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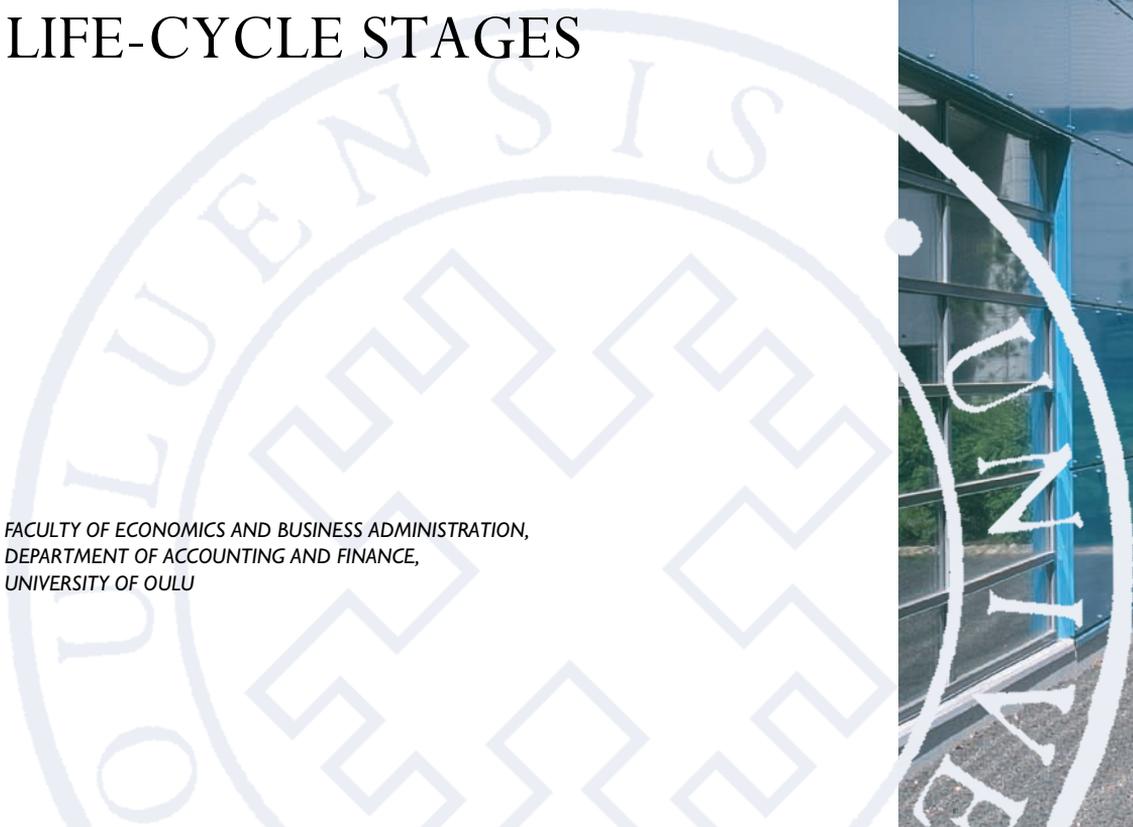
*Hanna Silvola*

MANAGEMENT ACCOUNTING  
AND CONTROL SYSTEMS  
USED BY R&D INTENSIVE  
FIRMS IN DIFFERENT  
ORGANIZATIONAL  
LIFE-CYCLE STAGES

FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION,  
DEPARTMENT OF ACCOUNTING AND FINANCE,  
UNIVERSITY OF OULU

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*HANNA SILVOLA*

**MANAGEMENT ACCOUNTING  
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LIFE-CYCLE STAGES**

Academic dissertation to be presented, with the assent of  
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**Silvola, Hanna, Management accounting and control systems used by R&D intensive firms in different organizational life-cycle stages**

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***Abstract***

This dissertation investigates the use of management accounting and control systems in R&D intensive firms in different organizational life-cycle stages. The thesis consists of four essays focusing on two categories of management accounting and control systems: capital budgeting decisions and management control systems. First, we investigate the evaluation and financing of investment projects in R&D intensive firms. Second, we moreover investigate how R&D intensive firms themselves use management control systems and how investors control their investments in R&D intensive target firms. The survey method within a contingency framework is used in the first three essays while the last essay represents the case study method. However, the dissertation as a whole is based on two main contexts, i.e. the organizational life-cycle and the field of high technology.

The results indicate that more sophisticated capital budgeting methods are used in large-sized R&D intensive firms while small-sized firms are not so likely to use these methods. The results indicate that firms understand the nature of R&D investment on the level of strategic management, because they have adopted strategic management tools in order to achieve better financial performance. We conclude that high R&D intensity plays an important role in management accounting, suggesting that large-sized high R&D intensity firms take note of special characteristics of R&D investments when taking strategic capital budgeting decisions. The comparison of the growth and revival stages extends the earlier life-cycle literature indicating that the information produced by management accounting and control systems is at least as important in the revival firm as it is during the first growth stage.

*Keywords:* capital budgeting, high technology, management accounting and control system, organizational life-cycle, R&D, venture capital investor



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Oulu, 25<sup>th</sup> January 2007

Hanna Silvola

## **List of essays**

The thesis is based on the introductory chapter and the following essays:

- I Silvola Hanna (2006) Low-intensity R&D and Capital Budgeting Decisions in IT Firms. *Advances in Management Accounting* 15: 21–49.
- II Silvola Hanna (2006) Capital Budgeting Methods and Management Control Tools in High R&D Intensity Firms.
- III Silvola Hanna (2006) Do Organizational Life-Cycle and Venture Capital Investors Affect the Management Control Practices Used by the Firm?
- IV Silvola Hanna (2006) Investor, Management Accounting Information and the Organizational Life Cycle.



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# 1 Introduction

In the management accounting literature there has been a growing interest in the life-cycle issue and some studies investigating management accounting from the life-cycle perspective have recently been published (e.g., Moores & Yuen 2001, Md Auzair & Langfield-Smith 2005, Davila 2005, Granlund & Taipaleenmäki 2005). These studies report that the organizational life-cycle has a significant impact on a firm's management accounting and control systems. On the other hand, these systems help firms to move on along with the life-cycle. The influence of the life-cycle on management accounting has been reported to be especially important for growing firms (Davila 2005, Granlund & Taipaleenmäki 2005). These firms, especially in the field of high technology, often have problems with the sufficiency of financing. Earlier studies report that the development-oriented high-tech firms involve high risk and growth potential, have a lot of intangible assets and a lack of collateral (e.g., Granlund & Taipaleenmäki 2005, Cassar 2004, Davila et al. 2003). Therefore, venture capital investors can solve the financing problems of development-oriented growth firms for which debt financing is typically not an option. Several earlier studies also report that venture capital investors have great power in several areas of the business of the target firm, including management control, business development and strategic decision-making (e.g., Gorman & Sahlman 1989, Hellman & Puri 2000, 2002, Kaplan & Strömberg 2001, Lerner & Tsai 2000, Robbie et al. 1997). It has also been suggested that the external pressure caused by venture capitalists drives the development of more organized control processes and accounting systems, especially in start-up and growing high technology-oriented firms (e.g., Davila 2005, Gorman & Sahlman 1989, Granlund & Taipaleenmäki 2005, Lerner et al. 2003, Mitchell et al. 1997, Robbie et al. 1997).

The purpose of the thesis is to investigate the use of management accounting and control systems in R&D intensive firms in different organizational life-cycle stages by using the Miller and Friesen (1983, 1984) life-cycle model. The thesis consists of four essays focusing on two categories of management accounting and control systems i.e. capital budgeting decisions and management controls. The first essay uses data for small-sized firms with high R&D intensity to investigate the methods that they use for evaluating the profitability of investment projects, estimating the cost of capital and making decisions related to the capital structure. The second essay investigates capital

budgeting methods and strategic management control tools used by the large-sized firms with high R&D intensity. The third essay investigates the role of venture capital investors in the firm's use of management control practices at different organizational life-cycle stages. The fourth essay describes and explains how the investor uses management accounting information produced by the target firm across its organizational life-cycle stages. The survey method within the contingency framework is used in the first three essays while the last essay uses the case study method.

The remainder of the introductory chapter is organized as follows. Earlier literature on management accounting and control systems from the life-cycle perspective is reviewed in Section 2. The chapter presents life-cycle models and selection criteria of the model used in this thesis. The high technology context is described in Section 3. Section 4 presents the research questions and methods outlining the framework for the thesis and describing the data of the thesis. The main results of each essay are reported in Section 5 and the last section concludes the chapter.

## **2 The life-cycle perspective in management accounting**

### **2.1 Life-cycle models in the accounting literature**

The well-known growth models created by Greiner (1972), Churchill and Lewis (1983) and Miller and Friesen (1983) are all based on five common stages having fairly similar characteristics. In Greiner's model, growing organizations move through five distinguishable phases of development, each of which contains a relatively calm period of growth that culminates in a management crisis. Firms pass through crisis after crisis in Churchill and Lewis' model, which also contains of five stages. The Miller and Friesen (1983) model demonstrates firms' passage through the five phases showing how firms vary significantly in their strategies, environments, structures and decision-making styles, giving out specific measures for successful and unsuccessful phases. In addition to these three classical models, the literature also contains a few other life-cycle models in which a diverse array of characteristics is used to describe the organizational development. According to these studies the organization varies across the organizational life-cycle stages by individual cognitive orientation, structure, strategy, leadership style, critical development areas, problems and environmental conditions (e.g., Torbert 1974, Adizes 1979, Quinn & Cameron 1983, Gupta & Chin 1990, 1993, Victor & Boynton 1998).

In earlier studies, life-cycle theories have been applied in order to predict how the use of management accounting and control systems varies across the life-cycle stages of firms, how these systems affect the firm and how the life-cycle stage of the firm affects the design of these systems. According to earlier studies the internal characteristics of organizations and the external contexts in which the organizations operate change according to the life-cycle stages of the firm (e.g., Greiner 1972, Churchill & Lewis 1983, Miller & Friesen 1983, 1984 and Merchant 1997). Actually, the life-cycle stages are defined by these organizational characteristics of the firm. The life-cycle literature shows that the common life-cycle indicators, such as the age and the size of the organization, are the drivers of the emergence of management control systems (Davila, 2005). In addition, the form of the organization and financial ratios are often used as life-cycle indicators (Friesen & Miller 1984). Generally, as the firm develops, more complex structures and more sophisticated decision-making styles prevail (Miller & Friesen 1983).

Explanations and descriptions behind the organizational features, such as life-cycle issues, have rarely been investigated in the management accounting literature. However, in recent years interest in life-cycle issues has been growing (e.g., Moores & Yuen 2001, Md Auzair & Langfield-Smith 2005, Davila 2005, Granlund & Taipaleenmäki 2005). Moores and Yuen (2001) implement the Miller and Friesen life-cycle model when studying the management accounting systems used in the Australian clothing and footwear industry. Davila (2005) also uses Miller and Friesen's life-cycle model when investigating the adoption of management control systems in growing technology-oriented firms in California. He reports that the size and age of the firm as life-cycle indicators, the replacement of the founder as CEO and the existence of outside investors are drivers of the emergence of the management control systems. On the other hand, Granlund and Taipaleenmäki (2005) implement Victor and Boynton's corporate evolution life-cycle model in the study of management control and controllership in Finnish new economy firms. They report that the new economy firms tend to prioritize planning over control and they also have to meet the expectations of venture capital investors when developing their management control systems. Compared to traditional life-cycle models Victor and Boynton's model covers only on the birth and growth stages presenting stages as craft work, mass production work, process enhancement, mass customization and co-configuration. Finally, Md. Auzair and Langfield-Smith (2005) investigate the effect of life-cycle stage on bureaucratic management control systems in Australian service organizations using a self-categorization measure based on the firm's own assessment of its life-cycle stage as proposed by Kazanjian and Drazin (1990). They report that the organizational life-cycle has a significant effect on the design of a firm's management control systems.

## **2.2 The life-cycle model used in the thesis**

In this thesis, the Miller and Friesen (1983) model is applied in the third and fourth essays. We had two main reasons for choosing this model. First, the same model must be applied in the survey (the third essay) and in the case study (the fourth essay) in order to ensure a consistent structure for the thesis. Therefore, the model must be a universal one applicable to firms of different sizes and to firms that operate in different industries. Therefore, the selected model needs to be a natural "cradle-to-grave" life-cycle model basing the life-cycle classification mainly on common life-cycle indicators such as an age, size and form of organization. We choose a model which has also been tested in management accounting studies in order to have research that is comparable to earlier studies. Miller and Friesen have tested the model themselves several times (e.g., Miller & Friesen 1980a,b, 1983, 1984). In addition, the Miller and Friesen model has a strong background in empirical accounting research (Moores & Yuen 2001, Davila 2005).

Miller and Friesen's (1983) model includes five life-cycle stages, i.e. birth, growth, maturity, revival and decline after which the organization can try to renew itself and go back to basics or shut up shop. Firms go through these five different phases in which the strategies, organizational structures and decision-making styles of the firm differ across the organizational life-cycles. However, firms do not necessarily go through these stages

in the same order as many other organizational life-cycle theories usually assume. In addition, the model gives specific measures for successful and unsuccessful phases.

In the survey, we asked firms to report whether they were in the birth, growth, maturity, revival or decline life-cycle stage following the original Miller and Friesen (1983) life-cycle model. This method to identify the life-cycle stage of the firm is also called a self-categorization measure (Kazanjian & Drazin 1990, Md Auzair & Langfield-Smith 2005). After gathering the data, a summary statistics of the responses are used to compare the Miller and Friesen (1983, 1984) criteria in order to check that the respondents have classified their firms in accordance with the original model. In the case study, the life-cycle stage of the firm is carried out through the interpretation of the primary data. In addition to interviews, the financial ratios of the firm give signs on the current life-cycle stage of the firm. Confirmation for the interpretation was requested from the interviewees.

## **3 R&D investments**

### **3.1 Nature of R&D investments**

Investments in research and development have increased markedly in Finland for almost 20 years, especially in the late 1990s. In OECD comparisons, Finland's proportion of investment in research and development in relation to gross domestic product (GDP) has been rising steadily, even during the economic recession at the beginning of the 1990s. Finland's ratio of R&D expenditures to GDP is high by international comparison. The amount of R&D investments is greater than industrial firms spend on fixed investment. The metal and electronics industry is responsible for more than 80 per cent of all the R&D investment in Finland. Most of this is accounted for by the electronics and electrical industry. R&D has an important role to play in the Finnish economy, because many firms have attained strong domestic and international market positions in products created and developed by high-technology R&D (OECD 2004).

A high-tech firm can be defined as a firm that systematically develops, produces, or uses new technological skills and invests money in R&D activities (Laitinen 2001). These firms have certain special characteristics that affect their business operations. High-tech firms have a strong scientific-technical base and they have been established for the purpose of exploiting technological innovations (Berry, 1998). These firms operate on fast-changing markets where they need to respond quickly to technological and market developments (Ackroyd 1995). In addition to high R&D intensity, high-tech firms are characterized by knowledge intensity, high business risk, high growth potential and the need for venture capital financing (e.g., Granlund & Taipaleenmäki 2005, Cassar 2004, Davila et al. 2003).

High-tech firms have a number of characteristics that make them different from ordinary manufacturing firms because of huge investments in research and development. Earlier studies report that these development-oriented firms have a lot of intangible assets, high risk and high growth potential (see, for instance, Cassar 2004). Therefore, R&D investments generate more uncertain future benefits than investments in capital assets. The profits of the coming years are generated slowly, because the time lag between the investment in R&D and the realization of benefits is generally unknown and usually

long. At the end of the development process clients' needs may have changed because of the lengthy development process. Risk in R&D investment is estimated to be about three-to-four times as large as that on capital expenditures (Kothari, Laguerre & Leone, 1998).

However, the infusion of external capital is one of the most important events in the early life-cycle of any enterprise with serious growth ambitions, after which the growth is significantly greater (Davila et al. 2003, Reid 1999). Sales growth and market share are particularly important for the long-term survival of growth firms in technology-based industries (Bantel 1997). Intangible investments are either immediately expensed in financial reports or arbitrarily amortized because knowledge-based growth firms invest heavily in R&D, customer-base creation, franchise and brand development (Amir & Lev 1996). As a result, key financial variables, earnings and book values are often low and appear unrelated to market values. However, higher R&D intensity compared to the industry average leads to larger stock-price increases only for firms in high-technology industries (Chan, Martin & Kensinger 1990). Therefore, investment in R&D in high technology-oriented firms has been seen as a positive signal to the market. Previous findings indicate that R&D expenditures can be seen as an investment rather than a cost (e.g. Chan et al. 2001, Doukas & Switzer 1992, Jaffe 1986, Lev & Sougiannis 1996). The results regarding the capital budgeting decisions of R&D intensive firms are limited; even though the industry has grown rapidly, they make substantial R&D investments and there are certain special characteristics that are likely to affect their capital budgeting decisions.

However, unsuccessful strategic decisions on capital budgeting investment can be so expensive as to threaten the existence of the growth firm in a highly uncertain industry. These firms do not have excess resources because limited tangible assets cause a lack of collateral (Wernerfelt & Karnani 1987). Therefore venture capital investors can solve the financing problems of newly-established development-oriented firms for which debt financing is typically not an option. These risky investments are related to growth opportunities but also generate more uncertain future benefits than investments in other capital expenditures. Venture capital investors require sufficient return on these investments, and therefore, it is a relatively expensive way of financing (Hall 2002).

### **3.2 Role of venture capital investors**

In addition to funds, venture capital investors have much more to give their target firms. Venture capital investors have a great influence on several areas of business of the target firm, such as business development, strategic decisions and management control. They provide a lot of support for the companies in which they have invested, helping them to develop business plans, supporting them with acquisitions, giving strategic advice on partnerships and building the internal organization of the company (e.g., Gorman & Sahlman 1989, Hellman & Puri 2000, 2002, Kaplan & Strömberg 2001, Lerner et al. 2003, Robbie et al. 1997).

Earlier studies find that the external pressure caused by venture capitalists drives the development of more organized control processes and accounting systems, especially in start-up and growing high technology-oriented firms (e.g., Davila 2005, Gorman & Sahlman 1989, Granlund & Taipaleenmäki 2005, Lerner et al. 2003, Mitchell et al. 1997,

Robbie et al. 1997). In fact, the number of management accounting systems adopted by the firms is related to venture capital funding (Davila & Foster, 2004). As Granlund and Taipaleenmäki (2005) report, the investors require reliable control and reporting systems. Earlier studies also indicate that the control is associated with the performance of the firm because venture capital investors obtain full control of the firm when the firm performs poorly (Kaplan & Strömberg 2003, Robbie et al. 1997). According to Granlund and Taipaleenmäki (2005) management control systems provide tools to manage growth in general, and act as legitimizing tools in the eyes of equity capitalists in particular. In addition, management accounting information has a significant role in the monitoring of activities of the invested firm to decrease agency costs (Davila & Foster 2004).

## **4 Research questions, methods and contribution of the thesis**

### **4.1 Structure of the thesis**

The thesis consists of four essays focusing on different issues in management accounting and control systems resulting in differences in research questions and methods between the essays. The survey method within a contingency framework is used in the first three essays while the last essay represents the case study method. However, the thesis as a whole is based on two main contexts, i.e. the organizational life-cycle and the field of high technology. Both issues are included in all four essays of the thesis.

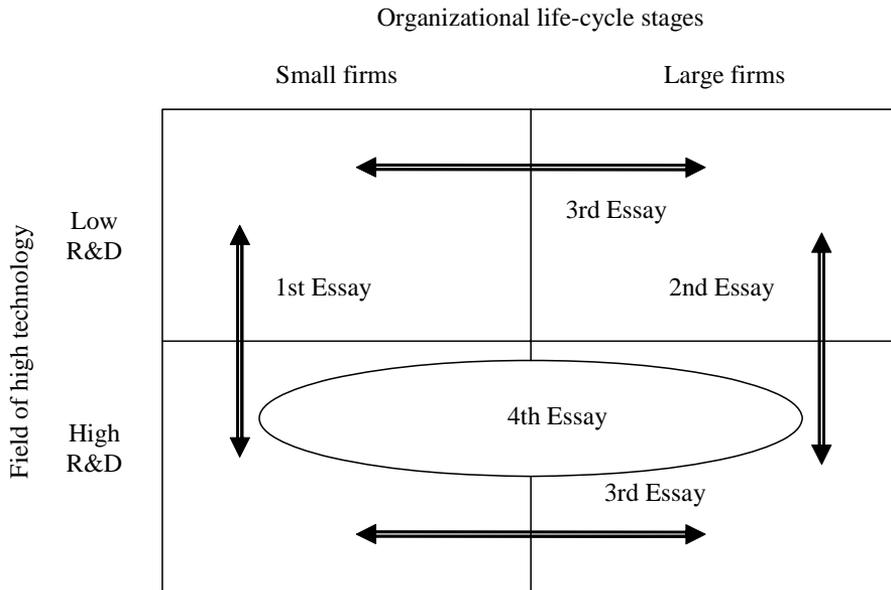
The first three essays of the thesis are based on surveys, building their theoretical perspectives on contingency framework (e.g., Thompson 1967, Perrow 1967, Lawrence & Lorsch 1969). Covaleski, Dirsmith and Samuel (1996) argue that “*Contingency theory took the insights on such critical organizational processes as decision making and control as depicted in the literature on organizational decision making and combined these with sociological functionalist concerns regarding the impact of such structural factors on organizational behaviour*”. The contingency approach assumes that the managerial behavior of management accounting practices depends on a wide variety of firm elements. A contingency framework is guided by the general hypothesis that organizations whose internal features best match with the demand of their environments will achieve the best adaptation. The particular contingencies do not suggest an ideal form of management accounting practices, but rather define a set of practices that would be beneficial in each particular circumstance.

Contingency factors that have been examined in relation to management accounting can be classified as the internal factors operating at the company level and as the external factors at more wide-ranging level. The most common internal factors include organizational size (Khandwalla 1972, Burns & Waterhouse 1975, Merchant 1981), technology (Khandwalla 1977, Merchant 1984, Dunk 1992), and companies’ strategies (Miles & Snow 1978, Gupta & Govindarajan 1984, Simons 1987, Chenhall & Morris 1995, see also review by Langfield-Smith 1997). External factors examined in the management accounting literature in contingency framework are external environment (Khandwalla 1977, Merchant 1990, Chapman 1997, Hartmann 2000), national culture

(Hofstede 1984, Harrison 1992, O'Connor 1995) and environmental uncertainty and hostility (Khandwalla 1972, Gordon & Miller 1976, Otley 1978, see also reviews by Donalson 2001 and Tymon 1998). External environment includes several issues such as the effect of suppliers, competitors, customers, financial service markets and regulation of markets (e.g. Khandwalla 1972). However, Chenhall (2003) points out that it might be difficult to strictly separate the external and internal environment in the future because the changing environment may cause many new pressures for organizations.

Organizational size, which is applied as the contingency variable in the first and second essays of this thesis, is treated as one fundamental contextual factor included in organizational theory and its contingency approaches (e.g., Chapman 1997, Chenhall 2003). However, the majority of management accounting studies have concentrated on relatively large firms in recent decades (e.g., Luft & Shields 2003). According to Chenhall (2003), recent revolutionary global changes in business environments and information technology are more likely to affect the operations and structures of smaller firms, and probably also impact on their design and use of management control systems. Recently, the life-cycle construct, which is used in third essay of this thesis has also been introduced as a contingent variable that influences management accounting and control systems (Moore & Yuen 2001, Md Auzair & Langfield-Smith 2005).

In this thesis, the organizational life-cycle perspective is applied in the two first essays investigating small and large firms because the size of the firm is commonly used as a life-cycle indicator (e.g., Miller & Friesen 1983). Earlier studies indicate that relatively small firms operate usually in highly predictable and stable environments in which the decision-making is individualized, and therefore, sophisticated management accounting is not needed (Khandwalla 1973). This raises a question concerning the need for sophisticated management accounting and control systems in small firms operating in a fast-changing, unpredictable and unstable environment like the high technology industry. Small firms with high R&D intensity are investigated in particular in the first essay. The second essay investigates large firms with R&D intensity. In the third and fourth essays the organizational life-cycle stages of the firms are measured using Miller and Friesen (1983, 1984) life-cycle classification measures. The high-technology orientation can be seen in the data because all the samples of three surveys include firms operating in the field of high technology, have high R&D intensity and are venture capital funded. In addition, the case study describes the firm which operates in the field of high technology. Figure 1 depicts the general framework of the thesis.



**Fig. 1. Framework for the doctoral thesis**

## 4.2 Research questions

The purpose of the thesis is to investigate the use of management accounting and control systems in R&D intensive firms. This question is investigated by the organizational life-cycle approach using Miller and Friesen (1983, 1984) life-cycle model. The setting points out questions from two categories of management accounting and control systems i.e. issues related to capital budgeting decisions and management controls. The first category produces questions on how investment projects in R&D intensive firms are evaluated and how the accepted projects are financed. The category related to management controls produces questions on how R&D intensive firms themselves use management control systems and how investors control their investments in R&D intensive target firms. A description of the use of these management accounting practices across the organizational life-cycle stages is provided as a result of the thesis. The summary of the research questions presented in Table 1 shows that several areas of management accounting are covered in this thesis.

*Table 1. Summary of the research questions.*

| Essay                 | Research questions   | Research method |
|-----------------------|--|-----------------|
| 1 <sup>st</sup> Essay | How do small-sized R&D intensive firms evaluate their investment proposals?<br>Methods used for evaluating the profitability of investment projects<br>Methods used for estimating the cost of capital<br>Decision-making related to their capital structure   | Survey          |
| 2 <sup>nd</sup> Essay | How are capital budgeting methods and management control tools used in large-sized R&D intensive firms?<br>Methods used for evaluating the profitability of investments projects<br>Common reasons to use formal capital budgeting techniques<br>Methods used for estimating the cost of capital and risk<br>Use of strategic management control tools | Survey          |
| 3 <sup>rd</sup> Essay | How do the organizational life-cycle and venture capital investors affect the management control practices used by the firm?<br>Business goals<br>Success factors of business<br>Length of business planning horizon<br>Use of management (accounting) techniques<br>Goals of budgeting<br>Use of budgeting methods                                    | Survey          |
| 4 <sup>th</sup> Essay | How does an investor use management accounting information to control the target firm?<br>Investor's control of its investment in the target firm at different life-cycle stages<br>Use of management accounting information in this process   | Case study      |

First, we focus on capital budgeting issues. R&D investments have many special features that are likely to affect the way the firms evaluate and control these investments. R&D investments involve exceptionally high risk, because the outcome of these investment projects is more uncertain than that of other capital expenditures. Therefore, it could be assumed, for instance, that high R&D intensity firms are likely to use the capital budgeting methods that put emphasis on the assessment of the risk of the investment in terms of the cost of capital. The first essay investigates small-sized firms having different R&D intensity focusing on the methods used to evaluate the profitability of investment projects, to estimate the cost of capital and to make decisions related to capital structure. The second essay investigates capital budgeting techniques, common reasons for using formal capital budgeting techniques, the measurement of the cost of capital and risk and strategic management control tools used by the large-sized firms with high R&D intensity. These issues become especially important in the R&D intensive firms in which venture capital investors are usually an important source of financing. It could be expected that they are interested in the ways in which target firms evaluate their investment proposals i.e. how the target firm uses the funds allocated to their firm by the investor.

Second, we investigate if the power of venture capital investors also extends to the use of management controls. It could be expected that venture capital investors require more advanced management control systems to obtain more reliable information on how the invested funds are managed in target firms. Most of the studies investigating management

controls in target firms focus on the use of particular management control systems (e.g., Mitchell, Reid & Terry 1997, Robbie, Wright & Chiplin 2001). In this thesis, the setting is applied to the life-cycle approach. The third essay investigates the role of venture capital investors in the firm's use of management control practices at different organizational life-cycle stages. We pay attention to several management accounting issues that can be used for controlling the firm's activities such as business goals, success factors of businesses, length of business planning horizon, use of management accounting techniques, goals of budgeting and the use of budgeting methods. The fourth essay investigates control of the target firm from the perspective of the venture capital investor. It describes and explains how the investor uses management accounting information produced by the case firm throughout its organizational life-cycle stages in order to control its investment.

### **4.3 Anticipated contributions**

This thesis extends the current literature in four main respects. First, it contributes to the literature by providing evidence on management accounting and control systems from the organizational life-cycle perspective. Two different life-cycle measures, i.e. the size of the firm and the life-cycle stage, are empirically tested. Both accounting issues of the thesis, i.e. capital budgeting decisions and management control systems, have previously been investigated mainly in large-sized and public firms. There is very little research on management accounting in small high-tech firms, although they are faced with more complex challenges than are small firms in other industries. The first and second essays of the thesis investigate these issues separately in small- and large-sized firms. The life-cycle stage is defined more precisely by using the Miller and Friesen (1983, 1984) life-cycle model in the third and fourth essays providing an opportunity to compare the first and second growth stages while the accounting literature traditionally does not separate the growth and revival stages (e.g., Macintosh 1995).

Second, the current thesis investigates how the special nature of R&D intensity affects the use of management accounting and control systems across the organizational life-cycle stages of the firm. R&D intensity among other special characteristics of the firms operating in the field of high technology provides an interesting setting for the thesis because these firms differ widely from traditionally operating industries (e.g., Berry 1998, Granlund & Taipaleenmäki 2005, Laitinen 2001). While the investment nature of R&D expenditures has been confirmed in numerous studies, little is known of how R&D intensive firms evaluate and control their capital investments. We contribute to the accounting literature by filling this important gap.

Third, the combination of the life-cycle framework and the field of high technology raises the question concerning the finance of firms at the beginning of the life-cycle. Therefore, we explore the role of venture capital investors in the firm's use of management accounting and control systems. The role of venture capital investors provides a richer context for this thesis by incorporating elements of financial accounting into this management accounting study. This setting contributes to the earlier studies providing evidence of the role of venture capital investors during the second growth stage

of the firm while the earlier literature has explored the role of venture capital investors during the first growth (e.g., Cassar 2004, Davila et al. 2003, Hellman & Puri 2002).

Fourth, the essay contributes to the literature by using a sample of Finnish firms and, therefore, provides results from outside the UK, the US or Australia, where most of the studies in this field have been accomplished. The Finnish sample provides a good empirical setting for the thesis, because venture capital providers are an important source of funds for the large number of R&D intensive firms established during the last decade. These firms have passed their first growth during the 90's because the high-tech industry has grown rapidly. Moreover, the thesis provides unique results contributing to the life-cycle literature because the first of these firms are currently at the beginning of their second growth stage.

#### **4.4 Methodological framework and data environment**

Triangulation is applied in the thesis because it combines elements of both quantitative (survey method) and qualitative (case study) research. The rationale for method triangulation is to avoid potential validity threats that are typically based on the potential strengths and weaknesses of different methods (see e.g., Abernethy et al. 1999, Birnberg et al. 1990). Triangulation between survey method and case study may provide a relatively strong means of assessing the degree of convergence as well as elaborating on divergences between results obtained (e.g., Model 2005, Jick 1979, Sieber 1973). It has also been argued that the current research practices can be improved by combining the survey and case methods in order to gain great potential for enhancing both the empirical and the theoretical contribution of management accounting research (Malmi & Granlund 2006). In this thesis, the positivist research tradition emphasises statistical inference as a basis for generalizations in three survey studies. Similarly, a case study method contributes to a more holistic and richer contextual understanding of survey results and helps to explain apparent anomalies and issues emanating from the survey.

The data gathered for empirical analyses vary between the essays because the thesis combines elements of both quantitative and qualitative research. The use of contingency framework, adopted in three survey studies, may cause some limitations to the study (e.g., Covalleski et al. 1996, Hartmann & Moers 1999, 2003). In addition, the use of a survey method means challenges in the study (e.g., Dillman 1999, Van der Stede et al. 2005, Wallace & Mellor 1988). The case study setting for the fourth essay is designed recognizing the framework of the surveys because its task is to provide a richer contextual understanding of the survey results. Table 2 summarizes the data used in the thesis. Issues arising from each set of data are discussed next.

*Table 2. Summary of the data used in the thesis.*

| Essay                 | Survey population                             | Sample size | Response rate | Gathered            |
|-----------------------|---|-------------|---------------|---------------------|
| 1 <sup>st</sup> Essay | Small software firms                          | 22/217      | (10.1%)       | April 2002          |
|                       | Small firms in other industries               | 78/250      | (32.0%)       |                     |
| 2 <sup>nd</sup> Essay | 500 biggest firms<br>(all industries)         | 101/500     | (20.2%)       | April 2002          |
| 3 <sup>rd</sup> Essay | Random sample:<br>(all sizes, all industries) | 105/500     | (21.0%)       | March 2004          |
| 4 <sup>th</sup> Essay | The case:<br>Investor and the target firm     | 1+1         |               | January-May<br>2006 |

In order to gather representative data and reduce sampling error, the characteristics of the target sample of surveys were defined before gathering the data (e.g. Dillman 1999, Van der Stede et al. 2005). All samples should share some predefined characteristics, i.e. cover some firms that operate in the field of high technology, have high R&D intensity and be venture capital funded. In addition, data are gathered such that all firms are located in the Greater Helsinki Area. The first essay covers two samples in order to identify the special characteristics of the software industry. A similar questionnaire was sent by post to the sample of small-sized software firms and to the sample of control firms i.e. small-sized firms operating in other industries because we wanted to ensure that software firms would be surely included in the sample. Otherwise, both samples were gathered randomly. The second essay includes data gathered by sending a postal questionnaire randomly to the 500 biggest firms operating in the Greater Helsinki area. Therefore, the data covers firms of all sizes and industries. Respondents had a chance to respond to the questionnaire using the Internet questionnaire, or traditionally, by sending the questionnaire by post. We received only 15 responses to the Internet questionnaire and 90 responses to the postal questionnaire.

The low response rate is a potential limitation of the generalizability of the results. In this thesis, the sample of software firms is relatively low. Therefore, two samples are pooled in the first essay. Hence, the software industry is presented as a dummy variable and compared to other small-sized firms. However, these software firms represent the characteristics of Finnish software firms well despite the response rate (e.g., Hietala et al. 2002). The final sample size of each survey is approximately 100 responses. For comparison, it was found that the median sample size is 125 in the mail surveys published in eight management accounting journals during the past two decades (Van der Stede et al. 2005). It is often claimed that such a sample size is large enough for meaningful statistical analysis (e.g., Md Auzair & Langfield-Smith 2005). However, a higher response rate might increase the generalizability of the results.

It has also been argued that the quality of survey data should focus on non-response bias, which depends on both sample size and response rate, rather than on the sample per se (Van der Stede et al. 2005). Therefore, non-response bias tests are undertaken to provide sufficient confidence in the representativeness of the samples. Non-response bias depends primarily on the extent to which the respondents are systematically different from the non-responders. For instance, the earlier studies suggest that directors of larger firms might be more likely to answer the questionnaires as a part of their managerial tasks (Wallace & Mellor 1988). In order to get a compare early versus late respondents, the

earliest 20 percent of responses were compared to the latest 20 percent of replies in all samples. The results remain basically the same. In the first essay, the non-response bias is analyzed for the two sets of data separately, because two sets of questionnaires were distributed even though the samples were afterwards pooled. In the third essay, the postal and Internet responses were also compared. The result of the comparison suggests that the firms operating in the high technology industries are more likely to answer using Internet than by completing the postal questionnaires. However, the results for management accounting remain the same.

Response error causes a construct validity problem which threatens the internal validity if respondents do not understand the questions (e.g., Van der Stede et al. 2005). Response error is also known as measurement error and is usually caused by poorly designed questionnaires (Dillman 1999). Therefore, the questionnaires used for the study were designed, when possible, by exploiting previous questionnaires in the field. In addition, all foreign terms were also translated into Finnish even though they might be better known by their English names. The questionnaires were also pilot tested before data gathering with a group of academic colleagues, chief accountants and financial directors (see, e.g., Dillman 1999). Thus, some feedback and advice were received on survey design and formulation to make the questionnaires more explicit and easier to answer. In addition, the questionnaire was always addressed to the financial director or the person who was the most eligible within each firm to complete the survey. In all three essays, the survey method was executed in a similar way and therefore all samples were subjected to similar bias-testing.

In the fourth essay, a case study method is adopted in order to help to explain issues arising from the surveys. The case firm was selected through purposeful sampling such that the sample fits a predefined profile i.e. the case firm fits the characteristics of the firms in the three surveys (Patton 1990). To be eligible for selection, the case firm had to meet the following criteria: the case firm has to cover several life-cycle stages, must operate in the field of high-tech industry, needs to have some R&D activity, and finally, has to have a venture capital investor who invested in the company at the beginning of its life-cycle. Lastly, but most important, we also had to find an investor which constructs a matching pair, i.e. an investor who had invested in a selected target firm.

## **5 Main findings**

### **5.1 Effect of the life-cycle and R&D intensity of the firm on capital budgeting**

The summary of the effects of the life-cycle and R&D intensity of the firm on capital budgeting are presented in Table 3. The special characteristics of R&D investment are reflected in ways of taking capital budgeting decisions in high-tech firms. The results indicate that the systematic use of capital budgeting methods is limited in the small-sized firms despite their R&D intensity. The results indicate that the return on investment and the payback period method are the most frequently used methods for assessing the profitability of investments in small-sized high-tech firms. The result extends the previous findings of the significance of strategic investments in R&D-intensive firms by revealing that these small firms use formal capital budgeting methods only within strategic investments. However, the results indicate that large-sized R&D intensive firms use more sophisticated capital budgeting methods that are based on the present values of future cash flows, such as the net present value method and internal rate of return when evaluating the investment proposals. The results are consistent with previous capital budgeting studies (see, for instance, Graham & Harvey 2001) arguing that large-sized firms use sophisticated capital budgeting methods when evaluating the profitability of an investment.

*Table 3. Summary of the results on the effect of R&D intensity and life-cycle on capital budgeting.*

|                    | The organizational life-cycle   |  |
|--------------------|---|--|
| Low R&D intensity  | Systematic use of capital budgeting methods is limited, only the ROI and the pay-back period methods are often used | Low R&D intensity firms use sophisticated capital budgeting methods less frequently than high R&D intensive firms  |
|                    | Evaluation of cost of capital based on simple and informal methods  | Evaluation of cost of capital based on simple and informal methods   |
| High R&D intensity | Systematic use of capital budgeting methods is limited, only the ROI and the pay-back period methods are often used | High R&D intensity firms use more sophisticated capital budgeting methods than other large firms   |
|                    | Formal capital budgeting methods are used within strategic investments  | Formal capital budgeting methods are used especially within strategic and large investments  |
|                    | Evaluation of cost of capital based on simple and informal methods  | Evaluation of cost of capital based on simple and informal methods   |
|                    | Software firms have abandoned capital budgeting decisions because of financial problems                             | Management control tools e.g. budgeting, control and bonus systems and strategic alliances are used more often in large high R&D intensity firms than in large low R&D intensity firms |
|                    | Software firms are seeking a main financier and co-owners while other small firms are not                           |  |

Consistent with the earlier literature (e.g., Graham & Harvey 2001) small-sized firms are not likely to use sophisticated methods such as CAPM to estimate the cost of capital. Therefore, the cost of capital is based on previous experience, owner's return requirement or cost of liabilities in all small-sized firms despite their R&D intensity. According to earlier studies, large-sized firms use sophisticated methods to estimate the cost of capital (e.g., Graham & Harvey 2001). However, the results of this study indicate that Finnish large-sized firms do not use sophisticated methods either. Thus, the results of large-sized R&D intensive firms also suggest that the management of these firms follows venture capitalists' requirements, because the cost of capital is defined by owners return requirement. Therefore the risk capital providers are interested in knowing the value of the expected returns on R&D investment.

Capital structure is different in small-sized high-tech firms than in firms in other industries. Financing problems and budgetary constraints are typical problems in small high-tech firms and the reasons why small software firms abandon their investment decisions. Decision-making related to capital structure differs between small high-tech firms and other firms because the software firms are seeking a main financier and co-owners and they try to avoid running into debt.

The results indicate that the effect of R&D intensity can be seen on the level of strategic management, because management control tools, control and bonus systems and strategic alliances, are typically more often used in the high R&D intensity firms than in the low R&D intensity firms. Generally R&D-intensive firms need more efficient control and bonus systems and strategic alliances with other firms in order to manage intangible assets and fast growth. In addition, equity investors add pressure of having management control systems, because of the risky and long horizon of intangible R&D investment.

## **5.2 Effect of the organizational life-cycle stage of the firm on management accounting and control systems**

The third and fourth essays of the thesis concentrate on the impact of specific life-cycle stage of the firm on management accounting and control systems. Table 4 presents a summary of the effects of the life-cycle stage of the firm on different issues of management accounting. Generally the results are consistent with the earlier life-cycle literature, which suggests that structures become more complex and decision-making becomes more sophisticated as a firm develops (Miller & Friesen 1983).

Venture capital investors seem to have a significant role in the R&D intensive firms in which they have invested. They probably do not require the specific management information directly from the firms, but they guide the firm's strategic decision-making, and therefore indirectly develop the management accounting practices of the firms. The results indicate that the planning horizon is longest in growth firms which have venture capital investors. The shareholder-oriented goals of business, such as increasing the value of the firm and producing profit for the owners, are more important for the maturity firms with venture capital investors than for the firms with no venture funding. In addition, ERP systems are often used in revival firms which have venture capital investors. The results reveal that earnings management and control of profit centers become more important when a firm approaches the end of its life-cycle because revival firms seem to place more emphasis on these success factors than do other firms. The results likewise indicate some similarities across the life-cycle stages. Budgeting is usually a form of co-operation in all firms regardless of the life-cycle stage of the firm. However, the most authoritarian budgeting is applied at the maturity stage and a less formal method again in revival firms. The results are consistent with Miller and Friesen's (1983) life-cycle model, which suggests that an organization is at its most bureaucratic in its mature stage.

*Table 4. Summary of the results on the effect of life-cycle on management controls.*

| MAS & MCS                | Organizational life-cycle   |
|--------------------------|---|
| Management control tools | Growth firm is controlled by the owners and venture capital investors<br>Management controls are equally important in revival stage than in growth stage  |
| Business planning        | The planning horizon is longest in growth firms which have venture capital investors<br>Investors are interested in growth rate as a return on investment in growth firm but in the revival stage they require dividends as a base of return in addition to growth rate<br>Firms with investors have shareholder-oriented business goals i.e. increase the value of the firm and produce profit for owners in maturity firms<br>Success factors of revival firms are earnings management and control of profit centers<br>The strategic viewpoint was already in decision-making during the first growth stage, but it turned to management accounting in revival stage |
| MA techniques            | ERP systems are often used in revival firms with venture capital investors  |
| Budgeting methods        | All firms regardless of life-cycle stage use the democratic budgeting method and have similar budgetary goals<br>The most authoritarian budgeting is applied in the maturity stage and a less formal method again in revival firms  |

Earlier studies point out that organizational life-cycle has a significant impact on a firm's management accounting control systems, especially in growth firms. In this thesis, the comparison of the first and second growth stages extends the earlier life-cycle literature by providing more detailed evidence of differences in the growth and revival stages. The case study points out four main differences between the first and second growth. Investors require dividends as a base of return in addition to growth rate. The strategic viewpoint has come to management accounting, the business environment has dramatically changed and the effectiveness of the business has become more essential in revival firms compared to growth firms. Therefore, the expanding firm can not be managed with a similar concept than the firm which is growing for the first time. Management controls can therefore help firms in moving along the life-cycle. The results indicate that the information produced by the management accounting and control systems is essential for both the venture capital investor and the target firm in strategic decision-making. The results are consistent with the earlier studies indicating that the venture capital investor controls the target firm through the enhanced management accounting information systems and through a seat on the board of directors (e.g., Mitchell et al. 1998, Reid et al. 1997, Smith 2005). While the earlier literature suggests that the organizational life-cycle has a significant impact on a firm's management accounting and control systems, especially in growth firms (e.g., Davila 2005, Granlund & Taipaleenmäki 2005), we conclude that the information produced by those systems is at least as important in the revival firm.

## **6 Concluding remarks**

This thesis investigates the use of management accounting and control systems in R&D intensive firms. The organizational life-cycle approach is applied in the thesis producing a description of the use of management accounting and control systems in R&D intensive firms across the organizational life-cycle stages. Management accounting and control systems are divided into two categories i.e. issues related to capital budgeting decisions and management controls. First, we investigate the evaluation and financing of investment projects in R&D intensive firms. Second, we investigate how R&D intensive firms themselves use management control systems and how investors control their investments in R&D intensive target firms.

R&D investments have many special features that are likely to affect the way the firms evaluate and control these investments. R&D investments involve exceptionally high risk, because the outcome of these investment projects is more uncertain than that of the other capital expenditures. Therefore, it could be assumed, for instance, that the high R&D intensity firms are likely to use those capital budgeting methods that put emphasis on the assessment of the risk of the investment in terms of the cost of capital. These issues become especially important in the R&D intensive firms in which venture capital investors are usually an important source of financing. It could be anticipated that they are interested in the ways in which target firms evaluate their investment proposals i.e. how the target firm uses the funds which has allocated to their firm by an investor. In this thesis, the affect of venture capital investors on management accounting and control systems is investigated across the organizational life-cycle stages of the firm, while the earlier studies suggest that the role of venture capital investors is emphasised in start-up and growth firms (e.g., Cassar 2004, Davila et al. 2003, Hellman & Puri 2002). Earlier studies indicate that management controls can be seen as a help for firms when they move along their life-cycle because the structures become more complex and decision-making becomes more sophisticated as a firm develops (Miller & Friesen 1983, Granlund & Taipaleenmäki 2005). However, only few management accounting studies from a life-cycle perspective have been published so far (e.g., Moores & Yuen 2001, Md Auzair & Langfield-Smith 2005, Davila 2005, Granlund & Taipaleenmäki 2005). These studies reveal that the organizational life-cycle has a significant impact on a firm's management accounting systems and management control systems.

The thesis consists of four essays from which the survey method within a contingency framework is used in three of them while the case study method is applied in the fourth essay. The first essay investigates small-sized firms having different R&D intensity focusing on the methods used to evaluate the profitability of investment projects, to estimate the cost of capital and to make decisions related to capital structure. In addition to capital budgeting issues, the second essay investigates the strategic management control tools used by the large-sized firms with different R&D intensity. The results indicate that more sophisticated capital budgeting methods are used in large-sized R&D intensive firms while small-sized firms are not so likely to use these methods. The results indicate that firms understand the nature of R&D investment on the level of strategic management, because they have adopted strategic management tools in order to achieve better financial performance. Therefore, we conclude that high R&D intensity plays an important role in management accounting, suggesting that large-sized high R&D intensity firms observe special characteristics of R&D investments when taking strategic capital budgeting decisions.

Earlier studies point out that the organizational life-cycle has a significant impact on a firm's management accounting control systems, especially in growth firms (e.g., Davila 2005, Granlund & Taipaleenmäki 2005). In this thesis, the comparison of the first and second growth stages extends the earlier life-cycle literature by providing more detailed evidence on differences of the growth and revival stages. We conclude that the information produced by management accounting and control systems is at least as important in the revival firm as it is during the first growth stage.

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## Essays

The thesis is based on the introductory chapter and the following essays:

- I Silvola Hanna (2006) Low-intensity R&D and Capital Budgeting Decisions in IT Firms. *Advances in Management Accounting* 15: 21–49.
- II Silvola Hanna (2006) Capital Budgeting Methods and Management Control Tools in High R&D Intensity Firms.
- III Silvola Hanna (2006) Do Organizational Life-Cycle and Venture Capital Investors Affect the Management Control Practices Used by the Firm?
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