ABSTRACT

Title of Document:	MANDATING DISCLOSURE OF R&D BENEFITS AND COSTS TO EXTRACT MANAGERS' PRIVATE INFORMATION: OBSTACLES AND PRACTICAL CONSIDERATIONS
	Ai-Ru Yen, Ph.D., 2007
Directed By:	Professor, Oliver Kim, Department of Accounting and Information Assurance

This study suggests that mandating managers to disclose information about the net benefit of R&D outside financial statements is worth to be considered as one potential approach to improve the market's valuation of R&D and to improve managers' R&D-related decision making process. A transition of the R&D reporting practice from cost focused to net benefit focused is viewed necessary. A stream of two mandatory reporting systems is established for the transition to take place more smoothly. It is expected that information asymmetry can be reduced after information about R&D net benefit becomes publicly available. This study contributes to the literature in three ways. First, this is the first study which seriously considers the direct disclosure of net benefit of R&D as a way to improve the R&D reporting practice. Second, this study proposes a stream of reporting systems in the transition. The current R&D reporting practice can be transited gradually toward the desirable R&D reporting practice following the stream. Finally, this study points out that both market participants and firms will be potentially benefited in the transition. Not only the negative impact of information asymmetry will be reduced but also some potential subsidiary benefits will be provided by the transition.

MANDATING DISCLOSURE OF R&D BENEFITS AND COSTS TO EXTRACT
MANAGERS' PRIVATE INFORMATION: OBSTACLES AND PRACTICAL
CONSIDERATIONS

By

Ai-Ru Yen

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2007

Advisory Committee:
Professor Oliver Kim, Chair
Professor James P. Bedingfield
Professor Martin Loeb
Associate Professor Tien-Mo Shih
Assistant Professor Paul Zantek

Table of Contents

Lists of Figures

Lists of Tables

Acknowledgments

This study would not have been possible without the support of many people. I would like to thank first and foremost all my committee members for their valuable assistance and constructive comments. I especially would like to thank my advisor, Dr. Oliver Kim, for his patience, for guiding me toward a creative research methodology, and for always motivating me to keep going throughout the phases of this study.

I would like to thank my colleagues, Chih-Yang Tseng and Jing-Wen Yang, for their suggestions and encouragements. Thanks are also due to my fellow classmates, Ming-Feng Lin and Sherae Daniel, for their helpful comments and proof readings.

Finally, words alone cannot express the thanks I owe to my parents for their support and love. I would never be where I am today without them.

Chapter 1: Introduction

While most people realize the importance of Research and Development (R&D) activities[1] in sustaining a firm's future profitability, few can point out how much R&D contributes to future profitability. This is because the link between R&D activities and future profitability has seldom been clearly identified and reported. Most publicly available financial information of R&D is about the costs of R&D. Financial information about the benefits of R&D is not prevalent in the market. This cost-focused R&D reporting practice exaggerates information asymmetry between firms and the market about the value of R&D. As a result, the market's valuation of R&D tends to be biased and the biased market valuation subsequently provides incentives for managers to make opportunistic R&D investment decisions. Because such decisions are often made at the cost of future profitability, the intrinsic value of those firms could be seriously hurt in the long run.

The purpose of this study is to suggest one way to alleviate the negative impact of information asymmetry on market valuation and managerial R&D decision makings. A transition of the R&D reporting practice from cost focused to net benefit focused is suggested

---

[1] Formal definitions of R&D activities will be given in section 4.2.1.

as one way to reduce the negative impact of information asymmetry. It is expected that more

information about the net benefit of R&D^2 will become publicly available in a net

benefit-focused R&D reporting practice. The degree of information asymmetry can be

reduced after more information about the net benefit of R&D becomes publicly available and

so the related negative impacts can be alleviated. Accordingly, this study focuses on the issue

of how to increase the amount of publicly available information about the net benefit of R&D

and how to ensure the usefulness of such information so that the transition of the reporting

practice can be made progress.

The previous accounting literature on R&D implicitly suggests the need of the

transition and suggests that the transition can take place on financial statements by altering

R&D recognition rules. Different from what has been considered in the previous accounting

studies on R&D, this study proposes that the transition can take place outside financial

statements by establishing additional mandatory disclosure requirements. The reasons are

twofold. First, because the realization of R&D net benefit is highly uncertain, the quality of

information from financial statements can be damaged if information about the net benefit of

R&D is recognized on financial statements. One complementary way is to disclose such

information outside financial statements in order to maintain the quality of financial

---

^{2} Formal definitions of information about the net benefit of R&D will be provided in section 4.2.6.

statements. Second, it is evident that voluntary disclosures of information about the net benefit of R&D are not widespread in the current R&D reporting practice. An intervention of accounting standard-setting body is viewed as a necessary force to expedite the transition of the R&D reporting practice. Based on the above two reasons, a stream of two mandatory reporting systems, including the target reporting system and the transitional reporting system, outside financial statements is established and proposed as a new avenue for the transition to take place.

More specifically, in the target reporting system, firms will be required to provide information about the expected future net benefits of R&D and information about the realization of net benefits of R&D. Since a firm's future cash flow will be positively related to the future net benefit flow from R&D activities, the market can directly assess the firm's future cash flow and price more appropriately after the target reporting system is implemented. Although the market can assess the potential of future cash flows more directly after information about future net benefits of R&D is publicly available, it may be difficult to force firms to provide reasonable expectations for some R&D projects. It also takes time for people to be accommodated to the net benefit-focused reporting practice. Although it is more desirable to have publicly available information about the future net benefit of R&D, the target reporting system may not be implemented successfully in the short run due to the

above practical considerations. To initiate the transition in the short run and to make the process become more smoothly, a transitional reporting system is established in addition to the target reporting system. Firms will be required to provide only information about the realization of net benefits of R&D in the transitional reporting system. It is expected that the transitional reporting system has more potential to be implemented in the near future because the reporting obligation is less than that in the target reporting system. Although there will not be publicly available information about the future net benefit of R&D, the market can still be benefited by learning information about the performance of firms' past R&D activities in the short run. The R&D reporting practice can be transited toward a more desirable reporting practice gradually. Figure 1 provides an overview of the proposed transition.

(Insert Figure 1 about here)

One important issue in this study is whether useful information will be provided under the proposed mandatory reporting requirements. Because the realization of the net benefit of R&D is highly uncertain, it is unlikely to require firms to provide perfect information about the future net benefit of R&D. However, since managers possess superior information about the net benefit of R&D than the market does, information provided by managers, as long as has a certain level of precision, will be useful. The more precise the information is the more useful it will be. Therefore, it is of our interest to have some

4

mechanism to induce more precise information from firms in the reporting system.

Based on the findings and suggestions from Lundholm [1999, 2003], the requirement of disclosing historical reports about the net benefit for each R&D project[3] is viewed as a potential mechanism to induce useful reports. Two examples are provided to demonstrate that, under certain circumstances, if a firm intends to misreport the future net benefit of one project, there will be negative impacts on the valuation of its other R&D projects when the precision of misreported information can be observed from the corresponding reporting history. Because managers are aware of the potential negative impact of providing less precise expectation, they will report more cautiously. In addition, the build-up credibility by providing more precise expectation in the history will benefit firms. It is believed that under the requirement of disclosing past reports for each R&D project, information with an optimal level of precision will be provided in equilibrium and the usefulness of information can be ensured to a certain extent.

In order to present historical information more concisely, the use of diagram is proposed as an alternative way to disclose information. Hence, different from tabulated financial statements, one feature of the proposed reporting systems is that information will be disclosed diagrammatically. The other feature of the proposed reporting systems is that

---

[3] For the reporting purpose, information about R&D activities with identifiable and distinguishable technical objective will be grouped as information for one R&D project. More detail will be given in section. 4.2.2.

non-financial R&D information, such as the descriptions of R&D projects, physical progress of R&D, and the target market, etc., will not be required. It is believed that the proprietary cost can be restricted and the net benefit of reporting will not be damaged by the additional mandatory reporting requirements. It is also expected that managers will be more willing to supply information with higher level of precision when the proprietary cost of reporting is restricted[4].

In addition to the alleviated negative impacts of information asymmetry, there will be other potential benefits if the transition can take place successfully following the proposed stream. Market participants will not only be benefited from the lowered information search cost but also from the lowered risk related to their investment decisions after more information about the net benefit of R&D becomes publicly available. Firms will also be benefited from the additional reporting requirements. Managers will be forced to participate in the R&D decision making process earlier and more intensively[5]. They will also be encouraged to improve their ability to handle the uncertainty related to R&D. Better R&D-related decisions can be made with an enhanced R&D decision making process and

---

[4] The circumstance that financial information about R&D is not prevalent in voluntary disclosure is consistent with proprietary theories (see, for example, Dye [1986], Darrough and Stoughton [1990], and Verrecchia [1983, 1990a, 2001]) which suggest that firms limit their voluntary disclosure of relevant information to the financial market because the existence of disclosure related costs. Therefore, if proprietary costs can be restricted, firms may be more willing to provide more precise information.
[5] To obtain information about the net benefit of R&D, communications across departments within a firm is necessary. CEO plays a coordination role in communicating the needs and allocating the resources within a firm. The coordination process encourages CEO to get involved in R&D decision making process earlier to make more effective decisions (see, Roussel et al. [1991]) and in turn benefits the whole firm.

will benefit those firms eventually.

The main contributions of this study are as follows. First, the direct disclosure of information about the net benefit of R&D has not been considered as one potential way to alleviate possible negative impacts of information asymmetry by the previous accounting literature on R&D. Prior studies focus on the issue of how to improve the usefulness of information about R&D costs on financial statements by examining alternative reporting rules[6]. The need for a transition of the R&D reporting practice on financial statements is implicitly suggested by prior studies. This study not only explicitly points out the need of the transition but also specifies a new direction for the transition to take place. Information asymmetry can be directly reduced after direct disclosures of the net benefit of R&D become publicly available. It is our understanding that this study is the first accounting study which seriously considers the direct disclosure of net benefit of R&D as a potential approach to transit the R&D reporting practice and to reduce negative impacts of information asymmetry.

Second, a stream of two possible reporting systems along the path of the transition is established. The target reporting system is designed as an avenue for managers to provide

---

[6] One suggestion that has been made is that the current R&D financial reporting rule, which is regulated by Statement of Financial Accounting Standard (hereafter SFAS) No. 2, *Accounting for Research and Development Costs*, should be replaced by alternative reporting rules, such as capitalization or successful-efforts methods. There are studies provide evidence that R&D information will become more value relevant if alternative reporting rules are applied. This evidence implies that R&D information, when reported on financial statements, can be more informative under the regulation of alternative reporting rules. See section 2.2 for the related literature review.

information about R&D that can be directly associated to market valuation (i.e. the future net benefit of R&D). Although it has less potential to be implemented in the short run, the target reporting system provides a prototype of the desirable R&D reporting practice. Furthermore, after taking some practical considerations into account, this study suggests that a transitional reporting system is needed to initiate the transition process in the short run. The progress of transition can be made gradually with the implementation of the transitional reporting system. Following the established stream, it is believed that the current R&D reporting practice can be improved smoothly toward a more desirable R&D reporting practice.

Finally, this study points out that there will be potential net benefits by transiting the R&D reporting practice in the direction suggested by this study. Market participants will be benefited from the reduced uncertainty of R&D and can price firms more appropriately with lower information search costs. Firms will be benefited from improved R&D decision making process. The requirement of disclosing past information also helps firms to build up their credibility. Firms' reports can affect the valuation more significantly if there is higher build-up credibility.

There are three main limitations of the study. First, possible impacts on social welfare and potential litigation costs are not examined. It is possible that imposing additional mandatory disclosure requirements is not always socially optimal (see, for example, Admati

and Pfleiderer [2000] and Sapra [2002]). Second, the proposed mechanism in the reporting system cannot perfectly prevent managers from misreporting. Only the incentive for misreporting can be reduced. Finally, only a few practical concerns and obstacles have been considered in this study. It is possible that there are other practical issues related to the implementation of the reporting system that have not been addressed in this study.

Because the proposed reporting requirements have not been implemented practically, whether the systems can work as effectively as expected remains as an open question. In the near future, an accounting behavioral experiment can be designed and performed to examine managers' reporting behaviors and the impact of managers' reports on the valuation of R&D under the proposed reporting requirements. Such a setting can provide an initial evidence of the feasibility of the reporting system and is considered as a possible future extension of this study.

The rest of the study is organized as follows. Chapter 2 provides the background of the study. Chapter 3 examines issues related to the quality of information provided by firms. How the requirement of reporting historical information can work as a potential mechanism to induce useful reports and how firms will determine the optimal precision level of their reports will be addressed. Chapter 4 summarizes key features of the reporting requirements and provides formal definitions of terms that are used often throughout this study. Issues

related to the target reporting system, such as the reporting requirements, practical

considerations, and potential benefits, are introduced in Chapter 5. Chapter 6 discusses

potential obstacles to the implementation of the target reporting system and introduces the

transitional reporting system. Chapter 7 concludes the study and discusses the limitations and

one possible future extension of this study.

Chapter 2: Background

2.1 Current R&D reporting practice

It is well known that R&D activities play an important role in sustaining firms' future profitability. According to the National Science Foundation (NSF), since 1953, U.S. R&D expenditures as a percentage of GDP[7] have ranged from a minimum of 1.4% (in 1953) to a maximum of 2.9% (in 1964). Most of the growth in the R&D to GDP ratio can be attributed to increases in nonfederal R&D spending. Nonfederal-financed R&D, the majority of which is financed by industry, increased from 0.6% of GDP in 1953 to an estimated 1.9% of GDP in 2004 when R&D spending in industries has approached to 200 billion in 2004. The statistics demonstrate the importance of R&D in the economy and the industry.

Although the importance of R&D activities to both individual firm and the whole economy is conspicuous, there is not much publicly available information about benefits and risks of R&D activities in the market. Current publicly available R&D financial information is generally restricted to cost-side information. For example, only R&D expense can be observed from financial statements. In the section of MD&A in annual reports often only the

---

[7] The ratio of R&D expenditures to GDP is an indicator of the intensity of R&D activity in relation to other economic activity and can be used to gauge a nation's commitment to R&D at different points in time (see *National Patterns of Research and Development Resources: 2004*).

ratio of R&D expense to Sales Revenue and the change of the ratio from past years are reported. The budget of R&D spending is discussed in terms of the percentage of sales but with no more detail. Similar reporting practices can be found when examining other voluntary disclosures such as press release or media report. A few examples of the current R&D reporting practice are given in Appendix A

Moreover, publicly available information related to R&D benefits and risks is often non-financial and without explicit quantitative measures. For example, below are two examples that can be observed commonly from annual reports:

--"Our long-term viability and growth will depend upon the successful development and commercialization of other products from our research and development activities"

--"Product development and commercialization involve a high degree of risk. Only a small number of research and development programs result in the commercialization of a product."

The first statement indicates that benefits of R&D activities are to sustain the firm's long-term viability and growth; however, how and in what degree R&D activities provide these benefits are not specified or measured. The other statement points out that the degree of risk related to R&D activities are high; however, how high the degree is not measured. The observations from the current R&D reporting practice suggest that firms are not used to disclosing quantified financial information about the performance of their R&D activities. One consequence is that it is difficult for interesting market participants to evaluate the

financial performance of R&D activities based on publicly available information. There will also not be any objective benchmark, for instance, the rate of returns on R&D investment, to compare the financial performance of R&D across firms. With the cost-focused R&D reporting practice, there will be information search costs to gather benefit-related R&D financial information in the market. There will also be incentives for managers to make opportunistic R&D decisions in the absence of an objective R&D financial performance evaluation standard. Previous accounting studies on R&D have addressed the consequence of the cost-focused R&D reporting practice and the related concerns will be discussed in the following section.

2.2 Prior Literature

Three main concerns in the prior accounting literature on R&D are summarized to point out academic concerns for the current R&D financial reporting practice. The concerns are all centered on the rule of reporting R&D costs on financial statements. The first concern is the inability of the immediate expensing rule to identify the relationship between R&D costs and future benefits. The second concern is the potential negative impact of the immediate expensing rule on R&D-related decision makings. The third concern is whether alternative R&D reporting rules can improve the usefulness of R&D information. Each

concern will be addressed respectively below.

The first concern is that benefits related to R&D costs have not been appropriately considered under the immediate expensing rule. One argument for the immediate expensing rule in SFAS No. 2 is that there is no direct relationship between R&D costs and future benefits so that R&D costs are expensed immediately when they occur. Contrary to the argument, R&D costs have been demonstrated to be associated with future benefits. For example, Sougiannis [1994] finds that one dollar outlay in R&D leads to a two dollar increase in earnings of the sample firms over a seven year period. Kothari et al. [2002] show that the contribution of current R&D expense to the variability of future earnings is three times greater than that of investment in property, plant and equipment.

Additional empirical evidence about the relation between R&D costs and related benefits has been provided by the relation between R&D costs and stock prices. For example, Bublitz and Ettredge [1989], Boone and Raman [2004], Chan et. al. [1990], Duke [1976], and Hirshey and Weygandt [1985] find that R&D costs affect stock prices or returns. If it is true that the market's expectation of firms' future profitability is captured by stock prices, the positive relationship between R&D costs and stock prices implies the positive relationship between R&D costs and future profitability. Results from these studies are also against the claim of the lack of association between R&D costs and future benefits

The second concern is about the impact of the immediate expensing rule on managerial decision makings. Because the immediate expensing rule does not consider benefits of R&D costs, there is information asymmetry between firms and investors about the value of R&D. As Aboody and Lev [2000] indicate, because no information is required to be provided about the productivity and the value of R&D, the current R&D reporting practice exacerbates information asymmetry. In the presence of information asymmetry, management has incentives to manipulate its R&D decisions for different purposes. A number of studies have demonstrated that R&D is manipulated for managerial purposes which sometimes impede the firms' future potential. For example, Duke et al. [1980], Horwitz and Kolodny [1980], and Wasley and Linsmeier [1992] demonstrate that firms reduce their R&D outlays without appropriate managerial concerns after the immediate expensing requirement was imposed. Baber et al. [1992], Bushee [1998], Oswald and Zarowin [2006] and Perry and Grinaker [1994] further provide evidence that R&D spending is managed to meet short-term earnings goals[8].

Different circumstances that managers use R&D costs to manage earnings are also considered. Cheng [2004] and Dechow and Sloan [1991] examine R&D expenditure

---

[8] The incentive to meet short-term earnings goals is created when the market fixates on current earnings without looking beyond reported earnings by recognizing the value of R&D. Results from Boone and Raman [2004] and Luft and Shields [2001] suggest that when the market fixates on current earnings, equity mispricing is likely to occur. To avoid such mispricing, management tends to manipulate the amount of R&D spending.

decisions in the context of Chief Executive Officer (CEO) compensation. Their results indicate that there are opportunistic R&D reductions when CEOs approach retirement. In examining initial public offering (IPO), Darrough and Rangan [2001] find that the change of R&D expenditures is negatively associated with the level of managerial selling in an IPO which indicate that firms manage R&D earnings at the time of IPO. These studies provide evidence that firms manipulate R&D costs in different circumstances.

Finally, because the immediate expensing rule does not adequately consider benefits from R&D activities, researchers become interested in examining the implication of alternative accounting rules for R&D. For example, Lev and Sougiannis [1996] explore the implication of the capitalization rule by estimating the R&D capital and adjusting the reported earnings and book value. They conclude that the R&D capitalization process yields value-relevant information to investors. In a simulation study for a pharmaceutical R&D program, Healy et al. [2002] find that capitalizing R&D outlays with the successful-efforts method provides a stronger relationship between accounting information and economic values.

There have also been direct investigations on the impact of the capitalization rule from SFAS No. 86, *Accounting for the Cost of Computer Software to be Sold, Leased, or Otherwise Marketed*, which requires the capitalization of certain software development costs

incurred subsequent to establishing technological feasibility. For example, Aboody and Lev [1998] find that annually capitalized software development costs are positively associated with stock returns and software development capital assets are positively associated with stock prices. Mohd [2005] shows that investors' uncertainty about the future benefits of software development costs is reduced when firms capitalize these costs.

Consistent with above empirical findings, Luft and Shields [2001] suggest that capitalizing R&D costs affect information users' perception on future earnings through experimental settings. Lev and Zarowin [1999] also call for the use of capitalization of certain intangibles including R&D, and systematic and continual restatement to improve value relevance of accounting information.

In sum, prior accounting studies on R&D raise concerns that the immediate expensing rule fails to address the relationship between R&D costs and future benefits and exacerbating information asymmetry creates incentives for opportunistic R&D decision makings. Alternative R&D recognition rules, such as the capitalization or successful-efforts methods, have been suggested to improve the usefulness of R&D information reported on financial statements. These concerns demonstrate that the current R&D reporting practice on financial statements is not appropriate and certain improvements have to be made to alleviate potential negative impacts.

2.3 Motivations for additional R&D mandatory reporting requirements

From the previous accounting literature on R&D, it is known that there are negative impacts of information asymmetry about the value of R&D. Such impacts can be alleviated if more publicly available information about the benefit of R&D activities is provided. In order to achieve this target, a transition from cost-focused reporting practice to net benefit-focused reporting practice is viewed necessary and cannot be avoided. The suggestion of altering R&D recognition rules on financial statements by the previous accounting literature on R&D also implies the need for the transition of the current R&D reporting practice.

Figure 2 provides an overview of two possible paths of the transition of R&D reporting practice. The progress of the transition can be made on financial statements or on disclosures outside financial statements. The prior accounting literature on R&D implicitly suggests that the progress of the transition can be made by altering recognition rules of R&D related information on financial statements. For example, the reporting practice under the immediate expensing rule is cost focused and the reporting practice under the capitalization rule is more benefit focused. The suggestion that the reporting rule of R&D is switched from the immediate reporting rule to the capitalization rule implies that the transition can take place on financial statements.

(Insert Figure 2 about here)

Different from the focus of the prior literature, this study suggests that the transition can take place on disclosures outside financial statements. A set of additional mandatory reporting requirements for managers to disclose information outside financial statements is established and considered as an approach to make progress of the transition. The reasons are twofold. First, the observation that voluntary disclosures of information about benefits of R&D are not widespread in practice suggests that managers are reluctant to disclose such information when there is no mandatory reporting requirement. Without an intervention of accounting standard-setting body, it will be difficult to shift the R&D reporting practice from cost focused to benefit focused. A force from the standard-setting body is necessary for the transition to take place. Hence, setting up mandatory reporting requirements for managers to report information about the benefit of R&D activities is considered as a more effective approach.

Second, it is possible that the transition can be completed on financial statements in the future. For instance, recognizing the deficiency of the immediate expensing rule, not only the U.S. but also some foreign countries have allowed the capitalization of R&D costs under certain conditions[9]. It is possible that the accounting standard of R&D will be revised

---

[9] For instance, U.K. accounting principle for R&D cost (SSAP No. 13) permits the capitalization and subsequent amortization of development expenditures if (1) there is a clearly defined project; (2) the related expenditure is separately identifiable; (3) the outcome of the project has been assessed with reasonable certainty; (4) the aggregate of deferred development costs, and other related costs is reasonably expected to be exceeded by related future sales or other revenues; and (5) adequate resources exist, or are reasonably expected to be

following the trend of fair value accounting[10] so that the net benefit of R&D activities can be recognized on financial statements in the future. Altering the R&D recognition rule on financial statement indeed is one feasible way to transit the R&D reporting practice.

However, it should be noted that the transition of the R&D reporting practice by altering recognition rules on financial statements has its own deficiency. Because R&D activities involve a great degree of uncertainty, it is likely that firms will need to revise the reported net benefit of R&D on financial statements frequently. It can be expected that the frequent revision will cause a greater degree of variability of information on financial statements. As a result, financial statements reflect not only results from economic activities but also the change of uncertainty from reporting the net benefit of R&D. The quality of information on financial statements could therefore be damaged if the net benefit of R&D is recognized on financial statements.

One complementary way to prevent the information quality of financial statements from being damaged is to disclose such information in a separate disclosure outside financial statements. On the one part, the information quality of financial statements will not be

affected by the uncertainty of R&D net benefits. On the other part, information about the net benefit of R&D can still be learned by market participants from a separate disclosure outside financial statements. Hence, unlike prior accounting studies, this study considers reporting R&D benefits in a separate disclosure outside financial statements as a better approach.

Additional mandatory reporting systems outside financial statements are established for firms to report information about the net benefit of R&D based on the above two reasons. A stream of two reporting systems is developed along the path of the transition and is highlighted in the shaded boxes in Figure 2. The target reporting system has desirable features but may not be feasible in the short run. The transitional reporting system is then established as a buffer in the transition. Details of the proposed mandatory R&D reporting systems will be examined in later chapters.

Chapter 3: The quality of useful R&D information

As mentioned earlier, this study looks for ways to improve the valuation of R&D and to reduce incentives for opportunistic R&D decision makings. Mandating managers to report information about the net benefit of R&D in a separate disclosure outside financial statements is proposed as one potential way to reduce negative impacts of information asymmetry. Since the design of the reporting system (or the reporting requirements) will affect managers' reporting behaviors and in turn affect the quality of information provided by managers, it is crucial to first consider the impact of managers' potential reporting behaviors on the quality of information and further adapt the design of the reporting system to ensure the quality of information provided by managers.

In this chapter, the quality for R&D information provided by firms to be useful is first identified. Requiring managers to report their past reports for each R&D projects is viewed as a potential mechanism to induce managers to provide useful information about the future net benefit of R&D. Under such requirement, how managers' reporting behaviors affect information quality and the market's valuation of R&D will then be examined in two examples. The optimal reporting decision will be addressed at the end of this chapter.

3.1 The quality of information about the net benefit of R&D

In this section, the usefulness of information about the net benefit of R&D will be first identified and the quality for such information to be useful will then be examined.

3.1.1 The usefulness of information about the net benefit of R&D

Information about the net benefit of R&D will affect both the valuation of R&D and the incentive for opportunistic R&D decision makings only when it is used. Its usefulness depends on the degree of this impact; the higher the impact the more useful the information. To highlight the impact of R&D information, an example is provided as follows. Consider a situation when a firm's future net benefit flow totally comes from its R&D activities and its earnings equal to the net benefit of R&D. To maintain earnings flow, it is necessary for the firm to fund R&D activities every year. Further assume that the market valuation of the firm is based on the expected future earnings flow so that the higher expected earnings the higher the market valuation.

The impact of information about the future net benefit of R&D on the market valuation and the managerial decision making are analyzed in three scenarios listed in Table 1. In scenario 1, the firm currently has earnings $80 and it is expected that the $80 will be persistent in the future as long as the firm continues spending $20 in its R&D activities in each year. In scenario 1, the expected future earnings flow will be $80 per year, and the

market valuation of the firm will be made according to the expected future earnings flow.

(Insert Table 1 about here)

Assume that the manager is considering whether to spend an additional $10 on R&D annually beginning in the current year. The manager privately observes that the increase of $10 in R&D will create $30 more earnings annually beginning next year. In other words, the net benefit flow from the additional R&D expenditure is $20 per year beginning next year.

In scenario 2, it is assumed that there is no publicly available information about the net benefit of the additional R&D expenditure. Earnings in current year will be reduced to $70 after the additional $10 R&D cost is spent. Since current earnings are expected to be persistent in the future, the expected future earnings flow will be revised to $70 per year. The market valuation of the firm will be made according to $70 expected future earnings flow. As a result, the market valuation of the firm at the end of current year in scenario 2 will be lower than that in scenario 1.

The situation differs when additional information about the net benefit of the additional R&D spending is disclosed. In scenario 3, assume that the manager reports his private information about the future net benefit of R&D to the market. After recognizing that there will be $20 increase of the future net benefit flow from the additional $10 R&D cost, the market will adjust its expectation of the firm's future earnings flow into $100 (i.e.

(100+30)-(20+10)) per year instead of using current earnings as the basis to estimate future earnings flow. The market valuation at the end of current period in scenario 3 will hence be higher than that in scenario 1 and scenario 2.

Because the market valuation in scenario 2 is the lowest, the manager, when he cares only about the current market value and when he does not want to disclose his private information, would drop the chance of getting more earnings and stay in scenario 1. Apparently, this decision is opportunistic because it is not made to maximize the firm's economic value. The incentive is created because the market does not have information about the link between the incremental R&D costs and related future net benefits, and values the firm's future earnings flow inappropriately. When the market is provided with information about the future net benefit of the additional R&D costs and corrects its valuation accordingly (i.e. in scenario 3), the manager will spend $10 on R&D. The opportunistic R&D decision making will not be necessary.

From the above example, it can be seen that when information about the future net benefit of R&D is disclosed, the market valuation will be less biased and the incentive for opportunistic decision makings can be reduced. The higher the impact the more useful information provided by managers.

3.1.2 The quality of useful R&D information

As discussed in the above section, the usefulness of information about the future net benefit of R&D is determined by its impact on market valuation and on R&D-related decision makings. The degree of the impact will mainly depend on the degree of how much reported information is being used, which in turn is determined by the degree of the quality of reported information. In other words, information with better quality will be used more and have greater impact.

There are different dimensions of information quality. For example, Statement of Financial Accounting Concepts No. 2, *Qualitative Characteristics of Accounting Information,* defines the primary accounting information qualities as reliability and relevance, and the secondary information qualities as comparability and consistency. Information about the net benefit of R&D is viewed as part of accounting information and hence its quality can be measured according to these dimensions. However, since the realization of the net benefit of R&D often involves with a great amount of uncertainties, not all dimensions of the quality of historical accounting information, especially the reliability, can be applied appropriately.

Instead of following dimensions of accounting information quality, the emphasis of the quality of information about the future net benefit of R&D will be put on the precision of information in this study. More specifically, the quality is viewed to be higher if its precision

is (or is perceived to be) higher. The usefulness of information increases when the precision increases. To see this point clearly, it is known that the relative precision of two signals affects the valuation weight that will be put on each signal from the disclosure theory (e.g. Verrecchia [2001]). Denote a normally distributed random variable, k, as a firm's future cash flow with mean $\bar{k}$ and variance g^{-1}. The distribution of x is public information. For simplicity, assume that the firm's future cash flow equals to the future net benefit of its R&D. The firm is required to provide information about the net benefit of R&D to the market. The report issued by the firm is denoted as r and the precision of the report is u. The conditional expected future cash flow when r is disclosed and when u is known by the market is as follows:

$$E[k \mid r, \beta] = \beta \cdot r + (1 - \beta) \cdot \bar{x},$$

where β is the relative precision of r and x, and $\beta = u / (u + g)$.

It can be observed that the firm's report will have a greater impact on the conditional expected future cash flow when more weights are put on it. The greater the impact the more useful the firm's report. The weight depends on the relative precision of the firm's report. As long as there is a certain degree of precision of the firm's report (i.e. $\beta \neq 0$), information provided by the firm will be useful because it will affect the market's expectation of the firm's future cash flow. The usefulness increases in the precision; therefore, when the firm's

report has no precision at all, it is useless and will not be used. On the contrary, managers can improve the impact of their reports on the market valuation by offering more precise information.

Above is the case when the precision of the firm's report is observable at the time when the market valuation is made. In real life, the precision of a firm's report can only be observed *ex post*. The inability of market participants to observe the precision *ex ante* creates incentives for managers to misreport. Accordingly, how to reduce such incentives so that managers will be encouraged to provide more useful information is a crucial issue when designing the proposed reporting system. The issue will be addressed with more details in the next section.

3.2 A potential mechanism to induce reports with quality

As mentioned in the previous section, information provided by managers, as long as with a certain level of precision, will be useful in assisting the market's valuation of R&D. Hence, how to induce managers to provide information with a certain level of precision is a crucial issue. Lundholm [1999] suggests that *ex post* reporting of accuracy of a firm's prior estimates can improve the incentive for firms to makes more accurate estimates *ex ante*. He [2003] further shows how accounting reports about the past can lend credibility to a firm's

more timely discretionary disclosures. This study extends his works and considers the requirement of disclosing managers' past expectations as well as the realization of their expectations as a potential mechanism to induce managers to provide information with a certain level of precision.

The potential mechanism works when historical information about the net benefit of each R&D project is disclosed separately. When the net benefit of one project is fully realized, the precision of information provided by management regarding the future net benefit of the project will be revealed from the reporting history. The market will use the realized precision to update its belief of the precisions of management's expectations of other projects. The updated perceived precision of management's expectation will then be used to value those projects. The higher the realized precision, the more the market will trust managers' reports and the more managers' expectation will affect the market's valuation. In other words, the credibility of managers' report will be built up by the realized precisions and will affect the market's valuation.

Because there will be benefits from the build-up credibility, it is not always worthwhile for managers to provide less precise expectations. The incentive for managers to provide imprecise expectations can therefore be restricted after considering the related potential impacts. Since the realized precisions can be observed from managers' past reports

about their expectations of the future net benefit of R&D, it is expected that the requirement of disclosing historical information for each R&D project can work as a potential mechanism to induce managers to provide more precise expectations.

In this section, two examples are provided to show how managers' past reporting decisions affect the realized precision and in turn affect the valuation of R&D under the requirement of reporting historical information. The first example illustrates how the realized precision of expectation about the future net benefit of one project affects the perceived precision of expectation about the future net benefit of the other project from a theoretical viewpoint. It demonstrates that, under certain reasonable conditions, the intended over-(under-)statement of the net benefit of one project will negatively affect the evaluation of the other project. The potential negative impacts come from the loss of credibility. Intuitively, managers will report more cautiously after taking such impacts into account. A numerical example is further provided to illustrate the impact of managers' past reporting decisions on the realized precision and the market's valuation more realistically. The optimal reporting decision after taking into account such impacts will be examined in the next section.

Before proceeding to the examples, definitions of notations that will be used in the following subsections are summarized below.

$\tilde{x}_i$:   Publicly available information about the net benefit of R&D project i; it is

assumed to be normally distributed with mean $\bar{x}$ and variance h^{-1}

y_i: The manager's private information about the net benefit of R&D project i; it is

assumed to be normally distributed with mean $\bar{x}$ and variance u^{-1}

r_i: Reported net benefit of R&D project i; $r_i = y_i + \varepsilon_i$

ε_i: The manipulation error included in the report for R&D project i

h: The precision of the publicly available information about the net benefit of R&D

project

u_i: The precision of manager's private information about the net benefit of R&D

project i

ρ_i: The precision of reported information from managers r_i; $\rho_i = uv/(v + u\varepsilon_i^2)$

ρ_0:   The market's initial belief of the precision of managers' report

$E(\rho_i)$:   The perceived precision of reported information by the market

β_i: The relative precision of publicly available information and manager's report

about the net benefit of project i

V_i: The market's valuation of R&D project i;

$E(V_i)$:   The expected market's valuation of R&D project i

3.2.1 A theoretical example

Assume that a firm undertakes two R&D projects in different periods. Each R&D project is assumed to have similar amounts of net benefit and similar amount of risk but with distinguishable technical objective. The second project is launched one period later than the first project. The net benefits from two R&D projects are normally distributed random variables $\tilde{x}_i, i = 1,2$ with mean $\bar{x}$ and variance h^{-1}, and the distribution is public information. It takes two periods for the net benefits to be realized. Before the launch of each R&D project, management of the firm has private information about the realization of $\tilde{x}$. Its private information is denoted as $y_i, i = 1,2$ and is normally distributed with mean $\bar{x}$ and variance u^{-1}. Because management possesses superior information about the net benefits of R&D projects, it is assumed that $u^{-1} < h^{-1}$ (i.e. management's private information contains smaller variance than the market's information).

Assume that management is required to report its expectation about the future net benefit of R&D projects based on its private information at the end of the first period after each project is launched. Management's report for each project is denoted as $r_i, i = 1,2$. The net benefit of each R&D project will be fully realized at the end of the second period after its launch. The event and related information are summarized in Figure 3.

(Insert Figure 3 about here)

Because the market cannot observe management's private information directly,

whether management provides information based on its private information is unknown to the market. Hence, it is possible for management to misreport[11]. Let $r_i = y_i + \varepsilon_i$, where ε_i is the manipulated noise that can be controlled by the management and cannot be observed by the market. Assume that the variance of the report increases as ε_i increases, and is expressed as $\mathrm{var}(r_i) = u^{-1} + v^{-1}\varepsilon_i^2$. When management misreports, the variance of the report will increase in the squared noises. The precision is defined as the reciprocal of variances so that h, u, and $\rho_i = uv/(v + u\varepsilon_i^2)$ are precisions of $\tilde{x}$, y_i, and r_i respectively. Adding more noises in the report will decrease the precision of the report.

The market does not know the precision of management's expectation at the time when it receives management's report but it is assumed that the market will know that after the net benefit is fully realized. In other words, the precision of r_1 is assumed to be observed by the market at $t=2$ and the precision of r_2 can be observed at $t=3$. Before the realization of the precision of r_1, it is assumed that the market's prior belief of the precision of management's report is ρ_0. After receiving r_1, the market forms its belief of the precision of r_1 based on its prior belief. Its belief of the precision of r_1 is denoted as $E(\rho_1 \mid \rho_0) = \rho_0$. At $t=2$, after the precision of r_1 is realized and becomes observable, the market updates its

---

[11] In this example, the decision to acquire more precise information is not considered in order to concentrate on the impact of intended misreport. It is also possible for managers to acquire and report more precise information. Such possibility will be considered in the optimal reporting decision, which will be addressed in section 3.3.

belief of the precision of r_2 based on the realized precision of r_1 and its prior belief, and

the updated perceived precision level of r_2 is denoted as $E(\rho_2 \mid \rho_1, \rho_0) = c\rho_1 + (1-c)\rho_0$ [12].

The market values R&D projects based on its expectation of the net benefit of each

project and its risk tolerance. Following the notation used by Kanodia and Lee [1998], the

market valuation of each project V_i can be denoted as:

$$V_i = \beta_i r_i + (1-\beta_i)\bar{x} - \lambda(1-\beta_i)h^{-1}, \quad (1)$$

where β_i is the weight the market places on management's report, λ is the degree of risk

aversion, and $\lambda(1-\beta)h^{-1}$ is the discount of risk. The higher λ is the more risk discount

the market will adjust from the expected value of the project. β_i depends on the relative

precision of r_i and the market's prior belief and can be expressed as: $\beta_1 = \rho_0/(\rho_0 + h)$

and $\beta_2 = [c\rho_1 + (1-c)\rho_0]/[c\rho_1 + (1-c)\rho_0 + h]$. Let $c\rho_1 + (1-c)\rho_0 = A$ so that

$\beta_2 = A/(A+h)$.

To focus on the impact of management's reporting decision on the evaluation of R&D

projects, it is assumed that management's utility increases in the market's valuation of R&D

projects so that management prefers having higher market valuation of R&D. The decision

whether to add noises will depend on the impact of the noises on the expected market

valuation of each R&D project, $E(V_i)$. Since the focus here is how the *ex post* realization of

---

[12] The weight *c* is selected by the market and is taken as given when examining management's decision.

precision level affects the *ex ante* reporting behavior, I focus on management's decision at

$t=1$. In other words, the issue of concern is to show how management chooses ε_1 (and thus

ρ_1) at $t=1$ when it knows that the realization of ρ_1 at $t=2$ will affect the market's belief of

ρ_2 (and thus affects $E(V_2)$).

The marginal impact of ε_1 on $E(V_1)$ and $E(V_2)$ given management' private

information can be shown by the following first-order derivatives:

$$\frac{\partial E(V_1)}{\partial \varepsilon_1} = \frac{\rho_0}{\rho_0 + h} \qquad (2)$$

and

$$\frac{\partial E(V_2)}{\partial \varepsilon_1} = \frac{-2cu^2 v \varepsilon_1}{(A+h)^2 (v + u\varepsilon_1^2)^2} [h(y_2 - \bar{x}) + \lambda]. \ (3) \ ^{13}$$

The impact of ε_1 on $E(V_1)$ is a positive constant. The increase of ε_1 increases the

market evaluation by $\rho_0 /(\rho_0 + h)$; therefore, without considering the potential impact

on $E(V_2)$, management will prefer adding more positive noises to increase $E(V_1)$. However,

from equation (3), the impact of ε_1 on the second project's expected valuation equals to

zero only when $\varepsilon_1 = 0$ or when $y_2 = \bar{x} - (\lambda / h)$. In other words, management should

consider not only the impact of ε_1 on $E(V_1)$ but also that on $E(V_2)$ when neither $\varepsilon_1 = 0$

nor $y_2 = \bar{x} - (\lambda / h)$. When the impact of ε_1 on $E(V_2)$ is considered, management will find

---

[13] Management observes y_2 at t=1 so that he will use y_2 as the basis to estimate the market's evaluation of
the second project. Hence r_2 is replaced by y_2 in the equation.

out that it is not always optimal to add positive noises in r_1 as discussed below.

First, it can be seen from equation (3) that the sign of $\partial E(V_2)/\partial \varepsilon_1$ depends on the sign of ε_1 and that of $[h(y_2 - \bar{x}) + \lambda]$. When the sign of ε_1 is consistent with the sign of $[h(y_2 - \bar{x}) + \lambda]$, the impact from adding more noises on $E(V_2)$ will be negative. For example, if management privately observes that net benefit of the second project is greater than the mean market valuation (i.e. $y_2 > \bar{x} - (\lambda/h)$), and if he considers to add positive noises (i.e. $\varepsilon_1 > 0$), then $E(V_2)$ will be decreasing in ε_1. This implies that the smaller the positive noise (i.e. less positive) the less negative impact on $E(V_2)$. Contrarily, when $y_2 < \bar{x} - (\lambda/h)$, adding more positive noise will have more positive impact on $E(V_2)$. The observation from the result is summarized below:

Observation 1. When $y_2 > \bar{x} - (\lambda/h)$, adding more positive noise will have more negative impact on $E(V_2)$; Contrarily, when $y_2 < \bar{x} - (\lambda/h)$, adding more positive noise will have more positive impact on $E(V_2)$.

The implication of observation 1 is that, the overstatement of expectation in the first report will have negative impacts on the valuation of the second project when management privately observes that the net benefit of the second project will be greater than the mean market valuation. Only when the expected net benefit of the second project is less than the mean market valuation will the overstatement have positive impacts on the valuation of the

36

second project. $E(V_2)$ will be better off if $E(\rho_2 \mid \rho_1, \rho_0)$ is lowered and the market puts

more weight on its prior mean, which is higher than the net benefit of the second project.

The result is intuitive because it shows that when management prefers r_2 receiving

more weight in the valuation of the second project, it will provide more precise expectation

in r_1. On the contrary, management has incentive to misreport its private information when it

privately observes that the net benefit of the second project is bad (i.e. $y_2 < \bar{x} - (\lambda / h)$) and it

prefers less weight (i.e. smaller β_2) of its report in valuing the second project. To reduce the

weight on its report, management will be induced to include ε_1 in r_1 to decrease ρ_1,

which will in turn decrease $E(\rho_2 \mid \rho_1, \rho_0)$. The optimal amount of noise will be determined

by setting $(\partial E(V_1) / \partial \varepsilon_1) + (\partial E(V_2) / \partial \varepsilon_1) = 0$ when management's objective is to maximize

the aggregate valuation of the two projects (i.e. $\underset{\varepsilon_1}{Max} \;\; E(V_1) + E(V_2)$).

From the above example it can be seen that when the market can observe the

realization of ρ_1, it is not always optimal for management to misreport after considering the

potential impact of the second project's market valuation. When it is expected that

subsequent R&D projects will have net benefits greater than the mean market expected net

benefit, the noise added in the previous reports will only damage the valuation of the

subsequent projects. By requiring management to report the history of its expectations as

well as the realization of its expectation, management will be induced to consider the

potential impact of the realized precision of its past reports on the valuation of subsequent R&D projects. Hence, the requirement of reporting historical information is viewed as a potential mechanism to reduce incentives for misreporting and to ensure certain level of precision of management's report.

3.2.2 A numerical example

In the above example, the decision management faces is quite simple: it only needs to consider the impact of one report of the first project on the evaluation of the second project. In practice, the major part of net benefit of an R&D project often can be realized after several years. Hence, there will be several chances for management to update its expectation for the same project (i.e. multiple reports for one project). The situation in real life will be more complicate than what has been modeled. Below I use a numerical example to illustrate more realistically how different reporting behaviors affect the realized precision of information that has been reported for one project and in turn affects the perceived precision of information reported for another project.

Consider a situation when it takes three periods for the net benefit of an R&D project to be realized and management will need to report its private information about the future net benefit of R&D of this project as well as the realization of the net benefit at the end of each

reporting period. The net benefit of the project will be realized at the end of the third reporting period so that management can only misreport information in the first two reports. In order to emphasize how different reporting behaviors, especially when managers intend to misreport, will affect the realized precision, it is assumed that management has very precise private information. Further assume that management privately observes that the realization of the net benefit of the project will be $100 before it undertakes the project (i.e. at the beginning of the first reporting period) and its private information remains unchanged throughout the three reporting periods.

In the first report, management can report its expectation in one of three ways: it can report its private information truthfully (i.e. report $100), overstate its private information (e.g. report $125), or understate its private information (e.g. report $75). In the second report, it has four choices: report an amount equal to what it reported in the first report, report its private information truthfully, overstate or understate its private information. Figure 4 lists 12 different patterns of reporting behavior and each is assigned with a case number (i.e. the number in the parenthesis). Market participants cannot observe management's private information and they don't know the precision of management's expectations in the first two accounting period. However, after the net benefit is fully realized at the end of the third period, the precision of management's report will be known.

Under the assumption that the realized net benefit at the end of the third reporting period is $101 (i.e. management must report $101 regardless of its previous reporting behaviors), the realized precision in each case is listed at the end of each reporting behavior in Figure 4.

(Insert Figure 4 about here)

It can be observed clearly that the reporting behavior in case 2-2 and case 2-3 have the highest realized precisions. The two cases represent the same reporting behavior when management reports its private information truthfully throughout the reporting periods. The second highest precisions are obtained when management overstates in only one report (case 1-3 and 2-1). The third highest precisions are when management understates in only one report (case 2-4 and 3-2). The lowest precision is obtained when management understates in the first report and further understates in the second report (case 3-4). From the example, it is clear to see that different reporting behaviors end up with different realized precisions

After observing the realized precision of information provided by management regarding the net benefit of the project, the market will update its belief of the precision of information provided by management regarding the future net benefit of a subsequent project. Using the same definition and notations in the theoretical example, the updated perceived precision level is a weighted average of the market's prior belief of the precision of

management's report, i.e. $c\rho_1 + (1-c)\rho_0$, where c is the weight determined by the market.

Table 2 lists the updated perceived precision for each case under different assumptions of ρ_0

and c. It is assumed that the market has a lower prior perceived level of precision of

information provided by management in scenario 1 (ρ_0=0.001) than in scenario 2 (ρ_0=0.005).

In each case, three weights are given (c=0.3, 0.5 and 0.7) for comparison. The higher the

weight, the more the realized precision affects the updated perceived precision level.

(Insert Table 2 about here)

The updated perceived precision level will then be applied to value the subsequent

project. Assume that the market values R&D projects according to equation (1) in the prior

section and assume that the reported net benefit for the other project equals to $150 (i.e.

$r_2 = 150$) and the prior distribution of the net benefit has mean equals to $100 (i.e. $\bar{x} = 100$)

and variance equals to 333 (i.e. h^{-1}= 333). Further assume that the market's risk aversion

equals to 0.002 (i.e. $\lambda = 0.002$). Table 3 lists the market's valuation of the R&D project.

(Insert Table 3 about here)

It can be found that only when the realized precision is high will the valuation of the

subsequent project closes to management's current report. Because the mean of the net

benefit is lower than what management reports in this case (i.e. $\bar{x} < r_2$), the decrease of the

weight on management's report will decrease the valuation of the project[14]. The decrease of

the valuation can be viewed as the cost of misreporting in prior reports. Because of the

potential costs arising from misreporting, it is not always worthwhile for management to

provide less precise expectations. The observation is the same as observation 1 in the

theoretical example. Both the theoretical example and the numerical example demonstrate

that it is not always optimal for management to provide imprecise expectation when what it

reported in the past will be disclosed and the realized precision of its previous reports can be

observed.

3.3 The optimal reporting decision

The above examples illustrate how managers' past reporting decisions would affect

the realized precision and the valuation of subsequent R&D projects if their past reports were

required to be reported. The requirement of disclosing the reporting history will force

managers to consider the impact of their reporting behaviors on the valuation of subsequent

R&D projects. The impact on the market's valuation of R&D will be higher when more

precise reports are observed. In addition, the market's valuation of R&D when more precise

reports are provided will be less biased and the perceived risk will also be reduced. Firms

---

[14] The situation reverses when the management's report is lower than prior mean. In this case, the market
valuation will increase when the weight on management's report decreases.

will be benefited from the improved market valuation more when their reports affect the valuation more. The optimal precision level will be determined after such benefits are considered.

More specifically, the optimal reporting decision will be determined by maximizing the net benefit of reporting, which depends on the related benefits and costs. The potential benefit of disclosing more precise information about the net benefit of R&D comes from the improved market valuation: the valuation of R&D will be less biased and the risk discount will also be reduced. From equation (1), it is known that the valuation of R&D will be affected by the precision of managers' reports and the benefit of providing information with a certain level of precision can be further denoted as:

$$B(\rho) = \beta \mid r - \bar{x} \mid + \beta \lambda h^{-1} = \beta(\mid r - \bar{x} \mid + \lambda h^{-1}). \quad (4)$$

$\mid r - \bar{x} \mid$ in equation (4) represents the absolute value of the improved market expectation about the future net benefit of R&D, and λh^{-1} represents the amount of risk discount. β represents the relative precision of managers' reports and the market's prior information and it can be further denoted as $\rho/(\rho + h)$, where ρ represents the precision of managers' reports and h represents the precision of the market's prior information. In general, $\beta(\mid r - \bar{x} \mid + \lambda h^{-1})$ represents the benefit of the improved market valuation when managers' reports have a certain level of precision. When more precise information is

provided, the market's expectation about the net benefit of R&D will be improved and be less

biased. The risk discount from the uncertainty of the R&D net benefit will also be reduced.

The amount of benefit will depend on β. The higher β is the greater the benefit is.

Furthermore, the benefit of the improved market valuation increases at a decreasing rate with

ρ because $B'(\rho) > 0$ and $B''(\rho) < 0$ (i.e. the benefit function will be concave down). The

benefit of providing information with different levels of precision can be depicted as line A in

Figure 5.

(Insert Figure 5 about here)

When past reports are disclosed, the market will be able to observe the precision of

managers' reports about the expected net benefit of R&D eventually. As a result, β will be

greater when more precise information has been provided in equilibrium. Consequently, the

benefit of providing rough guess will be lower than that of providing perfect expectation. In

addition, the marginal benefit from providing more precise information will become smaller

and smaller. The maximum benefit when perfect information is provided (i.e. when β

approaches 1) will be equal to $|r - \bar{x}| + \lambda h^{-1}$.

On the other hand, different reporting decisions accompany different amounts of cost.

Line B in Figure 5 represents the cost of providing information, including the information

gathering cost and the proprietary cost. The cost will also be increasing with the precision

level. For instance, rough guesses can be made without any information searching cost and they will not provide any competitive advantage to competitors so that the proprietary cost will also be low. More costs will be spent in order to get more precise expectations about the net benefits of R&D. For example, managers will have to spend more costs to evaluate the probability of success, to measure the market demand, or to study the trend of the industry or the whole economy in order to improve the precision of their expectations. The proprietary cost will also increase when more precise information is provided. Competitors can take advantage of using more precise information from one firm and the relative competitive advantages of the firm will be damaged more seriously. In addition, the cost to provide perfect expectation will be infinite since it is unlikely to perfectly foresee the future. The cost will therefore increase at an increasing rate with β and will have a concave-up functional form as depicted in line B.

The net benefit of providing information with different levels of precision equals to the difference of the benefit and the cost. Based on Figure 5, the net benefit can be depicted in Figure 6. Because both the benefit and the cost of providing imprecise information are low, the net benefit of providing imprecise information will be low. Furthermore, since the benefit function will be concave down and the cost function will be concave up, the net benefit will be positive on some interval. The net benefit will be zero when the cost equals to the

maximum amount of the benefit, $|r - \bar{x}| + \lambda h^{-1}$. In equilibrium, firms' optimal reporting decisions will be determined when the net benefit is maximized. Firms will report information with precision level ρ^* to receive the maximized amount of net benefit.

(Insert Figure 6 about here)

Under the proposed reporting requirements, the net benefit of disclosing required information will be affected by managers' credibility. Providing more precise information in the past can build up managers' credibility and will create more benefits in the future. Contrarily, providing imprecise information in the past can damage the credibility of managers' reports and will affect the market's valuation less significantly. Since managers' past reporting behaviors will be observed by the market eventually, managers will be forced to consider the impact of their reporting behaviors on their credibility. The requirement of reporting past information thus not only reduces the incentive of misreporting but also highlights the benefit of providing more precise information. In the long run, managers will realize the benefit of providing more precise information about the net benefit of R&D and will also be less against the additional mandatory reporting requirement.

In short, information provided by managers about the net benefit of R&D will be useful as long as it has a certain level of precision. The requirement of disclosing past reports for each R&D project is viewed as a potential mechanism to induce more precise reports

from managers. It further encourages managers to consider the benefit of the build-up

credibility by providing more precise expectation. In equilibrium, firms will be induced to

provide information with an optimal precision level. Such information will benefit not only

market participants but also firms from the improved market valuation.

Chapter 4: Key features and definitions of terms

Before proceeding to details of the reporting systems, two key features of the reporting requirements and formal definitions of terms used often in this study will first be addressed in this chapter. Reporting requirements in the target reporting system and the transitional reporting system will be examined in chapter 5 and chapter 6 respectively.

4.1 Key features of the reporting requirements

In chapter 3, it has been discussed that the design of the reporting system should have embedded mechanisms that can induce useful reports from firms. The reporting requirements are therefore developed with attempts to create such mechanisms. Two features of the reporting requirements are created accordingly and can be observed in both the target reporting system and the transitional reporting system.

First, not only current but also past reports will be disclosed. As mentioned in chapter 3, the requirement of disclosing historical information is viewed as a potential mechanism to reduce incentives for reporting imprecise information. Hence, what managers have reported in the past is required to be disclosed in the current report. Because R&D activities are

long-term activities, there could be historical information for several periods in one single report for each R&D project. In additional to disclosing historical information in tables, the use of diagrams is considered as an alternative way to present historical information more concisely. Both managers' reporting behaviors and the change of information about the net benefit of R&D over time can be observed from diagrams easier. This study hence focuses on illustrating how to report information diagrammatically[15].

Second, managers' private R&D information is quantified and will be reported in numbers[16]. As discussed in chapter 3, the optimal reporting strategy depends on the net benefit of reporting. To improve the willingness of firms to provide more precise information, the net benefit of reporting such information must be positive. One way to improve the net benefit is to reduce the potential proprietary cost by restricting the amount of proprietary information in the proposed manadatory disclosure. Non-financial R&D information, such as the description of projects, the physical progress, the expected time to launch commercialization, and the market target, etc., is often confidential and associated with higher disclosure costs. The proprietary cost could be inevitably huge if such information were reported. One potential consequence is that managers will provide useless information

---

[15] In addition to reporting the required information in tables or diagrams, managers can provide their explanations in the disclosures if necessary.
[16] Although private information is summarized in numbers, managers are still required to provide statements to briefly explain any change of information or to provide necessary supplemental information.

to avoide the proprietary costs. It is believed that the amount of proprietary cost can be restricted if only financial numbers are reported. In this way, firms will be more willing to provide useful information and the implementation of the reporting systems will be more feasible.

4.2 Formal definitions of terms

Formal definitions of terms that used frequently in this study, including R&D activities, R&D projects, R&D costs, returns on R&D costs, the net benefit of R&D, and information about the net benefit of R&D, are defined separately below.

4.2.1 R&D activities

R&D activities are defined according to SFAS No. 2:

> "Research is planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service (hereafter "product") or a new process or technique (hereafter "process") or in bringing about a significant improvement to an existing product or process.
>
> Development is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use. It includes the conceptual formulation, design, and testing of product alternative, construction of prototypes, and operation of pilot plants. It does not include routine or periodic alterations to existing products, production lines, manufacturing processes, and other on-going operations even though those alterations may represent improvements and it does not include market research or market testing activities."

The objective of R&D activities is called the technical objective in this study.

According to the above definition, the technical objective can generally be identified by product, process, or design. R&D activities are undertaken to fulfill their technical objectives. The technical objective is fulfilled when the target product, process, or design is created. The target product, process or design is called the technical output from R&D activities.

4.2.2 R&D projects

It is often that firms have R&D activities with different technical objectives at the same time. For the reporting purpose, information about R&D activities with identifiable and distinguishable technical objective will be grouped as information for one R&D project. An R&D project is technically finished when its technical objective is accomplished and the technical output is generated (for example, when the product prototype is established). In addition to technical objectives, R&D projects often have immediate commercial objectives[17] or specific application plans. Commercial objectives can be defined by returns, market share, or growth rate. An R&D project is commercially accomplished when its commercial objective is fulfilled and there will not be any further commercial benefits. Similarly, the application plan is accomplished when the technical result is applied. The life of an R&D project ends when both its technical and commercial objectives are fulfilled and no more related benefits or costs.

---

[17] Not all R&D projects have immediate commercial objectives. For example, according to the definition by NSF, basic research is defined as research that advances scientific knowledge but does not have specific immediate commercial objectives.

4.2.3 R&D costs

R&D costs are costs directly associated with R&D activities in each accounting period. They are necessary costs to accomplish the technical objectives of R&D projects. Elements of costs to be identified with R&D activities as defined in paragraph 11 of SFAS No.2 include materials, equipment, and facilities, personnel, intangibles purchased from others, contract services, and indirect costs. Total R&D costs of an R&D project are the necessary amount of R&D cost to accomplish the technical objective of the project. Because R&D activities will be continued until the technical objective is fulfilled, the amount of total R&D costs often is allocated to several periods. Cumulative R&D costs will be equal to total R&D costs when the technical objective is achieved.

4.2.4 Returns on total R&D costs

Returns on total R&D costs (hereafter returns on R&D) of an R&D project are returns created from the technical output of R&D activities in each accounting period. The amount of returns can be determined according to the objective of the project. For example, when the objective of the project is to create a new product to increase sales revenue, the amount of returns will be equal to sales revenues from selling the product substract any necessary expenses, such as costs of goods sold and advertising expense, in each accounting period. When the objective of the project is to apply the technical result from R&D activities to the

production process so that the production lead time can be reduced, the amount of returns will be equal to the savings of production costs from the shortened lead time.

Returns on R&D will be generated only after R&D projects are technically finished. There are no returns generated during the process of R&D activities until the technical objective is accomplished and the technical output is created. Returns on R&D will continue to be generated and cumulated until the commercial objective of the project is fulfilled.

4.2.5 The net benefit of R&D

The net benefit of R&D (or the net benefit of an R&D project) is the net financial benefit created from an R&D project. It is the difference between cumulative returns on R&D substract cumulative R&D costs. Before the technical objective is fulfilled, the net benefit of the project is negative and is equal to the amount of cumulative R&D costs. The R&D project is breakeven when the cumulative R&D costs equal to the cumulative returns on R&D (i.e. the net benefit equals to zero). Total net benefits of an R&D project equal to total returns on R&D substract total R&D costs. The relationship between returns on R&D and the net benefit of R&D is depicted in Figure 7-1.

(Insert Figure 7-1 about here)

4.2.6 Information about the net benefit of R&D

Information about the net benefit of R&D includes the expected net benefit (ENB), and

the cumulative realized net benefit (CRNB). ENB is managers' *ex ante* expectations about the total net benefit of R&D that will be realized in the future. It equals to the present value of expected total returns on R&D substract expected total R&D costs. The expectation is based on implicit future plans that a firm is assumed to have made about its R&D activities. Because it is difficult to estimate the net benefit of R&D perfectly *ex ante*, the ENB is subject to change. Different underlying assumptions and analysis tools can be applied to obtain the expectation as long as the uncertainty involved in R&D activities are appropriately considered[18].

The CRNB equals to cumulative realized returns on R&D substract cumulative R&D costs. It is the realization of the ENB. The difference between the CRNB and the ENB is the unrealized net benefit. Before the realization of any net benefit, the ENB is the total amount of unrealized net benefit that is expected to be realized in the future. The unrealized net benefit becomes realized as time passes by. When all unrealized net benefits become realized, there will be no difference between the ENB and the CRNB. In other words, when there are

---

[18] Important underlying assumptions that affect the ENB include, for example, probability of success (both technical and commercial), time-to-completion, time-to-commercialize, product life cycle, discount factors, available resources to conduct R&D activities, technical competitive advantages, market demands and the condition of the economy. These assumptions may differ from firm to firm and are subject to change. Meanwhile, different analysis tools can assist managers in deriving the ENB. For example, discounted cash flow valuation method and Real-Option methods are two popular analysis methods in valuing future opportunity. Capital assets pricing model may be applied to determine the appropriate discount factor. The selection of analysis tools depends on situation and management's preference. It does not matter when firms apply different assumptions and analysis tools in deriving the ENB. As long as the expectation is reasonable, how management derives the expectation is not a concern in the reporting system.

no more benefits or costs to be realized in the future, the ENB is fully realized and reflected

in the CRNB. The relationship between the total net benefit, the CRNB, and the unrealized

net benefit can be observed from Figure 7-2.

(Insert Figure 7-2 about here)

Chapter 5: The target reporting system

In the target reporting system, information about the future net benefit of R&D as well as the realized net benefit of R&D will be organized and disclosed in three levels according to the degree of information aggregation. In the first level, information about the net benefit of R&D of each R&D project will be disclosed separately. Information from the first level will then be aggregated into the second level according to the age of each project. Information regarding net benefits of all R&D projects will be aggregated in the third level. Because the target reporting system is designed as a prototype of a desired R&D reporting practice, some modifications may have to be made when the reporting requirements are implemented in practice. Three possible modifications will be addressed after the introduction of the proposed reporting requirements. Potential benefits if the target reporting system can be implemented successfully will be discussed at the end of this chapter. A fictitious example is give in Appendix B to illustrate the implementation of the target reporting system more realisticly.

5.1 Level 1—information of individual R&D project

5.1.1 General reporting requirements

In level 1, firms will be required to report the ENB and the CRNB for each individual R&D project. As mentioned earlier, both past and current reports will be disclosed. Figure 8 illustrates the disclosure for an R&D project at time t. For illustration purpose, only patterns are depicted without specifying any numbers. Line A in Figure 8 depicts the pattern of the reported ENB since the launch of the project. Each point in line A represents the reported ENB at each reporting date. Line B depicts the pattern of the reported CRNB since the launch of the project. Each point in line B represents the amount of CRNB at each reporting date. Other information can be added to support line A and line B if viewed necessary. For instance, line C in Figure 8 depicts the cumulative R&D costs. It becomes flat when there are no more R&D activities. The gap between line B and line C represents cumulative returns on R&D.

(Insert Figure 8 about here)

Several significant events related to the R&D project can be observed from Figure 8. First, it can be observed that the R&D project was technically finished at time t-n-m. Since the returns on R&D can be realized only after the technical accomplishment, the CRNB will be more and more negative as more R&D costs are cumulated. The upward trend of line B after time t-n-m indicates that there were realized returns on R&D, which happens only after

57

the technical objective is accomplished. The observation that line C is flat after *t-n-m* also

indicates the technical accomplishment. Because more and more returns on R&D were

realized after time *t-n-m*, the gap between line B and line C becomes wider and wider.

Second, the R&D project broke even at time *t-n*. A project breaks even when the realized

returns on R&D equal to total R&D costs, which makes the CRNB equal to zero. Since the

CRNB equals to zero at time *t-n*, it is known that the project broke even at that time. Third,

the distance between line A and line B represents the amount of unrealized net benefit. The

amount of unrealized net benefit becomes less and less when more and more returns on R&D

become realized. Because the returns on R&D become realized after time *t-n-m*, the gap

between line A and line B narrows after that point of time.

When the ENB is fully realized, line A and line B will meet each other. When no

more returns are expected to be realized in the future, both lines will stop at the intersection.

Each R&D project will either end up with a gain (i.e. positive net benefits) or a loss (i.e.

negative net benefits). Figure 8-1 and Figure 8-2 demonstrate the disclosures when the R&D

project ends ups with a gain and when it ends up with a loss respectively. When both the

technical and the commercial objectives of an R&D project are accomplished successfully,

the project generally will end up with a positive amount of net benefit as shown in Figure 8-1.

On the contrary, when either the technical or the commercial objective of an R&D project

cannot be fully fulfilled, the amount of unrealized net benefit will have to be wiped out. In this case, it is often that the CRNB is negative. Figure 8-2 provides an illustration when the project ends up with a loss. The drop of the expected net benefit reflects the fact that it is less likely for the unrealized net benefit to be realized in the future. The net benefit of the project will be equal to the amount of CRNB at that time.

(Insert Figure 8-1 and Figure 8-2 about here)

5.1.2 The implications of reporting historical information

As illustrated in chapter 3, different reporting behaviors will result in different realized precisions and in turn will affect the valuation of other projects. Historical information is proposed to be presented diagrammatically so that managers' reporting behaviors can be observed clearly. Figure 9 depicts five possible patterns of the reported ENB that information users may observe. The reported ENB in case 1 has an increasing trend, which indicates that the expectation of the project's net benefit has been revising upward over time. A convex pattern can be observed from case 2 which indicates that there was a period of time that the expectation of the project's net benefit was getting worse but later on it was revised back. Case 3 shows a mobile pattern. It indicates that management has frequently revised its expectation in the past. Case 4 has a pattern similar to line A in Figure 8. The past peak suggests that the current expectation of the project's net benefit is no longer as

good as before. Finally, the flat pattern in case 5 indicates that management has never changed its expectation.

(Insert Figure 9 about here)

Because no one could perfectly foresee the uncertainty, management's expectation is subject to change. As long as the updates from management reflect the underlying change of the uncertainty, they become informative signals. However, since market participants cannot tell how precise management's expectation is before the realization of its expectation, they can only judge the quality of information indirectly by comparing the patterns among different R&D projects. For instance, if there was always a peak in the history of different R&D projects at different time points, it is likely that management is used to making over-optimistic expectations at the early stages of R&D. But if the peaks appeared at the same time for all projects, it is more likely that the updates reflect the change of economy condition that affects all projects. Furthermore, if management keeps updating its expectation upward but the realization of net benefit has never been significant, the credibility of the optimistic expectation also becomes suspicious. Therefore, such reporting strategy cannot be sustained in equilibrium.

It is not reasonable to require any manager to provide perfect expectation; however, the frequency and the amount of change of expectation that can be observed from reports of

different projects, when putting together, will reveal a manager's ability to handle the uncertainty. In the presence of similar level of uncertainty and profitability, if one firm manages the uncertainty better than the other, market participants will prefer using the report from the former to the latter. In equilibrium, the reports provided by incompetent management will not be used. As a result, reports from incompetent managers will have no impact on the market's valuation and there will be no benefits for those firms to provide mandatory information. After considering the result, rational managers will be induced to improve their abilities to handle the uncertainty under the requirement of disclosing their past reports.

5.2 Level 2—information of classified R&D projects

Firms often have more than one R&D project at the same time. The first level in the target reporting system provides information about the net benefit of each individual R&D project but it does not provide links among different R&D projects within a firm. Further, it is hard to compare information about the net benefit of R&D across different firms without certain benchmarks. In the second level of the target reporting system, each R&D project will be classified to an age group according to the age of the project. The age of an R&D project is defined as the number of years since the project's launch. Information about the net benefit

of each R&D project will then be aggregated in each age group. The longer a project has been undertaken the older the project is. The age is adopted as the classification benchmark because it is an objective measure that can be easily understood and applied, and it captures the long-term feature of R&D.

Information users can compare the amount of ENB and the amount of CRNB from one age group with that from another age group. Similarly, information users can compare information from the same age group across different firms. Generally speaking, given the same amount of CRNB, younger projects are preferred to older projects because it takes shorter time for the net benefit of younger project to be realized. Similarly, given the age, projects with the largest CRNB are preferred. After information is classified, the information comparability will be improved.

Two types of disclosures will be required in the second level. First, a disclosure similar to the disclosure in the first level will be prepared for each age group. For Age 1 group, there will be one point for the ENB and one point for the CRNB. There will not be a trend for Age 1 group since it only has information for one period. For Age 2 group, there will be two points for the ENB and two points for the CRNB so that a two-period trend can be observed. For Age t group, a pattern similar to Figure 7 can be observed. Examples are provided in Figure B-2 in Appendix B.

Second, a static diagram, which presents the status of the ENB and the CRNB from each age group at the reporting date, will be required. Figure 10 is given as an example. At the end of 2003, all R&D projects in a firm are classified into six age groups. The oldest projects were launched six years ago while the youngest projects were launched just one year ago. Three general observations can be seen from Figure 10. First, projects in Age 5 and Age 6 groups are finished both technically and commercially because the ENB equals to the CRNB in both age groups. Second, projects in Age 4 group are approaching the breakeven point since the CRNB in this group is close to zero. Finally, projects in Age 3 group have the largest amount of unrealized net benefit which indicates that the firm has spent a lot on those R&D projects but has not received significant returns. For more examples, see Figure B-3 in Appendix B.

(Insert Figure 10 about here)

Because information will be reported and organized according to ages of R&D projects, the information comparability is enhanced. Market participants are able to compare information among each age group across firms. For instance, it is expected that more positive CRNB can be observed from older R&D projects in general. The market's valuations of R&D projects from same age groups will be lower for those with smaller or more negative amounts of CRNB. It is also expected that younger projects will have more negative CRNB

because it takes time to accomplish the technical objectives. The market will realize that the negative CRNB is not due to bad performances but is due to the fact that younger projects are still under development. The valuation will be less biased accordingly.

5.3 Level 3--aggregate R&D information

Information about the net benefit of R&D from all R&D projects will be aggregated in level 3. General reporting requirements are first discussed and one adjustment to highlight management's change of expectation is then examined. Two sets of financial ratios that make use of aggregate R&D information are developed for the application of aggregate R&D information.

5.3.1 General reporting requirements

The amount of ENB and the amount of CRNB from all R&D projects are aggregated in the third level. At time *t*, the aggregate ENB (CRNB) is the sum of the ENB (CRNB) from all R&D projects at time *t*. Similarly, the aggregate ENB (CRNB) at time *t-1* is the sum of the ENB (CRNB) from all ongoing R&D projects at time *t-1* and so forth.

(Insert Figure 11 about here)

Figure 11 is given for illustration purpose. Line A in Figure 11 depicts the aggregate ENB and line B depicts the aggregate CRNB. Compare to line B in Figure 8, line B in Figure

11 is less convex because the increase of the CRNB from one project could be offset by the decrease of that from another project. The gap between line A and line B represents the aggregate unrealized net benefit. Unlike the disclosure for individual project, there will not be an intersection of line A and line B in Figure 11 unless the firm stops undertaking any R&D project. In other words, as long as there are new-launched R&D projects there will be unrealized net benefits. Further, when an R&D project is discontinued, there will be a drop of line A. Line B will not be affected by the discontinued project. When a project is discontinued, the aggregate unrealized net benefit will decrease because the unrealized net benefit of the discontinued project will no longer have chance to be realized and is needed to be wiped out. Other related information can be added to support line A and line B. For instance, line C in Figure 11 depicts the aggregate cumulative R&D costs. The gap between line B and line C equals to aggregate returns on R&D.

5.3.2 The impact of management's change of expectation

The trend of the aggregate ENB as depicted in line A in Figure 11 will be affected when management changes its expectation, launches new projects, or discontinues existing projects. Impacts from different sources will offset each other after the aggregation. For example, the upward adjustment of the ENB from one project will be offset by the downward adjustment of that from other projects. Moreover, impacts of launching or discontinuing

R&D projects will offset each other. The aggregate ENB will be adjusted upward (downward) by the amount of the ENB from the new-launched (discontinued) project. The continuous launching (discontinuing) of projects in each period results in an increasing (decreasing) trend of the aggregate ENB. When the amount of ENB from new projects equals to that from discontinued projects the impacts on the aggregate ENB will be offset. Finally, the impact of change of expectation will be offset by the impact of launching or discontinuing R&D projects. When one impact is greater than the other, the direction of the aggregate trend will be dominated by the greater one.

The impact of management's change of expectation is of concern because if management intends to mislead investors, the cost related to the change of reported expectation will be less than the cost related to launching or discontinuing projects. Therefore, it is more likely that management manipulates information users' expectations by changing the reported ENB. To highlight this possibility, the impact of management's change of expectations is separated from the impact of launching or discontinuing projects.

Line D is added in Figure 11 to separate the impact of management's change of expectations. It depicts the trend of the aggregate ENB after excluding the impact of the change of expectation. In other words, line D will only be affected by impacts of launching or discontinuing projects. Line D in Figure 11 has a slightly increasing trend, which indicates

that, on average, the impact of launching projects is greater than that of discontinuing projects. The distance between line A and line D captures the impact of the change of expectation. By observing the gap between line A and line D, market participants can learn how much management has changed its expectation since the very first R&D project was launched. In Figure 11, the gap between line A and line D widens. This suggests that management has been adjusting its expectation upward. When there is no change of expectation, line A will overlap line D (see the example in Figure B-4).

5.3.3 An application of aggregate R&D information—financial analysis

Similar to financial analysis that assess firms' viability, stability, and profitability using financial ratios, aggregate R&D financial information can be further analyzed by using simple financial ratios. Two sets of ratios are developed to assist information users in utilizing reported aggregate R&D information. The first set of ratios is designed to measure how fast management's expectation has been realized in the past. The second set of ratios is designed to measure how long it takes for the rest of expectation to be realized. Table 4 provides a summary of the definition of each ratio. An example is given below to show how these ratios will be useful in assisting the evaluation of R&D performance and improving the comparability of information.

(*Insert Table 4 and Table 5 about here*)

Consider a situation when an investor evaluates two firms' R&D activities. Aggregate R&D information of each firm is provided in Table 5. It can be seen that the two firms have the same amount of aggregate ENB and aggregate CRNB. It seems that there is no difference of the profitability of R&D projects between these two firms by comparing the amount of ENB and CRNB of each firm. However, when analyzing the ratios, it can be seen that the rate of net benefit realization of firm 2 is faster so that time to fulfill unrealized net benefit is shorter. Because investors prefer the uncertainty being resolved faster in general[19], the faster management's expectation is realized the better. It is reasonable to expect that the valuation of firm 2's R&D activities will be assessed better. From this example, it can be seen that the valuation of R&D activities and the information comparability can be improved when applying these ratios.

5.4 Possible modifications

The target reporting system is designed as a prototype of the desirable R&D reporting system. Hence, potential problems that may incur when implementing the target reporting system in practice should be considered. Three possible modifications of the implementation

---

[19] Fore example, Gandhi et al. [1989] suggest that investors are better off with the early resolution of uncertainty because they can arrange their consumption and investment to maximize their utilities if the uncertainty resolves early.

of the proposed reporting requirements are considered accordingly.

First, the requirement of disclosing historical information may need to be modified when the reporting requirements are implemented in practice. Under the going concern assumption, firms will have a long life. The requirement of reporting all past reports may not be feasible under the going concern assumption because information could be affected by other exogenous factors, such as the impact of economy cycle, in the long run. Some bounds may be needed in order to set up the limit of the length of the required history when implementing the system in practice.

Second, the requirement of disclosing information for each R&D project separately in level 1 is likely to produce a long disclosure. When a firm has a lot of R&D projects, a great many of the disclosures will be obtained in level 1. Too many disclosures may not generate sound effects. Instead, it will be difficult for information users to get the most useful information they need. Therefore, the requirement of disclosing information of individual R&D project can be modified by the principle of materiality. Information about the net benefit of more significant projects (e.g. those with greater scale or larger impact) will still be disclosed separately. However, information about the net benefit of less significant projects can be grouped and reported in one disclosure. Such adjustment is similar to the disclosure of segment information. It is believed that the implementation of the target system in such way

will be more feasible.

Finally, there are three levels in the target reporting system. Although it is ideal if information with different degrees of aggregation can be presented at the same time, whether disclosures from all levels are necessary to be reported will need to be considered further. For example, when there is only one R&D project, information in each level has no difference and only one disclosure is needed. Moreover, when there is a high degree of heterogeneity among R&D projects, separate disclosures of each R&D project could be more useful than providing aggregate information. Hence, it may not be necessary that information will be reported in all three levels when implementing the reporting system in practice.

5.5 Potential benefits of implementing the target reporting system

The main purpose of designing the target reporting system is to improve the valuation of R&D and to reduce the opportunistic R&D decision making. It is often true that a firm's future cash flows are highly associated with the net benefit flow of R&D; therefore, the market price of the firm will be closely related to the valuation of R&D. If the target reporting system can be implemented successfully, market participants can directly assess future net benefit flows of R&D and price the firm more appropriately. Since the market price will be determined after considering the future net benefit flow from R&D activities,

opportunistic R&D decisions that sacrifice long-term net benefits of R&D to meet short-term target will be no longer necessary. It is likely for firms to have such benefits after information about the future net benefit is disclosed.

In addition to the above main benefits, there are other potential benefits following the implementation of the target reporting system. For example, information search costs about the value of R&D will be less than before. Because R&D activities have been important economic activities, there is a great demand for information related to R&D activities, especially the potential benefits created from R&D. Once the target reporting requirements are imposed, such information will be publicly available. The savings of information search costs can be great. Market participants will also be benefited from the lower uncertainty of investing in firms with R&D activities after more information about future cash flows are available.

Moreover, managers will be encouraged to improve their ability to handle the uncertainty. Because the precision of managers' reports will be observed by the market and the precision will depend on managers' ability to foresee or manage the uncertainty, information provided by incompetent managers will not be used in equilibrium. Consequently, managers will have to be involved in R&D decision making processes earlier and more intensively to learn more information about the uncertainty of R&D before issue

their reports. More deliberate decisions are expected and those firms with more competent

managers will be benefited.

Chapter 6: The transitional reporting system

Although the target reporting system has desirable features and can potentially benefit both market participants and firms if implemented successfully, it is expected that the progress of the transition of the reporting practice may not be made in single step. In this chapter, possible obstacles to the implementation of the target reporting requirements are briefly discussed. To overcome the obstacles and to initiate the transition process, a transitional reporting system is proposed and will be introduced following the discussion of possible obstacles.

6.1 Possible obstacles

Two main obstacles to the implementation of the target reporting system are expected. Both obstacles are related to the feasibility of the requirement of disclosing managers' *ex ante* expectation of R&D net benefit. First, it is common that managers decide to launch R&D projects by their instincts without first quantifying potential net benefits. Such decisions could be made just to satisfy managers' ideals without considering potential benefits in advance. Imprudent R&D decisions can still generate profits because it is evident that many innovations bring unexpected profits after they are created. There is no standard

process for managers to make their R&D investment decisions. However, when managers are used to making R&D-related decisions without deliberate plans, it will be difficult to require them to provide a reasonable figure of future net benefits of R&D. The quality of managers' expectation could also be too low to be useful in this case.

Second, it can be foreseen that managers will fight against disclosing the ENB of R&D projects. Although managers are protected from liability for forward-looking disclosures on projected performance or operations when certain conditions are met[20] under the SEC's safe harbor provision in the Private Securities Litigation Act of 1995, the great amount of uncertainty involved in R&D could still discourage managers from providing specific estimation. It is likely that the market will blame the imprecise information on mangers' inability without recognizing the potential impact of uncertainty. Further, confidential information is possible to be refined from management's expectation by competent competitors and proprietary costs will be inevitable. Hence, managers may be reluctant to provide information about the future net benefit of R&D.

Because of these two potential obstacles, it may be difficult to implement the target reporting system, especially the requirement of disclosing the ENB in the short run. To

---

[20] Section 102 in the act indicates that if (i) the disclosure is accompanied by certain cautionary statements, or (ii) the plaintiff fails to prove that the disclosure was made with actual knowledge of its misleading nature, managers are protected from the liability for the forward-looking disclosures.

initiate the transition process, a transitional reporting system is developed and is discussed in the next section.

6.2 The transitional reporting requirements

The above obstacles suggest that it may not be easy to implement the target reporting system in the short run. It is also true that it will take time for the transition to be put into practice. However, the need for more R&D financial information is imperative and should be seriously considered. To overcome the obstacles and to initiate the transition, a transitional reporting system is developed as an initial step in the transition. As the first step in the transition, managers will only be required to report information about realized returns on R&D in the transitional reporting system. Because managers are no longer required to provide their expectation of future R&D net benefit, the reduced reporting obligation may improve the feasibility of the proposed transition.

Information about the realized returns from past R&D activities is required because it provides evidence of the profitability of past R&D activities. In the absence of information about the future net benefit, such information is necessary to persuade market participants that current R&D activities have potential to create future financial benefits. In addition, market participants can predict future net benefits of R&D from the past realization. Even if

there is no direct information about future net benefits of R&D, the valuation of R&D can be made more appropriately when there is information about realized returns R&D than when there is only information about R&D costs. Information from the transitional reporting system will still be useful to a certain extent.

The proposed disclosure in the transitional reporting system is illustrated in Figure 12. For each R&D project, managers will be required to report realized R&D costs and realized returns on R&D costs. Realized R&D costs are the cumulative amount of R&D costs that has been invested since the beginning of R&D activities. Realized returns on R&D costs are the cumulative amount of returns that has been generated since the end of R&D activities. Definitions of R&D costs and returns on R&D have been given in section 4.2.

(Insert Figure 12 and Figure 13 about here)

As shown in Figure 12, the technical objective of the project is accomplished at time *t* because there is no more R&D costs being invested after time *t* and the amount of cumulative R&D costs remains the same after *t* (i.e. the line becomes flat). Returns on R&D begin to be realized after *t*. At time *t+n*, cumulative realized returns equal to cumulative R&D costs (i.e. the net benefit of the R&D project equals to zero). After *t+n*, the net benefit of the project becomes to be greater than zero.

Information from each individual R&D project can further be aggregated. An example

of the aggregate transitional disclosure is provided in Figure 13. For simplicity, both the aggregate cumulative R&D costs and the aggregate cumulative returns on R&D are assumed to be linear functions of time. The main difference between the aggregate disclosure and the individual disclosure is that the aggregate cumulative R&D costs will keep increasing as long as there are R&D activities going on. The amount of time needed for aggregate R&D activities to break even will depend on the functional forms of the aggregate cumulative R&D costs and the aggregate cumulative returns on R&D.

It is believed that the transitional reporting system has more potential to be implemented in practice. The requirement does not ask managers to disclose any forward-looking information and the proprietary cost of disclosing realized information can be further limited. In addition, information about realized returns on R&D demonstrates that R&D activities are not valueless activities. The valuation of firms' R&D activities can be made more appropriately when such information is provided. Because the proprietary cost of disclosure is limited and the valuation of R&D can be improved by the additional disclosure, it is likely that managers will be more willing to provide such information and will be less against to the implementation of the transitional reporting system. The transition of the reporting practice can potentially be initiated in the short run and the R&D reporting practice can move toward a more desirable reporting practice accordingly.

Chapter 7: Conclusion

Currently, the R&D reporting practice is cost focused. Information about the net benefit of R&D is not widespread and the lack of such information exacerbates information asymmetry, which results in biased market valuation and opportunistic R&D decision makings. This study suggests that a transition of current reporting practice from cost focused to net benefit focused is necessary to reduce the negative impact of information asymmetry. A path of the transition beyond what has been considered by the previous literature is identified. A stream of two reporting systems, including the target reporting system and the transitional reporting system, outside financial statements is proposed for managers to provide more information about the net benefit of R&D to the market. It is expected that the transition can be made gradually along the path identified by this study and the negative impact of information asymmetry can be alleviated effectively.

Because all past reports for each R&D project will be disclosed separately, managers, when making their reporting decisions, will be forced to consider benefits of the build-up credibility by providing more precise information. In equilibrium, information with an optimal level of precision will be provided. Quality of managers' reports can be ensured to

a certain extent and market participants will be benefited from having more useful information in their decision makings. Firms will also be benefited by receiving the maximum amount of net benefit of providing required information. Although there will be obstacles to the implementation of the proposed reporting systems in the short run, the proposed path of the transition is worth to be considered because both the market and the firms will potentially be benefited.

The main contributions of this study are as follows. First, this study explicitly points out the need of the transition of the R&D reporting practice and it also specifies a new path for the transition to take place. The direct disclosure of information about the net benefit of R&D is considered as one potential way to alleviate possible negative impacts of information asymmetry. It is our understanding that this study is the first accounting study which seriously considers the direct disclosure of net benefit of R&D as a potential approach to transit the R&D reporting practice and to mitigate negative impacts of information asymmetry. This study also gives accounting regulators insights into the improvement of the R&D reporting practice beyond what has been provided in the prior literature.

Second, a stream of two reporting systems along the path of the transition is established. The target reporting system is designed as an avenue for managers to provide information that can be directly associated to market valuation (i.e. the future net benefit of

R&D). Although it has less potential to be implemented in the short run, the target reporting

system provides a prototype of the desirable reporting practice. On the other hand, the

transitional reporting system is designed to have more potential to be implemented in the

short run. It acts as a cushion to the impact of the transition on both the market and the firms.

The progress of the transition is expected to be made gradually with the implementation of

the transitional reporting system initially. It is believed that the current R&D reporting

practice can be improved smoothly toward the desirable R&D reporting practice eventually

following the established stream.

Finally, this study points out that there will be potential net benefits by transiting the

reporting practice along the suggested path. The valuation of R&D will be less biased and the

incentive for opportunistic R&D decision makings will be reduced. In addition to the

alleviated negative impacts of information asymmetry, some other potential benefits, such as

the lower information search costs, the better R&D decision making process, and the

reduction of the perceived risk, have also been identified. Those potential benefits suggest

that the transition will benefit not only market participants but also firms.

There are several limitations of this research. First, the proposed reporting system is

designed with an attempt to minimize the proprietary cost from disclosing proprietary

information. However, other potential costs, such as auditing costs and potential litigation

costs, are not considered in the design. Further, the potential impact from introducing a new reporting system on social welfare is not addressed. The neglect of those potential costs is not because they are not important but because they are outside the focus of this research. It will be interesting to consider the impact of those potential costs in the future. Second, the proposed reporting system cannot perfectly prevent managers from misreporting. Only the incentive for misreporting is reduced and a reasonable degree of precision can be maintained. This limitation is due to the uncertainty of future events and is inevitable when requiring forward-looking information from anyone. Finally, only a few practical concerns and obstacles have been considered in this study. It is possible that there are other practical issues related to the implementation of the reporting system that have not been addressed in this study.

Because the proposed reporting systems have not been put into practice, in the absence of empirical evidence, whether the systems can work as effectively as expected remains as an open question. In the near future, one potential extension of this study is to examine the effectiveness of the proposed reporting systems by performing an accounting behavioral experiment. The experiment will be designed to examine managers' reporting behaviors and the impact of managers' reports on the valuation of R&D projects under the proposed reporting requirements. People participate in the experiment will be assigned to two

groups: those in an experimental group will be given financial statements and additional information from the proposed disclosures while those in a control group will be given financial statements only. In each group, people will be further divided into two subgroups: one will play the role of managers and the other will play the role of market participants. The impacts of the proposed disclosure can be observed by comparing the reporting behaviors and the valuation of R&D between two groups. Such a setting can provide an initial evidence of the feasibility of the reporting systems and can provide more policy implications about the improvement of the R&D reporting practice.

Appendix A: Examples of current R&D reporting practice

1. Information from annual reports

   Source: Annual report 2005 from 3M

(see http://media.corporate-ir.net/media_files/NYS/MMM/reports/2005ar.pdf)

(1) Information in MD&A

  "Research, development, and related expenses as a percent of sales were flat when comparing 2005 to 2004. However, spending in dollars increased approximately 4%, reflecting 3M's continuing commitment to fund future growth for the Company."

(2) Information in significant accounting policy section

  "Research, development, and related expenses: These costs are charged to operations in the year incurred and are shown on a separate line of the Consolidated Statement of Income. Research and development expenses, covering basic scientific research and the application of scientific advances to the development or new and improved products and their uses, totaled $798 million in 2005, $759 million in 2004 and $749 million in 2003. Related expenses primarily include technical support provided to customers for existing products by 3M laboratories and internally developed patent costs, which include costs and fees incurred to prepare, file, secure and maintain patents."

2. Information from conference calls

a. Information about expected R&D cost

  "With lower projected revenue in our fourth quarter, we are taking measures to keep operating expenses in line and expect them to be comparable or slightly down from the third quarter. SG&A expenses are expected to be between $10.3 million and $10.8 million and R&D is expected to be between $6.3 million to $6.6 million."

Source: "Q3 2006 Martek Biosciences Corporation Earnings Conference Call – Final",
Voxant FD (FAIR DISCLOSURE) WIRE, 09/06/2006.

b. Information about R&D physical progress

"…there's several studies going on and we don't expect any results, there won't be any results this year. There may not be any results next year. These are 6 to 12 month studies and yes, so 2008 I would say we're going to start to see some results.

Source: "Q3 2006 Martek Biosciences Corporation Earnings Conference Call – Final", Voxant FD (FAIR DISCLOSURE) WIRE, 09/06/2006.

c. Information about R&D cost reimbursement

"Applying this metric to Nastech in 2004, we had reimbursement revenue of $1 million, or about 5% of our R&D expenses. For 2005, this revenue increased to $3.5 million, which represented 12% of R&D expenses. Year-to-date for 2006 we have, in fact, recognized revenue of over $9 million, which is approximately 30% of our R&D expenses.

Over the last two years, not only has reimbursement revenue increased over nine-fold, but the increase in revenue has significantly outpaced our R&D costs. While we expect substantial quarter-to-quarter and year-over-year fluctuation of this metric, we see this progress as an outstanding accomplishment. "

Source: "Q3 2006 Nastech Pharmaceutical Earnings Presentation – Final", Voxant FD (FAIR DISCLOSURE) WIRE, 11/01/2006.

Appendix B: An example of the implementation of the target reporting System

In this fictitious example, a firm is assumed to begin its R&D activities seven years ago and it has four R&D projects ongoing and one discontinued project at the end of year 2005 (current accounting year). Some of them were launched at the same time while some not. The titles of the projects are anonymous so that only financial numbers are observed.

Level 1. Individual R&D project

For an individual project, information about the net benefit is first summarized in separate tables. For example, the firm has gathered the following information about the net benefit of project A and organized it in Table B-1.

(Insert Table B-1 about here)

After preparing information of each R&D project, information of every R&D project is further summarized in Table B-2 to be used in making the diagram. The disclosure of information about the net benefit of each project is then presented through diagrams as shown Figure B-1.

(Insert Table B-2 and Figure B-1 about here)

Several observations can be seen from Figure B-1: (1) It takes more time for project A (about three years) to bring benefits than project B, C, and D; (2) The amount of unrealized net benefit for project A,B and C is quite small which suggests that the expected net benefit for these three projects has almost been fulfilled; (3) Project A, C, and D consistently brings benefits to the firm; (4) Project B brings more profits in early years but the contribution is getting smaller. Management expected the prospects of project B was good one year earlier but revised it downward probably because of the smaller amount of realized net benefit; (5) Lines for the CRNB and the ENB for project E have intersected, which indicates that no more net benefit is going to be realized. Further, the significant drop of the ENB suggests that there was a loss of the project probably due to the failure to achieve either technical or commercial objective so that the firm withdrew (or discontinued) the product; (6) Project F began just one year ago. Thus, the CRNB is negative and the distance between the ENB and the CRNB for project F is the greatest at the end of year 2005.

Level 2. Classified R&D Projects

To provide a more general picture of R&D activities, projects with the same age are

grouped. Table B-3 shows summarized information in the classified project level. Ages of the firm's R&D project range from 2 to 7. For Age 7 and Age 2 groups, the classified information is the same as individual project's report because only one project in each age group. Each of Age 4 group and Age 6 group includes two R&D projects. Based on summarized information, each group will have its own diagram as shown in Figure B-2. Two observations can be seen from Figure B-2: First, it takes the shortest time (2 and half years) for R&D projects in Age 6 group to break even. Second, there is a significant decreasing trend for Age 4 group largely due to the failure of project E.

(Insert Table B-3 and Figure B-2 about here)

To show further the difference among each group, a static diagram which shows information from all age group at the same time is prepared. Figure B-3 is the reported static diagram. Two observations can be seen from Figure B-3: First, the ENB for Age 6 and 7 groups are almost fulfilled. Second, the youngest project is still under development hence the realized net benefit is negative.

Level 3. Aggregate R&D Project

Table B-4 summarizes aggregate information of all R&D projects in the firm. The aggregate ENB (CRNB) in each year equals to the sum of ENB (CRNB) from all ongoing R&D projects in each year. To distinguish the impact from changing of expectation, the initial ENB (the first estimate made when each R&D project was launched) for each R&D project is kept. The difference between the initial ENB and the current ENB is the accumulated amount of change of expectation. Figure B-4 shows the disclosure of aggregate R&D activities. Three things can be observed from the figure. First, overall R&D activities in the firm has achieved breakeven in year 2004. Second, the firm did not change its expectation frequently over the years so that the aggregate initial ENB almost overlaps the aggregate ENB. Third, in 2005, there is a significant downward change, which is due to the write-off of project E.

(Insert Table B-4 and Figure B-4 about here)

References

Aboody, D., and B. Lev, 1998, "The Value Relevance of Intangibles: The Case of Software Capitalization", *Journal of Accounting Research* 36 (Supplement): 161-191.

Aboody, D., and B. Lev, 2000, "Information Asymmetry, R&D and Insider Gains", *The Journal of Finance* 55 (6): 2747-2766.

Admati, A and P. Pfleiderer, 2000, "Forcing Firms to Talk: Financial Disclosure Regulation and Externalities", *The Review of Financial Studies* 13 (3): 479-519.

Baber, W., P. Fairfield, and A. Robin, 1991, "The Effect of Concern About Reported Income on Discretionary Spending Decisions: the Case of Research and Development", *The Accounting Review* 66 (Oct.): 818-829.

Barth, M., R. Kasznik, and M. McNichols, 2001, "Analyst Coverage and Intangible Assets", *Journal of Accounting Research* 39 (1): 1-34.

Boone, P. and K. Raman, 2001, "Off-Balance Sheet R&D Assets and Market Liquidity", *Journal of Accounting and Public Policy* 20 (2): 91-128.

Boone, P. and K. Raman, 2004, "Does the Market Fixate on Reported Earnings for R&D Firms?" *Journal of Accounting, Auditing, and Finance* 19 (Spring): 185-218.

Biblitz, B., and M. Ettredge, 1989, "The Information in Discretionary Outlays: Advertising, Research, and Development", *The Accounting Review* 64 (1): 108-124.

Bushee, B., 1998, "The influence of Institutional Investors on Myopic R&D Investment Behavior", *The Accounting Review* 73 (July): 305-333.

Chan, L., J. Lakonishik, and T. Sougiannis, 2001, "The Stock Market Valuation of Research and Development Expenditures", *The Journal of Finance* 56 (6): 2431-2456.

Cheng, S., 2004, "R&D Expenditures and CEO Compensation", *The Accounting Review* 79

(Apr.): 305-328.

Core, J., 2001, "A Review of the Empirical Disclosure Literature", *Journal of Accounting and Economics* 31 (September), 441-456.

Darrough, M. and S. Rangan, 2004, "Do Insiders Manipulate Earnings When They Sell Their Shares in an Initial Public Offering?' Working paper, Baruch College.

Dechew, P., and R. Sloan, 1991, "Executive Incentives and the Horizon Problem: An Experimental Investigation", *Journal of Accounting and Economics* 14 (1): 51-89

Dukes, R., T. Dyckman, and J. Elliott, 1980, "Accounting for Research and Development Costs: The impact on Research and Development Expenditures", *Journal of Accounting Research* 18 (Supplement): 1-26.

Dye, R., 1989, "Proprietary and Nonproprietary Disclosures", *Journal of Business* 59 (2): 331-366.

Financial Accounting Standards Board (FASB), 1974, *Accounting for Research and Development Costs*, SFAS No. 2, Stanford, CT: FASB.

Financial Accounting Standards Board (FASB), 1985, *Accounting for the Cost of Computer Software to be Sold, Leased, or Otherwise Marketed*, Vols. 1 and 2, SFAS No. 86, Stanford, CT: FASB.

Gandhi, D., M. Rashid, and K. Riener, 1989, "Intertemporal Resolution of Uncertainty and Portfolio Behavior", *The Financial Review* 24 (3): 491-497.

Grabowski, H., and J. Vernon, 1990, "A New Look at the Returns and Risks to Pharmaceutical R&D", *Management Science* 36 (7): 804-821.

Healy, P, S. Myers, and C. Howe, 2002, "R&D Accounting and the Tradeoff between Relevance and Objectivity", *Journal of Accounting Research* 40 (June): 677-710.

Hirschey, M. and J. Weygandt, 1985, "Amortization Policy for Advertising and Research and

Development Expenditures", *Journal of Accounting Research* 23 (Spring): 326-335.

Hirst, D., K. Jackson, and L. Koonce, 2003, "Improving Financial Reports by Revealing the Accuracy of Prior Estimates", *Contemporary Accounting Research* 20 (1): 165-193.

Horwitz, B., and R. Kolodny, 1980, "The Economic Effects of Involuntary Uniformity in the Financial Reporting of R&D Expenditures", *Journal of Accounting Research* 18 (Supplement): 38-74.

Kanodia, C, and D. Lee, 1998, "Investment and Disclosure: The Disciplinary Role of Periodic Performance Reports", *Journal of Accounting Research* 36 (1): 33-55.

Lev, B., and P. Zarowin, 1999, "The Boundaries of Financial Reporting and How to Extend Them", *Journal of Accounting Research* (Autumn): 353-385.

Lev, B., and T. Sougiannis, 1996, "The Capitalization, Amortization, and Value-Relevance of R&D", *Journal of Accounting and Economics* 21 (1): 107-138.

Luft, J., and M. Shields, 2001, "Why Does Fixation Persist? Experimental Evidence on the Judgment Performance Effects of Expensing Intangibles", *The Accounting Review* 76 (Oct.): 561-587.

Lundholm, R., 1999, "Reporting on the Past: A New Approach to Improving Accounting Today", *Accounting Horizon* 13 (4): 315-322.

Lundholm, R., 2003, "Historical Accounting and The Endogenous Credibility of Current Disclosure", J*ournal of Accounting, Auditing, and Finance* 18 (1): 207-229.

Mohd, E., 2005, "Accounting for Software Development Costs and Information Asymmetry", *The Accounting Review* 80: 1211-1231.

National Science Foundation, Division of Science Resources Statistics, *National Patterns of Research and Development Resources: 2003*, NSF 05-308, Brandon Shackelford (Arlington, VA 2005).

National Science Foundation, Division of Science Resources Statistics, *National Patterns of R&D Resources: 2004 Date Update*, NSF 06-327, Project Officer, Brandon Shackelford (Arlington, VA 2006).

Roussel, P., K. Saad, and T. Erickson, Third Generation R&D: Managing the Link to Corporate Strategy, Boston: Harvard Business School Press, 1991.

Stapleton, R., and M. Subrahamanyam, 1978, "A Multiperiod Equilibrium Asset Pricing Model", *Econometrica* 46 (5): 1077-1096.

Oswald D., and P. Zarowin, 2006, "Capitalization vs. Expensing of R&D and Earnings Management", Working Paper, London Business School.

Perry, S., and R. Grinaker, 1994, " Earnings Expectations and Discretionary Research and Development Expenditures", *Accounting Horizons* 8 (4): 43-51

Sapra, H., 2002, "Do Mandatory Hedge Disclosures Discourage or Encourage Excessive Speculation?" *Journal of Accounting Research* 40 (3): 933-964.

Verrecchia, R., 1983, "Discretionary Disclosure", *Journal of Accounting and Economics* 5: 365-380.

Verrecchia, R., 1990a, "Discretionary Disclosure and Information Quality", *Journal of Accounting and Economics* 12: 179-194.

Verrecchia R., 2001," Essays on Disclosure", *Journal of Accounting and Economics* 32 (Dec.): 97-180.

Wasley, C., and T. Linsmeier, 1992, "A Further Examination of the Economic Consequences of SFAS No.2", *Journal of Accounting Research* 30 (1): 156-164.

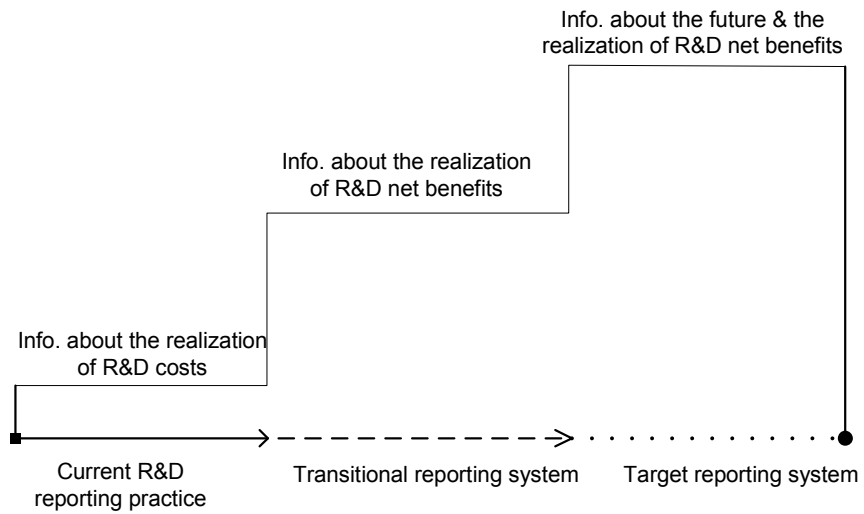Figure 1   The overview of the proposed transition of R&D reporting practice

Figure 2   Potential paths of the transition of the R&D reporting practice
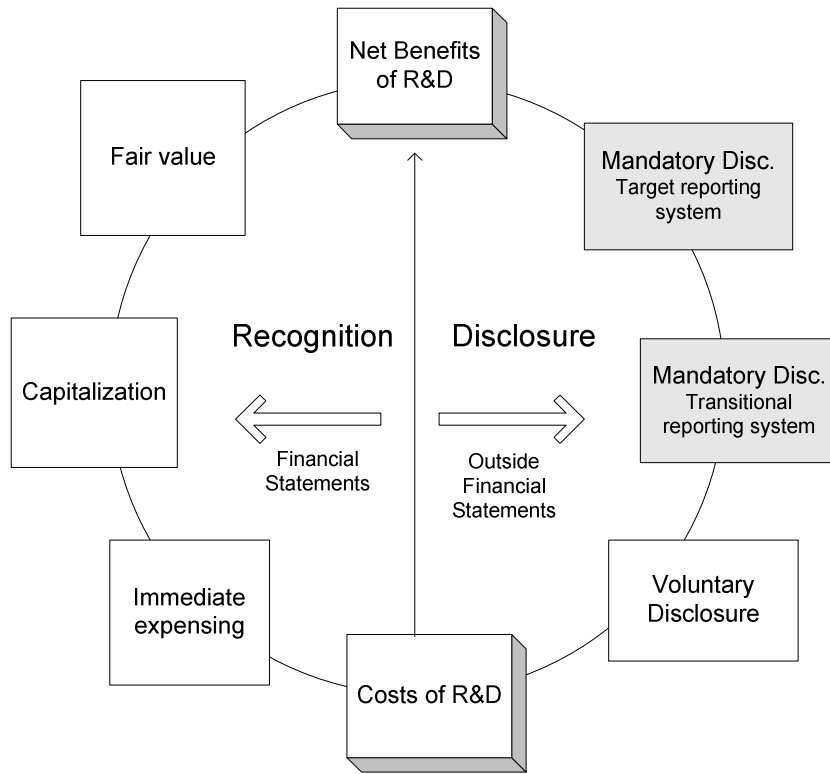
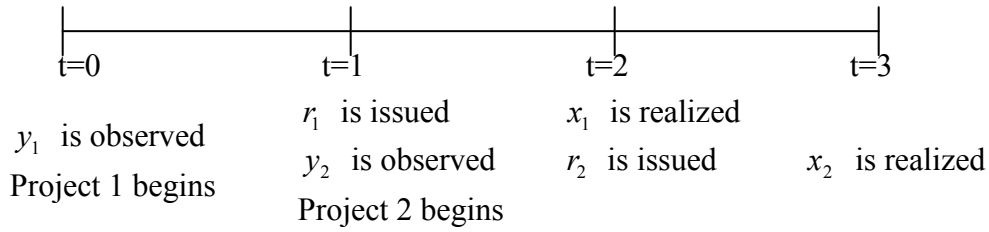Figure 3   Timeline of the events in the theoretical example

t=0   t=1   t=2   t=3

r_1 is issued x_1 is realized

y_1 is observed

y_2 is observed r_2 is issued x_2 is realized

Project 1 begins

Project 2 begins

Figure 4   Realized precision following different reporting behaviors

Reporting Behavior (Case number)		Realized precision (when NB =101)
Overstate (1) R1=125	Overstate (1-1) R2=150	0.0018
	Same (1-2) R2=125	0.0050
	Truthful (1-3) R2=100	0.0066
	Understate (1-4) R2=75	0.0024
Truthful (2) R1=100	Overstate (2-1) R2=125	0.0066
	Truthful=Same (2-2 &2-3) R2=100	4
	Understate (2-4) R2=75	0.0062
Understate (3) R1=75	Overstate (3-1) R2=125	0.0024
	Truthful (3-2) R2=100	0.0062
	Same (3-3) R2=75	0.0046
	Understate (3-4) R2=50	0.0017

Private information NB=100

Figure 5   Costs and benefits of providing required information
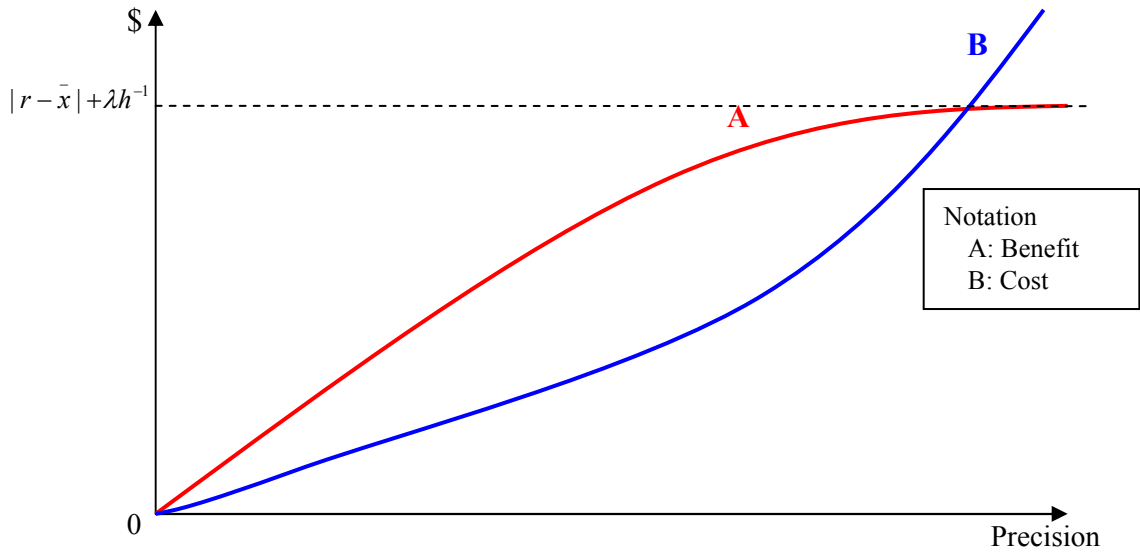
$\$$

$|r-\bar{x}|+\lambda h^{-1}$

B

A

Notation
A: Benefit
B: Cost

0

Precision

Figure 6   The net benefit of providing required information

$\$$

0

ρ^*

Precision
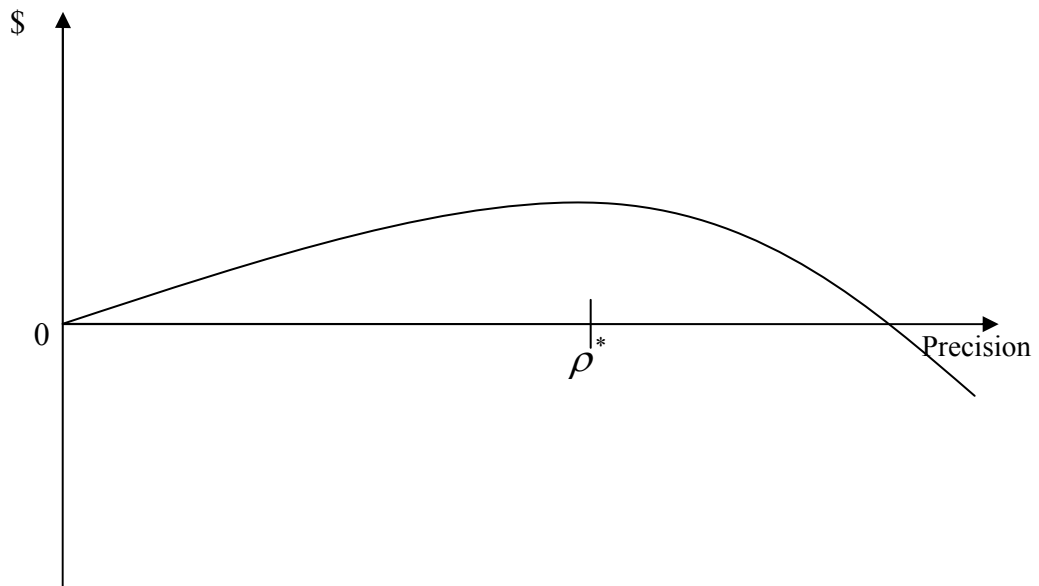
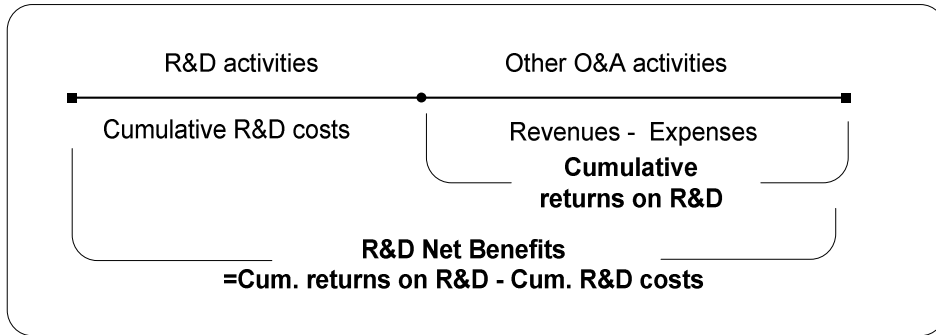Figure 7-1   Returns on R&D and net benefits of R&D

Figure 7-2   Realized net benefits and unrealized net benefits

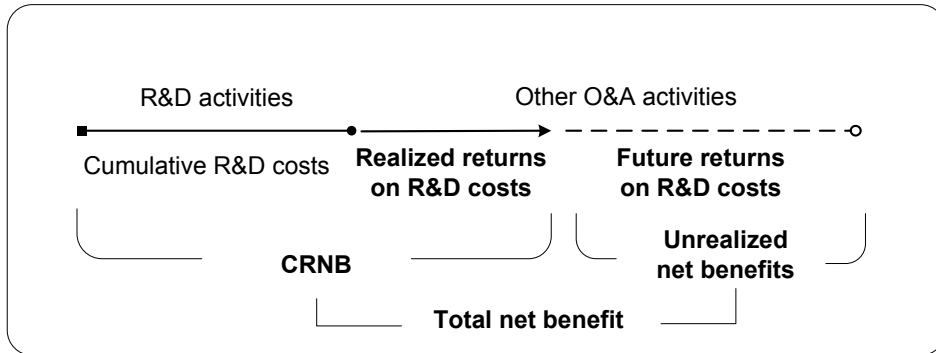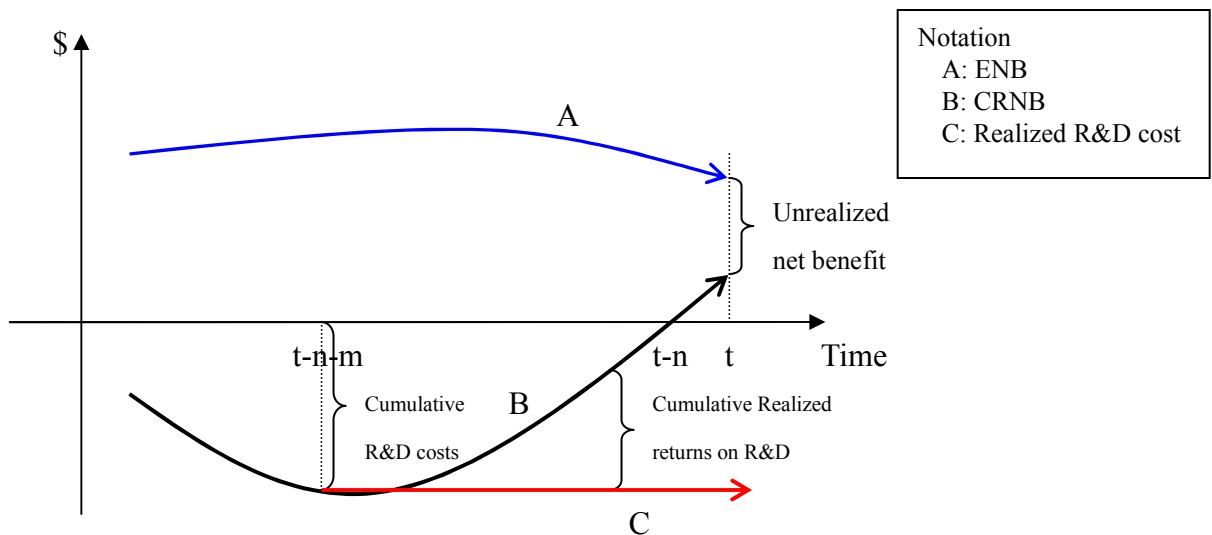Figure 8   The disclosure of information of an R&D project
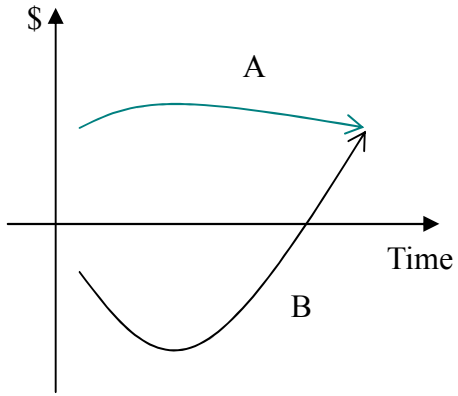
Figure 8-1 R&D project with a gain   Figure 8-2 R&D project with a loss
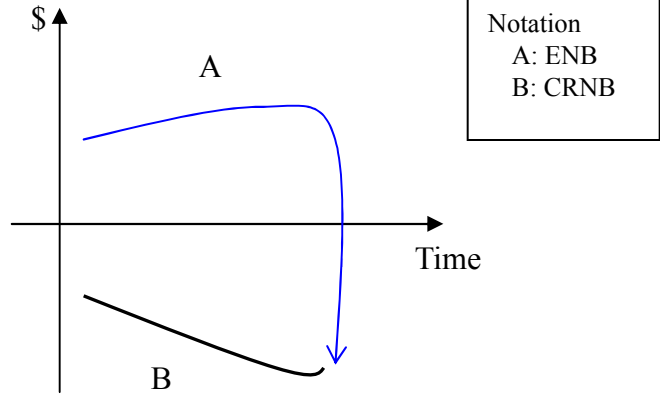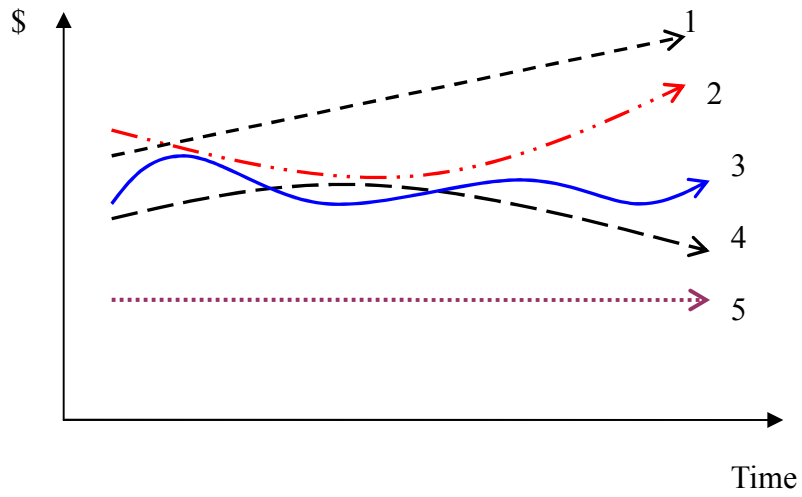

Figure 9   Different patterns of reported ENB
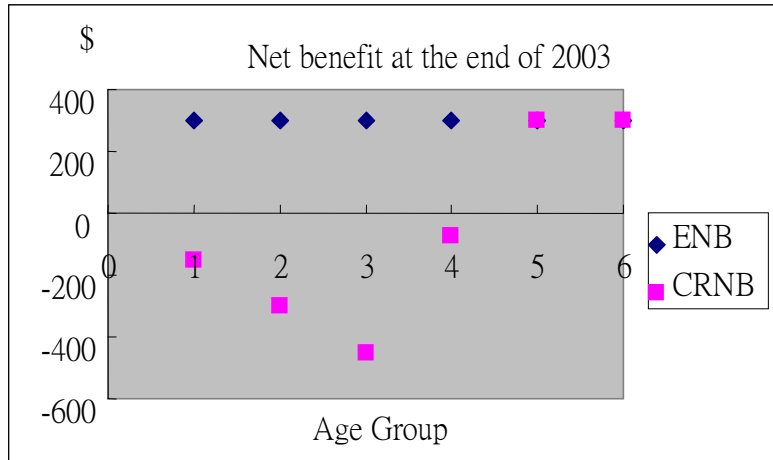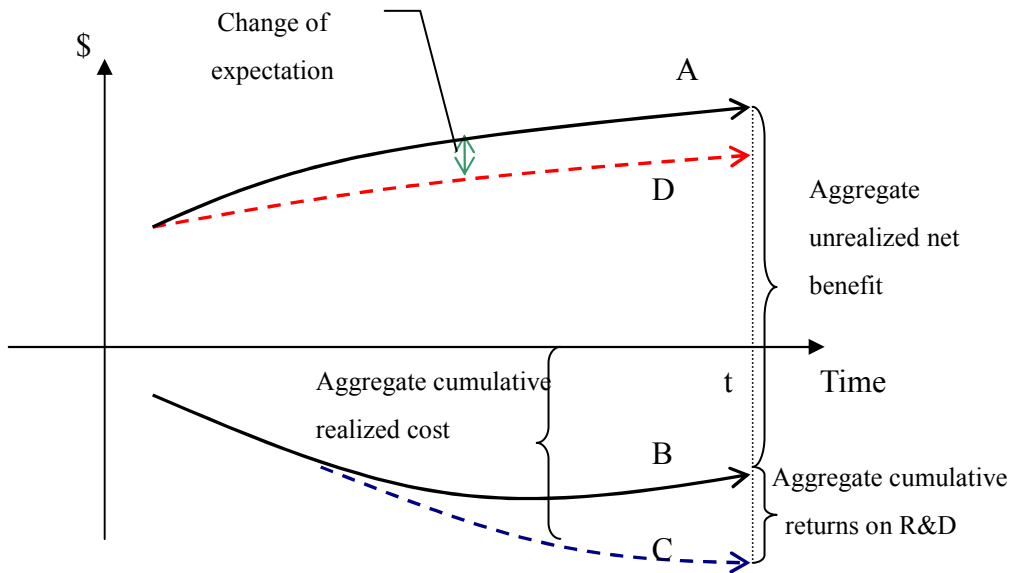
Figure 10　Level 2: Static diagram at the end of 2003

Figure 11　Level 3: Aggregate R&D financial information

Notation
A: Aggregate ENB
B: Aggregate CRNB
C: Aggregate cumulative realized R&D cost
D: Aggregate initial ENB

Figure 12   The disclosure for an R&D project- transitional reporting system
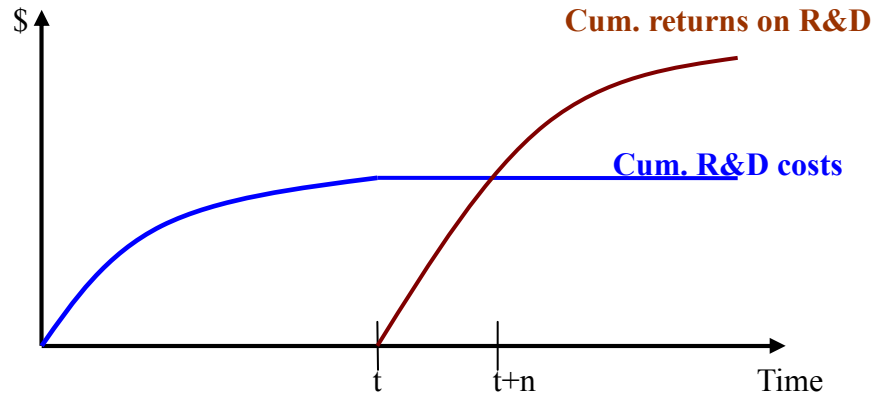

Figure 13   The disclosure of aggregate R&D information- transitional reporting system

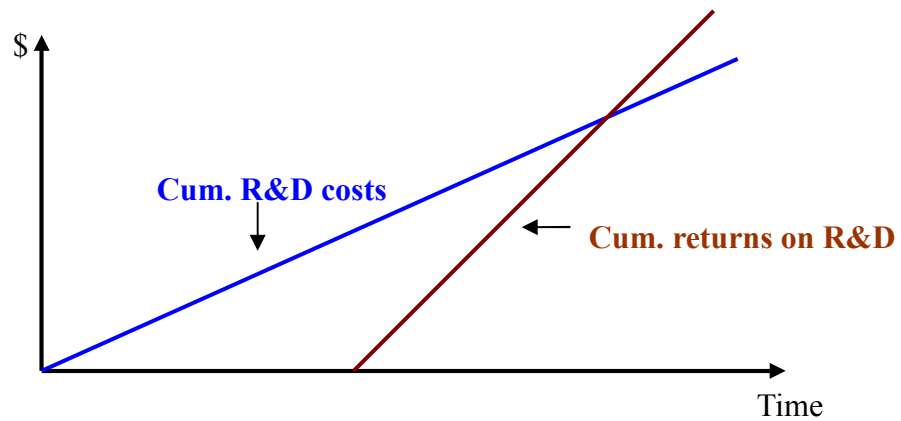# Figure B-1   Disclosures of individual R&D project- target reporting system
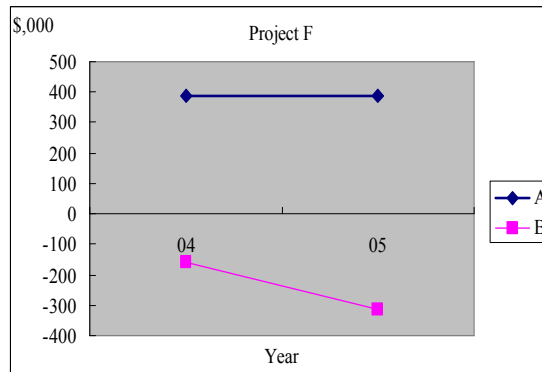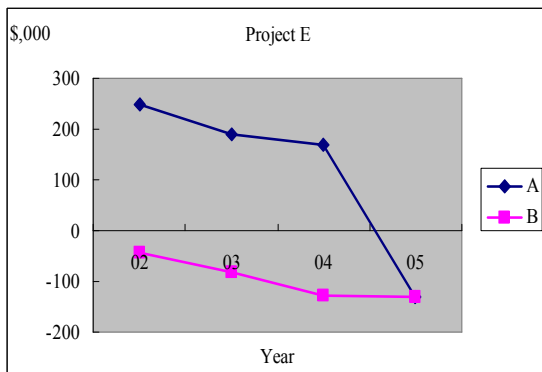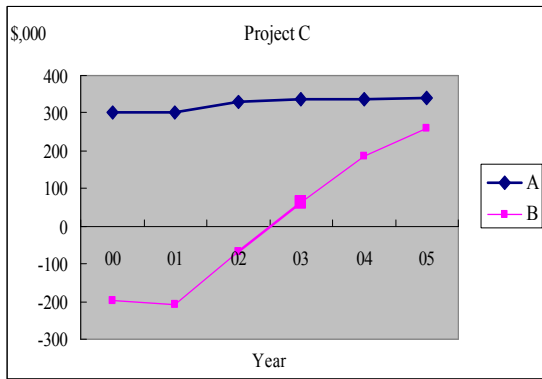
Notation:

A: ENB

B: CRNB

Figure B-2　Disclosures of classified R&D projects-target reporting system

Age 7 group

Age 6 group

Age 4 group

Age 2 group
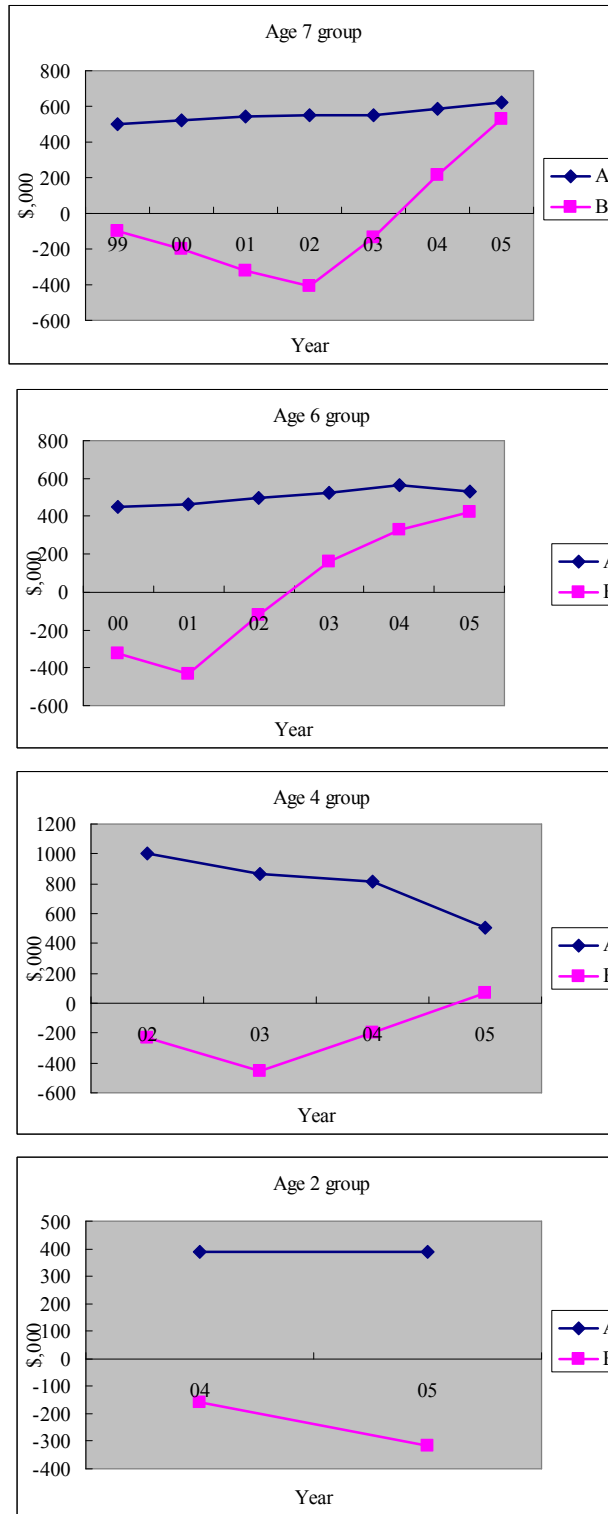
A: Classified ENB

B: Classified CRNB

Figure B-3　The disclosure of static diagram-target reporting system

Figure B-4　The disclosure of aggregate R&D information-target reporting system
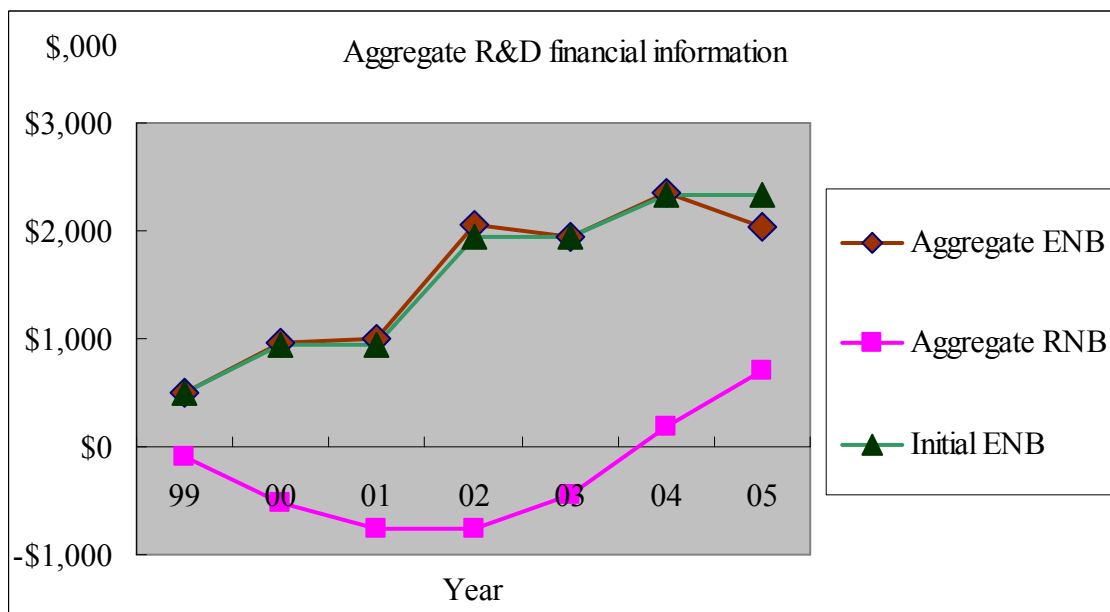
Table 1 Impacts of R&D information on expected future earnings

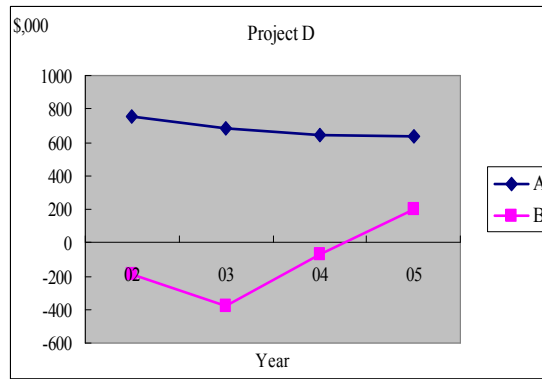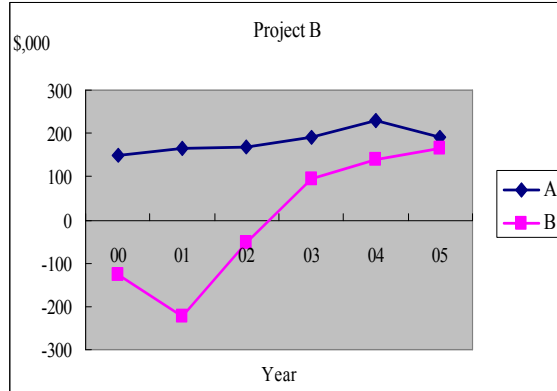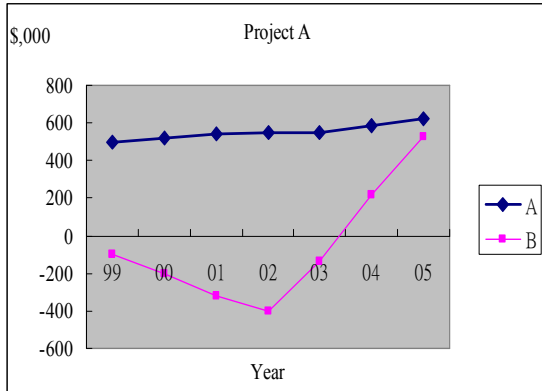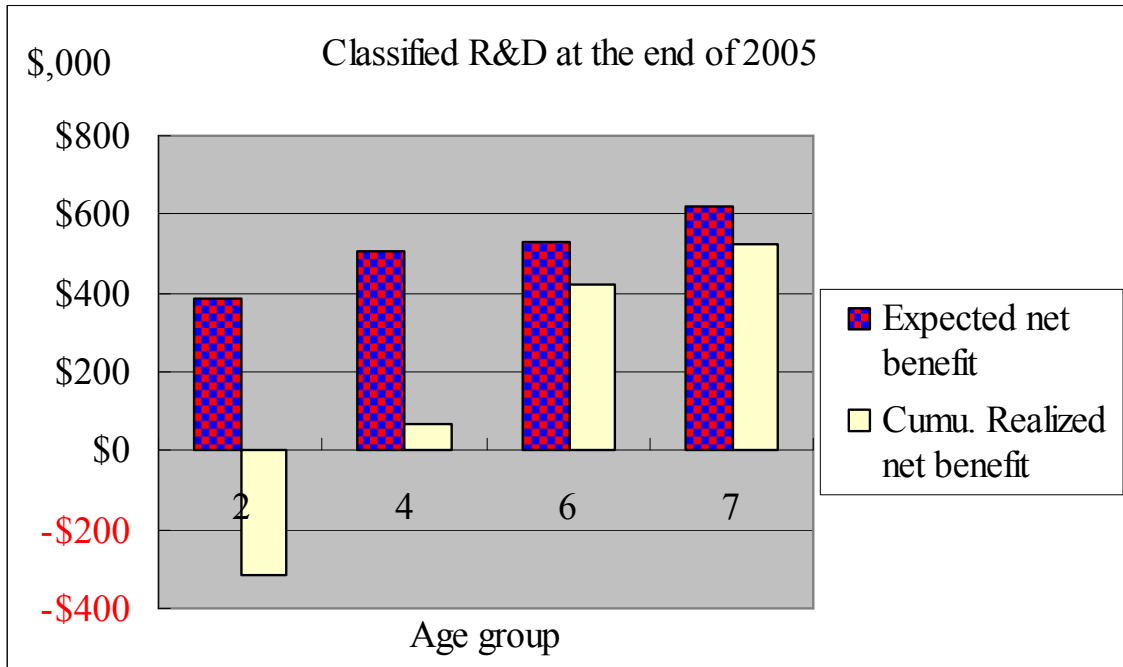|	Current realized earnings at t	Future expected earnings at t
Scenario 1. No increase of R&D cost.		
Earnings before R&D	$100	$100
R&D expense	(20)	(20)
Earnings	$ 80	$ 80
Scenario 2. Increase $10 in R&D cost without additional R&D		
Earnings before R&D	$100	$100
R&D expense	(30)	(30)
Earnings	$70	$ 70
Scenario 3. Increase $10 in R&D cost with additional R&D information		
Earnings before R&D	$100	$130
R&D expense	(30)	(30)
Earnings	$ 70	$100

Table 2 Updated perceived precision levels

		Updated perceived precision level					
		Scenario 1: $\rho_0 = 0.001$			Scenario 2: $\rho_0 = 0.005$		
Reporting behavior	Realized precision	c=0.3	c=0.5	c=0.7	c=0.3	c=0.5	c=0.7
1-1	0.0018	0.0012	0.0014	0.0015	0.0040	0.0034	0.0047
1-2	0.0050	0.0022	0.0030	0.0038	0.0050	0.0050	0.0070
1-3	0.0066	0.0027	0.0038	0.0049	0.0055	0.0058	0.0081
1-4	0.0024	0.0014	0.0017	0.0020	0.0042	0.0037	0.0052
2-1	0.0066	0.0027	0.0038	0.0049	0.0055	0.0058	0.0081
2-2	4.0000	1.2007	2.0005	2.8003	1.2035	2.0025	2.8035
2-3	4.0000	1.2007	2.0005	2.8003	1.2035	2.0025	2.8035
2-4	0.0062	0.0026	0.0036	0.0047	0.0054	0.0056	0.0079
3-1	0.0024	0.0014	0.0017	0.0020	0.0042	0.0037	0.0052
3-2	0.0062	0.0026	0.0036	0.0047	0.0054	0.0056	0.0079
3-3	0.0046	0.0021	0.0028	0.0035	0.0049	0.0048	0.0067
3-4	0.0017	0.0012	0.0014	0.0015	0.0040	0.0034	0.0047

Table 3　The market valuation based on the updated precision levels

The market valuation

Reporting behavior	Scenario 1: ρ_0=0.001			Scenario 2: ρ_0=0.005		
	c=0.3	c=0.5	c=0.7	c=0.3	c=0.5	c=0.7
1-1	114.11	115.39	116.58	128.39	126.22	130.38
1-2	120.76	124.65	127.63	131.00	130.99	134.79
1-3	123.19	127.59	130.75	132.05	132.69	136.30
1-4	115.61	117.65	119.47	128.95	127.31	131.42
2-1	123.19	127.59	130.75	132.05	132.69	136.30
2-2	149.87	149.92	149.95	149.87	149.92	149.95
2-3	149.87	149.92	149.95	149.87	149.92	149.95
2-4	122.70	127.01	130.15	131.83	132.35	136.00
3-1	115.61	117.65	119.47	128.95	127.31	131.42
3-2	122.70	127.01	130.15	131.83	132.35	136.00
3-3	120.10	123.82	126.71	130.72	130.53	134.37
3-4	113.91	115.09	116.19	128.32	126.08	130.25

Table 4　Summary of financial ratios using aggregate R&D information

Ratios to measure the speed
Rate of cost reimbursement= % of cost reimbursed/time elapsed
Rate of benefit realization= % of RB/time elapsed
Rate of net benefit realization=% of RNB/time elapsed
Ratios to measure the time
Time to break even= (1-% of cost reimbursed)/ rate of cost reimbursement
Time to fulfill unrealized benefit= (1-% of RB)/rate of benefit realization
Time to fulfill unrealized net benefit = (1-% of RNB)/rate of net benefit realization

where　% of cost reimbursed=aggregate CRB/aggregate CRC

　　　　time elapsed = the number of years elapsed sine the first launch of R&D activities

　　　　% of RB= aggregate CRB/ aggregate TEB

　　　　% of RNB= aggregate CRNB/ aggregate ENB

Table 5　The application of R&D financial ratios

	Firm 1	Firm 2
Aggregate expected net benefit	$ 200	$ 200
Aggregate cumulative realized net benefit	$ 50	$ 50
Rate for net benefit realization	8%	15%
Number of years to fulfill unrealized net benefit	16	8

Table B-1　Financial information of an R&D project

Item	Year	2005	2004	2003	2002	2001	2000	1999
	Project A Expected and Realized Net Benefit							
	(in thousand dollar)　At the End of Year							
	Expected net benefit							
1	Total Expected benefit	$1,360	$1,230	$1,240	$1,240	$1,230	$1,220	$1,200
2	Total Expected cost	740	700	690	690	690	700	700
3=1-2	Expected net benefit	$620	$589	$550	$550	$540	$520	$500
	Realized net benefit							
4	Cumulative Realized benefit, B.B.	$841	$426	$36	$0	$0	$0	$0
5	Current Realized benefit	370	415	390	36	0	0	0
6=4+5	Cumulative Realized benefit, E.B.	$1,211	$841	$426	$36	$0	$0	$0
7	Cumulative Realized cost, B.B.	$625	$565	$440	$320	$200	$100	$0
8	Current Realized cost	60	60	125	120	120	100	100
	R&D cost	0	0	0	90	120	100	100
	Non R&D cost	60	60	125	30	0	0	0
9=7-8	Cumulative Realized cost, E.B.	$685	$625	$565	$440	$320	$200	$100
10=5-8	Current realized net benefit	$310	$355	$265	-$84	-$120	-$100	-$100
11=6-9	Cumulative realized net benefit	$526	$216	-$139	-$404	-$320	-$200	-$100
	Unrealized net benefit							
12=1-6	Unrealized benefit	$149	$389	$814	$1,204	$1,230	$1,220	$1,200
13=2-9	Unrealized cost	55	75	125	250	370	500	600
14=12-13	Unrealized net benefit	$94	$373	$689	$954	$860	$720	$600

Table B-2   Summary of ENB and CRNB of individual R&D project

Project	A		B		C		D		E		F	
Year	ENB	CRNB	ENB	CRNB	ENB	CRNB	ENB	CRNB	ENB	CRNB	ENB	CRNB
2005	$620	$526	$192	$165	$339	$258	$638	$199	-$130	-$130	$387	-$316
2004	$589	$216	$230	$140	$335	$186	$645	-$67	$168	-$128	$387	-$158
2003	$550	-$139	$190	$96	$335	$62	$680	-$375	$190	-$83		
2002	$550	-$404	$170	-$52	$330	-$68	$753	-$185	$248	-$43		
2001	$540	-$320	$165	-$224	$300	-$208						
2000	$520	-$200	$150	-$128	$300	-$198						
1999	$500	-$100										

Table B-3   Summary of ENB and CRNB of classified R&D project

Project	Age 2		Age 4		Age 6		Age 7	
Year	ENB	CRNB	ENB	CRNB	ENB	CRNB	ENB	CRNB
2005	$387	-$316	$508	$69	$531	$423	$620	$526
2004	$387	-$158	$813	-$195	$565	$326	$589	$216
2003			$870	-$458	$525	$158	$550	-$139
2002			$1,001	-$228	$500	-$120	$550	-$404
2001					$465	-$432	$540	-$320
2000					$450	-$326	$520	-$200
1999							$500	-$100

Table B-4   Aggregate R&D financial information

Year	99	00	01	02	03	04	05
ENB	$500	$970	$1,005	$2,051	$1,945	$2,354	$2,046
CRNB	-$100	-$526	-$752	-$752	-$439	$189	$702
Initial ENB	$500	$950	$950	$1,951	$1,951	$2,338	$2,338
Change of estimation		$20	$55	$100	-$6	$16	-$292