the profit center managers could not sufficiently influence share price. Frequent organizational restructurings blurred the ability to identify the effects of cost cutting in decreasing subsequent income, and they created a temptation for minimizing R&D investments. Minimizing R&D investments increased annual financial performance, which improved managers' chances for promotion and decreased the risk of demotion or dismissal and thereby increased a manager's personal potential future income. Such pressures to minimize R&D investments were balanced slightly by the top management's concern for ensuring adequate competitiveness, which made drastic cuts in R&D investments undesirable and also offered to some

extent an opportunity to boost managers' careers through R&D investments.

In total, the balance on incentives for R&D investments by profit center managers tended to tilt towards a preference for minimizing R&D investments without excessively sacrificing competitiveness. However, formal R&D expenditure limits were usually higher than the actual R&D expenditures, and corporate management sometimes encouraged the lower-level managers to increase the total division R&D expenditures. Therefore, a profit center manager was not formally limited to investing more in R&D if a profit center manager wanted to do so.

Project managers

As it was difficult for the division manager to achieve adequate annual financial performance unless the profit center managers contributed accordingly, the profit center managers were also dependent on the R&D project managers to find a good balance between minimizing R&D investments and ensuring adequate competitiveness in the following years. The profit center managers approved a budget for each R&D project each fall and even adjusted the budget at milestones during the year, but they did not have time to make the bulk of the detailed decisions that influenced the cost and future income potential of each project. The profit center managers delegated these decisions to their subordinate project managers.

Because R&D projects were aimed at creating new knowledge, it was typically difficult to predict with high accuracy what would actually need to be done to succeed in learning or how much time it would take (Ruefli and Sarrazin, 1981; Cooper and Kleinschmidt, 1986; Cooper, 1990; Block and Macmillan, 1993; Mintzberg, 1994; McGrath and MacMillan, 1995). Project budgets were based on the best estimates of the necessary tasks at the time of budgeting, but rigidly following the plan was not always the preferred alternative as new knowledge was discovered during the course of the project. Such uncertainty was usually taken into account when preparing a project plan and budget, and not all the tasks were defined in detail, but the intention was to define the details as new knowledge was learned during the project. A project manager was even often allowed to exceed the budget that had been approved by a profit center manager to some extent, using his or her own judgment. The amount of changes and detailed task definitions was usually so high that a profit center manager would not have had the time to approve each change. As a result, many of the decisions on how to react to the changes and how to define the tasks in detail were left to a project manager, and these decisions also influenced the project's actual

cost. In conclusion, a profit center manager delegated part of the resources to be allocated by a project manager and let the project manager find a good balance between minimizing R&D investments while ensuring adequate competitiveness in following years.

The decisions made by R&D project managers on actual project costs were not a marginal determinant of the total annual financial performance of a profit center. Instead, the actual cost of R&D projects was one of the critical elements in determining the total annual financial performance of a profit center. Such substantial impact can be illustrated by estimates that are based on the average financial performance of the division.

Over the years, the division invested, on average, 3% of sales in R&D, and operating profit per sales was, on average, 5% and never exceeded 10%. This situation was paralleled the profit center level on average, even if there was some variation. As the profit centers had ten R&D projects per year on average, each project represented an average of 0.3% of sales for the profit center. If a project manager could save 30% of the cost of an average-sized project, the savings were 0.1% of the operating profit per sales of the entire profit center. Such a savings may not have been the most critical determinant of the profit center manager's annual financial performance, but it was nevertheless one of the visible determinants, relative to the average of 5%. In addition, relative to many of the other costs, an R&D project's cost was something that could be easily cut without an immediate decrease in sales. It was not at all unusual that a project's actual cost was 30% below, or above, the project budget, as this was actually the situation for more than half of the R&D projects. Thus, profit center managers with pressure to meet expectations for annual financial performance had a reason to be interested in how much their project managers actually spent on R&D projects.

Given how important it was for profit center managers to maximize annual financial performance without excessively risking competitiveness and how much the annual financial performance was influenced by an R&D project's actual cost, it is likely that profit center managers were motivated to choose an R&D project manager that could establish a delicate balance between minimizing a project's actual cost and ensuring adequate competitiveness. There were no standard or documented rules for how profit center managers should choose individuals for job positions in their organizations, but it is possible that the project decisions made by project managers influenced their future careers and income.

When an R&D project manager made project decisions, a profit center manager could evaluate how the project manager balanced the project's actual cost and future income potential. A project manager that could

minimize a project's actual cost and develop some new knowledge toward generating future income was likely to be an attractive candidate to manage R&D projects or some other position under a profit center manager in future. A profit center manager was likely to prefer such R&D project managers rather than those who either spent excessively or could not develop useful knowledge. Thus, the career and future income of an R&D manager likely depended on how well the project manager could minimize the cost and develop knowledge that generated future income.

Of these two criteria, evaluating the usefulness of developed knowledge was likely to be much more uncertain and difficult. On the other hand, the project's actual cost was easy and reliable to evaluate. A profit center manager could track how much a project manager actually spent on an R&D project and compare it to the budget. Often it was possible to track the performance against budget not only for the project as a whole but also for individual tasks. The lower the project's actual cost was, the better it supported the profit center manager's pressure for minimizing profit center costs. Thus, it is likely that actual cost was a strong determinant of how attractive an R&D project manager was regarded for future R&D project manager positions, or other management positions, by a profit center manager.

The process of choosing candidates for new R&D project manager or other managerial positions was not just an occasional exception, but it was a fairly common practice. As illustrated in Table 4-1 above, the division's organizational structure changed frequently. The whole profit center structure of the division was reorganized frequently, and only a few profit centers existed for several years. Further, the organizations within the profit centers evolved frequently. The restructuring of the organization was often combined with layoffs. Thus, R&D project managers were under the constant pressure of being placed in a position either as a continuing manager of an existing R&D project in a new organizational structure or in a new R&D project, or being nominated for another position within the organization rather than being dismissed during layoffs. The choice of managers for new positions and for dismissal was often in the hands of the profit center managers. Thus, the profit center managers had considerable influence on the career of all of the managers in their organizations, including the R&D project managers. As a result, project decisions by a project manager were likely to influence the future career and income of the project manager. Further, as the profit center managers experienced strong pressures to minimize costs, the career and future income of an R&D manager were likely to depend on how well the project manager could minimize the costs in R&D projects.

Even if the career and future income of an R&D manager were likely to depend on what type of decisions they made in R&D projects and how well they minimized a project's actual cost, there is no direct evidence on how much R&D project managers intentionally took such aspects into account when making decisions in R&D projects. Project managers did not have incentives to communicate or document such personal motivations and no evidence was available to confirm such personal motivations. Agency theory (e.g., Alchian and Demsetz, 1972; Ross, 1973; Jensen and Meckling, 1976) suggests that individuals maximize their own interests even when managing resources that belonging to someone else. This finding suggests that when a project manager was deciding how to react to a project's changes and how to define project tasks in detail, he or she made choices that were based on which alternative he or she expected to maximize his or her own future personal income. It is possible that some R&D project managers were more careful than others in considering how the decisions influenced a project's actual cost and how it further influenced their future career options. However, the pressure to keep costs to a minimum was such a regularly communicated topic in the division that it can be assumed that most of the R&D project managers had a motivation to minimize their R&D project's actual cost unless they were convinced that the profit center manager regarded the costly tasks to be useful. In conclusion, a project manager had an incentive to minimize an R&D project's actual cost unless the profit center manager could be convinced otherwise.

4.1.5   Agency context

The case firm provides an agency context for testing the hypotheses. The basic agency relationship started at the top with the owners as principals and the board as agents. The CEO was an agent who reported to the board as a principal. The CEO was a principal in relation to the division managers, who were agents in relation to the CEO. In a sense, the CEO had a double role as an agent and a principal. The division managers also acted as principals in relation to the managers who reported to them. This vertical hierarchy of principal-agent dyads was repeated down the organizational hierarchy. With respect to the R&D projects, the profit center managers were in a principal role relative to the R&D project managers, who were agents in that dyad. For testing the hypotheses of this study, this study focuses on the latter principal-agent dyad, in which the profit center managers function as principals and the R&D project managers function as agents.

In this agency context, a profit center manager is defined as a principal and a project manager as an agent. The R&D project reviewers are regarded as reviewers who help the principal to evaluate the agent. Ideally, the hypotheses would also be tested for the principal-agent dyads at higher levels in the corporate hierarchy, but no data exists for the hypothesized control mechanisms for the higher level agency dyads.

4.2 Data

The sample consists of R&D projects. The data were obtained from the division's R&D project reporting information system, which included information on R&D projects over a thirteen-year period between 1997 and 2009. Between 1997 and 2003, the work that took more than one year was organized as separate projects, one for each year. A new system that enabled multiyear projects was introduced in 2004. However, the variables used in this study evolved from year to year. Therefore, the project system was sampled annually after year-end, and the work that had been done in a project in a prior year was counted as a separate project. In other words, project length was always a maximum of one year. The sampling methodology obtained 3,079 projects over the sample period. However, 504 projects from years 1997 and 1998 were needed to calculate the lagged variables of the study. Further, 428 projects were screened out due to a possibly unreliable dependent variable, which is discussed below. Thus, the final sample that was used to test the hypotheses consisted of 2,147 projects. An investment in a project varied from a few thousand to 2.5 million euros. In total, over 260 million euros were invested in 2,147 projects.

The data analysis relies on written information from the R&D project reporting system and the corporate public accounting records for actual income information. The analysis could have been complemented by a survey to or structured interviews with the profit center managers or the R&D project managers. The managers could have been asked for their opinions on how they thought they or the other managers were taking into account the hypothesized control mechanisms when making decisions that were related R&D projects. Such a complementary analysis was not taken for the following reasons. First, the data from the R&D project reporting system was historical data, and it would not have matched with a survey or structured interviews, which would have decreased the complementary value somewhat, if not completely. Second, asking opinions of the managers would have addressed perceptions, which would have required

an extension of the theoretical framework. The question of how individuals make decisions does not necessarily coincide with how they think or report how they make the decisions (e.g., Simon, 1947). Prior research has recommended behavioral measures rather than perceptual ones (Hansen et al., 2005). This study followed the recommended approach of observing how the managers actually make decisions. Investigating how managers thought they behaved could have been a following step, but it would have required a broader theoretical framework, which would have been outside of the scope of this study.

4.3 Variables

4.3.1 Dependent variables

Research and development (R&D) expenditures have been widely used in previous research to measure activities related to long-term learning in firms. Hoskisson et al. (1993) and Palmer and Wiseman (1999) used R&D intensity, defined as R&D expenditures per sales, to measure managerial risk taking. Kim et al. (2008) used R&D intensity to measure risky and uncertain long-term investments, that is, investments with outcomes that are neither immediate nor certain. Lee and O'Neill (2003) and Sanders and Hambrick (2007) used R&D expenditures instead of R&D intensity to measure uncertain long-term investments.

According to Cohen and Levinthal (1989), economists generally consider R&D as the creation of new information. Helfat (1994a, 1994b) and Mahlich and Roediger-Schluga (2006) used R&D intensity to measure knowledge creation by firms. Greve (2003), Chen and Miller (2007), and Chen (2008) used R&D intensity to measure organizational search. Dosi (1988) argued that R&D reflects a firm's innovation activity. Hoskisson and Hitt (1988), Hitt et al. (1996), and Hundley et al. (1996) measured a firm's commitment to innovative activities through R&D intensity.

In summary, R&D expenditures have been used to measure risky and uncertain long-term investments. They have also been used to measure knowledge creation, organizational search, and innovation. Such activities are in essence learning new knowledge. Therefore, R&D expenditures are used in this study to measure investments in learning new knowledge that is likely to take a long time to generate income.

Previous research has tended to focus on R&D expenditures by firms as a whole rather than R&D expenditures in organizational units within firms. Such a focus is warranted because the past research has focused on top

management. However, as a whole, a firm's R&D expenditures are typically the sum of R&D expenditures from several organizational units within a firm. Because this study aims to understand the control mechanisms at the lower organizational levels, R&D expenditures at lower organizational levels are used instead of the sum for the whole firm.

An R&D project budget

R&D expenditures are measured at the level of individual R&D projects. Because profit center managers determined the budget of R&D projects, R&D project budgets are used to measure R&D expenditures by profit center managers. The project budget approved by a profit center manager reflects the profit center manager's investment in learning new knowledge that is likely to take a long time to generate income. Project budget is measured as the R&D project budget indicated in the R&D project reporting system. A logarithmic transformation is used for project budgets in models in which it is the dependent variable.

An R&D project's actual cost

Because R&D project managers determined the actual cost of R&D projects, an R&D project's actual cost is used to measure R&D expenditures by R&D project managers. The project's actual cost reflects the R&D project manager's investment in learning new knowledge that is likely to take a long time to generate income. Project actual cost is measured as the R&D project expenditures that are indicated in the R&D project reporting system. A logarithmic transformation is used for a project's actual cost in the models in which it is the dependent variable.

The R&D projects' actual costs often exceeded the project budget for many of the projects in the case firm. A project manager could usually exceed a project's budget without a permit from the project profit center manager. On the other hand, actual costs exceeded budgets with 50% or more for 410 projects, including projects with zero budgets. Projects were excluded from this study because it is likely that the project managers of these projects had had to ask for an approval from the profit center manager but had not updated the project budget accordingly.

4.3.2   Independent variables

Previous research has relied on both surveys and text analyses to investigate the amount of communication that is related to various topics. Studies that are based on surveys usually ask respondents to estimate the amount of communication with others or the use of written communication materials (Keller, 2001; Lewis et al., 2002; Haas and Hansen, 2007; Westphal and Graebner, 2010). Studies that are based on text analysis have been more specific by actually counting the length of the text related to certain topics. A number of studies have investigated the annual reports that are published by firms, usually focusing on the letters to shareholders that are included in annual reports. (Bowman, 1976, 1984; Staw et al., 1983; D'Aveni and MacMillan, 1990; Abrahamson and Park, 1994). These studies have focused on certain topics and have counted the number of lines or sentences that are related to a topic. Additionally, the written business plans submitted to venture capital firms (MacMillan and Narasimha, 1987), the proxy statements published by firms (Matejka et al., 2009), and the written minutes of boards of directors (Tuggle et al., 2010a) have been analyzed based on a similar approach of counting the number of sentences related to certain topics.

The text analysis approach used in previous research was also used in this study. Instead of annual reports or other instruments that have been used as data in past research, this study is based on the information sheets written for each R&D project. Each R&D project had a project information sheet in the R&D project information system. Part of the information on a project sheet was filled out prior to the project's budget approval, and the rest was completed during the course of the project. Some of the fields in the project information sheet included attached documents. The information that was entered into a project sheet prior to the project's budget approval was intended to justify the project's approval. The information that was entered into the project sheet during the course of a project was intended to justify how well the project was progressing according to the project plan and to justify any deviations from the plan based on new knowledge discovered during the course of the project. Quantity of ex ante reasoning of an investment decision is measured as the logarithm of the size of a project's information sheet without any attached documents.

For a model that tests project actual cost by R&D project managers, the size of the project information sheet adequately reflects the quantity of ex ante reasoning because both the information filled out prior to the project's

budget approval and that filled out during the actual project help the project manager to justify the actions to a profit center manager.

However, for a model testing project budget by profit center managers, an ideal measure would include only the size of the project information sheet prior to budget approval. In practice, it was not possible to distinguish exactly which part of the project information sheet was filled before project budget approval. However, it was possible to measure how much the information increased from year to year in projects that lasted for several years. On average, the size of a project information sheet increased over time for all of the projects, but when this was controlled, the size of information sheet increased less than 30% for projects continued from the previous year. This increase included both updates during the year and revisions for a new budget approval at year end. Thus, it suggests that a large majority of information on the project information sheets was intended for project budget approval even if this amount could not be exactly measured. As a result, the size of a project information sheet is expected to be a good estimate of the size of the information sheet prior to project budget approval. Therefore, even if this estimate is not an ideal measure for the testing project budget by profit center managers, it is expected to be an adequate proxy measure.

Frequency of revision of written ex ante reasoning (H2)

Previous research on boards of directors has measured the frequency of monitoring and counseling by boards in several ways. Tuggle et al. (2010a) measured board meeting frequency as the count of the meetings per year. The frequency of actual information updates has also been measured. Judge and Zeithaml (1992) used a survey item that measured how board members utilized progress reports from the management. Tashakori and Boulton (1983) measured the frequency with which board members were provided analyses of a firm's internal financial, human, and structural factors.

The frequency of information updates was also measured in this study to test the hypothesis on the frequency of revisions of ex ante written reasoning. Each R&D project information sheet had a log that listed each revision of the information sheet. The log included the date of revision and the name of the person who did the revision. Thus, it was possible to determine how often the written reasoning on an R&D project sheet was updated based on new knowledge. Frequency of revision of written ex ante reasoning is measured as the number of times an R&D project information sheet was updated during the course of the project. If a project information sheet was updated more than once in the same day, only one update was

counted because several updates were likely to be working copies of the same update to be communicated to a profit center manager as a single update.

Number of reviewers (H3)

As the concept of reviewers is theoretically new, previous research did not develop readily available empirical variables that could be used as such. Boards of directors provide a close theoretical concept that has been studied extensively with established empirical variables. As discussed in the theory chapter above, the reviewers who were related to hypothesis 4 are distinct from boards of directors. The main differences are that boards of directors act at the apex of a firm and make decisions collectively. However, the empirical studies on boards of directors provide a useful starting point for developing empirical measures. A number of past studies on boards of directors have included the number of directors as a key measure (Judge and Zeithaml, 1992: Pearce and Zahra, 1992; Geletkanycz and Hambrick, 1997; Carpenter and Westphal, 2001; Golden and Zajac, 2001; Cheng, 2008: Deutsch et al., 2010; Duchin et al., 2010; Haynes and Hillman, 2010; Tuggle et al., 2010b).

Financial analysts who follow firms and analyze them for the needs of investors are also somewhat related to the concept of reviewers. Thus, the empirical research on financial analysts can also provide some guidance for measuring reviewers empirically. A number of past studies on financial analysts have included the number of analysts as a key measure (Wright et al., 2002; Yu, 2008; Duchin et al., 2010; Pfarrer et al., 2010).

As discussed above, a number of reviewers were nominated for each R&D project, and not all projects had reviewers. Such reviewers acted much like the reviewers who are discussed in the theory chapter for hypothesis 3. The R&D project reviewers helped the profit center managers to evaluate their projects as investments, and they also evaluated the competence of the project managers. The R&D project reviewers could also support the project managers' careers by sharing the word of the competence of project managers to managers who may hire project managers for other tasks in future. Because the R&D project reviewers played a role that was similar to the reviewers related to hypothesis 4, the logarithm of number of R&D project reviewers is used as a measure of the number of reviewers. If a project does not have any reviewers, the number of reviewers is zero. In this case, the reviewer-related variables as discussed below are zero.

Reviewers' mutual reviewing tenure (H4)

Previous research on corporate governance has measured average board tenure to investigate the effects of tenure (Singh and Harianto, 1989; Kosnik, 1990; Mallette and Fowler, 1992; Carpenter and Westphal, 2001; Golden and Zajac, 2001). However, whereas boards are relatively permanent mechanisms, and only their membership changes, the reviewer teams established by a principal are temporary in comparison. Thus, measuring the average tenure of reviewers in a reviewer team is not an accurate measure of the mutual past review experience among reviewers. Instead, the past review experience among reviewers in a review team is better captured by the past mutual experience of each pair of reviewers in all of the various past review teams.

Past mutual experience of each pair of reviewers can be calculated as the number of past projects that two reviewers have reviewed together in the past. These numbers can then be summed to get the total past cooperation by all of the reviewers. However, such a sum needs to be divided properly to be independent of the number of reviewers. The proper denominator is suggested by network density, which is an established and widely applied measure in social network theory (Mizruchi and Brewster Stearns, 2001; Morrison, 2002; Soda et al., 2004; Sparrowe et al., 2001; Reagans et al., 2005; Fleming et al., 2007; Mors 2010; Wong and Boh, 2010). Network density provides an adequate basis for a measure for reviewers' mutual reviewing tenure. Network density for any group of individuals is defined as the number of the past ties among the members of the group divided by the total number of possible ties in the group, which equals $(n(n-1))/2$ where n is the number of members in the group. Network density is also used to measure reviewers' mutual reviewing tenure.

The number of past projects that two reviewers have reviewed together in the previous two years is calculated for each pair of reviewers of the project. These numbers are then summed to get the total past cooperation by all the reviewers. This sum is divided by the total number of possible ties between the reviewers according to a network density measure, as discussed above. This number is used as the measure of the reviewers' mutual reviewing tenure for each project.

Reviewers' reviewing tenure with agent (H5)

Previous research on boards of directors has measured board members' tenure with the CEO as the ratio of a CEO's tenure to the average board tenure (Singh and Harianto, 1989; Sundaramurthy, 1996). As explained

above, average board tenure cannot be directly adapted to reviewers. Therefore, reviewers' reviewing tenure with an agent cannot be adapted directly from measures that have been used for board members' tenure with a CEO.

However, the reviewers' reviewing tenure with an agent can be adapted based on a measure of tie strength that has been applied in social network theory (McFadyen and Cannella, 2004; Soda et al., 2004; Reagans et al., 2005; Fleming et al., 2007). The past mutual working experience between two individuals has been measured by tie strength as the number of projects or tasks the individuals have performed together in the past. For example, Soda et al. (2004) used a data set of TV productions and counted the number of projects on which two individuals had worked together in the past. An approach that is similar to tie strength is used in this study to measure the number of times that the reviewers had evaluated a project manager in the past.

The extent to which the reviewers of a project had reviewed a project manager in the past is first obtained by identifying the past projects that were led by the project manager in the previous two years. The number of reviewers of the current project as reviewers of each past project that was managed by the project manager is counted. Then, the numbers of these past projects are summed together. Finally, this sum of past reviews is divided by the number of reviewers to obtain the measure of reviewers' reviewing tenure with agent for the current project.

Reviewers' ties to external reviewers (H6)

Again, the past research does not provide a readily available empirical measure for reviewers' ties to external reviewers. External reviewers are defined as individuals with whom the reviewers have reviewed projects in the past but who are not reviewers in the current project. However, the past research on board interlocks and social network theory provides useful empirical measures as the basis for measuring reviewers' ties to external reviewers. Past studies on board interlocks have measured the number of boards on which board members sit (Davis, 1991; Haunschild, 1993; Arthurs et al., 2008). The board members in such others boards provide indirect ties for a focal firm. Studies in social network theory have gone one step further and measured the number of individuals as indirect ties. In their study of patent inventors, Fleming et al. (2007) measured the number of external ties to a focal inventor's collaborators and defined external ties as the individuals who have not collaborated with the focal inventor. Soda et al. (2004), Smith et al. (2005), and Vissa and Chacar (2009) studied

different types of teams and measured the number of ties the team members had with other individuals who were not included in the team. Such measures counted not only the number of ties of an individual but also the total number of ties of all of the team members, thereby quantifying the number of ties of the team as a whole. This approach can also be used to measure reviewers' ties to external reviewers in this study.

Reviewers' ties to external reviewers are measured as the number of reviewers with whom the reviewers of a project had worked on other projects over the previous two years. The variable is calculated by first listing all of the other projects that the reviewers of a project had reviewed over the previous two years. Next, all of the reviewers that are listed for these other projects are identified, and the reviewers of the current project are excluded from the list. No person is counted twice as an external reviewer. The number of the reviewers that remain on this list is divided by the number of reviewers to obtain a measure of the reviewers' ties to external reviewers.

Principal's attention (H7)

Occasio (1997) proposed that decision makers are more likely attend to issues with greater value and relevance to an organization. The past research on investment processes in large organizations has found that larger investments attract more management attention than smaller investments (e.g., Chandler, 1962; Bower, 1970). Moreover, larger investments raise attention at more numerous and higher organizational levels. The size of an investment is also used to measure attention in this study.

Because a profit center manager is regarded as a principal in the research context, a principal's attention is based on the attention that a profit center manager pays to an R&D project. The attention of a profit center manager is expected to focus on the R&D projects with the largest budgets. There are two alternatives of comparison groups among R&D projects. The first alternative is to compare an R&D project to the other R&D projects of a profit center manager. However, when testing a model on the total R&D investment by profit center managers that include all of the R&D projects of a profit center manager, this alternative does not distinguish attention differences between different profit center managers. Instead, the attention of a profit center manager can also be measured by comparing the budget of an R&D project to other R&D projects within a business line, which is the organizational level above the profit centers. Such a definition supports testing a model on the total R&D investment by profit center managers.

Comparing R&D projects to other R&D projects within a business line is also theoretically an attractive measure of the attention of profit center managers because R&D projects that are large relative to others in a business line are likely to be noticed by business line managers. Business line managers may ask questions about such projects. Such projects are also likely to be the basis for how business line managers evaluate profit center managers in ensuring competitiveness over the coming years. Thus, profit center managers are likely to pay the most attention to such projects as well.

Comparing R&D projects to other R&D projects within a business line can also be used as a measure of a principal's attention when testing an R&D investment by R&D project managers. Thus, a principal's attention for a project is measured as the negative of the number of other projects with larger budget within a business line.

Income decrease (H8)

Several authors have measured income changes with return on assets (Hambrick and D'Aveni, 1988; Bromiley, 1991; Wiseman and Bromiley, 1996; Lant et al., 1992; Palmer and Wiseman, 1999; Audia et al., 2000; Greve, 2003; Miller and Chen, 2004; Audia and Greve, 2006; Sanders and Hambrick, 2007; Chen and Miller, 2007). Singh (1986) and Hill et al. (1991) relied on after-tax return on assets to measure income changes. Some authors have used return on equity instead (Bromiley, 1991; Wiseman and Bromiley, 1996; Palmer and Wiseman, 1999; Audia and Greve, 2006).

Grabowski (1968) measured income based on after-tax profit and depreciation and divided their sum by sales. Grabowski and Vernon (2000) and Mahlich and Roediger-Schluga (2006) elaborated on this measure by adding after-tax R&D expenditures in the sum in the numerator. Hundley et al. (1996) measured operating profit per sales. Many other authors have also based their income measures on return on sales, but they did not specify the measures in detail (Bromiley, 1991; Wiseman and Bromiley, 1996: Audia et al., 2000; Greve, 2003; Audia and Greve, 2006; Morrow et al., 2007).

The operating profit per sales was the key measure for evaluating the financial performance in the case firm. The managers with profit and loss responsibilities at various organizational levels had annual targets for operating profit per sales, and the ratio was frequently tracked in management reviews. In addition, many of the managers' actions were justified as an effort to increase operating profits per sales. Even if it would be optimal to measure the income of each profit center manager separately,

no such data were available for the whole sample. Instead, the division income was measured. However, all of the profit center managers were operating in the same market, and their incomes are all assumed to have been strongly correlated with each other. Thus, the changes in division income are assumed to reflect the changes in profit center manager incomes. The division operating profit per sales is chosen as the measure of income for this study. The income information was obtained from public accounting records. The income change is defined as the change in operating profit per sales relative to the previous year. Income decrease is defined as negative income changes.

Time horizon (H9)

Previous studies on research and development activities have categorized such activities into different types because the different types of activities tend to differ in dimensions such as time span, specific relative to general problem orientation, and the generation of new knowledge relative to the use of existing knowledge. Typically, R&D activities are categorized as basic research, applied research, product development, and technical services (Tushman, 1977, 1979; Katz, 1982; Reagans and Zuckerman, 2001). The case division did not use the exact same categorizations of R&D activities but used the categorization in three types based on different periods of times to generate income, reflecting a similar characterization of R&D activities.

All of the R&D projects within the case division are regarded as long-term investments because they were expected to take longer than one year to generate income, with the exception of some minor occasional income from product pilots. Projects were further categorized into three types that had different time horizons. Projects with modestly long time horizons typically were expected to generate income in one to three years. Such projects focused on product development. Projects with medium long time horizons typically were expected to generate income in three to five years. Such projects focused on developing technologies and the components to be used as the basis for product development projects later. Finally, projects with very long time horizons were typically not expected to generate income until sometime after five years. Such projects usually focused on applied research. This project categorization was used to measure the time horizon for each project.

4.3.3 Control variables

Project year

Longitudinal studies usually include a variable for year to control to account for unobserved differences across time (e.g., Mishina et al., 2004; Reagans et al., 2005; Deutsch et al., 2010). In this study, year is included to control for any types of annual changes in the research context. Each year is included as a separate binary variable. In particular, the project year can control for the effects from the introduction of a new R&D project reporting information system in 2004.

Continuation project

Between 1997 and 2003, the work that took more than one year was organized as separate projects, one for each year. A new system that enabled multiyear projects was introduced in 2004. However, the variables used in this study evolved from year to year even within these projects. Therefore, the project system was sampled annually after year-end, and the work that was done on a project in a prior year was counted as a separate project. In other words, project length was always one year at maximum.

However, even if the measured variables evolved from year to year in multiyear projects, they may have been somewhat related over years. It is also possible that a project manager expected the profit center manager and the reviewers to be more knowledgeable about such a project, thereby influencing the project manager's motivation to invest in the project. Therefore, project continuation is controlled with a binary variable that indicates whether a project with a similar name existed in the previous year.

Project milestones

The R&D projects were divided into a sequence of phases. Each phase ended at a milestone at which the profit center manager could decide whether to continue the project to the next phase. A profit center manager needed to evaluate the project to make such a continuation decision. It is possible that a project manager might expect the profit center manager and the reviewers to be more knowledgeable about a project, which they had evaluated at previous milestones, thereby influencing the project manager's motivation to invest in the project. The number of milestones that were

passed by a project also reflects the progress of the project's work and may therefore influence the project's actual cost. Therefore, project milestones is included as a control and measured as the number of milestones that have been passed by a project.

Project status problems

The R&D project information sheet had an indicator for communicating if a project had encountered any problems achieving a project's objectives, such as technical, cost, schedule, and other objectives. The status of a project reflects the progress of the project's work and may therefore influence a project's actual cost. Therefore, project status problems was controlled as a binary variable that indicated if a project had encountered any problems in achieving a project's objectives.

Project manager frugality

Previous research on R&D has found that R&D investments are persistent at the firm level and are correlated with R&D investments in the past (Hambrick et al., 1983; Hansen and Hill, 1991; Helfat, 1994b; Mahlich and Roediger-Schluga, 2006). It is possible that R&D investing also is persistent at the individual level of R&D project managers. In particular, it may be that a project manager had a tendency to spend relative to project budget.

A project manager could spend more or less than the budget set for a project by a profit center manager. It may be that certain project managers were more skilled in keeping a project's actual cost to the minimum than others. On the other hand, it is possible that some project managers were under heavier myopic pressure for cost minimization and avoided any actions pertaining to increased costs as much as possible within a project's objectives, whereas some project managers perceived greater benefits than threats from taking actions that increased a project's cost above the minimum. It is also possible that some project managers were able to receive approval for relatively high budgets with a high reserve for contingencies.

The projects that were managed in the past two years were identified for each project manager. For each of these projects, a ratio was calculated as the difference between a project's budget and the project's actual cost, divided by the project's budget. The higher this ratio, the lower the project's actual cost is relative to the project's budget. Project manager frugality is

measured as the average of this ratio in the projects that were managed by a project manager in the past two years.

If a project manager has a tendency to spend more relative to a project's budget, project manager frugality is expected to have negative effect on the project's actual cost. On the other hand, a project's budget was determined by a profit center manager, and project manager frugality can have either a positive or a negative effect on a project's budget. If profit center managers preferred managers who could keep costs to the minimum, project manager frugality is expected to increase a profit center manager's total budget as profit center managers are likely to be more willing to invest if their projects are managed by frugal project managers. However, if profit center managers appreciated more project managers who spent more relative to the budget, perhaps because such project managers could come up better with new ideas of learning investments during projects, project manager frugality has negative effect profit center manager budget.

Reviewer experience

Previous research on various teams has measured a team's experience in work that is related to the current work of a team's members as such experience can influence the current work of the team. Team experience has been measured as the number of days during which team members have worked on similar tasks (Drazin and Rao, 2002), the average tenure of a team's members since graduation (Reagans et al. 2005), the number of similar positions that have been previously held by a team's members (Kor and Misangyi, 2008), and the number of companies at which a team's members had previously worked (Kirsch et al. 2009). Following the past research, the experience of the reviewers as a team is also measured in the study.

The more that reviewers had reviewed R&D projects in the past, the more competent they could be in evaluating a project and the competence of a project manager. A project manager could expect a more reliable competence evaluation if the project reviewers had extensive past review experience. This may have motivated a project manager to increase a project's actual cost. On the other hand, if a project had just one reviewer, and that reviewer was very experienced, the reviewer may have been dominating. This situation may have limited the initiative of a project manager, thereby decreasing a project's actual cost. Because a reviewer's experience could influence a project's actual cost, it is controlled with a variable. Reviewer experience is measured as the number of times that

project reviewers have reviewed R&D projects in the past two years divided by the number of reviewers.

4.4 Models for hypotheses testing

4.4.1 Main models

Each hypothesis of this study addresses investments by two decision makers in an agency dyad: (i) the agent and (ii) the principal. Thus, two types of empirical models are used to test the hypotheses, one for a principal and one for an agent. In this study, profit center managers are regarded as the principals and R&D project managers are regarded as the agents.

An R&D project's budget is used to measure R&D expenditures by profit center managers. Because a profit center manager can invest in several R&D projects per year, the R&D expenditures by a profit center manager can be investigated either at the level of individual projects or through an annual portfolio that includes all of the a profit center manager's R&D projects for a given year. However, even when a profit center manager has several parallel R&D projects, they are typically managed by different project managers and involve different reviewers. Because the hypotheses of this study are focused on studying the principal-agent dyad and data provides variables for each individual R&D project, R&D expenditure by a profit center manager is examined by a model that is based on individual projects rather than on the annual portfolio of all of a profit center manager's projects. The variables that are included in the model for profit center managers are described in Table 4-3.

An R&D project's actual cost is used to measure R&D expenditures by R&D project managers. Again, a project manager can manage several R&D projects per year, but a profit manager's R&D expenditures are examined by a model that is based on individual projects for the same reasons, as in the case of profit center managers. The variables included in the model for profit center managers are described in Table 4-3.

Table 4-3 The main models for hypotheses testing

Model 1: Project actual cost by project manager	Model 2: Project budget by profit center manager

Dependent variable
    Project actual cost
	Dependent variable
	    Project budget

Control variables
    Project year dummy variable
    Project budget
    Continuation project
    Project milestones
    Project status problems
    Project manager frugality
    Reviewer experience
	Control variables
	    Project year dummy variable
	    Project budget in previous year
	    Continuation project
	
	    Project manager frugality
	    Reviewer experience

Independent variables
    Quantity of written ex ante reasoning
    Frequency of revision of written ex ante reasoning
    Number of reviewers
    Reviewers' mutual reviewing tenure
    Reviewers' reviewing tenure with agent
    Reviewers' ties to external reviewers
    Principal's attention
	Independent variables
	    Quantity of written ex ante reasoning
	
	    Number of reviewers
	    Reviewers' mutual reviewing tenure
	    Reviewers' reviewing tenure with agent
	    Reviewers' ties to external reviewers
	    Principal's attention

4.4.2 Modeling the effect of income decrease

The binary income decrease variable is based on annual income and is controlled by the project year variable. Hypotheses H8 proposes moderating the effects that are due to income decrease. To test these effects, a product term with the binary income decrease variable is inserted for each independent variable in the two main models above. If this additional variable is significant, it implies that the effect of the corresponding hypothesized control mechanism differs significantly between income increases and decreases. If this additional variable is not significant, there is no significant difference in the effect of the corresponding hypothesized control mechanism between income increases and decreases.

4.4.3 Modeling the effect of time horizon

Hypotheses H9 proposes the effects that are due a project's time horizon. To test these effects, projects are divided into three separate subsamples that are based on the project-level variable Time horizon. In other words, the effects of the control mechanisms are tested separately for projects with modestly (1-3 years), medium (3-5 years), and very (>5 years) long time horizons. These subsamples are tested for each of the two main models described above. In addition, the full models including all of the subsamples are tested for both the main models.

4.5   Statistical methods

Each R&D project is related to one profit center manager and one project manager. Moreover, each profit center manager and project manager can have several R&D projects per year. The R&D projects that are related to the same profit center manager can be correlated with respect to several variables. Similarly, R&D projects that are managed by the same project manager can also be correlated. Ordinary least squares (OLS) regression with time dummies and cluster-robust standard errors is the statistical method used to test the hypotheses in this study because it can account for possible correlation within profit center managers and project managers (e.g., Petersen, 2009; Arai, 2011).

As discussed above, some of the projects were multiyear projects and the potential correlation between different years of a multiyear project is controlled with the variable Continuation project. In addition to this control variable, annual projects related to the same multiyear project can be clustered. Rather than including a multiyear project as the third clustering dimension, each model was analyzed using two clustering alternatives. First, each model was tested by clustering that was based on profit center managers and multiyear projects. Second, each model was run by clustering based on project managers and multiyear projects. The results for these two clustering alternatives were almost identical to the results from clustering based on profit center managers and project managers only. Thus, the results that were based on the two alternatives, including clustering based on multiyear projects, are not reported.

The OLS regression helps to analyze how the variation of one dependent variable depends on the variation of several dependent variables (Box et al., 1978; Faraway, 2002). In terms of mathematical notation, the OLS regression is based on equations in the form of $y_i = b_0 + b_1 x_{1i} + ... + b_N x_{Ni} + e_i$ where y_i are values observed for the dependent variable, $x_{1i} ... x_{Ni}$ are the values observed for the independent variables, $b_0 .... b_N$ are the regression coefficients to be calculated and e_i is the error term that is represented by the residuals of the model. The equations are solved by finding regression coefficients that minimize the sum of the squared residuals.

The results from the OLS regression provide useful conclusions only if the data complies with a number of assumptions. The most critical assumptions are homoscedasticity and low multicollinearity. The homoscedasticity assumption is met if the variance of error terms is constant for all the values of the independent variables. If this assumption is violated, the errors are heteroscadastic. Several tests such as the Breusch-

Pagan test exist for detecting heteroscedasticity. Heteroscedasticity can be corrected in several ways. In this study, heteroscedasticity is addressed by using cluster-robust standard errors (Petersen, 2009; Arai, 2011). Standard errors are corrected for two dimensions of clustering, profit center managers and project managers.

The assumption of low multicollinearity requires that none of the independent variables have excessive mutual correlation. Multicollinearity can be detected by a high correlation between two independent variables. Typically, correlations below 0.7 are considered to be adequate for a low multicollinearity (e.g., Deutsch et al., 2010), but variance inflation factors (VIF) can also be calculated for each independent variable (O'Brian, 2007). If the VIF values are below 10, the assumption of low multicollinearity is adequately met. If a high multicollinearity is detected, it can be addressed by not including the highly correlated variables in the same model. In addition to homoscedasticity and low multicollinearity, the normality of error terms is sometimes investigated, but normality is not critical for the validity of the OLS regression, especially when the sample size is large enough as it is in this study (e.g., Faraway, 2002).

If the assumptions of the OLS regression are met, it can be used to test the hypotheses between the independent variables and the dependent variable. The hypothesis testing is based on regression coefficients. A standard error can be calculated for each regression coefficient. Standard errors can be further corrected for clustering as discussed above. Corrected standard errors can then be used to estimate the likelihood that each regression coefficient differs from zero. If a regression coefficient has a high enough probability of being different from zero, the coefficient is regarded as significant, and the corresponding dependent variable is interpreted to have a significant effect on the dependent variable. Such significance is regarded as support for the tested hypothesis of the relationship between the independent and the dependent variables. Finally, the statistical significance of the overall OLS model can be tested with an F-test based on F-statistic. The OLS model is considered to be significant if the model F-statistic is below 0.05.

5. Results

5.1   Model 1: Project actual cost

Descriptive statistics, including the means, standard errors, and correlations for the main model, are presented in Table 5-1. The descriptive statistics, including the means, standard errors, and correlations for the subsamples that are based on time horizon are presented in Table 7-1, Table 7-2, and Table 7-3.

As expected, the reviewers' mutual reviewing tenure and its squared term have a high correlation. None of the other correlations of the independent variables exceeds 0.7, and multicollinearity is not expected to become a problem for these variables (e.g., Deutsch et al., 2010). Additionally, the variance inflation factors (VIF) of the independent variables can be examined to detect multicollinearity problems in all the models (O'Brian, 2007). The VIF values are calculated for all the models. Again, the mutual reviewing tenure and its squared term have high VIF values, but none of the others exceed 10, indicating no multicollinearity problems.

The correlations related to the variables that test the effects of income decrease are relatively high; few even exceed 0.7. This finding creates the potential for multicollinearity problems. To address these potential problems, a separate model is tested for the effect of income decrease on each independent variable. This approach also helps to minimize the total number of variables, enabling a better identification of significant effects.

Model 1 is split into 48 different submodels to test the effects of control and independent variables and the effects of time horizon and income decrease. All of the 48 different submodels are defined and summarized in Table 5-2.

R statistical software is used for statistical analysis. First, ordinary least squares linear regression is applied for each model with an R function lm. The Breusch-Pagan test for the heteroscedasticity of residuals of the OLS models suggests that the residuals of most of the models are heteroscedastic, but this was corrected by testing the significance of the coefficients using cluster-robust standard errors. The significance of the

coefficients was tested with cluster-robust standard errors with R function coeftest from library lmtest, as proposed by Arai (2011).

Table 5-3, Table 5-4, Table 5-5, Table 7-4, Table 7-5, Table 7-6, Table 7-7, Table 7-8, Table 7-9, Table 7-10, Table 7-11, and Table 7-12 summarize the results of the regression analysis for all the submodels of Model 1. These tables include the F-statistics of each model, and the statistics suggest that the models are significant. Table 5-6 summarizes the effects that are identified in all the submodels. The results are discussed below, one hypothesis at a time. For each hypothesis, the direct effect is analyzed first, followed by an analysis of the moderating effects.

Table 5-1 Descriptive statistics and correlations: All projects

Descriptive statistics and correlations
Time horizon: All projects

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 R&D project budget (log)	4.57	1.06																								
2 R&D project actual cost (log)	3.96	1.40	0.81																							
3 R&D project budget	165	211	0.78	0.65																						
4 R&D project budget T-1	65.5	162	0.37	0.34	0.48																					
5 Continuation project	0.47	0.50	0.12	0.11	0.08	0.43																				
6 Project milestones	1.77	1.73	-0.05	0.02	-0.05	-0.06	-0.18																			
7 Project status problems	0.44	0.50	0.00	-0.01	0.00	0.03	0.11	0.02																		
8 Agent frugality	-0.15	2.25	-0.04	-0.04	-0.04	0.01	-0.04	0.06	-0.03																	
9 Reviewer experience	8.86	10.6	0.02	-0.06	-0.01	0.06	0.16	-0.23	-0.04	0.00																
10 Quantity of written ex ante reasoning	9.21	1.04	0.24	0.24	0.20	0.21	0.35	-0.59	0.17	-0.07	0.07															
11 Frequency of revision of written ex ante reasoning	5.17	2.94	0.15	0.20	0.14	0.05	0.05	-0.20	0.00	-0.03	-0.14	0.38														
12 Number of reviewers	0.75	0.55	0.13	0.13	0.10	0.12	0.11	-0.24	0.02	-0.02	-0.07	0.29	0.16													
13 Reviewers' mutual reviewing tenure	0.23	0.75	0.05	0.07	0.03	0.10	0.13	-0.18	0.04	-0.02	0.06	0.18	0.03	0.41												
14 Reviewers' mutual reviewing tenure squared	0.62	3.95	0.02	0.04	0.00	0.02	0.03	-0.09	0.00	0.00	0.08	0.06	0.00	0.18	0.86											
15 Reviewers' reviewing tenure with agent	0.83	1.44	-0.01	-0.04	-0.02	0.12	0.22	-0.06	-0.01	0.02	0.51	0.01	-0.11	0.18	0.13	0.08										
16 Reviewers' ties to external reviewers	2.16	4.32	0.14	0.11	0.10	0.11	0.27	-0.36	0.06	-0.06	0.43	0.45	0.08	0.20	0.16	0.10	0.17									
17 Principal's attention	-29.2	26.5	0.50	0.44	0.41	0.17	-0.12	0.23	-0.10	0.03	-0.02	-0.24	-0.04	-0.01	0.02	0.03	0.02	-0.18								
18 Income decrease x Quantity of written ex ante reasoning	4.10	4.45	0.00	-0.02	-0.03	-0.09	-0.19	0.15	-0.22	0.05	0.00	-0.24	-0.01	-0.01	-0.09	-0.02	-0.02	-0.15	0.03							
19 Income decrease x Frequency of revision of written ex ante reasoning	2.31	3.20	0.05	0.07	0.03	-0.07	-0.18	0.01	-0.22	0.04	-0.09	-0.07	0.39	0.07	-0.07	-0.02	-0.10	-0.08	0.03	**0.81**						
20 Income decrease x Number of reviewers	0.34	0.50	0.02	0.00	0.00	-0.05	-0.14	0.01	-0.20	0.04	-0.03	-0.10	0.07	0.39	0.05	0.05	0.04	-0.08	0.00	**0.76**	0.67					
21 Income decrease x Reviewers' mutual reviewing tenure	0.07	0.49	0.01	0.03	0.00	0.00	-0.02	-0.01	-0.06	0.01	0.04	-0.01	0.00	0.17	0.62	**0.71**	0.02	0.04	0.03	0.16	0.13	0.31				
22 Income decrease x Reviewers' mutual reviewing tenure squared	0.24	3.22	0.01	0.03	-0.02	-0.02	-0.04	-0.01	-0.05	0.00	0.05	-0.02	-0.01	0.07	0.56	**0.81**	0.01	0.03	0.03	0.08	0.06	0.14	**0.89**			
23 Income decrease x Reviewers' reviewing tenure with agent	0.37	1.17	-0.08	-0.13	-0.08	0.00	0.05	0.04	-0.07	0.03	0.44	-0.17	-0.14	0.04	-0.02	0.00	**0.71**	-0.07	0.02	0.33	0.16	0.31	0.08	0.04		
24 Income decrease x Reviewers' ties to external reviewers	0.61	2.16	0.06	0.05	0.03	0.00	0.09	-0.17	-0.13	0.02	0.11	0.14	0.11	0.08	0.06	0.07	-0.01	0.40	-0.09	0.35	0.35	0.32	0.18	0.08	0.12	
25 Income decrease x Principal's attention	-12.8	22.0	0.27	0.25	0.23	0.13	0.06	-0.05	0.15	-0.04	0.02	0.12	0.03	-0.02	0.08	0.04	0.01	0.05	0.47	-0.64	-0.50	-0.51	-0.07	-0.01	0.10	-0.32

N=2147

Table 5-2 Summary and definitions of submodels for Model 1

Model	Time horizon	Independent variables	Income decrease effect
Model 1.1.1	All projects	No, controls only	No
Model 1.1.2	All projects	Yes	No
Model 1.1.2.1	All projects	Yes, test for H4b	No
Model 1.1.3.1	All projects	Yes	H1
Model 1.1.3.2	All projects	Yes	H2
Model 1.1.3.3	All projects	Yes	H3
Model 1.1.3.4.1	All projects	Yes	H4
Model 1.1.3.4.2	All projects	Yes, test for H4b	H4
Model 1.1.3.4.2	All projects	Yes, test for H4b	H4
Model 1.1.3.5	All projects	Yes	H5
Model 1.1.3.6	All projects	Yes	H6
Model 1.1.3.7	All projects	Yes	H7
Model 1.2.1	Modestly long time horizon	No, controls only	No
Model 1.2.2	Modestly long time horizon	Yes	No
Model 1.2.2.1	Modestly long time horizon	Yes, test for H4b	No
Model 1.2.3.1	Modestly long time horizon	Yes	H1
Model 1.2.3.2	Modestly long time horizon	Yes	H2
Model 1.2.3.3	Modestly long time horizon	Yes	H3
Model 1.2.3.4.1	Modestly long time horizon	Yes	H4
Model 1.2.3.4.2	Modestly long time horizon	Yes, test for H4b	H4
Model 1.2.3.4.3	Modestly long time horizon	Yes, test for H4b	H4
Model 1.2.3.5	Modestly long time horizon	Yes	H5
Model 1.2.3.6	Modestly long time horizon	Yes	H6
Model 1.2.3.7	Modestly long time horizon	Yes	H7
Model 1.3.1	Medium long time horizon	No, controls only	No
Model 1.3.2	Medium long time horizon	Yes	No
Model 1.3.2.1	Medium long time horizon	Yes, test for H4b	No
Model 1.3.3.1	Medium long time horizon	Yes	H1
Model 1.3.3.2	Medium long time horizon	Yes	H2
Model 1.3.3.3	Medium long time horizon	Yes	H3
Model 1.3.3.4.1	Medium long time horizon	Yes	H4
Model 1.3.3.4.2	Medium long time horizon	Yes, test for H4b	H4
Model 1.3.3.4.3	Medium long time horizon	Yes, test for H4b	H4
Model 1.3.3.5	Medium long time horizon	Yes	H5
Model 1.3.3.6	Medium long time horizon	Yes	H6
Model 1.3.3.7	Medium long time horizon	Yes	H7
Model 1.4.1	Very long time horizon	No, controls only	No
Model 1.4.2	Very long time horizon	Yes	No
Model 1.4.2.1	Very long time horizon	Yes, test for H4b	No
Model 1.4.3.1	Very long time horizon	Yes	H1
Model 1.4.3.2	Very long time horizon	Yes	H2
Model 1.4.3.3	Very long time horizon	Yes	H3
Model 1.4.3.4.1	Very long time horizon	Yes	H4
Model 1.4.3.4.2	Very long time horizon	Yes, test for H4b	H4
Model 1.4.3.4.3	Very long time horizon	Yes, test for H4b	H4
Model 1.4.3.5	Very long time horizon	Yes	H5
Model 1.4.3.6	Very long time horizon	Yes	H6
Model 1.4.3.7	Very long time horizon	Yes	H7

Table 5-3 Regression analysis with a R&D project's actual cost as the dependent variable, All projects, Part 1

Regression analysis							
Time horizon: All R&D projects							
Dependent variable: R&D project actual cost	Model 1.1.1		Model 1.1.2		Model 1.1.2.1	
Control variables							
Project budget	0.0042 ***	(0.0003)	0.0031 ***	(0.0003)	0.0031 ***	(0.0003)
Continuation project	0.1835 **	(0.0578)	0.1799 ***	(0.0522)	0.1805 ***	(0.0523)
Project milestones	0.1662 ***	(0.0284)	0.1199 ***	(0.0270)	0.1199 ***	(0.0270)
Project status problems	-0.0667	(0.0551)	-0.0936 .	(0.0498)	-0.0933 .	(0.0500)
Agent frugality	-0.0107 *	(0.0044)	-0.0110	(0.0070)	-0.0111	(0.0070)
Reviewer experience	-0.0019	(0.0029)	-0.0076 *	(0.0035)	-0.0076 *	(0.0035)
Independent variables							
H1: Quantity of written ex ante reasoning			0.3224 ***	(0.0549)	0.3225 ***	(0.0550)
H2: Frequency of revision of written ex ante reasoning			0.0240 *	(0.0108)	0.0241 *	(0.0108)
H3: Number of reviewers			0.0273	(0.0522)	0.0316	(0.0559)
H4: Reviewers' mutual reviewing tenure			0.0469	(0.0366)	0.0327	(0.0667)
H4: Reviewers' mutual reviewing tenure squared					0.0028	(0.0088)
H5: Reviewers' reviewing tenure with agent			-0.0201	(0.0236)	-0.0200	(0.0235)
H6: Reviewers' ties to external reviewers			0.0251 ***	(0.0070)	0.0250 ***	(0.0070)
H7: Principal's attention			0.0164 ***	(0.0017)	0.0164 ***	(0.0017)
Constant	2.4905 ***	(0.1958)	0.6399	(0.4542)	0.6370	(0.4546)
N	2147		2147		2147	
R2	0.451		0.532		0.532	
Adjusted R2	0.447		0.527		0.527	
F	109.2 ***		104.9 ***		100.5 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 5-4 Regression analysis with R&D project actual cost as the dependent variable, All projects, Part 2

Regression analysis						
Time horizon: All R&D projects						
Dependent variable: R&D project actual cost	Model 1.1.3.1		Model 1.1.3.2		Model 1.1.3.3	
Control variables						
Project budget	0.0031 ***	(0.0003)	0.0031 ***	(0.0003)	0.0031 ***	(0.0003)
Continuation project	0.1854 ***	(0.0514)	0.1819 ***	(0.0523)	0.1793 ***	(0.0520)
Project milestones	0.1141 ***	(0.0262)	0.1192 ***	(0.0269)	0.1200 ***	(0.0270)
Project status problems	-0.0888 .	(0.0492)	-0.0942 .	(0.0498)	-0.0931 .	(0.0499)
Agent frugality	-0.0112	(0.0071)	-0.0118 .	(0.0071)	-0.0108	(0.0071)
Reviewer experience	-0.0068 .	(0.0035)	-0.0076 *	(0.0035)	-0.0073 *	(0.0036)
Independent variables						
H1: Quantity of written ex ante reasoning	0.2336 ***	(0.0636)	0.3228 ***	(0.0548)	0.3235 ***	(0.0550)
H2: Frequency of revision of written ex ante reasoning	0.0251 *	(0.0107)	0.0163	(0.0134)	0.0236 *	(0.0108)
H3: Number of reviewers	0.0279	(0.0527)	0.0283	(0.0522)	0.0566	(0.0552)
H4: Reviewers' mutual reviewing tenure	0.0438	(0.0370)	0.0494	(0.0368)	0.0463	(0.0361)
H4: Reviewers' mutual reviewing tenure squared						
H5: Reviewers' reviewing tenure with agent	-0.0211	(0.0235)	-0.0206	(0.0236)	-0.0201	(0.0236)
H6: Reviewers' ties to external reviewers	0.0261 ***	(0.0070)	0.0255 ***	(0.0069)	0.0250 ***	(0.0069)
H7: Principal's attention	0.0163 ***	(0.0017)	0.0164 ***	(0.0016)	0.0163 ***	(0.0017)
H8: Income decrease x Quantity of written ex ante reasoning	0.2345 *	(0.0928)				
H8: Income decrease x Frequency of revision of written ex ante reasoning			0.0214	(0.0207)		
H8: Income decrease x Number of reviewers					-0.0750	(0.0996)
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent						
H8: Income decrease x Reviewers' ties to external reviewers						
H8: Income decrease x Principal's attention						
Constant	-0.5955	(0.6499)	0.6036	(0.4530)	0.6470	(0.4551)
N	2147		2147		2147	
R2	0.534		0.532		0.532	
Adjusted R2	0.529		0.527		0.527	
F	101.3 ***		100.6 ***		100.6 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 5-5 Regression analysis with R&D project actual cost as the dependent variable, All projects, Part 3

Regression analysis

Time horizon: All R&D projects

Dependent variable: R&D project actual cost

	Model 1.1.3.4.1	Model 1.1.3.4.2	Model 1.1.3.4.3	Model 1.1.3.5	Model 1.1.3.6	Model 1.1.3.7
Control variables						
Project budget	0.0031 *** (0.0003)	0.0031 *** (0.0003)	0.0031 *** (0.0003)	0.0031 *** (0.0003)	0.0031 *** (0.0003)	0.0031 *** (0.0003)
Continuation project	0.1798 *** (0.0521)	0.1810 *** (0.0522)	0.1812 *** (0.0522)	0.1716 *** (0.0519)	0.1831 *** (0.0524)	0.1881 *** (0.0523)
Project milestones	0.1212 *** (0.0268)	0.1213 *** (0.0268)	0.1209 *** (0.0268)	0.1174 *** (0.0270)	0.1201 *** (0.0270)	0.1176 *** (0.0269)
Project status problems	-0.0940 . (0.0497)	-0.0933 . (0.0499)	-0.0928 . (0.0499)	-0.0945 . (0.0501)	-0.0913 . (0.0499)	-0.0929 . (0.0497)
Agent frugality	-0.0110 (0.0070)	-0.0111 (0.0070)	-0.0110 (0.0070)	-0.0110 (0.0069)	-0.0114 (0.0069)	-0.0093 (0.0070)
Reviewer experience	-0.0073 * (0.0035)	-0.0074 * (0.0035)	-0.0074 * (0.0035)	-0.0066 (0.0035)	-0.0070 . (0.0036)	-0.0069 * (0.0035)
Independent variables						
H1: Quantity of written ex ante reasoning	0.3245 *** (0.0550)	0.3249 *** (0.0552)	0.3253 *** (0.0552)	0.3204 *** (0.0544)	0.3250 *** (0.0551)	0.3271 *** (0.0551)
H2: Frequency of revision of written ex ante reasoning	0.0232 * (0.0109)	0.0232 * (0.0109)	0.0233 * (0.0109)	0.0247 * (0.0109)	0.0246 * (0.0107)	0.0234 * (0.0107)
H3: Number of reviewers	0.0248 (0.0528)	0.0337 (0.0554)	0.0303 (0.0569)	0.0342 (0.0520)	0.0251 (0.0520)	0.0164 (0.0531)
H4: Reviewers' mutual reviewing tenure	0.0772 . (0.0452)	0.0501 (0.0662)	0.0746 (0.0820)	0.0401 (0.0360)	0.0438 (0.0373)	0.0497 (0.0364)
H4: Reviewers' mutual reviewing tenure squared		0.0059 (0.0098)	-0.0024 (0.0209)			
H5: Reviewers' reviewing tenure with agent	-0.0217 (0.0237)	-0.0217 (0.0237)	-0.0215 (0.0237)	0.0181 (0.0283)	-0.0220 (0.0236)	-0.0212 (0.0230)
H6: Reviewers' ties to external reviewers	0.0254 *** (0.0070)	0.0252 *** (0.0070)	0.0254 *** (0.0070)	0.0234 *** (0.0070)	0.0200 * (0.0078)	0.0239 *** (0.0069)
H7: Principal's attention	0.0164 *** (0.0017)	0.0164 *** (0.0017)	0.0164 *** (0.0017)	0.0164 *** (0.0017)	0.0164 *** (0.0017)	0.0188 *** (0.0021)
H8: Income decrease x Quantity of written ex ante reasoning	-0.0657 (0.0629)	-0.0726 (0.0643)	-0.0905 (0.0704)			
H8: Income decrease x Frequency of revision of written ex ante reasoning			0.0089 (0.0156)			
H8: Income decrease x Number of reviewers						
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent				-0.0745 . (0.0395)		
H8: Income decrease x Reviewers' ties to external reviewers					0.0181 (0.0139)	
H8: Income decrease x Principal's attention						-0.0058 * (0.0027)
Constant	0.6218 (0.4550)	0.6135 (0.4567)	0.6130 (0.4564)	0.7041 (0.4536)	0.6084 (0.4569)	0.4912 (0.4569)
N	2147	2147	2147	2147	2147	2147
R2	0.532	0.532	0.532	0.533	0.532	0.534
Adjusted R2	0.527	0.527	0.527	0.528	0.527	0.529
F	100.6 ***	96.56 ***	92.84 ***	101.0 ***	100.7 ***	101.4 ***

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 5-6 Summary of regression results with R&D project actual cost as the dependent variable

Dependent variable: R&D project actual cost	All projects	Time horizon		
		Modestly long	Medium long	Very long
H1: Quantity of written ex ante reasoning	+	+	+	+
Income decrease if different	++	0	0	++
H2: Frequency of revision of written ex ante reasoning	+	+	0	0
Income decrease if different	0	0	0	+
H3: Number of reviewers	0	0	0	+
Income decrease if different	0	0	0	0
H4: Reviewers' mutual reviewing tenure	+	0	0	+
Income decrease if different	0	0	U	0
H5: Reviewers' reviewing tenure with agent	0	0	0	-
Income decrease if different	-	-	0	0
H6: Reviewers' ties to external reviewers	+	0	+	0
Income decrease if different	0	0	0	+
H7: Principal's attention	+	+	+	+
Income decrease if different	+ -	+ -	0	0

Effects: Additional effects for income decrease

0 = Not significant   ++ = More positive than income increase

+ = Positive   + - = Positive but less positive that income increase

- = Negative

U = U-curved

5.1.1 Quantity of written ex ante reasoning

The results from Model 1.1.2 support hypothesis H1 that the quantity of written ex ante reasoning has a positive and significant effect (β=.3224, p<.001) on a R&D project's actual cost. Model 1.1.3.1 further supports hypothesis H8 that this effect increases when income decreases (β=.2345, p<.05).

The effect of time horizon predicted by hypothesis H9 is analyzed with models 1.2.2, 1.2.3.1, 1.3.2, 1.3.3.1, 1.4.2.1, and 1.4.3.1. This analysis suggests that the positive effect is increased by income decrease only for projects with very long time horizons (β=.3836, p<.05) but not for projects with modestly or medium long time horizons. This finding supports hypothesis H9 that the effect predicted by hypothesis H8 increases as the time horizon increases.

In summary, the results provide support for the direct effect predicted by hypothesis H1. In addition, the moderating effect of income decrease as predicted by hypothesis H8 is supported. Finally, the moderating effect of time horizon as predicted by hypothesis H9 is also supported.

5.1.2 Frequency of revision of written ex ante reasoning

The results from Model 1.1.2 support hypothesis H2 that the frequency of ex ante reasoning has positive and significant effect (β=.0240, p<.05) on an R&D project actual cost.

The analysis of the effect of time horizon by models 1.2.2, 1.2.3.2, 1.3.2, 1.3.3.2, 1.4.2.1, and 1.4.3.2 provides additional insight into the effect of the frequency of revision of written ex ante reasoning. Projects with modestly long time horizons actually have positive effect (β=.0364, p<.05) from the frequency of revision of written ex ante reasoning regardless of income change. Projects with very long time horizons have positive effect (β=.0703, p<.10), but only when income decreases. This finding is according to hypothesis H8. Projects with medium long time horizons have no significant effect at all.

The findings suggest that the effect of time horizon is more complex than predicted by hypothesis H9. Contrary to hypothesis H9, projects with modestly long time horizons can benefit most from frequent updates to written reasoning. A potential reason is that these projects are closest to market launch, and profit center managers are likely to pay attention to these projects more often to ensure a smooth launch to market. These projects are likely to be under constant attention by a profit center manager

with not much room for increased attention to the frequency if income decreases. On the other hand, projects with very long time horizons are not as critical for immediate income, and project managers feel no significant gain from more frequent revisions of written ex ante reasoning when income increases. However, when income decreases, these projects are most sensitive to myopia, and project managers feel they can benefit by increasing the frequency of revisions of written ex ante reasoning by profit center managers. This behavior is in accordance with the predictions of hypotheses H8 and H9. It is also similar to how project managers react to income decrease by also increasing the quantity of ex ante reasoning for projects with very long time horizons.

In summary, the results provide support for the direct effects that were predicted by hypothesis H2. In addition, the moderating effect of income decrease predicted by hypothesis H8 is supported. Finally, the moderating effect of time horizon as predicted by hypothesis H9 is partially supported, but the effect is more complex than predicted.

5.1.3 Number of reviewers

Model 1.1.2 has no significant effect for the number of reviewers. Model 1.1.3.3 on the effect of income decrease provides the same result of no significance. The analysis of the effect of time horizon by models 1.2.2, 1.2.3.3, 1.3.2, 1.3.3.3, 1.4.2.1, and 1.4.3.3 provides additional insight into the effect of the number of reviewers. The analysis of model 1.4.2.1 suggests that the effect of the number of reviewers is significant for projects with very long time horizons (β=.1790, p<.10). This finding supports hypothesis H3 that predicts such a positive effect. On the other hand, the effect is not significant for projects with modestly or medium long time horizons. It seems that the effect of the number of reviewers is somewhat weak as it has no significant effect when the time horizon is medium, long or shorter. However, the findings support hypothesis H9, which predicts that the positive effect of the number of reviewers is stronger for projects with longer time horizons.

In summary, the results provide support for the effect predicted by hypothesis H3. The moderating effect of income decrease predicted by hypothesis H8 is not supported. Finally, the moderating effect of time horizon predicted by hypothesis H9 is supported.

5.1.4 Reviewers' mutual reviewing tenure

The results from models 1.1.2 and 1.1.2.1 do not show any significant effect for reviewers' mutual reviewing tenure. However, adding the effect for income decrease in model 1.1.3.4.1 makes the effect significant. Thus, reviewers' mutual reviewing tenure has a positive and significant effect (β=.0772, p<.10) on an R&D project actual cost. The effect of income decrease is insignificant.

The analysis of the effect of time horizon by models 1.2.2, 1.2.2.1, 1.2.3.4.1, 1.2.3.4.2, 1.2.3.4.3, 1.3.2, 1.3.2.1, 1.3.3.4.1, 1.3.3.4.2, 1.3.3.4.3, 1.4.2, 1.4.2.1, 1.4.3.4.1, 1.4.3.4.2, and 1.4.3.4.3 provides additional insight into the effect of reviewers' mutual reviewing tenure. The effect is not significant in any of the models 1.2.2, 1.2.2.1, 1.2.3.4.1, 1.2.3.4.2, and 1.2.3.4.3 analyzing projects with modestly long time horizons. Models 1.3.2 shows that the effect is positive and significant (β=.1143, p<.10) for projects with medium time horizons. In model 1.4.2.1, the direct effect is not significant, but the squared term is positive and significant (β=.0249, p<.10). Thus, reviewers' mutual reviewing tenure also has a positive effect for projects with very long time horizons. The results support hypothesis H4a, which predicts that reviewers' mutual reviewing tenure increases an R&D project actual cost. Moreover, the effect is only significant for projects with medium and very long time horizons, supporting hypothesis H9, which predicts that the effect of reviewers' mutual reviewing tenure increases as time horizon increases.

The results from model 1.3.3.4.3 show that the effect of reviewers' mutual reviewing tenure is U-curved for projects with medium time horizons when income decreases. In other words, the effect is first negative, but it turns into a positive effect when reviewers' mutual reviewing tenure becomes high enough. This finding is somewhat peculiar because it is not linear on the time horizon as projects with modestly or very long time horizons do not have similar effects. It remains an open question as to how the time horizon influences the effect of the reviewers' ties to external reviewers when income decreases. The effect for an R&D project budget is somewhat similar but more consistent, as discussed below.

In summary, the results provide support for the direct effect predicted by hypothesis H4a. The alternative hypothesis H4b is not supported. The moderating effect of income decrease as predicted by hypothesis H8 is not supported. Finally, the moderating effect of time horizon predicted by hypothesis H9 is supported.

5.1.5 Reviewers' reviewing tenure with agent

Model 1.1.2 has no significant effect for the reviewers' reviewing tenure with an agent. Model 1.1.3.5 shows that the effect of the reviewers' reviewing tenure with an agent is negative (β=-.0745, p<.10) when income decreases. The analysis of the effect of time horizon by models 1.2.2, 1.2.3.5, 1.3.2, 1.3.3.5, 1.4.2.1, and 1.4.3.5 provides additional insight into the effect of reviewers' reviewing tenure with an agent. The effect is negative for projects with very long time horizons (β=-.0890, p<.10). The effect is significant and negative for projects with modestly long time horizons (β=-.0900, p<.10) but only when income decreases. The results support hypothesis H5b, which predicts that the effect of reviewers' reviewing tenure with an agent is negative. If reviewers have reviewed a project manager extensively in the past, the profit center manager is likely to suspect that the reviewers have a deeper social tie with the project manager and may be too positively biased for the project manager.

However, the negative effect of reviewers' reviewing tenure with agent is limited to projects with very long time horizons or situations in which income decreases. When income is not decreasing, the effect is not significant for projects with modestly or medium long time horizons. This finding seems possible because profit center managers are expected to be less familiar with knowledge related to projects with very long time horizons as such projects tend to rely most on novel knowledge. On the other hand, projects with shorter time horizons involve knowledge that is likely to be more familiar to profit center managers. As a result, profit center managers can better evaluate potential bias by reviewers and are less concerned about potential bias. Therefore, reviewers' reviewing tenure with agent does not decrease investments by project managers when project time horizon is not very long and income is not decreasing. Hypothesis H9 predicts that the positive effect from reviewers' reviewing tenure with agent increases as time horizon increases but the findings suggest that, on the contrary, it is the negative effect that increases.

The results also show than when income decreases, the effect of reviewers' reviewing tenure with agent becomes negative, regardless of time horizon. A possible explanation for this finding seems to be that as income decreases, profit center managers start to question a project's reasoning more critically and intensively. The potential bias due to reviewers who are familiar with project managers becomes more of a concern under such pressure when income decreases. Hypothesis H8 predicts that the positive effect from reviewers' reviewing tenure with agent increases as income

decreases, but the findings suggest that, on the contrary, it is the negative effect that increases.

In summary, the results provide support for the direct effect predicted by hypothesis H5b. The alternative hypothesis H5a is not supported. Support for the moderating effect of income decrease is found, but the effect is contrary to the prediction by hypothesis H8. Finally, support for the moderating effect of time horizon is found, but the effect is also contrary to the prediction by hypothesis H9.

5.1.6   Reviewers' ties to external reviewers

The results from Model 1.1.2 support hypothesis H6 that the reviewers' ties to external reviewers have a positive and significant effect (β=.0251, p<.001) on an R&D project actual cost.

The analysis of the effect of time horizon 1.2.2, 1.2.3.6, 1.3.2, 1.3.3.6, 1.4.2.1, and 1.4.3.6 provides additional insight into the effect of the reviewers' ties to external reviewers. The analysis suggests that the effect is significant only for projects with medium (β=.0370, p<.01) and very (β=.0300, p<.05) long time horizons to income but not for projects with modestly long time horizons. This supports hypothesis H9, which proposes that the effect of reviewers' ties to external reviewers is increased by increasing time horizon. The analysis on the period of time that is required to produce income also suggests that reviewers' ties to external reviewers have effect for projects with very long time horizons only when income decreases (β=.0650, p<.05) but not when income increases. Such increasing effect from income decrease supports hypothesis H8 and the related hypothesis H9.

In summary, the results provide support for the direct effect predicted by hypothesis H6. In addition, the moderating effect of income decrease predicted by hypothesis H8 is supported. Finally, the moderating effect of time horizons predicted by hypothesis H9 is also supported.

5.1.7   Principal's attention

The results from Model 1.1.2 support hypothesis H7 that the principal's attention has positive and significant effect (β=.0164, p<.001) on an R&D project actual cost. On the other hand, results from model 1.1.3.7 differ somewhat from hypothesis H8 because the effect of principal's attention does not increase but is less positive (β=.0188-.0058, p<.05) when income decreases.

The analysis of the effect of time horizon by models 1.2.2, 1.2.3.7, 1.3.2, 1.3.3.7, 1.4.2.1, and 1.4.3.7 provides additional insight into the effect of principal's attention when income decreases. The effect of principal's attention becomes less positive only for projects with modestly long time horizons (β=.0172-.0055, p<.10) but not for projects with medium (β=.0152, p<.001) or very (β=.0220, p<.001) long time horizons. This finding supports hypothesis H9 that predicts that principal's attention can better limit managerial myopia for projects with longer time horizons. Profit center managers and managers higher in the hierarchy are likely to be more familiar with projects with modestly long time horizons because these projects focus on more established knowledge than other projects. Thus, principal's attention increases understanding by these managers relatively less than for projects with longer time horizons. As the benefit from principal's attention is lower for projects with modestly long time horizons, it does not provide as strong support against myopia for these projects when income decreases.

In summary, the results provide support for the direct effect predicted by hypothesis H7. Support for the moderating effect of income decrease is found but the effect is contrary to prediction by hypothesis H8. Finally, the moderating effect of time horizon predicted by hypothesis H9 is supported.

5.2 Model 2: Project budget

Descriptive statistics including means, standard errors, and correlations for the main model are presented in Table 5-1. Descriptive statistics including means, standard errors, and correlations for subsamples based on time horizon are presented in Table 7-1, Table 7-2, and Table 7-3.

As expected, reviewers' mutual reviewing tenure and its squared term have a high correlation. None of the other correlations of the independent variables exceeds 0.7 and multicollinearity is not expected to become a problem for these variables (e.g., Deutsch et al., 2010). Also variance inflation factors (VIF) of the independent variables can be examined to detect multicollinearity problems in all the models (O'Brian, 2007). VIF values are calculated for all the following models. Again, mutual reviewing tenure and its squared term have high VIF values but none of the others exceed 10, indicating no multicollinearity problems.

Correlations related to variables testing the effects of income decrease are relatively high, few even exceed 0.7. This creates potential for multicollinearity problems. To address potential problems, a separate model is tested for the effect of income decrease on each independent variable. This approach also helps minimize the total number of variables, enabling better identification of significant effects.

Model 2 is split into 44 different submodels to test effects of control and independent variables and effects of time horizon and income decrease. All the 44 different submodels are defined and summarized in Table 5-7.

R statistical software is used for statistical analysis. First, ordinary least squares linear regression is applied for each model with R function lm. Breusch-Pagan test for the heteroscedasticity of residuals of OLS models suggests that the residuals of the most models are heteroscedastic but this is corrected by testing the significance of the coefficients using cluster-robust standard errors. The significance of coefficients is tested with cluster-robust standard errors with R function coeftest from library lmtest as proposed by Arai (2011).

Table 5-8, Table 5-9, Table 5-10, Table 7-13, Table 7-14, Table 7-15, Table 7-16, Table 7-17, Table 7-18, Table 7-19, Table 7-20, and Table 7-21 summarize the results of regression analysis for all the submodels of Model 2. These tables include F-statistics of each model and the statistics suggest that the models are significant. Table 5-11 summarizes the effects identified in all the submodels. The results are discussed next one hypothesis at a time. For each hypothesis, the direct effect is analyzed first, followed by an analysis of moderating effects.

Table 5-7 Summary and definitions of submodels for Model 2

Model	Time horizon	Independent variables	Income decrease effect
Model 2.1.1	All projects	No, controls only	No
Model 2.1.2	All projects	Yes	No
Model 2.1.2.1	All projects	Yes, test for H4b	No
Model 2.1.3.1	All projects	Yes	H1
Model 2.1.3.3	All projects	Yes	H3
Model 2.1.3.4.1	All projects	Yes	H4
Model 2.1.3.4.2	All projects	Yes, test for H4b	H4
Model 2.1.3.4.2	All projects	Yes, test for H4b	H4
Model 2.1.3.5	All projects	Yes	H5
Model 2.1.3.6	All projects	Yes	H6
Model 2.1.3.7	All projects	Yes	H7
Model 2.2.1	Modestly long time horizon	No, controls only	No
Model 2.2.2	Modestly long time horizon	Yes	No
Model 2.2.2.1	Modestly long time horizon	Yes, test for H4b	No
Model 2.2.3.1	Modestly long time horizon	Yes	H1
Model 2.2.3.3	Modestly long time horizon	Yes	H3
Model 2.2.3.4.1	Modestly long time horizon	Yes	H4
Model 2.2.3.4.2	Modestly long time horizon	Yes, test for H4b	H4
Model 2.2.3.4.3	Modestly long time horizon	Yes, test for H4b	H4
Model 2.2.3.5	Modestly long time horizon	Yes	H5
Model 2.2.3.6	Modestly long time horizon	Yes	H6
Model 2.2.3.7	Modestly long time horizon	Yes	H7
Model 2.3.1	Medium long time horizon	No, controls only	No
Model 2.3.2	Medium long time horizon	Yes	No
Model 2.3.2.1	Medium long time horizon	Yes, test for H4b	No
Model 2.3.3.1	Medium long time horizon	Yes	H1
Model 2.3.3.3	Medium long time horizon	Yes	H3
Model 2.3.3.4.1	Medium long time horizon	Yes	H4
Model 2.3.3.4.2	Medium long time horizon	Yes, test for H4b	H4
Model 2.3.3.4.3	Medium long time horizon	Yes, test for H4b	H4
Model 2.3.3.5	Medium long time horizon	Yes	H5
Model 2.3.3.6	Medium long time horizon	Yes	H6
Model 2.3.3.7	Medium long time horizon	Yes	H7
Model 2.4.1	Very long time horizon	No, controls only	No
Model 2.4.2	Very long time horizon	Yes	No
Model 2.4.2.1	Very long time horizon	Yes, test for H4b	No
Model 2.4.3.1	Very long time horizon	Yes	H1
Model 2.4.3.3	Very long time horizon	Yes	H3
Model 2.4.3.4.1	Very long time horizon	Yes	H4
Model 2.4.3.4.2	Very long time horizon	Yes, test for H4b	H4
Model 2.4.3.4.3	Very long time horizon	Yes, test for H4b	H4
Model 2.4.3.5	Very long time horizon	Yes	H5
Model 2.4.3.6	Very long time horizon	Yes	H6
Model 2.4.3.7	Very long time horizon	Yes	H7

Table 5-8 Regression analysis with R&D project budget as the dependent variable, All projects, Part 1

Regression analysis						
Time horizon: All R&D projects						
Dependent variable: R&D project budget	**Model 2.1.1**		**Model 2.1.2**		**Model 2.1.2.1**	
Control variables						
Project budget	0.0026 ***	(0.0002)	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)
Continuation project	-0.1634 *	(0.0734)	0.0122	(0.0631)	0.0145	(0.0632)
Agent frugality	-0.0210	(0.0142)	-0.0159 ***	(0.0041)	-0.0161 ***	(0.0040)
Reviewer experience	-0.0004	(0.0030)	-0.0050	(0.0033)	-0.0051	(0.0033)
Independent variables						
H1: Quantity of written ex ante reasoning			0.3127 ***	(0.0445)	0.3133 ***	(0.0445)
H3: Number of reviewers			0.0503	(0.0579)	0.0729	(0.0601)
H4: Reviewers' mutual reviewing tenure			-0.0662 .	(0.0365)	-0.1407 *	(0.0674)
H4: Reviewers' mutual reviewing tenure squared					0.0147 .	(0.0084)
H5: Reviewers' reviewing tenure with agent			-0.0382 .	(0.0221)	-0.0379 .	(0.0220)
H6: Reviewers' ties to external reviewers			0.0358 ***	(0.0073)	0.0354 ***	(0.0074)
H7: Principal's attention			0.0240 ***	(0.0014)	0.0239 ***	(0.0014)
Constant	4.4130 ***	(0.1669)	2.6319 ***	(0.4082)	2.6165 ***	(0.4068)
N	2147		2147		2147	
R2	0.165		0.476		0.477	
Adjusted R2	0.159		0.471		0.472	
F	30.08 ***		96.59 ***		92.18 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

147

Table 5-9 Regression analysis with R&D project budget as the dependent variable, All projects, Part 2

Regression analysis
Time horizon: All R&D projects

Dependent variable : R&D project budget	Model 2.1.3.1		Model 2.1.3.3		Model 2.1.3.4.1		Model 2.1.3.4.2		Model 2.1.3.4.3	
Control variables										
Project budget	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)
Continuation project	0.0146	(0.0631)	0.0131	(0.0634)	0.0123	(0.0629)	0.0141	(0.0631)	0.0132	(0.0628)
Agent frugality	-0.0161 ***	(0.0040)	-0.0161 ***	(0.0040)	-0.0159 ***	(0.0041)	-0.0161 ***	(0.0040)	-0.0159 ***	(0.0041)
Reviewer experience	-0.0050	(0.0033)	-0.0048	(0.0034)	-0.0050	(0.0034)	-0.0050	(0.0034)	-0.0049	(0.0034)
Independent variables										
H1: Quantity of written ex ante reasoning	0.3035 ***	(0.0626)	0.3133 ***	(0.0444)	0.3127 ***	(0.0445)	0.3134 ***	(0.0445)	0.3128 ***	(0.0444)
H3: Number of reviewers	0.0736	(0.0607)	0.0974	(0.0720)	0.0504	(0.0565)	0.0742	(0.0604)	0.0642	(0.0604)
H4: Reviewers' mutual reviewing tenure	-0.1409 *	(0.0676)	-0.1466 *	(0.0662)	-0.0663	(0.0444)	-0.1390 *	(0.0672)	-0.0508	(0.0885)
H4: Reviewers' mutual reviewing tenure squared	0.0147 .	(0.0085)	0.0155 .	(0.0082)			0.0178 .	(0.0101)	-0.0055	(0.0191)
H5: Reviewers' reviewing tenure with agent	-0.0380 .	(0.0220)	-0.0381 .	(0.0221)	-0.0382 .	(0.0223)	-0.0385 .	(0.0222)	-0.0384 .	(0.0223)
H6: Reviewers' ties to external reviewers	0.0354 ***	(0.0074)	0.0347 ***	(0.0074)	0.0358 ***	(0.0073)	0.0352 ***	(0.0074)	0.0351 ***	(0.0074)
H7: Principal's attention	0.0239 ***	(0.0014)	0.0239 ***	(0.0014)	0.0240 ***	(0.0014)	0.0239 ***	(0.0014)	0.0239 ***	(0.0014)
H8: Income decrease x Quantity of written ex ante reasoning	0.0224	(0.0823)								
H8: Income decrease x Number of reviewers			-0.0633	(0.1004)						
H8: Income decrease x Reviewers' mutual reviewing tenure					0.0003	(0.0649)				
H8: Income decrease x Reviewers' mutual reviewing tenure squared										
H8: Income decrease x Reviewers' reviewing tenure with agent							-0.0388	(0.0659)		
H8: Income decrease x Reviewers' ties to external reviewers									-0.2004	(0.1223)
H8: Income decrease x Principal's attention									0.0356 .	(0.0206)
Constant	2.5087 ***	(0.4916)	2.6299 ***	(0.4122)	2.6319 ***	(0.4081)	2.6156 ***	(0.4068)	2.6258 ***	(0.4067)
N	2147		2147		2147		2147		2147	
R2	0.477		0.477		0.476		0.477		0.478	
Adjusted R2	0.471		0.471		0.471		0.471		0.472	
F	87.96 ***		88.02 ***		91.94 ***		88.00 ***		84.40 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 5-10 Regression analysis with R&D project budget as the dependent variable, All projects, Part 3

Regression analysis

Time horizon: All R&D projects

Dependent variable: R&D project budget	Model 2.1.3.5		Model 2.1.3.6		Model 2.1.3.7	
Control variables						
Project budget	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)	0.0014 ***	(0.0002)
Continuation project	0.0146	(0.0636)	0.0164	(0.0636)	0.0150	(0.0628)
Agent frugality	-0.0164 ***	(0.0041)	-0.0158 ***	(0.0039)	-0.0161 ***	(0.0040)
Reviewer experience	-0.0040	(0.0036)	-0.0052	(0.0033)	-0.0050	(0.0033)
Independent variables						
H1: Quantity of written ex ante reasoning	0.3122 ***	(0.0444)	0.3133 ***	(0.0445)	0.3131 ***	(0.0446)
H3: Number of reviewers	0.0765	(0.0603)	0.0692	(0.0596)	0.0718	(0.0601)
H4: Reviewers' mutual reviewing tenure	-0.1507 *	(0.0685)	-0.1418 *	(0.0672)	-0.1403 *	(0.0674)
H4: Reviewers' mutual reviewing tenure squared	0.0157 .	(0.0085)	0.0152 .	(0.0084)	0.0147 .	(0.0084)
H5: Reviewers' reviewing tenure with agent	-0.0076	(0.0282)	-0.0384 .	(0.0221)	-0.0381 .	(0.0219)
H6: Reviewers' ties to external reviewers	0.0325 ***	(0.0075)	0.0382 ***	(0.0082)	0.0355 ***	(0.0074)
H7: Principal's attention	0.0239 ***	(0.0014)	0.0240 ***	(0.0014)	0.0243 ***	(0.0023)
H8: Income decrease x Quantity of written ex ante reasoning	-0.0556	(0.0393)				
H8: Income decrease x Number of reviewers			-0.0143	(0.0130)		
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent						
H8: Income decrease x Reviewers' ties to external reviewers						
H8: Income decrease x Principal's attention					-0.0007	(0.0027)
Constant	2.6434 ***	(0.4078)	2.6216 ***	(0.4069)	2.6061 ***	(0.4054)
N	2147		2147		2147	
R2	0.478		0.477		0.477	
Adjusted R2	0.472		0.472		0.471	
F	88.36 ***		88.08 ***		87.97 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 5-11 Summary of regression results with R&D project budget as the dependent variable

Dependent variable:	All projects	Time horizon		
R&D project budget		Modestly long	Medium long	Very long
H1: Quantity of written ex ante reasoning	+	+	+	+
Income decrease if different	0	0	0	0
H2: Frequency of revision of written ex ante reasoning				
Income decrease if different				
H3: Number of reviewers	0	0	0	0
Income decrease if different	0	0	0	0
H4: Reviewers' mutual reviewing tenure	U	0	0	0
Income decrease if different	+	U	+	U
H5: Reviewers' reviewing tenure with agent	-	0	0	-
Income decrease if different	0	0	0	0
H6: Reviewers' ties to external reviewers	+	+	+	+
Income decrease if different	0	+ -	0	0
H7: Principal's attention	+	+	+	+
Income decrease if different	0	0	0	0

Effects: Additional effects for income decrease

0 = Not significant   ++ = More positive than income increase

+ = Positive   + - = Positive but less positive that income increase

- = Negative

U = U-curved

5.2.1 Quantity of written ex ante reasoning

The results from Model 2.1.2.1 show that, as predicted by hypothesis H1, the quantity of ex ante reasoning has a positive and significant effect (β=.3133, p<.001) on an R&D project budget. The analysis of the effect of time horizon by models 2.2.2, 2.2.3.1, 2.3.2, 2.3.3.1, 2.4.2.1, and 2.4.3.1 provides little additional insight into the effect of the quantity of ex ante reasoning. The effect is positive for projects with all different types of time horizons and no support is found for hypothesis H9 that predicts that the quantity of ex ante reasoning has larger effect for projects with longer time horizons. The effect of income decrease is not significant in any model. Thus, no support is found for hypothesis H8 that proposes that the quantity of ex ante reasoning has larger effect when income decreases.

In summary, the results provide support for the effect predicted by hypothesis H1. No support is found for the moderating effects predicted by hypotheses H8 and H9.

5.2.2 Frequency of revision of written ex ante reasoning

This control mechanism is not studied for an R&D project budget decisions since it is used only after project budget is approved.

5.2.3 Number of reviewers

Model 2.1.2.1 has no significant effect for the number of reviewers. Model 2.1.3.3 on the effect of income decrease provides the same result of no significance. Also the analysis of the effect of time horizon by models 2.2.2, 2.2.3.3, 2.3.2, 2.3.3.3, 2.4.2.1, and 2.4.3.3 shows no significant effects. Thus, hypothesis H3 is not supported.

The analyses below show that other reviewer characteristics have significant effects on a profit center manager's R&D project actual cost. A possible explanation for the insignificance of the number of reviewers is that profit center managers pay more attention to the qualitative characteristics of reviewers rather than just the pure number of reviewers as such.

In summary, the results do not provide support for the direct effect predicted by hypothesis H3. Further, no support is found for the moderating effects predicted by hypotheses H8 and H9.

5.2.4   Reviewers' mutual reviewing tenure

The results from Model 2.1.2.1 show that reviewers' mutual reviewing tenure has a U-curved effect on an R&D project budget. However, model 2.1.3.4.3 shows that the effect disappears when the effect of income decrease is included. In model 2.1.3.4.3, only the squared term is positive and significant (β=.0356, p<.10) and only when income decreases.

The analysis of the effect of time horizon by models 2.2.2, 2.2.2.1, 2.2.3.4.1, 2.2.3.4.2, 2.2.3.4.3, 2.3.2, 2.3.2.1, 2.3.3.4.1, 2.3.3.4.2, 2.3.3.4.3, 2.4.2, 2.4.2.1, 2.4.3.4.1, 2.4.3.4.2, and 2.4.3.4.3 provides additional insight into the effect of reviewers' mutual reviewing tenure. Model 2.2.3.4.3 shows that reviewers' mutual reviewing tenure has a U-curved effect (β=-.3557, p<.10, squared β=.0847, p<.10) for projects with modestly long time horizons but only when income decreases. The effect is not significant when income increases. Similarly, model 2.4.3.4.3 shows that reviewers' mutual reviewing tenure has a U-curved effect (β=-.3852, p<.10, squared β=.0527, p<.05) for projects with very long time horizons but only when income decreases. For projects with medium long time horizons, model 2.3.3.4.3 shows that only the squared term is positive and significant (β=.1670, p<.10) and only when income decreases. It is somewhat peculiar why the direct effect is not significant for projects with medium long time horizons as it is for other projects. However, the results suggest that the effect of reviewers' mutual reviewing tenure does not increase with increasing time horizon, and as a result, hypothesis H9, which predicts this effect, is not supported.

The results suggest that reviewers' mutual reviewing tenure has an effect only when income decreases and not when income decreases. However, hypothesis H8 is not supported because income decrease does not only increase the positive effect of reviewers' mutual reviewing tenure. Instead, it seems that the effect is first negative but turns into a positive effect when reviewers' mutual reviewing tenure becomes high enough. The findings are contrary to the decreasing effect of a high degree of reviewers' mutual reviewing tenure as predicted by hypothesis H4b. Instead, it seems that a high degree of reviewers' mutual reviewing tenure has an increasing effect. However, the findings do not support hypothesis H4a either. Hypothesis H4a predicts a linear positive effect of reviewers' mutual reviewing tenure. The findings show that the effect is first a decreasing, and then it begins to increase only when reviewers' mutual reviewing tenure becomes high enough.

Hypotheses H4a and H4b are based on the two phenomena that were proposed by the theory. On one hand, the theory suggests that as reviewers

work together, they learn how to best utilize their varying knowledge. On the other hand, as reviewers work together, their knowledge becomes more overlapping, and the reviewers may benefit less from the variety in their individual knowledge sets. A potential explanation for the finding of a U-curved effect is that the first theoretical argument of the benefits from working together requires a relatively long mutual reviewing tenure. Before such benefits can develop, the negative effect from increasing knowledge overlap dominates. In other words, when reviewers have low mutual tenure, they can benefit from their different experience and knowledge. As the mutual tenure increases, reviewers' knowledge becomes more overlapping and they may benefit less from the variety in knowledge in their joint review task. However, when reviewers gather enough mutual review experience, they gradually learn how to best utilize the remaining differences in their knowledge. They learn to work better together, which improves their ability to review. As a result, the effect of reviewers' mutual reviewing tenure first decreases but then begins to increase, as the results show.

In summary, the results do not support hypotheses H4a and H4b, but they suggest that the effect is somewhat different from the prediction. No support is found for the moderating effects predicted by hypotheses H8 and H9.

5.2.5 Reviewers' reviewing tenure with agent

The results from Model 2.1.2.1 show that, as predicted by hypothesis H5b, reviewers' reviewing tenure with agent has a negative and significant effect (β=-.0379, p<.10) on an R&D project budget. Model 2.1.3.5 on the effect of income decrease provides no support for hypothesis H8 that predicts that the effect of reviewers' reviewing tenure with agent increases when income decreases.

The analysis of the effect of time horizon by models 2.2.2, 2.2.3.5, 2.3.2, 2.3.3.5, 2.4.2.1, and 2.4.3.5 provides more insight into the effect. The analysis shows that reviewers' reviewing tenure with agent has a negative and significant effect (β= -.1160, p<.01) for projects with very long time horizons but not for other projects. This finding provides support for hypothesis H5b, which predicts that reviewers' reviewing tenure with agent has a negative effect because profit center managers are concerned about the reviewers' potential bias for the agent due to the reviewers' past social ties with the agent. This negative effect is only limited to projects with very long time horizons probably because these projects mostly focus on novel knowledge that is less familiar to the profit center managers. As profit

center managers are expected to be more familiar with the knowledge that is related to projects with modestly and medium long time horizons, profit center managers can better notice and take into account possible biases due to reviewers being familiar with project managers. Hypothesis H9 predicts that the positive effect from reviewers' reviewing tenure with agent increases as time horizon increases but the findings suggest that on the contrary, it is the negative effect that increases.

In summary, the results provide support for the effect predicted by hypothesis H5b. The alternative hypothesis H5a is not supported. No support was found for the moderating effect predicted by hypothesis H8. Finally, support for the moderating effect of time horizon is found but the effect is contrary to the prediction by hypothesis H9.

5.2.6 Reviewers' ties to external reviewers

The results from Model 2.1.2.1 show that reviewers' ties to external reviewers have positive and significant effect (β=.0354, p<.001) on an R&D project budget. This finding supports hypothesis H6. Model 2.1.3.6 further shows that this effect does not change when income decreases.

The analysis of the effect of time horizon by models 2.2.2, 2.2.3.6, 2.3.2, 2.3.3.6, 2.4.2.1, and 2.4.3.6 provides some additional results about the effect. The effect of reviewers' ties to external reviewers becomes less positive only for projects with modestly long time horizons (β=.0377-.0358, p<.05) but not for projects with medium (β=.0495, p<.01) or very (β=.0333, p<.001) long time horizons. A possible explanation for the findings is that the gain from external reviewers is higher for projects with longer time horizons because such projects involve more novel knowledge. The access to broader knowledge through external reviewers helps the reviewers to better evaluate projects. On the other hand, such a gain is lower for projects with modestly long time horizons because these projects tend to be based on less novel knowledge. As income decreases, profit center managers start to question a project's reasoning more critically and intensively. Because the gain from external reviewers is relatively weaker for projects with modestly long time horizons, the positive effect of reviewers' ties to external reviewers becomes less positive. This finding is contrary to hypothesis H8, which predicts that the effect of reviewers' ties to external reviewers increases when income decreases. On the other hand, the effect does not become weaker for projects with longer time horizons because these projects benefit more from external reviewers. This result supports hypothesis H9, which predicts that the positive effect of reviewers' ties to external reviewers is stronger for projects with longer time horizons.

154

In summary, the results provide support for the direct effect predicted by hypothesis H6. Support for the moderating effect of income decrease is found, but the effect is contrary to the prediction by hypothesis H8. Finally, the moderating effect of time horizon predicted by hypothesis H9 is supported.

5.2.7 Principal's attention

The results from Model 2.1.2.1 show that the principal's attention has positive and significant effect (β=.0239, p<.001) on an R&D project budget. Thus, hypothesis H7 is supported. Model 2.1.3.7 provides no support for hypothesis H8, which predicts that the effect of a principal's attention increases when income decreases.

The analysis of the effect of time horizon by models 2.2.2, 2.2.3.7, 2.3.2, 2.3.3.7, 2.4.2.1, and 2.4.3.7 provides little additional insight into the effect. The effect is positive for projects with all different types of time horizons, and no support is found for hypothesis H9, which predicts that the quantity of ex ante reasoning has a larger effect for projects with longer time horizons.

In summary, the results provide support for the direct effect predicted by hypothesis H7. No support was found for the moderating effects predicted by hypotheses H8 and H9.

5.3 Comparison across models

Table 5-12 summarizes all the effects identified in all the models.

Table 5-12 Comparison of regression results of all models

	Dependent variable: R&D project actual cost				Dependent variable: R&D project budget			
	All projects	Time horizon			All projects	Time horizon		
		Modestly long	Medium long	Very long		Modestly long	Medium long	Very long
H1: Quantity of written ex ante reasoning	+	+	+	+	+	+	+	+
Income decrease if different	++	0	0	++	0	0	0	0
H2: Frequency of revision of written ex ante reasoning	+	+	0	0				
Income decrease if different	0	0	0	+				
H3: Number of reviewers	0	0	0	+	0	0	0	0
Income decrease if different	0	0	0	0	0	0	0	0
H4: Reviewers' mutual reviewing tenure	+	0	0	+	0	0	0	0
Income decrease if different	0	0	U	0	+	U	+	U
H5: Reviewers' reviewing tenure with agent	0	0	0	-	-	0	0	-
Income decrease if different	-	-	0	0	0	0	0	0
H6: Reviewers' ties to external reviewers	+	0	+	0	+	+	+	+
Income decrease if different	0	0	0	+	0	+ -	0	0
H7: Principal's attention	+	+	+	+	+	+	+	+
Income decrease if different	+ -	+ -	0	0	0	0	0	0

Effects: Additional effects for income decrease
0 = Not significant   ++ = More positive than income increase
+ = Positive   + - = Positive but less positive that income increase
- = Negative
U = U-curved

5.3.1 Quantity of ex ante reasoning

Overall, the findings on the effect of the quantity of ex ante reasoning are quite similar across the two models and suggest that the quantity of ex ante reasoning increases R&D expenditures by both profit center and project managers. The effect is slightly stronger for project managers because there is an increasing effect for project managers for projects with very long time horizons when income decreases but no such increase for profit center managers. In summary, both models provide support for hypotheses H1 and also for hypotheses H8 and H9, which are supported for project managers.

5.3.2 Frequency of revision of written ex ante reasoning

The effect of the frequency of the revision of written ex ante reasoning is investigated only for project managers as the mechanism is used after budget approval, and it is therefore not expected to influence budgets that have been determined by profit center managers.

5.3.3 Number of reviewers

The findings on the effect of the number of reviewers are quite similar across the two models because the number of reviewers has no significant effect in most cases. It seems that it is usually more the qualities than the sheer quantity of reviewers that determines the amount of an investment. However, the number of reviewers has a positive effect on an R&D project actual cost for projects with very long time horizons. In summary, hypotheses H3 and H9 are supported for project managers. No hypotheses are supported for profit center managers.

5.3.4 Reviewers' mutual reviewing tenure

The findings suggest that reviewers' mutual reviewing tenure has different types of effects for project managers and profit center managers. Reviewers' mutual reviewing tenure has a positive effect for investments by project managers but only when a project's time horizon is medium long or longer. On the other hand, for profit center managers, reviewers' mutual reviewing tenure depends on income decrease and is significant only when income decreases. Moreover, the effect is first negative and starts to increase when reviewers' mutual reviewing tenure becomes high enough. In summary, hypotheses H4a and H9 are supported for project managers, whereas the effect for profit center managers is different from the predictions of hypotheses H4a and H4b.

5.3.5 Reviewers' reviewing tenure with agent

The findings show that reviewers' reviewing tenure with agent has quite similar effects for project managers and profit center managers. The effect is a negative effect for projects with very long time horizons for both project managers and profit center managers. However, in addition, the effect is negative for project managers regardless of time horizon when income decreases. In other words, project managers are more sensitive to reviewers' reviewing tenure with agent than profit center managers. Because income decrease has no effect for profit center managers, it seems that project managers are somewhat overcautious in relation to income decreases. In summary, for both project managers and profit center managers, the findings support hypothesis H5b and are contrary to hypothesis H9. In addition, the findings for project managers are contrary to hypothesis H8.

5.3.6 Reviewers' ties to external reviewers

The findings suggest that reviewers' ties to external reviewers have different types of effects for project managers and profit center managers. Reviewers' ties to external reviewers seem to provide somewhat more benefit for profit center managers than project managers. The effect is positive and significant for project managers only for projects with medium long or longer time horizons. On other hand, the effect is positive for profit center managers regardless of time horizon even though the effect is slightly weaker for projects with modestly long time horizons when income decreases. In summary, hypotheses H1 and H9 are supported for both project managers and profit center managers. Hypothesis H8 is supported for project managers, but the findings are contrary to hypothesis H8 for profit center managers.

5.3.7 Principal's attention

The findings on the effect of a principal's attention are quite similar for profit center and project managers and suggest that a principal's attention increases R&D expenditures by both profit center and project managers. Project managers and profit center managers differ in their reactions to income decrease. Income decrease does not change the effect for profit center managers, but it weakens the positive effect for project managers for projects with modestly long time horizons. The findings suggest that, as in case of reviewers' reviewing tenure with agent, project managers are somewhat overcautious on income decreases because profit center managers do not seem to react to income decreases in a similar manner. In summary, hypothesis H7 is a support for both project managers and profit center managers. In addition, the findings for project managers support hypothesis H9, but they are contrary to hypothesis H8.

5.4 Summary of results

The results of the hypotheses tests are summarized in Table 5-13. The results are discussed further in the next chapter.

Table 5-13 Summary of results

Investments by (i) an agent and (ii) a principal in learning new knowledge that is likely to take a long time to generate income are positively related to the	(i) Agent	(ii) Principal
H1 Quantity of written ex ante reasoning of an investment's income potential	**Supported**	**Supported**
H2 Frequency of revision of written ex ante reasoning of an investment's income potential	**Supported**	
H3 Number of reviewers	**Supported**	Not significant
H4 (a) Reviewers' mutual reviewing tenure, or alternatively,	**Supported**	Not significant
(b) Have an inverted U relationship with reviewers' mutual reviewing tenure	Not significant	**Contrary supported**
H5 (a) Reviewers' reviewing tenure with the agent, or alternatively,	Not significant	Not significant
(b) Are negatively related to reviewers' reviewing tenure with the agent	**Supported**	**Supported**
H6 Reviewers' ties to external reviewers	**Supported**	**Supported**
H7 Principal's attention to the investment	**Supported**	**Supported**
The positive effects predicted by		
H8 H1 through H7 are expected to be amplified when income decreases	**Supported:** H1, H2. H6 **Contrary:** H5,H7	**Supported:** - **Contrary:** H6
H9 H1 through H8 are expected to be amplified as an investment's time horizon increases	**Supported:** H1, H3, H4, H6, H7, H8 **Contrary:** H5	**Supported:** H6 **Contrary:** H5

6. Discussion and conclusions

6.1 Discussion of results

This study set out to analyze how large organizations can improve the controls against managerial myopia at the lower organizational levels to increase investments in learning new knowledge that is likely to take a long time to generate income. The analysis began with a review of the extant body of knowledge that is related to the research problem. In particular, previous research on corporate governance, corporate internal controls, investments in learning, and managerial myopia were reviewed. Previous research was found to have identified a number of control mechanisms against managerial myopia at the upper echelons. The arguments that had been developed for the apex of an organization were extended to the lower organizational levels.

The hypotheses were tested empirically with quantitative statistical methods, applying a regression analysis. The empirical testing was based on data from research and development projects within a division of a large, publicly traded, global industrial corporation. The sample consisted of over 260 million euros invested in 2,147 research and development projects over a thirteen-year period between 1997 and 2009.

6.1.1 The written ex ante reasoning as a control mechanism

The first two hypotheses of this study propose that a principal can increase investments in learning new knowledge that is likely to take a long time to generate income by asking an agent to prepare a written ex ante reasoning of an investment's income potential. A written ex ante reasoning can outline the cause-and-effect relationships that exist between future income and the factors that influence it. A written ex ante reasoning is developed as an extension from the concept of strategic controls, with which corporate management can evaluate division managers based on their longer term strategic decisions rather than short-term financial performance only (Gupta, 1987; Hill and Hoskisson, 1987; Baysinger and

160

Hoskisson, 1989, 1990; Hitt et al., 1990; Goold and Quinn, 1990; Hoskisson et al., 1991, 1993; Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn, 1999). Whereas strategic controls are limited to controls that are based on the strategies at the apex of a corporation, written ex ante reasoning can be applied to other types of investments at the lower organizational levels.

Hypothesis H1 predicts that investments by both a principal and an agent in learning new knowledge that is likely to take a long time to generate income are positively related to the quantity of written ex ante reasoning of an investment's income potential. The empirical findings on both the agent and the principal support this hypothesis. Hypothesis H2 proposes that investments by both the principal and the agent in learning new knowledge that is likely to take a long time to generate income are positively related to the frequency of the revisions of written ex ante reasoning for an investment's income potential. No empirical data are available for testing the hypothesis for the principal, but evidence supporting the hypothesis for the agent is found. In conclusion, the empirical findings suggest that, as predicted by the hypotheses, written ex ante reasoning can curb managerial myopia at the organizational levels below the upper echelons.

6.1.2 Reviewers as control mechanism

Hypotheses H3 through H6 propose that a principal can increase investments in learning new knowledge that is likely to take a long time to generate income by hiring reviewers to support the principal in controlling an agent. The principal can ask the reviewers to give their opinions on supporting the principal to evaluate the potential income from resources that are delegated to the agent and the agent's competence in managing such resources. Reviewers as a control mechanism are based on an extension of the role of the board of directors at the very apex of a corporation. The corporate governance literature has investigated extensively the role the board of directors, in particular its role in controlling management (e.g., Jensen and Meckling, 1976; Holmström, 1979; Fama, 1980; Fama and Jensen, 1983a, 1983b). However, the role of the board of directors is limited to monitoring top management. The control of the reviewers proposed in the study investigates the application of a similar mechanism at the lower organizational levels. In particular, previous research on boards has identified that the effectiveness of a board in its role of controlling management depends on various characteristics such as board members' quantity and qualities such as tenure and social ties. Accordingly, this study investigates how the similar attributes of the

reviewers influence investments in learning new knowledge that is likely to take a long time to generate income.

Hypothesis H3 predicts that investments by both a principal and an agent in learning new knowledge that is likely to take a long time to generate income are positively related to the number of reviewers who are hired by the principal to control the agent. The empirical findings of this study provide support for hypothesis H3 for the agent but not for the principal. However, the analysis of the effect of the time horizon notes that the effect is positive for the agent only when time horizon is very long. It seems that it is usually the qualities of reviewers rather than the quantity as such that determines the decision making by an agent and a principal. Nevertheless, the principal can also sometimes curb managerial myopia and increase investments in long-term learning by hiring reviewers to review the agent.

As with the mutual tenure of board members (Alderfer, 1986; Singh and Harianto, 1989; Forbes and Milliken, 1999, reviewers' mutual reviewing tenure is also expected to influence the effectiveness of their control. Applied to reviewers, this finding suggests that with increasing mutual tenure, reviewers learn how to best utilize their varying knowledge in developing new insight into improving an agent's learning plans and utilizing their external ties to facilitate the agent's cooperation with external resources owners. The agent can also feel more confident that reviewers can better evaluate his or her competence, thereby further decreasing managerial myopia. Hypothesis H4a posits that investments in learning new knowledge that is likely to take a long time to generate income are positively related to reviewers' mutual reviewing tenure. On the other hand, the research on boards suggests that excessive mutual tenure may cause groupthink, which hinders the effectiveness of the board (Kosnik, 1990; Mallette and Fowler, 1992; Johnson et al., 1993; Golden and Zajac, 2001; Tuggle et al., 2010a). Thus, an alternative hypothesis, H4b, predicts that the effect of reviewers' mutual reviewing tenure is not linear but curvilinear, that is, the effect begins to decrease when mutual tenure is excessively long.

The empirical evidence shows that the effect of reviewers' mutual reviewing tenure is different for an agent and a principal. The empirical evidence supports the positive effect predicted by hypothesis H4a for an agent. However, the effect is somewhat weak because it is significant only when time horizon is long enough. For the principal, the effect of reviewers' mutual reviewing tenure is somewhat different than predicted by either hypothesis H4a or H4b. In particular, the effect is significant only when income decreases and it is U-curved: it is first negative, but it becomes positive when reviewers' mutual reviewing tenure is high enough. However, such an effect seems possible based on the two contrary effects as proposed

162

by the related theory, but they seem to be balanced differently than predicted. When reviewers have low mutual tenure, they can benefit from their different experience and knowledge. As the mutual tenure increases, the reviewers' knowledge overlaps more, and they may benefit less from the variety in knowledge in their joint review task. However, when reviewers gather enough mutual review experience, they gradually learn how to best utilize the remaining differences in their knowledge. They learn to work better together, which improves their ability to conduct a review. As a result, the effect of reviewers' mutual reviewing tenure first decreases, but it eventually begins to increase. In conclusion, the effect of reviewers' mutual reviewing tenure is somewhat different than predicted, but it provides the principal with a control mechanism to curb managerial myopia at the organizational levels below the upper echelons.

Hypotheses H5a and H5b propose that reviewers' reviewing tenure with an agent has either a positive (a) or a negative (b) effect on investments in learning new knowledge that is likely to take a long time to generate income. The positive effect is based on the predictions that as reviewers learn to know an agent, they can better counsel the agent and understand the agent's competence. On the other hand, the past research on boards suggests that board members with long tenure are more likely to have become friendly with management, compromising their effectiveness in monitoring (Alderfer, 1986; Singh and Harianto, 1989; Sundaramurthy, 1996; Shen, 2003; Kor, 2006; Dalton et al., 2007). Thus, an alternative hypothesis of a negative effect by reviewers' reviewing tenure with an agent is formulated.

The empirical findings of this study support hypothesis H5b for both an agent and a principal. The negative effect suggests that both the agent and the principal are concerned about the potential bias of the reviewers who are familiar with the agent. However, the findings suggest that such concern depends on both time horizon and income changes. For both the agent and the principal, the negative effect is significant only when time horizon is long enough and if income is not decreasing. It seems that when time horizon is shorter, investments tend to involved less novel information, and it is easier for a principal to identify and take into account any bias by reviewers. Moreover, the findings show that an agent tends to be more cautious with respect to potential bias because the effect is negative for the agent regardless of time horizon when income decreases. The principal does not react to income decrease with similar caution. In conclusion, the findings of this study suggest that when using reviewers as a control to curb managerial myopia, attention needs to be paid to using

reviewers who are too familiar with an agent because it can limit investments in long-term learning in certain situations.

Hypothesis H6 predicts that reviewers' ties to external reviewers increase investments in learning new knowledge that is likely to take a long time to generate income. The hypothesis is based on the corporate governance literature that suggests that board member's appointments in additional external boards provide them with contact with other directors, and such contacts are a source of valuable information that helps the board members to increase their effectiveness (Pfeffer and Salancik, 1978; Burt, 1980; Davis, 1991; Haunschild, 1993; Haunschild and Beckman, 1998; Carpenter and Westphal, 2001). Similarly, when reviewers work with various other reviewers in reviewing different investments and agents, they form ties to many reviewers who can provide them with valuable information that contributes to their effectiveness as reviewers.

The empirical findings of this study provide support for hypothesis H6 for an agent and a principal. The effect of the reviewers' ties to external reviewers is positive for both the agent and the reviewer. Reviewers' ties to external reviewers seem to provide somewhat more benefit for the principal than the agent. The effect is positive and significant for the agent only when time horizon is long enough. When time horizon is shorter, the investment is likely to involve less novel knowledge, and the agent experiences less of a benefit from the external reviewers who can provide access to novel knowledge. On other hand, the effect is positive for the principal, regardless of the time horizon, even though the effect is slightly weaker when income decreases. In conclusion, the principal can curb managerial myopia and increase investments in long-term learning by hiring reviewers who have extensive ties to other external reviewers due to their past reviewing experiences.

6.1.3 The effect of a principal's attention

Hypothesis H7 predicts that investments in learning new knowledge that is likely to take a long time to generate income are increased by a principal's attention to the investment. Ocasio (1997) proposed that decision makers are more likely attend to issues with greater value and relevance to an organization. The literature on corporate governance also proposes that the attention of boards of directors is subject to the mechanisms that is proposed by the attention-based view of a firm (e.g., Golden and Zajac, 2001; Tuggle et al., 2010b). In addition, management is expected to pay the most attention to the largest investments that are the most critical to determining income (e.g., Chandler, 1962; Bower, 1970). This study

proposes that a principal's attention as a function of investment size also influences the principal's attention to learning investments. Increased attention by a principal is expected to improve the principal's understanding of an investment and an agent's competence. Therefore, both investments by an agent and a principal are expected to increase. The empirical results provide support for hypothesis H7 for both the agent and the principal.

6.1.4 The effects of income decrease

Hypothesis H8 predicts that the positive effects predicted by hypotheses H1 through H7 are amplified when income decreases. When managerial myopia is not controlled, an income decrease is expected to increase such myopia. This is because when an agent is controlled based on short-term financial control, an income decrease increases the agent's experience of pressure to improve income in the next period. Minimizing investments in long-term learning is the most attractive alternative to decreasing costs because such a cut does not decrease short-term sales. Because the controls against myopia are expected to help a principal to evaluate an agent's competence, which is also based on attributes other than short-term financial performance, income decrease is likely to have a relatively lesser impact on the evaluation of an agent's competence. In particular, the agent's future career is less dependent on the agent's ability to increase income over the subsequent period. Thus, the agent experiences less pressure to increase income by resorting to cutting investments in learning. As a consequence, managerial myopia is not increased as much after an income decrease.

The empirical findings support hypothesis H8 for the agent for a number of mechanisms hypothesized above. For the agent, the effects of the quantity (H1) of a written ex ante reasoning and the frequency (H2) of the revision of the written ex ante reasoning and the reviewers' ties to external reviewers (H6) increase when income decreases. However, hypothesis H8 is not supported for the principal for any of the mechanisms that are hypothesized above.

On the other hand, the results on some of the mechanisms suggest that the effect of income decrease is more refined. The effect of reviewers' reviewing tenure with an agent (H5) becomes negative and significant for the agent when income decreases. As already discussed above for hypothesis H5, such a negative effect is expected to be due to a concern that reviewers who are familiar with an agent are biased for the agent, which

weakens the credibility of the reviewers in evaluating the agent's competence when income decreases.

In addition, the positive effect of a principal's attention (H7) becomes weaker for an agent when income decreases. This finding suggests that the effect of a principal's attention is moderated by the time horizon. The principal's attention provides the most gains for projects with relatively long time horizons. This finding is expected because such projects tend to involve more knowledge that is novel for a principal, and the principal's attention increases his or her understanding, which helps to decrease managerial myopia. On the other hand, the principal is more familiar with project with only modestly long time horizons and the benefit from the principal's attention is weaker. Such weaker benefits are more easily decreased when the pressure for managerial myopia increases when income decreases.

For the principal, the positive effect of the reviewers' ties to external reviewers (H6) also becomes weaker for investments with modestly long time horizons when income decreases. Such an effect seems possible because investments with modestly long time horizons tend to benefit less from external reviewers because they involve less novel knowledge than investments with longer time horizons. The benefit from external reviewers is highest for longer term investments that involve more novel knowledge. As income decreases, the principal begins to question the investments more critically and intensively, and the gain from external reviewers is less useful in addressing such increasing pressure.

6.1.5 The effect of time horizon

Hypothesis H9 predicts that the positive effects predicted by hypotheses H1 through H8 are amplified as an investment's time horizon increases. Previous research on organizational learning suggests that some learning investments take much longer to generate income than others (e.g., Tushman and Anderson, 1986; March, 1991; Christensen and Bower, 1996). An agent is expected to have different preferences for long-term learning investments with different temporal distances in generating income. The more distant in time the potential income from an investment, the less likely the agent's income will be impacted by the learning. Therefore, if the agent is evaluated based on financial performance, the agent's motivation to make a learning investment decreases as the investment's time to generate potential income decreases. Because the controls against myopia are expected to help the principal to evaluate the agent's competence based on attributes other than financial performance, income decrease is likely to

have a relatively lesser impact on the evaluation of the agent's competence. Thus, the agent has fewer reasons to determine a preference for investments based excessively on their time to generate potential income. Consequently, this process increases both an agent's and a principal's investments in learning new knowledge that is likely to take a long time to generate income.

The empirical findings support hypothesis H9 for a number of mechanisms as hypothesized above. For the agent, the effects of the quantity of written ex ante reasoning (H1), the number of reviewers (H3), the reviewers' mutual reviewing tenure (H4), the reviewers' ties to external reviewers (H6), the principal's attention (H7), and the positive effect of income decrease (H8) on the quantity of written ex ante reasoning and the frequency of revisions of written ex ante reasoning and on the reviewers' ties to external reviewers increase when an investment's time horizon is extended. For a principal, the effect of the reviewers' ties to external reviewers (H6) increases when an investment's time horizon increases.

However, the results for some other mechanisms suggest that the effect of the time horizon is more complex. The effect of the frequency of revisions of a written ex ante reasoning (H2) seems to include a positive element as predicted by hypothesis H9; however, in addition, the results hint at the existence of an additional positive effect. The frequency of revisions of written ex ante reasoning seems to also be beneficial for projects with modestly long time horizons and a possible explanation is that these projects are closest to market launch, and the principal is likely to be paying attention to such projects more often to ensure a smooth launch to market.

In addition, the effect of the time horizon seems to be contrary to the hypothesis for the effect of reviewers' reviewing tenure with an agent (H5) for the agent and the principal. Rather than increasing the positive effect of reviewers' reviewing tenure with an agent as predicted by hypothesis H9, increasing a time horizon actually increases the negative effect of reviewers' reviewing tenure with an agent. As discussed above, this finding seems to be due to an increasing concern for potential bias by reviewers who are familiar with the agent. The empirical results suggest that the potential benefits from reviewers' reviewing tenure with an agent are lost through a principal's decreasing ability to evaluate the bias by reviewers who are familiar with an agent.

6.2 Theoretical and empirical contributions

The theoretical and empirical results provide several contributions. The extension of the applications of agency theory to the lower organizational levels is the major contribution of this study. In addition, this study makes a number of other contributions to the literature on managerial myopia and organizational learning. The theory that is developed in this study is subjected to quantitative empirical testing. Thus, the theoretical contributions of this study are supported by empirical validation.

This study contributes to agency theory by extending applications of agency theory to the lower organizational levels. Agency theory posits that a principal can control an agent through a combination of compensation and monitoring. Previous research has investigated how compensation can be applied throughout organizations that consist of several levels. However, the past research on the applications of certain monitoring mechanisms has focused on the upper echelons of organizations. This study examines two such monitoring mechanisms, boards of directors and strategic controls, and extends them with applications at the lower organizational levels.

Boards of directors have been identified as applications of monitoring as proposed by agency theory (e.g., Fama and Jensen, 1983a; Eisenhardt, 1989). A principal can monitor an agent by using a board of directors, and such monitoring helps the principal to reduce agency costs. Previous research on corporate governance has investigated how shareholders can monitor the management by a board of directors, but the use of a board of directors is limited to this highest organizational level. Nevertheless, management also needs to control agents at the lower organizational levels, and managers at the lower organizational levels have their own agents that need to be monitored. However, the past research has not examined how managers at the lower organizational levels would utilize a control mechanism that is similar to a board of directors to control their agents. This study contributes to agency theory by examining how managers at the lower organizational levels can also control their agents with reviewers, a mechanism that is similar to a board of directors. Because most of the decisions that influence the performance of large organizations are made by managers at the lower organizational levels, this contribution provides a relevant theoretical extension of the application of monitoring mechanisms proposed by agency theory.

Strategic controls serve as another monitoring mechanism that has been investigated by the past research on corporate internal controls (e.g., Gupta, 1987; Hill and Hoskisson, 1987; Baysinger and Hoskisson, 1989, 1990; Hitt et al., 1990; Goold and Quinn, 1990; Hoskisson et al., 1991, 1993;

Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn, 1999). Previous research on corporate internal controls has focused on examining how a CEO as a principal can monitor the division management as an agent through strategic controls. This study extends the scope of strategic controls in two dimensions. First, the scope is extended from the strategy making to learning investments. Second, the focus on the CEO-division management dyad is extended to cover the lower organizational levels. This study contributes to agency theory by examining how managers at the lower organizational levels can control their agents by applying ex ante reasoning, a mechanism derived from strategic controls as an application of monitoring of an agent by a principal. This contribution provides a relevant theoretical extension of the application of the monitoring mechanism proposed by agency theory because most of decisions that influence the performance of large organizations are made by managers at the lower organizational levels.

In addition to extending the applications of agency theory to the lower organizational levels, this study also makes a number of other contributions to the literature on managerial myopia and organizational learning.

The literature on managerial myopia has extensively examined how financial controls limit long-term learning in organizations (Hayes and Abernathy, 1980; Hill, 1985; Porter, 1992; Hoskisson et al., 1993; Jensen, 1993; Levinthal and March, 1993; Laverty, 1996; Zahra, 1996; Miller, 2002; Marginson and McAulay, 2008: Barrett, 2010; Souder and Shaver, 2010). On the other hand, the literature has paid less attention to identifying the factors that can curb the myopic effect produced by financial controls. A stream of research has studied how strategic controls can be used to balance financial controls to reduce managerial myopia, but it has focused on the CEO-division management dyad and strategy making (Hitt et al., 1990; Johnson et al., 1993; Hitt et al., 1996; Barringer and Bluedorn., 1999). This study extends the past research on strategic controls by showing that an ex ante reasoning can be applied at the lower organizational levels to limit managerial myopia. In addition, this study identifies the use of reviewers at the lower organizational levels as a control for limiting managerial myopia. Similar control not been investigated at the lower organizational levels by previous research. In conclusion, this study contributes to the literature on managerial myopia by showing that the control mechanisms examined in this study can be applied to limit managerial myopia.

The literature on organizational learning has paid substantial attention to analyzing how investments in learning depend on financial performance (e.g., Cyert and March, 1963; Kahneman and Tversky, 1979; Staw et al.,

1981; Singh, 1986; Hundley et al., 1996; Mone at al., 1998; Greve, 2003, Chen and Miller, 2007; Chen, 2008). This research is dominated by the behavioral theory of the firm that was initiated by Cyert and March (1963). The research has investigated how an organization's financial performance, which is reflected by measures such as current income and its relationship to the past and peer income, slack, and the closeness to bankruptcy, can influence an organization's investments in areas such as learning, research and development intensity. This study suggests that an organization's reaction to financial performance is influenced by the controls that are applied within the organization. In particular, the findings of this study show that the effect from controls such as ex ante reasoning and reviewers can be amplified or attenuated when an organization's income decreases. Because investments in learning depend on such moderation, these organizational controls influence how investments in learning change when income decreases. This study contributes to the research on organizational learning by showing how the control mechanisms examined in this study can have moderating effects with financial performance on determining investments in learning.

The literature on organizational learning has also paid considerable attention to identifying the factors that determine the balance between exploration and exploitation (March, 1991). However, the past research on exploration and exploitation has focused on investigating how organizational structure, and decentralization in particular, determines the balance between exploration and exploitation (e.g., Gupta et al., 2006; Fang et al., 2010). The findings of this study show that organizational controls influence investments in long-term learning. On the other hand, March (1991) noted that exploration is more remote in time than exploitation. Even if this study does not specifically examine exploration and exploitation, exploration can involve long-term learning. The findings of this study contribute to the literature on exploration and exploitation by suggesting that it can be extended by investigating how the organizational control mechanisms examined in this study influence the balance between exploration and exploitation.

6.3   Managerial implications

The findings of this study have several implications for practitioners. In essence, this study aims to support the growth and long-term competitiveness of large organizations. In particular, this study is intended to help managers who perceive opportunities for growth and

competitiveness but feel that they lack the adequate tools to motivate their organizations to pursue such opportunities. The tradition of short-term financial control usually dominates organizations and shapes many organizational processes throughout an organization. In such an organizational environment, managers may feel that even if they would like to motivate their organization to pursue the learning that is needed for growth and competitiveness, they actually have few alternatives other than short-term financial control. This study provides some ideas that managers can adopt and adapt further to meet their needs to balance the managerial myopia that is inflicted by the dominance of short-term financial control. In particular, this study identifies the use of written ex ante reasoning and reviewers as potential controls to encourage investments in learning new knowledge that is likely to take a long time to generate income.

The findings of this study suggest that managers who wish to increase investments in long-term learning can request that their organizations establish information systems and processes for the preparation of written ex ante reasoning. For example, managers can ask their subordinates to plan and justify their investments properly in written format before making such investments. Managers may also require their subordinates to adopt a similar practice and to cascade the use of written ex ante reasoning throughout the lower organizational levels. To make written ex ante reasoning effective, managers need to read the prepared reports and reread them again over time to evaluate the competence of their reports. Moreover, managers needs to ask their reports to revise their written ex ante reasoning frequently to give them an opportunity to propose changes to the original plan. It is likely that the efficient use of written ex ante reasoning takes some practice at first, even training. This study does not provide any guidelines on the detailed content of written ex ante reasoning but the vast literature on strategy and innovation (e.g., Porter, 1980; Senge, 1990; Block and MacMillan, 1993; Hamel and Prahalad, 1994; Utterback, 1994; Mintzberg et al., 1998; McGrath and MacMillan, 2000a, 2000b) and business planning (e.g., MacMillan and Narasimha, 1987; Roberts, 1991; Hormozi et al., 2002; Martens et al., 2007; Kirsch et al., 2009) provides plenty of examples that can be used as a basis for training on what can be taken into account in ex ante reasoning for an investment's income potential.

In addition, the findings of this study suggest that managers who wish to increase investments in long-term learning can benefit from the use of reviewers at the lower organizational levels. Managers can employ reviewers to review their various investments and direct reports. Further, managers can cascade the practice throughout all of the levels of their

organizations. In establishing reviewer systems, it is recommended that managers pay attention the design of reviewing tasks to create networks between reviewers. The findings of this study suggest that reviewing is improved by both reviewers' mutual reviewing tenure and their ties to external reviewers. Mutual reviewing tenure can be increased when individuals engage together in several different review tasks over time. On the other hand, reviewers' ties to other reviewers can be increased by mixing different reviewers in different review tasks. The benefits from reviewers' mutual reviewing tenure and their ties to external reviewers can both be captured through a balanced composition of review teams that include some reviewers with mutual reviewing tenure but at the same time including some reviewers that have low mutual reviewing tenure to build new ties between reviewers. In addition, the findings of this study suggest that involving some reviewers who have previously reviewed an individual requires some caution because such reviewers may decrease the individual's motivation when the managers themselves are not familiar enough with the related knowledge to be able to assess a potential bias of a reviewer for the individual.

Managers at any organizational level can motivate their organizations to increase learning investments with written ex ante reasoning and reviewers. However, if the managers themselves are not controlled with such mechanisms but only with short-term financial controls, the benefits from written ex ante reasoning and reviewers may be more limited. This finding is due to the fact that such managers are likely to have limited room to allocate their resources to long-term learning in the first place. However, if managers at lower organizational levels can afford some long-term learning investments, they can benefit from written ex ante reasoning and reviewers.

It is the CEOs that can most benefit from the findings of this study. They typically have some equity-based incentives in addition to short-term financial control through boards of directors. Thus, CEOs have incentives to allocate resources to the long-term learning that is needed for growth and competitiveness. Traditionally, CEOs have had limited means of encouraging long-term learning in their organizations. They could apply strategic controls for their division managers, but that left most of organizational levels dependent on short-term financial control. However, CEOs usually have the power to design control processes that are used throughout the organizational levels. The findings of this study suggest that CEOs can cascade the use of written ex ante reasoning and reviewers throughout the lower organizational levels. This study does not provide details for such corporate level control systems based on written ex ante

reasoning and reviewers, but it outlines the fundamental mechanisms that CEOs can adapt to the specific needs of their organizations.

The findings of this study also suggest recommendations for boards of directors. The role of a board of directors includes ensuring the growth and long-term competitiveness of an organization. Boards can improve their effectiveness in this role by requiring CEOs to complement financial control systems with the controls against managerial myopia identified in this study. Moreover, whenever CEOs propose the adoption of such controls, boards are recommended to support the CEOs in such efforts.

Finally, the findings of this study have implications for investors and shareholders. Ultimately, it is the shareholders who can most benefit when organizations grow and sustain their competitiveness over long run. Today, shareholder return is limited due to widespread managerial myopia in organizations. Because the findings of this study suggest methods for how organizations can reduce the dilemma of managerial myopia, the findings provide shareholders with the means for improved wealth creation. In particular, shareholders who have a preference for long-term investments are recommended to invest in firms that can demonstrate that they complement short-term financial control with controls based on written ex ante reasoning and reviewers throughout all the organizational levels.

6.4   Limitations

The empirical findings of this study are based on a single large industrial company. The generalizability of the findings from a study based on the investigation of a single organization is inherently suspect. Any finding can be due to something that is idiosyncratic to the organization, and similar phenomena may not exist in most other organizations. This risk can be minimized by sampling an organization that is a typical representative of many similar organizations and does not have the idiosyncratic characteristics that would be critical to the findings. To address the potential limitation of the generalizability of findings, a typical industrial corporation was chosen for investigation. To further minimize the risk of any idiosyncratic characteristics, the corporation and the processes within it were analyzed and described in detail. This analysis suggests that the activities within the organization match closely with the findings of the past literature on corporations, and no idiosyncratic characteristics critical to the findings were observed. Therefore, the findings from this study are assumed to be generalizable to a broader population of similar corporations.

The empirical data consists of research and development projects. Research and development expenditures have been widely used by the past research to measure the activities related to long-term learning in firms (e.g., Hoskisson and Hitt, 1988; Hoskisson et al., 1993; Helfat, 1994a, 1994b; Hitt et al, 1996; Hundley et al., 1996; Palmer and Wiseman, 1999; Greve, 2003; Lee and O'Neill, 2003; Chen and Miller, 2007; Sanders and Hambrick, 2007; Chen, 2008; Kim et al., 2008). Research and development projects are expected to effectively represent general investments in learning new knowledge that is likely to take a long time to generate income, but adequate caution is nevertheless warranted in generalizing the results to different types of long-term learning.

The empirical analysis of this study relies on written information from the R&D project reporting system and corporate public accounting records of the case organization for actual income information. The analysis could have been complemented by a survey or structured interviews. Managers could have been asked for their opinions on how they thought they or the other managers were taking into account the hypothesized control mechanisms when making decisions related to R&D projects. Such a complementary analysis was not done for the following reasons. First, the data from the R&D project reporting system was historical data, and it would not have matched with a survey or structured interviews, which would have decreased the complementary value somewhat, even if not completely. Second, asking opinions of the managers would have addressed perceptions, which would have required an extension of the theoretical framework as well. The question of how individuals make decisions does not necessarily coincide with how they think or report how they make the decisions (e.g., Simon, 1947). The prior research has recommended behavioral measures instead of perceptual ones (Hansen et al., 2005). This study followed the recommended approach of observing how managers actually make decisions.

The empirical model of this study includes some unexplained variance due to the limitations of data availability. The literature on organizational learning suggests that the income potential of existing production and learning opportunities changes frequently as new knowledge is acquired (e.g., Herriott et al., 1985; Green et al., 2003). Thus, the relative attractiveness of an R&D project changes continuously. A large part of the variation of a project's actual cost relative to the budget is expected to be due to such changes in knowledge about the potential income from a project or alternative investment opportunities. However, the data available for this study did not include information on such changes in knowledge, and therefore this effect is not controlled in the empirical test. Thus,

changes in knowledge over the course of an R&D project remain a cause of the unexplained variance.

6.5   Directions for further research

The limitations of this study point out the need for testing the theory of this study in other firms. The models and hypothesis developed in this study should be tested through large sample designs. Adequate resources should be allocated to such large sample studies because of the intensive nature of the investigation of large numbers of decision makers within each firm. Because the theory of this study focuses on large firms with several organizational levels, large firms would be most suitable for studies based on larger samples.

In addition, further research could extend the empirical findings of this study by investigating decision makers at several organizational levels at the same time. This study is based on an analysis of the dyad between profit center managers and R&D project managers, but further dynamics are likely to be found through simultaneous attention to controls at the higher organizational levels. For example, Baysinger and Hoskisson (1990) and Johnson et al. (1993) investigated how corporate governance mechanisms interacted with corporate internal controls. Such investigations could also be extended to include controls at the lower organizational levels identified in this study.

The empirical findings of this study are based on research and development projects. Albeit an important type of long-term learning, they are not the only type of long-term learning investments in organizations. Organizations also typically have other types of investments related to business development and internal organizational processes, and these investments can also involve substantial investments in learning new knowledge that is likely to take a long time to generate income. The mechanisms identified in this study could also be tested on such other long-term learning investments.

This study has investigated how the identified mechanisms influence investments in learning new knowledge that is likely to take a long time to generate income. The literature on managerial myopia suggests that such learning improves long-term competitiveness and increases shareholder value. However, further empirical research could test how shareholder value and a firm's long-term competitiveness depend on the mechanisms identified in this study.

The findings of this study suggest that there may be opportunities to develop new theoretical insights through a combination of theories related to organizational learning with the organizational control theories and corporate governance literature. The balance between exploration and exploitation has attracted wide research interest. Exploration can involve the type of long-term learning that is the focus of this study. The findings of this study hint that further research on exploration and exploitation might investigate the effects of the controls examined in this study as well as other organizational controls that have been developed in the past research. The relationship between financial performance and organizational learning is another topic that has raised considerable attention in the past research. In addition, this stream of research may benefit from an analysis of opportunities to integrate research that incorporates theories related to organizational control. This study found some initial links between these two streams of research, but a more thorough examination of the integration of these research streams may provide fruitful ground for developing new theoretical insights.

Finally, the findings of this study suggest that more research on controls for managerial myopia is needed. Previous research on managerial myopia suggests that the phenomenon has societal consequences due to its critical role for competitiveness, and research on identifying factors to limit managerial myopia can have practical relevance and impact. The findings of this study suggest that managerial myopia is not an insurmountable dilemma. Rather, managerial myopia is an agency cost that can be adjusted with organizational controls. Further research into identifying controls for managerial myopia may provide an understanding of other types of controls. In particular, previous research on organizational controls has focused on the organizational upper echelons, whereas mechanisms within large and complex organizations have attracted less attention. Thus, a detailed, in-depth investigation inside different types of organizations may yet reveal unknown territories in which new types of controls against managerial myopia may be found. In conclusion, this study suggests that more research on different types of organizational controls is warranted.

7. Appendix

Table 7-1 Descriptive statistics and correlation: Projects with modestly long time horizon

Descriptive statistics and correlations
Time horizon: R&D projects with modestly long time horizon

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 R&D project budget (log)	4.55	1.10																								
2 R&D project actual cost (log)	3.97	1.43	0.84																							
3 R&D project budget	165	198	0.82	0.72																						
4 R&D project budget T-1	68.9	155	0.40	0.39	0.46																					
5 Continuation project	0.47	0.50	0.16	0.17	0.13	0.47																				
6 Project milestones	1.81	1.72	-0.09	-0.06	-0.12	-0.11	-0.20																			
7 Project status problems	0.45	0.50	-0.02	0.01	0.01	0.05	0.08	0.01																		
8 Agent frugality	-0.16	2.47	-0.04	-0.04	-0.05	0.03	-0.02	0.06	0.00																	
9 Reviewer experience	8.21	9.2	0.05	-0.03	0.03	0.07	0.14	-0.25	-0.03	-0.01																
10 Quantity of written ex ante reasoning	9.18	1.04	0.30	0.26	0.29	0.27	0.38	-0.61	0.18	-0.06	0.10															
11 Frequency of revision of written ex ante reasoning	5.13	2.84	0.21	0.21	0.17	0.06	0.07	-0.21	0.00	0.00	-0.12	0.37														
12 Number of reviewers	0.74	0.55	0.18	0.17	0.19	0.19	0.15	-0.18	0.01	0.03	-0.07	0.25	0.12													
13 Reviewers' mutual reviewing tenure	0.24	0.75	0.06	0.06	0.05	0.09	0.10	-0.13	0.06	0.00	0.15	0.15	-0.01	0.40												
14 Reviewers' mutual reviewing tenure squared	0.61	4.11	0.00	0.02	0.00	0.00	-0.01	-0.05	-0.01	0.01	0.10	0.04	-0.03	0.15	0.85											
15 Reviewers' reviewing tenure with agent	0.78	1.31	0.06	0.02	0.05	0.19	0.22	-0.10	-0.04	0.02	0.49	0.06	-0.13	0.22	0.15	0.06										
16 Reviewers' ties to external reviewers	1.91	3.95	0.17	0.12	0.16	0.12	0.25	-0.34	0.05	-0.04	0.45	0.41	0.08	0.22	0.19	0.11	0.22									
17 Principal's attention	-29.0	27.0	0.47	0.47	0.43	0.18	-0.11	0.24	-0.09	0.08	-0.03	-0.23	-0.04	0.04	-0.01	0.02	0.02	-0.14								
18 Income decrease x Quantity of written ex ante reasoning	4.08	4.46	0.01	-0.01	-0.05	-0.10	-0.18	0.18	-0.21	0.05	-0.02	-0.21	-0.02	-0.01	-0.07	0.02	-0.05	-0.11	0.02							
19 Income decrease x Frequency of revision of written ex ante reasoning	2.27	3.15	0.06	0.07	0.02	-0.09	-0.17	0.03	-0.21	0.04	-0.09	-0.05	0.39	0.04	-0.07	0.00	-0.12	-0.05	0.02	0.81						
20 Income decrease x Number of reviewers	0.33	0.48	0.02	0.01	-0.02	-0.06	-0.12	0.07	-0.20	0.04	-0.06	-0.09	0.04	0.35	0.06	0.09	0.02	-0.06	-0.03	0.78	0.67					
21 Income decrease x Reviewers' mutual reviewing tenure	0.08	0.56	-0.02	0.01	-0.01	-0.02	-0.03	0.03	-0.06	0.01	0.07	-0.02	-0.02	0.14	0.72	0.84	0.02	0.05	0.02	0.16	0.11	0.28				
22 Income decrease x Reviewers' mutual reviewing tenure squared	0.32	3.84	0.00	0.02	-0.01	-0.03	-0.05	0.01	-0.05	0.01	0.07	-0.02	-0.02	0.06	0.66	0.93	0.00	0.04	0.04	0.09	0.06	0.15	0.91			
23 Income decrease x Reviewers' reviewing tenure with agent	0.33	1.00	-0.12	-0.08	-0.08	0.01	0.06	0.05	-0.12	0.03	0.39	-0.15	-0.15	0.04	-0.01	0.01	0.65	-0.03	0.00	0.35	0.16	0.34	0.08	0.03		
24 Income decrease x Reviewers' ties to external reviewers	0.60	2.22	0.03	0.03	0.02	0.01	0.12	-0.16	-0.11	0.02	0.15	0.15	0.10	0.06	0.07	0.09	0.01	0.47	-0.11	0.34	0.34	0.30	0.17	0.12	0.13	
25 Income decrease x Principal's attention	-12.8	22.5	0.25	0.24	0.14	0.04	-0.05	0.13	-0.04	0.09	0.02	0.03	-0.04	0.06	0.03	0.01	0.00	0.49	-0.63	-0.49	-0.53	-0.07	-0.02	-0.24	-0.33

Table 7-2 Descriptive statistics and correlation: Projects with medium long time horizon

Descriptive statistics and correlations
Time horizon: R&D projects with medium long time horizon

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 R&D project budget (log)	4.73	1.01																								
2 R&D project actual cost (log)	4.10	1.35	0.79																							
3 R&D project budget	180	204	0.80	0.65																						
4 R&D project budget T-1	69.0	152	0.36	0.30	0.45																					
5 Continuation project	0.48	0.50	0.08	0.04	0.05	0.47																				
6 Project milestones	1.94	1.72	0.05	0.16	0.04	-0.08	-0.21																			
7 Project status problems	0.46	0.50	-0.04	0.00	-0.03	0.04	0.10	0.08																		
8 Agent frugality	-0.04	0.46	-0.04	0.00	-0.03	0.01	-0.03	0.07	-0.03																	
9 Reviewer experience	9.95	12.8	-0.03	-0.12	-0.05	0.08	0.18	-0.28	-0.03	0.04																
10 Quantity of written ex ante reasoning	9.24	1.06	0.17	0.17	0.16	0.24	0.33	-0.58	0.12	-0.06	0.10															
11 Frequency of revision of written ex ante reasoning	5.33	3.15	0.15	0.19	0.17	0.04	0.01	-0.23	0.01	0.04	-0.18	0.42														
12 Number of reviewers	0.78	0.53	0.11	0.07	0.11	0.14	0.07	-0.34	-0.01	-0.11	-0.08	0.31	0.20													
13 Reviewers' mutual reviewing tenure	0.20	0.62	0.12	0.10	0.10	0.23	0.21	-0.22	0.01	-0.14	0.00	0.20	0.06	0.44												
14 Reviewers' mutual reviewing tenure squared	0.43	2.04	0.08	0.06	0.06	0.16	0.17	-0.14	0.01	-0.09	0.03	0.12	0.04	0.26	**0.92**											
15 Reviewers' reviewing tenure with agent	0.86	1.42	-0.02	-0.03	-0.02	0.17	0.32	-0.03	0.07	0.04	0.44	0.05	-0.07	0.12	0.08	0.06										
16 Reviewers' ties to external reviewers	2.66	5.00	0.11	0.07	0.09	0.20	0.32	-0.44	0.08	-0.01	0.47	0.53	0.09	0.14	0.11	0.10	0.20									
17 Principal's attention	-25.8	24.7	0.52	0.39	0.41	0.17	-0.15	0.26	-0.14	-0.01	-0.07	-0.29	-0.06	-0.05	0.05	0.05	-0.03	-0.29								
18 Income decrease x Quantity of written ex ante reasoning	4.20	4.51	0.02	-0.02	0.00	-0.12	-0.21	0.06	-0.22	0.06	-0.02	-0.19	-0.02	0.02	-0.09	-0.08	-0.10	-0.25	0.05							
19 Income decrease x Frequency of revision of written ex ante reasoning	2.40	3.39	0.07	0.08	0.07	-0.10	-0.19	-0.06	-0.22	0.04	-0.11	0.00	0.41	0.12	-0.04	-0.05	-0.15	-0.14	0.04	**0.79**						
20 Income decrease x Number of reviewers	0.36	0.53	0.02	0.00	0.03	-0.08	-0.18	-0.08	-0.21	0.03	-0.03	-0.06	0.08	0.47	0.08	0.01	-0.02	-0.15	0.02	**0.75**	0.67					
21 Income decrease x Reviewers' mutual reviewing tenure	0.06	0.34	0.08	0.08	0.04	0.04	0.06	-0.07	-0.08	-0.02	-0.01	0.02	0.05	0.29	0.50	0.38	0.04	0.00	0.04	0.22	0.21	0.43				
22 Income decrease x Reviewers' mutual reviewing tenure squared	0.12	0.91	0.09	0.09	0.06	0.05	0.08	0.00	-0.04	-0.02	0.00	-0.02	0.03	0.17	0.29	0.47	0.07	0.00	0.06	0.14	0.13	0.27	**0.92**			
23 Income decrease x Reviewers' reviewing tenure with agent	0.34	1.08	-0.05	-0.10	-0.04	0.02	0.09	0.07	-0.01	0.04	0.35	-0.17	-0.14	0.06	0.01	0.02	0.65	-0.10	0.03	0.32	0.14	0.30	0.15	0.15		
24 Income decrease x Reviewers' ties to external reviewers	0.57	1.95	0.11	0.09	0.10	0.02	0.11	-0.19	-0.19	0.01	0.08	0.15	0.15	0.12	0.05	0.02	-0.04	0.27	-0.04	0.36	0.39	0.35	0.21	0.14	0.08	
25 Income decrease x Principal's attention	-11.3	19.5	0.29	0.25	0.24	0.14	0.07	0.01	0.15	-0.03	0.01	0.07	0.03	-0.03	0.08	0.08	0.06	0.14	0.45	-0.63	-0.47	-0.48	-0.09	-0.02	-0.20	-0.27

Table 7-3 Descriptive statistics and correlation: Projects with very long time horizon

Descriptive statistics and correlations
Time horizon: R&D projects with very long time horizon

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 R&D project budget (log)	4.43	1.02																								
2 R&D project actual cost (log)	3.79	1.37	0.77																							
3 R&D project budget	147	248	0.71	0.53																						
4 R&D project budget T-1	54.0	189	0.32	0.28	0.52																					
5 Continuation project	0.47	0.50	0.06	0.05	0.02	0.30																				
6 Project milestones	1.50	1.75	-0.09	-0.02	-0.03	0.04	-0.10																			
7 Project status problems	0.40	0.49	0.05	-0.01	-0.02	-0.03	0.16	-0.05																		
8 Agent frugality	-0.24	2.89	-0.07	-0.06	-0.03	-0.02	-0.08	0.07	-0.09																	
9 Reviewer experience	8.74	9.6	0.01	-0.02	-0.04	0.02	0.20	-0.15	-0.07	0.02																
10 Quantity of written ex ante reasoning	9.23	1.00	0.19	0.24	0.04	0.09	0.29	-0.58	0.23	-0.13	0.01															
11 Frequency of revision of written ex ante reasoning	5.09	2.92	0.12	0.18	0.06	0.03	0.08	-0.16	-0.02	-0.10	-0.13	0.35														
12 Number of reviewers	0.73	0.57	0.03	0.09	-0.07	-0.03	0.05	-0.28	0.07	-0.10	-0.05	0.36	0.18													
13 Reviewers' mutual reviewing tenure	0.27	0.89	0.03	0.08	-0.04	0.02	0.11	-0.22	0.05	-0.04	0.11	0.24	0.07	0.43												
14 Reviewers' mutual reviewing tenure squared	0.87	5.12	0.05	0.07	-0.01	0.02	0.05	-0.14	0.00	0.00	0.11	0.10	0.02	0.21	**0.88**											
15 Reviewers' reviewing tenure with agent	0.86	1.64	-0.13	-0.12	-0.11	0.00	0.17	0.00	0.00	0.01	0.62	-0.10	-0.12	0.16	0.16	0.12										
16 Reviewers' ties to external reviewers	2.19	4.28	0.11	0.11	-0.02	0.00	0.24	-0.33	0.07	-0.15	0.34	0.41	0.04	0.22	0.19	0.13	0.07									
17 Principal's attention	-33.7	26.9	0.43	0.43	0.35	0.14	-0.12	0.17	-0.09	0.02	0.05	-0.21	-0.02	-0.08	0.04	0.08	0.07	-0.18								
18 Income decrease x Quantity of written ex ante reasoning	3.98	4.39	-0.04	-0.04	-0.03	-0.02	-0.18	0.20	-0.24	0.08	0.04	-0.38	0.01	-0.03	-0.14	-0.07	0.09	-0.13	0.04							
19 Income decrease x Frequency of revision of written ex ante reasoning	2.28	3.12	0.02	0.05	0.01	0.00	-0.16	0.06	-0.24	0.06	-0.05	-0.19	0.36	0.06	-0.11	-0.06	-0.01	-0.08	0.04	**0.83**						
20 Income decrease x Number of reviewers	0.32	0.49	-0.01	-0.02	-0.01	0.00	-0.14	0.00	-0.17	0.05	0.01	-0.17	0.11	0.40	0.01	0.00	0.13	-0.04	0.00	**0.73**	0.69					
21 Income decrease x Reviewers' mutual reviewing tenure	0.06	0.46	0.03	0.05	-0.01	-0.01	-0.08	-0.10	-0.08	0.01	0.04	0.01	0.02	0.19	0.48	0.58	0.03	0.05	0.04	0.15	0.14	0.32				
22 Income decrease x Reviewers' mutual reviewing tenure squared	0.21	3.37	0.04	0.05	0.01	-0.02	-0.05	-0.05	-0.05	0.00	0.06	-0.01	-0.01	0.06	0.45	0.65	0.03	0.06	0.04	0.07	0.05	0.13	**0.91**			
23 Income decrease x Reviewers' reviewing tenure with agent	0.47	1.47	-0.14	-0.14	-0.09	-0.02	0.04	0.05	-0.01	0.03	0.57	-0.21	-0.12	0.04	-0.04	-0.01	**0.82**	-0.07	0.05	0.34	0.18	0.31	0.07	0.05		
24 Income decrease x Reviewers' ties to external reviewers	0.66	2.27	0.05	0.05	0.00	-0.02	0.02	-0.18	-0.13	0.02	0.11	0.09	0.09	0.09	0.03	0.06	0.00	0.43	-0.09	0.37	0.34	0.35	0.19	0.15	0.08	
25 Income decrease x Principal's attention	-14.8	23.5	0.25	0.27	0.19	0.09	0.07	-0.13	0.20	-0.06	0.00	0.26	0.02	0.01	0.12	0.08	-0.03	0.05	0.43	-0.69	-0.55	-0.51	-0.05	-0.01	-0.20	-0.33

Table 7-4 Regression analysis with R&D project actual cost as the dependent variable, Projects with modestly long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with modestly long time to income

Dependent variable : R&D project actual cost

	Model 1.2.1		Model 1.2.2		Model 1.2.2.1	
Control variables						
Project budget	0.0051 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)
Continuation project	0.3074 ***	(0.0776)	0.2976 ***	(0.0670)	0.2972 ***	(0.0673)
Project milestones	0.0935 *	(0.0367)	0.0725 .	(0.0380)	0.0725 .	(0.0380)
Project status problems	-0.0921	(0.0687)	-0.1061 .	(0.0631)	-0.1067 .	(0.0634)
Agent frugality	-0.0067	(0.0053)	-0.0127 .	(0.0076)	-0.0127 .	(0.0076)
Reviewer experience	-0.0044	(0.0037)	-0.0076	(0.0054)	-0.0075	(0.0054)
Independent variables						
H1: Quantity of written ex ante reasoning			0.1901 **	(0.0693)	0.1902 **	(0.0693)
H2: Frequency of revision of written ex ante reasoning			0.0322 *	(0.0140)	0.0321 *	(0.0140)
H3: Number of reviewers			-0.0450	(0.0645)	-0.0495	(0.0686)
H4: Reviewers' mutual reviewing tenure			0.0387	(0.0449)	0.0529	(0.0992)
H4: Reviewers' mutual reviewing tenure squared					-0.0027	(0.0124)
H5: Reviewers' reviewing tenure with agent			-0.0035	(0.0304)	-0.0037	(0.0306)
H6: Reviewers' ties to external reviewers			0.0112	(0.0094)	0.0113	(0.0094)
H7: Principal's attention			0.0148 ***	(0.0016)	0.0148 ***	(0.0016)
Constant	2.6208 ***	(0.2010)	1.7146 **	(0.5349)	1.7162 **	(0.5345)
N	1118		1118		1118	
R2	0.534		0.588		0.588	
Adjusted R2	0.528		0.579		0.579	
F	79.00 ***		67.79 ***		64.91 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-5 Regression analysis with R&D project actual cost as the dependent variable, Projects with modestly long time horizon, Part 2

Regression analysis

Time horizon: R&D projects with modestly long time to income

Dependent variable: R&D project actual cost

	Model 1.2.3.1		Model 1.2.3.2		Model 1.2.3.3	
Control variables						
Project budget	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)
Continuation project	0.3038 ***	(0.0679)	0.2969 ***	(0.0673)	0.2982 ***	(0.0668)
Project milestones	0.0686 .	(0.0370)	0.0729 .	(0.0381)	0.0725 .	(0.0380)
Project status problems	-0.1030	(0.0629)	-0.1051 .	(0.0630)	-0.1060 .	(0.0631)
Agent frugality	-0.0130 .	(0.0075)	-0.0125	(0.0076)	-0.0128 .	(0.0077)
Reviewer experience	-0.0072	(0.0054)	-0.0075	(0.0054)	-0.0076	(0.0054)
Independent variables						
H1: Quantity of written ex ante reasoning	0.1357	(0.0835)	0.1896 **	(0.0694)	0.1895 **	(0.0699)
H2: Frequency of revision of written ex ante reasoning	0.0329 *	(0.0141)	0.0364 *	(0.0162)	0.0323 *	(0.0138)
H3: Number of reviewers	-0.0481	(0.0654)	-0.0461	(0.0638)	-0.0513	(0.0773)
H4: Reviewers' mutual reviewing tenure	0.0379	(0.0454)	0.0378	(0.0449)	0.0386	(0.0449)
H4: Reviewers' mutual reviewing tenure squared						
H5: Reviewers' reviewing tenure with agent	-0.0029	(0.0302)	-0.0034	(0.0303)	-0.0035	(0.0304)
H6: Reviewers' ties to external reviewers	0.0119	(0.0094)	0.0108	(0.0094)	0.0112	(0.0094)
H7: Principal's attention	0.0147 ***	(0.0016)	0.0148 ***	(0.0016)	0.0148 ***	(0.0016)
H8: Income decrease x Quantity of written ex ante reasoning	0.1533	(0.1153)				
H8: Income decrease x Frequency of revision of written ex ante reasoning			-0.0114	(0.0250)		
H8: Income decrease x Number of reviewers					0.0164	(0.1186)
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent						
H8: Income decrease x Reviewers' ties to external reviewers						
H8: Income decrease x Principal's attention						
Constant	0.8777	(0.7771)	1.7348 **	(0.5360)	1.7150 **	(0.5350)
N	1118		1118		1118	
R2	0.588		0.588		0.588	
Adjusted R2	0.579		0.579		0.579	
F	65.12 ***		64.93 ***		64.91 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

182

Table 7-6 Regression analysis with R&D project actual cost as the dependent variable, Projects with modestly long time horizon, Part 3

Regression analysis
Time horizon: R&D projects with modestly long time to income
Dependent variable: R&D project actual cost

	Model 1.2.3.4.1		Model 1.2.3.4.2		Model 1.2.3.4.3		Model 1.2.3.5		Model 1.2.3.6		Model 1.2.3.7	
Control variables												
Project budget	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)	0.0039 ***	(0.0003)
Continuation project	0.2983 ***	(0.0670)	0.2979 ***	(0.0673)	0.2985 ***	(0.0679)	0.2859 ***	(0.0671)	0.2988 ***	(0.0670)	0.3039 ***	(0.0670)
Project milestones	0.0718 .	(0.0379)	0.0713 .	(0.0377)	0.0715 .	(0.0378)	0.0677 .	(0.0383)	0.0724 .	(0.0379)	0.0707 .	(0.0378)
Project status problems	-0.1045 .	(0.0634)	-0.1051 .	(0.0635)	-0.1052 .	(0.0635)	-0.1115 .	(0.0633)	-0.1047 .	(0.0637)	-0.1095 .	(0.0624)
Agent frugality	-0.0129 .	(0.0076)	-0.0130 .	(0.0076)	-0.0131 .	(0.0076)	-0.0121 .	(0.0077)	-0.0131 .	(0.0073)	-0.0102 .	(0.0082)
Reviewer experience	-0.0077	(0.0054)	-0.0077	(0.0054)	-0.0077	(0.0054)	-0.0067	(0.0050)	-0.0074	(0.0054)	-0.0071	(0.0052)
Independent variables												
H1: Quantity of written ex ante reasoning	0.1889 **	(0.0696)	0.1883 **	(0.0696)	0.1881 **	(0.0698)	0.1888 **	(0.0685)	0.1910 **	(0.0693)	0.1963 **	(0.0698)
H2: Frequency of revision of written ex ante reasoning	0.0325 *	(0.0140)	0.0324 *	(0.0140)	0.0324 *	(0.0140)	0.0328 *	(0.0138)	0.0326 *	(0.0138)	0.0328 *	(0.0138)
H3: Number of reviewers	-0.0419	(0.0665)	-0.0520	(0.0682)	-0.0497	(0.0702)	-0.0347	(0.0643)	-0.0461	(0.0644)	-0.0614	(0.0658)
H4: Reviewers' mutual reviewing tenure	0.0187	(0.0888)	0.0437	(0.1008)	0.0269	(0.1334)	0.0326	(0.0444)	0.0372	(0.0457)	0.0469	(0.0457)
H4: Reviewers' mutual reviewing tenure squared			-0.0074	(0.0190)	-0.0012	(0.0479)						
H5: Reviewers' reviewing tenure with agent	-0.0024	(0.0309)	-0.0024	(0.0309)	-0.0026	(0.0310)	0.0395	(0.0346)	-0.0043	(0.0305)	-0.0052	(0.0300)
H6: Reviewers' ties to external reviewers	0.0111	(0.0094)	0.0112	(0.0094)	0.0110	(0.0095)	0.0103	(0.0092)	0.0093	(0.0104)	0.0107	(0.0092)
H7: Principal's attention	0.0147 ***	(0.0016)	0.0148 ***	(0.0016)	0.0148 ***	(0.0016)	0.0148 ***	(0.0016)	0.0148 ***	(0.0016)	0.0172 ***	(0.0020)
H8: Income decrease x Quantity of written ex ante reasoning												
H8: Income decrease x Frequency of revision of written ex ante reasoning												
H8: Income decrease x Number of reviewers	0.0305	(0.1007)	0.0519	(0.1369)	0.0645	(0.1301)						
H8: Income decrease x Reviewers' mutual reviewing tenure					-0.0059	(0.0371)						
H8: Income decrease x Reviewers' mutual reviewing tenure squared							-0.0900 .	(0.0519)				
H8: Income decrease x Reviewers' reviewing tenure with agent									0.0069	(0.0197)		
H8: Income decrease x Reviewers' ties to external reviewers											-0.0055 .	(0.0030)
H8: Income decrease x Principal's attention												
Constant	1.7239 **	(0.5367)	1.7350 **	(0.5370)	1.7349 **	(0.5372)	1.7923 ***	(0.5296)	1.7043 **	(0.5354)	1.5667 **	(0.5454)
N	1118		1118		1118		1118		1118		1118	
R2	0.588		0.588		0.588		0.589		0.588		0.590	
Adjusted R2	0.579		0.578		0.578		0.580		0.579		0.581	
F	64.92 ***		62.28 ***		59.84 ***		65.30 ***		64.92 ***		65.48 ***	

. $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 7-7 Regression analysis with R&D project actual cost as the dependent variable, Projects with medium long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with medium long time to income

Dependent variable : R&D project actual cost

	Model 1.3.1		Model 1.3.2		Model 1.3.2.1	
Control variables						
Project budget	0.0042 ***	(0.0004)	0.0032 ***	(0.0004)	0.0031 ***	(0.0004)
Continuation project	0.0493	(0.1089)	0.0418	(0.1064)	0.0379	(0.1062)
Project milestones	0.2245 ***	(0.0548)	0.1794 **	(0.0569)	0.1814 **	(0.0571)
Project status problems	-0.0398	(0.0857)	-0.0169	(0.0773)	-0.0175	(0.0775)
Agent frugality	0.0841	(0.1021)	0.0745	(0.0958)	0.0838	(0.0986)
Reviewer experience	-0.0019	(0.0036)	-0.0085 *	(0.0039)	-0.0082 *	(0.0039)
Independent variables						
H1: Quantity of written ex ante reasoning			0.3156 ***	(0.0721)	0.3131 ***	(0.0729)
H2: Frequency of revision of written ex ante reasoning			0.0141	(0.0208)	0.0160	(0.0206)
H3: Number of reviewers			0.0528	(0.1165)	0.0078	(0.1210)
H4: Reviewers' mutual reviewing tenure			0.1143 .	(0.0635)	0.3435 *	(0.1729)
H4: Reviewers' mutual reviewing tenure squared					-0.0687	(0.0454)
H5: Reviewers' reviewing tenure with agent			-0.0131	(0.0359)	-0.0138	(0.0359)
H6: Reviewers' ties to external reviewers			0.0370 **	(0.0123)	0.0379 **	(0.0126)
H7: Principal's attention			0.0132 ***	(0.0027)	0.0130 ***	(0.0027)
Constant	2.5925 ***	(0.2264)	0.6246	(0.6278)	0.6460	(0.6342)
N	557		557		557	
R2	0.475		0.532		0.533	
Adjusted R2	0.459		0.512		0.512	
F	30.51 ***		26.36 ***		25.34 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-8 Regression analysis with R&D project actual cost as the dependent variable, Projects with medium long time horizon, Part 2

Regression analysis

Time horizon: R&D projects with medium long time to income

Dependent variable: R&D project actual cost

	Model 1.3.3.1		Model 1.3.3.2		Model 1.3.3.3	
Control variables						
Project budget	0.0032 ***	(0.0004)	0.0032 ***	(0.0004)	0.0032 ***	(0.0004)
Continuation project	0.0343	(0.1078)	0.0399	(0.1074)	0.0403	(0.1059)
Project milestones	0.1735 **	(0.0577)	0.1773 **	(0.0567)	0.1811 **	(0.0569)
Project status problems	-0.0172	(0.0767)	-0.0169	(0.0769)	-0.0128	(0.0783)
Agent frugality	0.0683	(0.0958)	0.0662	(0.0958)	0.0647	(0.1016)
Reviewer experience	-0.0083 *	(0.0039)	-0.0086 *	(0.0039)	-0.0076 .	(0.0039)
Independent variables						
H1: Quantity of written ex ante reasoning	0.2449 **	(0.0844)	0.3166 ***	(0.0721)	0.3193 ***	(0.0723)
H2: Frequency of revision of written ex ante reasoning	0.0142	(0.0207)	0.0002	(0.0313)	0.0133	(0.0205)
H3: Number of reviewers	0.0494	(0.1156)	0.0555	(0.1166)	0.1262	(0.1529)
H4: Reviewers' mutual reviewing tenure	0.1127 .	(0.0635)	0.1185 .	(0.0644)	0.1113 .	(0.0635)
H4: Reviewers' mutual reviewing tenure squared						
H5: Reviewers' reviewing tenure with agent	-0.0122	(0.0358)	-0.0135	(0.0362)	-0.0138	(0.0361)
H6: Reviewers' ties to external reviewers	0.0388 **	(0.0122)	0.0372 **	(0.0123)	0.0366 **	(0.0121)
H7: Principal's attention	0.0134 ***	(0.0027)	0.0133 ***	(0.0027)	0.0130 ***	(0.0027)
H8: Income decrease x Quantity of written ex ante reasoning	0.1840	(0.1684)				
H8: Income decrease x Frequency of revision of written ex ante reasoning			0.0325	(0.0368)		
H8: Income decrease x Number of reviewers					-0.1719	(0.2053)
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent						
H8: Income decrease x Reviewers' ties to external reviewers						
H8: Income decrease x Principal's attention						
Constant	-0.3137	(1.1806)	0.5751	(0.6332)	0.6101	(0.6304)
N	557		557		557	
R2	0.534		0.533		0.533	
Adjusted R2	0.513		0.512		0.512	
F	25.36 ***		25.30 ***		25.29 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

185

Table 7-9 Regression analysis with R&D project actual cost as the dependent variable, Projects with medium long time horizon, Part 3

Regression analysis
Time horizon: R&D projects with medium long time to income
Dependent variable: R&D project actual cost

	Model 1.3.3.4.1	Model 1.3.3.4.2	Model 1.3.3.4.3	Model 1.3.3.5	Model 1.3.3.6	Model 1.3.3.7
Control variables						
Project budget	0.0031 *** (0.0004)	0.0031 *** (0.0004)	0.0031 *** (0.0004)	0.0032 *** (0.0004)	0.0032 *** (0.0004)	0.0031 *** (0.0004)
Continuation project	0.0434 (0.1071)	0.0408 (0.1069)	0.0368 (0.1072)	0.0394 (0.1066)	0.0416 (0.1068)	0.0433 (0.1085)
Project milestones	0.1863 ** (0.0572)	0.1864 ** (0.0573)	0.1850 ** (0.0573)	0.1811 ** (0.0571)	0.1795 ** (0.0568)	0.1767 ** (0.0571)
Project status problems	-0.0121 (0.0779)	-0.0132 (0.0780)	-0.0125 (0.0779)	-0.0165 (0.0778)	-0.0170 (0.0775)	-0.0134 (0.0774)
Agent frugality	0.0536 (0.1000)	0.0624 (0.1027)	0.0545 (0.1025)	0.0724 (0.0961)	0.0747 (0.0964)	0.0722 (0.0980)
Reviewer experience	-0.0079 * (0.0039)	-0.0078 * (0.0039)	-0.0079 * (0.0039)	-0.0082 * (0.0039)	-0.0085 * (0.0040)	-0.0083 * (0.0039)
Independent variables						
H1: Quantity of written ex ante reasoning	0.3208 *** (0.0719)	0.3185 *** (0.0725)	0.3239 *** (0.0720)	0.3137 *** (0.0721)	0.3154 *** (0.0730)	0.3141 *** (0.0709)
H2: Frequency of revision of written ex ante reasoning	0.0119 (0.0208)	0.0134 (0.0208)	0.0120 (0.0208)	0.0145 (0.0209)	0.0141 (0.0209)	0.0120 (0.0202)
H3: Number of reviewers	0.0446 (0.1156)	0.0191 (0.1195)	0.0325 (0.1202)	0.0549 (0.1164)	0.0528 (0.1167)	0.0417 (0.1169)
H4: Reviewers' mutual reviewing tenure	0.2154 ** (0.0742)	0.3363 . (0.1750)	0.2712 (0.1855)	0.1124 . (0.0633)	0.1143 . (0.0639)	0.1160 . (0.0629)
H4: Reviewers' mutual reviewing tenure squared		-0.0410 (0.0471)	-0.0284 (0.0486)			
H5: Reviewers' reviewing tenure with agent	-0.0157 (0.0355)	-0.0157 (0.0356)	-0.0178 (0.0355)	0.0030 (0.0534)	-0.0131 (0.0363)	-0.0135 (0.0355)
H6: Reviewers' ties to external reviewers	0.0378 ** (0.0125)	0.0381 ** (0.0127)	0.0379 ** (0.0127)	0.0361 ** (0.0120)	0.0372 * (0.0153)	0.0364 ** (0.0123)
H7: Principal's attention	0.0132 *** (0.0027)	0.0131 *** (0.0027)	0.0131 *** (0.0027)	0.0132 *** (0.0027)	0.0132 *** (0.0027)	0.0152 *** (0.0033)
H8: Income decrease x Quantity of written ex ante reasoning						
H8: Income decrease x Frequency of revision of written ex ante reasoning						
H8: Income decrease x Number of reviewers						
H8: Income decrease x Reviewers' mutual reviewing tenure	-0.2328 * (0.1124)	-0.1964 . (0.1118)	-0.2569 * (0.1132)			
H8: Income decrease x Reviewers' mutual reviewing tenure squared			0.0634 * (0.0288)			
H8: Income decrease x Reviewers' reviewing tenure with agent				-0.0312 (0.0604)		
H8: Income decrease x Reviewers' ties to external reviewers					-0.0005 (0.0175)	
H8: Income decrease x Principal's attention						-0.0050 (0.0044)
Constant	0.5647 (0.6273)	0.5869 (0.6315)	0.5504 (0.6293)	0.6484 (0.6285)	0.6263 (0.6378)	0.5756 (0.6171)
N	557	557	557	557	557	557
R2	0.534	0.535	0.536	0.532	0.532	0.534
Adjusted R2	0.513	0.513	0.513	0.511	0.511	0.513
F	25.45 ***	24.42 ***	23.55 ***	25.24 ***	25.21 ***	25.37 ***

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 7-10 Regression analysis with R&D project actual cost as the dependent variable, Projects with very long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with very long time to income

Dependent variable: R&D project actual cost

	Model 1.4.1		Model 1.4.2		Model 1.4.2.1	
Control variables						
Project budget	0.0029 ***	(0.0005)	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)
Continuation project	0.0106	(0.1180)	0.0599	(0.1114)	0.0608	(0.1112)
Project milestones	0.1723 **	(0.0623)	0.1019 .	(0.0579)	0.1014 .	(0.0579)
Project status problems	-0.0410	(0.1288)	-0.1039	(0.1234)	-0.0986	(0.1248)
Agent frugality	-0.0187 *	(0.0092)	-0.0045	(0.0137)	-0.0048	(0.0146)
Reviewer experience	0.0084	(0.0057)	0.0039	(0.0075)	0.0040	(0.0075)
Independent variables						
H1: Quantity of written ex ante reasoning			0.5372 ***	(0.1021)	0.5443 ***	(0.1036)
H2: Frequency of revision of written ex ante reasoning			0.0116	(0.0180)	0.0126	(0.0180)
H3: Number of reviewers			0.1329	(0.0996)	0.1790 .	(0.1040)
H4: Reviewers' mutual reviewing tenure			0.0401	(0.0695)	-0.1025	(0.1157)
H4: Reviewers' mutual reviewing tenure squared					0.0249 .	(0.0139)
H5: Reviewers' reviewing tenure with agent			-0.0882	(0.0536)	-0.0890 .	(0.0537)
H6: Reviewers' ties to external reviewers			0.0315 *	(0.0129)	0.0300 *	(0.0131)
H7: Principal's attention			0.0194 ***	(0.0031)	0.0192 ***	(0.0031)
Constant	2.2795 ***	(0.3625)	-1.0071	(0.9073)	-1.0981	(0.9228)
N	468		468		468	
R2	0.323		0.484		0.485	
Adjusted R2	0.299		0.457		0.457	
F	13.47 ***		18.10 ***		17.40 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-11 Regression analysis with R&D project actual cost as the dependent variable, Projects with very long time horizon, Part 2

Regression analysis

Time horizon: R&D projects with very long time to income

Dependent variable: R&D project actual cost

	Model 1.4.3.1		Model 1.4.3.2		Model 1.4.3.3	
Control variables						
Project budget	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)
Continuation project	0.0735	(0.1096)	0.0703	(0.1133)	0.0648	(0.1108)
Project milestones	0.0960 .	(0.0556)	0.0983 .	(0.0564)	0.1013 .	(0.0580)
Project status problems	-0.0801	(0.1215)	-0.0891	(0.1238)	-0.0989	(0.1251)
Agent frugality	-0.0044	(0.0138)	-0.0081	(0.0143)	-0.0049	(0.0149)
Reviewer experience	0.0069	(0.0074)	0.0046	(0.0073)	0.0042	(0.0075)
Independent variables						
H1: Quantity of written ex ante reasoning	0.3816 ***	(0.1133)	0.5369 ***	(0.1005)	0.5423 ***	(0.1047)
H2: Frequency of revision of written ex ante reasoning	0.0154	(0.0178)	-0.0078	(0.0206)	0.0129	(0.0180)
H3: Number of reviewers	0.2030 .	(0.1041)	0.1603	(0.1038)	0.1997 *	(0.1016)
H4: Reviewers' mutual reviewing tenure	-0.1015	(0.1122)	-0.0691	(0.1177)	-0.1076	(0.1150)
H4: Reviewers' mutual reviewing tenure squared	0.0233 .	(0.0137)	0.0210	(0.0142)	0.0254	(0.0139)
H5: Reviewers' reviewing tenure with agent	-0.1002 .	(0.0559)	-0.0937 .	(0.0540)	-0.0890 .	(0.0536)
H6: Reviewers' ties to external reviewers	0.0292 *	(0.0136)	0.0317 *	(0.0135)	0.0299 *	(0.0131)
H7: Principal's attention	0.0187 ***	(0.0029)	0.0191 ***	(0.0030)	0.0192 ***	(0.0031)
H8: Income decrease x Quantity of written ex ante reasoning	0.3836 *	(0.1910)				
H8: Income decrease x Frequency of revision of written ex ante reasoning			0.0703 .	(0.0424)		
H8: Income decrease x Number of reviewers					-0.0560	(0.2058)
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent						
H8: Income decrease x Reviewers' ties to external reviewers						
H8: Income decrease x Principal's attention						
Constant	-3.0247 *	(1.5266)	-1.1619	(0.8993)	-1.0688	(0.9385)
N	468		468		468	
R2	0.491		0.489		0.485	
Adjusted R2	0.462		0.460		0.456	
F	17.04 ***		16.89 ***		16.68 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-12 Regression analysis with R&D project actual cost as the dependent variable, Projects with very long time horizon, Part 3

Regression analysis

Time horizon: R&D projects with very long time to income

Dependent variable: R&D project actual cost

	Model 1.4.3.4.1		Model 1.4.3.4.2		Model 1.4.3.4.3		Model 1.4.3.5		Model 1.4.3.6		Model 1.4.3.7	
Control variables												
Project budget	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)	0.0021 ***	(0.0004)	0.0022 ***	(0.0004)	0.0022 ***	(0.0004)
Continuation project	0.0625	(0.1111)	0.0628	(0.1110)	0.0621	(0.1116)	0.0562	(0.1115)	0.0668	(0.1110)	0.0781	(0.1102)
Project milestones	0.0996 .	(0.0581)	0.0996 .	(0.0581)	0.0996 .	(0.0582)	0.0970 .	(0.0586)	0.1078 .	(0.0572)	0.1004 .	(0.0578)
Project status problems	-0.0937	(0.1244)	-0.0910	(0.1252)	-0.0908	(0.1254)	-0.0946	(0.1263)	-0.0953	(0.1231)	-0.0931	(0.1247)
Agent frugality	-0.0058	(0.0142)	-0.0059	(0.0148)	-0.0059	(0.0149)	-0.0054	(0.0147)	-0.0020	(0.0125)	-0.0040	(0.0150)
Reviewer experience	0.0043	(0.0074)	0.0044	(0.0074)	0.0044	(0.0075)	0.0064	(0.0080)	0.0059	(0.0073)	0.0052	(0.0075)
Independent variables												
H1: Quantity of written ex ante reasoning	0.5445 ***	(0.1019)	0.5490 ***	(0.1031)	0.5493 ***	(0.1034)	0.5437 ***	(0.1021)	0.5385 ***	(0.1013)	0.5603 ***	(0.1033)
H2: Frequency of revision of written ex ante reasoning	0.0094	(0.0184)	0.0105	(0.0184)	0.0104	(0.0184)	0.0135	(0.0181)	0.0174	(0.0185)	0.0121	(0.0179)
H3: Number of reviewers	0.1438	(0.0966)	0.1789 .	(0.1034)	0.1798 .	(0.1036)	0.1867 .	(0.1039)	0.1954 .	(0.1051)	0.1769 .	(0.1015)
H4: Reviewers' mutual reviewing tenure	0.0669	(0.0651)	-0.0506	(0.1328)	-0.0550	(0.1347)	-0.1164	(0.1173)	-0.1321	(0.1148)	-0.1064	(0.1186)
H4: Reviewers' mutual reviewing tenure squared			0.0198	(0.0158)	0.0213	(0.0199)	0.0250 .	(0.0139)	0.0290 *	(0.0140)	0.0240 .	(0.0142)
H5: Reviewers' reviewing tenure with agent	-0.0906 .	(0.0535)	-0.0909 .	(0.0536)	-0.0910 .	(0.0537)	-0.0522	(0.0527)	-0.0953 .	(0.0537)	-0.0862	(0.0528)
H6: Reviewers' ties to external reviewers	0.0312 *	(0.0128)	0.0301 *	(0.0130)	0.0300 *	(0.0131)	0.0273 *	(0.0136)	0.0115	(0.0134)	0.0272 *	(0.0126)
H7: Principal's attention	0.0193 ***	(0.0031)	0.0192 ***	(0.0031)	0.0192 ***	(0.0031)	0.0194 ***	(0.0031)	0.0196 ***	(0.0031)	0.0220 ***	(0.0041)
H8: Income decrease x Quantity of written ex ante reasoning												
H8: Income decrease x Frequency of revision of written ex ante reasoning												
H8: Income decrease x Number of reviewers												
H8: Income decrease x Reviewers' mutual reviewing tenure	-0.2104	(0.1686)	-0.1796	(0.1881)	-0.1811	(0.1897)						
H8: Income decrease x Reviewers' mutual reviewing tenure squared					-0.0020	(0.0111)						
H8: Income decrease x Reviewers' reviewing tenure with agent							-0.0784	(0.0873)				
H8: Income decrease x Reviewers' ties to external reviewers												
H8: Income decrease x Principal's attention									0.0650 *	(0.0280)	-0.0074	(0.0046)
Constant	-1.0698	(0.9069)	-1.1331	(0.9189)	-1.1356	(0.9215)	-1.0385	(0.9258)	-1.0962	(0.9020)	-1.4611	(0.9007)
N	468		468		468		468		468		468	
R2	0.486		0.487		0.487		0.487		0.491		0.489	
Adjusted R2	0.458		0.458		0.456		0.458		0.462		0.460	
F	17.43 ***		16.76 ***		16.08 ***		16.79 ***		17.07 ***		16.92 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-13 Regression analysis with R&D project budget as the dependent variable, Projects with modestly long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with modestly long time to income

Dependent variable : R&D project budget	Model 2.2.1		Model 2.2.2		Model 2.2.2.1	
Control variables						
Project budget	0.0030 ***	(0.0003)	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)
Continuation project	-0.1864 *	(0.0875)	-0.0192	(0.0715)	-0.0179	(0.0717)
Agent frugality	-0.0215	(0.0222)	-0.0202 *	(0.0090)	-0.0203 *	(0.0091)
Reviewer experience	0.0010	(0.0042)	-0.0020	(0.0045)	-0.0023	(0.0044)
Independent variables						
H1: Quantity of written ex ante reasoning			0.3527 ***	(0.0657)	0.3526 ***	(0.0659)
H3: Number of reviewers			0.0609	(0.0786)	0.0831	(0.0830)
H4: Reviewers' mutual reviewing tenure			-0.0903 .	(0.0482)	-0.1610 .	(0.0826)
H4: Reviewers' mutual reviewing tenure squared					0.0134	(0.0109)
H5: Reviewers' reviewing tenure with agent			-0.0160	(0.0283)	-0.0149	(0.0281)
H6: Reviewers' ties to external reviewers			0.0287 **	(0.0100)	0.0285 **	(0.0100)
H7: Principal's attention			0.0239 ***	(0.0016)	0.0239 ***	(0.0016)
Constant	4.3215 ***	(0.1888)	2.1511 ***	(0.5812)	2.1419 ***	(0.5815)
N	1118		1118		1118	
R2	0.209		0.515		0.516	
Adjusted R2	0.199		0.507		0.507	
F	20.82 ***		58.35 ***		55.64 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-14 Regression analysis with R&D project budget as the dependent variable, Projects with modestly long time horizon, Part 2

Regression analysis

Time horizon: R&D projects with modestly long time to income

Dependent variable: R&D project budget

	Model 2.2.3.1		Model 2.2.3.3		Model 2.2.3.4.1		Model 2.2.3.4.2		Model 2.2.3.4.3	
Control variables										
Project budget	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)
Continuation project	-0.0189	(0.0707)	-0.0211	(0.0720)	-0.0192	(0.0715)	-0.0174	(0.0717)	-0.0200	(0.0718)
Agent frugality	-0.0202 *	(0.0090)	-0.0204 *	(0.0090)	-0.0202 *	(0.0090)	-0.0204 *	(0.0091)	-0.0202 *	(0.0088)
Reviewer experience	-0.0020	(0.0044)	-0.0018	(0.0045)	-0.0020	(0.0045)	-0.0021	(0.0045)	-0.0021	(0.0045)
Independent variables										
H1: Quantity of written ex ante reasoning	0.3497 ***	(0.0900)	0.3532 ***	(0.0653)	0.3529 ***	(0.0657)	0.3540 ***	(0.0659)	0.3545 ***	(0.0657)
H3: Number of reviewers	0.0611	(0.0794)	0.0844	(0.0999)	0.0599	(0.0791)	0.0835	(0.0831)	0.0438	(0.0850)
H4: Reviewers' mutual reviewing tenure	-0.0903 .	(0.0483)	-0.0915 .	(0.0483)	-0.0863	(0.0614)	-0.1557 .	(0.0796)	0.0737	(0.1653)
H4: Reviewers' mutual reviewing tenure squared							0.0211	(0.0158)	-0.0548	(0.0480)
H5: Reviewers' reviewing tenure with agent	-0.0160	(0.0283)	-0.0161	(0.0284)	-0.0162	(0.0285)	-0.0162	(0.0284)	-0.0142	(0.0285)
H6: Reviewers' ties to external reviewers	0.0287 **	(0.0100)	0.0278 **	(0.0101)	0.0286 **	(0.0100)	0.0281 **	(0.0101)	0.0285 **	(0.0102)
H7: Principal's attention	0.0239 ***	(0.0016)	0.0239 ***	(0.0016)	0.0240 ***	(0.0016)	0.0239 ***	(0.0016)	0.0238 ***	(0.0016)
H8: Income decrease x Quantity of written ex ante reasoning	0.0072	(0.1203)								
H8: Income decrease x Number of reviewers			-0.0715	(0.1314)						
H8: Income decrease x Reviewers' mutual reviewing tenure					-0.0065	(0.0871)	-0.0739	(0.1050)	-0.3557 .	(0.1859)
H8: Income decrease x Reviewers' mutual reviewing tenure squared									0.0847 .	(0.0476)
H8: Income decrease x Reviewers' reviewing tenure with agent										
H8: Income decrease x Reviewers' ties to external reviewers										
H8: Income decrease x Principal's attention										
Constant	2.1151 **	(0.7335)	2.1666 ***	(0.5892)	2.1506 ***	(0.5817)	2.1306 ***	(0.5820)	2.1455 ***	(0.5811)
N	1118		1118		1118		1118		1118	
R2	0.515		0.516		0.515		0.516		0.518	
Adjusted R2	0.506		0.506		0.506		0.507		0.508	
F	55.52 ***		55.57 ***		55.52 ***		53.14 ***		51.15 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-15 Regression analysis with R&D project budget as the dependent variable, Projects with modestly long time horizon, Part 3

Regression analysis

Time horizon: R&D projects with modestly long time to income

Dependent variable: R&D project budget

	Model 2.2.3.5		Model 2.2.3.6		Model 2.2.3.7	
Control variables						
Project budget	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)	0.0015 ***	(0.0003)
Continuation project	-0.0136	(0.0721)	-0.0146	(0.0717)	-0.0184	(0.0713)
Agent frugality	-0.0203 *	(0.0089)	-0.0197 *	(0.0085)	-0.0203 *	(0.0089)
Reviewer experience	-0.0005	(0.0047)	-0.0022	(0.0044)	-0.0019	(0.0045)
Independent variables						
H1: Quantity of written ex ante reasoning	0.3512 ***	(0.0657)	0.3535 ***	(0.0654)	0.3529 ***	(0.0659)
H3: Number of reviewers	0.0648	(0.0786)	0.0465	(0.0784)	0.0589	(0.0786)
H4: Reviewers' mutual reviewing tenure	-0.0953 *	(0.0481)	-0.0834 .	(0.0473)	-0.0896 .	(0.0483)
H4: Reviewers' mutual reviewing tenure squared						
H5: Reviewers' reviewing tenure with agent	0.0205	(0.0358)	-0.0183	(0.0285)	-0.0163	(0.0282)
H6: Reviewers' ties to external reviewers	0.0249 *	(0.0100)	0.0377 ***	(0.0109)	0.0286 **	(0.0100)
H7: Principal's attention	0.0239 ***	(0.0016)	0.0239 ***	(0.0016)	0.0243 ***	(0.0025)
H8: Income decrease x Quantity of written ex ante reasoning						
H8: Income decrease x Number of reviewers						
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent	-0.0762	(0.0513)				
H8: Income decrease x Reviewers' ties to external reviewers			-0.0358 *	(0.0145)		
H8: Income decrease x Principal's attention					-0.0007	(0.0029)
Constant	2.1887 ***	(0.5830)	2.1584 ***	(0.5788)	2.1362 ***	(0.5826)
N	1118		1118		1118	
R2	0.517		0.518		0.516	
Adjusted R2	0.508		0.508		0.506	
F	55.91 ***		56.01 ***		55.54 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-16 Regression analysis with R&D project budget as the dependent variable, Projects with medium long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with medium long time to income

Dependent variable: R&D project budget

	Model 2.3.1		Model 2.3.2		Model 2.3.2.1	
Control variables						
Project budget	0.0028 ***	(0.0002)	0.0012 ***	(0.0003)	0.0012 ***	(0.0003)
Continuation project	-0.2252 .	(0.1252)	0.0256	(0.1157)	0.0248	(0.1158)
Agent frugality	-0.1270 **	(0.0392)	-0.0755	(0.0496)	-0.0788	(0.0522)
Reviewer experience	-0.0034	(0.0036)	-0.0101 **	(0.0034)	-0.0101 **	(0.0034)
Independent variables						
H1: Quantity of written ex ante reasoning			0.2867 ***	(0.0556)	0.2863 ***	(0.0554)
H3: Number of reviewers			0.0930	(0.1227)	0.1062	(0.1252)
H4: Reviewers' mutual reviewing tenure			-0.0075	(0.0594)	-0.0772	(0.1580)
H4: Reviewers' mutual reviewing tenure squared					0.0208	(0.0471)
H5: Reviewers' reviewing tenure with agent			-0.0357	(0.0267)	-0.0356	(0.0267)
H6: Reviewers' ties to external reviewers			0.0527 ***	(0.0142)	0.0524 ***	(0.0143)
H7: Principal's attention			0.0258 ***	(0.0021)	0.0258 ***	(0.0021)
Constant	4.6822 ***	(0.2167)	3.0224 ***	(0.4994)	3.0227 ***	(0.4983)
N	557		557		557	
R2	0.155		0.483		0.483	
Adjusted R2	0.133		0.463		0.463	
F	7.10 ***		25.01 ***		23.80 ***	

. $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-17 Regression analysis with R&D project budget as the dependent variable, Projects with medium long time horizon, Part 2

Regression analysis

Time horizon: R&D projects with medium long time to income

Dependent variable: R&D project budget

	Model 2.3.3.1	Model 2.3.3.3	Model 2.3.3.4.1	Model 2.3.3.4.2	Model 2.3.3.4.3
Control variables					
Project budget	0.0013 *** (0.0003)	0.0012 *** (0.0003)	0.0012 *** (0.0003)	0.0013 *** (0.0003)	0.0012 *** (0.0003)
Continuation project	0.0130 (0.1151)	0.0257 (0.1152)	0.0233 (0.1166)	0.0217 (0.1170)	0.0144 (0.1155)
Agent frugality	-0.0695 (0.0490)	-0.0731 (0.0505)	-0.0764 (0.0501)	-0.0812 (0.0532)	-0.0736 (0.0533)
Reviewer experience	-0.0097 ** (0.0033)	-0.0095 ** (0.0035)	-0.0101 ** (0.0034)	-0.0102 ** (0.0034)	-0.0099 ** (0.0034)
Independent variables					
H1: Quantity of written ex ante reasoning	0.2034 ** (0.0684)	0.2891 *** (0.0559)	0.2874 *** (0.0557)	0.2870 *** (0.0555)	0.2860 *** (0.0544)
H3: Number of reviewers	0.0882 (0.1222)	0.1512 (0.1779)	0.0907 (0.1235)	0.1081 (0.1254)	0.1228 (0.1254)
H4: Reviewers' mutual reviewing tenure	-0.0073 (0.0592)	-0.0104 (0.0598)	-0.0262 (0.0755)	-0.1269 (0.1783)	-0.0283 (0.2032)
H4: Reviewers' mutual reviewing tenure squared				0.0285 (0.0480)	-0.0018 (0.0563)
H5: Reviewers' reviewing tenure with agent	-0.0334 (0.0261)	-0.0362 (0.0268)	-0.0360 (0.0267)	-0.0359 (0.0267)	-0.0388 (0.0265)
H6: Reviewers' ties to external reviewers	0.0553 *** (0.0141)	0.0522 *** (0.0138)	0.0526 *** (0.0143)	0.0522 *** (0.0144)	0.0522 *** (0.0144)
H7: Principal's attention	0.0259 *** (0.0021)	0.0257 *** (0.0021)	0.0257 *** (0.0021)	0.0258 *** (0.0021)	0.0257 *** (0.0021)
H8: Income decrease x Quantity of written ex ante reasoning	0.1740 (0.1153)				
H8: Income decrease x Number of reviewers		-0.1246 (0.2207)			
H8: Income decrease x Reviewers' mutual reviewing tenure			0.0668 (0.1052)	0.0852 (0.1059)	-0.3763 (0.3017)
H8: Income decrease x Reviewers' mutual reviewing tenure squared					0.1670 . (0.0932)
H8: Income decrease x Reviewers' reviewing tenure with agent					
H8: Income decrease x Reviewers' ties to external reviewers					
H8: Income decrease x Principal's attention					
Constant	2.2547 ** (0.8198)	3.0187 *** (0.5029)	3.0188 *** (0.5000)	3.0181 *** (0.4983)	3.0215 *** (0.4896)
N	557	557	557	557	557
R2	0.485	0.484	0.483	0.483	0.486
Adjusted R2	0.465	0.463	0.463	0.462	0.464
F	24.01 ***	23.85 ***	23.81 ***	22.72 ***	21.89 ***

. $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-18 Regression analysis with R&D project budget as the dependent variable, Projects with medium long time horizon, Part 3

Regression analysis

Time horizon: R&D projects with medium long time to income

Dependent variable: R&D project budget

	Model 2.3.3.5		Model 2.3.3.6		Model 2.3.3.7	
Control variables						
Project budget	0.0012 ***	(0.0003)	0.0012 ***	(0.0003)	0.0012 ***	(0.0003)
Continuation project	0.0254	(0.1160)	0.0194	(0.1166)	0.0246	(0.1161)
Agent frugality	-0.0755	(0.0496)	-0.0732	(0.0498)	-0.0780	(0.0496)
Reviewer experience	-0.0100 **	(0.0034)	-0.0100 **	(0.0034)	-0.0101 **	(0.0034)
Independent variables						
H1: Quantity of written ex ante reasoning	0.2865 ***	(0.0558)	0.2863 ***	(0.0553)	0.2894 ***	(0.0548)
H3: Number of reviewers	0.0933	(0.1232)	0.0936	(0.1229)	0.0940	(0.1231)
H4: Reviewers' mutual reviewing tenure	-0.0074	(0.0594)	-0.0078	(0.0595)	-0.0069	(0.0591)
H4: Reviewers' mutual reviewing tenure squared						
H5: Reviewers' reviewing tenure with agent	-0.0333	(0.0413)	-0.0341	(0.0270)	-0.0357	(0.0268)
H6: Reviewers' ties to external reviewers	0.0525 ***	(0.0141)	0.0495 **	(0.0156)	0.0521 ***	(0.0145)
H7: Principal's attention	0.0258 ***	(0.0021)	0.0256 ***	(0.0021)	0.0251 ***	(0.0030)
H8: Income decrease x Quantity of written ex ante reasoning						
H8: Income decrease x Number of reviewers						
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent	-0.0049	(0.0474)				
H8: Income decrease x Reviewers' ties to external reviewers			0.0206	(0.0239)		
H8: Income decrease x Principal's attention					0.0014	(0.0039)
Constant	3.0257 ***	(0.5021)	3.0207 ***	(0.4963)	3.0180 ***	(0.4998)
N	557		557		557	
R2	0.483		0.484		0.483	
Adjusted R2	0.462		0.463		0.463	
F	23.78 ***		23.85 ***		23.80 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-19 Regression analysis with R&D project budget as the dependent variable, Projects with very long time horizon, Part 1

Regression analysis

Time horizon: R&D projects with very long time to income

Dependent variable: R&D project budget

	Model 2.4.1		Model 2.4.2		Model 2.4.2.1	
Control variables						
Project budget	0.0017 ***	(0.0003)	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)
Continuation project	-0.1562	(0.1239)	0.0463	(0.1108)	0.0489	(0.1112)
Agent frugality	-0.0204 *	(0.0081)	-0.0090 *	(0.0039)	-0.0094 *	(0.0038)
Reviewer experience	0.0017	(0.0042)	0.0028	(0.0062)	0.0029	(0.0062)
Independent variables						
H1: Quantity of written ex ante reasoning			0.2119 **	(0.0802)	0.2207 **	(0.0798)
H3: Number of reviewers			0.0260	(0.0970)	0.0740	(0.1039)
H4: Reviewers' mutual reviewing tenure			-0.0371	(0.0502)	-0.1849 .	(0.1045)
H4: Reviewers' mutual reviewing tenure squared					0.0258 *	(0.0126)
H5: Reviewers' reviewing tenure with agent			-0.1154 **	(0.0395)	-0.1160 **	(0.0394)
H6: Reviewers' ties to external reviewers			0.0336 ***	(0.0087)	0.0321 ***	(0.0088)
H7: Principal's attention			0.0214 ***	(0.0023)	0.0213 ***	(0.0022)
Constant	4.2954 ***	(0.1351)	3.5311 ***	(0.7394)	3.4265 ***	(0.7364)
N	468		468		468	
R2	0.146		0.414		0.417	
Adjusted R2	0.119		0.388		0.389	
F	5.52 ***		15.78 ***		15.18 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

Table 7-20 Regression analysis with R&D project budget as the dependent variable, Projects with very long time horizon, Part 2

Regression analysis
Time horizon: R&D projects with very long time to income

Dependent variable: R&D project budget	Model 2.4.3.1		Model 2.4.3.3		Model 2.4.3.4.1		Model 2.4.3.4.2		Model 2.4.3.4.3	
Control variables										
Project budget	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)
Continuation project	0.0480	(0.1112)	0.0489	(0.1113)	0.0477	(0.1121)	0.0451	(0.1128)	0.0396	(0.1130)
Agent frugality	-0.0091 *	(0.0038)	-0.0094 *	(0.0038)	-0.0089 *	(0.0039)	-0.0095 *	(0.0039)	-0.0092 *	(0.0040)
Reviewer experience	0.0024	(0.0063)	0.0028	(0.0062)	0.0027	(0.0062)	0.0031	(0.0063)	0.0033	(0.0063)
Independent variables										
H1: Quantity of written ex ante reasoning	0.2560 *	(0.1007)	0.2214 **	(0.0804)	0.2123 **	(0.0802)	0.2209 **	(0.0799)	0.2188 **	(0.0798)
H3: Number of reviewers	0.0688	(0.1051)	0.0629	(0.1192)	0.0267	(0.0963)	0.0788	(0.1059)	0.0862	(0.1058)
H4: Reviewers' mutual reviewing tenure	-0.1863 .	(0.1048)	-0.1815 .	(0.1051)	-0.0419	(0.0529)	-0.1918 .	(0.1072)	-0.1062	(0.1175)
H4: Reviewers' mutual reviewing tenure squared	0.0259 *	(0.0126)	0.0255 *	(0.0126)			0.0295 *	(0.0139)	0.0108	(0.0175)
H5: Reviewers' reviewing tenure with agent	-0.1136 **	(0.0382)	-0.1161 **	(0.0394)	-0.1151 **	(0.0398)	-0.1168 **	(0.0395)	-0.1179 **	(0.0393)
H6: Reviewers' ties to external reviewers	0.0321 ***	(0.0088)	0.0324 ***	(0.0086)	0.0337 ***	(0.0089)	0.0315 ***	(0.0089)	0.0299 ***	(0.0088)
H7: Principal's attention	0.0213 ***	(0.0022)	0.0213 ***	(0.0022)	0.0214 ***	(0.0023)	0.0213 ***	(0.0022)	0.0215 ***	(0.0022)
H8: Income decrease x Quantity of written ex ante reasoning	-0.0779	(0.1484)								
H8: Income decrease x Number of reviewers			0.0270	(0.1739)						
H8: Income decrease x Reviewers' mutual reviewing tenure					0.0178	(0.1005)	-0.0521	(0.0826)	-0.3852 .	(0.2071)
H8: Income decrease x Reviewers' mutual reviewing tenure squared									0.0527 *	(0.0242)
H8: Income decrease x Reviewers' reviewing tenure with agent										
H8: Income decrease x Reviewers' ties to external reviewers										
H8: Income decrease x Principal's attention										
Constant	3.7932 ***	(1.0603)	3.4154 ***	(0.7488)	3.5271 ***	(0.7394)	3.4235 ***	(0.7361)	3.4445 ***	(0.7344)
N	468		468		468		468		468	
R2	0.417		0.417		0.414		0.417		0.420	
Adjusted R2	0.388		0.388		0.386		0.388		0.390	
F	14.48 ***		14.46 ***		15.00 ***		14.47 ***		13.96 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001
Unstandardized coefficients; Cluster-robust standard errors in parentheses.
Project year control variables not reported

Table 7-21 Regression analysis with R&D project budget as the dependent variable, Projects with very long time horizon, Part 3

8.

Regression analysis

Time horizon: R&D projects with very long time to income

Dependent variable: R&D project budget

	Model 2.4.3.5		Model 2.4.3.6		Model 2.4.3.7	
Control variables						
Project budget	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)	0.0012 ***	(0.0002)
Continuation project	0.0453	(0.1126)	0.0490	(0.1113)	0.0494	(0.1110)
Agent frugality	-0.0098 *	(0.0040)	-0.0092 *	(0.0038)	-0.0093 *	(0.0039)
Reviewer experience	0.0040	(0.0069)	0.0029	(0.0063)	0.0031	(0.0062)
Independent variables						
H1: Quantity of written ex ante reasoning	0.2237 **	(0.0783)	0.2214 **	(0.0802)	0.2208 **	(0.0796)
H3: Number of reviewers	0.0759	(0.1041)	0.0723	(0.1041)	0.0728	(0.1035)
H4: Reviewers' mutual reviewing tenure	-0.2024 .	(0.1066)	-0.1876 .	(0.1058)	-0.1815 .	(0.1070)
H4: Reviewers' mutual reviewing tenure squared	0.0274 *	(0.0127)	0.0262 *	(0.0127)	0.0253 .	(0.0130)
H5: Reviewers' reviewing tenure with agent	-0.0873 *	(0.0418)	-0.1157 **	(0.0396)	-0.1159 **	(0.0391)
H6: Reviewers' ties to external reviewers	0.0300 **	(0.0094)	0.0333 ***	(0.0095)	0.0325 ***	(0.0090)
H7: Principal's attention	0.0213 ***	(0.0022)	0.0213 ***	(0.0022)	0.0219 ***	(0.0035)
H8: Income decrease x Quantity of written ex ante reasoning						
H8: Income decrease x Number of reviewers						
H8: Income decrease x Reviewers' mutual reviewing tenure						
H8: Income decrease x Reviewers' mutual reviewing tenure squared						
H8: Income decrease x Reviewers' reviewing tenure with agent	-0.0436	(0.0549)				
H8: Income decrease x Reviewers' ties to external reviewers			-0.0062	(0.0189)		
H8: Income decrease x Principal's attention					-0.0015	(0.0041)
Constant	3.4118 ***	(0.7279)	3.4223 ***	(0.7396)	3.3904 ***	(0.7192)
N	468		468		468	
R2	0.418		0.417		0.417	
Adjusted R2	0.389		0.388		0.388	
F	14.50 ***		14.46 ***		14.47 ***	

. p < 0.10 * p < 0.05 ** p < 0.01 *** p < 0.001

Unstandardized coefficients; Cluster-robust standard errors in parentheses.

Project year control variables not reported

References

Abrahamson, E., & Park, C. 1994. Concealment of negative organizational outcomes: An agency theory perspective. Academy of Management Journal, 37(5): 1302-1334.

Adams, R. B., & Ferreira, D. 2007. A theory of friendly boards. Journal of Finance, 62(1): 217-250.

Aghion, P., & Bolton, P. 1992. An incomplete contracts approach to financial contracting. Review of Economic Studies, 59(3): 473-494.

Aghion, P., & Tirole, J. 1997. Formal and real authority in organizations. Journal of Political Economy, 105(1): 1-29.

Aguilera, R. V., & Jackson, G. 2010. Comparative and international corporate governance. Academy of Management Annals, 4(1): 485-556.

Alchian, A. A., & Demsetz, H. 1972. Production, information costs, and economic organization. American Economic Review, 62(5): 777-795.

Alderfer, C. P. 1986. From the boardroom: The invisible director on corporate boards. Harvard Business Review, November-December: 38-52.

Alexander, J. A., Fennell, M. L., & Halpern, M. T. 1993. Leadership instability in hospitals: The influence of board-CEO relations and organizational growth and decline. Administrative Science Quarterly, 38: 74-99.

Amabile, T. M. 1993. Motivational synergy: Toward new conceptualizations of intrinsic and extrinsic motivation in the workplace. Human Resource Management Review, 3(3): 185-201.

Anderson, M. H. 2008. Social networks and the cognitive motivation to realize network opportunities: A study of managers' information gathering behaviors. Journal of Organizational Behavior, 59: 51-78.

Arai, M. 2011. Cluster-robust standard errors using R. Stockholm University. Available at: http://people.su.se/~ma/clustering.pdf (accessed 27 February 2013).

Arthurs, J. D., Hoskisson, R. E., Busenitz, L. W., & Johnson, R. A. 2008. Managerial agents watching other agents: Multiple agency conflicts regarding underpricing in IPO firms. Academy of Management Journal, 51(2): 277-294.

Audia, P. G., & Greve, H. R. 2006. Less likely to fail: Low performance, firm size, and factory expansion in the shipbuilding industry. Management Science, 52(1): 83-94.

Audia, P. G., Locke, E. A., & Smith, K. G. 2000. The paradox of success: An archival and a laboratory study of strategic persistence following radical environmental change. Academy of Management Journal, 43(5): 837-853.

Baker, G. P. 1992. Incentive contracts and performance measurement. Journal of Political Economy, 100(3): 598-614.

Baker, G., Gibbons, R., & Murphy, K. J. 1999. Informal authority in organizations. Journal of Law, Economics, & Organization. 15(1): 56-73.

Baker, G. P., Jensen, M. C., & Murphy, K. J. 1988. Compensation and incentives: Practice vs. theory. Journal of Finance, 43(3): 593-616.

Baliga, B. R., Moyer, R. C., & Rao, R. S. 1996. CEO duality and firm performance: What's the fuss? Strategic Management Journal, 17: 41-53.

Balkin, D. B., Markman, G. D., & Gomez-Meija, L. R. 2000. Is CEO pay in high-technology firms related to innovation? Academy of Management Journal, 43(6): 1118-1129.

Barnard, C. I. 1938. The functions of the executive. Revised edition 1968. Cambride: MA: Harvard University Press.

Barrett, C. 2010. Smart people, smart ideas and the right environment drive innovation. Research Technology Management, January-February, 2010.

Barringer, B. R., & Bluedorn, A. C. 1999. The relationship between corporate entrepreneurship and strategic management. Strategic Management Journal, 20: 421-444.

Baysinger, B., & Hoskisson, R. E. 1989. Diversification strategy and R&D intensity in multiproduct firms. Academy of Management Journal, 32(2): 310-332.

Baysinger, B., & Hoskisson, R. E. 1990. The composition of boards of directors and strategic control: Effects on corporate strategy. Academy of Management Review, 15(1): 72-87.

Baysinger, B. D., Kosnik, R. D., & Turk, T. A. 1991. Effects of board and ownership structure on corporate R&D strategy. Academy of Management Journal, 34(1): 205-214.

Bazerman, M. H., & Schoorman, F. D. 1983. A limited rationality model of interlocking directorates. Academy of Management Review, 8(2): 206-217.

Biais, B., & Weber, M. 2009. Hindsight bias, risk perception, and investment performance. Management Science, 55(6): 1018-1029.

Block, Z., & MacMillan, I. C. 1993. Corporate venturing: Creating new businesses with the firm. Boston, MA: Harvard Business School Press.

Boeker, W., & Goodstein, J. 1993. Performance and successor choice: The moderating effects of governance and ownership. Academy of Management Journal, 36(1): 172-186.

Bower, J. L. 1970. Managing the resource allocation process: A study of corporate planning and investment. Revised edition 1986. Boston, MA: Harvard Business School Press.

Bowman, E. H. 1976. Strategy and the weather. Sloan Management Review, 17(2): 49-62.

Bowman, E. H. 1984. Content analysis of annual reports for corporate strategy and risk. Interfaces, 14(1): 61-71.

Box, G. E. P., Hunter, W. G., & Hunter, J. S. 1978. Statistic for experimenters: An introduction to design, data analysis, and model building. Wiley.

Boyd, B. K. 1995. CEO duality and firm performance: A contingency model. Strategic Management Journal, 16: 301-312.

Briscoe, F., & Tsai W. 2011. Overcoming relational inertia: How organizational members respond to acquisition events in a law firm. Administrative Science Quarterly, 56(3): 408-440.

Bromiley, P. 1991. Testing a causal model of corporate risk taking and performance. Academy of Management Journal, 34(1): 37-59.

Burkart, M., Gromb, D., & Panunzi, F. 1997. Large shareholders, monitoring, and the value of the firm. Quarterly Journal of Economics, 112(3): 693-728.

Burns, N., & Kedia, S. 2006. The impact of performance-based compensation on misreporting. Journal of Financial Economics, 79: 35-67.

Burt, R. S. 1980. Cooptive corporate actor networks: A reconsideration of interlocking directorates involving American manufacturing. Administrative Science Quarterly: 557- 582.

Carpenter, M. A., & Westphal, J. D. 2001. The strategic context of external network ties: Examining the impact of director appointments on board involvement in strategic decision making. Academy of Management Journal, 44(4): 639-660.

Cesarini, D., Dawes, C. T., Johannesson, M., Lichtenstein, P., & Wallace, B. 2009. Genetic variation in preferences for giving and risk taking. Quarterly Journal of Economics, May 2009: 809-842.

Chaganti, R. S., Mahajan, V., & Sharma, S. 1985. Corporate board size, composition and corporate failures in retailing industry. Journal of Management Studies, 22(4): 400-417.

Chandler, A. D., Jr. 1962. Strategy and structure: Chapters in the history of the American industrial enterprise. Cambridge, MA: MIT Press.

Chen, W. 2008. Determinants of firms' backward- and forward-looking R&D search behavior. Organization Science, 19(4): 609-622.

Chen, W., & Miller, K. D. 2007. Situational and institutional determinants of firms' R&D search intensity. Strategic Management Journal, 28: 369-381.

Cheng, S. 2008. Board size and the variability of corporate performance. Journal of Financial Economics, 87: 157-176.

Chevalier, J., & Ellison, G. 1999. Career concerns of mutual fund managers. Quarterly Journal of Economics, 114(2): 389-432.

Christensen, C. M., & Bower, J. L. 1996. Customer power, strategic investment, and the failure of leading firms. Strategic Management Journal, 17(3): 197-218.

Cohen, W. M., & Levinthal, D. A. 1989. Innovation and learning: The two faces of R&D. The Economic Journal, 99: 569-596.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35(1): 128-152.

Coles, J. L., Daniel, N. D., & Naveen, L. 2006. Managerial incentives and risk-taking. Journal of Financial Economics 79: 431–468.

Collins J. C., & Porras, J. I. 1994. Built to last. New York: HarperBusiness.

Connelly, B. L., Tihanyi, L., Certo, S. T., & Hitt, M. A. 2010. Marching to the beat of different drummers: The influence of institutional owners on competitive actions. Academy of Management Journal, 53(4): 723-742.

Conyon, M. J., & Peck, S. I. 1998. Board control, remuneration committees, and top management compensation. Academy of Management Journal, 41(2): 146-157.

Cooper, R. G. 1990. Stage-gate systems: A new tool for managing new products. Business Horizons, 33(3): 44-54.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. 2002a. Optimizing the stage-gate process: What best-practice companies do – I. Research Technology Management, 45(5): 21-27.

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. 2002b. Optimizing the stage-gate process: What best-practice companies do – II. Research Technology Management, 45(6): 43-49.

Cooper, R. G., & Kleinschmidt, E. J. 1986. An investigation in to the new product process: Steps, deficiencies, and impact. Journal of Product Innovation Management, 3(2): 71-85.

Cross, R., & Sproull, L. 2004. More than an answer: Information relationships for actionable knowledge. Organization Science, 15(4): 446-462.

Cyert, R. M. & March, J. G. 1963. A behavioral theory of the firm. Revised edition 1992. Malden, MA: Blackwell Publishers.

D'Aveni, R. A., & MacMillan, I. C. 1990. Crises and the content of managerial communications: A study of the focus of attention of top managers in surviving and failing firms. Administrative Science Quarterly, 35: 634-657.

Daily, C. M., & Dalton D. R. 1993. Boards of directors leadership and structure: Control and performance implications. Entrepreneurship Theory and Practice, Spring: 65-81.

Daily, C. M., & Dalton D. R. 1994a. Bankruptcy and corporate governance: The impact of board composition and structure. Academy of Management Journal, 37(6): 1603-1617.

Daily, C. M., & Dalton D. R. 1994b. Corporate governance and the bankrupt firm: An empirical assessment. Strategic Management Journal, 15: 643-654.

Daily, C. M., & Dalton D. R. 1995. CEO and director turnover in failing firms: An illusion of change? Strategic Management Journal, 16(5): 393-400.

Daily, C. M., Dalton, D. R., & Rajagopalan, N. 2003. Governance through ownership: Centuries of practice, decades of research. Academy of Management Journal, 45(2): 151-158.

Dalton, D. R., Daily, C. M., Certo, S. T., & Roengpitya, R. 2003. Meta-analyses of financial performance and equity: Fusion or confusion? Academy of Management Journal, 46(1): 13-26.

Dalton, D. R., Daily, C. M., Ellstrand, A. E., & Johnson, J. L. 1998. Meta-analytic reviews of board composition, leadership structure, and financial performance. Strategic Management Journal, 19: 269-290.

Dalton, D. R., Daily, C. M., Johnson, J. L., & Ellstrand, A. E. 1999. Number of directors and financial performance: A meta-analysis. Academy of Management Journal, 42(6): 674-686.

Dalton, D. R., Hitt, M. A., Certo, S. T., & Dalton, C. M. 2007. The fundamental agency problem and its mitigation: Independence, equity, and the market for corporate control. Academy of Management Annals, 1-64.

Davis, G. F. 1991. Agents without principles? The spread of the poison pill through the intercorporate network. Administrative Science Quarterly, 36(4): 583-613.

Davis, G. F. 2005.New directors in corporate governance. Annual Review of Sociology, 31: 143-162.

Denis, D. J., & Sarin, A. 1999. Ownership and board structures in publicly traded corporations. Journal of Financial Economics, 52: 187-223.

Deutsch, Y., Keil, T., & Laamanen, T. 2007. Decision making in acquisitions: The effect of outside directors' compensation on acquisition patterns. Journal of Management, 33(1): 30-56.

Deutsch, Y., Keil, T., & Laamanen, T. 2010. A dual agency view of board compensation: The join effects of outside director and CEO stock options on firm risk. Strategic Management Journal, 32: 212-227.

Dewett, T. 2007. Linking intrinsic motivation, risk taking, and employee creativity in an R&D environment. R&D Management, 37(3): 197-208.

Dosi, G. 1988. Sources, procedures, and microeconomic effects of innovation. Journal of Economic Literature, 26(3): 1120-1171.

Drazin, R., & Rao, H. 2002. Harnessing managerial knowledge to implement product-line extensions: How do mutual fund families allocate portfolio managers to old and new funds? Academy of Management Journal, 45(3): 609-619.

Duchin, R., Matsusaka, J. G., & Ozbas, O. 2010. When are outside directors effective? Journal of Financial Economics, 96: 195-214.

Eisenberg, T., Sundgren, S., & Wells, M. T. 1998. Larger board size and decreasing firm value in small firms. Journal of Financial Economics, 48: 35-54.

Eisenberger, R., & Aselage, J. 2008. Incremental effects of reward on experienced performance pressure: Positive outcomes for intrinsic interest and creativity. Journal of Organizational Behavior, 30(1): 95-117.

Eisenberger, R., Jones, J. R., Stinglhamber, F., Shanock, L., & Randall, A. T. 2005. Flow experiences at work: for high need achievers alone? Journal of Organizational Behavior, 26: 755-775.

Eisenhardt, K. M. 1985. Control: Organizations and economic approaches. Management Science, 31(2): 134-149.

Eisenhardt, K. M. 1989. Agency theory: An assessment and review. Academy of Management Review, 14(1): 57-74.

Fama, E. F. 1980. Agency problems and the theory of the firm. Journal of Political Economy, 88(2): 288-307.

Fama, E. F., & Jensen, M. C. 1983a. Separation of ownership and control. Journal of Law and Economics, 26: 301-325.

Fama, E. F., & Jensen, M. C. 1983b. Agency problems and residual claims. Journal of Law and Economics, 26: 327-349.

Fang, C., Lee, J., & Schilling, M. A. 2010. Balancing exploration and exploitation through structural design: The isolation of subgroups and organizational learning. Organization Science, 21(3): 625-642.

Faraway, J. J. 2002. Practical regression and ANOVA using R. http://cran.r-project.org/doc/contrib/Faraway-PRA.pdf

Fleming, L., Mingo, S., & Chen, D. 2007. Collaborative brokerage, generative creativity, and creative success. Administrative Science Quarterly, 52: 443-475.

Forbes, D. P., & Milliken, F. J. 1999. Cognition and corporate governance: Understanding boards of directors as strategic decision-making groups. Academy of Management Review, 24(3): 489-505.

Foss, N. 2003. Selective intervention and internal hybrids: Interpreting and learning from the rise and decline of the Oticon spaghetti organization. Organization Science, 14(3): 331-349.

Gargiulo, M., & Benassi, M. 2000. Trapped in your own net? Network cohesion, structural holes, and the adaptation of social capital. Organization Science, 11(2): 183-196.

Gargiulo, M.,Ertug, G., & Galunic, C. 2009. The two faces of control: Network closure and individual performance among knowledge workers. Administrative Science Quarterly, 54: 299-333.

Geletkanycz, M. A., & Hambrick, D. C. 1997. The external ties of top executives: Implications for strategic choice and performance. Administrative Science Quarterly, 42(4): 654-681.

Gibbons, R., & Murphy, K. J. 1992. Optimal incentive contracts in the presence of career concerns: Theory and evidence. Journal of Political Economy, 100(3): 468-505.

Gilson, S. C. 1990. Bankruptcy, boards, banks, and blockholders: Evidence on changes in corporate ownership and control when firms default. Journal of Financial Economics, 27: 355-387.

Gilson, S. C., & Vetsuypens, M. R. 1993. CEO compensation in financially distressed firms: An empirical analysis. Journal of Finance, 48(2): 425-458.

Glimcher, P. W., Kable, J., & Louei, K. 2007. Neuroeconomic studies of impulsivity: Now or just as soon as possible? American Economic Review, 97(2): 142-147.

Glimcher, P. W., & Rustichini, A. 2004. Neuroeconomics: The consilience of brain and decision. Science, 306: 447- 452.

Golden, B. R., & Zajac, E. J. 2001. When will boards influence strategy? Inclination x power = strategic change. Strategic Management Journal, 22(12): 1087-1111.

Gompers, P., Kovner, A., Lerner, J., & Scharfstein, D. 2010. Performance persistence in entrepreneurship. Journal of Financial Economics, 96: 18-32.

Goodstein, J., Gautam, K., & Boeker, W. 1994. The effects of board size and diversity on strategic change. Strategic Management Journal, 15: 241-250.

Goold, M., & Quinn, J. J. 1990. The paradox of strategic controls. Strategic Management Journal, 11: 43-57.

Grabowski, H. G. 1968. The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries. Journal of Political Economy, 76(2): 292-306.

Grabowski, H. G., & Baxter, N. D. 1973. Rivalry in industrial research and development: An empirical study. Journal of Industrial Economics, 21(3): 209-235.

Grabowski, H., & Vernon, J. 2000. The determinants of pharmaceutical research and development expenditures. Journal of Evolutionary Economics, 10(1/2): 201-215.

Green, S. G., Welsh, M. A., & Dehler, G. E. 2003. Advocacy, performance, and threshold influences on decisions to terminate new product development. Academy of Management Journal, 46(4): 419-434.

Grégoire, D. A., Barr, P. S., & Shephard, D. A. 2010. Cognitive processes of opportunity recognition: The role of structural alignment. Organization Science, 21(2): 413-431.

Greve, H. R. 1998. Managerial cognition and the mimetic adoption of market positions: What you see is what you do. Strategic Management Journal, 19(10): 967-988.

Greve, H. R. 2003. A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. Academy of Management Journal, 46(6): 685-702.

Greve, H. R., & Taylor, A. 2000. Innovations as catalysts for organizational change: Shifts in organizational cognition and search. Administrative Science Quarterly, 45(1): 54-80.

Grinyer, P., & McKiernan, P. 1990. Generating major change in stagnating companies. Strategic Management Journal, 11(4): 131-146.

Gulati, R., & Westphal, J. D. 1999. Cooperative or controlling? The effects of CEO-board relations and the content of interlocks on the formation of joint ventures. Administrative Science Quarterly, 44: 473-506.

Gupta, A. K. 1987. SBU strategies, corporate-SBU relations, and SBU effectiveness in strategy implementation. Academy of Management Journal, 30(3): 477-500.

Gupta, A. K., Smith, K. G., & Shalley, C. E. 2006. The interplay between exploration and exploitation. Academy of Management Journal, 49(4): 693-706.

Haas, M. R., & Hansen, M. T. 2007. Different knowledge, different benefits: Toward a productivity perspective on knowledge sharing in organizations. Strategic Management Journal, 28: 1133-1153.

Haleblian, J., & Rajagopalan, N. 2006. A cognitive model of CEO dismissal: Understanding the influence of board perceptions, attributions and efficacy beliefs. Journal of Management Studies, 43(5): 1009-1026.

Hambrick, D. C., & D'Aveni, R. A. 1988. Large corporate failures as downward spirals. Administrative Science Quarterly, 33: 1-23.

Hambrick, D. C., & Jackson, E. M. 2000. Outside directors with a stake: The linchpin in improving governance. California Management Review, 42(2): 108-127.

Hambrick, D. C., MacMillan, I. C., & Barbosa, R. R. 1983. Business unit strategy and changes in the product R&D budget. Management Science, 29(7): 757-769.

Hambrick, D. C., & Mason, P. A. 1984. Upper echelons: The organization as a reflection of its top managers. Academy of Management Review, 9(2): 193-206.

Hamel, G., & Prahalad, C. K. 1994. Competing for the future. Harvard Business School Press.

Hansen, G. S., & Hill, C. W. L. 1991. Are institutional investors myopic? A time-series study of four technology-driven industries. Strategic Management Journal, 12(1): 1-16.

Hansen, M. T. 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. Administrative Science Quarterly, 44(1): 82-111.

Hansen, M. T., Mors, M. L., & Lovas, B. 2005. Knowledge sharing in organizations: Multiple networks, multiple phases. Academy of Management Journal, 48(5): 776-793.

Harris, J., & Bromiley, P. 2007. Incentives to cheat: The influence of executive compensation and firm performance on financial misrepresentation. Organization Science, 18(3): 350-367.

Harris, M., & Raviv, A. 1978. Some results on incentive contracts with applications to education and employment, health insurance, and law enforcement. American Economic Review, 68(1): 20-30.

Harris, M., & Raviv, A. 1979. Optimal incentive contracts with imperfect information. Journal of Economic Theory, 20: 231-259.

Haunschild, P. R. 1993. Interorganizational imitation: The impact of interlocks on corporate acquisition activity. Administrative Science Quarterly, 38(4): 564-592.

Haunschild, P. R., & Beckman, C. M. 1998. When do interlocks matter?: Alternative sources of information and interlock influence. Administrative Science Quarterly, 43: 815-844.

Hayes, R. H., & Abernathy, W. J. 1980. Managing our way to economic decline. Harvard Business Review, July-August: 67-77.

Haynes, K. T., & Hillman, A. 2010. The effect of board capital and CEO power on strategic change. Strategic Management Journal, 31: 1145-1163.

Helfat, C. E. 1994a. Firm-specificity in corporate applied R&D. Organization Science, 5(2): 173-184.

Helfat, C. E. 1994b. Evolutionary trajectories in petroleum firm R&D. Management Science, 40(12): 1720-1747.

Henderson, R., & Cockburn, I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. Strategic Management Journal, 15, winter special issue: 63-84.

Hendry, J. 2002. The principal's other problems: Honest incompetence and the specification of objectives. Academy of Management Review, 27(1): 98-113.

Hermalin, B. E., & Weisbach, M. S. 1991. The effects of board composition and direct incentives on firm performance. Financial Management: 101-112.

Hermalin, B. E., & Weisbach, M. S. 2003. Board of directors as an endogenously determined institution: A survey of the economic literature. Economic Policy Review: 7-26.

Herriott, S. R., Levinthal, D., & March, J. G. 1985. Learning from experience in organizations. American Economic Review, 75(2): 298-302.

Hill, C. W. L. 1985. Oliver Williamson and the M-firm firm: A critical review. Journal of Economic Issues, 19(3): 731-751.

Hill, C. W. L., & Hoskisson, R. E. 1987. Strategy and structure in the multiproduct firm. Academy of Management Review, 12(2): 331-341.

Hill, C. W. L., & Snell, S. A. 1988. External control, corporate strategy, and firm performance in research-intensive industries. Strategic Management Journal, 9(6): 577-590.

Hillman, A. J., Cannella, A. A. Jr., & Paetzold, R. L. 2000. The resource dependence role of corporate directors: Strategic adaptation of board composition in response to environmental change. Journal of Management Studies, 37(2): 235-255.

Hillman, A. J., & Dalziel, T. 2003. Boards of directors and firm performance: Integrating agency and resource dependency perspectives. Academy of Management Review, 28(3): 383-396.

Himmelberg, C. P., Hubbard, R. G., & Palia, D. 1999. Understanding the determinants of managerial ownership and the link between ownership and performance. Journal of Financial Economics, 53: 353-384.

Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. 1990. Mergers and acquisitions and managerial commitment to innovation in M-form firms. Strategic Management Journal, 11(special issue): 29-47.

Hitt, M. A., Hoskisson, R. E., Ireland, R. D., & Harrison, J. S. 1991. Effects of acquisitions on R&D inputs and outputs. Academy of Management Journal, 34(3): 693-706.

Hitt, M. A., Hoskisson, R. E., Johnson, R. A., & Moesel, D. D. 1996. The market for corporate control and firm innovation. Academy of Management Journal, 39(5): 1084-1119.

Holderness, C. G., Kroszner, & Sheehan, D. P. 1999. Were the good old days that good? Changes in managerial stock ownership since the Great Depression. Journal of Finance, 54(2): 435-469.

Holmström, B. 1979. Moral hazard and observability. Bell Journal of Economics, 10(1): 74-91.

Holmström, B. 1999. Managerial incentive problems: A dynamic perspective. Review of Economic Studies, 66: 169-182.

Hormozi, A. M., Sutton, G. S., McMinn, R. D., & Lucio, W. 2002. Business plans for new or small business: Paving the path to success. Management Decision, 40(7/8): 755- 763.

Hoskisson, R. E., & Hitt, M. A. 1988. Strategic control systems and relative R&D investment in large multiproduct firms. Strategic Management Journal, 9(6): 605-621.

Hoskisson, R. E., Hitt, M. A., & Hill, C. W. L. 1991. Managerial risk taking in diversified firms: An evolutionary perspective. Organization Science, 2(3): 296-314.

Hoskisson, R. E., Hitt, M. A., & Hill, C. W. L. 1993. Managerial incentives and investment in R&D in large multiproduct firms. Organization Science, 4(2): 325-341.

Hoskisson, R. E., Hitt, M. A., Johnson, R. A., & Grossman, W. 2002. Conflicting voices: The effects of institutional ownership heterogeneity and internal governance on corporate innovation strategies. Academy of Management Journal, 45, 4: 697-716.

Hoskisson, R. E., Johnson, R. A., & Moesel, D. D. 1994. Corporate divestiture intensity in restructuring firms: Effects of governance, strategy, and performance. Academy of Management Journal, 37(5): 1207-1251.

Huber, G. P. 1991. Organizational learning: The contributing processes and the literatures. Organization Science, 2(1): 88-115.

Hundley, G., Jacobson, C. K., & Park, S. H. 1996. Effects of profitability and liquidity on R&D intensity: Japanese and U.S. companies compared. Academy of Management Journal, 39(6): 1659-1674.

Ibarra, H. 1993. Network centrality, power, and innovation involvement: Determinants of technical and administrative roles. Academy of Management Journal, 36(3): 471-501.

Jaeger, A. M., & Baliga, B. R. 1985. Control systems and strategic adaptation: Lessons from the Japanese experience. Strategic Management Journal, 6(2): 115-134.

Jensen, M. C. 1993. The modern industrial revolution, exit, and the failure of internal control systems. Journal of Finance, 48(3): 831-880.

Jensen, M. C., & Meckling, W. H. 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics, 3: 305-360.

Jensen, M. C., & Murphy, K. J. 1990. Performance pay and top-management incentives. Journal of Political Economy, 98(2): 225-264.

Johnson, R. A., Hoskisson, R. E., & Hitt, M. A. 1993. Board of director involvement in restructuring: The effects of board versus managerial controls and characteristics. Strategic Management Journal, 14: 33-50.

Judge, W. Q. Jr., & Zeithaml, C. P. 1992. Institutional and strategic choice perspectives on board involvement in the strategic decision process. Academy of Management Journal, 35(4): 766-794.

Kahneman, D., & Tversky, A. 1979. Prospect theory: An analysis of decision under risk. Econometrica, 47(2): 263-292.

Katz, R. 1982. The effects of group longevity on project communication and performance. Administrative Science Quarterly, 27(1): 81-104.

Katz, R. 2005. Motivating technical professionals today. Research Technology Management, 48(6): 19-27.

Keller, R. T. 2001. Cross-functional project groups in research and product development: Diversity, communications, job stress, and outcomes. Academy of Management Journal, 44(3): 547-555.

Kesner, I. F. 1988. Directors' characteristics and committee membership: An investigation of type, occupation, tenure, and gender. Academy of Management Journal, 31(1): 66-84.

Kim, H., Kim, H., & Lee, P. M. 2008. Ownership structure and the relationship between financial slack and R&D investments: Evidence from Korean firms. Organization Science, 19(3): 404-418.

Kim, B., & Oh, H. 2002. Economic compensation compositions preferred by R&D personnel of different R&D types and intrinsic values. R&D Management, 32(1): 47-59.

Kirsch, L. J. 1996. The management of complex tasks in organizations: Controlling the systems department process. Organization Science: 7(1): 1-21.

Kirsch, D., Goldfarb, B., & Gera, A. 2009. Form or substance: The role of business plans in venture capital decision making. Strategic Management Journal, 30: 487-515.

Knott, A. M., & Posen, H. E. 2009. Firm R&D behavior and evolving technology in established industries. Organization Science, 20(2): 352-367.

Kochhar, R., & David, P. 1996. Institutional investors and firm innovation: A test of competing hypotheses. Strategic Management Journal, 17(1): 73-84.

Kor, Y. Y. 2006. Direct and interaction effects of top management team and board compositions on R&D investment strategy. Strategic Management Journal, 27: 1081-1099.

Kor, Y. Y., & Misangyi, V. F. 2008. Outside directors' industry-specific experience and firms' liability of newness. Strategic Management Journal, 29(12): 1345-1355.

Kosnik, R. D. 1987. Greenmail: A study of board perforamnce in corporate governance. Administrative Science Quarterly, 32(2): 163-185.

Kosnik, R. D. 1990. Effects of board demography and directors' incentives on corporate greenmail decisions. Academy of Management Journal, 33(1): 129-150.

Kroll, M., Walters, B. A., & Wright, P. 2008. Board vigilance, director experience, and corporate outcomes. Strategic Management Journal, 29: 363-382.

Lant, T. K., Milliken, F. J., & Batra, B. 1992. The role of managerial learning and interpretation in strategic persistence and reorientation: An empirical exploration. Strategic Management Journal, 13: 585-608.

Laverty, K. J. 1996. Economic "short-termism": The debate, the unresolved issues, and the implications for management practice and research. Academy of Management Review, 21(3): 825-860.

Lee, P. M., & O'Neill, H. M. 2003. Ownership structures and R&D investments of U.S. and Japanese firms: Agency and stewardship perspectives. Academy of Management Journal, 46(2): 212-225.

Leonard-Barton, D. 1992. Core capabilities and core rigidities: A paradox in managing new product development. Strategic Management Journal, 13, summer special issue: 111-125.

Levinthal, D. A., & March, J. G. 1993. The myopia of learning. Strategic management journal, 14, winter special issue: 95-112.

Levitt, B., & March, J. G. 1988. Organizational learning. Annual Review of Sociology, 14: 319-340.

Lewis, M. W., Welsh, M. A., Dehler, G. E., & Green, S. G. 2002. Product development tensions: Exploring contracting styles of project management. Academy of Management Journal, 45(3): 546-564.

Lundblad, C. 2007. The risk return tradeoff in the long run. Journal of Financial Economics, 85: 123-150.

MacMillan, I. C., & Narasimha, P. N. S. 1987. Characteristics distinguishing funded from unfunded business plans evaluated by venture capitalists. Strategic Management Journal, 8(6): 579-585.

Mahlich, J. C., & Roediger-Schluga, T. 2006. The determinants of pharmaceutical R&D expenditures: Evidence from Japan. Review of Industrial Organization, 28: 145-164.

Mallette, P., & Fowler, K. L. 1992. Effects of board composition and stock ownership on the adoption of "poison pills". Academy of Management Journal, 35(5): 1010-1035.

Mansfield, E. 1964. Industrial research and development expenditures: Determinants, prospects, and relation to size of firm and inventive output. Journal of Political Economy, 72(4): 319-340.

March, J. G. 1991. Exploration and exploitation in organizational learning. Organization Science, 2(1): 71-87.

Marginson, D., & McAulay, L. 2008. Exploring the debate on short-termism: A theoretical and empirical analysis. Strategic Management Journal, 29: 273-292.

Martens, M. L., Jennings, J. E., & Jennings, P. D. 2007. Do the stories they tell get them the money they need? The role of entrepreneurial narratives in resource acquisition. Academy of Management Journal, 50(5): 1107-1132.

Maslow, A. H. 1968. Toward a Psychology of Being. 3rd ed. 1999. New York: Wiley.

Masulis, R. W., Wang, C., & Xie, F. 2009. Agency problems at dual-class companies. Journal of Finance, 64(4): 1697-1727.

Matejka, M., Merchant, K. A., & van der Stede, W. A. 2009. Employment horizon and the choice of performance measures: Empirical evidence from annual bonus plans of loss-making entities. Management Science, 55(6): 890-905.

McConnell, J. J., & Servaes, H. 1990. Additional evidence on equity ownership and corporate value. Journal of Financial Economics, 27: 595-612.

McEvily, B., & Zaheer, A. 1999. Bridging ties: A source of firm heterogeneity in competitive capabilities. Strategic Management Journal, 20(12): 1133-1156.

McFadyen, M. A., & Cannella, A. A., Jr. 2004. Social capital and knowledge creation: Diminishing returns of the number and strength of exchange relationships. Academy of Management Journal, 47(5): 735-746.

McGrath, R. G., & MacMillan, I. C. 1995. Discovery-driven planning. Harvard Business Review, July-August: 44-54.

McGrath, R. G., & MacMillan, I. C. 2000a. Assessing technology projects using real options reasoning. Research Technology Management, 43(4): 35-49.

McGrath, R. G., & MacMillan, I. C. 2000b. The entrepreneurial mindset. Harvard Business School Press.

McNeil, C., Nichaus, G., & Powers, E. 2004. Management turnover in subsidiaries of conglomerates versus stand-alone firms. Journal of Financial Economics, 72: 63-96.

Mehra, A., Dixon, A. L., Brass, D. J., & Robertson, B. 2006. The social network ties of group leaders: Implications for group performance and leader reputation. Orgnization Science, 17(1): 64-79.

Miller, K. D. 2002. Knowledge inventories and managerial myopia. Strategic Management Journal, 23: 689-706.

Miller, K. D., & Chen, W. 2004. Variable organizational risk preferences: Tests of the March-Shapira model. Academy of Management Journal, 47(1): 105-115.

Mintzberg, H. 1994. The rise and fall of strategic planning. Prentice-Hall.

Mintzberg, H., Ahlstrand, B., & Lampel, J. 1998. Strategy safari. The Free Press.

Mishina, Y., Pollock, T. G., & Porac, J. F. 2004. Are more resources always better for growth? Resource stickiness in market and product expansion. Strategic Management Journal, 25(12): 1179-1197.

Mizurchi, M. S. 1983. Who controls whom? An examination of the relation between management and boards of directors in large American corporations. Academy of Management Review, 8(3): 426-435.

Mizruchi, M. S. 1996. What do interlocks do? An analysis, critique, and assessment of research on interlocking directorates. Annual Review of Sociology, 22: 271-298.

Mizruchi, M. S., & Brewster Stearns, L. 2001. Getting deals done: The use of social networks in bank decision-making. American Sociological Review, 66(5): 647-671.

Mone, M. A., McKinley, W., & Barker, V. L., III. 1998. Organizational decline and innovation: A contingency framework. Academy of Management Review, 23(1): 115-132.

Montague, P. R., & Berns, G. S. 2002. Neural economics and the biological substrates of valuation. Neuron, 36: 265-284.

Montague, P.R., King-Casas, B., & Cohen, J. D. 2006. Imaging valuation models in human choice. Annual Review of Neuroscience, 29: 417-448.

Morck, R., Shleifer, A., & Vishny, R. W. 1988. Management ownership and market valuation: An empirical analysis. Journal of Financial Economics, 20: 293-315.

Morck, R., Shleifer, A., & Vishny, R. W. 1989. Alternative mechanisms for corporate control. American Economic Review, 79(4): 842-852.

Morrison, E. W. 2002. Newcomers' relationships: The role of social network ties during socialization. Academy of Management Journal, 45(6): 1149-1160.

Morrow, J. L., Jr., Sirmon, D. G., Hitt, M. A., & Holcomb, T. R. 2007. Creating value in the face of declining performance: Firm strategies and organizational recovery. Strategic Management Journal, 28: 271-283.

Mors, M. L. 2010. Innovation in a global consulting firm: When the problem is too much diversity. Strategic Management Journal, 31: 841-872.

Mosakowski, E. 1997. Strategy making under causal ambiguity: Conceptual issues and empirical evidence. Organization Science, 8(4): 414-442.

Narayanan, M. P. 1985. Managerial incentives for short-term results. Journal of Finance, 40(5): 1469-1484.

Nebus, J. 2006. Building collegial information networks: A theory of advice network generation. Academy of Management Review, 31(3): 615-637.

Nerkar, A., & Paruchuri, S. 2005. Evolution of R&D capabilities: The role of knowledge networks within a firm. Management Science, 51(5): 771-785.

Newbert, S. L. 2008. Value, rareness, competitive advantage, and performance: A conceptual-level empirical investigation of the resource-based view of the firm. Strategic Management Journal, 29: 745-768.

Nohria, N., & Gulati, R. 1996. Is slack good or bad for innovation? Academy of Management Journal, 39(5): 1245-1264.

Nyberg, A. J., Fulmer, I. S., Gerhart, B., & Carpenter, M. A. 2010. Agency theory revisited: CEO return and shareholder interest alignment. Academy of Management Journal, 53(5): 1029-1049.

O'Brian, R. M. 2007. A caution regarding rules of thumb for variance inflation factors. Quality & Quantity, 41: 673-690.

Obstfeld, D. 2005. Social networks, the tertius iungens orientation, and involvement in innovation. Administrative Science Quarterly, 50: 100-130.

Ocasio, W. 1997. Towards an attention-based view of the firm. Strategic Management Journal, 18, summer special issue: 187-206.

Oldham, G. R., & Cummings, A. 1996. Employee creativity and contextual factors at work. Academy of Management Journal, 39(3): 607-634.

Osterloh, M., & Frey, B. S. 2000. Motivation, knowledge transfer, and organizational forms. Organization Science, 11(5): 538-550.

Ouchi, W. G. 1977. The relationship between organizational structure and organizational control. Administrative Science Quarterly, 22(4): 95-113.

Ouchi, W. G. 1979. A conceptual framework for the design of organizational control mechanisms. Management Science, 25(9): 833-848.

Ouchi, W. G. 1980. Markets, bureaucracies, and clans. Administrative Science Quarterly: 129-141.

Palmer, T. B., & Wiseman, R. M. 1999. Decoupling risk taking from income stream uncertainty: A holistic model of risk. Strategic Management Journal, 20: 1037-1062.

Palomeras, N., & Melero, E. 2010. Markets for inventors: Learning-by-hiring as a driver of mobility. Management Science, 56(5): 881-895.

Pearce, J. A. III, & Zahra, S. A. 1992. Board composition from a strategic contingency perspective. Journal of Management Studies, 29(4): 411-438.

Pennings, J. M. E., & Smidts, A. 2003. The shape of utility functions and organizational behavior. Management Science, 49(9): 1251-1263.

Perry-Smith, J. E. 2006. Social yet creative: The role of social relationships in facilitating individual creativity. Academy of Management Journal, 49(1): 85-101.

Petersen, M. A. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies, 22(1): 435-480.

Pettigrew, A. M. 1992. The character and significance of strategy process research. Strategic Management Journal, Winter92 Special Issue: 5-16.

Pfarrer, M. D., Pollock, T. G., & Rindova, V. P. 2010. A tale of two assets: The effects of firm reputation and celebrity on earnings surprises and investors' reactions. Academy of Management Journal, 53(5) 1131-1152.

Pfeffer, J. 1972. Size and composition of corporate boards of directors: The organization and its environment. Administrative Science Quarterly: 218-228.

Pfeffer, J., & Salancik, G. R. 1978. The external control of organizations. New York: Harper & Row.

Porter, M. E. 1980. Competitive strategy: Techniques for analyzing industries and competitors. New York: The Free Press.

Porter, M. E. 1992. Capital disadvantage: America's failing capital investment system. Harvard Business Review, September-October: 65-82.

Pratt, J. W. 1964. Risk aversion in the small and in the large. Econometrica, 32(1/2): 122-136.

Prelec, D., & Loewenstein, G. 1991. Decision making over time and under uncertainty: A common approach. Management Science, 37(7): 770-786.

Rayo, L, & Becker, G. S. 2007. Evolutionary efficiency and happiness. Journal of Political Economy, 115(2): 302-337.

Reagans, R., & McEvily, B. 2003. Network structure and knowledge transfer: The effects of cohesion and range. Administrative Science Quarterly, 48: 240-267.

Reagans, R., & Zuckerman, E. W. 2001. Networks, diversity, and productivity: The social capital of corporate R&D teams. Organization Science, 12(4): 502-517.

Reagans, R., Argote, L., & Brooks, D. 2005. Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. Management Science, 51(6): 869-881.

Rechner, P. L., & Dalton, D. R. 1991. CEO duality and organizational performance: A longitudinal analysis. Strategic Management Journal, 12: 155-160.

Roberts, E. B. 1991. High stakes for high-tech entrepreneurs: Understanding venture capital decision making. Sloan Management Review, 32(2): 9-20.

Rodan, S., & Galunic, C. 2004. More than network structure: How knowledge heterogeneity influences managerial performance and innovativeness. Strategic Management Journal, 25: 541-562.

Ross, S. A. 1973. The economic theory of agency: The principal's problem. American Economic Review, 63(2): 134-139.

Ruefli, T., & Sarrazin, J. 1981. Strategic control of corporate development under ambiguous circumstances. Management Science, 27(10): 1158-1170.

Rumelt, R. P. 1974. Strategy, structure, and economic performance. Revised edition 1986. Boston, MA: Harvard Business School Press.

Ryan, H. E. Jr., & Wiggins, R. A. III. 2004. Who is in whose pocket? Director compensation, board independence, and barriers to effective monitoring. Journal of Financial Economics, 73: 497-524.

Sanders, W. G., & Hambrick, D. C. 2007. Swinging for the fences: The effects of CEO stock options on company risk taking and performance. Academy of Management Journal, 50(5): 1055-1078.

Sauerman, H., & Cohen, W. M. 2010. What makes them tick? Employee motives and firm innovation. Management Science, 56(12): 2134-2153.

Schreyögg, G., & Steinmann, H. 1987. Strategic control: A new perspective. Academy of Management Review, 12(1): 91-103.

Schumpeter, J. A. 1934. The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle. Reprinted in 1978. New York: Oxford University Press.

Schwartz, K. B., & Menon, K. 1985. Executive succession in failing firms. Academy of Management Journal, 28(3): 680-686.

Senge, P. M. 1990. The fifth discipline: The art and practice of the learning organization. New York: Doubleday.

Shane, S. 2000. Prior knowledge and the discovery of entrepreneurial opportunities. Organization Science, 11(4): 448-469.

Shen, W. 2003. The dynamics of the CEO-board relationship: An evolutionary perspective. Academy of Management Review, 28(3): 466-476.

Shleifer, A., & Vishny, R. W. 1997. A survey of corporate governance. Journal of Finance, 52(2): 737-783.

Siggelkow, N. 2007. Persuasion with case studies. Academy of Management Journal, 50(1): 20-24.

Simon, H. A. 1947. Administrative behavior: A study of decision-making processes in administrative organizations. Fourth edition 1997. New York: The Free Press.

Singh, H., & Harianto, F. 1989. Management-board relationships, takeover risk, and the adoption of golden parachutes. Academy of Management Journal, 32(1): 7-24.

Singh, J. V. 1986. Performance, slack, and risk taking in organizational decision making. Academy of Management Journal, 29(3): 562-585.

Sitkin, S. B., & Pablo, A. L. 1992. Reconceptualizing the determinants of risk behavior. Academy of Management Review, 17(1): 9-38.

Smith, K, Dickhaut, J, McCabe, K., & Pardo, J. V. 2002. Neuronal substrates for choice under ambiguity, risk, gains, and losses. Management Science, 48(6): 711-718.

Smith, K.G., Collins, C. J., & Clark, K. D. 2005. Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. Academy of Management Journal, 48(2): 346-357.

Snell, S. A. 1992. Control theory in strategic human resource management: The mediating effect of administrative information. Academy of Management Journal, 35(2): 292-327.

Soda, G., Usai, A., & Zaheer, A. 2004. Network memory: The influence of past and current networks on performance. Academy of Management Journal, 47(6): 893-906.

Souder, D., & Shaver, J. M. 2010. Constraints and incentives for making long horizon corporate investments. Strategic Management Journal, 31: 1316-1336.

Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. 2001. Social networks and the performance of individuals and groups. Academy of Management Journal, 44(2): 316-325

Staw, B. M., McKechnie, P. I., & Puffer, S. M. 1983. The justification of organizational performance. Administrative Science Quarterly, 28: 582-600.

Staw, B. M., Sanderlands, L. E., & Dutton, J. E. 1981. Threat rigidity effects in organizational behavior: A multilevel analysis. Administrative Science Quarterly, 26(4): 501-524.

Stein, J. C. 1989. Efficient capital markets, inefficient firms: A model of myopic corporate behavior. Quarterly Journal of Economics, 104(4): 655-669.

Stiles, P. 2001. The impact of the board on strategy: An empirical examination. Journal of Management Studies, 38(5): 627-650.

Sundaramurthy, C. 1996. Corporate governance within the context of antitakeover provisions. Strategic Management Journal, 17: 377-394.

Sutton, R. I., & Hargadon, A. 1996. Brainstorming groups in context: Effectiveness in a product design firm. Administrative Science Quarterly, 41(4): 685-718.

Tashakori, A., & Boulton, W. 1983. A look at the board's role in planning. Journal of Business Strategy, 3(3): 64-70.

Thompson, J. D. 1967. Organizations in Action. New York: McGraw-Hill.

Tierney, P., Farmer, S. M., & Graen, G. B. 1999. An examination of leadership and employee creativity: The relevance of traits and relationships. Personnel Psychology, 52: 591-620.

Tosi, H. L., Weyner, S., Katz, J. P., & Gomez-Meija, L. R. 2000. How much does performance matter? A meta-analysis of CEO pay studies. Journal of Management, 26(2): 301-339.

Tsai, W, & Ghoshal, S. 1998. Social capital and value creation: The role of intrafirm networks. Academy of Management Journal, 41(4): 464-476.

Tuggle, C. S., Schnatterly, K., & Johnson, R. A. 2010a. Attention patterns in the boardroom: How board composition and processes affect discussion of entrepreneurial issues. Academy of Management Journal, 53(3): 550-571.

Tuggle, C. S., Sirmon, D. G., Reutzel, C. R., & Bierman, L. 2010b. Commading board of director attention: Investigating how organizational performance and CEO duality affect board members' attention to monitoring. Strategic Management Journal, 31: 946-968.

Tushman, M. L. 1977. Special boundary roles in the innovation process. Administrative Science Quarterly, 22(4): 587-605.

Tushman, M. L. 1979. External communications and project performance: An investigation into the role of gatekeepers. Management Science, 26(11): 1071-1085.

Tushman, M. L., & Andeson, P. 1986. Technological discontinuities and organizational environments. Administrative Science Quarterly, 31: 439-465.

Uotila, J., Maula, M., Keil, T., & Zahra, S. A. 2009. Exploration, exploitation, and financial performance: Analysis of S&P 500 corporations. Strategic Management Journal, 30: 221-231.

Utterback, J. M. 1994. Mastering the dynamics of innovation. Boston: MA: Harvard Business School Press.

Vissa, B., & Chacar, A. S. 2009. Leveraging ties: The contingent value of entrepreneurial teams' external advice networks on Indian software venture performance. Strategic Management Journal, 30: 1179-1191.

Walsh, J. P., & Seward, J. K. 1990. On the efficiency of internal and external corporate control mechanisms. Academy of Management Review, 15(3): 421-458.

Weisbach, M. S. 1988. Outside directors and CEO turnover. Journal of Financial Economics, 20: 431-460.

Wernerfelt, B. 1984. A resource-based view of the firm. Strategic Management Journal, 5(2): 171-180.

Westphal, J. D. 1999. Collaboration in the boardroom: Behavioral and performance consequences of CEO-board social ties. Academy of Management Journal, 42(1): 7-24.

Westphal, J. D., & Graebner, M. E. 2010. A matter of appearances: How corporate leaders manage the impressions of financial analysts about the conduct of their boards. Academy of Management Journal, 53(1): 15-43.

Westphal, J. D., Seidel, M. L., & Stewart, K. J. 2001. Second-order imitation: Uncovering latent effects of board network ties. Administrative Science Quarterly, 46: 717-747.

Westphal, J. D., & Zajac, E. J. 1995. Who shall govern? CEO/board power, demographic similarity,and new director selection. Administrative Science Quarterly, 40: 60-83.

Williams, M. A., & Rao, R. P. 2006. CEO stock options and equity risk incentives. Journal of Business Finance and Accounting, 33(1)&(2): 26-44.

Wiseman, R. M., & Bromiley, P. 1996. Toward a model of risk in declining organizations: An empirical examination of risk, performance and decline. Organization Science, 7(5): 524-543.

Wolf, M., van Doorn, G. S., Leimar, O., & Weissing, F. J. 2007. Life-history trade-offs favour the evolution of animal personalities. Nature, 447: 581-584.

Wong, S., & Boh, W. F. 2010. Leveraging the ties of others to build a reputation for trustworthiness among peers. Academy of Management Journal, 53(1): 129-146.

Wright, P., Kroll, M., & Elenkov, D. 2002. Acquisition returns, increase in firm size, and chief executive officer compensation: The moderating role of monitoring. Academy of Management Journal, 45(3): 599-608.

Wright, P., Kroll, M., Krug, J. A., Pettus, M. 2007. Influences of top management team incentives on firm risk taking. Strategic Management Journal, 28: 81-89.

Yermack, D. 1996. Higher market valuation of companies with a small board of directors. Journal of Financial Economics, 40: 185-211.

Yermack, D. 2004. Remuneration, retention, and reputation incentives for outside directors. Journal of Finance: 59(5): 2281-2308.

Yu, F. 2008. Analyst coverage and earnings management. Journal of Financial Economics, 88: 245-271.

Zahra, S. A. 1996. Governance, ownership, and corporate entrepreneurship: The moderating impact of industry technological opportunities. Academy of Management Journal, 39(6): 1713-1735.

Zahra, S. A., & George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. Academy of Management Review, 27(2): 185-203.

Zahra, S. A., & Pearce, J. A., II. 1989. Boards of directors and corporate financial performance: A review and integrative model. Journal of Management, 15(2): 291-334.

Zajac, E. J., & Westphal, J. D. 1996. Director reputation, CEO-board power, and the dynamics of board interlocks. Administrative Science Quarterly, 41: 507-529.

Zenger, T. R., & Marshall, C. R. 2000. Determinants of incentive intensity in group-based rewards. Academy of Management Journal, 43(2): 149-163.

Zhang, X., & Bartol, K. M. 2010. Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement. Academy of Management Journal, 53(1): 107-128.

BUSINESS +
ECONOMY

ART +
DESIGN +
ARCHITECTURE

SCIENCE +
TECHNOLOGY

CROSSOVER

DOCTORAL
DISSERTATIONS