Swedish Convertible Bonds and their Valuation

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Preface

This study, carried out at the Economic Research Institute, is submitted as dissertation to the Stockholm School of Economics.

The author has been entirely free to conduct his research in his own way as an expression of his own ideas.

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Stockholm in September 1993

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Director of the Institute

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Head of the Managerial
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Stockholm in September, 1993

Tomas Sörensson

Contents

1 Introduction and overview

1.1 Introduction

In the late 1970s, the Swedish financial market was very small, not attracting much attention from the public or the big international investors. Today, 1993, the daily changes in the stock market index are reported by the big news programs on Swedish Television. International investors are among the most important actors on the Swedish stock market. With many new instruments on the market and an increasing activity of the market participants, the need for appropriate valuation models increases. The pricing of a complicated instrument is extremely difficult without a formal valuation model. This dissertation will show how to price complicated financial instruments, using convertible bonds as an application. We apply and compare valuation models of increasing complexity. Furthermore, this dissertation will give information about the convertible bond market in Sweden, especially convertible bond issues to employees.

1.2 The questions

The main question which we consider in this dissertation is how the choice of model for valuing a convertible bond influences the value which is obtained. Another question considered in the dissertation is why convertible bond issues to employees became so popular. In connection with this second question, the extent and economic consequences of these issues are investigated. These two questions are closely connected to each other, since

all new issues have to be valued in order to establish a price of each issue when it is launched. With the new income tax law taken by the parliament on January 1, 1990, a price has to be established for tax reasons (Prop. 1989/90:50 1989).

1.3 Purpose

The research in this dissertation is mainly motivated by the huge growth in the market for financial instruments in Sweden and the increased demand for knowledge about the valuation of such instruments. More precisely, the main motive for this dissertation is to gain more knowledge about the valuation of convertible bonds.

Convertible bonds must be regarded as complicated financial instruments. The models which we use and develop for the valuation of convertible bonds could certainly be used for other complicated instruments as well. In that sense, the dissertation encompasses more than just the valuation of convertible bonds. The empirical testing of the models (especially one particular model with a complicated capital structure) undertaken in this dissertation has been asked for by the academic community since those models were developed in the mid 70s (see for example Schaefer 1980, pp. 931-932; Mason and Merton 1985, p. 31).

The explosive growth of convertible bond issues to employees in Sweden is a unique phenomenon in the world. How this can be explained is an interesting question. We will try to do so within the framework of financial innovation. The focus of the empirical survey of the convertible bond market will be on convertible bonds issued to employees rather than on convertible bonds issued for financing purposes. Convertible bonds have certainly been used as a financing device for Swedish companies, but we focus on employee issues, since the latter are so dominant.

1.4 Research approach

Two different approaches have been used in this dissertation. For the first part, a survey of primary and secondary sources was conducted. Annual reports were mostly used in combination with research reports, prospectuses and articles from various newspapers.

Primary data were gathered from the Stockholm Stock Exchange, VPC[1], and Ackordscentralen Stockholm.

The second part of the dissertation, Chapters 3 - 5, makes use of an another approach, since it is of a more technical nature: Contingent Claims Analysis (CCA)[2] valuation models are tested on real cases. A sensitivity analysis is also carried out on a real case.

1.5 Framework

The theoretical framework will be different for the two parts of the dissertation. For the first part, Chapter 2, we are mainly referring to the theory of financial innovation. The rest of the dissertation makes use of option pricing theory, more specifically, Contingent Claims Analysis.

1.6 The contribution of the dissertation

The main contribution of this dissertation is new knowledge on the use of convertible bonds in the Swedish capital market and on the use of complicated valuation models. There are widespread misconceptions on the use of convertible bonds and their valuation. At a first glance, one could think that there is not much new knowledge to be gained from studying such instruments. But a convertible bond is a instrument that gives rise to many interesting questions from several perspectives, in particular those of

- an issuing company,
- an investor,
- an employee,
- the company's house bank,
- the owners,
- legal regulations,

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[1] In Swedish: Värdepapperscentralen (a public authority for ownership records pertaining to financial securities).

[2] An option theory based technique for determining the value of a claim whose payoffs depend upon the development of one or several underlying variables.

- taxation,
- scientific questions (agency theory, signalling, valuation of instruments, empirical evidence, application of valuation methods).

After reading this dissertation, the reader will have gained some knowledge about the Swedish convertible bond market, with emphasis on convertible bond issues to employees. The reader will also have learned about several models for valuing convertible bonds and their implementation. Furthermore, the dissertation gives an understanding of what results can be obtained with the different models. The details given are enough to set up the computer programs for the models presented.

In summary, the contributions of this work are: a description of the features of the convertible bond market in Sweden, an explanation of why convertible bond issues to employees became so popular, the economic outcomes of over 200 convertible bond issues to employees, a technical description of how to use fairly complicated models for valuing convertible bonds, an analysis of the effects of model choice on convertible bond values, and an identification of key factors in valuation models and their interaction.

1.7 A preview of subsequent chapters

In Chapter 2, an overview of the Swedish convertible bond market is given. The chapter is divided into two main parts. One part is a description of the Swedish convertible bond market with a focus on employee issues, and the second part an empirical survey of the economic outcomes of these issues. In Chapter 3, three valuation models are described, all within the framework of CCA, the first model having three versions. The underlying theory is presented, with the necessary assumptions for the valuation models to work. The technical aspects of the valuation models are fully described. In Chapter 4, we perform an empirical test of four model versions of increasing complexity for valuing convertible bonds. In Chapter 5, we perform a sensitivity study and compare the most complicated model with two simpler models. In Chapter 6, we summarize the dissertation and present the main conclusions.

2 The Swedish convertible bond market - employee issues

2.1 Introduction

Most convertible bond issues in Sweden have been aimed at the employees. The overall growth of the Swedish convertible bond market was in fact caused to great extent by the huge amount of issues to employees. The great number of these issues distinguishes the Swedish market from other markets. According to a study by Sköldebrand (1989, p. 73), the number of issues launched and proposed to employees in Sweden was 292 in 247 companies, by August 1989.

As one effect of the great number of employee issues, a new tax law was passed in Sweden January 1, 1990 (Prop. 1989/90:50 1989). This law states that the employee should pay income tax on the difference between the market value of the convertible bond at the time of issue and what he or she paid for the bond at that same point in time. Another effect of these issues to employees was the debate which they gave rise to. The debate concerned various features such as too favorable conditions (Fabege (Dagens Industri June 21, 1989; September 27, 1989)), too big issues (Hufvudstaden (Dagens Industri April 3, 1989)), that the individual was not allowed to buy as much as he/she wanted, that the management got too much of the issue (Trygg-Hansa (Dagens Industri February 2, 1989; October 4, 1989)), that the taxation had to change (Dagens Industri February 17, 1989). This debate also gave rise to research on various aspects of convertible bond issues to employees. This study will

try to integrate and summarize previous research and also relate it to the prevailing theory regarding the emergence of new financial instruments.

2.1.1 The motive for this research

The main motive for studying the convertible bond market is the need for background knowledge about convertible bonds on the Swedish scene. This research, as reported in this chapter, can serve as an introduction and background to the technical parts of this dissertation. It is also a study that stands by itself. The research method is to use available written documents, i. e., newspapers, annual reports, prospectuses, business journals and research reports.

2.1.2 Previous research on employee issues

The research that has been done previously on employee issues of convertible bonds in Sweden has focused on four perspectives. One study has been done on the volume and the economic consequences of these issues (Sköldebrand 1989). A couple of studies have been done on the effects of these issues from the employee's point of view (Gelin and Sundström 1990; Sundström 1991). The third perspective taken by researchers (Flodhammar 1991; Eriksson 1992) is the legislation regarding issues to employees. Flodhammar concentrates on legal aspects regarding convertible bond issues to all employees in a company. These legal aspects in many ways have relevance for all types of convertible bond issues. Eriksson focuses on issues to the top management in a company. The fourth perspective, taken by Anell (1989), is to study the efforts that have been undertaken to increase the number of stockholders in companies, especially among employees.

2.1.3 Contributions of this chapter

This chapter will give a broad overview of Swedish convertible bond issues to employees. It gives a historical review of the employee issues, hence providing insights that can be used if new issues are to be launched. This chapter clearly points to some of the fatal caveats of convertible bond issues to employees up to this date.

The chapter is organized as follows. In Section 2.2, a description of the characteristics of convertible bond issues to employees is given. Section 2.3 contains a theoretical framework for such issues. In Section 2.4, there is a discussion of employees as stockholders. Various tax laws and recommendations related to the convertible bond issues under study are discussed in Section 2.5. Section 2.6 contains a description of the design of a typical employee issue, the employee prospectus, and the prospectus for the general stockholder meeting. The valuation models used by the financial institutions handling the issues are outlined in Section 2.7. In Section 2.8, the outcome of the issues is discussed. Section 2.9 contains conclusions. Three appendices are attached to this chapter. Appendix 2:1 contains a list of all identified convertibles issued in Sweden to employees by listed companies. Appendix 2:2 and Appendix 2:3 contain supplementary materials, Appendix 2:2 on the design of convertible bonds issued for financing purposes, and Appendix 2:3 on plans for broadening employee share ownership in countries other than Sweden.

2.2 Characteristics of the Swedish convertible bond market

Since 1973, it has been possible for Swedish companies to issue convertible bonds. The huge increase in convertible bond issues started in 1985. The difference between the Swedish market and other markets is that the main body of convertible bond issues was aimed at the work forces in Sweden. One reason for the issues was the Swedish tax laws, which made it very unfavorable for employees to get wage increases, with a marginal tax rate of at least 65 percent in most cases in the early eighties. By obtaining convertible bonds in the company they worked for, the employees could participate in the rise of the share price and pay a very low tax, if a capital gain was realized. With a convertible bond, the risk and the cost was very low, if the company did not default on the bond. In prospectuses for convertible bond issues, the possibility of bankruptcy is mentioned at most in the form of a parenthesis or not mentioned at all. Unfortunately for some employees, the bankruptcy risk later became a reality.

In the following, a description of some different dimensions of convertible bond issues to employees in Sweden will be given. We will start with the development of the volume of the issues, and the type of companies issuing these bonds. Furthermore, the importance of the employee issues in a financing perspective will be considered. The stated motives for the

issues will be discussed, and evidence on the fulfillment of those motives will be presented.

2.2.1 The volume of convertible bond issues

The volume of convertible bonds in the Swedish convertible bond market is considerable. There were 212 issues in 158 companies (both listed and unlisted) administrated by VPC as of October 16, 1992 (VPC 1992). Note that many issues have expired in the last three years, since they were issued in 1984 - 1987, having a typical life time of five years. For issues launched by listed companies, the total nominal value is 16,237 MSEK (Sköldebrand 1989, and Annual Reports of the Stockholm Stock Exchange for 1989, 1990, and 1991).

There has been a number of big issues, both as pure financing devices and as issues to employees. One example of a big financing issue is Investor's convertible bond issue of 1991, with a nominal value of 3,564 MSEK (Investor 1991) (see also Appendix 2:2). A big convertible bond issue to employees was SE-banken's 1988 issue with a nominal value of 1,203 MSEK (Sköldebrand 1989). In the following, the focus will be on employee issues. The main arguments for this focus on convertible bond issues to employees are the following: They are a typical Swedish phenomenon. They are important, since more than 200.000 employees have participated. They have given rise to a specific tax law (see Subsection 2.5.6), with no clear model for estimating the certificate value for determining the amount of tax to be paid by the participants in the issues.

The volume of convertible bond issues to employees has been big both in value and in numbers. The start of a more noticeable volume came in 1983, with a peak in 1987. The last year with many issues was 1989. The volume in 1990 can be explained by a few large issues. The new tax law concerning convertible bond issues taken January 1, 1990, made it more unfavorable to issue convertibles to employees. This circumstance combined with the fact that all major companies had already issued convertible bonds had the effect that the number of new issues was very small after 1989. In Table 2.1, taken from Sköldebrand (1989), the volume of the issues, the number of issues, and the average size are displayed.

As we can see in Table 2.1, the number of loans is 278 up until August 15, 1989. The average size of the loans increases over time. In 1989, the number of loans was 18. Between 50 - 70 percent of the employees in the companies participated in these issues (Sköldebrand 1989, p. 75). After 1989, most of the listed companies had issued convertible bonds to the

employees. Several companies had issued more than one issue, to allow employees that did not participate in earlier issues to get a new chance to participate.

Table 2.1. Convertible bond issues to employees identified by Sköldebrand

Year	Volume (MSEK)	No. of issues	Average size (MSEK)
1978	6	1	6
1983	84	10	8
1984	570	36	16
1985	1,168	29	40
1986	1,748	45	39
1987	5,424	89	61
1988	4,287	50	86
1989*	2,999	18	167
Total	16,286	278	59

Note: *) Until August 15, 1989. Source: Sköldebrand 1989.

The number of unlisted companies that have issued convertibles compared to the corresponding number of listed companies can be seen in Table 2.2. In that table, loans proposed to be issued during 1989 are also counted, so the number of loans is not the same as in Table 2.1. The biggest value in Crowns of the issues is for listed companies on the AI-list (see Table 2.2). This is quite natural, since these companies are the biggest both in turnover and number of employees. The AI-list contains the most actively traded shares of the big Swedish companies.

It is quite surprising that there are so many convertibles issued to employees in unlisted companies. One has to remember the difficulties associated with valuing a convertible bond when there is no market value of the shares of the company. For a participant in such an issue, the liquidity effect represents a great deal of the risk, since it is very difficult to sell the convertible bond if the company is unlisted. The employees are heavily dependent on the company in such a case.

One explanation for the great number of issues among unlisted companies is that they view convertible bonds as a first step in the process of acquiring more stockholders and becoming listed. It is often understood that the companies are going public as soon as

possible after the convertible bond issue. As one example, Seco Tools could be mentioned. The company issued convertible bonds to the employees 1988 and became listed on August 1, 1989 (Annual Report Seco Tools 1988; Annual Report of the Stockholm Stock Exchange 1989). It would be very difficult to motivate employees to buy convertible bonds in a company that does not intend to get listed, since this is a prerequisite for obtaining a market value of the issue.

Table 2.2. Listed/not listed companies with convertible bond issues to employees.

	Number of companies	Number of issues	Value of convertible bonds (MSEK)
Listed	172	207	14,981
AI	79	93	13,691
AII	19	19	352
OTC	52	67	443
O-list	22	28	495
Not listed	75	85	1,304
Total	247	292	16,285

Note: AI = most actively traded stocks. AII = other stocks. OTC = over the counter list (small companies). O-list = unofficially traded stocks. Data for size until August 15, 1989, and form of listing until June 30, 1989. Source: Sköldebrand 1989.

2.2.2 Type of companies issuing convertible bonds to employees

The development in the late eighties had the effect that almost every listed company of any size had issued convertible bonds to the employees by 1990. Companies which were late to issue convertible bonds to their employees were those which already had some form of organized stock ownership plan or profit sharing program for their employees. To induce the employees to become stockholders in the company for which they work has been the goal of several companies. For companies in this category (with organized stock ownership plan or profit sharing program for their employees), an issue of convertible bonds to the employees had low priority, but eventually most of them issued such bonds nevertheless.

Companies owned by their employees, like consultant firms, also did not issue convertible bonds at first. Later on they, too, issued convertibles. Investment companies have

not issued convertible bonds to the employees, since there are very few employees in such firms. In our study, we define an employee issue as a convertible bond issue aimed at all employees in a company. This is the same definition that Sköldebrand (1989) uses.

2.2.3 Proportion of financing through employee issues

The huge amount of convertible bond issues to employees must be considered as important also in a financing perspective. Even though the majority of companies did not need the convertibles as a source of financing, the financing obtained was not bad for them. In Table 2.3 below, the financing through stock issues is compared with that obtained through employee issues of convertible bonds.

Table 2.3. New financing in Sweden through the stock market compared with convertible bond issues to employees.

Year	Stock issues (MSEK)	Convertible bond issues to employees in listed companies (MSEK)
1983	9,394	72
1984	6,565	460
1985	2,830	1,073
1986	4,284	1,638
1987	7,029	4,674
1988	6,148	4,083
1989	8,308	2,678
1990	9,923	1,559
1991	14,425	0
Total	68,906	16,237

Sources: Sköldebrand 1989, and Annual Reports of the Stockholm Stock Exchange 1989, 1990, and 1991.

As can be seen, the volume of convertible bond issues to employees is about 25 percent of the stock issues. In view of this fact, one must regard these issues as important. The convertible bond issues would create a noticeable amount of new shares and quite a big volume of new equity in the capital structure of the issuing companies, if they were to become converted. The effect of the new equity is that the debt/equity ratio improves. This

in turn means that the company can raise more money through straight debt.

2.2.4 Stated motives for employee issues

If one studies the companies' motives for issuing convertible bonds to the employees, given in various prospectuses, annual reports and other sources (references are given in Table 2.4), one finds that the main motive was to stimulate the employees and increase the feeling of affinity with the company and create an understanding of the company goals. Another important motive for issuing convertible bonds in certain industries was to minimize the number of people leaving the company. Letting employees buy convertible bonds in the company would tie them closer to the company and make them more reluctant to leave. Swedish industry demanded a well trained and educated work force, which made it very expensive to hire and train new employees. It was also advantageous in the competition for attractive professionals to be able to offer convertible bonds to the employees.

A valid motive, seldom stated explicitly, was to pay the top management through convertible bonds rather than through higher wages. The amount of money that some of the top managers put into these convertible issues was in many cases around one million Crowns. This is discussed in more detail in Subsection 2.4.2. This variant of incentive scheme was very popular during the period. By Swedish law, companies are forbidden to issue options on their own stock to the management.

In one of the companies that were studied by Sundström (1991, p. 66), a couple of the unions express the view that the true motive for the convertible bond issue to the employees was to pay the top management. 23 members of the top management on average signed up for a nominal value of 418.000 SEK (Sundström 1991). By July 1, 1989, the value of this allotment was 2.240.000 SEK (Sköldebrand 1989). Among the employees, the rate of participation in the issue was only 16 percent. The chief director of the board of this company was a dedicated fan of the so called "Pilot School", described in Subsection 2.4.1.

For a company going public, one can identify another motive for an issue of convertible bonds. That is, by increasing the number of owners through an issue of convertible bonds to the employees, the company can more easily fulfill the stock exchange requirements on the number of owners for listing a company. An employee issue also makes it possible for the company to get used to the outside attention which a listed company meets in a smaller

and more friendly environment. (Friendly in the sense that employees know the business and trust the management.)

The financing of the company was often a peripheral motive. This is seen in many prospectuses, where it was clearly stated that the issue was not needed as a source of financing. Most of the companies which issued convertible bonds to employees had no need for financing at this point in time. At the time of issue, they were often in a positive situation, with a good profitability and very strong balance sheets. Remember that the period to which we are referring is the mid 1980s when the stock market was very strong and there was an abundance of capital in Sweden due to the deregulation of the banking industry. It was also fairly easy to obtain financing over the stock market. To issue convertible bonds to the employees as a way of obtaining financing seemed quite unnecessary in this situation.

In Table 2.4, a collection of quotes regarding motives for issuing convertible bonds is displayed. The collection should be seen as concrete examples of stated motives. They are picked at random from various sources. That they are so similar could to some extent be explained by the fact that the Swedish business community is so small. Some of the company board directors are members of several of the other companies' boards of directors.

2.2.5 Studies of the motives for the employee issues and the fulfillment of the motives

In a study by Anell (1989), 126 listed companies were sent a questionnaire about the motives for their efforts to get the employees to become owners in the company. In the 121 companies which answered the questionnaire, the most important reason for broadening the group of stockholders to include the employees was to strengthen the commitment of the latter to the company and their feeling of affinity. The second most important reason was to give the employees a part of the increase in company value. To increase the productivity was seldom mentioned in this survey.

Regarding convertible bond issues to employees, Gelin and Sundström (1990) undertook a study of four companies which had issued convertible bonds to the employees. The study was performed by sending out questionnaires to half of the employees in the companies DN/Marieberg, Fundia Bygg AB and SCA/Östrand. In the company Ångpanneföreningen, 100 participants in the employee issue received the questionnaire. Altogether 833 questionnaires were filled out and returned. The study covers a great number of details on

Table 2.4. Collection of quotes regarding motives for issuing convertible bonds to employees. Translated freely from Swedish.

Company (representative)	Motive	Source
Andersons (CEO)	"It is my belief that ownership stimulates consideration for the company and efforts for a positive development of the company." "The employees, who by their good work contribute to the good result of the company, will then be able to share this as convertible bond holders."	Prospectus 1988
ASEA (deputy CEO)	"We wanted our employees committed in a winning and profitable way." "We wanted the people to accept that the subsidiaries are dependent on each other in the group of companies."	SAF-tidningen no. 17 May 5, 1990
Atlas-Copco (CEO)	"It is the opinion of the owners of the company that as many as possible of the employees should also become stockholders." "It will increase the interest in the development of the group and improve the feeling of affinity." "And as an effect of the issue, Atlas-Copco obtains capital. This decreases the need for obtaining debt."	Prospectus 1987
Jacobson & Widmark (CEO)	"Within a consultant firm as ours it is important that the employees are committed to their work and the company." "A long-range ownership is one way of increasing the motivation and strengthening the feeling of affinity."	Prospectus 1988
Munksjö (CEO)	"Munksjö's owners and board of directors have found it important to give the employees an opportunity to become owners." "A stake in the company increases the interest in the company and its operations as well as strengthens the feeling of affinity within the group of companies." "It will also give the employees a part in Munksjö's future profits."	Employee prospectus 1987 (Munksjö-Börsen, Company Newsletter)
Saab-Scania (CEO)	"We, as employees, now have the opportunity on favorable conditions to become stockholders, through convertible bonds." "The money will be used to finance an increasing growth of the company."	Employee prospectus 1988
(Board of directors)	"The motive for the issue is to create an ownership on a long-range basis among the employees and board of directors, which could be expected to increase the motivation in the future work as well as increase the feeling of affinity with the group and interest in its profitability."	Prospectus for general meeting
SE-banken (A member of the board)	"Within a service operation as ours, it is extremely important that the employees are committed to their work and their company. "An ownership on a long-range basis is *one* way of increasing the motivation and strengthening the feeling of affinity with the bank and the group." "The motive is to stimulate even more the interest in the company's operations and increase the feeling of affinity." "Furthermore, we naturally want to give our employees, who together are responsible for the development of the group, yet another opportunity to participate in the future development of the group."	Prospectus 1988
Skanska (Board of directors)	"The board of directors believes that the issue . . . could create an ownership on a long-range basis of the employees of the group of companies." "Such a commitment (ownership) could be expected to increase the motivation in the future work, stimulate an interest in the operations of the company and its profitability and increase the feeling of affinity with the company." "The money will be used for financing the ongoing operations of the company."	Prospectus 1988
Trygg-Hansa (CEO)	"Important with commitment." "To get the employees to participate in the reorganization of the company." "Heavy pressure from the employees, the allotment should be as big as possible."	Dagens Industri Feb. 2, 1989.

the employee issues. In the following, the main results will be summarized.

The study can not verify that convertible bond issues to employees increase the number of owners in the companies, with some minor exceptions. The stated motive in prospectuses, that the issues would increase the employees' commitment and productivity, is not supported by the study. The analysis shows a significant relationship between an interesting and developing work and a feeling of affinity with the company.

For the participants, the main reason for participating was pragmatic. They viewed it as a risk-free way of earning money. However, half of the respondents put forward reasons of principle, such as wanting to be with the company in the future, and that the issue was "right from the perspective of good principles". The given reasons for not participating were: Better with a wage increase, could not afford to participate (more than half of those not participating), too much risk, and that it was a bad offer.

Gelin and Sundström (1990, p. 123) found that the "average" holders of convertibles

- are more interested in the company and have a more appropriate picture of the company's performance,
- read the Annual Report to a greater extent than other employees,
- have a better knowledge of the company's stock price,
- talk more often about the company's performance with other employees,
- read the business pages in the newspaper more frequently than employees not having convertible bonds.

The study gives no evidence on whether this interest in the company was due to having convertible bonds or other factors (with the exception of Fundia, where the interest in the company has increased more among the convertible bond holders).

The same study finds that the chance that an employee owns convertibles increases if

- she/he is an older person, is saving in a stock fund, is a white collar, or member of the management,
- experiences the standards of the family as positive to convertible bonds,
- believes that the local union dislikes the convertible bonds,
- has a strong feeling of affinity for the company,

- has little feelings of affinity with the union,
- has less feelings of principle against convertible bond issues,
- views the work as fulfilling.

The white collar workers feel that their unions are positive to employee issues of convertible bonds. The blue collar workers feel that their unions are neutral or negative. In one case, Fundia, the feelings of affinity for the company are lower among the convertible bond holders compared to those not having convertible bonds. For more details on these four cases discussed by Gelin and Sundström (1990) refer also to Sundström 1991.

2.3 Theoretical framework

The issuing of convertible bonds to employees in Sweden could have been driven by agency theory considerations and by the financial innovation framework. Agency theory could be viewed as the foundation for the interest among the Swedish business community in a spread of ownership through holding stock (see Section 2.4 below). The framework of financial innovation can explain the choice of instrument.

On the Swedish scene, both academic and business, the treatment of convertible bond issues to employees has been from the perspective of agency theory. This dissertation will also apply the perspective of financial innovations to convertible bond issues. We argue that explaining the convertible bond issues to employees from the perspective of financial innovations is more fruitful than just viewing such issues as a solution to agency theory problems. In the following, relevant parts of those two theories will be described. The treatment of agency theory is to some extent inspired by Holmstrom and Tirole (1989). The theory of financial innovation is presented in such a way that it will give a framework for convertible bond issues to employees. A more detailed description is given by Merton (1990). He also gives many references on the subject.

2.3.1 Agency theory

The theory of the relationship between a principal and an agent is commonly referred to as agency theory. In a company where the manager and the ownership is separated, the

relationship between the parties has to be formalized by a contract. As soon as a contract is on hand, there will be agency costs (Jensen and Meckling 1976). The principal's (here defined as the stockholders') fundamental problem is to induce the agent (here defined as the manager) to act in his/her interest. The conflicts that can arise in such a situation and the incentive schemes that can be used are analyzed in agency theory. The underlying fundamental assumption is that each individual maximizes her/his utility.

As mentioned above, the contract between stockholders and manager gives rise to costs. One cost is the principal's cost for monitoring the agent. The agent incurs another cost in the efforts to guarantee the principal that he/she will not deviate from the principal's interest. The third cost is the principal's welfare loss which occurs since the agent will take some decisions that will lower the principal's expected utility (a total monitoring of the agent is impossible due to high costs). Since it is impossible to write contracts between the principal and agent that cover fully the operations of a large firm, most contracts leave plenty of room for the manager to act in his/her own interest, instead of the stockholders'.

A manager with only a salary contract will not incur any loss of capital in deviating from the interest of the stockholders. The level of the salary would be the same. Making the manager a stockholder is a method often used to increase the manager's motivation to act in the stockholders' interest. Unfortunately, this also creates problems. Just think of the manager working in a company sensitive to the exchange rate between the Swedish Crown and the US dollar. If a major change in that exchange rate takes place, the profit of the company can change substantially but caused by a factor beyond the control of the manager. This type of problem is mentioned by Holmstrom and Tirole (1989), and they argue that it should be solved by measuring managerial performance against competition as well as general economic circumstances. Schemes which explicitly compare management performance with competitors are in fact becoming more popular in the US.

A shortcoming of convertible bonds and other firm specific instruments as tools for solving agency costs are that they are hard to relate to external factors. A mix of a salary contract, which contains measures on external factors, and convertibles seems to be appropriate in this sense. Holmstrom and Tirole (1989) mention index options as an alternative, where the exercise price is contingent on industry or economy-wide circumstances.

2.3.2 The framework of financial innovations

The field of financial innovations is attracting a lot of attention from researchers today. Since this is a study of convertible bonds, those parts of financial innovation theory treating the emergence and spread of other more exotic instruments are left out. Finnerty (1992) provides a good overview. The use of the word innovation in this context is somewhat diffuse. Levitt (1966) defined an innovation to occur only when something is entirely new, having never been done before. After the first issues of convertible bonds to employees, it would hence be more appropriate to view the rest of the issues as product imitations.

Certainly there has been a lot of innovations, but how does one define a successful one? Miller (1986) defines a successful, significant innovation to be an innovation that survives and grows after the initiating force (for example, a deregulation) has been removed. It must also reduce dead-weight transaction costs and expand the reach of the market. What are then the causes of financial innovations? Miller (1986) expresses the following opinion: "*The major impulses to successful financial innovations over the past twenty years have come, I am saddened to have to say, from regulations and taxes*". Not that there were many new regulations imposed during the last twenty years in the US. It was just that the recovery in world economic development and trade made the old laws and regulations increasingly binding, particularly so given the surges in the level and volatility of interest rates, exchange rates and prices during the 1970s and 80s. The old laws were not binding in the slow growth economy of the war and the slow recovery years that followed. In that situation, the regulatory and tax constraints were not the most seriously binding constraints.

Merton (1990) assumes that the systematic driving forces behind financial innovations can be divided into three categories: (1) demand for "completing the markets" by providing opportunities for hedging, risk-pooling, risk-sharing and intertemporal or spatial transfers of resources that are not currently available; (2) the increasing of liquidity or the lowering of transaction costs; (3) reduction in agency costs caused by either asymmetric information between trading parties or principals' incomplete monitoring of their agents' performance.

In the Miller (1992) article the following reasons for the development of financial innovations are given: The move to floating exchange rates, new computer and information technology, that the burst of innovation in the 1970's was merely a delayed return to the long run growth path of financial improvement, and world economic growth. These reasons

combined with the regulation reason mentioned above triggered the burst of financial innovations.

Of the reasons for financial innovations, we believe that the following ones were the most important ones for the development leading to the spread of convertible bond issues to employees in Sweden: (1) The number one reason was the overall growth in the world economy and the period of growth in the Swedish economy that started in the early 1980s. (2) The growth of the Swedish stock market, which was caused by several events. Some important ones were a tax subsidized program for saving in stock funds, a couple of devaluations and several tax changes. (3) The deregulation of the banking sector. (4) The technological development which led to more instruments[3], thus meeting the market's need for risk-sharing and hedging. (5) The ongoing need for solving agency problems, such as monitoring, rewarding and controlling the agents. These reasons are important, but certainly not the only ones. However, they provide the setting for the emergence of the convertible bond issues to employees, and they clearly show that agency theory is only part of the story of convertible bonds.

In the following, the focus will be on one model for explaining the emergence of a financial innovation. This model is the regulatory dialectic framework, developed by Kane. His framework is very interesting, since it emphasizes and incorporates regulations imposed by government and other regulatory institutions. His model is very attractive to us since the Swedish financial market has been heavily regulated. Also, several changes in capital gains tax, in company tax, and personal income tax have taken place during this period.

Kane's (1977, 1981, 1983, 1984) framework of the regulatory dialectic model works by interpreting a cyclical interaction between political and economic pressures in regulated markets. Political processes of regulation and economic processes of regulation avoidance are treated as opposing forces that continuously adapt to each other. In this framework, a stationary equilibrium is virtually impossible, since there are repeating stages of regulatory avoidance and re-regulation. This process is not continuous. It is more in the form of lagged responses. Since there are differences in the capacity for creative adaptation of regulators, regulated institutions, and unregulated competitors, avoidance lags tend to be shorter than

[3] Technology in the sense of both hardware and software, where the software is the modern form of option pricing theory (CCA), which provided the production technology for sophisticated and tailor-made financial instruments.

regulatory lags (Kane 1983). He also argues that when structural changes in regulated markets kick off the game, the sequence becomes one of innovation, re-regulation and avoidance. The hypothesis is that the second and third stage in any sequence could be interpreted as the first step in a new sequence.

In the framework of the regulatory dialectic, financial innovations are driven by regulated and unregulated institutions' adaptation to observed changes in their markets, technological and regulatory constraints, and by regulatory bodies' adaptation to ensuing changes in their opportunity sets. Innovations are an effect of the adaptation to regulations.

One good example is the one percent transaction tax imposed on financial instruments traded on the Stockholm Stock Exchange on January 1, 1984. On January 1, 1986, it was raised by one percent to two percent. After the tax was imposed, the turnover on the Stockholm Stock Exchange decreased. The trading in Swedish stocks moved to other financial markets, mainly London. In 1991, the trade in Swedish stocks in London and on NASDAQ was 30 percent bigger than the trade in Stockholm for the same stocks (the Stockholm Stock Exchange 1991, p. 14). On January 1, 1991, the transaction tax was slashed to one percent. On December 1, 1991, it was abolished. Trading on the Stockholm Stock Exchange has increased considerably since the tax was lowered and eliminated.

It is quite clear that Kane's framework fits the convertible bond issues to employees in Sweden well. The deregulation of the financial market was necessary for the emergence of convertible bond issues to employees, since they were not allowed in Sweden before 1973. Several changes in the tax system have taken place since then, and the latest one (a re-regulation in the vocabulary of Kane), the income tax law passed 1990, caused the market for convertible bond issues to employees to decline fast. Other instruments such as warrants and options have become more interesting (see for example Affärsvärlden 15 1990, pp. 64-65).

Kane's framework is especially valuable for explaining why the companies used convertible bonds instead of other possible instruments. The changes in personal income tax which have been made so many times in Sweden, ending up with a marginal tax rate of 85 percent for high income employees (in the late seventies), intensified the search for means of rewarding employees in ways other than cash payment. One could then view the issuing of convertible bonds as avoidance, in the sequence of regulation, avoidance and re-regulation. One important condition for convertible bond issues to employees was the growth of the

financial market. That growth was not only due to different de-regulations, but they were important. The decline of issues in the early 90s is clearly an effect of a re-regulation in the form of the new personal income tax law passed by the parliament on January 1, 1990. The law makes it less profitable for employees to participate in convertible bond issues.

As stated earlier, the heavy use of convertible bond issues to employees could be viewed more as imitation rather than innovation. In the business community, a strategy often used is to watch and wait. After the success of the first issues, it was clear that others would follow. The spreading of convertible bonds can not be explained only by financial innovation or agency theory. It seems that the concept of product imitation also has some relevance for that spreading.

2.4 Employees as stockholders

Having employees as stockholders in the company they work for has been the goal of many company boards and managers. A convertible bond issue is one way of reaching that goal. When studying convertible bond issues to employees, the connection between such issues and the "Pilot school" has to be discussed (the "Pilot school" is described in the following section). The motive for employee issues is to get as many employees as possible to become stockholders in the company. The motive for the "Pilot School" coincides with this motive to some extent, as well. Representatives for various groups of stockholders express different views on "Pilots" participating in employee issues.

The Swedish Shareholders Association (Aktiespararna), which represents small stockholders in Sweden, has given recommendations on convertible bond issues to employees, both the management and all other employees. Regarding "Pilots", the Association argues that they should not be given any discount when offered convertible bonds. "Pilots" should pay the market price for the instrument, but broader groups of employees should be offered some discount on an issue (Flodhammar 1991, p. 35). The Association also recommends that the size of the allotment should not be bigger than a half year's wage. Wallander (1989, p. 15), who can be viewed as a representative for the top management, says that it would be better for all groups if the "Pilots" were allowed to buy at a discount and get much bigger allotments, since their work has a greater impact on the companies' results than the work of common employees. Wallander also views the board of

directors as "Pilots" who should be permitted to participate in the employee issues. This view is not shared by the Securities Council (Aktiemarknadsnämnden) and the Swedish Shareholders Association. These two organizations view the board members as having a controlling function, therefore not being "Pilots".

The unions are a very powerful group in Sweden. In Gelin and Sundström (1990), the views of the union Svenska Metallindustriarbetarförbundet (Swedish Metalworkers Union) are referred to. This union is clearly against convertible bonds, since the savings of the employees will be dependent on the success of the company they work for. Another argument against employees holding convertible bonds is that the solidarity between workers in different groups and companies could suffer relative to the commitment to their own companies. The union emphasizes that the most important factor for creating a feeling of affinity is the content of the work.

Wallander (1989, pp. 8-9) sees a deeper motive for the spread of ownership to employees. He thinks that the excellence of the free market system can not be accepted in broader circles, if economic gains only benefit a few persons. Hence, it is a problem that so few persons are holding shares. Increasing the number of stockholders in society will create legitimacy and acceptance for the superiority of the free market system. This makes it natural for a CEO to work for a broader ownership of the company.

A severe misconception by Wallander (1989, p. 25), which he shares with many others, is to view the huge amount of convertible bonds to employees as a spread of stock ownership in society. Technically, convertible bonds have no rights, such as voting power, the right to participate in the general meeting, and the right to be represented on the company board. To put it bluntly, convertible bonds give no influence at all. This lack of influence makes it very hard to view convertible bond holders as stockholders. There is no study which provides evidence on increases in the number of stockholders through these issues. The design of the employee issues, with bank loan financing, made it very interesting to sell the shares obtained through conversion (or part of them) and pay back the bank loan. The implication is that most employees sell quite soon, since they view the convertibles as money earned and not as a commitment to become stockholders.

A condition for becoming a stockholder is obviously that conversion takes place. If the stock price is below the nominal value of the convertible bond, no one will convert. In other words, the new stockholders are only fictitious until the outcome of the convertible bond

issue is clear.

2.4.1 The Swedish "Pilot school"

The underlying idea behind the "Pilot School" is agency theory. The application of the "Pilot School" seems to have been of great importance for the emergence of convertible bond issues to employees. Therefore, a description of the "Pilot School" will be now given.

2.4.1.1 Definition of the "Pilot School"

It is not entirely clear what is meant by the expression "Pilot School" and who can be said to be a "Pilot". Eriksson (1992) collected statements from various sources and found the following. Those advocating the "Pilot school" argue that the leader of the company should have shares in the company. The reasons for this are (freely translated from Swedish):

- A person holding stock in his/her own company can see the operations from two points of view - as a CEO and as a stockholder.
- The shares are valuable as an incentive.
- The holdings show confidence in the company and give a good image to the company.
- It is the closest you can get to a self-employed entrepreneur.

A quote from the early eighties that Eriksson (1992) has found goes like this *"the Pilot should be in the plane and not on the ground"*, meaning that the CEO should be in the same situation as the other stockholders. This view has been accepted broadly, and in March 1991 only 9 of 118 of the CEO's in the Swedish listed companies (AI and AII lists) did not hold shares in the companies for which they worked (Eriksson 1992).

A corner-stone of the Pilot School is the risk taken on by owning stocks. A quote on the matter goes like this: *"to buy options in the company is not a whole-hearted application of the Pilot School, since you do not put up any money of your own in the beginning"*. The person cited above views the convertible bond issues as an application of the Pilot School, even if the issues are aimed at the work forces.

The Leo commission was set up by the government to investigate the facts of the so

called Leo affair and to express an opinion as to what measures should be taken because of problems relating to company law and ethics evidenced in this case and similar ones. In the report of that commission (Ds Fi 1986:21 1986), the Pilot School is defined as the belief that the top management will work better in the interest of the stockholders and remain in the company longer, if it has a stake in the company and can benefit economically from this stake if the company is performing well.

2.4.1.2 Who is a Pilot

In some contexts it is unclear who is to be viewed as a Pilot. In the view of the Leo commission, it seems to be the top management of the company. Wallander (1989) mentions the CEO and other Pilots, and views the board of directors as advisory Pilots. In Eriksson (1992), several sources express the view that the Pilots are the individuals at the top level of management, and that the CEO is the person that is mainly thought of as the Pilot.

2.4.1.3 Arrangements of ownership for the Pilots

The management's stake used to be in the form of company shares. When convertible bonds and options appeared on the Swedish capital market, these types of instruments were frequently issued to the Pilots as well. The increase of the use of the Pilot School in the last twenty years is mainly due to the tax system. In the 70s, it was not uncommon with a marginal tax rate of 85 percent for individuals with high incomes. This made it very interesting for the companies to find different types of fringe benefits. Ownership in the company was one good fringe benefit (Wallander 1989). In the form of shares, it was very favorable in a tax perspective before the big changes of the tax laws in the 80s. Since all interest costs for bank loans were deductible in the income tax form before the changes of the tax laws, shares bought for borrowed money were mainly used. The company arranged the bank loans, and sometimes the major owner sold the shares to the management at a discount. One must also remember the effect on the bank loans of the huge inflation in Sweden during this period, which in effect financed the purchases of the shares.

After the changes of the tax laws in the 80s (lowering the marginal tax on income), convertible bonds became very popular, since if the stock price did not rise, the holder did

not convert. The holder only lost the non-tax deductible part of the difference between the interest paid on the bank loan financing the convertible bond and the convertible bond coupon.

This discussion of the Pilot school has focused on the rewarding effect. This effect is hard to distinguish from the motivation effect, namely that the management should be motivated to work in the interest of the stockholders. One problem with management holding shares in their own company mentioned by Wallander (1989) is the effect on the stock price of factors not controlled by the management. If the stock price goes down, they will not get a reward for their hard work. And if they have big bank loans, they have to worry about the cost of the loans. This problem of management holding shares can be avoided to some extent by using convertible bonds or options. Since a company in Sweden by law is not permitted to sell options on its own stock, options are issued to the Pilots by a big private owner, or by a company in the same sphere of companies.

Wallander (1989) argues that the rise of the Pilot School is due also to factors other than the belief of the stockholders and board members that this type of arrangement is good for the company. He argues that there are also equality reasons behind the rise. The potential Pilots know other Pilots and want to benefit from similar arrangements, as well. Fair rewards for the effort that the management puts into its work is another argument that Wallander (1989) refers to. This is an argument that the company board has a hard time to counter, when presented by a manager, since the board wants to be fair to the management.

2.4.2 The relation between the convertible bond issues to employees and the Pilot School

It is quite obvious that the Pilot School has had some importance for the spread of the convertible bond issues. The following evidence can be presented. Since Wallander can be viewed as a strong representative for the Pilot School, his statements must be considered as important. Wallander (1989, pp. 15-16) argues that in the interest of the company's stockholders, the convertible bond allotment to a Pilot should be of a size which has a great importance for the Pilot's economic situation. He also claims the same for the board of directors.

The size of the allotment of convertible bonds to the management is in many cases much bigger than that to other employees. Examples are Trygg-Hansa (Dagens Industri March 2,

1989), Saab-Scania (Saab-Scania 1988a), and Munksjö (Munksjö 1987). The examples show that in many cases the Pilot School has been applied in connection with these convertible bond issues to employees. It is hard to judge if the desire to reward the management is the main reason for the issues or not. There are also companies which use equal allotments independently of the position in the hierarchy of the company. Volvo is one example (Anell 1989, p. 113). In SCA, the equal allotment was due to oversubscription, which made the highest allotment 69,930 SEK. If it had not been for oversubscription, three members of the top management could have obtained an allotment of 1,984,500 SEK each if they had subscribed to it (Sundström 1991).

Apparently, the Pilot School can not be neglected as an explanation for the rapid spread of the convertible bond issues. Also, the benefits of convertible bonds were greatly improved by the tax system. The costs to the company and the manager were much lower than for other ways of paying the manager: The company does not have to pay the employer's contribution to social charges (approximately 65 percent of the wage), the manager does not have to pay the marginal tax (50 - 85 percent on the wage, the exact figure depending on what year we are referring to). The convertible bond coupon is a tax deductible cost for a company. This is also a strong argument for the company to issue convertible bonds instead of stocks, for which the dividend is not tax deductible.

2.5 Laws and recommendations concerning convertible bonds

A description will now be given of the tax laws and recommendations that have relevance for convertible bonds on the Swedish market. These laws can been seen as a product of the growth of the market and the new financial instruments that have appeared on the scene. As with most of the laws governing the business community, the laws are often an effect of events that have been attracting the interest of the public and the government. There has certainly been more legislation concerning the financial markets than what is described here. Since this dissertation is about convertible bonds, the focus is on the laws that have relevance for the convertible bond issues, mainly legislation that has appeared since 1985. First, a background of the laws is given. Then the work of the Leo commission is described, and the law related to that commission. After that, a description is given of the various laws and recommendations that are of interest for issuing convertible bonds.

2.5.1 Background for the tax laws concerning convertible bonds

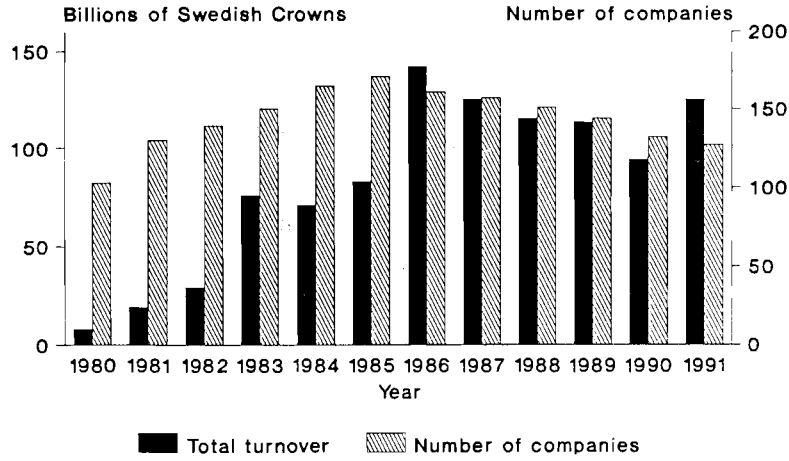
The growth of the Swedish capital market started in 1980. It was a tremendous growth that lasted into 1987 (see Figure 2.1). During this period, a lot of events took place that caused a great deal of attention from the public. One important event was the so called "Leo affair", which made the government set up a commission in January 1986, called the Leo commission. As a result of this investigation of stock issues to the top management of the Leo company, a law was passed on July 1, 1987, regarding the ethics and handling of issues to employees and board members of Swedish companies. This law concerns listed companies and companies that are to be listed later on. Since the work of the Leo commission and the resulting law is of relevance for convertible bond issues in Sweden, it will be described below.

2.5.2 The Leo investigation

The main reference in this subsection is the complete report from the Commission of Inquiry (called the Leo commission). The report (Ds Fi 1986:21 1986) is called "Targeted issues of stocks and related matters" (Riktade emissioner av aktier m.m., in Swedish).

The purpose of the work of the commission was to investigate a particular affair, the Leo affair, and to give suggestions on what measures should be taken regarding company law and ethics, with respect to the Leo affair and similar cases. The Leo affair concerned the handling of a targeted issue of shares by Leo AB (the decision to undertake the targeted issue was taken by a general stockholder meeting) to the top management and board members of the company Wilh. Sonesson AB. This company had bought Leo AB from a Danish company shortly before. This targeted issue was undertaken before Leo AB became listed. The targeted issue comprised a value of 169 MSEK. Of this sum, 57 MSEK was subscribed to by 25 private investors. Among these investors were the managing director of Leo, the managing director of Sonesson, the deputy managing directors both of Leo and Sonesson, and managers of subsidiaries of the two companies. A couple of these investors bought stocks for 10 MSEK each. This took place in November of 1983. The median price paid for the Leo stock when it was introduced on the Stockholm Stock Exchange in late 1985 represented a value increase of approximately 17 MSEK for an investment of 10 MSEK.

Figure 2.1
Size of the Swedish Stock Market
AI and All Lists



Source: Stockholm Stock Exchange
Annual Reports 1989, 1991.

The public debate focused on an alleged advantageous stock price in the targeted issue in 1983 and on the fact that the group of persons who received stocks in Leo was too large and that the allotments were unacceptably large in several cases. The critics viewed this as unethical and claimed that the stockholders of Sonesson were caused damage by this. Some other features of the targeted issue also encountered criticism.

The findings of the Commission were that the handling of the issue seemed dubious in the way it was aimed at persons belonging to the management of Sonesson. They also found the amount of each allotment very substantial. The fact that the management of the Leo company took part in the targeted issue could not be considered to deviate from common practice within the industry at that point of time. However, the allotment seemed remarkably large. The Commission was also of the opinion that the information concerning the issue given to the stockholders by the board of directors was too sparse. The management of Sonesson was also criticized by the Commission because the board of directors was not informed about an irrevocable offer from the Yggdrasil company to buy back the targeted issue from the private investors at the issue price. This offer was valid until March 30, 1986.

2.5.3 The Leo law

The report of the Commission of Inquiry concludes with recommendations for a new law to ensure that decisions on share issues and similar transactions (for example, convertible bond issues to employees) are carried out in such a way that minority interests can be safeguarded, and to ensure that stringent information be given both before and after such decisions. The law was taken in 1987 (Prop 1986/87:76 1986) and applies to listed companies and their subsidiaries. The main rules of the law are as follows:

The law applies to targeted issues of new shares, convertible bonds, and debenture loans with stock options to employees in general, officers in executive positions, or directors of the issuing company or a company belonging to the same group of companies. The law also applies to relatives of the individuals just mentioned. The law states that a parent company can not decide on a general meeting of an unlisted subsidiary to implement an issue of the kind referred to earlier, unless it has been passed on a general stockholder meeting of the parent company. The law also states that a general stockholder meeting of the company has to make the decision on issues of the kind mentioned above. The decision on an issue can be approved afterwards. No authority can be granted to the board of directors to decide on these matters.

In the notification to the stockholders of the general stockholder meeting to decide on an issue of the kind mentioned above, the complete terms of the issue must be presented. A decision on a targeted issue can only be passed by a prescribed majority. In this case, a prescribed majority is at least nine tenths of both the votes of the stockholders at the meeting and of the shares represented at the meeting (nine tenths of the votes of the stockholders and nine tenths of the shares represented at the meeting are not necessarily the same).

2.5.4 The capital gains tax law of 1985

As with many other things in Swedish society, the issuing of convertible bonds is closely related to the tax laws. The tax law regarding taxation of capital gains on convertible bonds has changed twice, July 1, 1985, and January 1, 1991. On January 1, 1990, a new income tax law became effective, including rules on convertible bond issues to employees. The greatest impact of the tax laws can be traced to the indenture provisions of the convertible

bonds. Two important factors, depending heavily on tax considerations, are the price of the issue and the length of the time period before the start of the conversion period. In the following, we describe the two tax laws, the capital gains tax and the income tax law, which are of importance for convertible bond issues.

A new capital gains tax law became effective on July 1, 1985. Before this tax law, convertible bonds were taxed as ordinary property. In this tax law, the rules concerning taxation of convertible bonds were made equal to the corresponding rules for taxation of shares. According to this law, the conversion into shares itself does not trigger any taxation. Only when the convertible bonds or the shares obtained by conversion are sold does taxation take place. 100 percent of the gain is taxable, if the convertible bonds have been held for *less than two years*. If they have been owned for *more than two years*, 40 percent of the gain is taxable. All transaction costs are deductible.

The two year limit for 100 percent taxable gains had the effect that the majority of convertible bond issues were designed so that they could not be converted until two years had passed. Hence, they could hardly be sold before two years. This was in the interest of the issuing companies, since they viewed the convertible bonds as an investment over a long time horizon. There was generally no trade in these issues during the first two years. The two features of an employee issue (the grace period of two years before conversion and the fact that it was not listed) made it more risky in the sense that it was difficult to sell. (As mentioned before, the companies issuing convertibles were so convinced of the success that they never thought of the bad liquidity as a risk for the participants).

2.5.5 The new capital gains tax law of 1991

A new capital gains tax law became effective on January 1, 1991 (Aktiespararen 1/2 1992, p. 29). This tax law made the time horizon for the holding of a security unimportant. The tax will always be 30 percent of the gain from selling a security, independent of the holding time.

2.5.6 The new income tax law of 1990

A new income tax law was passed on January 1, 1990. The new tax law among other things

concerns convertible bond issues to employees. As a background, the following may be mentioned: At the point of time when the proposal for the law was written (1989), the estimated unrealized gains on convertible bonds issued to employees were about 9 billion Crowns. The government wanted to tax such gains.

The tax law states that the employee has to pay income tax on the difference between the market value and what he/she pays for the convertible bond (Prop. 1989/90:50 1989). If there is no market value available, a *computed market value* should be used. This computed market value should be established by some model used by the capital market. When the instrument is sold, the holder should use the amount which he/she paid when he/she bought the instrument plus the amount on which he/she paid tax, as a deductible cost when capital gains are calculated. To summarize, if the issue is bought at a price under the computed market value, the employee could end up paying tax twice. First, income tax at the time of issue; and secondly capital gains tax when the instrument is sold.

An exception from the law is that an employee does not have to pay income tax if the issue is also aimed at investors in general and the allotment is less than 30.000 SEK. In this case, the total issue after conversion has to be less than 20 percent of the outstanding total number of shares, and the company must be unlisted when the issue is launched.

In an official investigation which eventually led to the new tax law (SOU 1989:33 1989), a discussion is carried out regarding the valuation of convertible bonds. In this discussion, the main determinants of convertible bond value are mentioned. In this respect, the analysis is good and quite exhaustive. What is striking is the lack of insight that bankruptcy can occur. This is a severe shortcoming. In the discussion, the Black-Scholes option pricing formula is mentioned. From the context, one can conclude that reference is made to a pricing model with a fixed time horizon, i. e., conversion can only take place at maturity. This is a fairly simple form of valuation. It is not documented that this is the model used by the market. On the contrary, it seems from available sources that a variety of models for valuing convertible bonds are used.

2.5.7 Recommendations regarding convertible bond issues

Various rules and recommendations regarding the handling of convertible bond issues and related matters have emerged over the last decade. According to Flodhammar (1991), the

following organizations have given rules and recommendations concerning convertible bond issues:

- Stockholm Stock Exchange (Stockholms Fondbörs)
- Financial Supervisory Authority (Finansinspektionen, f.d. Bankinspektionen)
- The Swedish Industry and Commerce Stock Exchange Council (Näringslivets Börskommitté)
- The Swedish Shareholders Association (Aktiespararna)
- Securities Council (Aktiemarknadsnämnden)
- Trefond Invest

In the following, a description is given of the relevant rules and recommendations (Ds Fi 1986:21 1986; Flodhammar 1991). A company which is to be listed on the Stockholm Stock Exchange has to sign a registration contract. This contract specifies that in the release to the press regarding the closing of the books, the company has to inform about any proposed issue of convertible bonds. The company also has to inform the Exchange at once when a decision to issue convertible bonds has been taken. It also has to specify at which group it is aimed.

The Financial Supervisory Authority has formulated a recommendation for the contract between a broker firm and a company which wants to be listed on the Over the Counter list. This recommendation is similar to the registration contract of the Stock Exchange.

The Swedish Industry and Commerce Stock Exchange Council (henceforth abbreviated SIC) has given recommendations regarding different matters which involve convertible bond issues. One recommendation concerns prospectuses for stock and convertible bond issues in unlisted companies where the public is to participate. The recommendation states that the complete conditions should be presented. A complete list of all issues in the company capital structure should be given. Furthermore, information should be given on the number of new shares that will be created upon conversion or when options are exercised. Board members and the top management's holdings of shares, convertible bonds and options should be specified in the prospectus. For take-over bids and mergers of companies, SIC issued a recommendation regarding the content of information that should be given. Among other things, information should be given on size and voting power of the buyer's holdings of

shares, convertible bonds and options in the target company.

The Swedish Shareholders Association has given the following recommendations regarding convertible bond issues to employees in a document dated September 8, 1988 (Flodhammar 1991, p. 34). In particular, certain information should be given in the notification of the general shareholder meeting which is to decide on the convertible bond issue to employees.

- Information should be given about to what categories of employees the offer is made, and the maximal amount of participation of the different categories.
- If the board members are allowed to participate in the issue, the conditions for them should be specified.
- Information on the conditions for the convertible bond should be given so that a market value can be estimated.
- The dilution factor for both the number of shares and voting power should not be more than 5 percent.
- Issues of convertible bonds that result in shares with strong voting power should be avoided.
- New employee issues of convertible bonds should be avoided as long as there are still outstanding employee issues in the company.
- The indenture provisions should be designed in such a way that the estimated market value does not differ much from the issue price. Under the condition that all employees are allowed to participate, and that all participants get the same allotment, the rebate could be around 5-8 percent.
- The top management should not be allowed any rebate.
- If there is to be any difference in allotment, the size of the yearly salary could be the criterion for the difference. Half the yearly salary should be the maximum allotment.
- If an employee does not participate up to the whole allotment, the remaining part should not be used by other participants.

In 1986, the Securities Council was set up by the Federation of Swedish Industries and the Stockholm Chamber of Commerce. The Securities Council has given some guidelines regarding convertible bond issues to employees (Flodhammar 1991, p. 35). The notification

for the general meeting which is to decide on a convertible bond issue to employees should contain the following:

- The size of the issue.
- Who has the right to participate.
- The nominal value of the convertible bonds, issue price, coupon and coupon date.
- Conversion period and conversion ratio.
- The increase of the stock capital upon full conversion.
- Dilution factor with regard to stock capital and voting power.

In the notification, the division between different categories of employees should also be clear and what different rights to participate they have. In 1989, the Council gave some further recommendations regarding employee issues of convertible bonds (Flodhammar 1991, p. 36):

- The dilution effect on stock capital and voting power should not be more than five percent.
- The price of the issue should be in accordance with some theoretical value estimated by a commonly used valuation model. This value could be adjusted for liquidity effects or other similar features.
- The amount of each employee's participation should not be more than half the yearly salary.
- Members of the board of directors should not participate in employee issues. If they are to participate in an issue, the decision on this should be taken by a general stockholder meeting. The participation of an individual board member should not be bigger than that of an employee.

Trefond Invest also gave recommendations which were similar to those given by The Swedish Shareholders Association.

In these laws and recommendations, there are further aspects of importance for convertible bond issues to employees. Since Flodhammar (1991) has studied those aspects from various points of view, reference is made to his study for more details.

2.5.8 Violations of the recommendations

It is quite clear that the recommendations from the Securities Council and other organizations mentioned above have had some deterring effects. However, a recommendation is only a recommendation, and there have been cases where the issuing companies have not followed the recommendations. One example is the company Hufvudstaden, where the allotments were much bigger than recommended (Dagens Industri April 3, 1989). Even the Leo law has been circumvented and violated by some shrewd convertible bond issue designs (Dagens Industri June 21, 1989). Fabege's convertible bond issue in the company Portalen is regarded as one of the worst cases by the Swedish Shareholders Association (Dagens Industri September 27, 1989). The Leo law and the recommendations were violated in several respects. The conversion price was set to be 53 percent of the asset value (Portalen was not listed at the time of issue) instead of recommended 120 percent. The dilution factor was almost 18 percent instead of the recommended 5 percent. And the information on the issue was just a small footnote in the annual report. The division among the participants never became public, since the bank handling the issue took over the whole issue first and later divided it up among employees.

2.6 The features of a typical employee convertible bond issue

Most convertible bonds issued to employees in Sweden have simple features. For example, they do not have put and call provisions. This is quite natural, considering the fact that they are not primarily issued to obtain financing. For financing issues, put and call features can be very important (see Stein 1992). However, issues with call provisions do exist. One example is the SCA company issue. This convertible bond can be called by the company after five years (Sundström 1991, p. 21). SCA seems to be familiar with indenture provisions of this type, having issued convertible bonds as a financing device. One of their convertible bond issues is quite a complicated creation (see Jennergren and Näslund 1990; see also Appendix 2:2). This could explain why the company has a call feature in the employee issue.

For approximately half of the convertible bond issues, the coupon is fixed. For the rest of the issues, the coupon is tied to the Swedish diskonto. The diskonto is set by the Swedish central bank. It used to be that rate which governed most of the interest rates on bank loans.

After the deregulation of the banking system, it is more regarded as an indicator of the interest rate level i Sweden. For the employees participating in the different issues, it is not crucial if the coupon is tied to the diskonto or not. The bank loans which are provided with the convertible bond issues have an interest rate that is closely connected to the level of the coupon. If the coupon is fixed, then the interest rate of the related bank loan is fixed. The interest on the bank loan is 2-3 percent higher than the coupon on the convertible bond. This difference is deductible in the taxation of personal income.

The typical Swedish convertible bond issue to employees has a life time of 5 years. Conversion is not permitted during the first two years. The convertible bond is usually not listed during the first two years, in order to avoid "speculation" in the employee issue. The conversion price is commonly set to be about 15 percent above the stock price. The stock price in this calculation is established as an average during a period before the date of the decision to launch the issue (cf. employee prospectus of Skandinaviska Enskilda Banken 1988). Fourteen days of stock price observations were used in the case of Atlas Copco (cf. employee prospectus of Atlas Copco 1987). The employee usually pays the nominal value of the bond for the issue.

2.6.1 The design of a typical issue to employees

The designs of the convertible bond issues to employees are very homogeneous. It seems like the firms designing the issues are very few, and are inspired by each other. Flodhammar arrives at the same conclusion, too. He investigated 48 complete prospectuses. They where all very similar, the conditions being more or less standardized (Flodhammar 1991). Typically the banks involved in the convertible bond issue provide a loan to the employees enabling them to participate even if they do not have the money needed for participation in the issue.

Usually there are at least two documents regarding an issue. One prospectus is distributed to the employees. The other prospectus, with the complete indenture provisions and covenants, is used at the board meeting and the stockholder general meeting were the launch decision is taken. The prospectus is accompanied by the latest annual report or an extract of the most important data from the balance sheet.

2.6.2 Employee prospectus

The prospectuses to the employees are often written as a newsletter. As an example, a description will be given of Munksjö's prospectus (Munksjö 1987). The newsletter starts with the motivation for the convertible bond issue, that the stockholders want the employees to be more interested in the company and identify themselves with the company. The stockholders want the employees to have the opportunity to participate in future gains, through convertible bonds. A statement that the management will participate in the issue is also on the front page of the prospectus.

On the first part of the second page, the main features of the convertible bond issue are described. The priority rules are described. It is clear that if the performance is bad, the holders of the convertible bond will only be paid off after the debt. The word bankruptcy is not mentioned. It is also clearly stated that the company borrows the money from the employees. The conversion feature of the convertible bond is also explained, and when the bond matures. The coupon of this particular convertible bond is 9.5 percent annually.

On the second part of the second page, the arrangements with the two banks which finance the employee issue are presented. Information is also given on how the administration of the bank loan is carried out. The interest on the bank loan is set to be 13 percent annually. The design of the convertible bond is connected with the bank loan. The convertible bond coupon is paid out to a bank account. From this account, the interest on the loan is automatically deducted a couple of days later. This means that the holder only has to provide the difference between 13 percent and 9.5 percent and make sure that the money is available in the account on the day of withdrawal.

On page three, information is given about various details of the issue. This is done in the form of questions and answers. The questions are of the following kind:

- If I terminate my employment, could I still keep the convertible?
- When should I convert?
- What will I have to pay in tax?

In this fashion, most of the indenture provisions and covenants are explained.

On pages four and five, an explanation is given of the factors which determine whether

the issue will be profitable or not for the participants. A short overview of the following topics is given:

- How the stock price is determined.
- The company strategy.
- How the product mix has changed over the last years.
- Some important economic data calculated with help of the balance sheet.
- The advantage of participating expressed by a representative for the management and by two union representatives.

On page six in the prospectus, an example of the cost for the employee to participate is shown. The economic outcome under different scenarios is also described. On page seven, the various forms necessary for the administration of the issue are displayed. It is shown how to fill them out. On page eight, there is a list of individuals responsible for information. The rules for the size of the allotments are described. An ordinary employee can get a an allotment of maximum 34,000 SEK in the first round, and minimum of 17,000 SEK. If there is room for more, the maximum is 68,000 SEK. For different levels of management, the allotments increase. The chairman of the board, the CEO, and the treasurer can get allotments of 1,500,000 SEK each.

Differentiated allotments are fairly common in the prospectuses. This is also in line with recommendations that have been given by various organizations (see Subsection 2.5.7). Sköldebrand (1989, p. 51) found that the unweighted average of allotments was 72,000 SEK in 70 loans issued by companies with more than 500 employees during the period 1983 - 1988.

2.6.3 The prospectus for the stockholder meeting

The prospectus which is used as the basis for the board meeting and the general stockholder meeting has to meet certain requirements, specified in Chapter 5 of the company law (Aktiebolagslagen (abbr. ABL) 1975). In general, the conditions for the convertible bond issue have to be designed in such a way that the corporate by-laws do not need to be changed when conversion takes place. There is a provision that the maximum value of stock capital

can be at most four times the minimum value (ABL 1975, Chapter 2 paragraph 1:4). The company has to consider the new stock capital that can result from conversion, when it decides on stock dividends or new stock issues during the life time of the convertible bond issue.

In the documentation of the decision on a convertible bond issue, the following has to be specified (this rule concerns all types of convertible bond issues):

- The size of the issue.
- Who is entitled to participate.
- Notification of the period when the stockholders can make use of their right to participate.
- Subscription period.
- The nominal value of the convertible bond, issue price and rate of coupon.
- When payment of the issue is due.
- The handling of possible oversubscription.
- Time and condition for conversion.
- Creditors' rights if the stock capital is changed before conversion, if new convertible bonds are issued, or if the company is dissolved or merged.
- How much the stock capital could be expanded (diluted) through conversion.
- If there are different classes of stock in the company, it must be specified into which class of stock the convertible bonds can be converted.

The document should also contain the last three years' annual reports, and a presentation of the company. If the company belongs to a group of companies, the group should be presented. Information on the board members, management, and ownership structure should also be given. When the convertible bond issue is aimed at a broader class of investors (at least 200), and the issue size is at least one million Crowns, a prospectus for the specific issue has to be provided by the company. This rule is not applicable to small and unlisted companies. The decision to launch a convertible bond issue is to be taken by the general stockholder meeting. If the Leo law is not applicable, that meeting can give the right to decide on the issue to the board of directors.

2.6.4 Important conditions in the convertible bond prospectus

Legal aspects of the convertible bond issues are not treated in detail in this chapter. But there are some very important features of the indenture provisions in the prospectuses that must be mentioned, since they have had some effects on the economic outcomes of convertible bond issues.

In the standard provisions of Swedish convertible bond prospectuses, there are three paragraphs that should be noted. The first paragraph of these three states that if the company does not pay interest on time to the holders of the issue, the bank (that handled the issue) can force the company to pay back the whole nominal value of the bond. This paragraph could trigger a bankruptcy, where the convertible bond holders could lose the whole nominal value. The second paragraph is also very important from the perspective of the convertible bond holders, since in this paragraph the issuing bank sets itself as representative of all convertible bond holders in any legal dispute inside or outside court. This could have serious consequences for the convertible bond holders, since the interest of the bank and the convertible bond holders could diverge considerably in many situations. The third paragraph states the priority between different classes of instruments in the capital structure in the case of a bankruptcy. The convertible bond issue has the same priority as other bonds, i.e., after other loans but before shares of stock. In this paragraph, there is no provision regarding the company's right to take on new loans. This means that the convertible bond holders have no control of the development of the company's capital structure. Since the convertible bond holders have no voting power, the indenture provisions are extremely important.

A solution to the problem just mentioned, that the company can issue more debt without the consent of the convertible bond holders, would be to use a put option in the indenture provisions. We would then have an instrument called a puttable convertible bond. With such a convertible bond, the holders would have the right to put the bonds back to the issuer if the company were to increase its leverage above some stated threshold. A "poison put" option of this kind would protect the bond holders against the risk of too much debt in the capital structure.

2.7 Valuation models presented in various prospectuses

Most prospectuses for employee issues do not present any valuation model for convertible bonds at all. In some prospectuses for convertible bonds issued as a financing device, valuation models have appeared (for example, Finnveden 1986; Investor 1991; N&T 1988). The most commonly used model for valuing convertible bonds is one where the convertible bond value is the sum of a bond part and an option part. The value of the option part is calculated using some version of the Black-Scholes formula for a European call option.

In a prospectus from Investor (Investor 1991), two valuation models are presented in more detail. Although Investor's convertible bond issue was not an employee issue, these models could be viewed as representative of models used, especially since one of the banking firms involved in the issue, Enskilda Fondkommission (a subsidiary of Skandinaviska Enskilda Banken), has been involved in several convertible bond issues to employees.

The value of the convertible bond is the sum of a bond part and an option part in the two models. The formula for the bond part is the same for both models (Formula (1))

$$Bond\ value = \sum_{i=1}^{(T-t)} \frac{coupon}{(1+r_m)^i} + \frac{NB}{(1+r_m)^{(T-t)}}, \tag{1}$$

where

T = time of expiration of the convertible bond,

t = current time,

$T\text{-}t$ = remaining time in years until expiration of the convertible bond,

r_m = the market required rate of return,

$coupon$ = convertible bond coupon,

NB = nominal value of the convertible bond.

The first model in the prospectus for calculating the value of the option part is the following formula (2)

$$Option\ value = S - \sum_{i=1}^{(T-t)} \frac{q(1+k)^i}{(1+r_m)^i} - \frac{X}{(1+r_m)^{(T-t)}}, \tag{2}$$

where

S = stock price,

k = assumed yearly increase in dividend,

q = current dividend,

X = conversion price.

The option value in formula (2) is the forward contract value. For the option part in the second model, they use the following version of the Black-Scholes formula

$$Option\ value = S_q N(d_1) - Xe^{-r_f (T-t)} N(d_2), \tag{3}$$

where

$$d_1 = \frac{\ln\frac{S_q}{X} + (r_f + \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}}, \qquad d_2 = d_1 - \sigma\sqrt{T-t},$$

and S_q = stock price adjusted for dividends in the following fashion,

$$S_q = S - \sum_{i=1}^{T-t} \frac{q(1+k)^i}{(1+r_m)^i},$$

where

q = current dividend,

r_f = risk-free rate of interest,

σ^2 = variance on the stock return,

N = standard cumulative normal distribution function,

X = conversion price.

This type of valuation models depends heavily on the assumptions made. In the Investor prospectus, this is also expressed on p. 36, especially the assumption of a yearly increase in dividend.

2.8 A study of the outcome of convertible bond issues

We have found in the prospectuses and in other contexts, for example, the new tax law concerning convertible bond issues to employees (Prop. 1989/90:50 1989), that the bankruptcy risk of convertible bonds issued to employees is more or less neglected. However, as we now turn to the outcome of the issues, it will be seen that some of them have, in fact, been involved in bankruptcies.

The economic outcome should be measured over a longer time horizon, since a convertible bond has a long life time, usually five years. This study captures the perspective of a longer time horizon, since we have convertible bonds issued since 1984 in the sample. Since we are interested in knowing how many issues have defaulted, we study what has happened to the convertible bond issues to employees up until October 15, 1992. By way of preview, we have a population of 234 issues. In this population, 16 companies with 20 issues have suspended payments (and in most cases also filed for bankruptcy). The total nominal value of these issues is 515.4 MSEK.

2.8.1 Data

Data were obtained from prospectuses, annual reports and magazines and newspapers reporting about these issues. A search in the ownership records of a public authority (VPC) was also carried out. We concentrate on listed companies, or companies that have been listed. A few issues of unlisted companies are included in the population, as well as issues of some companies that never got listed before they filed for bankruptcy.

The overall aim was to identify and describe all convertible bonds issued to employees in Swedish companies in the last 10 years. We use the population of Sköldebrand (1989) as a starting point, since she argues that for unlisted companies with more than 500 employees and for all listed companies and companies previously listed, nearly all issues have been found. We have sorted out some convertible bond issues that were aimed at the top management and not to all employees of the companies. We define convertible bond issues to employees to be issues aimed at all employees in a company.

The main data source has been the annual reports for the companies. Since the annual reports have been audited, the credibility of the data must be regarded as high. Since errors

can never be avoided in printing, other sources have been used as well to check the data in the annual reports. A check for stock splits and stock issues has also been carried out.

2.8.2 Measuring corporate bond performance

To obtain a measure of the bankruptcy rate among the convertible bond issues to employees is our main concern. The risk of bankruptcy is an important factor to consider when investing in these issues. In addition, the investors in fixed-interest bonds generally have to consider the two other major determinants of risk in investing in bonds, interest rate risk and liquidity risk. For convertible bond issues to employees, the risk of default and the liquidity risk are closely connected, since the majority of the issues did not get listed during the first two years. Normally, the liquidity risk is mirrored by the spread. In the worst case scenario for a traded bond, the price could be bad in the sense that the spread is very big. For the employee issues, with no trade in the instrument, the default risk is even more important than for bonds which are traded, since they can not be sold or converted during the first two years. The banks handling the issues in some cases provided an unofficial market. If this was not the case, the holder had to wait until the conversion period started and then convert into shares and sell the shares.

A special case is Avesta's issue. For this issue, the indenture provisions stated that when the conversion period started, all convertible bonds were to be converted automatically. The loan that had been provided by the bank was to be paid back at that point in time. The broker firm that handled the conversion and the selling of the shares, for those convertible owners who wanted to sell their stocks immediately upon conversion, messed things up. The convertible bond holders lost money, since the stock price went down from 50 Crowns to 40 Crowns before they managed to sell the shares. The nominal value was 20 Crowns (Dagens Industri November 16, 1989).

For half of the convertible bond issues to employees in Sweden, the coupon is tied to the diskonto. The diskonto is changed in accordance with the changes in the interest rate level on the market. For these issues, the interest rate risk is not that important.

The bankruptcy risk and the liquidity risk are the two risks to consider. Since the liquidity risk is dependent on the bankruptcy risk, the focus will be on the latter. Using approaches to bond measurement from foreign and international markets can be difficult,

since the rating system is not used that much in Sweden.

According to Altman (1989), three approaches have mainly been used to measure defaults on bonds. One approach has been to measure the rate of default as the value of defaulting issues for some specific population of debt compared with the value of bonds outstanding that could have defaulted. The annual defaults are then usually compared to observed promised yield spreads in order to assess the attractiveness of particular bonds or classes of bonds. The second approach has been to compare default rates with ex-post returns to assess whether investors have been compensated for the risks which they have accepted. The third approach has been to estimate the default risk premium included in the price of a bond -- that is, the required risk premium -- and to compare that premium to the actual default experience of a particular quality class of debt.

Altman's own approach seeks to measure the expected mortality of bonds in a manner similar to that used by actuaries in assessing human mortality. This concept incorporates the possibility of redemptions, calls, sinking funds, and maturity. He measures the default rates for various classes of debt on a yearly basis. The default rate is the quotient between the amount of the defaulted bonds and the amount of the outstanding bonds. The purpose of his study is different from ours, but his approach is interesting. We have mergers in our population. In his case, there were no mergers, but sinking funds, calls and redemptions. We do not have any calls in our population but one redemption. With his measure, he found that low rated bonds earned healthy returns compared to higher rated bonds.

In our study, we focus on the total bankruptcy rate of convertible bond issues to employees. Since the employees normally invest only in one convertible bond, the most interesting feature is the probability of bankruptcy. We measure the bankruptcy rate by comparing the amount defaulted to the total nominal value of the issued bonds.

2.8.3 The outcome of convertible bond issues to employees

One of the most interesting questions regarding convertible bonds for the participants in the issues as well as the companies issuing them concerns the economic outcome of the issues. For the participants, the major measure of success is whether an issue turns out to be profitable, since it is supposed to be a reward for dedication and good performance. For the company a negative outcome could be bad. That is, it would create hard feelings among the

employees, if the stock price never reaches the conversion price. Also, it would not give the desired new stockholders. If the financing aspect of the issue were crucial for the company, the lower interest on the convertible bond compared to straight debt could be of some consolation.

2.8.3.1 Outcome of the issues up until October 15, 1992

The outcome of the issues is presented in Table 2.5, and is further analyzed in Tables 2.7 - 2.9. The outcome for the individual issues is listed in Appendix 2:1. We have identified 234 issues. For 23 of these, we do not have complete data, and 2 issues pertain to unlisted

Table 2.5. Outcome of convertible bond issues to employees in Sweden

Population	Number of issues	Nominal value (MSEK)
Total number of issues	234	17.957.3
Missing observations	23	203.5
Unlisted issues	2	6.8
Observed number of issues	209	17,747.0
Issues not expired	76	11,789.0
Expired issues	48	1,942.0
Mergers	64	3 ,461.6
Suspended payments and/or filed for bankruptcy	20	515.4
Redeemed	1	39.6
Total number of observed issues	209	17,747.0

companies. Altogether, we have data on 209 issues. The total nominal value of the 234 issues is 17,957.3 million Crowns (MSEK). Note that the nominal value in Table 2.3 pertains to issues in listed companies. Some of the issues in our population were issued by companies which were unlisted at the time of issue.

Taking a closer look at the 209 issues, 76 issues are still outstanding, having a nominal value of 11,789.0 MSEK. 48 issues have expired, and 64 have been involved in mergers.

The number of issues involved in some form of bankruptcy is 20 (16 companies), with a nominal value of 515.4 MSEK, as already mentioned earlier. We also have one redemption in the population. The complete figures are displayed in Table 2.5.

2.8.3.2 Issues not expired

The issues that have not expired yet are the most interesting ones, since the holders have to decide on how to handle them. For a holder, it is extremely important to consider the bankruptcy risk in the financial turmoil of today. If the company survives, the holder will at least obtain the nominal value of the convertible bond. However, the issue itself could

Table 2.6. Status of issues not expired by October 15, 1992

Stock price/nominal value	Number of issues	Percent
Higher than 1	6	7.9
At 1	2	2.6
Below 1	68	89.5
Total	76	100.0
Nominal value (MSEK)	11,789.0	

Note: At 1, the stock price is equal to the nominal value of the convertible bond.

trigger bankruptcy when it expires. Issues of the magnitude of hundreds of millions of Crowns will be especially vulnerable.

From Table 2.6 above, we can see that 76 issues of 209 are still outstanding, representing a nominal value of 11,789.0 MSEK. Only six of the issues have a ratio of the stock price to the nominal value higher than 1, and 2 issues are at par. For the rest of the issues, 68, the stock price is below the nominal value. For some of the issues, the economic outcome seems at best to be the nominal value. In some cases, the stock price has to go up by 500 or 600 percent to reach the conversion price.

2.8.3.3 Expired issues

For the issues that have expired, the economic results are very good. The average ratio of the stock price to nominal value was 2.8. Studying the different years one by one, the ratio is best in 1989 and then declining (see Table 2.7 below). For the issues expired in 1992, the

Table 2.7. Outcome of issues expired by October 15, 1992

	Number of issues per year					Total	Percent
Stock price/nom. value	*Before 1988*	*1989*	*1990*	*1991*	*1992*		
Higher than 1	4	6	5	9	5	29	60.4
At 1	0	0	0	0	1	1	2.1
Below 1	0	0	1	10	7	18	37.5
Total number	4	6	6	19	13	48	100.0
Average outcome	5.00	7.98	2.55	1.75	1.39	2.8	
Nominal value (MSEK)	12.1	75.2	292.9	1,251	310.8	1,942	

Note: At 1, the stock price is equal to the nominal value of the convertible bond.

ratio is 1.39. Only six issues out of thirteen turned out to be at par or better in that year. For 1989, all six issues were above par. The figure of 7.98 is quite astonishing: It means eight times the amount invested for issues with a life time of five years. The average size of the issues expired in 1989 was only 12.5 million Swedish Crowns, compared to an average of 23.9 millions for the issues expired in 1992. Of all the expired issues (48), 30 were above or at par.

2.8.3.4 Issues involved in mergers

As we can see, there are a great number of issues that have been involved in mergers. It is a well known strategy among investors in the stock market to search for merger targets when investing in stocks, since such a strategy may earn excess returns. For the holders of convertible bonds, the mergers have been very good. On average they were paid 2.11 times the nominal value. The nominal value of the issues involved in mergers was 3,461.6 million

Crowns. Among the 64 issues out of 209 that have been involved in mergers, 58 got more than the nominal value back. No issue was paid less than the nominal value (see Table 2.8 below).

Table 2.8. Price paid for issues involved in mergers by October 15, 1992

	Number of issues per year					Total	Percent
Stock price/nom. val.	*Before 1988*	*1989*	*1990*	*1991*	*1992*		
Higher than 1	15	18	12	13	0	58	90.6
At 1	0	1	2	1	2	6	9.4
Below 1	0	0	0	0	0	0	0.0
Total number	15	19	14	14	2	64	100.0
Average outcome	2.68	1.91	1.92	2.12	2.0	2.11	
Nominal value (MSEK)	483	1,453	373.1	1,074	78.5	3,461.6	

Note: At 1, the stock price is equal to the nominal value of the convertible bond.

The average price for the issues involved in mergers is around twice the nominal value for all years, except for mergers in 1988 and earlier, for which the average price is 2.68. The year with the most mergers was 1989, with 19 issues involved in mergers, with a nominal value of 1,453 million Crowns.

One important result of mergers is that issues in companies which later on encountered problems have been saved from bad performance, or even bankruptcy. One example is Saab-Scania, which was merged and delisted. Since then the company has made heavy losses on its car manufacturing. It is possible that this could have given the convertible bond holders severe problems.

In the above, we have not discussed the economic value of the coupons. The level of the coupon is very important. This is apparent considering the merged company FUNDIA (name changed to FUNDIA from Welbond). In the FUNDIA issue, the level of the coupon was astonishing. Due to the design of the issue, the coupons turned out to be very profitable. The coupon was set to 20 percent of the company's profit before write-offs and taxes, or at least 4 percent. This meant that the coupon rate was 80 percent 1988 and 100 percent 1989 (Sundström 1991, p. 124). This design was bad for the company, since these coupons were

ruled not to be tax deductible by the tax authorities (Dagens Industri February 10, 1989). Fundia's profit was round 110 MSEK in 1988. Since the convertible bond matures in 1997, this would have been a very expensive issue, if the company had not been merged.

2.8.3.5 Issues involved in bankruptcies

At the heyday of issuing convertible bonds, no issue had defaulted. The grim recent economic development has also taken its toll among convertible bond issues to employees, however.

When analyzing bankruptcies, redemptions and mergers must be accounted for in the analysis as well, especially in those cases where the convertible bond issues have been saved from bad performance through mergers and redemptions. For example, the Enator issue was saved by a merger (Dagens Industri April 18, 1990). Östgötabanken's issue was saved by an early redemption (Östgötabanken 1991).

That bankruptcy could occur and that the money could be lost seems to have been overlooked by most companies. The belief in success was total. For example, in the SCA issue to employees, there were 300 employees that signed up for 1,000,000 SEK each (Sundström 1991). Since the issue was limited to 350 MSEK and was divided equally among all employees willing to participate, they ended up with an amount far from what they signed up for. The maximum amount turned out to be 69,930 SEK each.

Another illustration of how the bankruptcy risk was overseen is provided by the package offered to the employees by the handling bank (this type of package was a standard feature of the convertible bond issues to employees, as already mentioned above). In that package, a loan was offered to participants who did not have the cash for participating. The bonds were accepted as collateral for this loan. Since most of the participants used the loans to finance their purchases, this had the effect in a bankruptcy situation that the bank providing the loan would have to get its money back from individuals who had also lost their jobs. (See for example Dagens Industri November 17, 1992.) A bankruptcy for a company with a convertible bond issue to the employees is apparently particularly devastating for the employees, since they lose their jobs as well as their money invested. The employees often lose the whole nominal value of the bond, since it is very difficult for an individual to participate in the negotiations that take place among the liability holders after a company has

filed for bankruptcy.

The LEO commission, which among other things examined convertible bond issues to employees on the Swedish market during the period of 1984 and 1985, was aware of the bankruptcy risk. This is clearly expressed on p. 113 (Ds Fi 1986:21 1986). The commission emphasizes the risk inherent in the convertible being the employee's only investment in financial instruments. If the company goes bankrupt, the employee loses both job and money invested in the company (in most cases borrowed money). The commission also mentions the fact that there are examples of previously successful companies that have gone bankrupt.

A closer look at the bankrupt cases reveals the following: A number of Swedish companies with convertible bonds issued to employees have suspended payments (and in most cases filed for bankruptcy). The issues that have been involved in some form of bankruptcy are displayed in Table 2.9 below.

The total nominal value of these issues is 515.4 million Crowns. Measured in percent of the total nominal value of the 209 issues, 2.9 percent have been involved in bankruptcies. Measured by the number of issues, 9.57 percent have been involved. Of the defaulted issues, one company which has suspended payments has been financially restructured, and its two convertible bond issues have been redeemed at nominal value. Most of the defaulted companies have been involved in the real estate market as constructors, owners or providers of financing. One company in the population has gone bankrupt after maturity of the convertible bond. This company is BGB, a real estate company, specializing in commercial properties.

The best situation for employees holding convertible bonds in a company that is suspending payments or filing for bankruptcy is when the management still has its convertible bonds left. If so, the management will do everything to obtain some value for the convertible bonds in a reorganization of the company. It is then possible to save some value, if the losses are not too big (cf. the Ostermans case, where the convertible bond holders got the nominal value back in the reorganization (Ostermans 1991)).

2.8.4 The rate of conversion among the issues

The rate of conversion is important for the issuing company, since it is a primary goal of a convertible bond issue to create new stockholders. Obtaining more equity in the capital

Table 2.9. Companies with one or several employee issues of convertible bonds which have suspended payments and/or filed for bankruptcy by October 15, 1992

Company	Year of issue	Year of default	Nominal value of issue (MSEK)	Stock price/ conversion pr. June 30, 1989	Outcome*
Andersons	1988	1992	40.4	1.26	
Betongbyggen	1989	1992	10.0		
Cabanco	1987	1992	14.3		
Cominvest	1987	1992	20.0	2.25	
Conata	1989	1992	60.0		
Fordonia	1987	1992	30.0	0.47	
Heron	1991	1991	53.7		
Infina	1987	1992	50.4	0.95	
Invent	1989	1992	35.0		
Kullenbergs (Avena)	1988	1992	29.0	1.98	
Kullenbergs (Avena)	1989	1992	27.0		
Medicus	1989	1991	25.0		
NLK-Celpap	1988	1992	25.0		All value lost
Nyckeln	1988	1991	25.0	1.52	
Obligentia	1989	1992	36.0	0.93	5,000 SEK/holder + 10% of nominal value back
Optimum	1986	1991	10.0	3.58	
Optimum	1987	1991	0.5	2.97	
Optimum	1987	1991	12.5	2.97	
Osterman	1984	1991	1.7	3.20	Nominal value back
Osterman	1986	1991	10.0	2.00	Nominal value back
Total nominal value			**515.4**		
Percent defaulted (of nominal value)			2.9		
Number of issues defaulted, in percent			9.57		

Note: *) Revised February 24, 1993. The handling of the bankruptcy filings is usually not finished. There are some court cases for which the outcome is unknown.

structure of the firm means that the firm can issue more debt. This holds for both employee issues (Sköldebrand 1989) and financing issues (Stein 1992).

The convertibles that should have been converted by our measure constitute only 21.8 percent (29/133) of the total number of issues not outstanding (209 observed issues minus 76 issues not expired equals 133). That is, only for 21.8 percent of the issues was the stock price above the nominal value of the convertible bond upon expiration. In this respect, it is not clear how to account for the cases which have been involved in mergers. Most of the issues involved in mergers have been paid in cash, so obviously there has not been any increase in the number of stockholders. Of the issues still alive (76), only 7.9 percent had a stock price higher than the conversion price on October 15, 1992. Conversion is not necessarily the same as many new stockholders, since it could be that a lot of these new stockholders sell out and realize their gains at once. This is a plausible scenario, since the bank loan financing these issues always expires at the same time as the convertible bond.

2.9 Conclusions

During the period when the massive growth in employee issues of convertible bonds took place, the Swedish economy experienced strong growth. The deregulation of the banking sector in the early eighties had the effect that there was an abundance of capital on the market. This capital poured into the financial market, real estate market, the market for art and all other markets where money could be invested. A lot of unlisted companies got listed during this period. The turnover on the stock market increased tremendously from 1980 to 1987. We could also witness the emergence of many new financial instruments as well as an option market in Sweden. Short selling of stocks has recently been permitted. This is the latest piece of deregulation that has taken place.

There are several explanations for convertible bond issues to employees. These are:

- Growth in the economy.
- A deregulation of the banking industry and financial market.
- Changes in the tax systems, both for companies and private persons.
- The desire in the business community to broaden the ownership of the companies.
- An affordable way of rewarding the employees, with favorable tax conditions, both

for the company and the employees.

- A stated interest in the business community to increase the commitment and feeling of affinity for one's own company.
- A typical product imitation.

When the first companies had issued convertible bonds, in some cases with great success, other companies followed soon. That this is a typical case of product imitation can be verified by several observations in this study. First, the formal prospectuses are more or less copies of each other. The only features that differ are the company name, size of the issue, the coupon rate and the timing of the issue. Secondly, even companies that already had a program (different from convertible bonds) for getting the employees to become owners issued convertible bonds to their employees as well.

There are other arguments for issuing convertible bonds as well. For many companies, it was important to acquire new stockholders since the shares had to be spread among a certain number of persons to enable a listing on the Stock Exchange. Convertible bonds to the employees was one way of hopefully obtaining more stockholders. One argument that was put forward in several cases was the need for getting the employees motivated for changes in the organization (in the case of Fundia's steel manufacturing plant in Halmstad, however, the changes ended with the employees losing their jobs). Convertible bonds issued to employees were also a type of financing that did not burden the ordinary sources of capital. In general, it can be debated whether the companies involved needed the money as a source of financing. Most of the companies issuing convertible bonds were financially successful at the time when the issues were launched.

If one studies the volume of the issues and the companies, the most striking feature is the number of unlisted companies that have issued convertible bonds. The problem with the unlisted companies is the participants' dependence on the company. The bonds could not be sold because there was no market. A theoretical value of the convertible bonds could not be obtained, since there were no listed shares or other traded liabilities. The explanation for the great number of issues in unlisted companies is that they planned on getting listed fast. That the employees participated to such a great extent, in spite of the risk, can be explained by the desire to make easy money. Also, the employees' willingness to show commitment stimulated the participation in the issues (the commitment argument was often used by

unlisted companies).

The massive spread of convertible bonds among employees created problems for the unions, since the employees could then be expected to feel more affinity for their company than for the union and union members in other companies. It could also have an effect on the attitudes towards private ownership and the understanding of the companies' need for profits.

The debate on top management ethics also got a push through the extensive use of convertible bonds, and the size of allotments to the top management. There is evidence that the employee issues have been used as an excuse by the board of directors for applying the Pilot School. The issues were a good and fairly cheap way of rewarding the management. They were also an elegant form for solving some of the problems of other instruments that could alternatively have been used for rewarding the management.

The debate also created some needed legislation and recommendations for handling the issuing of securities. One important recommendation concerned the size of the allotment (half the yearly salary). If one is reasoning in strictly portfolio terms (i.e., that an individual investor should normally invest in different instruments), even this figure could be too big, if the convertible bond is the only investment made by the employee. Most of the convertible bond issues were fully financed by bank loans. For an average worker, an investment in equity using only borrowed money is a big risk, since the worker increases the risk through the leverage. In the worst case the whole nominal value could be lost. The convertible bonds must be viewed as equity, since they rank (like debenture loans, if the company has such) after every other instrument in priority, except shares of stock.

This chapter shows that the risks of the convertible bonds as an investment have been neglected. The complete prospectuses (which were read by very few, if any, employees) have some provisions that must be regarded as very important. The first important provision was that the issuing bank could terminate the convertible bond issue for several reasons, without asking the holders of the convertible bonds. The second provision was that the bank had given itself the right to represent the convertible bond holders in any legal argument inside or outside court. The consequence was that the convertible bond holders would be represented in the case of bankruptcy by a party that could have other obligations to consider first. Convertible bond holders have no organization that can represent them, if problems arise. This is a risk associated with convertible bonds that has never been mentioned. The

third important provision was that the company could borrow as much as it wanted before the expiration of the convertible bond issue, without the consent of the convertible bond holders.

The tax law that became the result of these convertible bond issues (Prop. 1989/90:50 1989) can be viewed as a typical product of the socialist government. It is a very strange way of thinking that it is a taxable benefit of employment to provide risk capital for the company you work for. The reasoning on how to estimate a market value for a convertible bond is a naive form of reasoning. The appropriate way of imposing a tax on employee issues is to tax the realized gain. To tax a theoretical option value seems very strange.

Finally, this chapter has shown that there are a lot of factors to consider when a convertible bond is issued, both for the company and the participants. The bankruptcy risk must be considered more seriously. The size of the allotment should be viewed in the light of the participant's economic situation, since the convertible bond must be viewed as risk capital without any voting power. The buyers of a convertible bond issue should consider the indenture provisions carefully, since they determine the risk of the instrument in many ways. Convertible bonds must be viewed as risky, more so than they have been viewed before.

Appendix 2:1 A list of convertible bond issues to employees in Sweden.

Company	Categ.	Year	Size MSEK	Ratio 1989	Ratio 1992	Date of issue	End date	Stock price	Conversion price
Adamas Ind	M	90	7	0.72	1.09	88	94	41.5	38
AGA	A		230	1.03	1.13	89	960630	260	230
ASG	A		132	0	0.42	90	950621	55	132
Alfa Laval A	M	91	71.2	2.08	3.64	84	920131	282	77.5
Alma	A		8.432	3	1.00	87	921231	40	40
Andersons	E	89	10	7.69	5.90	830223	890228	342	58
Andersons	FB	92	40.4	1.26	0.00	88	930531	0.35	119.3
Aranäs	M	92	27.5	2.1	1.00	88	931015	50	50
Arapt	Q		15.4	1.19	0.00	87	930630		220
Arapt	Q		20.8	1.41	0.00	87	930630		260
Arcona	E	91	25	2.92	1.06	85	910430	127	120
Arcona	A		45	0.84	0.02	89	940630	10	418
Argonaut	E	92	9.8	3.29	3.68	87	920215	40.5	11
Aritmos	A		52.5	1.19	0.46	87	930331	66	145
Asea	E	91	640	2.79	2.72	851206	910131	580	213.3
Astra	A		534.1	0.98	2.74	89	941001	509	186
Atlas Copco	A		155.9	1.82	1.47	870814	930315	221	150
Avesta	E	89	34	3.15	2.00	87	89	40	20
AWA Patent	M	90	0.4	1.63	2.48	87		495	200
AWA Patent	M	90	3.8	1.08	1.00	89		3	3
Axtrade (Hexatrade)	E	91	20.4	1.22	1.07	860930	910630	136	127.5
Axtrade	A		35	0.89	0.29	89	941001	50	175
Beijer Capital	A		30	1.18	0.00	87	950214	0.35	170
Beijer Industries	M	89	110	1.12	1.48	88	940408	193	130
Bergman Bev	E	91	25	1.27	0.80	851212	910630	80	100
Betongbyggen	FB	92	10	0	0.00	89	95		
BGB	E	92	1.68	4.88	0.32	85	920201	8	25
Bilspedition	A		210	2.95	0.23	86	931130	11.5	50.9
Bilspedition	A		38.89	1.84	0.15	88	951031	11.5	75.4
BK Elektronik	Q		1.6	2	0.00	84	900530	50	
Bongs	Q		3.5	2.1	0.00	87		10	
Brio	E	89	6	3.25	6.75	83	890831	135	20
ByggFast	A		2.5	6.94	0.09	86	921230	4.5	50
Cabanco	FB	92	14.26	0.65	0.00	87	920831		84
Cardo, gamla	M	85	18.3	1.17	1.17	83			240
Cardo	A		102.7	1.27	0.77	87	930315	200	260
Carnegie	M	89	150	1.89	2.36	86	920310	548	232
Cederroth	A		13.6	2.05	3.00	86	2006	30	10
Cherry	Q		1.5	5.33	0.00	85			
Cominvest	Q		9.9	4.09	0.00	84	90		22
Cominvest	FB		20	2.25	0.00	87	931015	0.05	40
Componenta	M	91	70	1.48	1.22	88	93	144	118
Conata	FB	92	60	0	0.00	89	94		
Custos (AB Vestos)	UL		4.4	0	0.00	88	980831		138
Dacke	M	89	50	1.2	1.52	87	930315	180	118.33
Data Logic	M	89	3.6	1.76	1.76	86	910630		119
Data Logic	M	89	4.94	1.45	1.45	87	930315		175
Depenova	M	91	18	1.11	1.17	88	950701	105	90
Diös	A		156	0	0.02	87	921027	3	130
Edebe	M	89	1	4.81	4.81	84	910901		13.5
Eken	E	91	11.484	2.17	1.14	86	911230	41	36
Elanders	E	88	3.6	5.85	1.93	84	881231	38.5	20
Ellos	M	88	81.975	1.05	1.05	870820	930401		257.5
Enator	M		30.6	0.69	1.00	89	940620	70	70
Eneqvist	M	90	6.6	0.69	2.05	86	921215	82	40
Ericsson	A		626.4	1.55	1.96	87	930315	104	53
Ernström	A		40.5	2.17	0.40	88	93	72.5	180
ESAB	E	92	37.5	0.96	1.72	85	920214	190	110.7
Esselte	E	91	261	2.47	0.79	86	911130	111	140

Essve	E	87	1.1	9.25	9.25	85	87		
Essve	M	91	5	2.31	2.50	87	930215	200	80
Euroc	A		19.293	2.5	0.90	860131	930131	30	33.3
Exab	A		1.3	2.85	0.63	87	940731	45	72
Fabege	E	90	12.9	3.51	1.81	83	900930	50	27.6
Fabege	E	91	3	3.51	0.91	84	910930	25	27.6
Fagerhult	M	89	10.88	1.8	2.57	840115	881231	583	227
Fermenta	A		3	2.72	0.26	83	921209	0.65	2.5
FFNS	E	92	16.4	2.37	0.90	87	920610	37	41
Finansrutin	A		4.55	1.42	0.09	88	93	5	54.2
Fläkt	M	88	144	2	2.00	86			
Fordonia	FB	92	30	0.47	0.00	87	94		
Forsheda	E	91	12.6	0.98	0.50	86	910630	104	210
Fortet	M	90	10	3	3.43	86	911124	120	35
Frico (Sevia International)	E	90	1.5	2.32	1.42	84	90	38	26.7
Gambro	A		48.5	0.9	1.59	871015	940310	238	149.4
Garphyttan	E	92	32.5	2.41	1.15	870701	920630	100	87
Geveko	A		30	1.5	0.58	880820	930820	46	78.75
Göteborgs FK	Q		0.54	0.67	0.00	88			
Graningeverken	A		35.2	1.38	0.65	87	971230	165	252
Gullspång	A		25.2	1.33	1.00	880901	930815	70	70
Gunnebo	M	88	9.5	1.1	1.10	87	930315		185
Hasselfors	E	91	8	3.07	1.09	84	910815	82	75
Hemglass	M	88	16.25	3.27	3.27	86	9106	187	110
Heron	FB	91	53.7	0	0.00	91	94		
Hexagon	M	90	65	3.27	1.70	86	910531		
Holmen	M	88	48	2.88	2.88	860101	910120		46.5
HP Färg	E	89	4	3.68	3.85	840731	890730	95	24.7
HP Färg	M	90	5	1.44	1.22	88	940501	113	63
Hufvudstaden	A		14.5	0.87	0.14	89	940715	18	125
Hydro Carbon	E	91	0.5	2.4	0.53	88	910831	8	15
IBS	E	91	9	2	1.00	86	91		90
IBS	A		27	1.27	0.25	87	930415	33	132.4
IDK	E	88	3	2.11	2.11	83	881230		41.65
IDK	M	90	0.93	0.98	1.06	86	910115	95	90
Iggesund	M	88	85.8	1.39	1.39	87	930315		530
Incentive	M	90	124.5	1.32	1.64	87	930301	311.65	190
Independent	M	89	15	2.43	2.43	84	900301		83.9
Independent	M	89	5.5	2.43	2.43	86	90		125
Independent	M	89	25	1.3	1.30	88	930301		242
Indevo	M	90	5.1	11.91	5.32	841015	911015	125	23.5
Industrimatematik	M	91	7.75	1.1	1.03	88	93	160	155
Infina (Indep. 90)	FB	92	50.4	0.95	0.00	870130	940130		
Inter Innovation	M	91	46.8	1.35	1.48	870130	911231	12615	8500
Invent	FB	92	35	0	0.00	89	95		91
ITAB	E	92	5.9	1.88	0.69	87	920930	45	65
ITAB	A		4.6	1.44	0.53	88	930930	45	85
J&W	A		56	0.97	0.06	880601	940701	9	140
JM	A		132.65	1.24	0.17	890217	940228	33	197
Kabe Husvagnar	A		9.4	0.88	0.13	88	93	10	76.3
Karolin Invest	E	92	10.4	2.52	1.69	86	920112	55	32.5
Klövern	A		27.9	0	0.16	900424	950930	8	49
Kontorsutveckling	Q		10	1.6	0.00	84	940424		30
Kontorsutveckling	Q		11.58	1.02	0.00	87			
Kramo	A		9	2	0.10	88	931231	10	100
Kullenbergs (Avena)	FB	92	29	1.98	0.00	88	931031	0	88.1
Kullenbergs (Avena)	FB	92	27	0	0.00	89	940630	0	151.8
Källdata	E	91	2.496	3.44	0.29	85	911001	8	27.6
Lundbergs	E	92	61.2	1.27	0.34	870814	920814	41	120
Malmros	M	91	17.5	1.02	1.11	871230	930415	195	175
Marieberg	E	91	36.9	5.36	2.40	85	910228	90	37.5
Martinsson	E	91	1.6	1.78	0.76	86	911231	25	33

Medicus	FB	91	25	0	0.00	89	94		
Memory	Q	90	2.25	10.2	0.00	84			
MODO	A		167.5	1.19	0.24	87	930315	82	335
MODO	A		95.3	0	0.24	880310	930331	82	335
MODO	A		73.2	0	0.24	89	930331	82	335
MODO	A		10.8	0	0.24	90	930331	82	335
Modulföretagen	Q		7.5	1.7	0.00	87			
Munksjö	M	90	64.2	1.65	1.75	87	930331	59.5	34
Måldata	A		8.5	1.05	0.20	88	930930	13	66
Nils Weibull	Q		4.8	1.38	0.00	83			
NK	A		72	1	0.08	87	930331	6.5	80
NLK-Celpap	FB	92	25	0	0.00	88	93		
Nobel	E	91	100	3.26	1.97	85	910430	65	33
Nolato	A		17	1	0.48	89		110	230
Nordbanken	M	89	148.8	1.28	1.90	871030	921030	300	157.5
Norden	M	91	6.084	0.72	1.00	87	930315		83
Nordstjernan	A		472	3.69	0.15	871115	940331	8.1	55
Nordstjernan	A		460	1.77	0.07	880909	950331	8.1	115
Nyckeln	FB	91	25	1.52	0.00	8808	930731		
Obligentia	FB	92	36	0.93	0.00	89			
OM	A		15	0	0.50	860607	941120	75	150
OPIAB(Cynrona)	A		2.53	2.64	0.27	84	921101	15	55
OPIAB(Cynrona)	A		4.29	2.64	0.27	85	921101	15	55
Optimum	FB	91	10	3.58	0.00	86			
Optimum	FB	91	0.5	2.97	0.00	87			
Optimum	FB	91	12.5	2.97	0.00	87			
Orrefors	A		10.2	1.41	0.53	870815	930430	41	78
Osterman	FB	91	1.66	3.2	1.00	84		12.5	12.5
Osterman	FB	91	10	2	1.00	86		20	20
Pargon	Q		3.23	0.1	0.00	87			
Pendax	M	88	2.97	2.24	2.24	86		74	33
Perstorp	A		109.9	1.52	0.86	870415	921015	147	170.6
Pharmacia	M	89	250	0.85	1.27	86	930613	228	180
Pharmacia	M	89	250	0.97	1.16	87	940221	238	205
Pharmacia	M	89	102	0.85	1.16	87	940221	238	205
Pharos(Spectra-Physics)	A		41.42	1.38	0.87	89	940401	73	83.5
Platzer	E	90	6.47	4.54	3.46	84	901015	140	40.5
Platzer	A		14.2	1.76	0.11	88	931031	11.5	105
PLM	Q		50	1.21	0.00	86			
PLM	M		50	1.12	0.00	870331	930115		195
PM	E	88	4.35	2.76	2.76	83			
PM	M	89	16	2	2.00	85	92	40	20
PM	M	89	14.4	1	1.00	88		48	48
PriFast	A		24	0	0.42		950630	70	165
Printcom	M	88	1.2	3.75	3.75	84	89		
Programator	E	89	14.7	12.03	12.03	83	890424		30
Programator	M	92	51	0.72	1.00	870909	930315	85	85
Pronator	E	89	6.5	13.62	15.54	78	890815	202	13
Prosparitas	Q	91	3	2.2	0.00	85	911231	7.1	
Pulsen	Q	91	8.4	0.68	0.00	87		80	
Radiosystem	M	88	4.5	8.57	8.57	84			
Radiosystem	M	88	1.5	6.4	6.40	85			
Radiosystem	M	88	10.5	2	2.00	87			
Realia	A		12	3.46	0.03	87	940115	2.25	65
Regnbågen	E	92	11.4	1.79	0.10	86	920630	5	51
Reinholds	M	89	28.3	1.5	1.50	870901	930131	220	147
Rein. Syd.(Bastionen)	A		99	0	0.02	890428	940701	1.8	110
Roslags Energi	M	91	6.28	1.2	1.76	89		520	295
Round Office	Q	89	4.2	0.37	0.00	85			
Round Office	Q	89	3.6	0.29	0.00	86			
Saab-Scania	M	91	796.3	1.04	1.52	880812	930930	334	220
Sandblom & Stone	E	92	13.9	1.11	0.17	861020	920228	19	115

Sandvik	E	92	102.8	4.15	4.87	850831	920315	387	79.5
SCA	A		350	1.3	0.64	87	950415	67	104
Scandiaconsult	A		13.63	1	0.13	89	940620	6.2	47
Scandiafelt	M	91	12.8	1.14	1.44	88	930915	260	180
SE-banken	A		1203.2	1.25	0.16	880620	950609	12.5	79
Seco Tools	A		30.6	0	0.93	88	950315	65	70
SHB	A		818	1.13	0.28	880901	960331	27	96.2
SIAB	A		95	1.37	0.18	87	921102	26	146
Skandia Int.	M	89	79	1.44	1.44	88		260	180
Skanska	A		844.7	1.11	0.20	890217	940215	48	235
Skarborgsbanken	M	89	22.05	1.2	2.04	871215	921215	200	98
SKF	E	90	237	3.03	3.05	84	900201	145	47.5
Skoogs	A		21.9	1.23	0.18	880901	930831	16	90.9
Skåne Gripen	E	90	20	2.12	0.90	84	901231	23.5	26
Skåne Gripen	E	91	8.3	1.36	1.07	85	910631	36	33.5
Skåne Gripen	E	91	62.5	1.98	0.62	86	911231	30	48.5
SMZ	Q	91	3.01	4.33	0.00	84		150	
Spendrups	Q		11.9	1.79	0.00	86			
Spendrups	A		11.9	1.79	0.82	87	921031	49	60
Spendrups	A		18	0.94	0.82	89	940815	49	60
SSAB	A		700	0	0.85	87	97	85	100
STORA	A		321	1.17	0.43	870821	930421	154	360
STORA	A		427	1.13	0.41	890113	940321	154	375
Strålfors	Q		4	3.1	0.00	84			
Svedbergs	M	90	10	1.2	1.45	87		120	82.5
Svedala	A		45.5	0	0.46	91	96	60	130
Swedish Match	M	89	169.8	1.75	1.75	86	911031	145.25	83
Sydost Invest	A		9	1	0.10	88	921231	4	39
Tax Free	Q	M90	9.846	0.46	0.10	87	940115	12	120
Tivox	E	92	5	0.95	0.79	89	920630	31	39
Transantlantic	M	89	5.4	2.07	2.07	850902	901230		
Trelleborg	E	91	20	11.43	6.79	841001	911231	95	14
Trustor	A		20	1.45	0.38	8811	931115	15	40
Trygg-Hansa	A		560.1	0	0.15	8904	940415	24	160
Uddeholm	M	90	40	1.15	1.63	89	940127	65	40
VBB	A		19.977	0	0.11	880115	930115	4.5	40
VBB (Beco)	UL		2.4	0	0.00	880501	930502		175
VBG	E	91	2.75	2.33	0.93	86	910715	42	45
VIAK	Q	M90	12.96	2.5	0.00	870116	911230		216
Volvo	A		755	1.17	0.55	870904	950331	213	385
Volvo	A		924	0	0.47	90	950331	213	450
Wallenstam	A		16	0	0.07	90	950630	14	200
Welbond (Fundia)	M	91	4.5	12	8.50	870701	970701	42.5	5
Wermia	M	91	10.553	0.87	1.24	890701	940701	105	85
Westergyllen	A		3	2.77	0.80	87	930801	30	37.5
Wihlborg	A		8.8	1.52	0.08	870720	931215	11	144.9
WSA	M	91	1.2	2.5	2.00	87	920815	60	30
Zetterbergs	E	92	2.3	1.71	0.98	861230	920315	83	85
Zetterbergs	A		2	1.21	0.33	80112	941216	40	120
Ångpanneför.	E	90	15	8.15	4.65	841218	901201	93	20
Östgötabanken	R	91	39.63	1.03	1.00	87	920930	94	94
			17957.3	483.1	294.79				
Total no. of issues	234								
Nominal value			17957.3						
Stock price/conv.pr. 1989				2.3115					
No. of listed issues 1992		209							
Stock price/conv.pr 1992					1.4105				

Symbols: A = Alive, E = Expired, M= Merger, FB = Filed for Bankruptcy or Suspension of Payments, R = Redeemed, Q = Question-mark, and UL = Unlisted.

Note: Ratio 1989 = Stock price June 30, 1989 / conversion price (Source: Sköldebrand, 1989)
Ratio 1992 = Stock price October 15, 1992 / conversion price

Appendix 2:2 On the design of convertible bonds issued for financing purposes

2:2.1 Introduction

In Chapter 2 we have concentrated on convertible bonds issued to employees. For the sake of completeness, we will now give an overview of the features of convertible bonds issued for financing purposes by Swedish companies. We concentrate on the design aspects of such issues. A review of theoretical explanations for issuing convertible bonds is given together with the implications for the design of convertible bonds which can be deduced from that theory. Empirical research on convertible bond issues is discussed in this context. Three Swedish cases are described. Finally, conclusions are given.

2:2.2 The use of convertible bonds by Swedish companies

In the following we will describe convertible bonds issued for financing purposes by Swedish companies. One category of issues that does not have a financing purpose comprises the issues made to top management as an application of the Pilot school (described in Subsection 2.4.1). When we studied employee issues, we defined issues aimed at the top management as not being employee issues. The convertible bonds that are sold to the top management have little effect, if any, on the financing of the company. They will hence not be discussed further. The important convertible bond issues in a financing perspective are large in volume,

but not as numerous as the employee issues (see Johansson and Plyhr 1992).

Swedish companies using convertible bonds for financing purposes issue such bonds both in the domestic capital market and the international capital market. The design of the convertible bonds depends on the market they are aimed at. Convertible bonds issued in the Swedish market have a simple design, whereas the convertible bonds aimed at the international market are more complicated. In the following, we will try to explain this from a theoretical perspective. The theory can be divided into two main parts. One part tries to explain the choice of instrument (i. e. why convertibles instead of equity or debt). The other part tries to look at the specific design aspect and how this is related to the markets and the institutional setting.

2:2.3 Review of theoretical framework

The fundamental question of why companies issue convertibles has not been completely explained by the theoretical models that have emerged over the years. Nor has empirical research been able to explain the use of convertible bonds. Various explanations compete with each other and in some cases act as complements to each other. In the following, various rationales given for the issuing of convertible bonds will be discussed.

A couple of frequently mentioned rationales are grounded on the fact that convertible bonds are relatively insensitive to variations in the riskiness of the underlying assets. Thus convertibles could be useful if it is difficult to estimate the asset risk (see for example Brennan and Schwartz 1986, and Subsection 3.2.1 in this dissertation), or if *ex post* risk shifting is a problem (see Green 1984).

Stein (1992) develops a theoretical model for the use of convertible bonds for obtaining financing. His model is also supported by a case which he presents. The rationale for convertibles is that companies may use convertible bonds to get equity into their capital structures "through the backdoor" in situations where informational asymmetries make conventional equity issues unattractive (as in Myers and Majluf 1984). The use of convertible bonds is an indirect mechanism for obtaining equity financing that decreases the adverse-selection costs associated with an equity issue. Cf. also Constantinides and Grundy (1989) for a somewhat similar discussion.

The theoretical model presented by Stein (1992) differs from other models of convertible

bond issuing in that it emphasizes two factors that have not drawn much attention in earlier theories: Firstly, the importance of the call provision, making it possible for companies to force early conversion; and secondly, that excessive debt can lead to costs of financial distress. Convertibles issued in the US are typically callable after the expiration of a modest call protection period (Asquith 1991). If companies issue convertible bonds with the hope of getting more equity into their capital structure, a call feature is crucial. With a call feature, it is possible to force investors to convert their bonds into shares of stock. Theories put forward earlier where risk-shifting is critical do actually not provide good explanations for the use of call provisions.

A key role in shaping the informational consequences of a convertible bond is played by costly financial distress. With costly distress, a substantially levered company will choose convertible financing only if it is relatively optimistic about the development of its stock price. If the stock price falls, no convertible bond owner will convert, and the company will be left with an even greater debt burden. Thus, the announcement of a convertible issue should be received more favorably by the market than an equity issue.

2:2.3.1 Empirical findings

The theory presented by Stein (1992) on the issuing of convertible bonds has several empirical implications. In the following, some related empirical research will be reviewed, since this will give a useful background for the analysis of the Swedish cases presented later on. Four categories of evidence will be discussed. They are: Managers' stated motives for convertible bonds; characteristics of firms using convertibles; convertible call provisions and the call policies applied by the firms; and effects of announcements of convertible bond issues.

2:2.3.1.1 Managerial motives

In an empirical study by Brigham (1966), it was found that the managers' (73 percent of the managers) primary goal when issuing convertibles was to get equity financing. Brigham also asked why they chose a convertible to obtain equity financing. 68 percent answered that they believed that their stock price would rise over time, thus providing a way of selling equity

at a price higher than the prevailing price. Hoffmeister (1977) found as one of the top three motives that the managers (70 percent of the managers) viewed the convertible bonds as a delayed equity issue. These studies show that the managers' main motive for convertible bonds is to obtain equity financing.

This is hard to square with the rationale of Constantinides and Grundy (1989) for convertible bonds. These authors argue that convertible bonds are used for resolving problems associated with asymmetric information. In their model, the issue of a convertible bond must be combined with a publicly observed *stock repurchase* to work. The implications of this model contradict the view expressed by managers in surveys, according to which convertible bonds are used for obtaining more equity. Other evidence also points to the fact that it is unlikely that firms would use the proceeds from convertible bond issues to repurchase equity. Results of several studies show that the proceeds from convertible issues are intended for capital expenditures, debt refinancing, and general corporate spending (Dann and Mikkelson 1984; Eckbo 1986; and Mikkelson and Partch 1986).

2:2.3.1.2 Firm characteristics

Stein's (1992) model implies that convertible bonds would be especially valuable for companies that are characterized by large informational asymmetries (this fits well with the argument of Brennan and Schwartz (1986)), or could face large costs of financial distress if they were to add more debt to their capital structures. Stein quotes two studies that confirm this view. These studies (Stein 1992, p. 13) show that firms with high debt-to-equity ratios are significantly more apt to use convertible bonds. One of the studies also shows that firms using convertibles have high ratios of R&D to sales, and that convertibles are strongly negatively related to the ratio of tangible assets to total assets and strongly positively related to market-to-book ratio. The two latter findings imply that financial distress would be costly.

2:2.3.1.3 Call policies

A study by Ingersoll (1977b) shows that firms delay the call of convertible bonds considerably. He had 124 firms in his sample. All but 6 delayed the call. The period covered in the study was 1968 to 1975. A later study on firms' call policies (Asquith 1991) finds that

the call feature is actually used to force prompt conversion after the expiration of the call protection period, if this is feasible considering cash flow and if the conversion price exceeds the call price. Furthermore, in Asquith's sample, approximately two-thirds of the convertible bond issues are eventually converted. These findings support the rationale for convertibles offered by Stein (1992). This is also in line with the stated expectations of the managers when they issue convertibles. The explanation for this documented shift in managers' behavior could be that they have developed a better understanding of the instrument since Ingersoll's study and that the valuation models developed in the late seventies (Brennan and Schwartz 1986; Ingersoll 1977a) have had an effect on the managerial behavior in the sample of the latter study, which covered the period 1980-1983. We view the models as important for making decisions on matters of call and conversion of convertible bonds. The models are also important when designing instruments such as convertible bonds (see McConnell and Schwartz 1992, p. 40; Ross 1989, p. 541; and Chapter 5 in this dissertation).

2:2.3.1.4 Stock-price reactions

In the framework of Myers and Majluf (1984), informational asymmetries make pure equity issues unattractive. A convertible bond issue would then mitigate some of the negative effects of an equity issue, since a convertible is a hybrid between debt and equity. This effect has been documented in studies of stock-price reactions to announcements of convertible bonds. Three studies on stock-price reactions to common stock offerings (Asquith and Mullins 1986; Masulis and Korwar 1986; and Mikkelson and Partch 1986) report an unweighted average of -3.57 percent. For convertible debt, the unweighted average stock-price reaction of three studies (Dann and Mikkelson 1984; Eckbo 1986; and Mikkelson and Partch 1986) is -1.65 percent. Furthermore, in the study by Mikkelson and Partch (1986), announcements of convertible bond issues had very little effect on the stock prices of firms with low bond ratings. For firms with high ratings, the effects were very negative. This supports the view that firms with bad ratings would not issue convertible debt if they were not optimistic about the future, since they would incur great costs if the convertibles were to remain unconverted. They could end up with having to refinance the convertible bonds at a very high cost.

The theoretical framework and empirical findings described above are from the US. In Sweden, the market for convertible bonds has been growing since the early 1980s. Trading

in convertible bonds has increased over the years, and the firms are continuously issuing convertible bonds for financing purposes. However, little empirical research on Swedish convertible issues for financing purposes has yet been done so far. Therefore we have to rely on research done on other markets. The issuing of convertible bonds to employees is well documented, on the other hand. As discussed earlier, employee issues seem mainly to be tax driven.

2:2.3.1.5 The design of convertible bonds for financing purposes, and institutional factors

To try to explain the growth in the use of convertible bonds without mentioning the institutional and market aspects would be a case of negligence. In Section 2.5, the legislation and recommendations regarding convertible bonds were described in great detail. Those recommendations point to tax considerations as the main force behind the issuing of convertible bonds to employees. When it comes to convertible bonds for financing purposes, tax considerations are also important, but as a part of the institutional setting.

The following discussion is inspired by Ross (1989). He develops a model for financial innovation, where agency theory and marketing are important and where financial institutions play an important role in the marketing of financial instruments. Financial markets have become institutional in that institutions are often the most significant traders and holders of active positions. These institutions range from transparent through translucent to opaque. For example, mutual funds are transparent, while savings and loan institutions are opaque. The unconstrained individual is the retail player in this framework, and the individual becomes the simplest and most transparent institution. Many open end mutual funds are just slightly less transparent and are used by individuals as efficient vehicles to hold securities. The agency and control problems of these institutions are relatively small. The agency problems are most severe for the opaque institutions, where the information asymmetries are the greatest between the participants and the institutions. The need for control and contractual structures to permit them to function is so critical that such structures more or less define those institutions.

With this approach, the financial markets are viewed as institutional markets, where the institutions are the major and significant forces. These institutions are governed by agency relations. In these markets, the institutions are important players. The role of marketing is

important for explaining the emergence and growth of financial instruments. Assuming markets to be perfect and frictionless as markets of neoclassical finance, there is no role for marketing per se. In a complete market the demands are completely spanned by the existing securities, and there is no need for more instruments. By definition, selling a financial instrument in a frictionless market is costless. However, in practice the more exotic the instrument, the more costly it is to sell it. In the context of spanning, the role of marketing is to leave as little nonspanned uncertainty as is efficient. Marketing "explains" the payoffs as long as the marginal cost of further explanation equals the marginal gain from the proposed transaction.

This framework recognizes that there is a cost of marketing new instruments. If the instrument is successful and long lived, it can go through a life cycle from innovation to establishment and, ultimately, to displacement. As an innovation, the instrument could be hand-tailored to particular needs. In a mature phase, the marketing costs are very small and the instrument becomes standard. Ross (1989) states that financial innovation arises as a natural adjunct of the supply and demand of participants, constrained by agency considerations, and where marketing costs help to shape the form of new instruments.

Applying the Ross framework to the Swedish convertible bond market, it is quite obvious that the convertible bonds issued to employees were at first a financial innovation, which has now matured and could disappear in the near future (a possible explanation for their disappearance is given in Subsection 2.3.2). The cost for the financial institutions of marketing the first convertible bonds was substantial. Since the tax law made the issues extremely favorable, one could argue that for this particular financial innovation the tax payer paid the marketing bill. The huge growth of employee issues made the marketing cost for pure financing issues very low.

2:2.4 An overview of the design of three convertible bond issues

In this section, three cases of financing issues will be described. We will look at the design of each particular issue and also try to identify the motives for the issue. The three convertible bond issues are: The 1993 Ericsson issue, the 1991 Investor issue, and the 1988 SCA issue. The criteria for selecting these three were that detailed information was available on the indenture provisions, that they were large issues, that they were clearly financing

issues, that both the stock and issue were listed, and that trading data could be obtained. The design of the three issues include typical features in Swedish companies.

The Ericsson and Investor issue are uncomplicated issues, whereas the SCA issue is a rather sophisticated creation, with both put and call provisions. For the majority of the Swedish issues, the coupon and conversion conditions are the main features to play around with when designing an issue. In essence, the design is a question of setting the coupon and the conversion conditions. Other parameters constant, with a high conversion price the coupon has to be set higher, since the chance for conversion is then smaller.

2:2.4.1 The Ericsson issue

The convertible bond issued by Ericsson is quite typical for convertible bonds issued on the Swedish market. It has no put and call conditions. The interesting question is thus the motive for the issue. The issue was made by offering rights to the old stockholders. No value was transferred from old shareholders to new shareholders. The stated motive (Ericsson 1993) for the issue was to strengthen the company's financial structure in view of anticipated acquisitions, and demands from customers for project financing (it is an advantage in the competition for contracts to be able to provide financing). The company also mentioned that the recent financial turmoil in Sweden and other countries has made it extremely difficult to obtain long-term financing. Therefore, a convertible bond issue was the best choice in such a situation. Together with the convertible bond issue, the company was also able to obtain a junior loan maturing at the same time as the convertible bond. The exact conditions, given below, of the issue were decided on May 22, 1993, by the board. Ericsson stock was trading on that day at 320 Crowns (closing price). It is quite obvious that both the management and the financing institutions view the convertible bond issue as equity, since the conversion price was set below the price at which the stock was trading. Normally, the convertibles are issued with a conversion price of between 15 - 20 percent above the prevailing stock price, measured as an unweighted average of a fourteen day period before the board meeting deciding on the issue. The fact that the company was able to obtain a loan simultaneously, maturing in seven years, junior to the convertible bond issue, indicates that the convertible was viewed more as equity than debt.

A summary of the conditions of the Ericsson convertible bond issue:

Nominal value: 10 SEK.
Issue size: 2,172 MSEK.
Issue price: 100 percent of nominal value.
Coupon: 4.25 percent annually.
Coupon date: February 15 every year, and June 30, 2000.
Issue date: July 1, 1993.
Expiration date: June 30, 2000.
Conversion price: 300 SEK, i. e. 30 convertibles are needed to obtain 1 share.
Type of shares: Common class B.
Conversion period: August 2, 1993 - May 31, 2000.

2:2.4.2 The Investor issue

The convertible bond issued by Investor is one of the largest convertible bonds issued in Sweden. As in the case of the Ericsson issue, the Investor issue was made by offering rights to the old stockholders. It was issued as a part of a financing package when the company acquired Saab-Scania. The total package was worth about 13.1 billion Swedish Crowns (BSEK). Of this amount, 7.5 BSEK was financed through straight debt. The rest was financed through two convertible bond issues, one to the market and one to the company Patricia. In the prospectus, Investor (Investor 1991) stated that one of the motives for issuing the convertible bonds was to obtain a well balanced capital structure and to limit the interest rate risk for the company. An additional argument for the convertible bond issue, put forward by Investor (Investor 1991, p. 13), is that a convertible bond is an interesting security to add to the portfolio for the shareholders of Investor. The convertible bond combines a high yield, lower risk, and a piece of the further increase in value of the company.

Furthermore, in the company's view there could be a considerable international interest in the convertible bond. An international placement was expected to increase the knowledge of Investor. This means that the company could get access to the international capital market and that it would be easier to obtain risk capital on that market in the future. In 1992, a part (1,353 MSEK) of the issue was switched to a ECU-denominated convertible bond (a so called Secured Exchangeable Bond). It was listed in Luxembourg and traded over the counter in London (Investor 1992). The ECU convertible has the same provisions as the original

Investor issue in all other respects. Through this issue of convertible bonds, the company could thus tap both the domestic and the international capital markets.

A summary of the conditions of the Investor convertible bond issue:

Nominal value: 44 SEK.
Issue size: 3,564 MSEK.
Issue price: 85.2 percent of nominal value.
Coupon: 8 percent annually.
Coupon date: June 24 every year, and June 21, 2001.
Issue date: June 24, 1991.
Expiration date: June 21, 2001.
Conversion price: 154 SEK, i. e. 3.5 convertibles are needed to obtain 1 share.
Type of shares: Common, class B.
Conversion period: June 25, 1991 - May 31, 2001.

2:2.4.3 The SCA issue

This issue has a rather complicated design, the implications of which will be mentioned. The design of an issue like the SCA convertible is a delicate matter, since many of the features interact with each other and have a great impact on the value. With complicated call and put provisions, as in the SCA convertible, the value of the instrument must be established with the help of some model. A model must also be used when the instrument is designed, since the interaction between various features would otherwise be very hard to predict.

SCA can call the convertible bond at any time after January 17, 1989, at the price displayed below. But this is under the condition that the stock price is above a certain level at the time of the call. As can be seen from the call conditions, this price increases over time. This call is the primary call option of the company. To avoid effects of short term stock price movements, the company can only use the call if the average quoted stock price has attained the stated level during some 20-day period prior to the call. The holders of the convertible bond have a put option, which allows them to put the convertible back on six specific days. The put option guarantees a yearly return on the bond of 7.875 percent until the time of exercise. The exercise price of the put option hence increases over time. At the same time, the company can call the bond on the same six specific days at the same prices. This is the company's secondary call option. Jennergren and Näslund (1990) find that these

A summary of the conditions of the SCA convertible bond issue:

Nominal value: 1000 ECU.
Issue size: 101 MECU.
Issue price: 100 percent of nominal value.
Coupon: 4.25 percent annually.
Coupon date: January 17.
Issue date: December, 1988.
Expiration date: January 17, 2004.
Conversion price: 406 SEK, i. e. 1 bond gives approximately 17 shares, the exact number depends on the ECU/SEK ratio. The conversion formula is (1000*ECU/SEK)/406.
Type of shares: Common stock denoted in Swedish Crowns.
Conversion period: January 17, 1989 - January 17, 2004.

Call conditions:

Redemption during the 12 months commencing on January 17	Call price	Level of quoted price of the SCA stock in SEK below which the bond may not be called
1989	105	406 * 1.30
1990	104	406 * 1.30
1991	103	406 * 1.30
1992	102	406 * 1.30
1993	101	406 * 1.30
1994	100	406 * 1.30
1995	100	406 * 1.33
1996	100	406 * 1.39
1997	100	406 * 1.46
1998	100	406 * 1.53
all later years	100	0 (no restrictions)

Put conditions:

January 17	Put price
1994	121.213
1995	126.509
1996	132.222
1997	138.384
1998	145.032
1999	152.203

put and call conditions have the effect that the convertible bond will be either redeemed or converted on January 17, 1994. This means that the effective life of the convertible is 5 years and not 15. This result is obtained by assuming that each party acts to maximize its value. Another finding in their study is that the value of the convertible bond need not to be monotonically increasing with increasing value of the underlying stock.

If the company for some reason would not have wanted to offer the put option, it could have compensated with a higher coupon. The disadvantage of a put option is that it could be used and thus cause refinancing costs for the company, if the stock price goes down (see Cooper 1993, p. 23).

The conditions of the SCA issue are evidently quite complicated. A further complication of this issue is that it is denominated in ECU rather than in Swedish Crowns (SEK).

2:2.5 Conclusions and an analysis of the three cases

The Ericsson issue fits well with some of the arguments empirical evidence presented above. The stated motive was to obtain equity financing through a convertible bond, which enabled the company to take on more straight debt. This motive is in accordance with the empirical findings of other studies. The issue has no call feature, which could be used to force conversion. But the conversion price was set far below what would be regarded as a common conversion price in the market, and there is no grace period (conversion is possible one month after issue).

The view of the management, that the convertible bond is a delayed equity issue, is further supported by the trend of declining interest rates during 1993 in Sweden. This makes conversion even more likely (falling interest rates normally means appreciating stock prices). Since convertibles traded on the Swedish market do not have call features, the design of the Ericsson issue was such that the above conversion conditions more or less substituted for the call feature.

In Stein's model, costly financial distress is an important factor. Ericsson had 17,440 MSEK in equity and 36,877 in debt by the end of 1992, and a negative cash-flow (Ericsson 1993). The company could face costly financial distress, and would thus choose convertible bonds only if it were optimistic about the future. And indeed, Ericsson is very optimistic. Statements by the CEO contain phrases such as "considerable increase in profits" (Ericsson

1993, p. 34).

As regards other characteristics of firms using convertible bonds, Ericsson fits well with them, too, since the company has a very high ratio of R&D to sales (15.7 percent for the fiscal year of 1992). Also, the company has a low ratio of tangible assets to total assets and a high market-to-book ratio. All this means that financial distress would be very costly for Ericsson. The P/E ratio has increased from 11.4 in 1988 to 29.4 in 1992 (measured in accordance with US GAAP).

Analyzing further the convertible bond of Ericsson, it is clear that the marketing cost of the issue could not be that great, since the bond is a standard construction. Moreover, this is not the first convertible bond issue by Ericsson (the company has issued both an employee issue and a financing issue denominated in CHF, the financing issue still outstanding). Ericsson is well known and probably one of the most analyzed companies on the Swedish financial market. In the Ross framework, institutions are the important players, and it may well be that the institutions demanded a convertible bond and rejected to participate in an equity issue, since most of the major institutional portfolios in Sweden hold Ericsson equity.

Using portfolio arguments, we find two arguments that point to the choice of convertible bonds instead of equity: Firstly, since most major institutional portfolios in Sweden had Ericsson equity, and the stock price had increased from around 100 SEK to 300 SEK in half a year, the holdings of Ericsson stock could be overweigthed in these portfolios. It may well be that a rebalancing of the portfolios was needed, inducing a selling of Ericsson stocks. But they could take on a convertible, since it is a bond with the upside potential of equity, with an embedded put option, with exercise price 300 SEK (conversion price). Replacing the stocks with convertibles would lock in the value increase caused by the rise in the stock price.

Secondly, if the employees of Ericsson are studied, they could hold a substantial number of shares, since the Ericsson employee convertible bond issue expired March, 1993, forcing a conversion of the convertible bonds (the conversion price was 53.0 SEK). Among the top management, 13 out of 19 held substantial amounts of Ericsson equity in late April, 1993 (Ericsson 1993, pp. 59-60), equity which could have been acquired through the employee issue. Since the tax laws nowadays make loans relatively unfavorable (see Subsections 2.5.4 - 2.5.6), a new convertible bond would be favorable for employees holding shares of common stock. They could sell the shares and participate in the issue at a low cost and still have the

upside potential of equity, with the implicit put option provided by the convertible bond.

Selling equity and investing in convertibles is a variant of the technique known as "cash extraction", which involves selling shares, buying the same number of deep-in-the-money warrants, and putting the cash balance on deposit (for an example, see Cooper 1993, p.21). A warrant deep-in-the-money has a delta close to one and therefore moves almost cent by cent in parallel with the common stock. Since Swedish companies by law are prohibited from issuing warrants on their own stock, a convertible is the closest instrument they can offer investors wanting to use this risk-averse strategy. The bond part of the convertible can thus be viewed as the cash balance on deposit in the warrant case.

The Investor issue fits well with the Stein model. The management's stated motive was to obtain new equity through a convertible bond in combination with straight debt. Investor exhibits characteristics of companies using convertible bonds. The Saab-Scania subsidiary of Investor is engaged in heavy product development (for example, a fighter jet and a new car model), which means that the ratio of R&D to sales is high, and the tangible assets are low. By using a standard design of the convertible bond, the marketing cost of the issue was held to a minimum. The Ericsson and Investor issues were designed and managed by the same financial institution. This must have had a positive impact on the marketing costs of the issues.

The SCA issue is aimed at a different financial market than the Ericsson and the Investor issues. By designing the issue with both call and put conditions, the company meets the specific demands by the investors on this market. In the Ross framework described above, SCA must be considered an opaque institution by the investors on the ECU convertible bond market (like other companies issuing convertibles in this market). The marketing cost of an issue not meeting the standards on this market would be extremely high. The cost would be at the same level as for a financial innovation. Since SCA is opaque, the put option of the convertible bond resolves some of the obvious agency problems. This is also acknowledged by the buyers, who accept that the company has given itself a call option to limit the cost of the issue.

The three cases described here provide a good insight into the design of convertible bonds. The theoretical framework for the choice of instrument is also provided. Convertible bonds are popular internationally and are becoming more popular as a financing device among Swedish companies. The initial cost of marketing such instruments in the Swedish

capital market was taken in connection with the employee issues of convertible bonds. This market is now exploited by companies not able to attract equity or straight debt, needing financing, with limited marketing costs only.

Appendix 2:3 Employee share ownership - an international outlook

2:3.1 Introduction

This chapter has discussed Swedish convertible bond issues to employees in great detail. Among the goals of these issues, one is to promote stock ownership among employees. For the sake of completeness, an overview of how this goal has been pursued in some other countries will now be given.

In the last decade, various forms of employee share ownership plans (ESOPs) have emerged in several countries. In the US and Japan, there are numerous ESOPs (Wilson 1992, pp. 19-21). Also in Sweden there are ESOPs (see Anell 1989), but they are few compared to the number of issues of convertible bonds to employees. The ESOPs in the UK and in the US are quite different from Swedish convertible bond issues to employees in many respects, since they are trusts connected to the companies on a long range basis. Moreover, they have been used for reasons other than just increasing stock ownership among employees (Bruner 1988, p. 57). Swedish convertibles, on the other hand, are sold to the employees, and in most cases the company is not involved any more after the sale. Since the main development of ESOPs has taken place in the US, the following discussion will be most relevant to employee share ownership in that country.

In Table A 2.3.1 below, the extent of various forms of promotion of employee

participation in profits and enterprise results (known as PEPPER schemes) in various European countries is displayed. The general attitude towards such promotion is favorable in the following countries: Denmark, Germany, France, Ireland, Netherlands and the UK (Wilson 1992).

The forms of promoting employee ownership vary. ESOPs have mainly been used in the US, Japan and the UK. In the US, about 8,200 companies were sponsoring ESOPs in 1988, with 11.7 million participants. 350,000 companies had profit-sharing plans, with 16.8 million participants (Conte and Kruse 1991). Profit sharing in various forms has been applied in most countries, and can be viewed as a first step towards the more formalized design represented by ESOPs. Tax legislation is important for the emergence of ESOPs, since the growth of such plans can partly be explained by favorable tax rules in the UK and the US. In Japan, there are no tax incentives for ESOPs. Japanese ESOPs cover production workers predominantly, and the shares are not available until retirement. In Sweden, the tax incentives for ESOPs were not the same as for convertible bond issues to employees, which explains why the latter became much more popular.

2:3.2 The development of ESOPs in the United Kingdom and in Europe

The features of typical UK ESOPs are the following (Wilson 1992, p. 3):

- The company sets up an employee benefit trust.
- The ESOP trust buys shares in the company using borrowed funds.
- The ESOP trust distributes shares to existing employees via an employee share scheme and acts as a market maker in the company's shares by buying them from sellers including employees.
- The ESOP trust repays loans using voluntary contributions from the company which may be tax deductible. As an effect of this, the ESOP can play a corporate finance role since the company may be able to benefit from tax relief on both the interest and principal on the company borrowing.
- As soon as the ESOP's borrowed funds are repaid, the ESOP share holding becomes free for distribution to individual employees via a share scheme of the company.

Table A 2.3.1. Summary of findings regarding PEPPER schemes in Europe			
Country	Type	No of schemes (benefits or profit share/emp.)	Employees involved
Belgium	ESO CPS	Around 20 quoted companies. Multinationals, banks, insurance companies.	On average 5%
Denmark	CPS SPS BPS ESO	Min. 50 schemes 20 schemes (2% of share capital) 27 schemes (DKR 3400/employee) 32 schemes (less than 2% of share capital)	
Germany	ESO, DPS PS	1,600 firms, 0.1% of all firms (DM 15 bn.) Max. 5,000 firms, (6.8% of wages)	1.3 m. 5.4% of individuals
France	DPS CPS ESO SO EBO	12,000 firms and 10,200 agreements (profit shares on average 3.4% of wage bill) 7000 agreements (profit shares on aver. 4.1% of wage bill) 350 firms (2/3 quoted) (free distr. of shares 3% of wage bill) 600 quoted companies 10-20 per year in 1980-90	4.6 m. (3 m. benefitting) 1.4 m. 600,000
Greece	CPS	Limited (lump sum of GD 30,000-50,000)	
Ireland	SO SPS	139 schemes 104 schemes, all in private sector	Executives 35,000
Italy	CPS ESO	25% of all large firms (3% of aver. earn.) 60 private firms in 1988 30 quoted companies (less than 5% of tot. share capital)	400,000 80% of all employees
Luxembourg	CPS, ESO	22% of firms, mainly banking (0.5-2 month wage)	
Netherlands	CPS SPD, BPS and SO	6-30% of firms (4.5-6.5% of aver. earn.) Very limited (3% of all schemes)	350.000 in 1975
Portugal	CPS	Limited, large firms in finance	
Spain	CPS	44% of medium and large firms, but only 6% linked to profits (5% of labor cost)	2% of salaried employees (often restric. to executives)
UK	DSO CPS SPS SO ESOPs	4326 schemes 1175 schemes (7% of employee pay) 890 schemes (2-4% of total wages) 891 schemes 20 schemes Total: 7282 schemes, 30% of firms	 293,000 757,000 623,000 2 m. emp. benefitting

Abbreviations: m.: million; PS: profit sharing; SPS: share based profit sharing; BSP: bond based profit sharing; CPS: cash based profit sharing; DPS: deferred profit sharing/investment funds; ESO employee share ownership; SO: stock options; DSO: discretionary share options; ESOPs: employee share ownership plans; EBO: employee buy-out. Source: Wilson 1992.

Traditionally share schemes are established by companies in the UK for the motivational benefits which they are supposed to provide. Naturally, the corporate finance reasons and tax benefits they provide are also important. Driven by agency theory considerations, share schemes have been implemented for key executives in the UK. In the last decade, share schemes have been designed to cover all employees, in order to motivate increased cooperation through horizontal monitoring, to increase commitment, and to create improvements in productivity over a longer term.

The arguments for ESOPs are the same as for share schemes, but in addition there is the feature of collective ownership provided by an ESOP. The existence of this type of ownership does give rise to the possibility that the employees as collective owners can have a voice in the governance of the company, acting as a block shareholder.

As an institutional body, an ESOP can have a role in a private company as market maker for the shares, allowing employees to buy or sell their shares. An ESOP also provides an opportunity for family shareholders and incumbent managers to dispose of their shares or to make a leveraged buyout. Comparing ESOPs to the Swedish issues of convertible bonds to employees, we see that the ESOP construction is better since it provides a market for the shares, enhancing the liquidity and thus decreasing the risk of investing in the shares. As mentioned above, convertible bonds issued to employees in Sweden can not be traded during the first two years, a feature creating a liquidity risk for the holder. Letting an ESOP buy existing shares is advantageous compared to issuing convertibles, since the shares acquired by the ESOP do not give rise to any dilution. As regards the possibility for incumbent managers and family shareholders to divest, convertible bonds could be as useful as shares.

When discussing ESOPs, a distinction has to be made between profit sharing and employee share ownership. Here we view profit sharing to be cash based schemes or equity based schemes, which are directly linked to some measure of business performance. ESOPs, on the other hand, enable employees to take part in enterprise performance and growth in profits via appreciating share values and/or receipt of dividends.

It can be seen in Table A 2.3.1 above that profit sharing and employee ownership have become widely accepted in Europe. A draft recommendation on profit sharing and employee ownership was approved by the European Commission in July, 1991. In the recommendation, member states are encouraged to provide the legal environment in which employee financial participation can develop and to consider tax and other incentives that might speed up the

adoption of such schemes. Many different forms of profit sharing and employee ownership plans have been introduced in the EC countries. The recommendation by the European commission is a step towards a unified approach on these matters. In the recommendation, various features are treated: That the schemes should be applied on a regular basis and at least award a bonus once a year; that there should be a pre-determined formula for setting the employee benefits before the beginning of each reference period; that profit sharing and employee ownership should not be a substitute for wage negotiations; that participation should be voluntary; that the amount of money involved for a typical employee should be significant but with a ceiling to avoid wide fluctuations in income; that the risks should not be too large for the employees participating; and that the employees should be the primary beneficiaries. The recommendation is applicable both to private and public enterprises. The size of the enterprise could vary from small to large, as long as the employee can see the performance of his/her own unit.

The most interesting point in the EC document is the discussion on how to treat the risk level for the employees in these types of programs. The recommendation mentions some form of insurance for employees against too heavy losses in situations where they invest in risk-bearing securities and the investment is heavily concentrated and large in relation to the employee's total assets. To the author's knowledge, this is the first time a discussion of an insurance policy of any kind has appeared in this context. In the Swedish debate on convertible bond issues to employees, this has never been discussed (cf. the previous discussion in Section 2.6 and Section 2.8).

Wilson (1992) mentions that advocates in the UK of wide employee share ownership and other forms of financial participation put forward the following factors which could have an impact on company performance: An incentive to increase employee work effort; a source of more positive worker attitudes, cooperative behavior and financial "awareness"; increased organizational efficiency through information sharing; decreases in worker-management tensions over pay and workplace organization; greater responsiveness to change; reductions in labor turnover and absenteeism; and a growth in the stock of human capital.

Many of these arguments can be recognized from the previous sections to have been used by firms as motivation for convertible bonds issued to employees in Sweden. Most of these arguments hence have counterarguments. For instance: There will always be free-riders; short-term goals will be in focus; necessary long-term investments could be postponed; the

risks are too big from a portfolio point of view for the employees. In any case, the validity of the above arguments is an empirical question.

An interesting question in this context concerns the financial effects of ESOPs. This question has attracted a lot of attention in the US. Therefore we continue with a review of the ESOPs in that country.

2:3.3 Aspects of employee ownership in the USA

Employee ownership has been around for a long time in the USA. However, it started to grow rapidly with the 1974 Tax Act, which permitted employers to deduct both principal and interest payments on loans to ESOPs. After 1974, several tax changes regarding ESOPs have taken place, and the 1989 Tax Act curtailed tax benefits relating to ESOPs. The growth continued during the late 1980s. For example, $ 25.7 billion in ESOPs were financed or announced from January to early December 1989, the vast majority of which were leveraged (Scholes and Wolfson 1990, p. 27). The amount of money involved in ESOPs has created a great deal of interest both in the political world, the business community and the academic world (see Blasi 1988, pp. 31-61). This development is interesting as a background to the Swedish experiences of efforts to increase employee ownership.

2:3.3.1 Defining an ESOP

The term "ESOP" could in some sense be misleading. Companies having ESOPs can be divided into three types (Rosen 1990): leveraged ESOPs (ESOPs that borrow money), nonleveraged ESOPs (ESOPs that do not borrow money, but have the authorization to do so), and stock bonus plans (plans which are not formally ESOPs, cannot borrow money, are subject to somewhat less restrictive rules, and do not enjoy all tax benefits). A statutory ESOP is a stock bonus plan authorized to borrow money, allowing the employer to make larger contributions to the plan. It also provides lenders with special tax incentives and allows owners of closely held companies to defer or avoid taxation on certain sales of shares to the ESOP.

The ESOP is a trust, where the shares are kept and managed. The employees obtain shares in accordance with some pre-set formula. In the beginning of an ESOP, the employees

do not own any shares, since they have not been allocated to them. How this allocation is done varies. Usually the management of the ESOP trust votes for the unallocated shares.

The price of these benefits is stricter rules than for stock bonus plans. It is required that ESOPs invest at least 51 percent of their assets in employer securities. ESOPs in publicly traded companies must pass voting rights through to employee participants. This means that companies that do not need the tax benefits will formally designate their plans as stock bonus plans, but they still call them ESOPs. It is estimated that around half of the existing plans are stock bonus plans (Rosen 1990, p. 40). The stock bonus plans are most common in larger companies, thus accounting for more than 80 percent of the employees involved. These data imply that the growth of employee ownership plans can be explained by other factors than pure tax incentives.

Some of the special tax benefits available to an ESOP are not available elsewhere. For example, an ESOP can borrow to finance its purchase of company stock at a tax subsidized rate and deduct the interest on the loan. (The lender can deduct up to 50 percent of the interest obtained on such a loan. This gain is often shared with the borrower.) A corporation can deduct dividends on the shares held by the ESOP, if those dividends are paid directly to the employees in cash, or if they are used as principal payments on an ESOP loan used for acquiring shares. Actually, the tax benefits are such that a fully employee-owned ESOP firm can pay out all of its before-tax income in the form of dividends, employee compensation and interest on ESOP loans.

2:3.3.2 The use of ESOPs

To view leveraged ESOPs strictly as employee benefits is to miss the significant restructuring of firms that has taken place using such plans. In a study of ESOPs established from 1979 to 1983 referred to in Bruner 1988 (p. 57) and undertaken by the General Accounting Office (GAO), 59 percent were used to buy out the owners of private companies. The owners were hence able to roll over their gains free of taxes into portfolios of securities. Divestitures accounted for 39 percent of the leveraged ESOPs. Eight percent of leveraged ESOPs were used to save failing companies. Some of the rescues have succeeded but several companies have gone bankrupt. ESOPs have also been used to terminate overfunded pension plans and forming ESOPs without paying any tax. Six percent of the leveraged ESOPs were used as

a takeover defence. Moreover, ESOPs have been used in some cases to raise new capital.

2:3.3.3 Arguments for ESOPs

Beyond the tax effects, there are at least two non-tax arguments for ESOPs (Chen and Kensinger 1988, p. 67). First, there is the potential for enhanced productivity through better employee motivation. The second argument is increased market control over reinvestment of corporate cash flows. Leveraged ESOPs commit the firm's cash flows to debt retirement for several years and hence divert funds from cash cows into the market place where the funds can be used for new ventures. As for the first argument, it has to be shown empirically that employee ownership increases productivity. If one views an ESOP strictly as a benefit from the employees' standpoint, then there may exist better alternatives than ESOPs as incentives.

In line with the second argument, ESOPs could be useful in restructuring the firm's equity clientele and may thus facilitate, or discourage, changes in corporate control. The managers' motivations could thus be aligned with those of the shareholders. An ESOP may be used as a vehicle to change and manage the corporate capital structure and to obtain new equity.

2:3.3.4 Financial effects of ESOPs

As a restructuring transaction, an ESOPs can have several significant financial effects. These effects have strategic implications that should not be neglected. There could be incentive effects, where the employees make wage concessions in exchange for shares, for instance giving up forms of compensation which are expensive for the employer but of less value to the employees. Another strategic implication is the restructuring of the equity clientele by giving shares to employees. An ESOP adds to the equity clientele a segment of investors who may value the company and its securities more highly than other investors who may have a short term horizon. Employees could be willing to buy securities on terms that outside investors would not.

A potentially important strategic implication is the voting control of the ESOP. The voting control is limited at the beginning of the ESOP, since the employees can not then use

the unallocated shares in voting. The fact that the trustees are usually appointed by the management (and relatively often are members of the management) decreases the voting control of the employees.

Yet further strategic implications of ESOPs are the following: ESOPs have become a standard tool in takeover defenses, thus having financial effects on the firm that can be long lasting and devastating for shareholders. The dilution effect of ESOPs can be substantial if the plans would only buy newly issued or treasury shares of stock. However, most shares bought by ESOPs in the US are not of that kind. Finally, a contingent claim on the firm is created by the financial guarantee which is required by the bank for an ESOP loan.

2:3.3.5 Company performance and ESOPs

Do ESOPs increase company performance? One of the important arguments for ESOPs has been that they increase performance, by providing incentives for employees to act in the interest of the owners. Rosen (1990) refers to a study undertaken by the National Center for Employee Ownership, comparing the five year before and five year after performance of 45 ESOP firms. To correct for changes in the economy and individual markets, performance measures were indexed by comparing these firms to at least five competitors for the entire period. Overall, the ESOP firms grew 3-4 per cent faster every year. Over a ten year period, this would create nearly 50 percent more jobs in the ESOP firms. Most of the difference came from the most participative one-third of the firms, i. e. firms which allowed a relatively high degree of input from the employees into decision making on the job level. Two other studies are also mentioned by Rosen (1990), where there were no documented effects of ESOPs on performance, however.

An event study by Chang (1990) of 165 ESOP announcements found that the average abnormal return for the two-day announcement period was 3.66 percent. About 65 percent of the firms showed positive abnormal returns. By a Wilcoxon signed-rank test, Chang found that the results were not driven by a few outliers. For LBO announcements, the average abnormal return was 11.45 percent and highly significant (t-value = 19.16). The abnormal return of an announcement of an ESOP defense was -2.34 percent and significant (t-value = -4.06). Furthermore, the findings of the study also showed that firms implementing an ESOP defense were characterized by low profitability and low managerial share ownership. This

means that the managers were suffering little wealth loss but enjoyed the benefits of controlling the firm. The defense resulted in a reduction of shareholder wealth. In conclusion, the study showed that the wealth effect is positive, which is consistent with tax, incentive, and/or voting rights explanations. To identify the impact of specific factors, a cross-sectional study would be needed.

An interesting point is the development of employee compensation in ESOP companies. In a study by Chaplinsky and Niehaus (1990) with a sample of 83 ESOP companies, 48.2 percent (40 companies) reported increases in employee compensation. 33 firms (39.8 percent) reported that no change had taken place. For five firms (6.0 percent), the level of compensation declined when the ESOP was adopted. The same study also reports that ESOP firms do not maximize the corporate tax benefits inherent in the plans, hence not providing the shareholders with the benefits which many ESOP advocates have claimed. The study shows that many firms retain large portions of dividends within the trust. This is due to the fact that firms consider the personal tax consequences of paying cash dividends on ESOP shares.

2:3.4 Concluding remarks

Employee share ownership is a topic that has attracted a lot of attention and will be in focus for many years to come. As is evident from the above discussion, there are many aspects to consider. The financial effects of ESOPs have been great in the US, and such plans will certainly be used in company restructurings in the future. As this is being written, new ESOPs are established in the US (for example, Northwest Airlines).

In Sweden, the discussion on employee ownership will continue. Even if the convertible bond issues to employees did not succeed in the goal of getting many new shareholders, the interest in the stock market which was partly created by these issues will probably lead to a further development of employee ownership of companies in Sweden in the future.

3 Valuation of convertible bonds - models

3.1 Introduction

The purpose of this chapter is to present three models for valuing convertible bonds (the first model actually comes in three versions). All models fall within the framework of Contingent Claims Analysis (CCA). Today complicated financial instruments like convertible bonds are most commonly valued within that framework. A contingent claim is an asset whose payoff depends on the value of another "underlying" asset, whose value in turn is determined exogenously. The underlying asset will often be referred to as underlying state variable or simply underlying variable. The model description in this chapter is fairly detailed. With models of this kind, one can value many different financial instruments, since the models can easily be modified.

Out of the models in this chapter, the first model has the stock value as underlying variable. This model is the most commonly used one for valuing convertible bonds. The second and third models use the firm value as underlying variable. Model II has two securities in the capital structure, common stock and convertible bonds. Model III has three securities in the capital structure, common stock, convertible bonds and debt. This model can be extended to handle more instruments in the capital structure, for example, warrants and other classes of debt.

Before presenting the models in detail, their theoretical foundation is discussed. The model framework is CCA, developed by Black-Scholes (1973) and Merton (1974, 1977). CCA captures quantitatively the major determinants of value for corporate liabilities: business

risk, financial risk, interest rate and indenture provisions. Business risk is captured in the volatility term, measured by the rate of return to the firm. Financial risk is given by the value of the firm and the amount and timing of the mandatory payouts. The choice of riskless interest rate provides an indication of the interest rate level. Indenture provisions are reflected in the boundary conditions of the models (Mason and Merton 1985).

When the option pricing formula was presented by Black and Scholes in 1973, this marked the start of a new perspective on the valuation of securities (Black and Scholes 1973). The theoretical development has been very fast after their seminal paper. The great insight of the above mentioned authors is that liabilities are contingent claims on the value of the underlying firm. Therefore such securities can be priced by absence of arbitrage. The value of each security is given by a general equation which depends on the riskless interest rate, the market value of the firm and the volatility of the firm. To distinguish among securities, there are different side conditions corresponding to covenants and indenture provisions.

The majority of models for valuing securities do not include the capital structure of the firm in the valuation model. The interaction between the different claims in the capital structure are important for determining the value of each individual claim. Most firms have complicated capital structures, with many individual securities. The securities themselves have complicated covenants and indenture provisions, which influence their values. The interaction between different securities in the capital structure will thus make the value of one security dependent on the other securities in the capital structure. Whereas a number of papers containing valuation models which ignore the capital structure have been published, very few papers have appeared where the capital structure is included. The description of one model including a fairly complicated capital structure (Model III below) given here is therefore one contribution of this dissertation.

The dissertation concentrates on the valuation of convertible bonds. A convertible bond can be viewed as a hybrid security. It is a combination of a bond and an option to convert into shares. It is related to a package of a bond and a warrant. The bond-warrant package differs from the convertible bond in the sense that when the warrant is exercised in the bond-warrant package, the investor can keep the bond. In the case of a convertible bond, the bond has to be given up at the same time as the option to convert into shares is exercised.

This chapter is structured in the following way. Section 3.2 discusses some earlier papers which are related to this dissertation. In Section 3.3 the theory is described. Section 3.4

contains a model overview. In Section 3.5 the stock value based model is described. Section 3.6 contains a description of the two firm value based models. After that, Section 3.7 discusses how to solve Model III numerically. Section 3.8 describes how the stock and firm volatility are estimated. Section 3.9 summarizes the chapter.

3.2 Earlier research

3.2.1 Some earlier papers on convertible bonds

Brennan and Schwartz (1977) developed a general algorithm for determining the value of a convertible bond. The numerical method which they use is called the implicit finite difference method. For a description of that method, see Schwartz (1977); cf. also Hull (1993, pp. 354-355). At the same time, Ingersoll (1977a) undertook a similar study, but he concentrated more on analytical solutions to convertible bond valuation problems in several special cases. The numerical approach taken by Brennan and Schwartz (1977) has been a bench mark for the further development of methods for valuing complicated financial instruments. A main difference between their approach and the approaches of certain other papers is that they use the firm value as underlying state variable. Furthermore, their numerical method enables them to handle rather complicated features of the instruments to be valued.

It is easier to implement models that work with the stock value as underlying state variable, mainly because it is hard to observe the value of the firm. However, Merton showed how to estimate the firm value if there is at least one traded asset (Merton 1974, p. 451).

In the LYON paper by McConnell and Schwartz (1986), the stock is used as the underlying state variable. The motive is that the indenture provisions are connected with the stock price; hence it would be difficult to use the firm value as state variable in this case. They also want to set up a "commercially usable" method that can be run on a personal computer. They argue that the theoretical gain from using the firm value as underlying state variable does not compensate for the effort involved in taking that approach.

A convertible bond often involves a dual option: The bondholder can choose to convert into common shares at any point in time, and the firm can call the bond for redemption. In the latter case, the bondholder may choose to convert the bond or redeem it. The optimal call

strategy (in the sense of maximizing existing shareholder value) is to call the convertible as soon as its value if called is equal to its value if not called (Brennan and Schwartz 1977). The underlying assumption is that the investors and the firm act optimally and expect the other party to do the same. This means that the company acts to maximize the value of the equity and minimize the value of the convertible bond. The investors, on the other hand, act to maximize the value of the convertible. The result is an equilibrium where neither party can improve its position by adopting another strategy (Brennan and Schwartz 1977). This aspect of convertible bond valuation does not arise in connection with Swedish convertible bonds issued to employees, since such convertible bonds can not be called by the firms (they do not have any call provisions).

The optimal call strategy just mentioned has been investigated empirically by Ingersoll (1977b) and Asquith (1991). These two studies have alredy been mentioned above (Appendix 2:2). In another type of study, Mikkelson (1981) found that an announcement of a call of a convertible bond had the effect of reducing the stock price by 2 percent. He suggests that this response on the part of the market is due to the market's recognition of the loss of interest tax shield from the bonds. Brennan and Schwartz (1986) argue that the "information effect" is a more plausible explanation. The market has been used to associating convertible calls with unfavorable events having nothing to do with conversion into shares. The market may suspect that the management is trying to eliminate as much fixed interest payments as possible in anticipation of bad times for the company.

Why do companies issue convertible debt? The simplistic arguments (which are not elaborated or mentioned in detail in Appendix 2:2) for convertible bond issues are that the interest payment on the bond part is lower than that on a straight bond; moreover, if conversion takes place, then the company has sold its shares at a higher price than the share price at the time of issue. A better explanation is given by Brennan and Schwartz (1986). They argue that convertible bond financing could be a preferred alternative for companies that are perceived to be fairly risky by the market and therefore have to pay a penalty coupon rate on a straight debt issue. If the management does not want to pay such a high coupon, because it does not agree on the risk level, it may be tempted to issue a convertible bond. As stated earlier, the convertible bond value can be seen as a sum of the bond part and the option part. This means that a convertible's value is not as sensitive to company risk as straight debt or an issue of common shares: If the risk level is high, the option part will be

more valuable because the chance of participating in the profits as a shareholder increases. On the other hand, if the risk is low, the bond part becomes more valuable and the option part less valuable. The upshot is that an investor does not have to make a very exact assessment of the risk of the company.

3.2.2 Research using CCA with interaction between different instruments in the capital structure

Empirical research on the interaction between the different instruments in the capital structure is not common. Only a couple of papers have analyzed how to handle the interaction between different instruments in the capital structure in the framework of Contingent Claims Analysis. Brennan and Schwartz (1980) use a two-state model to analyze a convertible bond in a capital structure of common stock, convertible bonds and straight debt. The two underlying variables are the firm value and the interest rate. They derive the valuation equation and indicate how the different covenants and indenture provisions can be taken care of. Furthermore, they show how changes in different parameters affect the value of the convertible bond. Regarding the use of a stochastic interest rate, the authors conclude that a one-state model with the firm value as underlying variable is sufficient for most cases.

Jones, Mason and Rosenfeld (1984) test Contingent Claims Analysis on the valuation of debt in typical corporate capital structures. They demonstrate that the value of callable debt need not to be a monotonic function of firm value. The interaction between different debt issues in a capital structure with multiple such issues is a major problem in applying Contingent Claims Analysis. Minimizing the market value of a particular bond by a call is not necessarily the same as minimizing the value of the bundle of debt instruments and hence maximizing the value of the equity in a complex capital structure. Jones, Mason and Rosenfeld argue that in order to identify the optimal call policies, one has to consider all states of possible capital structure and to choose that state of capital structure which maximizes the value of the equity. They show in their paper how to handle this problem analytically. The empirical test which they carry out shows that their model is not an improvement over a naive model.

Selby, Franks and Karki (1988) use the Contingent Claims Analysis framework to analyze the financial economics of loan guarantees and related wealth transfers. They show

how to value loan guarantees and also demonstrate the transfers of wealth between the security holders of the firm that take place when a new guaranteed loan is introduced into the capital structure. By this valuation, they show that the value of the loan guarantees depends very much on the maturity structure of the existing loans in the capital structure and their priorities vis-à-vis the new guaranteed loan. The authors show that most of the absolute value of the guarantee is received by the equity holders and short senior bondholders (short refers to the time to maturity).

3.3 Theoretical framework

The theory for Contingent Claims Analysis was developed by Black and Scholes (1973) and Merton (1974, 1977). They show that under certain assumptions corporate liabilities which are functions of the firm value and time obey a partial differential equation. This is shown with the use of an arbitrage argument (i. e., the absence of riskless arbitrage opportunities). The values of the liabilities do not depend on expected returns on assets and liabilities of the firm. However, they do depend on the risk-free interest rate, the firm volatility, and payouts on claims (such as dividends, coupons on the convertible bond, and amortization and interest payments on the debt). Most of the theoretical framework for valuing convertible bonds was mainly developed by Merton (1973, 1974, 1977), Brennan and Schwartz (1977), and Ingersoll (1977a, 1977b). For an overview of the use of Contingent Claims Analysis, see Mason and Merton (1985).

CCA rests on the following assumptions taken from Merton (1974, 1977):

(A1) There are no transactions costs, taxes, or problems with indivisibilities of assets.

(A2) There are a sufficient number of investors with comparable wealth levels so that each investor believes that he/she can buy and sell as much of an asset as he/she wants at the market price.

(A3) There exists an exchange market for borrowing and lending at the same rate of interest.

(A4) Short sales of all assets, with full use of the proceeds, are allowed.

(A5) Trading in assets takes place continuously in time.

(A6) The Modigliani-Miller theorem that the value of the firm is invariant to its capital

structure holds.

(A7) There is a riskless asset whose rate of return per unit time is known and constant over time. Denote this rate by r_f.

(A8) The dynamics for the underlying state variable, S, through time can be described by a diffusion process with a stochastic differential equation of the following form

$$dS = (\mu S - qS)dt + \sigma S dz$$

where μ is the instantaneous expected return on the underlying state variable, q is the instantaneous payout to the owner of the state variable, σ^2 is the instantaneous variance per unit time of the return on the underlying state variable (in this dissertation σ^2 is taken to be constant over time), and z is a standard Wiener process.

(A9) It is assumed that investors prefer more to less. It is assumed that investors agree on σ^2, but it is not assumed that they necessarily agree on μ.

Several of these assumptions are not necessary for the model to work, but are chosen for expositional convenience. In particular assumptions (A1)-(A4) can be substantially relaxed (Merton 1974). The most important assumptions are (A5), that the markets are open for trading most of the time, and (A8), which requires that the price movements are continuous and that the returns of the securities are serially independent.

3.4 Three different models for valuing convertible bonds

In the sequel a presentation of the different models for valuing convertible bonds will be given. All models are one-state contingent claims models (i. e. with one underlying state variable). They represent increasing degrees of technical sophistication. Model I has three versions, with Model Ia as the simplest one and Model Ic as the most complex one. Model Ia requires only one application of the Black-Scholes formula and one discounting operation. Model Ib requires many different applications of the Black-Scholes formula, in addition to several discounting operations to derive the residual value of the straight bond part at different points in time in order to find the optimal time horizon for conversion. For Model Ic a numerical method is required, like the implicit finite difference method (other numerical methods can also be used). Model II and Model III use the implicit finite difference method

with an iterative search for the unknown firm volatility. The most important theoretical difference between Models Ia-Ic and Models II-III is that the capital structure of the firm can be considered in models like Model II and Model III. For an overview of the models, see Table 3.1.

Table 3.1. Model overview

	Models with the value of the stock as underlying state variable
Model Ia	Convertible bond value = risky straight bond + European call option.
Model Ib	Convertible bond value = risky straight bond + pseudo-American call option.
Model Ic	Convertible bond value = risky straight bond + American call option.
	Models with the value of the firm as underlying state variable
Model II	Convertible bond value obtained by solving a partial differential equation, assuming firm value = common stock + convertible issue.
Model III	Convertible bond value obtained by solving a partial differential equation, assuming firm value = common stock + debt + convertible issue.

As seen in Table 3.1, Model I is a stock value based model, similar to the LYON model by McConnell and Schwartz (1986). Model II has the firm value as underlying variable, with a capital structure of common stock and convertible bonds. This model was developed by Brennan and Schwartz (1977). Model III also has the firm value as underlying variable but with a capital structure of common stock, convertible bonds and debt. Model III is similar to the model of Brennan and Schwartz (1980). However, as opposed to our Model III, the model by Brennan and Schwartz (1980) has a stochastic interest rate rather than an assumed constant interest rate.

The insights that can be gained from the models are quite different. The main difference between Model I on the one hand and Models II and III on the other hand, namely that

Model I uses the stock value as underlying state variable, means that Model I takes care of the bankruptcy risk by using a risk adjusted interest rate instead of the risk-free interest rate for calculating the straight bond part value of the convertible. It is not easy to set this risk adjusted interest rate so that it properly reflects the bankruptcy risk, especially if the instrument in question is not traded. Market participants use rules of thumb to set this interest rate.

In Model I, an increase in the volatility will increase the value of the convertible bond. However, this is true only as long as the risk adjusted interest rate is constant. If the volatility increases, the bankruptcy risk also increases. Hence, the risk adjusted interest rate should be increased. This means that the option value increases and the bond value decreases, so the total effect is not clear, as will be seen below. For Models II and III, the effect of increasing volatility is also unclear. Increasing volatility means that the bankruptcy risk increases in Models II and III. How this affects the value of the convertible bond can not be predicted. The interaction with the actual interest rate level and stock price has to be considered, as will be seen below.

With Models II and III, the bankruptcy risk and the dilution effect (dilution is not accounted for in Model I) can be accounted for in a more realistic fashion. These two factors must be regarded as very important, especially the bankruptcy risk. In most companies, there is debt that will be paid off before the convertible bond holders receive any payouts. Model I, on the other hand, totally disregards the capital structure of the firm.

Introducing more instruments into the capital structure creates a more realistic model for valuing convertible bonds. The volatility of the firm with several securities in the capital structure will not be the same as the volatility of the stock. This means that it will not be possible when using Model II or Model III to state in advance if changes in stock volatility will increase or decrease the convertible bond value.

By incorporating the actual debt into the capital structure as in Model III, we can better utilize the power of Contingent Claims Analysis. The valuation of the convertible bond will then be carried out with a full account of debt payments (i. e. amortization and interest payments), convertible bond coupon payments, and dividend payments. Consequently, there is a more realistic modelling of bankruptcy risk. This feature of Model III is the main advantage of that model compared to Model I and Model II. The disadvantage of Model III is its complexity, which makes it hard to implement.

In applying Model III, one has to make assumptions regarding the debt and the convertible bond. One debatable assumption which we make is that in the case of bankruptcy, there is a strict priority between the debt and the convertible bond. That is, we assume that in bankruptcy, the debt will be paid off in full before the holders of the convertible bonds obtain anything. The argument against this assumption is that the priority rules may not hold in a bankruptcy, since the negotiations between the parties may create a different priority. This may well be the case. But the argument for using strict priority in this study is that the stock value based model does not consider priority rules at all. We are comparing different models for establishing a value of a convertible bond issue when it is launched. To include priority rules different from our assumed ones seems difficult. Since priority rules can not be included in Model I, in any case, it would be even more difficult to compare the models. It may be noted that a recent paper by Longstaff and Schwartz (1992) on the valuation of risky debt allows for deviations from strict absolute priority.

Some further technical differences between stock value and firm value based models may be noted. Using the stock as underlying variable is an advantage when one has to consider put and call conditions. Those conditions are often expressed in terms of stock prices. To account for those conditions in a model with the firm value as underlying variable is more complicated. Dividends are easy to take care of in Model I because dividends are usually expressed as a percentage of the stock price. In Models II and III, it is hard to model dividends dependent on the firm value and compare them to the dividends in the stock value based model.

3.5 The stock value based model

The stock value based model is representative of commonly used approaches for valuing convertible bonds. Our model development has been inspired by earlier papers by Schwartz (1977) and by McConnell and Schwartz (1986).

3.5.1 General model features

In the framework of a one-state model, we assume a constant interest rate over the valuation period. To assume a stochastic interest rate would force us to use a two-state model.

Research done by Brennan and Schwartz (1980) indicates that using a two-state model with stochastic interest rate instead of a one-state model with constant interest rate does not improve the valuation enough to make up for the extra effort.

With the third variant of the stock value based model, we can handle complicated call and put features conditional on the stock price. This is done by resetting the initial condition. Conversion is handled similarly. Coupons are taken care of in the bond part of the model, as will be explained shortly. This type of model (i. e., a stock value based model) can not account for dilution. Bankruptcy risk is handled by using a risk adjusted interest rate for the bond part.

The value of the convertible bond in this model (all three variants) is regarded as the sum of a bond part and an option part. The value of the bond part is the sum of the nominal value of the convertible bond and the coupons, all discounted at the continuously compounded risk adjusted interest rate. The formula is

$$Bond\ value = \sum_{i=1}^{I} \frac{coupon_i}{e^{r_b T_i}} + \frac{nominal\ bond\ value}{e^{r_b T_I}} \tag{3.1}$$

where

T_i = time until coupon i,

r_b = continuously compounded risk adjusted interest rate,

$coupon_i$ = coupon amount in time period i,

I = index for the final time period (time of expiration).

How we set the risk adjusted interest rate is further discussed in chapter 4.

It is assumed that the stock value $S(t)$ obeys a diffusion process

$$dS = (\mu S - qS)dt + \sigma S dz, \tag{3.2}$$

where μ is the instantaneous expected return on the stock, q is the instantaneous dividend yield on the stock, σ^2 is the instantaneous variance per unit time on the stock return, and z is a standard Wiener process. q and σ^2 could be functions of S and t, but will be taken as constants in this dissertation. The formula for valuing a European call option on a stock with dividends as a continuous yield is (cf. Hull 1993, p. 248)

$$c = Se^{-q(T-t)}N(d_1) - Xe^{-r_f(T-t)}N(d_2), \tag{3.3}$$

where

$$d_1 = \frac{\ln\frac{S}{X} + (r_f - q + \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}}, \qquad d_2 = \frac{\ln\frac{S}{X} + (r_f - q - \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}},$$

and

S = current stock price,

X = exercise price,

$T\text{-}t$ = remaining life of the option, also denoted τ,

q = dividend yield,

r_f = risk-free rate of interest,

σ^2 = variance on the stock return,

N = standard cumulative normal distribution function,

t = current time.

3.5.2 Model variant with a European option part and a bond part

The simplest variant of the stock value based model is one which values the bond part with a risk adjusted interest rate and the option part with the option formula for a European call option with constant continuous dividend yield. In this model variant, it is assumed that conversion only takes place at expiration. The exercise price then is the nominal value and final coupon of the bond part.

3.5.3 Model variant with a pseudo-American option part and a bond part

The next model variant is one which values the bond part with a risk adjusted interest rate and the option part as a pseudo-American call option, where the remainder of the straight bond value is used as exercise price in the option value formula. The remainder of the straight bond value is the nominal value of the bond and coupons discounted at the risk adjusted interest rate (see formula (3.1) above). The exercise price will change at every time step. Assuming that conversion is permitted to take place before expiration, we will have to

examine every life time and specify in advance that life time which maximizes the value of the convertible bond. We use a risk adjusted interest rate on the bond part. That is, we calculate the exercise price with one interest rate and the option part with another interest rate (i. e., the risk-free interest rate). This is the pseudo-American approach.

As mentioned above, we specify the dividends as a continuous yield on the stock. Alternatively, we could have specified the dividends as discrete payments. In either case, dividends may lead to premature exercise of the option part of the convertible bond. The changes in exercise price will also influence the decision to convert prematurely (Merton 1973). In particular, the difference between the risk adjusted interest rate for the bond part and the risk-free interest rate for the option part means that premature exercise could occur due to the fact that the exercise price between coupons (i. e., the remainder of the straight bond part) increases towards maturity. If the difference between the risk adjusted interest rate, which we use for computing the exercise price (the remainder of the straight bond value), and the risk-free interest rate is big enough, it could be optimal to exercise in advance even with a zero dividend yield.

To illustrate this, we show the value of a convertible bond for one of the cases in our investigation where it is optimal to convert before maturity, due to a rise in the exercise price (see Figure 3.1). In the figure, the upper line is the convertible bond value and the lower line is the exercise price. The optimal conversion time is 5 periods before the expiration (in this study, one period is equal to two weeks). The periods where there are no values in Figure 3.1 are periods when conversion is not permitted. Note the coupon payments at the end of the life-time of the convertible bond. The final year's coupon is divided into two portions for this particular convertible bond. This can be seen very clearly in the development of the exercise price.

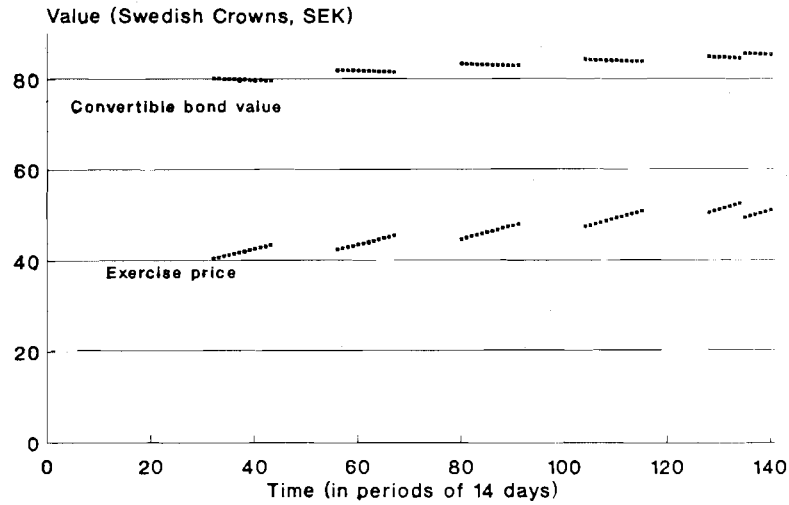
To summarize, the time to convert has to be specified in advance in the second model variant, so as to maximize the value of the convertible. In other words, the conversion decision may only depend on time to expiration, but not on the current stock price.

3.5.4 Model variant with an American option part and a bond part

In our third model variant, the convertible bond is valued as the sum of a risky bond and an American call option. The optimal conversion decision now depends on both the stock price

S and the time to expiration τ. In passing, it may be remarked that the LYON model of

Figure 3.1
Model Ib, value of convertible bond and exercise price.



McConnell and Schwartz (1986), although being similar in spirit to our third model variant, values the whole of the convertible bond as one single part. The bankruptcy risk is captured by one single interest rate, which they set to be an intermediate one rather than the risk-free rate.

The diffusion for the stock price has already been stated above, equation (3.2). Using an arbitrage argument, the value $A(S,\tau)$ of the American option part of the convertible bond must satisfy the partial differential equation

$$\frac{1}{2}\sigma_S^2 S^2 A_{SS} + (r_f S - qS)A_S - A_\tau - r_f A = 0, \tag{3.4}$$

where single and double subscripts on A denote first and second partial derivatives. As before, τ is the remaining time until expiration, and q is the continuous dividend yield on the stock. r_f is the continuous risk-free interest rate, known and constant over time.

To solve equation (3.4), we use a numerical method, because there is no closed form

solution which can incorporate the possibility of premature conversion. That method is the implicit finite difference method. Although other methods could presumably have been used, for instance, a lattice method, for consistency we nevertheless stick to the implicit finite difference method in this dissertation, since it is probably the only one (or at least the best one) for the firm value based model, which is used later in the dissertation. The implicit finite difference method can handle many different conditions (i. e., different put, call, and conversion conditions) of the particular security. (The convertibles valued in this dissertation can not be called or put, though). The remaining bond value, which is used as exercise price, is computed by using the risk adjusted interest rate. In the option part, the risk-free interest rate is used.

The differential equation (3.4) appears in the analysis of many different financial instruments. What differentiates those instruments are the initial and boundary conditions. For the option part of the convertible bond, the initial condition is given by the payoff at maturity (expiration of the convertible bond). That is

$$A(S,0) = 0 \qquad \text{if } S < B + k, \tag{3.4a}$$

$$A(S,0) = S - (B + k) \text{ if } S \geq B + k. \tag{3.4b}$$

In condition (3.4a) and (3.4b) we have that the owner of the convertible bond will exercise the option to convert into shares, if the stock price S is higher than the sum of nominal amount of the bond B plus the final coupon k (it is obviously assumed that one convertible bond can be converted into one share of stock). The left and right boundary conditions are

$$A(0,\tau) = 0, \tag{3.4c}$$

$$A_s(S,\tau) \rightarrow 1 \text{ as } S \rightarrow \infty. \tag{3.4d}$$

Condition (3.4c) states that the option to convert is worthless if the stock is worthless. As can be seen from condition (3.4d), the value of the option part of the convertible bond increases at the same rate as that of the stock, when the stock value reaches a very high value. Condition (3.4d) is actually only correct if the dividend yield q is equal to zero. This can be shown by taking the partial derivative of the Black-Scholes formula with respect to S and letting $S \rightarrow \infty$. A more appropriate boundary condition when we have a dividend

paying stock is actually:

$$A_s(S,\tau) = e^{-q\tau} \quad \text{as} \quad S \to \infty. \tag{3.4e}$$

In this situation, τ is not the time to maturity, but rather the time to the next point in time when conversion is permitted. In numerical calculations, the difference between the two right boundary conditions is very small. For the valuation that we are conducting, using the boundary condition (3.4e) instead of condition (3.4d) will only have a minute impact on the valuation.

Swedish convertible bonds typically have a period during which the owners are not permitted to convert their bonds into shares. This period is usually two years from the time of issue. For the time period when conversion is permitted, we have to check for every point in time that the value of the option part is at least as high as the stock value minus the remainder of the straight bond value. This is so, since the owner would convert into shares, if the value of the convertible if left unconverted would be lower than the stock value. Technically, this is done by resetting the computed value function.

3.6 The two models based on the firm value

3.6.1 Model II

Model II uses the value of the firm as underlying state variable. It is solved using a numerical method, the implicit finite difference method (the same method which we use in the case of Model Ic, the third variant of the stock value based model). Model II handles both bankruptcy and dilution effect through the initial and boundary conditions. This is in contrast to the stock value based model, which can not account for dilution and which handles bankruptcy through a risk adjusted interest rate.

Define:

V = total firm value, i. e., the total market value of the firm's outstanding securities (total firm value equals common stock plus the convertible bond issue),

$C(V,\tau)$ = the total value of the convertible bond issue,

q = the dividend yield as a fraction of the total firm value V,

σ_V = the volatility of the firm,

k = the total final coupon amount for the convertible issue,

B = the nominal value of the entire convertible issue,

w = the fraction of the firm that the convertible bond issue provides to the convertible owners, if conversion takes place.

When applying this model, the assumption is that the total market value of the firm's securities V is determined exogenously and independently of the call and conversion strategies applied (Merton 1974, 1977). This means that the value of a share after conversion is given by the value of the firm prior to conversion divided by the number of shares outstanding after conversion of the convertible bond issue. If we make the assumption that the firm value V follows the stochastic process (Merton 1974)

$$dV = (\mu V - qV)dt + \sigma_V V dz_V , \tag{3.5}$$

then $C(V,\tau)$ must satisfy the following partial differential equation

$$\frac{1}{2}\sigma_V^2 V^2 C_{VV} + (r_f V - qV)C_V - C_\tau - r_f C = 0. \tag{3.6}$$

Single and double subscripts on C denote first and second partial derivatives. As before, τ is remaining time until expiration. r_f is the continuously compounded risk-free interest rate.

In the differential equation (3.6), we only use the risk-free rate of interest (i. e. there is no risk adjusted interest rate). The stock value based model uses both the risk-free rate of interest and the risk adjusted rate of interest, as already mentioned several times. There is hence one more parameter in the stock value based model, and this makes the two models somewhat difficult to compare.

Dividends can be handled in different ways in a model like this. Here we let the dividend be a continuous stream, as is evident from the partial differential equation (3.6). In the Brennan and Schwartz model, on the other hand, dividends are discrete payments at pre-set dates (Brennan and Schwartz 1977, p. 1709). In either case, it is quite difficult to handle

dividends which depend on the stock value in a model with the firm value as underlying variable. The dividend yield approach in the stock value based model implies that dividends should be proportional to the stock value, and not to firm value. We handle this in the firm value based model by fixing dividends as a yield based on total firm value, in such a fashion that the total amount of dividends based on the starting firm value equals the corresponding total amount of dividends based on the starting stock value in the stock value based model. This is done in an outer loop.

The initial condition for $C(V,\tau)$ (at maturity) is:

$$C(V,0) = \begin{cases} V & \text{if } V < B+k, \\ B + k & \text{if } B+k \leq V < (B+k)/w, \\ wV & \text{if } (B+k)/w \leq V . \end{cases}$$

As mentioned above, w is the fraction of the total firm value to which the convertible owners are entitled, if conversion takes place. B is the nominal value of the convertible issue, and k the total final coupon. This initial condition reflects the fact that if firm value is less than the sum of the nominal bond value and final coupon, the holders of the convertible bond issue will get the total firm value. The bondholders will receive the par value plus final coupon, if the value of the company is greater than or equal to the par value plus coupon. However, if the conversion value is greater than the sum of nominal bond value and final coupon, the bondholders will convert and receive that proportion of the total firm value that they are entitled to. With an initial condition like the one above plus the following left and right boundary conditions, we handle both bankruptcy and dilution effects.

The boundary conditions are:

$$C(0,\tau) = 0,$$
$$C_V(V,\tau) \rightarrow w \text{ as } V \rightarrow \infty .$$

From these boundary conditions, it is clear that the convertible will be worthless if the firm becomes worthless (bankrupt). The ability to handle bankruptcy in this fashion is a valuable feature of this model compared to the stock value based model described earlier. This firm value based approach can be developed into more sophisticated models for valuing securities

in complicated capital structures; cf. Model III below. It is theoretically more palatable to use this approach instead of having the stock as underlying state variable, because modelling bankruptcy based on stock value is somewhat unrealistic (a stock can not go bankrupt). When we are modelling bankruptcy in our firm value based model, the bankruptcy is triggered when the firm value is too low to meet required payments (coupons and nominal value of the convertible issue).

Convertible bonds are not protected against dividend payments by the firm. A firm value based model accounts for this fact by incorporating the possibility of bankruptcy. Dividends affect the value of the convertible bond in two distinct ways. Firstly, they increase the probability of default and reduce the assets available for the bondholders in a bankruptcy scenario. This has an impact on the straight bond value. Secondly, if the probability of default is small (for high values of V), the conversion premium (i. e., the difference between the instrument value and the conversion value) is reduced, i. e. the value of the convertible bond approaches the conversion value (Brennan and Schwartz 1977, p. 1711).

In this model, we handle the coupon payments by discrete adjustments of the value function at the appropriate points in time (cf. Schwartz 1977 for a more extensive discussion of such adjustments, although in the context of dividends). Conversion before maturity is also handled by discrete adjustments. That is, we have to check for each point in time when conversion is permitted that the instrument value is at least as high as that part of total firm value to which the convertible owners are entitled, if they convert.

3.6.2 Model III

Model III is a firm value based model with three instruments in the liabilities side of the balance sheet, common stock, convertible bond issue, and debt. In the following, a description will be given of a numerical method that can be used to calculate the values of these instruments. We describe how to value the convertible bond and the debt. The value of the common stock can then be obtained as a residual.

The outline of Subsection 3.6.2 is as follows. First we present the model equations followed by the side conditions. The numerical solution procedure for this problem (we use the implicit finite difference method) is described in Section 3.7.

3.6.2.1 Model definitions

The definitions used for Model II are also used for Model III, plus the ones defined below.

Define:

F = nominal value of remaining debt,

f = amortization on debt,

g = interest payments on debt,

D = total value of debt.

In our model we make discrete adjustments for the convertible bond coupon. The amortization and interest payments on the debt are handled in the same fashion. With this approach, we can assume that the firm value V follows the same stochastic process (3.5) between discrete adjustments as Model II. The value of the total convertible bond issue must then satisfy the same partial differential equation (3.6) as the one used in Model II.

3.6.2.2 Conversion strategy

The optimal conversion strategy is an essential part of the valuation problem. The following description is similar to that of Brennan and Schwartz (1980). To be able to state the optimal conversion strategy, we need some definitions. The value of the firm V is equal to the sum of the market values of the convertible bond C, the common stock S, and the value of debt D. Formally,

$$V = C + S + D.$$

In the above expression, we are treating the market values of the convertible bond, the common stock, and the debt as totals. After conversion, the value of the firm can be expressed as

$$V = S + D.$$

Note that the above expressions refer to the total common stock, total convertible issue, and total debt (i. e., not to individual shares or certificates). Treating the values as aggregated values enables us to define the conversion value to be

$$\text{Conversion value} = w(V - D),$$

where w is that fraction of the residual value (the value of the firm minus the debt) which the convertible bond holders will obtain, if they convert into shares. w is defined as

$$w = \frac{n}{(n+N)},$$

where

n = number of new shares through conversion,

N = number of shares outstanding before conversion.

The optimal conversion decision will always be to convert if the value of the convertible bond falls below the conversion value. If the convertible bond value is above the conversion value, it will never be optimal to convert, because this involves a sure value loss. Hence, the optimal conversion condition is that the value of the convertible bond be equal to its conversion value

$$C = w(V - D).$$

A problem with this condition is that the optimal conversion strategy is not defined until the values of the debt and the convertible bond are determined. And the debt value itself depends on the choice of conversion strategy. This makes it necessary to value the convertible bond and the debt and to determine the optimal conversion strategy simultaneously. The interaction between the convertible bond and the debt is the main problem in incorporating debt into the valuation model.

To reiterate, for every point in time when conversion is permitted, one has to value the debt and the convertible bond simultaneously. The value of the debt will always depend on the convertible bond value, due to the fact that the coupon payments could be a reason for

bankruptcy. If there where no convertible bonds in the capital structure (i. e. conversion had already taken place), there would be no coupon payments. This source of bankruptcy risk would hence be eliminated. The value of the convertible bond will in turn depend on the debt in the capital structure for the same reason. That is, if there were less debt or no debt, the convertible bond would be worth more, because there would be less money paid out from the firm.

We handle the problem of the interaction between the debt and the convertible bond by calculating in each time step the value of the convertible and debt in three separate phases. In the first phase, we calculate the value of the debt under the assumption of no convertible bond in the capital structure. Secondly, the value of the convertible bond can then be obtained using *the optimal conversion decision rule*. Thirdly, the debt is revalued, taking into account the conversion decisions in the second phase. This means that in each time step, we have to work simultaneously with three value functions. Also, in each time step one has to consider the side conditions connected with each value function. Section 3.7 describes how to do this in the numerical solution method.

3.6.2.3 Initial and boundary conditions for the convertible bond

We make the *assumption*, in the case in which we will apply Model III, the Nordström & Thulin case, that the debt will mature at the same date as the convertible bond. The debt payment at maturity will then consist of remaining debt plus last interest payment. This assumption is imposed because an initial condition is needed. That is, there has to be a value of the debt at the end of the valuation period. Furthermore we *assume* that there is strict priority in case of bankruptcy, i. e. the whole debt will be paid before any firm value can be obtained by the holders of the convertible bonds. The above assumptions and the optimal conversion strategy presented earlier give the following initial conditions for C

$$C(V,0) = \begin{cases} 0 & \text{if } V < (F+g). \quad (3.7a) \\ V - (F+g) & \text{if } (B+k) > V - (F+g) \geq 0 \quad (3.7b) \\ B + k & \text{if } B+k \leq (V - (F+g)) < (B+k)/w \quad (3.7c) \\ w(V - (F+g)) & \text{if } w(V - (F+g)) \geq (B+k) \quad (3.7d) \end{cases}$$

B is the nominal value of the convertible bond, k is the final coupon of the convertible bond, F is the nominal value of the remaining debt and g is the interest payment on the remaining debt. Note that in the initial condition, the value of the debt D is equal to the nominal value of the debt F plus interest payment g. Therefore, at maturity, the conversion value will be the fraction w of the firm value minus the nominal value of debt plus the interest payment:

$$\text{Conversion value} = w(V - (F+g)).$$

The above initial (maturity) condition states that the holders of the convertible bonds will convert if the conversion value is greater than or equal to the nominal value of the convertible bond plus last coupon. The holder of the convertible bond will receive the nominal value of the convertible bond plus last coupon if this is less than the conversion value. However, if the firm value minus the nominal value of the debt plus interest payment is less than the nominal value of convertible bond plus last coupon, the convertible bond holders will receive the firm value minus the nominal value of the debt plus interest payment. If the firm value is less than the nominal value of the debt plus interest payment, the convertible bond holders will receive nothing. The boundary conditions are

$$C(0,\tau) = 0 \tag{3.8a}$$

$$C_V(V,\tau) \to w \text{ as } V \to \infty \tag{3.8b}$$

The left boundary condition (3.8a) says that if the firm value is zero, the value of the convertible bond is zero. If the value of the firm gets very large, the convertible bonds will be regarded as shares, and their value will change in accordance with their fraction of the firm value (the right boundary condition (3.8b)).

The value of the debt must satisfy the same type of partial differential equation as the value of the convertible bond (i. e. of the same form as equation (3.6)):

$$\frac{1}{2}\sigma_V^2 V^2 D_{VV} + (r_f V - qV)D_V - D_\tau - r_f D = 0. \tag{3.9}$$

D is the value of the debt. Single and double subscripts on D denote first and second partial derivatives.

From the assumption which we made regarding the maturity of the debt, it follows that the initial condition must be

$$D(V,0) = \min[V, (F+g)]. \tag{3.10}$$

That is, at maturity the debt will be worth $(F+g)$, if the firm value is greater than or equal to this amount. If the value of the firm V is less than the sum of the remaining nominal value of debt and interest payments, bankruptcy will be triggered, and the value of the debt will be equal to total firm value. The boundary conditions for the debt are as follows

$$D(0,\tau) = 0, \tag{3.11a}$$

$$D_V(V,\tau) \rightarrow 0 \text{ as } V \rightarrow \infty \tag{3.11b}$$

The first condition states that if the total firm value is zero, the debt will be worth zero. The second condition is that when the firm value reaches a high value, the value of the debt will not increase, i. e. the debt will be regarded as risk-free.

3.7 A description of the numerical solution

First we will give a short overview. After the overview, a detailed description is given of the most important parts of the numerical method. The description can be used for constructing a computer program for valuing financial instruments in a complex capital structure.

The solution procedure for this valuation problem is divided into three main parts, each part involving several phases. The first part of the procedure is the specification of constants and parameters. The second part is the outer loop. The outer loop is in turn divided into two groups of calculations, one for estimating the firm volatility, and the other for setting the dividend yield. For a complete description of this outer loop, see Section 3.8. The third part is what we call the inner loop. In the inner loop, the main body of the calculations is located. Note that the time steps are in reverse calendar time.

In the inner loop, the calculations start with setting the initial conditions for the three value functions, namely, the convertible bond value, the debt value *without* convertible bonds

in the capital structure, and the debt value *with* convertible bonds in the capital structure. For the two debt value functions, the initial conditions are the same. After the setting of initial conditions, the equation systems for the three value vectors are solved in every time step. This means that we have to obtain three value vectors in every time step. At those points in time when debt payments and coupon payments are due, the three value vectors have to be adjusted.

For every time step when conversion is permitted, we check if it is optimal to convert. Depending on the optimal choice, the value vectors are adjusted. The value vectors obtained in the current time step are then used in the following time step as starting values. A more technical description is given in the following subsections.

3.7.1 A detailed description of the valuation process

In the following, we give a detailed description of the numerical solution methodology. The description is divided into four parts, a detailed description of the initial and boundary conditions, the solution algorithm, a description of the adjustments for debt and coupon payments, and a description of how to check for optimal conversion.

For solving equations (3.6) and (3.9) expressed in finite difference form, a discrete grid of values of the independent variables V and τ is used. The points in the grid are defined by $V_i = ih$ $(i = 0, 1, 2, \ldots, (n-1), n)$ and $\tau_j = jm$ $(j = 0, 1, 2, \ldots, j^\circ)$. The symbols h and m are the discrete increment in the firm value and in time to maturity respectively. In the time dimension and the firm value dimension, the symbols n and j° represent the number of steps respectively. Apparently, j° times m is the exact length of the time period for the valuation of the convertible bond.

Define:

$C_{i,j}$ = the value of all convertible bonds outstanding (i. e., not of a single instrument), with the firm value equal to ih and time to expiration jm,

$D^1_{i,j}$ = value of debt *without* convertible bonds in the capital structure,

$D^2_{i,j}$ = value of debt *with* convertible bonds in the capital structure.

3.7.2 Initial conditions

At $j = 0$ we set the initial conditions (3.7a) - (3.7d) for equation (3.6) in the following manner.

$C_{i,0} = 0$ for $i = 0$ to $\{(F+g)/h\}$,
$C_{i,0} = ih - (F+g)$ for $i = \{(F+g)/h\} + 1$ to $(F+g+B+k)/h\}$.

For $i = \{(F+g+B+k)/h\} + 1$ to n, if $w(ih - (F+g)) > (B+k)$,
then $C_{i,0} = w(ih - (F+g))$,
otherwise $C_{i,0} = (B+k)$.

$\{a\}$ denotes the integer part of the real number a (i. e. $\{a\} \leq a$).

For the debt we set the initial condition (3.10) in the following fashion.

$D^1_{i,0} = ih$ for $i = 0$ to $\{(F+g)/h\}$,
$D^1_{i,0} = (F+g)$ for $i = \{(F+g)/h\} + 1$ to n.
Set $D^2_{i,0} = D^1_{i,0}$ for all i.

In the above expression, we have the bankruptcy condition that if the firm value is less than the total value of the debt payment (principal and interest), the debt value is equal to total firm value. Setting $D^2_{i,0} = D^1_{i,0}$ for all i in the above expression only means that at this point in time (the starting point in reverse calendar time), there is only one debt value vector to consider.

3.7.3 Solution algorithm

We describe how to solve equations (3.6) and (3.9), using equation (3.6) as an example. The procedure for the debt is similar (just put in a D instead of the C in the first two of the following equations). Writing equation (3.6) in the form of finite differences instead of partial derivatives enables us to approximate by the following equations which are solved for

each $j = 1, \ldots, j^{\circ}$.

For $i = 0$,

$$C_{0,j} = 0. \tag{3.12}$$

For $i = 1, 2, 3, \ldots, (n\text{-}1)$,

$$\alpha_i C_{i-1,j} + \beta_i C_{i,j} + \gamma_i C_{i+1,j} = C_{i,j-1}, \tag{3.13}$$

where

$$\alpha_i = -m\{\tfrac{1}{2}\sigma^2 i^2 - \tfrac{1}{2}(r_f - q)i\},$$
$$\beta_i = -m\{-\sigma^2 i^2 - (i/m) - r_f\},$$
$$\gamma_i = -m\{\tfrac{1}{2}\sigma^2 i^2 + \tfrac{1}{2}(r_f - q)i\}.$$

For $i = n$,

$$C_{n,j} = C_{n-1,j} + wh. \tag{3.14}$$

Equations (3.12) and (3.14) are derived from the boundary conditions (3.8a) and (3.8b). For the debt, the third equation corresponding to (3.14) is

$$D_{n,j} = D_{n-1,j}. \tag{3.15}$$

3.7.4 Payment of debt and coupons

At those points in time when coupons and amortization plus interest are paid, discrete adjustments are done to the three value function vectors. Within each time step, we calculate a value for each one of the three value vectors, i. e. for the convertible bond values, for the values of debt without convertible bonds in the capital structure, and for the values of the

debt with convertible bonds in the capital structure.

The value vector for the convertible bond is adjusted for debt payments and coupons in the following manner.

Define:

f = amortization of debt,

g = interest payment,

$int\_part = \{(f+g + coupon)/h\}$,

$frac\_part = (f+g + coupon)/h - int\_part$.

With these definitions, the adjustments are like this:

For $i = n$ down to $(int\_part + 1)$ set

$C_{i,j} = frac\_part*C_{i-int\_part-1,j} + (1 - frac\_part)*C_{i-int\_part,j}$.

This takes care of the decrease in value of the convertible bond due to the decrease in value of the firm, when there is a payment of amortization, interest, and coupon.

For i equal to $(int\_part + 1)$ up to n, the value of the convertible bond is then reset to be equal to the convertible bond value plus coupon:

For $i = (int\_part + 1)$ to n set

$C_{i,j} = C_{i,j} + coupon$.

The convertible bond value increases, since the coupon is paid to the convertible bond holders. However, for i less than or equal to $(int\_part + 1)$, bankruptcy occurs, since the firm value is not sufficient to cover the payments for amortization, interest and coupons. This is handled in the following manner.

For $i = 0$ to $\min[int\_part, \{(f+g + F)/h\}]$ set

$C_{i,j} = 0$.

For i equal to $\{(f+g + F)/h\} + 1$ and up to int_part, the convertible bond will be worth

the firm value minus the debt. This is expressed in the following fashion:

For $i = \{(f+g + F)/h\} + 1$ to int_part set
$C_{i,j} = ih - (f+g + F)$.

The above description is valid for the value vector of the convertible bond. For the two value vectors relating to the debt, $D^1_{i,j}$ and $D^2_{i,j}$, a similar procedure is used. We show the procedure for $D^2_{i,j}$, the situation where there are still convertible bonds in the capital structure.

Define:

$int\_part = \{(f+g + coupon)/h\}$,
$frac\_part = (f+g + coupon)/h - int\_part$.

Then we have:

For $i = n$ down to $(int\_part + 1)$ set
$D^2_{i,j} = frac\_part*D^2_{i\text{-}int\_part\text{-}1,j} + (1 - frac\_part)*D^2_{i\text{-}int\_part,j}$.
For $i = (int\_part + 1)$ to n set
$D^2_{i,j} = D^2_{i,j} + (f+g)$.
For $i = 0$ to $\min[int\_part, \{(f+g + F)/h\}]$ set
$D^2_{i,j} = ih$.
For $i = \{(f+g + F)/h\} + 1$ to int_part set
$D^2_{i,j} = (f+g + F)$.

As can be seen, there are payments of debt amortization, debt interest, and convertible bond coupons in this situation. Our bankruptcy conditions are seen here. For example, bankruptcy is implied by "For $i = 0$ to $\min[int\_part, \{(f+g + F)/h\}]$ set $D^2_{i,j} = ih$". This is interpreted as follows: For firm values from zero up to the minimum of the actual payment or the whole remaining debt, the debt is worth the value of the firm. Our priority rule, that the debt payments should be undertaken before the convertible bond holders get their coupons, can evidently be seen above.

3.7.5 Optimal conversion

After performing the adjustments for coupons and debt payments, the possible optimality of conversion before maturity has to be checked at those points in time when that is permitted. Recall from Subsection 3.6.2.2 that the condition for optimal conversion is

$$C = w(V - D),$$

where D is the current value of the debt. This is implemented in the following fashion:

For $i = 0$ to n
  if $C_{i,j} < w((ih) - D^1_{i,j})$ set
  $C_{i,j} = w((ih) - D^1_{i,j})$ and $D^2_{i,j} = D^1_{i,j}$.

If the convertible bond value $C_{i,j}$ is less than the residual value of the firm which the convertible bond holders obtain if they convert, conversion will take place. If so, $C_{i,j} = w((ih) - D^1_{i,j})$. If conversion takes place, the value of debt $D^2_{i,j}$ with convertible bonds in the capital structure is set equal to the value of the debt with no convertible bonds in the capital structure $D^1_{i,j}$. This means that the value function vector for $D^2_{i,j}$ is reset. However, for higher j values (earlier in time), the convertible is still assumed to exist. This check of the optimality of conversion is done for every point in time j when conversion is permitted.

At the final time step ($j = j°$), when the values of the convertible bond and the debt have been computed, the value of the common stock can be obtained as a residual. Formally,

$$S_{i,j°} = ih - C_{i,j°} - D^2_{i,j°}.$$

3.8 Estimation of volatility

3.8.1 Estimation of stock volatility

In the stock value based model, we use an estimate of historical volatility. There are some arguments for using implied volatility instead of historical volatility. Most importantly,

implied volatility is forward looking and captures the latest available information (cf. Figlewski 1990, p. 99). However, even if we wanted to use the implied volatility we can not do so here, because a majority of the companies in this dissertation did not have traded options at the valuation date. We are not adjusting for mean reversion (Poterba and Summers 1988) in our estimate of volatility. Adjusting for mean reversion would probably not improve much. In any case, the purpose of the subsequent investigation in Chapters 4 and 5 is to compare different models which use the same volatility estimate.

The volatility in the models is estimated using 120 trading days of share price information. In the LYON paper by McConnell and Schwartz (1986), 100 trading days are used. A recent text book (Hull 1993) mentions 90 to 180 days as an appropriate estimation time horizon. None of the companies investigated in Chapters 4 and 5 has a dividend date during the 120 days used for volatility estimation. The closing price of the trading day is used in the estimation. If there was no trade on a day, the bid price is used instead.

We use the following procedure to estimate volatility (Hull 1993, pp. 214-215; Figlewski 1990, pp. 96-97).

Define:

n = number of observations,

S_i = closing stock price at i:th interval (i=0, 1, . . ., n),

Δt = length of time interval in years,

u_i = $\ln(S_i/S_{i-1})$.

Since

$$S_i = S_{i-1}e^{u_i},$$

u_i is the continuously compounded return in the i:th interval for i = 1, 2, . . ., n. An unbiased estimate of the standard deviation, s, of the u_i's, is given by

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(u_i - \bar{u})^2},$$

The volatility σ can then be estimated as s^* where

$$s^* = \frac{s}{\sqrt{\Delta t}}.$$

The number of trading days on the Swedish stock exchange over a year is around 250. Hence we get $\Delta t = 1/250$. This way of estimating the volatility is satisfactory when the stock pays no dividend. In our case all companies pay dividends, but during the interval when we estimate the volatility there are no dividend dates, as already mentioned.

This estimate of the stock volatility is used directly in Model I. It is also used to derive the firm volatility which is used in the firm value based models, Model II and Model III.

3.8.2 Estimation of firm volatility

Using firm value rather than stock value as underlying state variable forces us to estimate firm volatility instead of stock volatility. This is problematic, since firm value and firm volatility can not be observed empirically. We define the firm value as the sum of common stock and the convertible bond issue in Model II and as the sum of debt, common stock and convertible bond in Model III. In other words, we use this definition of what the firm consists of for valuing the convertible issue. To derive the firm volatility, we use Ito's lemma on $S(V,t)$,

$$dS = S_V dV + S_t dt + \frac{1}{2} S_{VV} dV^2 \tag{3.16}$$

Rewriting the last term in equation (3.16), by using the assumption on how the firm value develops in accordance with equation (3.5), gives:

$$dS = S_V dV + S_t dt + \frac{1}{2} S_{VV}\, \sigma_V^2 V^2 dt,$$

where σ_V^2 = firm variance.

Dividing by S

$$\frac{dS}{S} = \frac{S_V\, dV + S_t dt + \frac{1}{2} S_{VV}\, \sigma_V^2\, dt}{S},$$

and taking the variance of both sides gives:

$$\text{var}\left[\frac{dS}{S}\right] = \sigma_S^2\, dt = \text{var}\left[\frac{S_V\, dV}{S}\right] = \text{var}\left[\frac{dV}{V} \cdot S_V \frac{V}{S}\right] = S_V^2\, \frac{V^2}{S^2}\, \sigma_V^2\, dt,$$

where $\sigma_S{}^2$ = stock variance. So it follows

$$\sigma_S^2 = \sigma_V^2 \cdot S_V^2 \cdot \left[\frac{V}{S}\right]^2,$$

and

$$\sigma_S = \sigma_V S_V \left[\frac{V}{S}\right]. \tag{3.17}$$

We now have an expression for the relation between stock volatility and firm volatility. Further rewriting (3.17), we get

$$\sigma_V = \sigma_S \left[\frac{S}{V}\right] \left[\frac{1}{S_V}\right]. \tag{3.18}$$

The above derivation is taken from Jarrow and Rudd (1983, p. 109-110); see also Merton (1974, p. 455-456). This approach has been taken in a few earlier studies, for example Jones, Mason and Rosenfeld (1984); Ronn and Verma (1986); Selby, Franks and Karki (1988).

As mentioned earlier, the firm value V is equal to what we include in the capital structure of our firm. This gives us the following relation,

$$V = S^* + \text{the value of other instruments included in the capital structure,} \tag{3.19}$$

where S^* is equal to the product of the listed stock price times the number of shares, i. e. the total value of the common stock.

By using the valuation model repeatedly, we get simultaneously solutions to equations (3.18) and (3.19). The procedure can be described in this way:

Step 0 : As a starting value, set the firm volatility equal to the stock volatility.

Step 1 : Use the valuation model to obtain the value of S for all values of V.

Step 2 : Select that value V^* for which $S(V^*)$ is closest to S^*. (This value will be an approximation, because we use a finite grid.) Also, compute S_{V^*}.

Step 3 : Using the known values of $S = S^*$ and σ_S, compute a new value of σ_V, with the help of V^* and S_{V^*} as computed in step 2. Return to step 1 after this.

In the valuation model, this estimation of the firm volatility is done in an outer loop. It only takes a few iterations to get convergence and an approximate solution to equations (3.18) and (3.19). See Table 3.2 for an example.

Table 3.2. Example of convergence in the outer loop.
Case: Catena.

Iteration	V^* (MSEK)	Difference between S^* and $S(V^*)$ (MSEK)	S_{V^*} in next iteration	σ_V^2 in next iteration
Run 1				
0	298.00			0.2818
1	298.00	-0.192	0.696	0.2338
2	298.00	0.658	0.697	0.2333
3	298.00	0.667	0.697	0.2333
4	298.00	0.667	0.697	0.2333
Run 2				
0				0.2818
1	300.00	-0.405	0.693	0.2331
2	300.00	0.469	0.694	0.2326
3	300.00	0.479	0.694	0.2326
4	300.00	0.479	0.694	0.2326

In this model, there is an element of trial and error. The approach which we use for handling dividends makes it necessary to make at least two runs. In run 2, we use the firm

value obtained in run 1, and divide the dividend payment by this firm value to get the dividend yield as a fraction of firm value. It should be noted that the dividend payment is known (i. e., the dividend yield which was assumed in the stock value based model multiplied by the total value of the common stock). This dividend yield is then used in the second run of the model. We then check if we have to make another run.

If the dividend yield as a proportion of the computed firm value is close to the actual, required dividend payment, we do not have to make another run. In the majority of cases, it is enough with two runs.

The main argument for using the implicit finite difference method is the need for estimating firm volatility. In our numerical solution technique, we use two outer loops outside the main program. The firm volatility is estimated in the "inner" outer loop, and the dividend yield is estimated in the "outer" outer loop. The way we estimate the firm volatility by using equation (3.18) means that in Model II we have to calculate the stock value and the convertible bond value for all the firm values (or, more precisely, a large number of firm values). The stock value is the residual, i. e. the firm value minus the convertible value. In Model III the debt has to be considered as well. Handling this in a lattice procedure would be computationally burdensome.

In a paper by Geske and Shastri (1985), the different aspects of choosing a valuation method are examined. They arrive at the conclusion that finite difference methods are more efficient when valuing a large number of options. But that is precisely our case. That is, we have to obtain common stock values for a large number of different firm values, in order to find V^* such that $S(V^*)$ is the closest to S^* (see step 2 in the "inner" outer loop, above).

3.9 Conclusions

In this chapter three models for valuing convertible bonds have been presented. They are of increasing technical sophistication. The theoretical framework has been given as well as the numerical solution methodology. The important message is that CCA offers a qualitative insight which could be viewed to be more important than the quantitative methodology. The insight is that corporate liabilities can be viewed as combinations of simple option contracts.

With help of the methods presented, computer programs can be set up for valuing convertible bonds and other complex securities. Chapter 3 has provided the necessary

technical background for understanding the problems that are posed and solved in the following chapters.

4 An empirical comparison of different valuation models

4.1 Introduction

In this chapter, which is an extended version of Sörensson (1993), an empirical test of two of the models presented in Chapter 3, Model I and Model II, is carried out. This test is probably the first one of its kind (at least to this author's knowledge). These models have previously been tested on a constructed case (Brennan and Schwartz 1977), or on one particular issue (MacConnell and Schwartz 1986; Jennergren and Näslund 1990; Jennergren and Sörensson 1991). The test performed here is unique in the sense that it is done on seven real issues of convertible bonds. The results obtained in this chapter give insights into problems of convertible bond valuation and also provide a background for the study carried out in Chapter 5.

In setting up this test of the models, the main concern has been to value convertible bonds at a point of time when they just have been introduced, or have a long time to maturity. It is important to be able to value correctly a convertible bond at the time of issue. The pricing has to be such that the issue can be sold, but without undue loss to existing owners. This study gives an understanding of how the different factors that enter into the valuation models affect the value of the convertible bond. In other words, this investigation shows under which conditions the choice of valuation model matters.

The outline of the chapter is as follows. First, the criteria for the selection of the cases

are discussed. The data used are displayed. Furthermore, the handling of the various parameters and variables that enter into the models is described. The results are displayed in five tables and analyzed in connection with each table. Finally, the conclusions are given.

4.2 Data

We compare the two valuation models on seven issues of convertible bonds, with the stock value based model having three submodels. We refer to the models as Ia, Ib, Ic, and II. The companies were chosen according to the following criteria:

- That information on the convertible bond be available.
- That no conversion had taken place before the valuation date.
- That information on the capital structure be available, and that the capital structure be simple, with few instruments in it (i. e., common stock, convertible bonds, and debt).
- That the company common stock be listed on the Stockholm Stock Exchange.

The companies whose convertible bonds are valued in this study are the following:

Andersons (employee issue)
Catena
Finnveden
Jacobson & Widmark (J&W) (employee issue)
Nordström & Thulin (N&T)
Saab-Scania (employee issue)
Volvo (employee issue)

In Table 4.1, the characteristics of these companies are displayed. They capture the whole range from small companies working on the domestic market to big international companies. They are in construction, wholesale of cars, engineering, investment, shipping, and car manufacturing. They also have different levels of volatility and dividends, the sizes of the convertible bond issues differ, the dilution factors differ, and the life times of the bonds are different. To carry out an empirical valuation, we need data for each case. This is a list of the data needed:

Valuation date,
closing stock price on the day preceding the valuation date,
nominal bond value,
the convertible bond coupon,
the coupon date,
if the last coupon is divided into two portions,
the total size of the convertible bond issue,
the time to maturity of the convertible bond,
the risk-free interest rate,
the risk adjusted interest rate,
the volatility of the stock,
dividend yield,
the number of shares,
the number of shares for one convertible bond,
conversion period,
company rating (if any).

These data are straightforward to handle. The majority of the convertible bonds issued in Sweden have relatively simple features as already mentioned in Section 2.6. In what follows, a description is given of the most important data.

The valuation date is chosen to be a date before the conversion period has started. In the firm value based model, we need the exact number of shares and convertible bonds. The stock value based model is not sensitive to the precise capital structure, because the latter is not included in that model. As stock price, we use the closing stock price on the day preceding our valuation date. If there was no closing price, we take the bid price. As nominal bond value, in the stock value based model, we use the value of one bond. In the firm value based model, we work with the nominal value of the whole bond issue. The coupon of a convertible bond is listed in percent of the nominal value of one bond. The coupon date has to be known, because we are discounting the coupons in the stock value based model. In the firm value based model, we handle the coupons by discrete adjustments of the value function at relevant points of time, as mentioned earlier.

As the risk-free interest rate, we use the interest rate on a government bond with the same maturity as the bond in question. That rate has to be converted from a discrete interest rate into a continuous one. The risk adjusted interest rate is commonly defined as the interest rate which a company would have to pay on a bond issue, with the same features as the bond part of the convertible bond. When people in the industry do a valuation of securities, they decide on the level of the risk adjusted interest rate by some "rule of thumb". They mention

one to two percent above the risk-free interest rate for big companies and two to three percent for small companies. The risk adjusted interest rate is supposed to capture the bankruptcy risk of the company. On the Swedish market, the risk premium is also a measure of the liquidity of the instrument in question. In our case, the liquidity premium is quite important, because the majority of our convertibles do not get listed at once; in fact, they typically become listed only after two years, or so.

Table 4.1. Company Data

COMPANY	Andersons	Catena	Finnveden	J&W	N&T	Saab	Volvo
Valuation date	890101	880101	860401	890101	900301	890101	890101
Stock price (SEK)	340.00	90.00	141.00	141.00	79.00	208.00	386.00
Nominal c.b. value	358.00	50.00	140.00	140.00	50.00	220.00	385.00
Stock value (MSEK)	776.1619	1890.0	158.1174	690.9141	1385.2429	14121.992	29955.533
Coupon in %	9.50	8.50	8.00	9.80	9.00	10.00	10.00
Size of c.b. (MSEK)	40.4	538.9	53.285120	56.0	29.2	796.3	924.0
Starting date	881125	860101	860401	880601	881212	880812	870904
Ending date	930531	910531	900630	940701	951230	930930	950331
Coupon date	1/3	31/5	30/6	28/2 31/8	30/12	12/8	1/2
Risk-free rate (%)*	10.32	10.59	10.59	10.31	13.46	10.32	10.26
Risk adjusted rate (%)*	12.55	12.81	12.81	12.54	15.62	11.62	11.60
Volatility	0.2399	0.5309	0.3607	0.2430	0.4674	0.2326	0.1638
Dividend (SEK)	3.50	2.00	1.00	0.50	2.00	7.75	14.00
No. of shares	2282829	21000000	1121400	4900100	17534720	67894192	77605009
No. of conv. bonds	112849	10778000	380608	400000	3137760	3619350	2400000
Conversion period	910102-930531	880601-910515	900102-900629	900702-940701	910701-951215	900813-930916	900905-950315
Dilution in %	4.94	51.32	33.94	8.16	17.89	5.33	3.09

Note: *) In continuous time.

In this empirical study, the risk adjusted interest rate is taken to be 1.5 percent above the risk-free interest rate for Saab-Scania and Volvo. For the other companies in the study, that interest rate is taken to be 2.5 percent above the risk-free rate of interest. The 1.5 and 2.5 percent are in discrete time.

The volatility of the stock is estimated using the 120 trading days preceding the valuation

date, as already mentioned in Subsection 3.8.1. In one case, Catena, 109 days are used because the company had a bonus issue (stock dividend), and it seems better to take a shorter time horizon than to include the movements of the stock price around the bonus issue. In the second model, the firm volatility is estimated as described in Subsection 3.8.2.

4.3 Results

In the first comparison, we do a valuation with a risk-free interest rate for the bond part in the stock value based model, and an assumed zero dividend yield. With a dividend yield of zero and a risk-free interest rate for the bond part of the convertible bond, the results should be the same for Models Ia, Ib, and Ic. The differences which we report between Model Ia and Ib on the one hand, and Model Ic, on the other hand, are due to the different numerical methods used.

The differences between Ia-Ic and II are due to the fact that they represent different models, where the conversion decision in Model II depends on the firm value instead of, as in Model Ic, the stock value. It is seen that there are very small differences between the models in Table 4.3a.

Table 4.3a. Value of convertible bonds with a risk-free interest rate in Model Ia-Ic, assuming no dividends.

	COMPANY						
	Andersons	Catena	Finnveden	J&W	N&T	Saab-Scania	Volvo
Model Ia	495.5162	106.5102	188.7774	204.5446	99.3505	302.3103	589.6724
Ib	495.5162	106.5102	188.7774	204.5446	99.3505	302.3103	589.6724
Ic	495.3215	106.4514	188.7797	204.5485	99.2927	302.1869	589.4234
II	495.5232	106.8401	189.0510	204.7566	99.6477	302.0215	590.0366

Note: Model Ia is the stock value based model, with a European option part.
Model Ib is the stock value based model, with the pseudo-American option part.
Model Ic is the stock value based model, where the option part value depends on both the stock price and time to expiration.
Model II is the firm value based model.

When we use the actual dividend yields, the differences between the models are small,

too. As mentioned earlier, comparing the firm value based model with the stock value based model is difficult in the sense that the dividend yield in the case of the firm value based model is taken as the dividend payment divided by the firm value. This dividend yield is calculated in the model, as described in Chapter 3. Arguably, it is not comparable to the actual yield on the stock. However, this is the most realistic way of handling the dividend yield in this context.

Table 4.3b. Value of convertible bonds, with a risk-free interest rate in Model Ia-Ic. Dividends.

	COMPANY						
	Andersons	Catena	Finnveden	J&W	N&T	Saab-Scania	Volvo
	Dividend in percent of stock value						
	1.03	2.22	0.71	0.35	2.53	3.73	3.63
Model Ia	482.9356	100.5321	185.3425	202.1248	89.1287	274.6806	517.1165
Ib	482.9356	100.5321	185.3425	202.1248	89.2913*	274.6806	518.1032**
Ic	483.3376	101.9163	185.6139	202.1819	90.4501	275.0516	518.5327
	Dividend in percent of firm value						
	0.96	1.40	0.49	0.32	2.10	3.46	3.48
II	483.3426	102.5468	186.0822	201.7784	90.6972	275.1876	518.8408

Note: *) The optimal time horizon is 2.5 months shorter than the expiration date.
**) The optimal time horizon is 1.5 months shorter than the expiration date.

We would expect the difference between Model I and Model II in Table 4.3b to be bigger, due to the fact that dilution is included in the firm value based model but not in the stock value based model. The dilution in one case is as much as 51.32 percent (dilution is equal to number of new shares created if conversion takes place, divided by the number of existing shares). The stock value based model in this particular comparison uses the risk-free interest rate and hence does not account for bankruptcy. Of course, the firm value based model takes bankruptcy into account (the convertible bond value depends on the whole firm value).

Dilution affects the value of the firm in two ways. On the one hand, the value of the firm is divided up among a larger number of shares. This is often thought of as reducing the value

per share. On the other hand, elimination of the coupon payments upon conversion decreases the bankruptcy risk and hence increases the value per share. In our investigation, these two contradictory effects apparently just about cancel each other.

Comparing the results of Model Ib and Model Ic in Table 4.3b, there are only two cases where the difference is more than one percent. These two cases are Catena (1.3769 percent) and N&T (1.2978 percent). What distinguishes these two cases from the other cases, and gives rise to this difference, is the combination of high volatility and relatively high dividend yield. From Table 4.1 we can see that the volatility is 53.09 percent for Catena and 46.74 percent for N&T. The dividend yields are 2.22 percent and 2.53 percent, respectively.

A simulation where the volatility is varied from 10 percent up to actual show that the combination of high volatility and relatively high dividend is in fact the reason for this difference between Model Ib and Model Ic (see Table 4.3c).

Table 4.3c. Comparing Model Ib and Model Ic, using different levels of volatility.

		VOLATILITY*				
		10	20	30	40	Actual
Catena	Model Ib	96.2347	96.2610	96.6795	97.8107	100.5321
Catena	Ic	96.2152	96.2813	97.0371	98.7551	101.9163
	Difference	-0.0195	0.0203	0.3576	0.9444	1.3842
N&T	Model Ib	85.7582	85.8316	86.5272	88.0055	89.2913
N&T	Ic	85.7167	85.9077	86.9295	88.8476	90.4501
	Difference	-0.0415	0.0761	0.4023	0.8421	1.1588

Note: *) In percent.

A possible explanation for the similarity in values obtained by the different models could be the fact that the nominal values of the convertible bonds are very close to the actual stock prices.

Examining the differences of the results for model versions Ia, Ib, and Ic, when a risk adjusted interest rate is used for the bond part, it is observed that those values are very close (see Table 4.4a). In a few cases, the results from model version Ic are slightly lower than

those of Ia and Ib. (This can also be seen in the earlier tables.) Theoretically, this could not happen; it is only due to the different numerical methods (model versions Ia and Ib use the Black-Scholes formula and discounting, whereas Ic uses the implicit finite difference method). In two cases, model version Ib gives a slightly higher value than Ia. This is due to the fact that the exercise price (the remainder of the straight bond part) is increasing over time, which means that it may be optimal to convert before expiration, as indicated in Subsection 3.5.3.

Table 4.4a. Value of convertible bonds with a risk adjusted interest rate in Model Ia-Ic, assuming no dividends.

	COMPANY						
	Andersons	Catena	Finnveden	J&W	N&T	Saab-Scania	Volvo
Model Ia	467.9068	103.4280	178.8523	192.0732	95.5726	291.5284	566.1133
Ib	467.9068	103.4280	178.8523	192.0738*	95.5726	291.5284	566.2889**
Ic	468.3208	103.6506	179.1072	192.0341	95.5741	291.4940	566.1602
II	495.5232	106.8401	189.0510	204.7566	99.6477	302.0215	590.0366

Note: *) The optimal time horizon is 14 days shorter than expiration date.
**) The optimal time horizon is 1.5 months shorter than expiration date.

Looking next at the difference between the results from Model I (all three versions) and Model II in Table 4.4a, it is seen that Model II leads to higher values. The differences are between 3 percent and 7 percent of Model I values, which is not insignificant. These differences, however, are entirely due to the choice of the risk adjusted interest rate, the one parameter that does not enter into Model II.

When we take the actual dividend yields and include them in the model, we can see from Table 4.4b that the difference between the stock value based model on the one hand and the firm value based model on the other hand is more or less the same as reported in Table 4.4a. In six of the seven cases in Table 4.4b, we can see that it makes a difference whether we use Model Ib or Model Ia. Model Ib selects the optimal time horizon for the value of the option part, and that optimal time horizon is often shorter than the expiration date, when a risk adjusted interest rate is used for the straight bond part, and when a positive dividend yield is included in the model. As mentioned earlier in Subsection 3.5.3, the optimal time horizon

will be shorter than maturity if the changes in exercise price over time are big enough. A sizable dividend yield will also make the optimal time horizon shorter. In the case of Catena, this horizon is nearly one year shorter than the life time of the convertible bond.

Table 4.4b. Value of convertible bonds, with a risk adjusted interest rate in Model Ia-Ic. Dividends.

	COMPANY						
	Andersons	Catena	Finnveden	J&W	N&T	Saab-Scania	Volvo
			Dividend in percent of stock value				
	1.03	2.22	0.71	0.35	2.53	3.73	3.63
Model Ia	455.3262	97.4499	175.4174	189.6527	85.3508	263.8987	493.5575
Ib	455.6046*	97.6139**	175.4174	189.6700♣	85.5827♣♣	264.1678♦	494.8159♦♦
Ic	456.3362	99.3440	175.9663	189.6314	87.0959	264.4902	495.3209
			Dividend in percent of firm value				
	0.96	1.40	0.49	0.32	2.10	3.46	3.48
II	483.3426	102.5468	186.0822	201.7784	90.6972	275.1876	518.8408

Note: *) The optimal time horizon is 2.5 months shorter than the expiration date.
**) The optimal time horizon is almost a year shorter than the expiration date.
♣) The optimal time horizon is 14 days shorter than the expiration date.
♣♣) The optimal time horizon is 2.5 months shorter than the expiration date.
♦) The optimal time horizon is 1 month shorter than the expiration date.
♦♦) The optimal time horizon is 1.5 months shorter than the expiration date.

The market value of the Nordström & Thulin convertible at the valuation date was 80.00 Crowns, so in this case Model Ia with a risk adjusted interest rate for the bond part comes closest. The other convertible bonds in the study were not listed at the valuation dates. It may be remarked that of the models compared in this chapter, Model Ia is by far the most commonly used model for valuing convertible bonds in the Swedish capital market. It should be emphasized that the valuations undertaken in this study are concerned with the comparability of different models, not with finding that model which tracks the market price of a convertible bond in the best way.

4.4 Conclusions

This chapter has compared values of convertible bonds obtained by four model versions. Those model versions represent increasing degrees of technical sophistication. The object is to find a model which is simple to use. If one considers stock value based model versions, then this investigation seems to indicate that there are few disadvantages in selecting Model Ia which is the simplest one (this is the model which most practitioners use). However, with dividends in the models, the case for model version Ia as opposed to Ib or Ic is not quite as strong. In fact, with dividends in the models, Model Ic is the best choice.

It is striking that dilution in itself does not seem to have much impact on convertible bond value. The dilution in the Catena case is nearly 52 percent, yet the results for Catena in Table 4.3a and Table 4.3b are qualitatively similar to those of the other companies. The dividend yields in the seven cases examined here are between 0.35 percent to 3.73 percent (see Table 4.4b). These different levels of dividend yield do not in themselves lead to differences between the models used here. The level of dividend yield makes a difference between models when the volatility is high, though.

The most important result of this investigation is that the choice of the level of risk adjusted interest rate for computing the remainder of the straight bond part of a convertible in the stock value based model is quite important, since it could lead to a considerable difference in computed values, when compared to the firm value based model. By setting "ad hoc" interest rates we obtained convertible values from the stock value based model which were 3 percent to 7 percent lower than the values obtained by the firm value based model.

A natural question is then: Which model gives the most correct results, the stock value based one or the firm value based one? The main difference between the models seems to be their method of handling bankruptcy risk. The stock value based model handles such risk by discounting the straight bond value part at a risk adjusted interest rate, whereas the firm value based model accounts for bankruptcy risk through initial and boundary conditions. However, it may be that those initial and boundary conditions are not sufficiently exact, if the assumed capital structure is too simple.

When one works with the firm value based model, one could observe the capital structure of the firm and choose the instruments to include in the valuation. In this chapter, we have assumed the simplest possible capital structure, consisting of common shares plus convertible

bonds (the same as in the original paper by Brennan and Schwartz (1977)). But that is perhaps too simple. A more realistic view of the financial risk of the company could be gained, if one included regular debt in the capital structure of the firm. The bankruptcy risk would then increase, due to coupons and amortization payments. That could lower the computed value of the convertible bond in the firm value based model. It is hence possible that the difference between the results in Table 4.4a from the stock value based model and the firm value based one would be eliminated in a more complete firm value based model with more instruments in the capital structure.

The results of this chapter show that for convertible bonds with simple features, the choice of model is not important. The choice of the level of the risk adjusted interest rate is more important.

5 A sensitivity study

5.1 Introduction

The results obtained in Chapter 4, that the difference between the values given by the tested models is not that big, suggests a sensitivity study of a more complex model (Model III), where the actual debt of the firm is included. This complex model is compared to two simpler models (Model Ic and Model II). All models mentioned have been described in Chapter 3. A study of this kind has not been done before, to the author's knowledge. In previous studies (Brennan and Schwartz 1977 and 1980; McConnell and Schwartz 1986), parameters have been changed one by one, and the results have been as could have been predicted. In this chapter, the approach is to change three parameters simultaneously and thus obtain a more dynamic and realistic analysis.

Undertaking such a sensitivity study enables a more thorough analysis of the important factors that govern the value of a financial instrument when using different valuation models. By this analysis, situations can be identified where the choice of model for valuing convertible bonds is important. In a situation with a low level of interest rate and a low stock price, the choice of model is shown to be most crucial.

In the following, the data which are used are described. The detailed design of the sensitivity study is given next. After that follows the first part of the study, where the parameters are changed one by one, and a discussion of some relevant earlier work. The results of the main study are then presented and compared to the results obtained in the earlier work. After that, a small extension of the study is undertaken, where one of the

models is modified slightly. The chapter ends with conclusions.

5.2 Data

Data were collected for Nordström & Thulin, a Swedish shipping line. The capitalization of the company on March 1, 1990, consisted of common stock, long-term debt, and a convertible bond issue.

The shares of common stock are listed on the Stockholm Stock Exchange, and the closing quote on February 28, 1990, was 79.00 Swedish Crowns. As for many companies in Sweden, there are several classes of shares with different voting power and restrictions on ownership by non-Swedish residents. We treat the different types of shares as one type. Altogether, the company had 17,534,720 shares of common stock.

The debt has no rating. It consists of secured loans and leases, with ships as collateral. We only consider the company's long-term debt. How to treat short-term debt is sometimes debated, but in this case we regard the short-term debt to be normal trade credits. The short-term debt may then be considered as outside the capital structure of the firm. This view of how to treat short-term debt can also be found in textbooks. (See for example Copeland and Weston 1988, p. 530.) The nominal value of the long-term debt was approximately 1,119,638,000 Swedish Crowns on March 1, 1990. The amortization and interest payments are displayed in Table 5.1. We simplify by assuming that interest and amortization payments are due at the end of each year. We also make the assumption that all debt will become payable on December 31, 1995 (the date of maturity of the convertible bond issue). We need this assumption, since there has to be an end date in a valuation model of this kind. If the firm value is lower than the sum of amortization and interest payments, bankruptcy is triggered in Model III.

The convertible issue consisted of 3,137,760 individual bonds, each with a nominal value of 50 Swedish Crowns. The convertible bond is non-callable, non-puttable and has a fixed coupon. The convertible bond can only be converted into shares of common stock during a certain period every year. It can be converted into shares of common stock between July 1 and December 15 each year between 1991 and 1995. The conversion ratio is one to one. If there are bonds not converted after December 15, 1995, they will be redeemed at nominal value plus coupon on December 31, 1995. Conversion is not permitted between December

15 and December 31, 1995, but we disregard this fact, just to simplify slightly. Instead we assume that conversion is permitted between July 15 and December 31, 1995. The coupon of the convertible bond is 9 percent of the nominal value. The coupon is paid at the end of each year, except for the last year, when it is paid in two installments, September 30 and December 31. This feature, of a split coupon in the last year of the convertible bond's life, is fairly common among Swedish issues of convertible bonds. The purpose of the split coupon is to stimulate the convertible bond holders to convert after September 30, if they have not already done so earlier.

The Nordström & Thulin convertible bond issue was sold with priority rights for existing shareholders. The old shareholders hence did not have to give up any value of the company to new shareholders. In other words, there was no conflict between old and new shareholders. It is also clear that this issue was not aimed at the employees. In Table 5.1, the data on the company are summarized and displayed.

Table 5.1. Data used in the simulation

Valuation date	March 1., 1990
Stock volatility (annual)	46.74%
Risk-free interest rate (continuous-time)	13.46%
Risk adjusted interest rate (continuous-time)	15.62%
Stock price	79.00 SEK
Nominal bond value	50.00 SEK
Coupon	9.00%
Conversion factor	1.0
Dividend yield on the stock	2.53%
Number of common shares	17,534,720
Number of convertible bonds	3,137,760
Long-term debt	1,119,683,000 SEK

Debt service for N&T 1990 - 95 (millions of Crowns)

Year	Interest	Amortization
1990	111.789	71.050
1991	104.695	74.209
1992	97.287	77.638
1993	89.535	93.254
1994	80.224	85.218
1995	71.716	718.314

5.3 The sensitivity study

5.3.1 Outline

The sensitivity study is done in two steps. Firstly, we compare the different models using the data from the base case. We study how the results from the different models vary with different levels of the stock price, stock volatility and interest rate. Secondly, we study the effects of simultaneous changes in the three parameters.

The results of the study are presented in two parts. The sensitivity to changes in stock price and interest rate level is presented first. (The volatility effect can be seen in Figures 5.3a-5.3d.) After that, the combined effects of changes in stock price, interest rate level and volatility are presented. The stock prices which we analyze are 79.0 (base case), 60.0, 50.0, 40.0, 30.0 and 20.0 Crowns. We choose lower stock values than 79.0 Crowns, the base case, because the nominal convertible bond value is 50.0 Crowns. Volatility levels are 46.74 (base case), 40.0, 30.0, 20.0 and 10.0 percent. The levels of volatility are chosen to be lower than the actual 46.74 percent because the usual range for stock volatility is 10 - 50 percent. Interest rate (risk-free) levels are 13.46 (base case), 10.0, 8.0 and 6.0 percent. For Model Ic, the risk adjusted interest rate is 2.5 percent in discrete time above the risk-free interest rate, for each risk-free interest rate level.

5.3.2 Effects of changes in stock price and interest rate only

Numerical results are presented in Table 5.2a and Table 5.2b, and displayed in Figure 5.2a and Figure 5.2b (note that figures are numbered so as to correspond to tables). In Figure 5.2a, the interest rate level is the original one, 13.46 percent. The stock price in Figure 5.2b is 79 Crowns.

In Table 5.2a, the values are given for different levels of stock price, with both the actual dividend yield and without any dividends in the models. The differences between the models are similar with and without dividends. The problem facing us when using the actual dividend yield is the comparison between the stock value based model and the two models that use the firm value as underlying variable. Due to model specifications regarding Model II and Model III, the dividend yield is measured as a fraction of the firm value. This makes

it difficult to compare it to the dividend yield in the stock value based model.

The relationship between the different model values does not change for a high level of the stock price. The relationship between values given by the different models starts to change in this case for a stock price of 30.00 Crowns (no dividends) and 40.00 Crowns (dividends).

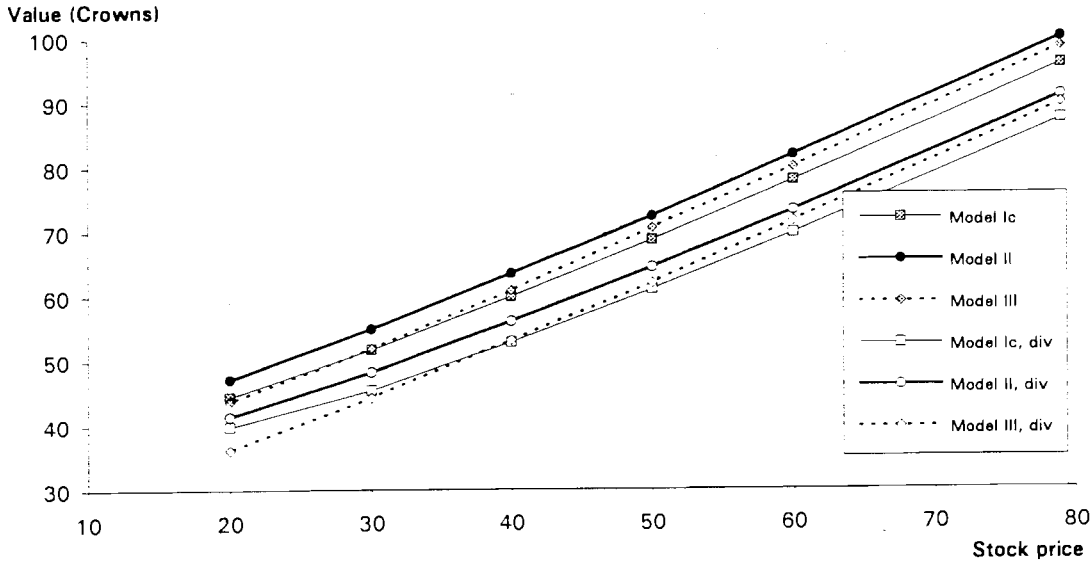
Table 5.2a. Comparison of how different models value the convertible bond when the stock price is altered. Original case.

		Dividends	
Stock price	Model Ic	Model II	Model III
79.00	87.0919	90.6972	89.5194
60.00	69.7268	73.1652	71.4972
50.00	61.0304	64.4453	62.0235
40.00	52.8611	56.0762	53.2072
30.00	45.5661	48.2849	44.4153
20.00	39.8353	41.4088	36.1967
		No Dividends	
Stock price	Model Ic	Model II	Model III
79.00	95.5741	99.6476	98.2545
60.00	77.7758	81.7270	79.8597
50.00	68.7041	72.3255	70.5061
40.00	59.9678	63.5167	60.8709
30.00	51.7603	55.0335	51.9390
20.00	44.4518	47.1547	43.7192

For the case with a non-zero dividend yield, Model III gives values that are closest to model II for high stock prices. For stock prices in the middle of the range, Model III gives values that are closest to Model Ic. For a stock price of 20 Crowns, Model III gives a value of the convertible bond that is considerably lower than the values given by the two other models when dividends are included. This could be an implication of Model III's ability to consider

bankruptcy risk in the most realistic fashion. With a stock price of 20.00 Crowns, the bankruptcy risk is considerable compared to a stock price of 79.00 Crowns. We have to remember that the firm value in Model II and Model III is inferred from the stock price.

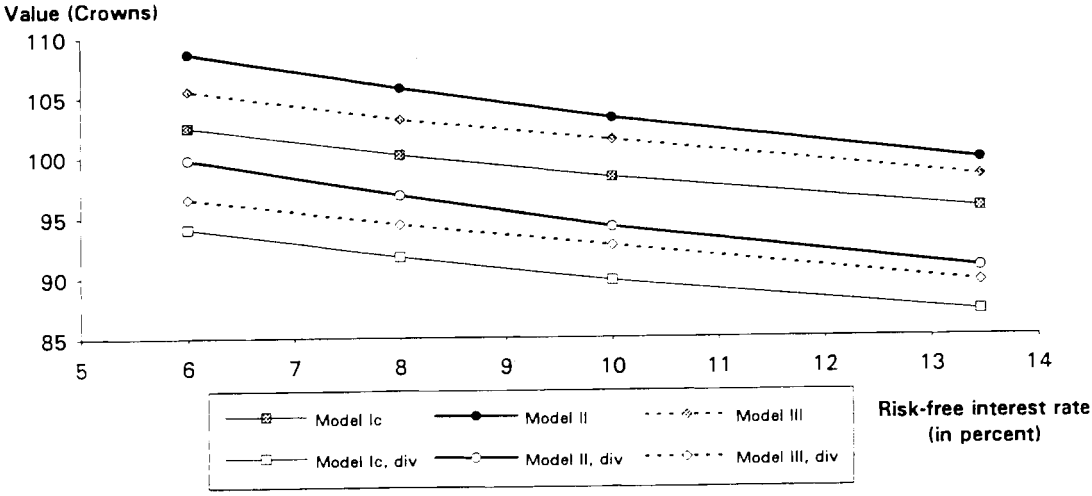
Figure 5.2a
Model values under different stock prices



The main reason for analyzing the interest rate level is the importance of that parameter for a security like a convertible bond, which can be viewed as a combination of a bond and an option. It is common that a convertible bond has a fixed coupon. If one values the convertible bond after a change in the interest rate level, the value of the bond part will have changed. The option feature is also sensitive to the interest rate level. With a higher interest rate, the value of the option part will increase. The impact on convertible bond value will be a combination of these two effects.

The convertible bond which we analyze in this study carries a coupon of 9 percent annually. With a stock price of 79.00 Crowns and a nominal convertible bond value of 50.00 Crowns, the value of the convertible bond goes up when the interest rate level goes down. This effect is captured to roughly the same extent in the different models, as can be seen in Figure 5.2b below and Table 5.2b in Appendix 5:1.

Figure 5.2b
Model values under different interest rate levels



5.3.3 Variation in volatility

We now summarize some earlier research concerning effects of changes in volatility. After that, we present our own sensitivity analysis when all three parameters (stock price, interest rate, and volatility) are changed simultaneously. This is done with the purpose of identifying combinations of stock price, volatility and interest rate level which lead to large differences in model values.

The results of the computations are presented in four figures, Figures 5.3a-5.3d. (The complete results of the computations are presented in four tables in the appendix to this chapter, Tables 5.3a-5.3d). The figures show values for different interest rate levels. In the following, we concentrate on the case without dividend payments in the models. We choose to concentrate on the non-dividend situation, because the differences between values produced by the models in the dividend situation are similar to those in the situation without dividends. Giving tables and figures for the non-zero dividend situation would lengthen the presentation without more insight (in fact, the effects mentioned below are magnified when dividends are included). As will be seen in Subsection 5.3.5, our results show that using a firm value based model or a stock value based model gives quite different values in certain situations. There are even some differences between the two firm value based models.

5.3.4 Earlier studies of volatility effects

The LYON model developed by McConnell and Schwartz (1986) is closely related to Model Ic. The argument for developing the LYON model was:

> Thus, our goal was to develop a model that is both rich enough to capture that salient ingredients [sic] of this complex security and simple enough to be implemented with an enhanced personal computer (McConnell and Schwartz 1986, p. 561).

They also undertook a sensitivity analysis where they looked at the impact of changes in the size of dividend yield, interest rate level, stock price and level of volatility. The combined effects of changes in these parameters are not analyzed. Regarding the effect of volatility changes, they write:

> It should come as no surprise that the LYON value increases monotonically with increases in the issuer's stock price and with increases in the volatility of the issuer's stock price. Additionally, as is the case with other stock price contingent claims, the LYON value is highly sensitive to changes in the volatility of the underlying stock (McConnell and Schwartz, 1986 p. 570).

In the paper "The Case for Convertibles" by Brennan and Schwartz (1986), the argument for issuing convertible bonds is the insensitivity of that instrument to the risk of the firm. For the case discussed in the paper, they conclude:

> In this case, a 10 percent increase in the risk actually results in a 1 percent increase in the value of the convertible. This supports the rationale for convertibles we offered above: they are likely to be especially attractive to an issuing company which is perceived as more risky by the market than by management (Brennan and Schwartz 1986, p. 63).

This argument can also be found in a recent paper by McConnell and Schwartz (1992).

In a paper written by Brennan and Schwartz (1977) where they develop a model close to our Model II, a sensitivity analysis is done of the effects of changes in some of the

parameters. They argue that the value of the convertible bond changes with different variance rates:

> . . . an increase in the variance rate may increase or decrease the value of the bond. First, at very low values where default is almost certain whatever the variance rate, there is no effect. At intermediate firm values, an increase in the variance rate both raises the expected loss through default as for a straight bond, and increases the expected gain from conversion . . . for higher firm values the debt is almost risk free, and the convertible bond is essentially equivalent to a riskless straight bond plus a warrant with an exercise price equal to the straight bond value. It is then well known that higher variance rates will lead to higher warrant values, and this effect is apparent for high firm values (Brennan and Schwartz 1977, p. 1712).

From this we can conclude that there seems to be contradictions between the views expressed and the results obtained in these papers. Firstly, there is a contradiction between the McConnell and Schwartz paper from 1986, where they argue that the LYON is very sensitive to changes in the volatility of the underlying stock, and the view expressed in the papers by Brennan and Schwartz, where the argument for issuing and buying convertible bonds is their insensitivity to the risk of the firm. Secondly, the sensitivity analyses done in the LYON paper (McConnell and Schwartz 1986) and in the paper "The Case for Convertibles" (Brennan and Schwartz 1986) give contradictory results. In the first paper, the convertible bond value increases considerably with an increase in the volatility, between 2 - 6 percent increase in value for an increase in the volatility of 10 percent. In the latter paper, they show a case of a 1 percent increase in convertible bond value for an increase of 10 percent in the volatility.

5.3.5 Results

In this part, we will present our results in four figures. The figures are for four different interest rate levels. As mentioned earlier, we concentrate on the case with no dividends in the models.

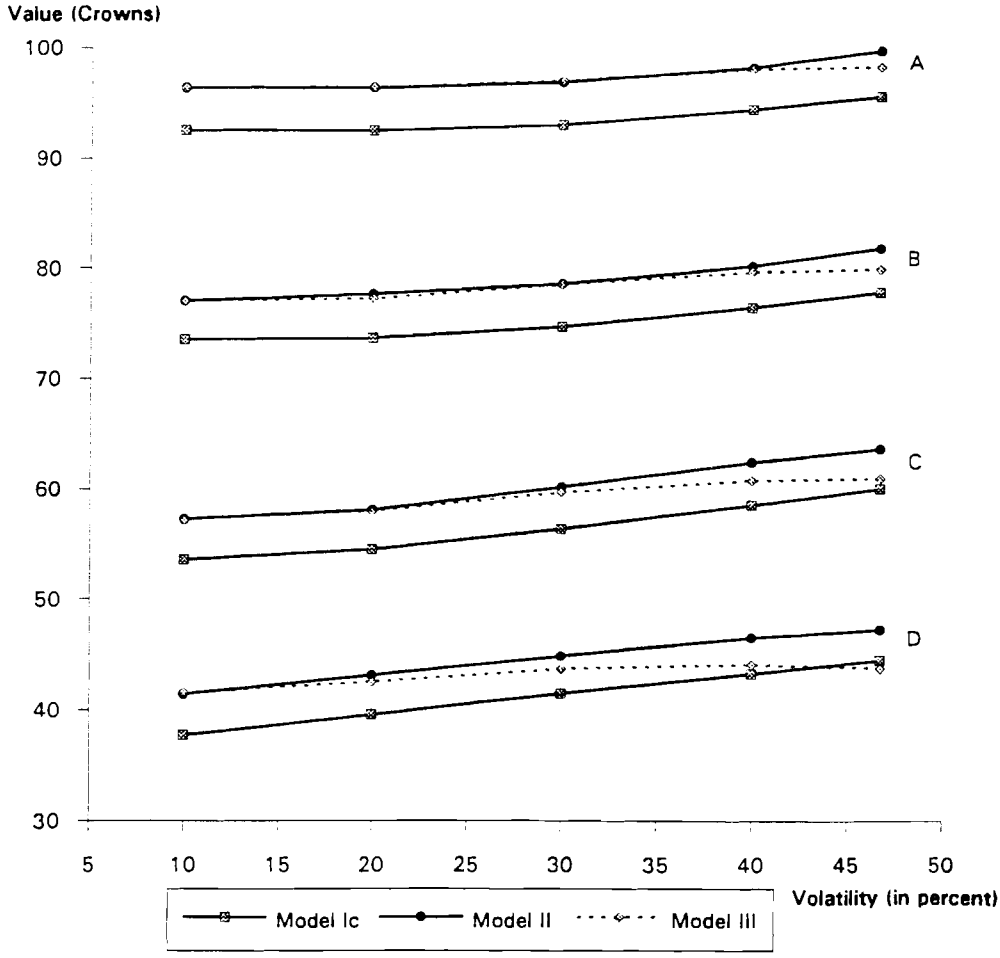
For an interest rate level of 13.46 percent (Figure 5.3a), which was the actual one at the

time of valuation, Model II and Model III give similar values for a low volatility. Model Ic gives quite different values at the time of valuation compared to the two other models.

But at a stock price of 20.00 Crowns, the value from Model Ic is higher than that from Model III, when the volatility is 46.74 percent (see Figure 5.3a). For a stock price of 79 Crowns, the convertible bond value derived with Model II is higher than Model III's at a

Figure 5.3a.

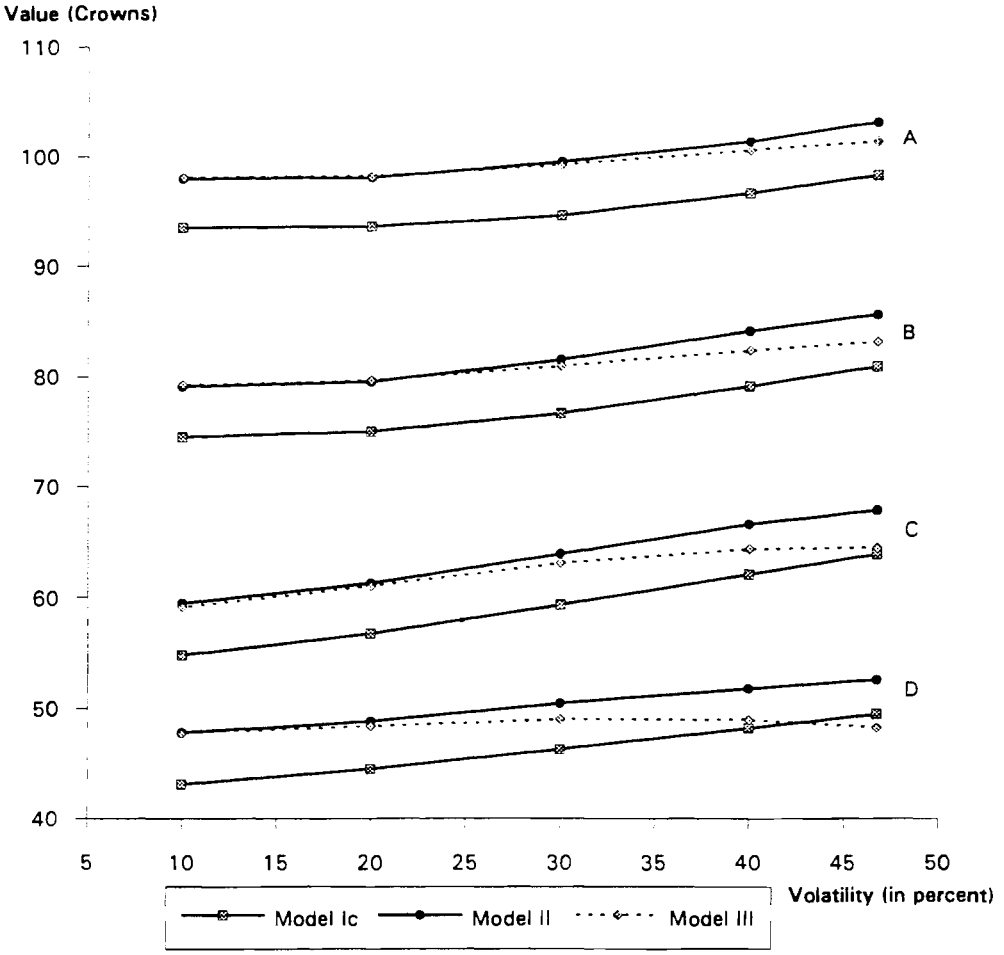
Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 13.46 percent. No dividends in the models.



volatility level of 40 percent and above. This divergence in convertible bond values given by the two models is magnified for lower stock prices. For a stock price of 20 Crowns, Model III gives a lower value than Model II for all volatility levels, except for a volatility of 10.00 percent. At the same interest rate level of 13.46 percent and a stock price of 20 Crowns, Model III gives a lower value of the convertible bond for a volatility of 46.74 percent than

Figure 5.3b.

Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 10.00 percent. No dividends in the models.

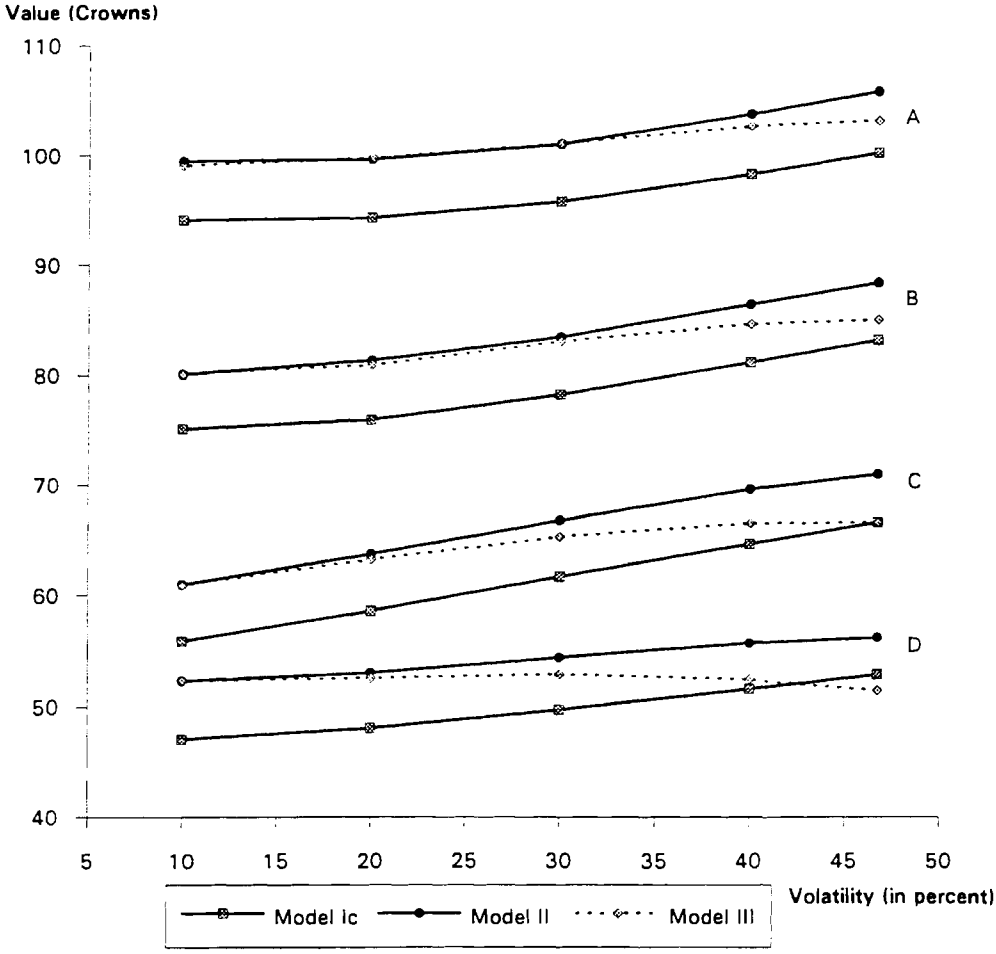


for a volatility of 40 percent.

At an interest rate level of 10.0 percent, the difference between Model Ic and the other two models is the same for low levels of volatility. For a stock price of 79 Crowns, Model II gives a higher convertible bond value than Model III already at a volatility level of 30 percent. The divergence between values given by Model II and Model III increases at a lower

Figure 5.3c.

Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 8.00 percent. No dividends in the models.



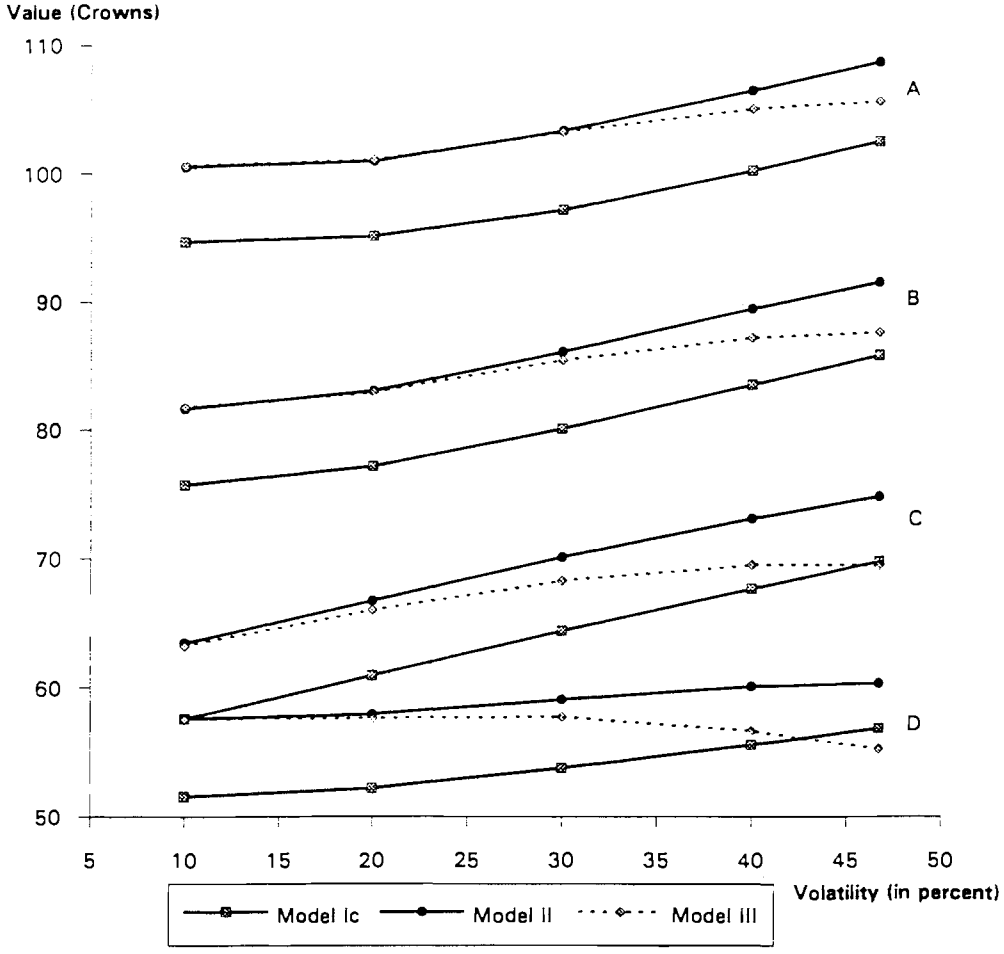
stock price. They are, in fact, larger than for an interest rate level of 13.46 percent (see Figure 5.3b).

For an interest rate level of 8 percent the results are similar to the results obtained at the 10 percent level (see Figure 5.3c).

The lowest interest rate level studied was 6 percent (see Figure 5.3d). At this interest rate

Figure 5.3d.

Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 6.00 percent. No dividends in the models.



level, we can still observe how close to each other are the values given by Model II and Model III for volatility levels of 10 and 20 percent. But for a volatility of 30 percent and more, there is an increasing difference in values. This difference increases for lower values of the stock price. At a stock price of 20 Crowns, the convertible bond value given by Model III peaks at a volatility of 30 percent. At this stock price level of 20 Crowns, Model II is not very sensitive to volatility at all. There is no major increase in Model II's convertible bond value when the volatility increases at this stock price level.

Our calculations for the case with dividends indicate that these tendencies are magnified. This is due to the fact that dividends lower the price of the stock and hence also the firm value.

5.3.6 Correspondence between our results and earlier results

For Model Ic, the results are in accordance with the results presented for the LYON model (McConnell and Schwartz 1986). In other words, Model Ic gives predictable results for changes in the studied parameters. However, the results from a LYON type of model are misleading for high volatility levels. The LYON is, in fact, unable to capture the "salient ingredients" of a convertible bond in these situations, which by no means can be regarded as unrealistic.

Our results for Model II show that the convertible bond value depends on the interaction between volatility and interest rate. This can be observed in Figure 5.3a-5.3d. The effect of higher volatility is greater at low interest rate levels. The results which we obtain with Model II are in accordance with results presented in the paper by Brennan and Schwartz (1977), were they show that the sensitivity of the value of a convertible bond to changes in volatility depends on the firm value. What they did not show, and what our study shows, is that the interest rate level also has an impact on this sensitivity to changes in volatility.

Our results show that the argument for convertible bonds, that they are insensitive to increases in risk, does actually depend on the model used. In the majority of cases with high volatility (above 20 percent), the values of the convertible bond produced by Model Ic and Model II (for high stock prices) are highly sensitive to changes in volatility. Only Model III seems to give the desired insensitivity to changes in volatility. As a consequence, Model III produces values considerably lower than the other models for high volatilities.

For Model III, we obtain slightly decreasing values of the convertible bond for higher volatilities under all interest rate levels for low values of the stock, i. e. low firm values (see Figures 5.3a-5.3d). The combined effects governing the value of a convertible bond are apparently not captured in all situations by simpler models like Model Ic. This is why the need for a complicated model like Model III is apparent. It is quite natural that Model III produces a lower value than Model II at high volatility levels, as it incorporates the burden of the actual debt, with the associated amortization and interest payments, thus accounting for the bankruptcy risk in the most realistic fashion. Model III is hence the most appropriate model.

In all of these different situations, i. e. with different stock price, volatility and interest rate levels, Model II gives the highest values in a majority of situations, and Model Ic the lowest. This can be explained by the fact that we use a risk adjusted interest rate for the straight bond part in Model Ic. This interest rate is set "ad hoc", as opposed to the risk-free interest rate which is the only one used in models II and III.

5.4 Correspondence between the level of the risk adjusted interest rate and the level of volatility

5.4.1 The traditional analysis

An extension of the traditional analysis of different models and their sensitivity to interest rate levels and levels of volatility will be done in the following part. The traditional approach of sensitivity analysis of a model with the value of the stock as underlying variable is to alter one parameter at a time and study the impact of this. This is also the case when changes in volatility are studied. In Model Ic, the value of a convertible bond is obtained as the sum of a bond part and an option part. The interest rate for discounting the bond part is a risk adjusted interest rate, which is supposed to capture the bankruptcy risk. Traditionally the level of this interest rate has not been connected to the level of volatility, although the volatility of the stock price, in the Contingent Claims Analysis framework, measures the business risk of the company (Mason and Merton 1985).

What we claim here is that the traditional view described above could be somewhat misleading. We argue that when performing a sensitivity analysis, the level of the risk

adjusted interest rate must be changed simultaneously with the changes in volatility. In this sense, the traditional approach is a simplification.

5.4.2 Treatment in earlier studies

One could regard the LYON Taming paper by McConnell and Schwartz (1986) as the state-of-the-art in the area of convertible bond valuation. They use a model with the value of the stock as underlying variable. To account for the bankruptcy risk, they use an intermediate interest rate level. The interest rate is set to be equivalent to the approximate yield of intermediate term bonds of the same risk rating as the examined bond. They perform a sensitivity analysis where among other things they study the effects of changes in the level of volatility. They do not change the interest rate level when they change the volatility level. The interest rate level is the same for all levels of volatility. With this approach, they find that the LYON is highly sensitive to changes in volatility.

Brennan and Schwartz (1986) describe the advantage of using convertible bonds as a financing tool. In their description of the effects of changes in different parameters, the ground for the reasoning seems to be that the interest rate level is constant when analyzing such effects. The pricing model for convertible bonds of Brennan and Schwartz (1977), with the firm as underlying variable, only involves the risk-free interest rate. The risk-free interest rate is always governed by the rate on an equivalent government bond, and the firm specific risk has no relevance for this interest rate. In the LYON Taming paper (McConnell and Schwartz 1986), the authors use a stock value based model, but fail to mention that there could be a relationship between the level of volatility and the risk adjusted interest rate in a model with the stock value as underlying variable. In the following, we are going to check if this oversight has an impact on the value of a convertible bond.

5.4.3 The design of the test

We study effects of simultaneous changes in the level of risk adjusted interest rate and the level of volatility in Model Ic and compare the results to those obtained for Model II and Model III (presented in Section 3.6.2). We do this by a comparison at two levels of the risk-free interest rate, of 13.46 percent and 6.00 percent. These results were already given in

Figure 5.3a and Figure 5.3d for Model II and Model III. We present the new results for Model Ic, now denoted Model Im, in Figure 5.4a and Figure 5.4d together with the old results for Models II and III.

The base case has a volatility of 0.4674 and a risk-free interest rate of 13.46 percent. The risk adjusted interest rate is then set to be 15.62 percent. The difference is 2.5 percent in discrete time. We perform the sensitivity analysis by using the following interest rate levels (where the premium is the difference between the risk adjusted and risk-free interest rates).

Volatility	0.10	0.20	0.30	0.40	0.4674
Premium	1.50	1.75	2.00	2.25	2.50

The premium is admittedly "ad hoc". The size of the steps between the interest rate levels could be discussed. However, we argue that this is of minor interest, since we just want to see whether this new approach makes any major difference in obtained model values. Using 1.5 percent as the bottom level makes sense, since a lower premium would be to low considering the liquidity effect and the bankruptcy risk incurred in this particular convertible bond issue.

5.4.4 Results of simultaneous changes in volatility and risk adjusted interest rate

We present the results from the simulations in two figures. In Figure 5.4a, we have a risk-free interest rate of 13.46 percent. The results of the sensitivity analysis of this risk-free interest rate level show that for low volatility levels the modified model, Model Im, gives higher values than Model Ic. This difference in values obviously decreases with higher volatility. The values from the modified model, Model Im, are closer to the values obtained by Model II and Model III.

For a risk-free interest rate level of 6.00 percent, the difference between Model Ic and Model Im is similar (see Figure 5.4d).

Using these different interest rates in Model Ic and Model Im makes it even more difficult to compare the stock value based model to Model II and Model III. It was difficult to compare Model Ic to the other two models before. Including a risk adjusted interest rate, tied to the volatility level, is not exactly a simplification.

5.5 Conclusions

Our investigation shows clearly the gain of including the debt in the valuation model. Earlier studies lack the analysis of changes in several parameters simultaneously. We show in this chapter that in some situations a more advanced firm value based model gives different

Figure 5.4a.

Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 13.46 percent. No dividends in the models.

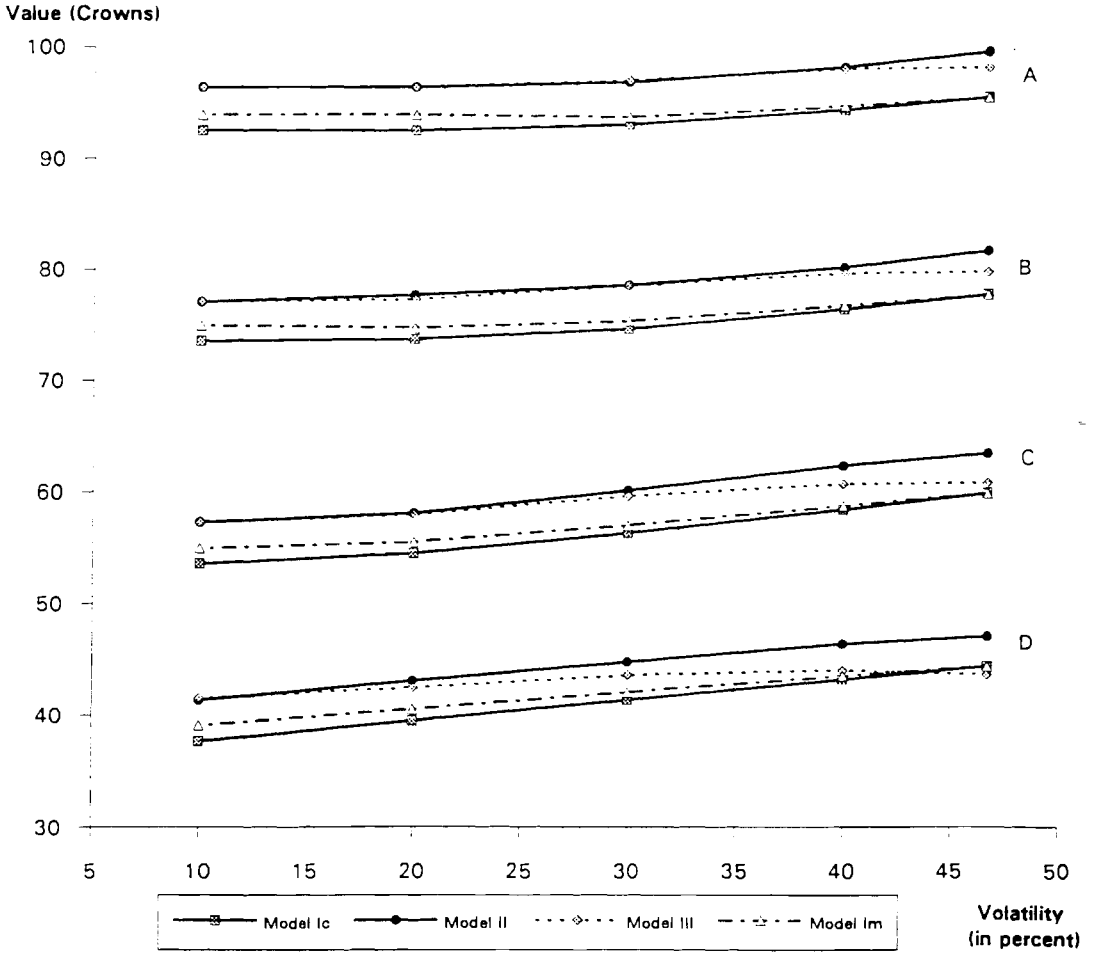
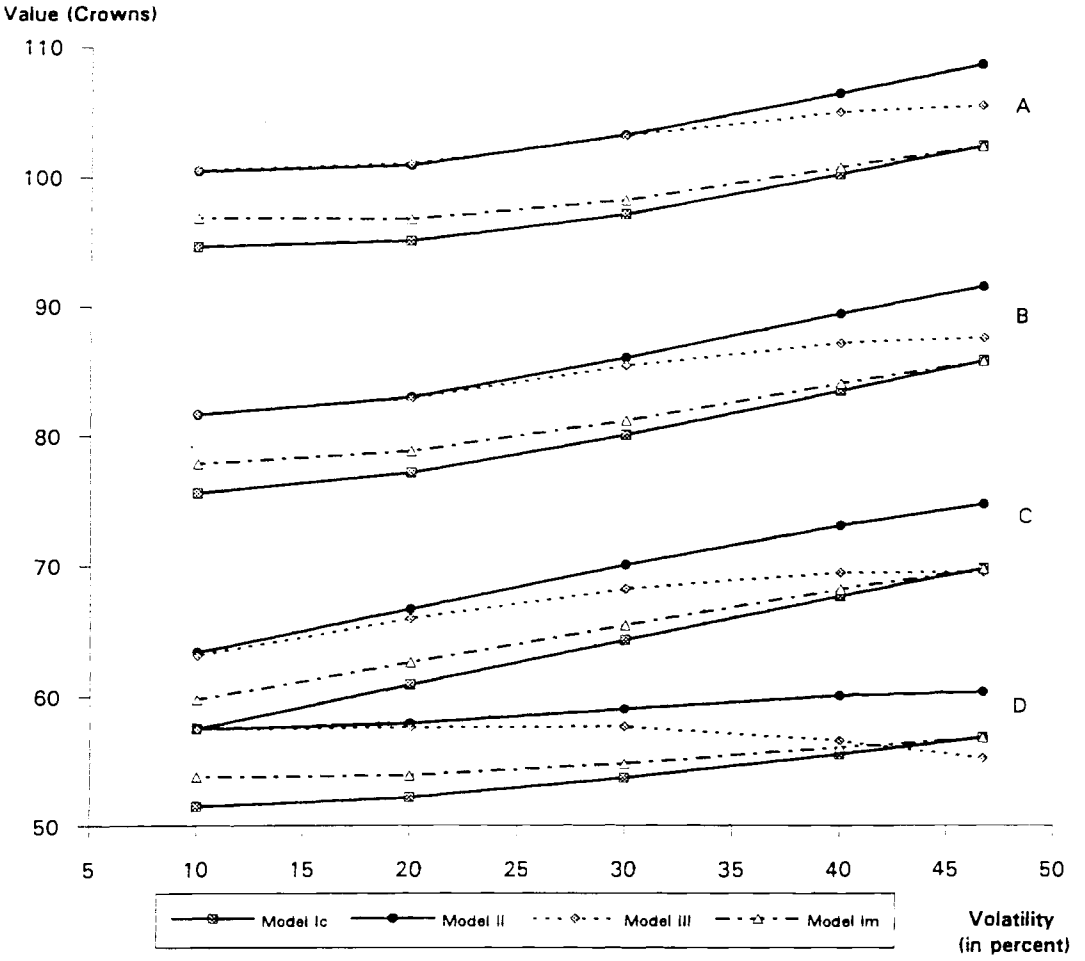


Figure 5.4d.

Convertible bond values for stock prices of 79 Crowns (A), 60 (B), 40 (C), 20 (D). Interest rate level 6.00 percent. No dividends in the models.



values for the convertible bond than the stock value based model. In particular, Model III sometimes gives values which decrease with increases in volatility, whereas Model Ic gives increasing values.

Our results make us believe more in a model like Model III (or Model II for some situations) than a model like Model Ic. We have shown that an increase in risk could give

both an increase or a decrease in the value of a convertible bond, depending on the conditions. In some respects, these results are similar to those obtained by Brennan and Schwartz (1977).

The fact that Model Ic accounts for bankruptcy risk only through the risk adjusted interest rate is critical in some situations where a proper account of bankruptcy risk would be most needed. The argument for convertible bonds is their alleged insensitivity to risk. However, if the bankruptcy risk is mainly in the form of large payments of interest and amortization on debt combined with high volatility, then the only model to capture this bankruptcy risk is Model III.

It would thus seem that our perception of the sensitivity of convertible bond values to risk, measured by volatility, depends on which model we use.

Appendix 5:1

Table 5.2b. Comparison of how different models value the convertible bond when the interest rate is altered. Original case.*

Risk-free interest rate (in percent)	Model Ic	Model II	Model III
	Dividends		
13.46	87.0919	90.6972	89.5194
10.00	89.7461	94.1834	92.6493
8.00	91.7059	96.7754	94.4207
6.00	94.0154	99.7298	96.4843
	No Dividends		
Risk-free interest rate (in percent)	Model Ic	Model II	Model III
13.46	95.5741	99.6476	98.2545
10.00	98.2372	103.1357	101.3690
8.00	100.1611	105.7004	103.0968
6.00	102.4002	105.5990	105.5231

Note: * Model Ic uses a risk adjusted interest rate for the bond part. In each case the risk adjusted interest rate is 2.5 percent above the risk-free interest rate measured in discrete time.

Table 5.3a. Sensitivity analysis of three models for valuing convertible bonds. No dividends in the models. Risk-free interest rate is 13.46 percent. Risk adjusted interest rate in Model I is 15.62 percent.

	Volatility in percent	Model Ic	Model II	Model III
Stock price 79.00 SEK				
	46.74	95.5741	99.6476	98.2545
	40.00	94.3594	98.1480	98.0125
(A)	30.00	93.0596	96.9142	97.0432
	20.00	92.5501	96.4220	96.4593
	10.00	92.5151	96.3880	96.3986
Stock price 60.00				
	46.74	77.7758	81.7270	79.8597
	40.00	76.3821	80.1572	79.6260
(B)	30.00	74.6558	78.5762	78.5631
	20.00	73.6765	77.6696	77.2386
	10.00	73.5152	77.0387	77.0494
Stock price 50.00				
	46.74	68.7041	72.3255	70.5061
	40.00	67.2350	71.1307	69.8768
(*)	30.00	65.2673	68.9780	68.7833
	20.00	63.8981	67.7151	67.7214
	10.00	63.5168	67.3654	67.3770
Stock price 40.00				
	46.74	59.9678	63.5167	60.8709
	40.00	58.4648	62.3564	60.7288
(C)	30.00	56.2977	60.1204	59.6547
	20.00	54.4593	58.0720	57.9650
	10.00	53.5481	57.2368	57.2536
Stock price 30.00				
	46.74	51.7603	55.0335	51.9390
	40.00	50.3145	53.7126	51.5535
(*)	30.00	48.1044	51.8421	50.6405
	20.00	45.9045	49.5771	49.2425
	10.00	44.0181	47.9436	47.9800
Stock price 20.00				
	46.74	44.4518	47.1547	43.7192
	40.00	43.2410	46.4594	44.0742
(D)	30.00	41.3936	44.7990	43.6590
	20.00	39.4932	43.1257	42.5070
	10.00	37.6811	41.4021	41.5442

Note: (*) Not included in Figure 5.3a.

Table 5.3b. Sensitivity analysis of three models for valuing convertible bonds. No dividends in the models. Risk-free interest rate is 10.00 percent. Risk adjusted interest rate in Model I is 12.24 percent.

	Volatility in percent	Model Ic	Model II	Model III
Stock price 79.00 SEK				
	46.74	98.2372	103.1357	101.3690
	40.00	96.5835	101.3146	100.5333
(A)	30.00	94.6082	99.4851	99.2280
	20.00	93.5881	98.0530	98.2263
	10.00	93.4547	97.9192	98.0497
Stock price 60.00				
	46.74	80.9179	85.5575	83.1417
	40.00	79.1144	84.0955	82.3707
(B)	30.00	76.6818	81.5428	81.0126
	20.00	74.9585	79.5296	79.6464
	10.00	74.4572	79.0560	79.1868
Stock price 50.00				
	46.74	72.1778	76.7422	73.4987
	40.00	70.3396	74.9703	73.2204
(*)	30.00	67.7052	72.2975	71.8838
	20.00	65.5090	70.3084	69.8805
	10.00	64.4836	68.9243	69.0516
Stock price 40.00				
	46.74	63.8482	67.8576	64.4802
	40.00	62.0438	66.5436	64.3257
(C)	30.00	59.3206	63.8914	63.0886
	20.00	56.7057	61.2118	60.9597
	10.00	54.7457	59.4743	59.1128
Stock price 30.00				
	46.74	56.1426	59.7181	55.8683
	40.00	54.4967	58.6565	55.6026
(*)	30.00	51.9396	56.3002	55.0394
	20.00	49.2788	53.6692	53.0848
	10.00	46.5793	51.2812	50.9544
Stock price 20.00				
	46.74	49.4481	52.5876	48.2787
	40.00	48.1785	51.7884	48.9686
(D)	30.00	46.2670	50.4334	48.9921
	20.00	44.4425	48.8017	48.3448
	10.00	43.0952	47.7620	47.7761

Note: (*) Not included in Figure 5.3b.

Table 5.3c. Sensitivity analysis of three models for valuing convertible bonds. No dividends in the models. Risk-free interest rate is 8.00 percent. Risk adjusted interest rate in Model I is 10.28 percent.

	Volatility in percent	Model Ic	Model II	Model III
Stock price 79.00 SEK				
	46.74	100.1611	105.7004	103.0968
	40.00	98.2174	103.6821	102.6092
(A)	30.00	95.7628	101.0235	101.0968
	20.00	94.3005	99.6427	99.7872
	10.00	94.0296	99.3851	99.0008
Stock price 60.00				
	46.74	83.1774	88.3468	85.0025
	40.00	81.1189	86.3674	84.6060
(B)	30.00	78.2275	83.4310	83.0813
	20.00	75.9449	81.3433	80.9290
	10.00	75.0433	80.0499	80.1475
Stock price 50.00				
	46.74	74.6631	79.6723	75.8836
	40.00	72.6056	77.7929	75.5853
(*)	30.00	69.5667	74.8209	74.1216
	20.00	66.8168	71.9691	71.7998
	10.00	65.1452	70.4647	70.5407
Stock price 40.00				
	46.74	66.6036	70.9735	66.6093
	40.00	64.6316	69.5950	66.5046
(C)	30.00	61.6044	66.7450	65.2555
	20.00	58.5577	63.7113	63.2285
	10.00	55.8427	60.9444	60.8944
Stock price 30.00				
	46.74	59.2210	63.0534	58.2578
	40.00	57.4768	62.0110	58.5128
(*)	30.00	54.7675	59.6072	58.0464
	20.00	51.9493	56.8776	56.0958
	10.00	49.0959	54.3311	53.9584
Stock price 20.00				
	46.74	52.9054	56.2312	51.5073
	40.00	51.6169	55.7538	52.4998
(D)	30.00	49.7232	54.3799	52.9272
	20.00	48.0310	53.0480	52.6000
	10.00	47.0325	52.3355	52.3270

Note: (*) Not included in Figure 5.3c.

Table 5.3d. Sensitivity analysis of three models for valuing convertible bonds. No dividends in the models. Risk-free interest rate is 6.00 percent. Risk adjusted interest rate in Model I is 8.33 percent.

	Volatility in percent	Model Ic	Model II	Model III
Stock price 79.00 SEK				
	46.74	102.4002	108.5990	105.5231
	40.00	100.1436	106.3762	104.9525
(A)	30.00	97.1497	103.2830	103.2236
	20.00	95.1196	100.9534	101.0830
	10.00	94.5956	100.4478	100.5490
Stock price 60.00				
	46.74	85.7980	91.5011	87.5794
	40.00	83.4776	89.3828	87.1477
(B)	30.00	80.1054	86.0710	85.4677
	20.00	77.1868	83.0390	82.9433
	10.00	75.6570	81.6389	81.7258
Stock price 50.00				
	46.74	77.5351	82.9879	78.1728
	40.00	75.2606	81.0192	77.8973
(*)	30.00	71.8218	77.7573	76.3641
	20.00	68.5037	74.4402	74.0796
	10.00	65.9797	71.7843	71.7880
Stock price 40.00				
	46.74	69.7709	74.7915	69.4934
	40.00	67.6424	73.0858	69.4675
(C)	30.00	64.3419	70.0696	68.2472
	20.00	60.9256	66.7322	66.0043
	10.00	57.5330	63.4185	63.1959
Stock price 30.00				
	46.74	62.7333	67.1002	61.4409
	40.00	60.9079	65.8482	61.8976
(*)	30.00	58.0924	63.6407	61.6483
	20.00	55.2212	60.9143	59.8624
	10.00	52.5303	58.4020	58.1737
Stock price 20.00				
	46.74	56.8101	60.3387	55.2237
	40.00	55.5186	60.0581	56.5936
(D)	30.00	53.6784	59.0253	57.6883
	20.00	52.1659	57.9068	57.6168
	10.00	51.4816	57.5192	57.5149

Note: (*) Not included in Figure 5.3d.

6 Summary and final conclusions

The dissertation contains two main parts, one descriptive and one technical. In the descriptive part, the convertible bond market in Sweden has been discussed. The focus in the descriptive part was on convertible bond issues to employees. The technical part outlines a set of models for valuing complex securities. The models are of increasing sophistication. Furthermore, an empirical comparison of the models is carried out as well as a sensitivity study. The results are positive in the sense that for most situations the simple model performs fairly well. But for certain situations the most complicated model, Model III, takes better care of the bankruptcy risk than the other models. The situation where the complicated model performs differently is in fact the one which we have in Sweden now. Today, in spite of a strong stock market during the Spring of 1993, many stock prices are far below their all-time highs and also far below the conversion prices for the majority of the convertible bonds. The interest rate level is also sinking (as of May, 1993). This is exactly the situation where model III accounts better for bankruptcy risk and dilution than the other models.

The main findings of Chapter 2 were that the massive growth in employee issues of convertible bonds took place during a short period in the 1980s, between 1983 and 1990. Several explanations for convertible bond issues to employees were found, including a growth in the economy, a deregulation of the banking industry and financial market, changes in the tax systems (both for companies and private persons), the desire in the business community to broaden the ownership of the companies, an affordable way of rewarding the employees (with favorable tax conditions both for the company and the employees), a stated interest in the business community to increase the commitment and feeling of affinity for one's own

company, and that they were a typical product imitation.

Regarding the volume of the issues, the most striking feature is the number of unlisted companies that have issued convertible bonds. The problem with the unlisted companies is the participants' dependence on the company. The bonds can not be sold because there is no market. A theoretical value of the convertible bonds can not be obtained, since there are no listed shares or other traded liabilities. The explanation for the great number of issues in unlisted companies is that they planned on getting listed fast. That the employees participated to such a great extent, in spite of the risk, can be explained by the desire to make easy money. Also, the employees' willingness to show commitment stimulated the participation in the issues.

The evidence cited in this dissertation indicates that employee issues have been used as an excuse by the board of directors for applying the Pilot School (giving the top management a stake in the company). The issues were a good and fairly cheep way of rewarding the management. They were also an elegant form for solving some of the problems of other instruments that could alternatively have been used for rewarding the management.

Due to the massive spread of the convertible bond issues to the employees, legislation and recommendations for handling the issuing of securities appeared in the mid 1980s. One important recommendation concerned the size of the allotment (half the yearly salary). If one is reasoning in strictly portfolio terms (i.e., that an individual investor should normally invest in different instruments), even this figure could be too big since most of the issues were fully financed by bank loans. This increased the risk for the individual participant considerably. The study shows that the risks of the convertible bonds as an investment have been neglected. The complete prospectuses contain some provisions that must be regarded as very important, since they could create problems for the participants. The first important provision was that the issuing bank could terminate the convertible bond issue for several reasons, without asking the holders of the convertible bonds. The second provision was that the bank had given itself the right to represent the convertible bond holders in any legal argument inside or outside court. The consequence was that the convertible bond holders would be represented in the case of bankruptcy by a party that could have other obligations to consider first. The third important provision was that the company could borrow as much as it wanted before the expiration of the convertible bond issue, without the consent of the convertible bond holders.

A new tax law also became the result of these convertible bond issues (Prop. 1989/90:50 1989). In this law, it is viewed to be a taxable benefit of employment to provide risk capital for the company you work for. This view is debatable, especially since the development after the law was taken shows that this type of benefit in many cases is not really a benefit. Issues with a nominal value of at least 500 million SEK have been involved in some form of bankruptcy, and in most cases the money has been lost. Chapter 2 shows in any case that there are many types of risks to consider when participating in convertible bond issues.

Chapter 3 gave a detailed description of a set of valuation models and how to implement them. In Chapter 4, a comparison of four valuation models was carried out. Those model versions represent different levels of technical sophistication. The object was to find a model that was easy to use and performed well in comparison with other possible models. With the results obtained from the seven issues used in the study, model Ic seems to be the best choice. The dividend yields in the seven cases examined were between 0.35 percent to 3.73 percent. These different levels of dividend yield do not in themselves lead to differences between the models used here. The level of dividend yield makes a difference between models when the volatility is high, though. The conclusion that can be drawn is that the most important feature is the risk adjusted interest rate. How to decide on this interest rate seems to be the crucial point when using Model I, since that interest rate is supposed to account for the bankruptcy risk. Since this seems to be quite difficult, the natural step is to use a model with the firm value as underlying variable, Model II or Model III. These two models can take care of complicated capital structures with several instruments in the capital structure. A sensitivity study of the interaction in the capital structure between various claims was reported in Chapter 5.

The model in Chapter 5 contained three instruments in the capital structure. This model can be extended to incorporate more instruments as well. Chapter 5 shows clearly the difference in computed value when including debt in the valuation model. The investigation hence points to the fact that in some situations a more advanced firm value based model gives different values for the convertible bond than a stock value based model. In particular, model III sometimes gives values which decrease with increases in volatility, whereas model I gives increasing values.

The sensitivity study in Chapter 5 is a strong case for model III (or model II for some situations). We have shown that an increase in risk could give both an increase or a decrease

in the value of a convertible bond, depending on the conditions. The fact that model I accounts for bankruptcy risk only through the risk adjusted interest rate is critical in some situations where a proper account of bankruptcy risk would be most needed. If the bankruptcy risk is mainly in the form of large payments of interest and amortization on debt combined with high volatility, then the only model to capture this bankruptcy risk is model III. The main finding is that the argument for convertible bonds, that they are insensitive to firm risk, could be driven by the model used for valuing them.

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