

EKONOMI OCH SAMHÄLLE

Skrifter utgivna vid Svenska handelshögskolan
Publications of the Swedish School of Economics
and Business Administration

Nr 126

MATTS ROSENBERG

ESSAYS ON STOCK OPTION COMPENSATION
AND THE ROLE OF INCENTIVES AND RISK

Helsingfors 2004

Essays on Stock Option Compensation and the Role of Incentives and Risk:

Key words: Agency costs; Capital expenditures; Contract design; Employment growth; Firm risk; Firm value; Optimal contracting; Principal-agent theory; Stock option incentives

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ISBN 951-555-826-3 (printed)
ISBN 951-555-827-1 (PDF)
ISSN 0424-7256

Yliopistopaino, Helsingfors 2004

To my parents and friends

Acknowledgements

During the initial phases of this project I attended a doctoral seminar where a senior professor talked about the significant impact pursuing a doctoral degree would have on all of us young prospective researchers. The senior professor argued that our lives would be changed forever. Listening to this, I felt that the senior professor was being rather dramatic, and felt that the speech somehow did not apply directly to me. However, at this stage of the process, I feel that the senior professor was right, to a certain extent. Throughout my doctoral studies, I have had the pleasure to interact and work with numerous brilliant and inspiring individuals, several of whom these days are good friends of mine. Moreover, I feel that I currently view the field of financial economics from a substantially more refined perspective than at the beginning of the process. Pursuing a doctoral degree has probably been the best choice I have made to date.

Several persons have contributed to this dissertation. First, I am deeply indebted to my supervisor Professor Eva Liljebloom who has contributed significantly during all phases of my doctoral studies. Anyone who has spent time at the Department of Finance and Statistics at the Swedish School of Economics and Business Administration realizes how an enormously valuable asset she is. Furthermore, I would like to thank Professor Anders Löflund for valuable advice and comments, from which this dissertation has benefited considerably. Professor Tom Berglund has also served as a source of inspiration during the process. In addition, my numerous conversations with Henrik Palmén about the nature of financial economics will be long remembered. This dissertation has also benefited to a great extent from the comments and suggestions made by my pre-examiners, Professor Yrjö Koskinen and Professor Lisa Meulbroek.

I am also sincerely indebted to Dr. Daniel Pasternack. As one of my supervisors, and co-author in two of the essays, Daniel has been of utmost importance during the route to a doctoral degree. As a matter of fact, Daniel already began to influence my ways in 1997, when he served as my M.Sc. freshman tutor, and taught me tricks of the trade in student partying and other “critical” elements of student life. The other “juniors” at the Department of Finance and Statistics deserve special thanks for providing a great atmosphere for doctoral research. In particular, I would like to thank Dr. Mohammed Aba Al-Khail, Dr. Anders Ekholm, Olga Karakozova, Benjamin Maury, and Dr. Alexander von Nandelstadh for their support and friendship throughout the process.

I would like to thank Alexander Corporate Finance Oy for providing the necessary data utilized in this dissertation, and for their supportive attitude against empirical financial economics research in Finland.

Financial support provided by Stiftelsen Svenska Handelshögskolan, The Finnish Academy of Sciences, The Waldemar von Frenckell Foundation, and The Finnish Association of Building Owners and Construction Clients is gratefully acknowledged.

Finally, I would like to thank my parents and friends. I want to express my deepest gratitude to my parents, Immu and Pelle, for their support and encouragement during the past 27 years. Last but not least, I want to thank all my friends, without whom life would be much less enjoyable.

Helsinki, February 2004

Matts Rosenberg

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PART A: THEORY, BACKGROUND, AND CENTRAL FINDINGS

The directors of [joint stock] companies, however, being managers rather of other people's money than of their own, it cannot be well expected, that they should watch over it with the same anxious vigilance with the partners in a private copartnery frequently watch over their own. Like the stewards of a rich man, they are apt to consider attention to small matters as not for their master's honour, and very easily give themselves a dispensation from having it. Negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company.

Adam Smith (1776)

1. Introduction

The purpose of the economic system is to satisfy the needs of individuals given limited resources. Economic theory assumes that individuals attempt to maximize their utility. A related goal is the maximization of wealth, and the assumption is that more wealth provides greater utility. In the economic system, individuals join together to form entities that participate in the production process. An important entity is the government, which by definition operates to promote the welfare of society. Another type of organization is the firm, which is structured by individuals to promote their own welfare. When firms and individuals act to maximize their utility and wealth, actions that are in their own self-interest combine together to produce a result that is in interest of the society. This represents the view of Adam Smith, who dictated that pursuit of individual interest leads to the best outcome for society as a whole.

One of the most important developments in the history of economic progress has been the foundation of corporations, accompanied by the separation of ownership and management. By transforming sole proprietorships and partnerships into corporations capital and ability have been able to meet in the economy, greater resources have been pooled together to provide an efficient scale of production, and allocation of risk has been made more efficient by transferring risk to outside diversified shareholders. In economics, the goal of the firm is, by assumption, to maximize the wealth of the firm's owners, which in modern public corporations implies maximizing shareholder value. The separation of ownership and management does not, however, come without costs. Indeed, this was already recognized by Adam Smith in *The Wealth of Nations*.¹

Costs associated with this separation arise because the preferences of the manager (the agent) may differ from the preferences of the shareholder (the principal). Hence, managers may act in ways not beneficial to shareholders, i.e., increase their own utility at the expense of shareholders.² A classic article by Berle and Means (1932) initiated the analysis of the problem caused by separation of ownership and control in the firm. Jensen and Meckling (1976) were the first to formalize the modern theory of the agency problem.³ Other important contributions to the literature include Ross (1973), Mirrlees (1974, 1976), Holmström (1979, 1982), Fama (1980), Grossman and Hart (1983), and Holmström and Milgrom (1987).

¹ In the 18th century when the text was written, most firms were organized as proprietorships, implying that separation of ownership and control was not a common phenomenon. However, Adam Smith viewed the few joint stock companies operating at the time as potentially creating conflicts of interest. See, e.g., Molin (1996) for a review of the historical development of the understanding of agency relations.

² Coase (1937) points out that firms and markets are essentially two alternative ways to regulate economic transactions between individuals. However, whereas market transactions do not imply a relation of subordination between the parties involved, transactions that take place inside a firm generally involve the exercise of power by one party over the other.

³ The Jensen and Meckling (1976) model analyzes the firm as a nexus of contracts between different stakeholders in the firm. A similar view is taken by Alchian and Demsetz (1972). In particular, the firm is viewed as a legal fiction in which the conflicting objectives of individuals are brought in equilibrium within a framework of contractual relations. Hence, agency problems may arise between other parties in the firm besides managers and shareholders. For example, agency problems of debt financing may arise between the shareholders and debtholders of the firm.

Although potential sources of conflicts of interest between managers and shareholders are almost unlimited in nature, theory suggests a number of factors, which may be of greater importance. First, Jensen and Meckling (1976) proposed a moral hazard explanation for conflicts of interest. In the case when ownership and control are separated in the firm, the manager will not bear 100% of the economic consequences of her actions. As a result, the manager has an incentive to consume private perquisites, which increases the manager's utility but reduces firm value. Moral hazard problems are also related to managerial effort aversion. That is, managers may reject positive net present value (NPV) projects because investments cause them disutility by forcing them to oversee the investment (private costs).⁴ Theory suggests that firms should distribute all funds in excess of that required for all profitable NPV projects to shareholders. However, Jensen (1986, 1993) argues that managers may take on wasteful (negative NPV) projects because they derive utility from controlling more assets (private benefits). Jensen's argument related to managerial empire-building has been formalized in an extensive line of work including Stulz (1990), Chang (1993), Hart and Moore (1995), and Zwiebel (1996), among others. Furthermore, studies on executive compensation have generally found that compensation is an increasing function of firm size (see, e.g., Jensen and Murphy, 1990), which suggests that managers may strive to increase the size of the firm beyond optimal to achieve greater financial benefits and prestige.

Differences in time horizons may also lead to conflicts of interest between managers and shareholders. In equilibrium, the value of the firm should be equal to the discounted value of all future expected free cash flows. Hence, in theory, the relevant time horizon of shareholders reaches into the indefinite future. Managers, on the other hand, may be biased by short-termism, since their term of employment is limited in time. As a result, managers may favor short-term projects yielding high accounting returns at the expense of long-term value enhancing projects, since their performance is reviewed periodically. Managerial short-termism is likely to be especially tempting for managers nearing departure from the firm, or even more severely, for managers whose employment is at risk because of poor performance (Hall, 2002).

One of the most important sources of potential conflicts of interest arising between managers and shareholders relates to risk preferences. Since managers have both their human capital (firm-specific skills gained during their tenure) and at least part of their financial capital (e.g., future salaries) disproportionately fixed in the firm, they are evidently not well-diversified. Hence, risk-averse managers with a disproportionate amount of wealth in one single firm will rationally take too few risks. The risk-bearing capability of well-diversified shareholders is, thus, substantially greater than the corresponding capability of the manager. As a result, risk-averse managers may seek to

⁴ In contrast, Shleifer and Vishny (1989) argue that rather than not investing, managers may have an incentive to select investments best suited to their personal skills, since such investments makes it more difficult to replace the manager in the future.

reduce firm risk to lower the risk of their human and financial capital invested in the firm (see, e.g., Amihud and Lev, 1981; Haugen and Senbet, 1981; Smith and Stulz, 1985).⁵

As with any other costs, the costs arising from the conflicts of interest between managers and shareholders will be captured by the financial markets and reflected in the firm's valuation. Several devices have been proposed in the literature, which may reduce the costs associated with the agency problem. These devices consist of internal and external control mechanisms. Internal control mechanisms include the monitoring function and the construction of efficient incentive contracts, whereas external mechanisms of corporate control include the capital market, the public sector, legislation, and the labor market. In general, the external sources of corporate control may be treated as exogenous to the firm, and hence, the most important factors for alleviating the agency problem consist of direct monitoring carried out by shareholders, and the design of executive compensation. However, ordinary atomistic shareholders in the modern corporation may not have the resources or skills to actively monitor managerial activities.⁶ As a result, the literature suggests that an efficient way to alleviate the agency problem is to alter the utility function of the agent (the manager). Specifically, remuneration may be structured by altering the utility function of the manager in a way that closer corresponds to the utility function of shareholders. In practice, this may be achieved by tying compensation to firm performance, e.g., directly to the value of the firm.

The use of stock options is generally seen as one of the most efficient means of aligning the interests of managers and shareholders. Since stock options give the holder a right to purchase shares in the firm at a specified price in the future, this implies that higher firm value is associated with a higher value of stock options, i.e., financial goals of managers are aligned with those of shareholders. The fact that stock options align financial goals of managers with those of shareholders, i.e., both parties gain from an increase in value, is a partial solution to the agency problem. However, stock option compensation is also motivated by the fact that this type of compensation is expected to provide incentives to increase risk. This is apparent because the value of stock options is an increasing function of risk. Hence, this may imply that compensation in the form of stock options alleviates the agency problem arising due to managerial risk aversion.⁷

Managerial pay-for-performance sensitivity has increased rapidly around the world. In early empirical work, Jensen and Murphy (1990a, 1990b) showed that pay-for-performance sensitivity resulting from stocks and stock options appeared to be quite low during the 1970s and early 1980s in the U.S. However, recent empirical research from the U.S. shows an enormous increase in pay-for-

⁵ This effect is similar to the debt overhang problem as in Myers (1977). However, whereas underinvestment related to the debt overhang problem stems from the conflict of interest between shareholders and debtholders, the underinvestment problem described above stems from managerial risk aversion.

⁶ Furthermore, since shareholders normally hold small fractions of the firm's shares, there is an inherent free-rider problem implying that shareholders may not find it optimal to actively monitor managerial activities, since the benefits are shared with all other shareholders.

⁷ This observation may help to explain why stock options have become the dominant part of managerial remuneration tying wealth to performance during the last decade, instead of, e.g., direct stock ownership.

performance sensitivity. Specifically, evidence suggests that a given change in the stock price changes the value of equity incentives by approximately 50 times more than changes in cash compensation (see, e.g., Hall and Liebman, 1998; Hall, 1999; Aggarwal and Samwick, 1999a; Murphy, 1999; Core et al., 2000; Bushman and Smith, 2001). The global trend has also reached Finland, where stock options seem to be the dominant form of equity-based compensation. The first public stock option plan in Finland was introduced in 1987, and since then firms have adopted stock option plans with an increasing pace.⁸ The fact that stock options seem to be an appealing form of executive compensation from a theoretical point of view, combined with the observation that the use of this compensation form has increased enormously during the recent years, implies that it is of utmost importance to conduct research on the dynamics of this type of compensation.

The research questions addressed in this thesis may be divided into two parts. First, the thesis aims to promote the understanding of the economics of stock option compensation, including aspects such as economic factors determining the use of this compensation form, the time-dimensional contracting frequency, and stock option contract design. In addition, the debated question concerning the relation between equity incentives and firm performance is analyzed, which also belongs to this first category. The second part of the thesis aims at examining the role of incentives and risk in corporate decision-making. By engaging in investment and employment decisions, firms invest in specialized physical and human capital. These firm-specific investments lead to variation in firms' investment opportunity sets, or in other words, their prospective investment opportunities and associated payoff distributions (Smith and Watts, 1992). Ultimately, these firm-specific investments result in firm growth. Hence, the second part of the thesis analyzes the impact of stock option incentives and risk on firm-specific investment.

The research questions of the thesis are analyzed in four separate essays. The first essay addresses several questions in the executive compensation literature. First, the essay examines whether the use of stock options can be explained sufficiently by predictions according to agency theory. Furthermore, the essay studies factors associated with time-dimensional contracting frequency. Finally, the essay explores a largely ignored issue in the literature, i.e., factors explaining the diversity in stock option vesting schedules and contract duration. The second essay explores one of the puzzles in the compensation literature by studying determinants of stock option contract design. In theory, optimal contract design should vary according to firm characteristics. However, in the U.S., variation in contract design seems to be surprisingly low (Murphy, 1999). This phenomenon is generally attributed to tax and accounting considerations in the U.S. In Finland, however, firms are not subject to similar restrictions, and the variation in contract design tends, in fact, to be quite high. Hence, examining the issue using Finnish data offers an interesting research opportunity.

⁸ A comprehensive review of the evolution of stock option compensation in Finland is provided in Pasternack (2002). The development of stock option compensation in Finland is also discussed in Hansson et al. (2002).

Theory suggests that agency problems may be related to managerial investment decisions. Thus, the third essay studies the impact of price and risk incentives arising from stock option compensation on firm investment. Furthermore, the essay explores one of the most debated questions in the literature, namely, the relation between incentives and firm performance. Finally, several strands of literature in both economics and corporate finance predict that uncertainty may be related to corporate decision-making. Previous research has shown that risk tends to slow down capital investment. However, in the fourth essay, it is hypothesized that risk slows down firm growth from a more universal perspective. Consistent with this prediction, it is shown that risk not only tends to slow down capital investment, but also employment growth. In addition, the essay explores whether the nature of the firm's compensation policy, in particular, whether the firm makes use of stock option compensation, affects the relation between risk and firm growth. In summary, the four essays contribute to the current understanding of the nature of stock options as a form of equity incentives, and how incentives and risk affect corporate decision-making. By this, the thesis promotes the knowledge related to the modern theory of the firm.

The purpose of the introduction to the thesis is to provide a review of the theoretical framework and background to the research questions addressed, and to discuss the central findings of the essays. Section 2 provides a review of the theory of firms and contracts. Section 3 presents literature on equity incentives. Section 4 discusses the role of incentives and risk in corporate decision-making, and the relation between incentives and firm performance. Finally, Section 5 discusses the central findings and contributions of the essays.

2. Principal-agent problems and incentives

This section provides a review of the nature of the firm and the principal-agent relation. Furthermore, the section provides a discussion of risk preferences. Finally, the section discusses the dynamics of optimal compensation contracts based on principal-agent theory.

2.1. The theory of the firm and contracts

To provide an overview of the development regarding the theory of the firm and contracts, it is appropriate to revert to the work of Coase (1937). This pioneering work rationalized the existence of firms, which had been largely neglected by neoclassical price theory. The main question addressed was whether production should be organized through market transactions or within firms through managing. The observation that a substantial amount of economic transactions were organized within firms suggests that there is a cost to using the price mechanism in the market (Coase, 1937). Hence, this laid the foundation for the transaction costs view of the firm, suggesting that production should

be organized within firms when transaction costs of using the market become significant relative to the costs of organizing production through managing.

However, subsequent research in the theory of the firm criticized the Coasian view of the firm by arguing that it ignored the conflicts of interest between managers and owners, an issue pointed out already in work by Berle and Means (1932). This strand of work includes, e.g., Alchian and Demsetz (1972) who proposed the property rights view of the firm. Hence, an important result from the property rights view of the firm is that ownership structure matters.⁹

The modern theories of the firm and contracts may be classified in two categories, where the first is generally referred to as incomplete contracting models, which rely on the assumption that contracting is costly, and hence, that there is need for ex post governance. This strand of literature includes, e.g., Williamson (1971, 1985), Grossman and Hart (1986), and Moore (1992). The second category may be defined as principal-agent models, which make the assumption that principals adopt contracts characterized by ex ante incentive alignment, under the constraints imposed by asymmetric information. The work by Alchian and Demsetz (1972), Holmström (1979, 1982), and Holmström and Milgrom (1991, 1994) belong to this category.

Indeed, the theoretical framework regarding firms and contracts has a long history and is substantial in nature. A thorough review covering the literature is beyond the scope of this introductory section, and hence, the focus in the subsequent review is placed on aspects relevant to the research questions in this thesis, in particular, the nature of information asymmetries, risk preferences, and the characteristics of optimal compensation contracts.

2.2. *The structure of information*

In principal-agent analysis, the agent and the principal are assumed to be interrelated through either an explicit or implicit contractual relation. The structure of information between the principal and the agent plays a crucial role in the analysis. A basic assumption in principal-agent analysis is that the principal cannot directly observe the activities of the agent, or that the agent possesses some other aspect of knowledge concerning the situation, which is not known by the principal. Hence, information asymmetry exists between the two parties. It is the asymmetric nature of information that gives rise to the principal-agent problem.

Principal-agent problems arising from asymmetric information may be divided into ex ante and ex post phenomena. Behavioral risks related to the ex ante category may arise because of pre-contractual opportunism, which is also known as adverse selection. In the context of adverse selection, the agent possesses private information before the contract is signed. Hence, the principal

⁹ Whereas the Coase Theorem (Coase, 1960) states that initial allocation of legal entitlements does not matter from an efficiency perspective as long as the transaction costs of exchange are zero (e.g., the structure of ownership is irrelevant), the property rights view of the firm assumes that contractual costs do exist, and hence, allocation of property rights becomes essential for efficiency considerations.

does not know the exact characteristics of the agent before designing the incentive contract.¹⁰ The adverse selection problem was originally identified and analyzed by Akerlof (1970) in the context of the market for used cars. Mechanisms for alleviating adverse selection problems include signaling and screening. For example, workers in the labor market may attempt to signal their high productivity by purchasing education (to a lower cost than workers with low productive capability). Moreover, employers may use different types of screening devices to reveal the characteristics of their prospective employees.

Behavioral risks occurring *ex post* in relation to the signing of the contract between the principal and the agent are classified as moral hazard problems. Moral hazard is defined as a situation when the agent undertakes a self-interested (hidden) action at the expense of the principal. Hidden (unobservable) actions are possible due to two reasons. First, it is costly for the principal to monitor the agent's actions. Second, it is often the case that the principal does not possess the necessary expertise to evaluate whether the action undertaken by the agent is in her best interest. That is, the process of monitoring is also incomplete. Hence, the moral hazard problem caused by information asymmetry between the two parties may be defined as post-contractual opportunism, and is generated by the agent's hidden actions (monitoring of the effort is difficult) and by hidden information (difficulties of verifying the agent's effort).

The contractual approach for reducing moral hazard problems is to design incentive systems. The typical moral hazard models in the spirit of, e.g., Holmström (1979) can be divided into two parts, depending on the information structure. The benchmark case occurs when information between the parties involved is symmetric. In this case, it is optimal for the principal to pay the agent a fixed salary (accompanied by punishment for deviations from the principal's action plan), since the principal can perfectly observe the efforts and actions of the agent. In this scenario, the agent bears no level of risk, because the principal holds all risk. Hence, the agent is fully insured. In the literature, this scenario is called the first-best solution. However, the interesting situations in principal-agent theory arise when information is asymmetric between the parties, a situation that more closely resembles reality. In this case, it is optimal for the principal to design an incentive contract that ties the compensation of the agent to productive outcomes, to ensure that the agent acts in the best interests of the principal. However, in this scenario risk is transferred to the agent. As a result, the expected utility of the principal is lower than in the case of symmetric information. Thus, the asymmetric information case is referred to as the second-best solution in the literature.

¹⁰ Stated differently, the adverse selection problem may also be characterized in terms of hidden knowledge, i.e., the agent has private information concerning a parameter of her optimization problem unavailable to the principal (Laffont and Martimort, 2002).

2.3. Risk preferences

The attitude regarding risk is an important ingredient in principal-agent analysis. In the literature, risk preferences enter into the picture through the assessment of the attitudes of the principal and the agent regarding uncertain income (wealth) in terms of expectations. Individual risk preferences dictate how the person assesses risk, and these assessments are formalized in terms of expected utility. Although a number of different variations are possible, the most common assumption is that the principal is neutral against risk, whereas the agent dislikes risk, i.e., she is risk-averse. This assumption is plausible, since the principal is in practice represented by a large number of outside shareholders that presumably hold well-diversified portfolios. The agent, on the other hand, implicitly holds a large fraction of both her human and financial capital invested in the firm, and hence, is not diversified.

Individual risk preferences take, in general, three distinct forms, i.e., individuals may be seen as risk-averse, risk-neutral, or risk-seeking. In the literature, it is commonly assumed that the behavior of individuals is in accordance with the axioms of cardinal utility (Von Neumann and Morgenstern, 1947). If these rationality assumptions are satisfied, then one may express individual preferences over wealth by utility functions with expected utility properties. Specifically, attitudes toward risk may be determined by examining the expected utility of wealth $E[U(W)]$ against the utility of expected wealth $U[E(W)]$. An individual is said to be risk-averse if $U[E(W)] > E[U(W)]$. Hence, a risk-averse individual will have a concave utility function for financial outcomes. As a result, she prefers a fixed level of wealth (the expected value) to bearing the risk of a random amount of wealth (with the same expected value). A risk-neutral individual will exhibit the property that $U[E(W)] = E[U(W)]$, i.e., risk does not affect behavior. The preferences of a risk-seeking individual are specified as $U[E(W)] < E[U(W)]$, which implies a convex utility function.¹¹ Finally, an important concept in the analysis is the certainty equivalent. In particular, a risk-averse individual is assumed to be indifferent between an uncertain level of wealth and the certainty equivalent of wealth, where the certainty equivalent level of wealth is specified as the expected level of wealth subtracted with the corresponding risk premium (Pratt, 1964).

2.4. Dynamics of the optimal compensation contract

The fundamental insight of principal-agent models is that there is a trade-off between risk and incentives. That is, to provide incentives to the agent it is necessary that she is affected by her performance, which implies that current and future compensation is subject to uncertainty.

¹¹ The relation between the shape of the utility function and attitudes toward risk is technically due to Jensen's inequality. Specifically, if $U(X)$ is a strictly concave function, then for any random variable X this implies that $E[U(X)] < U[E(X)]$.

Since the agent is presumably less well equipped to bear risk than the principal, there is an inherent cost in providing incentives. Hence, efficient incentive contracts aim at balancing the costs of risk-bearing against the corresponding incentive gains.

A vast amount of theoretical work has been conducted on the dynamics of optimal compensation contracts. Important contributions in this area have been provided by, e.g., Mirrlees (1974, 1976) and Holmström (1979, 1982). This body of research solves optimization problems related to finding efficient combinations of elements in compensation schemes. More specifically, these types of theoretical models formalize the principles governing the design of compensation schemes, and demonstrate how the design is affected through variation in the underlying parameters. One of the main purposes of this thesis is to explore the design of stock option contracts. Principal-agent theory provides a number of implications regarding the optimality of contract design, and hence, provides an excellent framework in which empirical observations may be compared to predictions from theory. Appendix A provides a derivation of the second-best compensation contract in the spirit of Mirrlees (1974, 1976) and Holmström (1979, 1982). The most important implication of the theoretical framework with regard to the research questions covered in this thesis is related to the so-called incentive-intensity principle. It can be showed that the optimal intensity of incentives (β) is given by:

$$\beta = \frac{P'(e)}{1 + rC''(e)V}, \quad (1)$$

where $P(e)$ refers to the expected profit to the principal, given the level of effort of the agent e . The agent's level of risk aversion is denoted by r . The term $C(e)$ is to be interpreted as the cost of the agent's effort, conditional on the effort level, whereas V is the minimum variance of estimated effort.

The incentive-intensity principle is based on the expression of the optimal level of β given in equation (1), and provides a number of implications regarding the optimal level of pay-for-performance. The first implication concerns the sensitivity of the profit $P(e)$ to the employee's effort. That is, lower incentives should be provided when profits are less sensitive to effort (when $P'(e)$ is low). In other words, it is pointless to provide costly incentives if the employee's effort does not increase profits, e.g., because the employee is working at her maximum limit. Second, optimal levels of pay-for-performance should be related to risk aversion. Specifically, equation (1) suggests that higher levels of risk aversion (r) are associated with lower levels of pay-for-performance, a result attributed to the notion that higher risk aversion increases the cost of risk-bearing. Furthermore, equation (1) suggests that higher level of incentives should be provided when measurement of the employee's effort is more precise (i.e., V is low). Finally, optimal pay-for-performance sensitivity

exhibits an inverse relation with $c''(e)$. This may be interpreted as the notion that optimal incentive levels should be greater when the marginal cost of effort increases less rapidly (i.e., $c''(e)$ is low).

3. Literature on equity incentives

This section provides an overview of the literature regarding economic determinants of equity incentives. Furthermore, the section discusses the issue of contract design. Finally, the section contains a review concerning the efficiency of equity incentives.

3.1. Economic determinants

The literature on equity incentives takes the view that optimal compensation policies should be undertaken to alleviate the agency problem. One way of alleviating the agency problem is to adopt equity incentives, e.g., by requiring managers to hold stocks in the firm, or by introducing stock options. Although stock options represent only one form of equity incentives, it seems as if this type of compensation has become the most dominant type of incentive compensation in Finland (and in a global context).¹² A detailed review of the differences between various types of equity incentives is beyond the scope of this introductory chapter. Moreover, the literature on equity incentives discusses, in general, the benefits and costs of universal equity-based compensation relative to other forms of compensation. Hence, the economic determinants driving the use of equity-based compensation is routinely assumed to apply to most forms of equity incentives. Some controversies exist, however, e.g., concerning the practice of granting stock options also to lower-level (non-executive) employees, which has become increasingly popular in the recent years. This issue will be addressed subsequent to the general review.

The general assumption in the literature is that equity incentives, e.g., stock options, are likely to be used frequently when expected agency costs are high and when monitoring is difficult (costly). A common assumption is that monitoring is difficult when the firm has significant growth opportunities. Specifically, information asymmetries arising from growth opportunities imply that evaluation of the manager's investment choices becomes more difficult (see, e.g., Mehran, 1992; Smith and Watts, 1992; Bizjak et al., 1993). In addition, when the firm's growth opportunities are substantial, this also suggests that actions undertaken by the manager has a greater impact on the outcome (firm value). Thus, growth opportunities are expected to be positively related to the use of equity incentives.

¹² In the literature on executive compensation, equity incentives refer to securities that create incentives to increase the stock price.

The findings of Smith and Watts (1992), Gaver and Gaver (1993), Mehran (1995), Guay (1999), Himmelberg et al. (1999), and Palia (2001) lend support to a positive relation between growth or investment opportunities and equity incentives.

Jensen and Meckling (1976) argue that larger firms are more difficult to monitor, which motivates greater incentives in large firms. Furthermore, Demsetz and Lehn (1985) suggest that the optimal firm size and optimal level of managerial ownership (incentives) is dependent on the firm's factor inputs and product markets. If the optimal firm size is large, then the cost of fixed proportionate equity ownership is, correspondingly, greater in large firms. Hence, the absolute value of equity holdings should increase with firm size. Moreover, larger firms are expected to require talented managers who demand higher compensation (Smith and Watts, 1992).

Demsetz and Lehn (1985) also suggest that firms operating in uncertain (noisier) environments have greater monitoring costs, which implies that stronger incentives are needed to compensate for the monitoring difficulties. Several studies have used the volatility of the firm's stock returns as a proxy for the noise in the firm's operating environment, and hypothesized that volatility is positively related to amount of equity incentives used (see, e.g., Core and Guay, 2001a).¹³ On the other hand, traditional agency theory posits a trade-off between incentives and risk, and specifically, would suggest that pay-for-performance sensitivity is decreasing in firm risk, since incentive contracts impose risk on the presumably risk-averse agent.

The degree of information asymmetry between managers and shareholders may also differ in diversified versus focused firms (Thomas, 2002). In particular, the degree of managerial discretion is expected to be greater in diversified firms. A number of studies in the literature show that diversified firms trade at a discount relative to matched portfolios of focused firms (see, e.g., Lang and Stulz, 1994; Berger and Ofek, 1995; Comment and Jarrell, 1995). Denis et al. (1997) argue that managers may derive private benefits from firm diversification that exceed their private costs, and hence, agency considerations may be relevant in explaining the documented value-loss associated with firm diversification. Hence, increased information asymmetry between managers and shareholders implying greater possibilities for managerial discretion, suggests that the importance of equity incentives may be higher in diversified firms compared to focused firms.

Capital structure may affect the use of equity incentives in a variety of ways. First, Jensen (1986, 1993) argues that the existence of debt in the firm's capital structure acts as a bonding mechanism for managers. By issuing debt, managers contractually bind themselves to pay out future cash flows to bondholders. Furthermore, Easterbrook (1984) suggests that the use of debt financing enhances external capital market monitoring, which reduces the extent of managerial discretion in the firm. Agency conflicts may also arise between shareholders and bondholders, where these types of

¹³ In addition, the value of stock options using standard models such as Black and Scholes (1973) and Merton (1973) is an increasing function of risk. Hence, greater risk may increase the willingness of employees to accept stock options as a form of compensation.

problems are expected to be most severe when the probability for financial distress is high. John and John (1993) predict that highly levered firms will tie compensation less closely to the stock price, to alleviate potential conflicts of interest between shareholders and debtholders (asset substitution). All of these arguments suggest that financial leverage will reduce the use of equity incentives. However, the risk-inducing nature of stock options may indicate that the use of this type of compensation, in fact, drives management to increase the degree of financial leverage. In empirical work, Mehran (1992) and Berger et al. (1997) showed that increases in financial leverage were positively associated with holdings of managerial stock options.

Ownership structure is expected to be related to the use of equity incentives. If the ownership structure of the firm is dispersed, with a lack of sufficient monitoring by shareholders, then equity incentives may serve as a substitute for monitoring activities. In addition, different types of equity incentives are expected to serve as substitutes for each other. Yermack (1995) hypothesizes that incentives provided by stock option awards will decrease when the chief executive officer (CEO) holds a large fraction of equity, but failed to document any significant relation. However, Mehran (1995) showed that the percentage of equity-based executive compensation was inversely related to the percentage of CEO equity holdings. The concentration of ownership is also expected to serve as a substitute for equity incentives. The personal costs for shareholders associated with monitoring of firm management may be too great to induce small (atomistic) shareholders to engage in monitoring activities, since the benefits are shared with all other shareholders in proportion to their level of ownership. Large shareholders, on the other hand, are able to reap relatively high benefits from monitoring activities, and hence, this suggests that large shareholders are more interested in monitoring activities. As a result, a greater degree of ownership concentration in the firm may reduce the need of equity incentives (Hoskinsson and Turk, 1990). Institutional shareholders are also assumed to be more active than ordinary shareholders, presumably interested in the design of corporate governance. David et al. (1998) showed that the level of CEO compensation was lower for firms with greater institutional ownership, but that CEOs in these firms received a larger fraction of their compensation in the form of equity incentives.

The granting of stock options also to lower-level (non-executive) employees has become popular among firms.¹⁴ In Finland, the first broad-based stock option plan was introduced in 1989. However, the literature argues that the practice of granting stock options to lower-level employees is troublesome from a theoretical point of view (see, e.g., Lazear, 1999; Core and Guay, 2001a; Oyer and Schaefer, 2002; Bergman and Jenter, 2002; Ittner et al., 2003).

¹⁴ For a broad sample of firms in the U.S. during the years 1994 – 1997, Core and Guay (2001a) documented that non-executive employees held 2/3 of all stock options outstanding.

The general claim of this literature is that it is difficult to theoretically justify the practice of granting stock options to lower-level employees, since positive incentive effects of stock options may be diminished by free-rider problems and by the cost of imposing risk on employees.

Core and Guay (2001a) argue that the incentive-alignment motivation for stock options is weaker in the case of lower-level employees, since these individuals are expected to have less influence on the stock price through their actions. Hence, in addition to the incentive motive for stock options, Core and Guay (2001a) hypothesize that firms grant stock options to lower-level employees to retain and attract certain types of employees, and to serve as a substitute for cash compensation.¹⁵ The retention motive is highlighted by the fact that stock options typically include vesting restrictions, i.e., stock options become vested (exercisable) over time, which suggests that this type of compensation may bond employees to the firm over an extended period of time. Moreover, requiring employees to hold stock options may serve to attract certain types of employees, such as individuals with lower degrees of risk aversion. Liquidity constraints may also be related to the use of stock options, i.e., implying a substitution effect between stock options and cash compensation. Since granting stock options does not involve contemporaneous outflows of cash, firms with cash flow constraints are expected to make use of stock options (Yermack, 1995). Hence, lower-level employees may receive stock options as a substitute for cash compensation in firms with liquidity constraints.

3.2. Variation in contract parameters

One important puzzle in the literature on executive compensation is related to the design of equity incentives. In particular, the design of stock option plans involves the choice of a number of different parameters besides the actual size and target group of the plan, e.g., exercise prices, contract duration, vesting schedules, as well as more exotic features such as dividend protection and performance-vesting/indexing. In the U.S., the design of stock option plans seems to be surprisingly uniform. Murphy (1999) showed that 95% of all stock option plans targeted to CEOs of 1000 large U.S. firms were granted at-the-money, i.e., with the exercise price equal to the firm's stock price at the grant date. Kole (1997) documented that the corresponding figure was 93% for a sample of Fortune 500 firms in 1980. In a similar manner as exercise prices, the duration of stock option plans seems to be very homogeneous in the U.S. In the sample of Murphy (1999), 83% of the stock option plans involved a contract duration of exactly 10 years, whereas 11% of the plans involved duration of 5 – 10 years.

Executive stock options are similar to American options, since they may be exercised early, i.e., before the expiration date of the contract. However, since these options typically involve vesting

¹⁵ In addition, Core and Qian (2000) predict that lower-level employees receive more stock options in firms where growth opportunities are more strongly related to human capital.

restrictions, they are technically Bermudan options, in other words, they become exercisable after a particular period of time. Yermack (2001) points out that vesting schedules is one parameter that actually exhibits a greater degree of variation in the U.S., with vesting schedules ranging from immediate vesting of the entire stock option plan, to vesting periods that approach the maximum contract duration. However, Yermack (2001) argues that the majority of these vesting schedules tend to be quite short, and are unlikely to affect managerial behavior, and that research is needed to verify two related research questions, i.e., i) why are vesting schedules so short, given that employee retention is presumably an important motive for stock option compensation, and ii) what explains the cross-sectional variation in vesting schedules? The only study to date trying to explain differences in vesting schedules has been conducted by Kole (1997), aiming to find univariate relations between vesting schedules and the degree of research and development (R&D) intensity in the firm, but the results failed to provide any robust conclusions.

The homogeneity regarding contract design in the U.S. may partly be explained by tax and accounting considerations. Bebchuk et al. (2002), among others, argue that the almost complete absence of in-the-money (discount) stock options may be explained by tax and accounting rules in the U.S.¹⁶ However, neither tax or accounting considerations in the U.S. can plausibly explain the non-existent practice of granting out-of-the-money (premium) stock options. Another important feature of stock option plans in the U.S. is the fact that they are almost exclusively not dividend protected. Murphy (1999) documents that only 1% of the sample stock option plans offered dividend protection. Once again, regulatory factors in the U.S. seem to be driving this observation. Fenn and Liang (2001) argue that this phenomenon is presumably driven by the fact that under current accounting standards in the U.S., dividend protected stock options are considered to be variable-plan options, due to the fact that exercise prices are contingent upon future events (dividend payments) and must therefore be recorded as a compensation expense in the income statement.¹⁷

In theory, optimal design of equity incentives, e.g., stock option plans, will vary from firm to firm depending on various characteristics. Hence, from a theoretical point of view it is somewhat difficult to justify the homogeneity of stock option compensation practices in the U.S. Finnish firms, however, are not subject to similar tax and accounting considerations which seem to limit the design of stock option plans in the U.S.

¹⁶ Specifically, discount stock options are not considered as “performance-based compensation” under Section 162(m) of the Internal Revenue Code in the U.S., and are thus not deductible if an executive’s total non-performance-based compensation exceeds \$1 million per year. Furthermore, discount stock options must be taken into earnings, whereas premium stock options and options issued at-the-money are not subject to this rule.

¹⁷ The value of a call option that is not subject to dividend protection decreases in line with dividend payments, since other things equal, dividends reduce expected terminal stock prices (Johnson and Tian, 2000). Hence, managers holding call options not subject to dividend protection may have incentives to reduce the amount of dividends. In the U.S., Lambert et al. (1989) and Fenn and Liang (2001) have documented inverse relations between dividends and holdings of executive stock options. In Finland, however, dividend protection has become an increasingly popular feature in connection with executive stock options. Liljeblom and Pasternack (2002) showed a positive relation between dividend distributions and the level of stock option holdings, when stock options are subject to dividend protection.

Moreover, the variation in contract parameters of stock option plans for Finnish firms has, in fact, been relatively high. Hence, a major goal of this thesis is to contribute to the literature by examining factors driving stock option contract design using Finnish data, which enables an excellent research setting.

3.3. The efficiency of equity incentives

The optimal contracting view taken in the literature assumes that shareholders of the firm represented by the board and/or compensation committee, design equity incentives exclusively to mitigate the agency problem (see, e.g., Ross, 1973; Holmström, 1979; Grossman and Hart, 1983; Milgrom and Roberts, 1992). A large part of the empirical work in the literature on executive compensation implicitly takes this view, i.e., assumes that when firms contract with their managers, incentive levels are, on average, set at value-maximizing levels (see, e.g., Demsetz and Lehn, 1985; Core and Guay, 1999; Himmelberg et al., 1999). If this is the case, then equity incentives have certainly been important in promoting the efficiency of the economic system as a whole.

More recently, however, the optimal contracting approach normally taken in the literature has been criticized by authors who argue that executives, in fact, have substantial influence related to the design of their own compensation. This approach is normally referred to as the managerial rent extraction view, which has evolved more recently in the literature (see, e.g., Bebchuk et al., 2002). In contrast to the optimal contracting view of executive compensation, the managerial rent extraction view suggests that a part of the agency problem between shareholders and managers is that managers use their compensation to provide themselves with rents. In particular, the amount of rents that an executive extracts is the excess of pay obtained over the amount that would maximize shareholder value.¹⁸

Furthermore, several authors argue and provide evidence that the board of directors (the device that optimally should protect the interests of shareholders, e.g., by monitoring the management of the firm) in practice serve at the discretion of the CEO (see, e.g., Hermalin and Weisbach, 1998; Shivdasani and Yermack, 1999). Other signs of managerial misbehavior in connection with executive stock options have been identified by, e.g., Yermack (1997), who finds positive abnormal stock returns immediately after the granting of stock option plans, a result attributed to the fact that managers time the granting of stock options prior to the release of favorable company news. Aboody and Kasznik (2000) present evidence that firms delay the disclosure of good news and hasten the release of bad news prior to the granting of stock options. In addition, Carpenter and Remmers

¹⁸ As an example, Hall (2002) reported that Dennis Kozlowski, the infamous former CEO of Tyco International Ltd., at one point received a stock option award consisting of nearly 6 million options, with a market value of approximately \$75 million, using standard option valuation methodology. It is very difficult to imagine that the size of such a stock option package would be optimal from a motivation or retention point of view.

(2001) present evidence suggesting that managers exploit inside information to decide on the timing of their exercises of stock options.

Another point gaining increased attention in the literature relates to the so-called value to cost efficiency of equity incentives (see, e.g., Lambert et al., 1991; Meulbroek, 2001; Hall, 2002). The important distinction to be made is the difference between the company cost of equity incentives and the value that executives and employees place on the same equity incentives. The company cost of equity incentives may be interpreted as the opportunity cost, i.e., the amount that the firm could obtain if it were to sell, e.g., stock options to outside well-diversified investors, rather than distributing them to executives and employees. In contrast, since executives and employees are presumably risk-averse and not well-diversified, they are expected to value equity incentives at less than the company cost (market value). In particular, because executives and employees due to, e.g., long vesting periods or board pressure are forced to hold large fractions of firm equity, fractions that are far beyond optimal from a portfolio diversification perspective, they should rationally discount the value of these equity holdings (Hall, 2002). This has been expressed in another way by Meulbroek (2001) who argues that to properly achieve incentive-alignment, the manager and employee must be exposed to firm-specific (unsystematic) risk. However, this forced exposure prevents the manager from optimal portfolio diversification. As a result, because undiversified managers and employees are exposed to the firm's total risk, but are rewarded only for the systematic portion of that risk through the stock's expected return, managers and employees will tend to value equity incentives (stocks or stock options) at less than their market value.¹⁹ The difference between the company cost of equity incentives and the private value that managers and employees place on equity incentives is defined as the deadweight cost by Meulbroek (2001). Jin (2002) provides additional insights to the understanding of the cost of risk in principal-agent relations. In particular, whereas hedging of firm-specific price movements acts against the motive of incentive-alignment, and may also be illegal, incentives are not reduced if managers and employees adjust their exposure to market (systematic) risk through trading of the market portfolio. Consistent with this view, he showed that pay-for-performance sensitivity is related to the firm's unsystematic risk, but not to systematic risk.

Advocates of the executive-value approach argue that measuring incentive effects using standard valuation methodologies such as Black and Scholes (1973) and Merton (1973) may not be the proper way to proceed. However, it should be stressed that private valuations of equity incentives are extremely difficult, if not impossible, to quantify in practice, since these valuations may vary from firm to firm, and between individuals within the firm. Furthermore, the theoretical private value

¹⁹ Standard principal-agent theory suggests that all types of risk are equally costly to the agent (the manager or employee). In contrast, Meulbroek (2001) argues that unsystematic risk is, in fact, more costly to the agent, since the expected market return fairly compensates the agent for bearing systematic risk, but does not compensate the agent from bearing unsystematic risk.

of equity incentives depends on subjective factors, e.g., personal risk aversion, which is most difficult to estimate in reality.

On the other hand, arguments have also been presented in favor of using standard valuation methodologies, i.e., the methods used in practically all existing empirical work in the field of executive compensation (see, e.g., Core and Guay, 2001b). Hence, the questions regarding the efficiency of equity incentives, i.e., whether firms' compensation policies reflect responses to agency problems or the creation of agency problems, and whether the measurement of equity incentives reflects true valuations, are obviously far from resolved in the literature, and thus, represent an area of important future research.

4. Impacts of incentives and risk

Another major goal of this thesis is to analyze the role of incentives and risk in corporate decision-making. An important feature in the literature is the clear distinction between the theory of corporate finance emphasizing separation of ownership and decision-making in the firm, and neoclassical theories of investment under uncertainty focusing on wealth-maximizing investment strategies. The integration of these two strands of literature is clearly an important agenda for future research.²⁰ Hence, an interesting aspect to consider is whether decision-making under uncertainty is affected by the use of equity incentives. Corporate decision-making naturally includes an extremely wide range of elements, including real decisions (e.g., capital investment), financial decisions (the choice of capital structure), as well as corporate strategy (e.g., the degree of diversification). However, this section is restricted to analyzing real decisions of the firm, since this constitutes the research questions addressed in this thesis. Furthermore, the section reviews literature on the relation between incentives and firm performance, a question, which is also important for this thesis.

4.1. The role of incentives and risk in corporate decision-making

Aggarwal and Samwick (1999c) point out that agency problems may lead managers to engage in either overinvestment or underinvestment. The notion that firms systematically engage in overinvestment can be found, e.g., in the work of Jensen (1986, 1993). In particular, managers may pursue negative NPV investment projects because utility is increased from controlling more assets, i.e., larger firms. Hence, private benefits of investment may drive managers to increase the size of the firm beyond optimum. As a result, shareholders need to enforce some form of mechanism that reduces the extent of managerial discretion with respect to the use of funds, and forces the manager to distribute excess means to shareholders. In the original paper of Jensen (1986), such devices include increased use of debt financing, dividends, as well as the market for corporate control.

²⁰ Some attempts to integrate these two strands of literature have been done (see, e.g., Kanninen, 2000).

However, the use of equity incentives may be an efficient device preventing the manager from engaging in value-destroying activities. Agency problems may also lead to underinvestment. In particular, managerial effort aversion (shirking) suggests that managers may pass up positive NPV investments, due to private costs of investment. As with overinvestment, a possible way to alleviate shirking is to tie managerial compensation to productive outcomes, such as the value of the firm.

Another agency problem, which may affect corporate decision-making, is related to managerial risk aversion. Beginning from the work of Jensen and Meckling (1976), the literature widely acknowledges that managerial risk aversion combined with sub-optimal concentration of firm-specific human and financial capital may prevent managers from undertaking risky but positive NPV investments on the behalf of risk-neutral shareholders. If risk-averse managers prefer to choose safer projects with lower NPVs, as opposed to riskier projects with higher NPVs, then the firm (the shareholders) may benefit from granting stock options, which introduces convexity in the compensation scheme, and hence, provides managers incentives to invest in riskier projects.²¹

An important point to be made is that any statistically significant relation between incentives and investment may suggest that firms are not contracting optimally with managers. Under the assumption that firms set incentive levels at optimum when contracting, and that re-contracting is continuously possible in the absence of frictions such as contracting costs, then one expects to find no relations between the level of incentives and the decisions undertaken by managers, e.g., firm investment. This represents the equilibrium argument of Demsetz and Lehn (1985), and serves as a natural null hypothesis in all empirical work on equity incentives and corporate decision-making.

Empirical evidence on the relation between incentives and investment has been provided by Aggarwal and Samwick (1999c), who showed that both Tobin's Q and investment are increasing in incentives, a result attributed to underinvestment problems. Datta et al. (2001) analyzed how executive compensation is related to acquisition decisions, and showed that managers with greater equity-based compensation pay lower acquisition premiums, and engage in risk-increasing acquisitions that earn higher post-acquisition returns. Ryan and Wiggins (2002) showed that growth opportunities determine the use of stock option compensation, and that stock option holdings are positively related to R&D investment. Moreover, they documented a negative relation between

²¹ In line with Agrawal and Mandelker (1987) the total wealth of the manager may be divided into three parts: W_S , W_H , and W_O . The first term refers to the value of stocks and stock options in the firm. The second term refers to the value of human capital. The third term refers to other assets uncorrelated with the firm. If the levels of W_S and W_O are low, then managerial actions are expected to be primarily related to their impact on W_H . If firm performance turns out to be poor, it may have the following impacts on W_H . First, compensation may decrease (see, e.g., Murphy, 1985). Furthermore, potential compensation provided by alternative employers presumably decreases (see, e.g., Amihud and Lev, 1981). Finally, if the firm goes bankrupt, firm-specific human capital is destroyed. Assuming that W_H is correlated with firm performance, then a positive relation exists between the variability of performance and the variability of W_H . Given that managers are risk-averse, they prefer to decrease the variability of firm performance. However, if W_S is considerable, and consists of instruments with convex payoffs, then this should mitigate the effect of risk aversion and provide increased incentives to engage in risky projects.

restricted stock holdings and R&D investment. The former result is consistent with the notion that convex payoffs from stock options may reduce the effect of managerial risk aversion, and provide the manager with incentives to engage in risky projects. The latter result supports the notion that if managerial wealth is primarily dependent on firm performance, i.e., not substantially increasing in risk, then managers may pass up risk-increasing positive NPV investments. Moreover, these results may be interpreted as supporting the arguments of, e.g., Jensen and Meckling (1976), Haugen and Senbet (1981), Smith and Stulz (1985), i.e., the view that the convexity of the relation between the stock price and manager's wealth, in addition to the slope, must be structured efficiently to provide managers with proper incentives to engage in value-maximizing investment and financing decisions.²² Rajgopal and Shevlin (2002) showed that oil exploration risk is increasing in the convexity of compensation payoffs.

Firm risk may affect real decisions of the firm in a variety of ways. Models of irreversible investment suggest that increased uncertainty slows down firm investment, since the option value of waiting for uncertainty to be resolved is increased (see, e.g., McDonald and Siegel, 1986; Pindyck, 1988; Dixit and Pindyck, 1994). Managerial risk preferences are also expected to affect investment. Hartman (1976) and Appelbaum and Katz (1986) show that firms with greater risk aversion will have lower output and factor inputs. Moreover, Zeira (1990) and Nakamura (1999) show that risk aversion induces a negative impact of uncertainty on investment. The degree of information asymmetry between borrowers and lenders may result in financing constraints (see, e.g., Greenwald et al., 1984; Myers and Majluf, 1984; Greenwald and Stiglitz, 1990). Increased uncertainty about future prospects and profitability may imply that some firms become constrained from external financing for firm-specific investments, because the probability of financial distress is increased. Hence, greater risk may reduce investment due to financing constraints. Moreover, the capital asset pricing model (CAPM) suggests that greater risk, measured as the covariance of returns from investments with respect to market returns, decreases firm investment, since the required rate of return is increased.²³ All of these arguments predict a negative investment – uncertainty relation. However, a positive relation is also plausible from a theoretical point of view. In the models of Hartman (1972) and Abel (1983), the marginal revenue product of capital (MRPC) is a convex function of shocks facing the firm. The convex shape of the MRPC suggests that a mean preserving spread in the distribution of a shock facing the firm will increase the expected return on investment.

While the relation between risk and firm-specific investment is ambiguous from a theoretical point of view, empirical evidence suggests that greater risk reduces investment (see, e.g., Leahy and Whited, 1996; Minton and Schrand, 1999; Ghosal and Loungani, 2000; Bulan, 2001; Bloom et al., 2001). However, previous empirical research has focused on the relation between firm risk and

²² See Guay (1999) for an in-depth discussion of this issue.

²³ Leahy and Whited (1996) provide an extensive review of stylized facts regarding the investment – uncertainty relation, including the role of the CAPM.

capital investment. More generally, it is important to study how risk affects real decisions from a broader perspective, i.e., how risk affects the growth of the firm. Hence, a contribution of this thesis is to study the impact of risk on firm-specific investment from a more general perspective.

In theory, managerial risk preferences are expected to be related to corporate decision-making. Indeed, this argument can be found in both the theories of corporate finance, as well as the neoclassical theories of investment under uncertainty. Moreover, a prediction in the literature is that the likelihood of a negative investment – uncertainty relation is increasing in the degree of managerial risk aversion. Since the convexity of payoffs induced by stock option compensation is expected to decrease managerial risk aversion, a straightforward implication to examine is whether the investment – uncertainty relation is dependent on the nature of the firm's compensation policies. This approach represents one step in the process of integrating the modern theories of the firm.

4.2. Incentives and firm performance

The impact of equity incentives on firm performance represents one of the most important puzzles in the literature on executive compensation. Given that separation of ownership and control implies possibilities for value-destroying behavior by managers, then the argument is that equity incentives should mitigate the agency problem, and consequently, be associated with greater firm performance. However, Core et al. (2003) argue that there is currently no theoretical or empirical consensus on how stock options and managerial equity ownership affect firm performance.

Studies on short-term stock price reactions to the adoption of executive stock option plans have shown positive abnormal returns subsequent to the event (Tehranian and Waagelein, 1985; DeFusco et al., 1990; Yermack, 1997; Aboody and Kasznik, 2000). However, the causes of these reactions are not clear-cut in the literature. For example, Yermack (1997) attributes this finding to the notion that managers exploit insider information regarding the timing of plan adoptions.

Conion and Freeman (2000) find that productivity is significantly higher in firms using stock option plans targeted to employees throughout the organization. Similarly, Sesil et al. (2000) document significant positive relations between the use of broad-based stock option plans and characteristics such as firm productivity, sales growth, and Tobin's Q , but fail to document any relation between broad-based incentives and stock returns.

The most cited research on the relation between incentives and firm performance is presumably the work by Morck et al. (1988) and McConnell and Servaes (1990). Treating Tobin's Q as a measure of firm performance, these authors show that firm performance is positively (although non-linearly) related to the fraction of equity held by managers. Moreover, the results of Aggarwal and Samwick (1999c) reassure these findings by showing that both investment and Tobin's Q are increasing in incentives.

As with the relation between incentives and investment, any statistically significant relation between incentives and firm value may be interpreted as the fact that firms are not setting and maintaining optimal incentive levels over time. Core and Larcker (2002) attempt to reconcile the literature on equity incentives and firm performance. They point out the fact that studies such as Morck et al. (1988) argue that observed managerial ownership is, on average, lower than optimal. Thus, increasing the level of managerial ownership may increase firm performance. At the other extreme, several studies, initiated by the work of Demsetz and Lehn (1985), argue that firms and managers contract optimally, and that this optimization suggests that incentive levels are, on average, set at value-maximizing levels. Hence, in equilibrium, no relation between incentives and firm performance is expected to be observed. The findings of Himmelberg et al. (1999) support this view. The important point to notice is the assumption made by both schools of thought regarding the nature of incentive contracting costs. That is, Morck et al. (1988) assume that contracting costs are so great that optimal contracting is impossible, suggesting that some firms will perform poorly. On the other hand, the equilibrium arguments made by Demsetz and Lehn (1985) imply that optimal contracting can be conducted continuously, in the absence of adjustment costs.

These two polar cases of the expected relation between equity incentives and firm performance may, however, be criticized for their stringent assumptions. Core and Larcker (2002) propose a new view regarding the relation, which may be considered both intuitive and appealing. They suggest a scenario in which firms optimize ownership (incentive) levels when contracting. This would imply no relation between incentives and performance at optimum. However, contracting is not continuous due to adjustment costs of contracting. Based on these arguments, they predict that some firms are below optimum and that their performance may be improved by increasing ownership (incentive) levels. Consistent with this view, they find that mandatory increases in suboptimal equity ownership are associated with increases in subsequent firm performance. In summary, the relation between equity incentives and firm performance is not resolved in the literature, and hence, requires further work to promote the current understanding.

5. Summary and contribution of the essays

The separate essays of the thesis are summarized in this concluding section. The section reviews the nature of the research questions addressed, presents the central findings, and discusses the contributions to the literature.

Essay 1: Stock option compensation in Finland: an analysis of economic determinants, contracting frequency, and design

Principal-agent theory provides a large number of predictions regarding the optimality of contracting practices. If compensation practices reflect predictions from the theory, then one expects explanatory variables measuring agency considerations to be systematically related to the use of equity incentives. Hence, the paper provides an analysis of factors determining the use of stock option plans. The results of this analysis suggest that variables measuring monitoring costs, growth opportunities, ownership structure, and risk are related to the use of stock options. The majority of the obtained results are well in accordance with principal-agent theory. For example, the likelihood of using stock options is found to be increasing in firm size and growth opportunities (see, e.g., Jensen and Meckling, 1976; Demsetz and Lehn, 1985; Milgrom and Roberts, 1992). Furthermore, the probability of using stock options is decreasing in firm risk. Principal-agent theory posits that a trade-off is involved between providing incentives and optimal risk-sharing for managers and shareholders. As a result, incentives should decrease with risk (see, e.g., Holmström, 1979).

In addition, the essay studies if the forces driving the use of stock option compensation differ depending on the target group of stock option plans, in particular, stock options targeted to top management, or to a broader base of employees. The results of this analysis provide less clear-cut conclusions. First, in line with expectations, large firms seem to grant stock options solely to top management. This is expected, since lower-level employees in large firms are less likely to be able to affect the stock price (see, e.g., Core and Guay, 2001a). Furthermore, cash flow constraints seem to increase the likelihood of using broad-based stock option plans. A plausible explanation for this observation is that cash-constrained firms grant stock options to lower-level (non-executive) employees as a substitute for a lower capacity to pay cash compensation (Yermack, 1995; Core and Guay, 2001a). Moreover, the results suggest that the positive relation between Tobin's Q and stock option compensation tends to hold strictly only in firms where stock options are awarded also to non-executive employees. Finally, the results suggest that stock option compensation targeted solely to top management is more likely to appear in diversified firms compared to focused firms. The degree of information asymmetry between shareholders and managers is expected to be greater in diversified firms (see, e.g., Thomas, 2002). Hence, the result seems plausible based on the argument that greater information asymmetry implies a higher need for controlling managerial discretion.

Stock option compensation practices are also studied from a somewhat different angle than in previous research. In particular, the essay studies the question of why some firms tend to contract with stock options more frequently than others, by examining factors related to the time-dimensional contracting frequency, i.e., the time elapsed between subsequent contracting events. The results of this analysis suggest that the level of growth opportunities seems to matter. Specifically, firms with high growth opportunities seem to contract more frequently over time, a result consistent with the view that incentive levels shift more rapidly from optimum in firms characterized by substantial growth opportunities.

Finally, the essay shifts the analysis to contract-level, by analyzing factors related to the design of vesting schedules and the duration of stock option plans. The results show that a higher degree of financial leverage reduces the length of vesting. Several arguments from the literature may be used to rationalize such a result. First, debt may serve as a substitute for long-term equity incentives (Jensen, 1986). In addition, Fudenberg et al. (1990) argue that the benefits of long-term contracting are increasing in the degree of growth opportunities. Hence, the result lends support to the substantial body of research showing an inverse relation between financial leverage and growth opportunities (see, e.g., Smith and Watts, 1992). More importantly, the probability of financial distress is increasing in financial leverage, which suggests that leverage increases firm risk. Moreover, greater firm risk is expected to reduce the value that risk-averse managers and employees place on equity incentives. To mitigate this decrease in valuation, firms may reduce restrictions on equity incentives, e.g., by shorter vesting (Hall, 2002). The results also suggest that vesting periods and contract duration are longer in state-owned firms. These observations support the labor retention motive commonly emphasized in Finnish state-owned firms. Interestingly, the results show that contract duration tends to be longer in diversified firms compared to focused firms. If firm focus serves as a proxy for the degree of information asymmetry (monitoring difficulty), and assuming that the benefits of long-term contracting are increasing in the degree of information asymmetry, then such a result seems plausible from an economic point of view.

Essay 1 contributes to the literature by providing an extensive analysis of stock option compensation practices in Finnish firms. Moreover, the essay contributes to the current understanding by analyzing time-dimensional contracting frequency from a different angle than in previous research. Most importantly, the essay is the first study to provide a comprehensive analysis of factors related to the design of vesting schedules and contract duration.

Essay 2: What determines stock option contract design?

The larger part of the empirical work in the executive compensation literature focuses on the incentive effects provided by stock option compensation (see, e.g., Yermack, 1995). However, the actual design of equity incentives, in particular stock options, is very limited in the U.S., e.g., nearly all stock options are granted at-the-money without dividend protection. This observation is routinely attributed to U.S. tax and accounting considerations (see, e.g., Murphy, 1999). Theory suggests that the design of optimal equity incentives will exhibit variation depending on firm characteristics. Finnish firms are not subject to similar tax and accounting considerations as U.S. firms, and correspondingly, the design of stock option plans for Finnish firms displays a relatively high degree of dispersion. Thus, the use of Finnish data creates an excellent research opportunity.

The essay analyzes factors related to several important contract attributes, including the scope of stock option plans, the exercise price, the target group, and the decision to include dividend protection. The results show that the scope of stock option plans, measured as the stock option overhang, is inversely related to Tobin's Q . Several well-known studies use Tobin's Q as a measure of firm performance (Morck et al., 1988; McConnell and Servaes, 1990). Hence, the result may be interpreted as the fact that poorly performing firms introduce larger stock option plans in relative terms. A result that shareholders would be willing to provide higher equity incentives in relative terms as a response to poor performance lends support to predictions from standard principal-agent theory (see, e.g., Holmström, 1979). In particular, lower incentives should be observed when firm performance is less sensitive to effort. Put differently, it is pointless to provide costly equity incentives if the effort of managers and employees does not improve performance, e.g., because the managers and employees are already working at their maximum efficiency. Hence, a result that poor firm performance is associated with greater equity incentives in relative terms seems reasonable. Furthermore, the results show that the scope of stock option plans is increasing in proxies for monitoring costs, a result in accordance with theory (see, e.g., Demsetz and Lehn, 1985). The results also show that the scope of stock option plans is greater in broad-based plans, and in plans offering dividend protection.

In the case of exercise prices, the results show that prior stock return is inversely related to the size of the stock option premium, measured as percentage out-of-the-moneyness. As such, the result supports expectations, since shareholders are assumed to respond to poor prior stock price performance by requiring a greater subsequent stock price appreciation to reward managers. In addition, the result is plausible in relation to the documented result regarding the scope of stock option plans. In particular, in the case of poor firm performance, shareholders may find it optimal to introduce stock option plans with a larger scope accompanied with more demanding features, such as a higher exercise price, since poor firm performance may be related to the fact that managers and

employees are not performing at maximum efficiency levels. Hence, providing an incentive structure as the one described is sensible, since greater effort is assumed to increase firm performance. An alternative explanation to the optimal contracting view is that managers enjoy greater negotiation power regarding the design of executive compensation after periods of higher stock price performance (see, e.g., Bebchuk et al., 2002).

The results indicate that the likelihood of granting broad-based stock option plans is increasing in institutional ownership, cash flow constraints, and decreasing in firm size. The latter two results are well in line with predictions from the literature (see, e.g., Yermack, 1995; Core and Guay, 2001a). The first result is attributed to the notion that institutional owners are presumably active investors with a greater interest in corporate governance, and as such, may be more willing to support the adoption of broad-based equity incentives. The results of the essay lend support to a negative relation between foreign ownership and the decision to include dividend protection. This observation may to some extent be attributed to differences in dividend taxation status between foreign and domestic shareholders in Finland (see, e.g., Liljeblom and Pasternack, 2002). Finally, firms paying zero-dividends are less likely to include dividend protection, whereas greater firm-specific risk is associated with a greater likelihood for dividend protection.

Essay 2 contributes to the current understanding on equity incentives by providing an extensive contract-level analysis of stock option design. Since Finnish firms are not subject to tax and accounting considerations restricting the design of stock option plans, the use of Finnish data offers a unique opportunity to analyze contracting behavior. The major contribution of the essay is to provide new evidence on factors driving important contract attributes, in particular, the exercise price of stock options, and more special features, such as dividend protection.

Essay 3: The impact of stock option incentives on investment and firm value

It is widely recognized in the literature that agency problems may lead to either underinvestment or overinvestment (Jensen and Meckling, 1976; Jensen, 1986, 1993; Aggarwal and Samwick, 1999c). Hence, the purpose of this essay is to quantify price and risk incentives arising from stock option compensation, and to determine whether incentives are related to the investment intensity of firms. Incentive effects arising from stock option compensation may be classified in two ways. First, because the value of stock options is increasing in the stock price, financial interests of managers are aligned with those of shareholders. However, this is only a partial solution to the agency problem, because the risk preferences of managers are expected to be different from the risk preferences of shareholders. In particular, managers are commonly assumed to be significantly more averse towards risk than the representative well-diversified shareholder. Since the value of stock

options is an increasing function of risk, this suggests that agency problems related to managerial risk aversion may be mitigated.

The results of the essay lend support to a positive relation between firm investment and the incentive to increase stock price (delta). It is important to notice, however, that if one makes the extreme assumption that all firms in the sample are optimizing incentive levels continuously, then one should not expect to document any statistically significant relation between the level of incentive provided and managerial action, such as firm investment (see, e.g., Demsetz and Lehn, 1985). Hence, the observation that firm investment is increasing in incentives may be considered as evidence against the equilibrium argument, and interpreted as a sign that firms, on average, are underinvesting, consistent with managers having private costs of investment (see, e.g., Aggarwal and Samwick, 1999c).

In addition, the essay examines whether price and risk incentives from stock options are related to firm value, measured as Tobin's Q . In the U.S., previous studies have typically focused on managerial stock ownership as a measure of equity incentives. Consistent with this strand of literature (Morck et al., 1988; McConnell and Servaes, 1990; Aggarwal and Samwick, 1999c), the results reveal that firm value is increasing in the incentive to increase stock price (delta) and in the incentive to increase risk (vega). As for investment intensity, these observations may be interpreted as evidence against the equilibrium arguments of, e.g., Demsetz and Lehn (1985). The essay also examines whether firm characteristics such as diversification, the level of free cash flow, and the target group of stock option plans affect the relations under investigation. In general, the results suggest that the documented relations are robust, with the exception that the positive relation between stock option incentives and firm value tends to be magnified in focused firms.

Finally, the essay takes the analysis a step further by allowing investment, firm value, and stock option incentives to be simultaneously determined. Several recent studies in the literature suggest that these factors may be endogenously determined (see, e.g., Cho, 1998; Himmelberg et al., 1999; Palia, 2001). The results of this analysis fail to provide any evidence that stock option incentives would affect firm investment. However, the documented positive relation between incentives and firm value is reassured by the results of this analysis. Finally, the results suggest that neither firm value nor investment intensity determine the level of incentives. One shortcoming of the analysis commonly shared with most existing empirical research in corporate finance is the reliance on Tobin's Q , measured using book values of debt capital. Thus, a positive relation between stock option incentives and Tobin's Q may be the result of asset substitution, i.e., transfer of wealth from debtholders to equityholders.

Essay 3 contributes to the literature in the following ways. First, this essay is probably the first study investigating the effect of stock option portfolio incentives (delta and vega) on firm investment. Furthermore, the essay examines the relation between the same incentive effects and firm value,

whereas most of the previous literature focuses on managerial stock ownership as a measure of equity incentives. In addition, the essay includes a simultaneous equation analysis, where firm investment, firm value, and stock option incentives are allowed to be endogenously determined. It seems as if this type of an analysis has only been conducted using managerial stock ownership in previous research. Finally, the use of Finnish data on stock option compensation enables a more exact measurement of stock option incentives than in previous research, mainly conducted using U.S. data.

Essay 4: Firm risk, investment, and employment growth

The relation between risk and corporate decision-making has for a long period been subject to analysis in several variants of economic theory, including the theory of corporate finance, as well as neoclassical theories of investment under uncertainty. This body of literature suggests that investment decisions may be influenced by factors such as the irreversible nature of investment (McDonald and Siegel, 1986; Pindyck, 1988; Dixit and Pindyck, 1994), information asymmetry between borrowers and lenders (Greenwald et al., 1984; Myers and Majluf, 1984; Greenwald and Stiglitz, 1990), managerial risk preferences (Hartman, 1976; Appelbaum and Katz, 1986; Zeira, 1990; Nakamura, 1999), as well as convexity of the marginal revenue product of capital (Hartman, 1972; Abel, 1983). Although the investment – uncertainty relation is ambiguous from a theoretical point of view, empirical evidence suggests that the relation is negative (see, e.g., Leahy and Whited, 1996; Minton and Schrand, 1999; Ghosal and Loungani, 2000; Bulan, 2001; Bloom et al., 2001).

This essay extends the current literature by examining the relation between risk and corporate decision-making from a more general point of view than in previous research. In particular, previous research has routinely examined the effect of risk on capital investment decisions. However, critical firm-specific investments affecting the growth of the firm extend beyond the simple case of capital investment. Economic theory defines the firm's production as a function of capital and labor, and hence, the growth of the firm may be measured besides by investment intensity, through the growth in employment. Thus, additional insight is brought into the literature by examining the effect of firm risk on both investment intensity and employment growth.

The results of the essay reassure the findings of previous research by documenting that greater firm risk tends to slow down capital investment. However, when firm risk is decomposed into systematic and unsystematic components, the results reveal that the negative relation is driven primarily by unsystematic risk. Moreover, systematic risk does not seem to affect investment intensity. Consistent with the main hypothesis of the essay, i.e., that firm risk not only affects investment intensity, but also firm growth more generally, the results show that firm risk decreases

employment growth. As in the case of investment intensity, the results suggest that unsystematic risk is the important factor.

A number of different interactions are examined in the essay. Several studies argue that managerial risk preferences are expected to affect the investment – uncertainty relation. A prediction in the literature is that increased managerial risk aversion should strengthen the inverse investment – uncertainty relation. Since a major motive underlying stock option compensation is to reduce the risk aversion of the manager, it is straightforward to hypothesize that managerial compensation providing convex payoffs should be related to the investment – uncertainty relation. However, the results of the essay fail, in general, to find any robust interaction effects regarding the relation between risk and firm growth, depending on the firm’s compensation policies.

Essay 4 contributes to the literature by extending the analysis of the relation between risk and corporate decision-making by hypothesizing and documenting that firm risk affects the growth of the firm from a more general perspective. Furthermore, the essay contributes to the evolving integration of theories of corporate finance and neoclassical theories of investment, by studying whether the investment – uncertainty relation is dependent on the firm’s compensation policies.

Appendix A

The following part provides a derivation of the second-best compensation contract, based on theoretical models of, e.g., Mirrlees (1974, 1976), Holmström (1979, 1982). For convenience, the review is restricted to a single-period setting. The following review is based on Milgrom and Roberts (1992) and Marini (2003).

A.1. Derivation of the second-best compensation contract

The model assumes that the agent (employee) has an exponential utility function taking the form $U(W) = -e^{-rW}$, where r is the employee's coefficient of absolute risk aversion. The utility function of the employee is concave because r is assumed to be greater than zero, which implies that the employee is risk-averse. Furthermore, the employee provides an effort e at the cost $C(e)$, whereas the principal (employer) is risk-neutral with an expected profit of $P(e)$. The effort of the employee is unobservable and can be estimated by observing the realized outcome z , which is defined as $z = e + x$.²⁴ That is, the realized outcome z depends on effort e and sources of randomness given by x . The assumption is that x is a random variable with $E(x) = 0$. Since effort is unobservable, the principal observes only the outcome z , which may be caused by different combinations of effort and luck. In addition, the employer may also observe another indicator, a random variable k , which could be, e.g., a peer-group benchmark, that is unrelated to effort e but correlated with the random term x . The assumption is that $E(k) = 0$. To achieve incentive-alignment, the employee's compensation contract (compensation rule) takes a linear form, and is given as:

$$w = \alpha + \beta(e + x + \gamma k), \tag{A.1}$$

where γ is the weight attached to the second indicator k by the employer. This suggests that the employer estimates effort as $(e + x + \gamma k)$. The parameter α in the linear compensation rule is interpreted as a fixed payment, whereas β measures the intensity of incentives, i.e., the sharing rate.

It is commonly assumed that the risk tolerance of the principal (the shareholders of the firm) is infinitely larger than the risk tolerance of the agent (the employee). Hence, the principal is assumed to be risk-neutral, whereas the agent is risk-averse. This suggests that the most efficient combination of risk-sharing would be to shift all risks to the principal, giving the agent full insurance. Indeed, the first-best solution implies that β in equation (A.1) is equal to zero, and the employee receives a fixed payment equal to α . However, this solution removes all financial incentives of the employee to provide effort. Thus, the efficient contract specifies compensation as a function of the parameters e ,

²⁴ For instance, z could be specified as the value of the firm's stock.

α , β , and γ , such that the total certainty equivalent (CE) to all parties is maximized. The total CE is equal to the average income for the principal and the agent subtracted by the risk premium. By the principle of value maximization, the efficient contract is such that the total CE of wealth is maximized for all individuals.²⁵ The total CE is specified as $CE_P + CE_A$. For the risk-neutral principal it is given as:

$$CE_P = P(e) - \alpha - \beta(e + \bar{x} + \bar{k}) = P(e) - \alpha - \beta e, \quad (\text{A.2})$$

given that $E(x) = E(k) = 0$. For the risk-averse employee, the CE is specified as follows:

$$CE_A = \alpha + \beta e - C(e) - \frac{1}{2} r \beta^2 \text{var}(x + \gamma k).^{26} \quad (\text{A.3})$$

Since the total CE is specified as the sum of equations (A.2) and (A.3), it is given as:

$$TCE = P(e) - C(e) - \frac{1}{2} r \beta^2 \text{var}(x + \gamma k). \quad (\text{A.4})$$

From equation (A.4) it is clear that the fixed proportion of compensation α is solely a transfer of profits between the employer and the employee (it does not affect the joint surplus, i.e., the sum of incomes). Hence, α does not influence the choice of the efficient contract, which suggests that the only relevant parameters in contract design are e , β , and γ . To find the optimal compensation contract, one begins by recognizing that the employee maximizes her expected utility with respect to effort e . This leads to the incentive compatibility constraint, specified as:

$$\beta = C'(e). \quad (\text{A.5})$$

The incentive compatibility constraint should be interpreted as follows. For every incentive intensity level β , the employee provides an effort level such that the marginal cost of one unit of additional effort $C'(e)$ is equal to the expected marginal benefit received by this additional effort, i.e., β .

Furthermore, to reach a solution for the optimal contract, γ is to be selected to minimize the variance of the estimated level of effort e , i.e., $\text{var}(x + \gamma k)$.

²⁵ Thus, maximizing the total CE is equal to maximizing the average wealth subtracted by the risk premium.

²⁶ The term $\frac{1}{2} r \beta^2 \text{var}(x + \gamma k)$ is the risk premium for the income risk that the agent bears.

According to the informativeness principle of Holmström (1979), the efficiency of compensation contracts is increased by factoring into the determinants of pay any performance measure that reduces the error with which the employee's effort is estimated, and by excluding performance measures that increase the error. Standard results from statistics imply that $\text{var}(x + \gamma k) = \text{var}(x) + \gamma^2 \text{var}(k) + 2\gamma \text{cov}(x, k)$. Hence, $\min_{\gamma} \text{var}(x + \gamma k)$, i.e., the minimum variance of the estimated effort is reached for $2\gamma \text{var}(k) + 2\text{cov}(x, k) = 0$. By solving for γ , we obtain the following expression:

$$\gamma = -\frac{\text{cov}(x, k)}{\text{var}(k)}. \quad (\text{A.6})$$

Hence, the informativeness principle suggests that when the variance of the estimate of effort $\text{var}(x + \gamma k) < \text{var}(x)$, then it is convenient to use the additional performance indicator k . On the contrary, if $\text{var}(x + \gamma k) > \text{var}(x)$, then it is optimal to ignore k , and set $\gamma = 0$.²⁷ Furthermore, the informativeness principle would suggest that compensation contracts tied to the firm's stock price may be improved by using relative performance evaluation, e.g., where the exercise price of stock options is determined relative to a peer-group benchmark (Holmström, 1982).²⁸

After selecting the appropriate γ in accordance with the informativeness principle, and with the knowledge how the employee reacts to incentives (incentive compatibility constraint), the employer chooses the efficient level of incentive intensity β . The optimal incentive intensity is solved through the following steps. First, one maximizes the total utility/total CE with respect to the level of effort e . The total CE is given by:

$$TCE = P(e) - C(e) - \frac{1}{2} r \beta^2 V, \quad (\text{A.7})$$

where $V = \min_{\gamma} \text{var}(x + \gamma k)$, given that the incentive compatibility constraint holds. Since $\beta = C'(e)$, equation (A.7) can be expressed as:

²⁷ It is important to notice that under the informativeness principle of Holmström (1979), the linear compensation contract is not strictly tied to, e.g., the firm's stock price because the employer prefers increasing stock prices, but because the stock price provides the employer with information of the employee's effort.

²⁸ In practice, however, relative performance evaluation seems to be seldom used. This observation has been analyzed extensively in the literature, and potential explanations for the fact that relative performance evaluation is used so rarely includes, e.g., design costs (Janakiraman et al., 1992), avoiding distortions in managers' decisions to enter other industries (Janakiraman et al., 1992; Dye, 1992), softening industry competition (Aggarwal and Samwick, 1999b), retaining employees during bull-markets (Himmelberg and Hubbard, 2001), discouraging excessive risk alteration (Levmore, 2001), tax considerations in the U.S. (Schizer, 2001), reducing risk-bearing costs (Murphy, 2002), and managerial ability to undo the effect of indexing (Jin, 2002).

$$TCE = P(e) - C(e) - \frac{1}{2}rC''(e)^2V. \quad (\text{A.8})$$

The first order condition for maximum with respect to effort e is given as:

$$\frac{\partial TCE}{\partial e} = P'(e) - C'(e) - rC''(e)C''(e)V = 0. \quad (\text{A.9})$$

To provide a solution for the optimal level of β , the expression for the incentive compatibility constraint $\beta = C'(e)$ is substituted back into the first order condition, which gives the following:

$$P'(e) - \beta - r\beta C''(e)V = P'(e) - \beta[1 + rC''(e)V] = 0. \quad (\text{A.10})$$

Finally, by rearranging terms the optimal level of incentive intensity is given by:

$$\beta = \frac{P'(e)}{1 + rC''(e)V}. \quad (\text{A.11})$$

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