TOWARDS THE IDENTIFICATION OF A COST-EFFECTIVE SECURITY FOR BIOTECHNOLOGY COMPANIES

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THE DETERMINATION OF A COST-EFFECTIVE SECURITY FOR BIOTECHNOLOGY COMPANIES

ABSTRACT

When biotechnology companies have a drug ready for submission to a regulatory authority issuer-investor aspects of security selection become important. If approval to market the drug is received then the company may wish to consider an alternative to their Equity and/or Option/Warrant type of financing. The successful issue of any security will require the approval of and the acquisition by interested investors as well as a guarantee that it is cost-effective as far as the issuer is concerned.

The research was divided into two parts: firstly, a questionnaire was sent to those institutional investors in Australia and the UK who were analysing pharmaceutical/ biotechnology companies; and secondly, based on the results obtained from the questionnaire, six securities were selected for further investigation. The research then centred on determining which security would have the greatest benefit for the companies. In this part of the study cash flows and net present values (NPV) were calculated for each security. Spreadsheets using these data then formed the foundation for conducting a Monte Carlo simulation. The results of these simulations highlighted those variables which had the greatest impact on the end of year cash flows and company NPVs. Finally, a decision tree model was developed to ascertain which security was the optimal one for the company to use during the first five years of marketing its first drug.

The results demonstrate that during this first five year period the type of funding for the companies included in the study would be the same as those currently employed. However, by the end of five years the dominance of options/warrants as a form of financing was declining in favour of other equity-type securities. Therefore, the implications are that even though some positive cash flows were being generated during this period, the cash outflows associated with servicing and refunding fixed interest-type securities mean that they are not the most cost-effective source of funds for these companies.

DEDICATION

To my husband David who has been my source of encouragement throughout my studies and for his patience and motivation when the obstacles seemed insurmountable.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1: INTRODUCTION

1.0 INTRODUCTION

In 1606 the first equity security was printed in Holland to finance and spread the risks of the Dutch East India Company's[1] operations in Asia. From this time on a large number of securities have been developed. Some have proved to be very successful and remain in existence today albeit in a modified form. Other securities have been designed for a specific purpose or situation which, when satisfied, leads to the demise of the security.

The financing requirements of a biotechnology or pharmaceutical company differ significantly from those of most other companies who are able to present annual profit figures, declare regular dividends and show a steady pattern of growth. The former companies undertake research and development (R&D) activities in order to develop a product or onsell technology so that profits will be generated and dividends paid.

This research will focus on the issuer-investor requirements for a security which would be appropriate for a biotechnology company seeking funds when it has a product ready for submission to a regulatory body. At this stage some drugs are certain of being approved and therefore the company can expect to commence generating positive cash flows and may consider an alternative to the current equity and options/warrants form of financing their operations. The successful introduction of a new security requires the approval of and acquisition by interested investors. However, the new security should also be one that enhances the company's net present value (NPV) during the first five years of marketing their inaugural product. As a result the product should be one that does not impact too detrimentally on the annual cash flows of the company in these early stages.

Hence the research objective is to ascertain a cost-effective security for a biotechnology company to issue which would meet the requirements of institutional investors. The Monte Carlo and decision tree techniques were used to determine which of the six securities selected from a survey of institutional investors, would be the most appropriate source of financing for the company to use. A NPV model provided a standardised approach to the problem and set a foundation for the Monte Carlo simulation and the decision tree techniques to build on.

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[1] Taken from a reprint prepared by the Amsterdam Stock Exchange.

This chapter will firstly describe the issuer's situation before moving on to explain the investor's requirements. Secondly, because a new type of security is being considered, a discussion of financial innovation and two of the main issues associated with this process, ie. asymmetric information and complete markets, will be undertaken. Finally, the aim and objectives of the research, its limitations and contribution to knowledge will be discussed.

1.1 THE ISSUER

The type of biotechnology company used in this study was one conducting research on a range of diseases in an effort to produce a drug which would eliminate or alleviate the symptoms of the ailment. In order to obtain some background on these companies the Finance Director of British Biotech plc in the United Kingdom and the Company Secretary of Biota Holdings Limited in Australia were interviewed. Profiles of these companies can be found in Appendix 1.

Initially these companies were financed by venture capital firms, many of which are affiliated with investment banks and then by equity or options (called warrants in the UK) on equity securities. The reason for not including debt in the capital structure is that the company does not generate a regular cash flow and therefore could not service the debt. In addition, because the firm's activities do not generate a profit there is no benefit to be received from a potential interest tax shield. Dividends also cannot be paid so the investors rely on growth in share price to compensate them for the risks they undertake in investing in a high risk company.

According to Balthasar et al. (1978)[2] companies in the pharmaceutical[3] industry require between five to ten years or more to become technically successful. Another five to eight years is required for them to reach full commercial potential (p. 151). The success rate in projects is also low with only one in ten projects reaching the registration stage. In order to achieve one technically successful project approximately 10,000 new chemical entities require screening. Even at this stage a product that is technically successful may not become commercially successful[4]. The stages which occur in the development of a drug from the preclinical stage through to making application to a regulatory body for approval to manufacture and market the product will be described in Chapter 4.

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[2] Balthasar, H V, Boschi, R A A and Menke, M M, "Calling the Shots in R & D", *Harvard Business Review*, May-June 1978, pp 151-160.

[3] The terms 'biotechnology company' and 'pharmaceutical company' are used interchangeably. For the purpose of this dissertation the operations are deemed to be closely allied.

When raising finance a biotechnology company has to divulge far more information than it may wish to do in order to raise funds. Unlike a manufacturing company, these companies do not make a profit, are not paying any dividends but are showing signs of growth and the potential exists for the development of a successful product. Therefore the institution that is to underwrite the issue will have a significant amount of inside information concerning the company's operations[5] and in some instances may experience a conflict of interest if they issue a security so that an existing investment increases in value. Gompers and Lerner (1997) found that this did not adversely affect the company's performance in the long-run and also that the securities did not have to be discounted more in order to be taken up by investors, especially if the institution has a good reputation.

In the early stages of development these companies provide full details of early clinical trials to their investors. However, once the firm obtains a higher profile then less information is provided about the early stage products and only information concerning drugs as they are about to reach the market are divulged. The reason for this is that the threat of competition is very strong, for example in year 2 of marketing a product there is a 50 percent chance that one competitor will be present rising to an 80 percent possibility that three competitors will be offering generic products in year 5[6]. The reduction in sales revenue from competition rises from 25 percent in year 2 to 57.8 percent in year 5.

Equity is considered to be the most suitable financing arrangement for high-tech, high risk investments due to the problems associated with a lack of collateral value for (R&D) investments[7]. This is borne out by Hall (1992)[8] who stated that banks preferred not to allow debt funds to be used for R&D investments because the intangible assets (ie. intellectual property) resulting from the investment are not physical assets and therefore cannot be used as collateral. Assets which could be redeployed (ie. used for another task or in another place) were suitable for debt

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[4] Foster, G, "R & D: Risk and Disillusion", *Management Today*, January 1, 1989, pp 50-55.
[5] Gompers, P and Lerner, J, "Conflict of Interest and Reputation in the Issuance of Public Securities: Evidence from Venture Capital", Harvard University: Unpublished Working Paper, November 1997.
[6] Myers, S C and Howe, C D, *A Life-Cycle Financial Model of Pharmaceutical R & D*, Mass. Inst. of Technology: Program of the Pharmaceutical Industry, April 1997; Cockburn, I, "Racing to Invest - Patent Races in Pharmaceutical Research", **in** *Risk and Return in the Pharmaceutical Industry*, London: Office of Health Economics, 1997.
[7] Himmelberg, C P and Petersen, B C, "R & D and Internal Finance: A Panel Study of Small Firms in High-tech Industries", *Review of Economics and Statistics*, 1994, pp 38-51.
[8] Hall, B H, "Investment and Research and Development at the Firm Level: Does the Source of Financing Matter?", National Bureau of Economic Research Inc., Working Paper Series, No. 4096, June 1992.

financing as they can be valued more readily using traditional accounting-based methods[9].

Biotechnology companies which are not yet at the stage of making an application to either the US Food and Drug Administration, the Medicines Control Association or the European Medicines Evaluation Agency would use equity funds to finance their operations. However, once the data concerning a drug are ready for submission to one of the above agencies then there is a strong likelihood of the product being marketed. At this stage it is possible to calculate the price of the product, the level of sales, market share and profits which would accrue from the sale of the drug. Consideration of a change to the company's capital structure also becomes feasible. The question to consider is what form of security is the most appropriate for the company to issue.

1.2 THE INVESTOR

The decision to alter the form of financing has strong implications for those investing in the firm. For example, if equity funding is used then the investors will in effect be owners of the company and will therefore monitor all aspects of the firm's risks[10]. Conversely, if debt financing is used then these security holders will only monitor the firm's potential to default. This monitoring, however, is costly and may reduce the amount the investor is prepared to hold in debt. Therefore, although the area of monitoring is reduced to one area of risk, the costs associated with default may cause the investor to ration the amount of debt exposure they wish to hold in a company.

Information concerning the company's operations are known to its management but investors do not have access to all of it, and therefore they must estimate the quality of the information they receive[11]. That is, the issuer of a new security must signal its quality to the investors who cannot distinguish the level of quality until this information is provided to them[12]. Even upon receipt of the information it is often extremely difficult and expensive for a firm's investment opportunities to be accurately evaluated by those who provide external funds[13]. Hence the firm may receive less

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[9] Gompers, P and Lerner, J, November 1997, op cit.
[10] Morgan, D P, "Financial Contracts when Costs and Returns are Private", *Journal of Monetary Economics*, 1993, **31**, pp 129-146.
[11] Brennan, M and Kraus, A, "Efficient Financing under Asymmetric Information", *Journal of Finance*, December 1987, **XLII**(5), pp 1225-1243.
[12] Heinkel, R, "A Theory of Capital Structure Relevance under Imperfect Information", *Journal of Finance*, December 1982, **37**(5), pp 1141-1150.
[13] Fazzari, S M, Hubbard, R G and Petersen, B C, "Financing Constraints and Corporate Investment", *Brookings Papers on Economic Activity*, 1988, **1**, pp 141-195.

financing for its investments if the information they provide is less than that required by the suppliers of funds.

In addition, information may not incorporate all aspects of a firm's value because some asset's value, such as intellectual property, may not be fully reflected in the share price. Because investors do not have this information, they may revise the company's value whenever they become aware the company is acting to transfer wealth. Thakor[14] endeavoured to determine what the impact of information-constrained stock valuation was on the choice of a firm's investment policy, that is, how did prices change in relation to the firm's investment choices. He found that if projects generated cash flows early on then the share price reaction was favourable compared with projects whose cash flows occurred later. An example of the latter type of projects were R&D investments and new products which may generate a higher surplus in the distant future compared to a lower valued project which would supply early cash flows.

This is especially difficult for biotechnology companies who, on the one hand, must convey complex technical information to investors while, on the other hand, must be careful not to provide their competitors with technical details which may give them a competitive advantage. Therefore, while their funding comes from equity-related sources the company must provide a significant amount of information about all their operations. Once a project reaches the stage of regulatory application then alternative sources of financing become possible and the information provided to investors will concentrate on this product and its future potential. Unfortunately the company presentations are delivered to a different type of investor who may not be as conversant with the company's operations as the equity investors were. Hence the information concerning the company and the security they are issuing needs to be sufficient for them to subscribe fully to the issue.

In the initial stages equity suits a high risk company, but upon application for licensing the potential for the company to generate a cash flow which will service debt becomes feasible. However, the bond and equity investors focus on different aspects of their investments. Equity investors accept annual losses and no dividend income in preference for a large capital gain. Bond brokers, on the other hand, require their debt to be serviced and are more concerned with debt cover and yields. Existing shareholders may not consider bonds to be a suitable form of financing because the funds used to pay interest could be better employed on further R&D.

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[14] Thakor, A V, "Information, Investment Horizon, and Price Reactions", *Journal of Financial and Quantitative Analysis*, December 1993, **28**(4), pp 459-482.

The financial innovations which have been developed have provided investors with a range of alternatives to equity and term lending. The issuers possess full information about their firm's operations and are fully aware of their credit risk but investors, presented with a range of alternative investment products have difficulty protecting their portfolios from credit risk.

1.3 FINANCIAL INNOVATION

Financial engineering (ie. security design) is reported by Finnerty[15] to involve

> "the design, the development, and the implementation of innovative financial instruments and processes, and the formulation of creative solutions to problems in finance" (p. 14).

The definition lists three different activities which comprise financial engineering. These are:

a) security innovation, ie. securities which are designed to satisfy the requirements of bank, mutual fund, or insurance company clients as well as companies seeking new forms of debt or equity instruments;

b) innovative financial process development which permits (i) a reduction in transaction costs, (ii) the alleviation of the effect of legislative/regulatory changes, and (iii) the development of new technology; and

c) the resolution of problems associated with areas of corporate finance such as cash or debt management, and asset-based financing (p. 15).

For the purpose of this research it is security innovation as described in a) above which is of interest.

Boot and Thakor[16] noted that the impact of financial innovation reduced frictions in the flow of information due to the stimulation of informed trading and improved liquidity and also by improved information transmission at lower cost. Table 1.1 lists 11 categories of factors which may be responsible for altering securities. Those factors which have been primarily responsible for the changes are tax asymmetries which benefit both issuer and investor, transaction costs, market illiquidity[17] and regulations[18]. The latter has caused innovation to occur "around prohibited types of profitable transactions" (p. 461). One example of this type of innovation, which arose as a result of a change in taxation

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[15] Finnerty, J D, Winter 1988, op cit.

[16] Boot, A W A and Thakor, A V, "Financial System Architecture", *Review of Financial Studies*, 1997, **10**(3), pp 693-733.

[17] Flood, M D, "Two Faces of Financial Innovation", *Federal Reserve Bank of St. Louis*, September-October 1992, **74**(5), pp 3-17.

[18] Miller, M H, "Financial Innovation: The Last Twenty Years and the Next", *Journal of Financial and Quantitative Analysis*, December 1986, **21**(4), pp 459-471.

was the Eurodollar market. This instrument was developed to counteract the ceiling placed on commercial bank term deposit interest rates[19].

Many new financial instruments are developed in order to lessen a firm's financial constraints. These constraints can be imposed externally by government regulations or by the marketplace which

> "defines the parameters of demand and supply for different financial products and simultaneously identifies the policy tools available to the firm" (p. 89)[20].

Internal constraints can be imposed by the firm when they set the rate of growth for assets or impose liquidity limitations on their funds.

Table 1.1: Factors Responsible for Financial Innovation[21]
The table shows the 11 categories of factors which may be responsible for the need to innovate financial securities. The main factors are tax asymmetries, transaction costs, market illiquidity and regulations.

Category	Factor
1	Tax asymmetries which produce tax savings for the issuer, investors (or both) but do not increase the tax liabilities of the other party
2	Transaction costs
3	Agency costs
4	Risk reduction/reallocation from one market participant to another
5	The chance to increase the liquidity of an asset
6	Changes to regulations and/or legislation
7	Level and volatility of interest rates
8	Level and volatility of prices
9	Academic research concerning risk/reduction characteristics of existing classes of securities
10	Accounting benefits
11	Technology advances

Innovation to assist the firm maximise its utility subject to these constraints is not free. Search and development costs are incurred which, while not as expensive as new technological innovation, do add to the expense of designing a new product. Other expenses arise from the operation of a secondary market and the installation of suitable computer

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[19] Miller, M H, December 1986, op cit., p 462.
[20] Silber, W L, "Recent Structural Change in the Capital Markets: The Process of Financial Innovation", *American Economic Review*, May 1983, **73**, pp 89-95.
[21] Finnerty, J D, "Financial Engineering in Corporate Finance: An Overview", *Financial Management*, Winter 1988, pp 14-33.

equipment[22]. These costs must be balanced by the benefits which accrue from a new financial security which has been designed to assist the firm's financing flexibility.

> "A new security is truly 'innovative' only if it (i) enables an investor to realise a higher after-tax risk-adjusted rate of return without adversely affecting the issuer's after-tax cost of funds, and/or (ii) enables an issuer to realise a lower after-tax cost of funds without adversely affecting investors, than had been possible prior to the introduction of the new security" (p. 18)[23].

The new security should make the financial markets more efficient and more complete - if the security is merely different then it is not 'truly innovative'. In order to be truly innovative the security must add value to the issuing company's shareholders and if the change is significant then the security will survive and continue to grow even though the reason for its existence has passed.

However, Miller (1986) states that innovation represents a change in two parts. The first part is a forecast change which can be determined from what has happened in the past. The second part refers to the unforecastable, unexpected changes which have led to the proliferation of new financial instruments. That is, financial innovations are unforecast improvements in previous financial instruments. Many of the changes are already in existence but had not been promoted until the financial environment was ready to accept the instruments.

Carter (1989)[24], Finnerty (1988) and Flood (1992)[25] stated that the reasons why financial innovation occurred was due to improved computer technology, regulations and taxes, etc. Carter noted that financial innovation was a) a response to inefficiencies and gaps in the intermediation process and b) had strengthened the process making it more efficient. Flood considered why some new securities failed, how they could be improved and the reasons that must be present for financial innovation to occur.

In contrast, Merton (1995)[26] forecasts that in the future financial innovation will be used as a risk management tool in order to reduce asymmetric information and agency costs, and also to increase the opportunity for risk sharing between issuers and investors. In a similar fashion, Demange and Laroque (1995)[27] investigated the problems associated with issuers who possessed inside information to determine if this acted as a disincentive to investors

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[22] Silber, W L, May 1983, op cit., p 90.
[23] Finnerty, J D, Winter 1988, op cit.
[24] Carter, M, "Financial Innovation and Financial Fragility", *Journal of Economic Issues*, September 1989, **23**(3), pp 779-793.
[25] Flood, M D, September-October 1992, op cit.
[26] Merton, R C, "Financial Innovation and the Management and Regulation of Financial Institutions", *Journal of Banking and Finance*, 1995, **19**, pp 461-481.

when they floated the company on the market. They found "that asymmetric information was a non-trivial distortionary factor in the decision to incorporate a company" (p. 251).

Miller (1992)[28] considered the disadvantages of security innovations, ie. that it does not produce physical commodities and therefore is non-productive. In addition, by causing a reduction in transaction costs there would be an increase in trading activities which would shorten short-term trading and planning horizons. Finally, the increase in trading activities caused volatility in the stockmarket to rise as a result of the new innovations.

The main issues that impact on the design of a new security concern information asymmetry and complete markets. A discussion of these areas is undertaken below.

1.3.1 Asymmetric Information

Asymmetric information occurs because one group, an entrepreneur, possesses inside information about the firm's operations and investment opportunities that investors do not have. The issue of what the entrepreneur does with this information and how much is disclosed to investors without affecting the interests of old investors is discussed by Myers and Majluf (1984)[29]. Based on the information they possess, the managers must decide whether the issue of new equity or risky debt is in the interests of old investors - if they do not issue securities then a misallocation of real capital investment occurs and the value of the firm declines. Their model assumes that investors are aware that the managers do possess more information than they do. Leyland and Pyle's (1977)[30] study is similar to Myers and Majluf's but they state that an outside investor will observe other factors, such as the financial commitment made by the insider to the project. The firm's choice of their capital structure, as well as their choice of the security to issue, also act as a signal to investors and if the information provided by the firm does not satisfy the information required by the investor then they may not raise all the funds they require[31] [32].

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[27] Demange, G and Laroque, G, "Private Information and the Design of Securities", *Journal of Economic Theory*, 1995, **65**, pp 233-257.
[28] Miller, M H, "Financial Innovation: Achievements and Prospects", *Journal of Applied Corporate Finance*, 1992, **4**(4), pp 4-11.
[29] Myers, S C and Majluf, N S, "Corporate Financing and Investment Decisions when Firms have Information that Investors do not have", *Journal of Financial Economics*, 1984, **13**, pp 187-221.
[30] Leyland, H E and Pyle, D H, "Informational Asymmetries, Financial Structure, and Financial Intermediation, *Journal of Finance*, May 1977, **32**(2), pp 371-387.
[31] Bayless, M and Chaplinsky, S, "Expectations of Security Type and the Information Content of Debt and Equity Offers", *Journal of Financial Intermediation*, June 1991, **1**, pp 195-214.
[32] Heinkel, R, 1982, op cit.

The cost of obtaining information which would enable investors to verify the accuracy of the firm's investment opportunities[33] [34] is very expensive and it is extremely difficult for the quality of a firm's investment opportunities to be accurately evaluated by those who provide external funds. In addition, while equity requires investors to monitor all aspects of investment so that all risks are taken into account, debt requires only the monitoring of default risk so that debt financing dominates equity due to a reduction in monitoring costs.

Some of these information problems can be overcome if investment banks are used. These organisations underwrite the debt and equity issues offered by entrepreneurs and hence need to value the projects accurately. If they are able to do this then investors will take up the issue. Research by Chemmanur and Fulghieri (1994)[35] found that investment banks which possessed a good reputation were more accurate at valuing the firm whose securities it was placing and hence were able to reduce the impact of equity market information asymmetry. In turn entrepreneurial firms chose investment banks who possessed a high prestige to underwrite their issues but preferred underwritten equity offerings and not placements. This finding was also supported by Petersen and Rajan (1994)[36] who found that if a relationship existed between borrowers and lenders then it affected the access to and the cost of funds. That is, the borrower's access to funds improved while the relationship had no real effect on the cost of the funds. However, if the firm had more than one lender then the availability of funds declined and the price of the funds rose.

The relationship between borrower and lender is important, especially if it is of a long duration, due to the amount of information the lender is able to obtain concerning the borrower's activities. The relationship does not, however, mean cheaper credit because a) the information is public or verifiable so that the relationship does not really matter and has no value; b) the relationship has value but more emphasis is placed on the availability of funds and not a reduction in interest rates; and c) there is no compulsion on the lender to pass on any benefit in the form of lower interest rates. However, Berger and Udell (1995)[37] analysed the relationship between banks and small companies and found that banks, as a result of analysing the information presented to them by the companies, obtained an information advantage which could be used to set the terms of loans. Their conclusions

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[33] Fazzari, S M, Hubbard, R G and Petersen, B C, 1988, op cit.
[34] Morgan, D P, 1993, op cit.
[35] Chemmanur, T J and Fulghieri, P, "Investment Bank Reputation, Information Production, and Financial Intermediation", *Journal of Finance,* March 1994, **XLIX**(1), pp 57-79.
[36] Petersen, M A and Rajan, R G, "The Benefits of Lending Relationships: Evidence from Small Business Data", *Journal of Finance*, March 1994, **XLIX**(1), pp 3-37.
[37] Berger, A N and Udell, G F, "Relationship Lending and Lines of Credit in Small Firm Finance", *Journal of Business*, **68**(3), pp 351-381.

agreed with those of Boot and Thakor (1994)[38] ie. if the relationship between the financial intermediary and the small company was a long-term one then loan interest rates would fall and the collateral required for the loan would be lower.

If the company has a high level of R&D spending and there will be a number of products resulting from this expenditure the success of the investment is very hard for outsiders to evaluate and will consequently lead to higher levels of asymmetric information. Alam and Walton (1995)[39] found that if these firms used debt finance good news was expected and a positive share price resulted as the expectation was that an R&D project was completed. The issue of debt was deemed to reflect potential positive abnormal future earnings by firms with asymmetrical information as the information was not previously reflected in share prices.

Noe and Rebello (1996)[40] found that financial policies of firms will differ depending on whether the firm is controlled by shareholders or managers as a result of their diametrically opposing objectives as far as the benefits accruing to them. For example, shareholders have a preference for debt whereas debtholders prefer equity. Therefore in order to "avoid mispricing losses, shareholder-controlled firms [will] reduce their dependence on both outside capital and debt financing" (p. 654)[41] whereas manager-controlled companies increase their dependence on debt financing and outside capital to achieve the same objective.

Boot and Thakor (1997)[42] note the existence of three informational problems, ie. incomplete information regarding the company's future projects; post-lending moral hazard regarding investment choices which may affect creditors' payments; and the uncertainty concerning potential post-lending moral hazard. These issues can also cause markets to be incomplete and this is discussed further in section 1.3.2 below.

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[38] Boot, A W A and Thakor, A V, "Moral Hazard and Secured Lending in an Infinitely Repeated Credit Market Game", *International Economic Review*, November 1994, **35**, pp 899-920.
[39] Alam, P and Walton, K S "Information Asymmetry and Valuation Effects of Debt Financing", *Financial Review*, May 1995, **30**(2), pp 289-311.
[40] Noe, T H and Rebello, M J, "Asymmetric Information, Managerial Opportunism, Financing, and Payout Policies", *Journal of Finance*, June 1996, **LI**(2), pp 637-660.
[41] Noe, T H and Rebello, M J, June 1996, op cit.
[42] Boot, A W A and Thakor, A V, 1997, op cit.

1.3.2 Complete Markets

Van Horne (1985)[43] states that financial innovation occurs in order to adapt to changes in the financial markets and by so doing make the markets more complete and efficient. A market will be deemed to be complete "when every contingency in the world corresponds to a distinct marketable security" (p. 622). In the real world a complete market will not occur because it is unlikely that the available securities will satisfy all the requirements of investors. Ross (1989)[44] takes this a step further by developing a model which considers, among other things, the costs associated with introducing new securities. He found that if a security was to be successful then it must be able to be standardised so that there was sufficient demand to justify the development and marketing costs.

Financial intermediaries exist in order to assist the flow of funds between borrowers and lenders. In the process they minimise transaction costs by offering a standard range of products and lessen problems associated with asymmetric information. In this way they are able to assist markets to become complete by providing a venue whereby the supply and demand for all securities can be satisfied. Therefore, entrepreneurs will use financial intermediaries in order to obtain funds to finance new investment projects. It is through this process that asymmetric information via adverse selection and moral hazard will affect the completeness of the financial markets[45].

Adverse selection occurs prior to the loan being taken out when entrepreneurs, due to their inside information concerning the company and its products, do not disclose any detrimental news which may affect their ability to receive funds. As a result the financial institution may be unable to differentiate between good and bad investments and will charge a rate for the project based on the risk for the industry as a whole. Hence the interest rate may be too high for some projects of good risk so that the investor will not proceed with the investment. On the other hand, the cost of the loan for some bad risks projects will be low enough for the investment to proceed and too few good quality projects and too many bad projects will be financed (p. 127)[46]. When the lender becomes aware that only borrowers who are bad risks are seeking loans they will withdraw their loan monies and ration credit in this particular segment of the market. Therefore, due to asymmetric information the financial markets are incomplete.

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[43] Van Horne, J C, "Of Financial Innovations and Excesses", *Journal of Finance*, July 1985, **XL**(3), pp 621-631.
[44] Ross, S A, "Institutional Markets, Financial Marketing and Financial Innovation", *Journal of Finance*, July 1989, **XLIV**(3), pp 541-556.
[45] Stemp, P J, "An Introduction to the Economics of Financial Markets", *The Australian Economic Review*, 4th Quarter 1994, **108**, pp 123-139.
[46] Stemp, P J, 1994, op cit.

Moral hazard occurs after the loan has been granted and has been defined by Tuttle et al. (1997)[47] "as an incentive to act in one's self-interest in conflict with the organisation's overall goals while being able to hide those actions through privately held information" (p. 7). This situation occurs if the agent may receive a benefit as a result of the private information. As a result, once the borrower has received the funds for investment they may decide to invest in riskier projects than the investor previously agreed to. If the investment is successful then default will not occur but if the investment is unsuccessful then the lender will bear most of the loss of the loan. This situation will also cause credit rationing to occur again leading to incomplete markets. If credit is rationed, interest rates may not equate to the supply and demand for loans. It is only when interest rates are in equilibrium that the market would be cleared and the supply of loans satisfied. Lenders only charge a higher rate of interest because they are unable to determine the borrower's true likelihood of default, ie. they protect themselves against borrowers who act opportunistically. However, risky projects with expected positive NPVs will be financed if lenders and borrowers have the same information because risk can be diversified by the lenders[48].

Van Horne discusses the good and bad aspects of financial innovation. While new securities enhance the financial system and encourage the markets to act in the best interests of the financial services industry, those that have no substance may not assist the market to become more complete - in other words not every new security is successful. However, Elul's (1995)[49] research showed that even with asymmetric information problems it is possible to introduce financial innovations which will provide both good and bad benefits to society. In fact, it was shown that it was possible to introduce a new security for which demand was small so that another previously unwanted asset would generate sufficient demand to satisfy the supply.

1.4 RESEARCH GAP

While the research noted above may seem rather diverse it does impact on the project to be undertaken. For example, previous studies have investigated the reasons why financial innovation in the form of security design has evolved. It has been found that not all products are successful and that if they have no appeal to investors then the issuer will not

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[47] Tuttle, B, Harrell, A and Harrison, P, "Moral Hazard, Ethical Considerations, and the Decision to Implement an Information System", *Journal of Management Information Systems: Jmis*, Spring 1997, **13**(4), pp 7-27.

[48] Fazzari, S M, Variato, A M, "Asymmetric Information and Keynesian Theories of Investment", *Journal of Post Keynesian Economics*, Spring 1994, **16**(3), pp 351-369.

[49] Elul, R, "Welfare Effects of Financial Innovation in Incomplete Markets Economies with Several Consumption Goods", *Journal of Economic Theory*, 1995, **65**, pp 43-78.

obtain the funds required. Sometimes this is not due to the design of the security but because the changes which caused the security to be developed have altered and it no longer meets the needs for which it was originally developed.

In order for a security to be successful the issue of asymmetric information becomes important. The significant research done in this area should assist the issuer to understand the amount and type of information an investor will require in order to participate in the security issue.

Finnerty (1988)[50] defines a new security as innovative if it benefits both the issuer and investor and in the process makes the markets more complete thereby adding value to the issuing company's shareholders. In order to achieve these goals a large number of securities have been developed primarily for the finance, banking, insurance and manufacturing industries. However, very little has been written about the financing requirements of an emerging biotechnology company. Any reference made to the funds used by these companies to fund their operations refers to equity and warrants (options) on equity. A number of articles mention the financing activities of a range of industries which may include pharmaceutical companies but the activities of the newer, smaller companies are dominated by the large firms such as GlaxoWellcome.

As a result three research questions have emerged on which this project has been based. Firstly, there appears to have been nothing written about the amount and type of information investors require from biotechnology companies prior to committing funds for investment. In addition, the type of security that these companies may issue which would satisfy the investor's requirements has not been considered. In order to elicit this information and the techniques used to analyse these companies, a random selection of institutional investors in Australia and the United Kingdom were surveyed by questionnaire.

Secondly, the financing requirements of biotechnology companies with their first product ready to market has not been covered by the literature. Up until this time due to the lack of a regular cash flow, equity and equity options have been used to finance the company's operations. Therefore, this research will seek to determine which of the securities supported by the investors is the most cost-effective one for the company to use in the first five years of marketing its inaugural product. The techniques used to do this were to a) ascertain the variations in cash flows and NPVs when a particular security was used; b) determine those variables which impacted significantly on the cash flows and NPVs using Monte Carlo

[50] Finnerty, J D, Winter 1988, op cit.

simulation; and c) use a decision tree model in order to ascertain which security was the most cost-effective one for the company to use. A second limitation of this project is that a large number of assumptions were made concerning the level of revenues and expenses associated with a biotechnology company marketing its first product. The accuracy or otherwise of these assumptions will affect the resultant cash flows and NPVs.

Thirdly, as mentioned in section 1.1 competition has a major effect on the level of sales for a biotechnology company if generic products are introduced very early in the life cycle of the new product. Using the Monte Carlo simulation technique, this research will try to establish if it is competition, or some other variable, that has a major impact on the company's cash flows.

Chapter 2 will describe the range of securities which have been designed in order to satisfy the requirements of issuers and investors. A number of these securities and a description of them were included in the questionnaire sent to institutional investors in order to ascertain their familiarity and use of different types of products; the development of the questionnaire and the analysis of the survey results forms Chapter 3. The information obtained from the survey forms the basis for Chapter 4 which described the initial stages of research undertaken prior to a drug being launched onto the market, and then lists the six securities which were selected for further analysis. Chapter 5 describes in detail the formulation of the spreadsheet model to calculate the cash flows and NPVs for each security. This model formed the basis for the Monte Carlo simulations which determined those variables which had the greatest impact on each security's NPV and is covered in Chapter 6, while in Chapter 7 the decision tree model used to ascertain the most cost-effective security for the company to use is discussed. Chapter 8 concludes the research and recommends areas for further research.

Chapter 2: FINANCIAL INNOVATION AND THE DESIGN OF SECURITIES

2.0 INTRODUCTION

Since the first company scrip was issued for the Dutch East India Company in 1606 a large number of securities have been developed[1] and offered to investors with varying levels of success. Many, such as debt and equity, have remained essentially the same and in many cases have formed the basis for the development of new products.

The introduction of new products has occurred in waves and in the early 1970s the demand for a greater variety of financial products arose as a consequence of the demise of the Bretton Woods agreement. This agreement had in place a fixed-exchange rate system which tied gold to the US dollar. However, increasing inflationary pressures meant that a more flexible exchange rate system was required. The subsequent volatility in the foreign exchange market caused uncertainties concerning future interest and exchange rates and created a demand for hedging facilities such as financial futures and options[2]. This demand was supported by computer refinements which permitted large amounts of data to be captured and aided the creation of an information revolution in the early 1970s. Additional refinements leading to computerised trading have permitted capital markets to become integrated globally[3].

At the same time, economic expansion required investment funds to finance industrial growth. This "variation in the level of economic activity affects not only the magnitude and type of funds needed, but also the risk attitudes of financial institutions and other market participants" (p. 475)[4]. Issuers and investors alike sought financial products which could provide them with some form of protection from volatility in the financial markets.

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[1] Such as those introduced in the late 1800s by the US railroad industry in order to ensure these companies could continue trading (Tufano, P, "Business Failure, Judicial Intervention and Financial Innovation: Restructuring US Railroads in the Nineteenth Century", *Business History Review*, Spring 1997, **71**(1), pp 1-40).

[2] Chicago Board of Trade, *The International Monetary Market*, Chicago Mercantile Exchange, 1982, p 2.

[3] Miller, M H, "Financial Innovation: Achievements and Prospects." *Journal of Applied Corporate Finance*, 1992, **4**(4), pp 4-11.

[4] Van Horne, J C, "Of Financial Innovations and Excesses." *Journal of Finance*, July 1985, **XL**(3), pp 621-631.

This chapter will describe the economic situation in existence in the early 1970s that provided the impetus for developing new securities which would meet the financing requirements of issuers and investors. A number of company-related constraints were also present which motivated financial engineers to alter the structure of existing securities in order to provide securities that were more cost-effective. These constraints and the characteristics peculiar to selected securities are detailed below. In order for companies to obtain the funds they require for their operations the securities they issue must satisfy an investor's requirements, therefore those aspects of security innovation that will benefit both the issuer and investor are also discussed. Many of the securities described in this chapter have been included in the questionnaire which was sent to institutional analysts in order to determine their familiarity with, and use of, the products.

2.1 HISTORY OF RECENT SECURITY INNOVATION

Tufano's (1997)[5] research into the problems associated with the US railroad industry in the late 1800s showed that a range of financial products (such as preferred stock, income bonds, deferred coupon bonds, etc) were developed by investment bankers to try and ensure that these companies could continue trading. The innovations were introduced to reduce financial constraints on the companies, and in many instances, voting trusts were put in place to protect both share- and bondholders' interests. It was very difficult to monitor bondholder interests because the courts protected the railways by modifying the terms of well-written prior contracts. As a result, investors discovered that some bonds, such as mortgage bonds, were less secure and enforceable than expected because the original contract did not envisage and include all contingencies. The reason the courts found in favour of the railroads was that if those companies were liquidated and closed down the US economy would have been severely affected. Therefore, the innovations at this time endeavoured to try and control the risk of judicial reinterpretation of information contained in bond contracts concerning seniority and security.

Tufano observed that the situation which existed in the 1970s and 1980s was another period of rapid financial innovation. Therefore, building on the information contained in Table 1.1 which details those factors responsible for security innovation, Table 2.1[6] lists a number of securities which have been developed during 1978-1991 and also gives the reasons for their innovation. Since 1981 most of the changes in financial markets and

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[5] Tufano, P, 1997, op cit.

[6] A more comprehensive list covering 20 years of financial security innovation can be found in Finnerty, J D, "Financial Engineering in Corporate Finance: An Overview", *Financial Management*, Winter 1988, pp 14-33.

practices have arisen in debt markets[7] and so many of the securities listed have been devised to cope with volatile inflation and the interest rate regime which occurred when currencies commenced floating or as a consequence of tax and regulatory changes. These will be discussed in the next section.

Table 2.1: Financial Innovations 1978-1991
The table shows the range of securities which were developed between 1978 and 1991 and provides the reason/s for their innovation.

Products	Primary Cause[8]
Adjustable and auction rate preferred stock	1, 3
Bonds with put options	1, 3
Currency option loans	1
Equity-for-debt swaps	3
Forward interest rate loan contracts, with ceilings and floors	1
Indexed sinking fund debentures	1
Interest rate and stock index futures markets	1, 2, 5
Interest rate swaps and currency swaps	1
IRA accounts	3
Issuance of, and investment in, high-yield (junk) bonds	1, 5
Liquid yield option notes (LYON)	3
Market index certificates of deposit	2, 4
Money market investment accounts	1, 2
Monthly income preferred stock	2, 3, 4
Municipal bond mutual funds	1, 3
New variations of adjustable rate mortgages	1, 2, 5
Options on futures contracts	1, 2, 5
Puttable stock	2
Securitisation of pass-through and other mortgages	1, 2, 4
Sinking fund preferred stock	2
Stock index growth notes (SIGN)	3
Stock warrant off-balance sheet R&D instrument (SWORD)	1, 5
Super NOW accounts	1, 2
Zero coupon bonds and coupon stripping	1, 5

(Adapted from Van Horne, July 1985).

[7]Carter, M, "Uncertainty, Liquidity and Speculation: A Keynesian Perspective on Financial Innovation in the Debt Markets", *Journal of Post Keynesian Economics*, Winter 1991-1992, 14(2), pp 169-182.

[8] Cause notation: 1, volatile inflation and interest rates; 2, regulatory; 3, tax issues; 4, level of economic activity; and 5, academic work.

2.1.1 Reasons for Development

Although changes in tax laws and security regulations are considered to be prime reasons for financial security innovation[9], the overriding requirement must stem from economic expansion and the need to lessen a firm's financial constraints in the uncertain environment of fluctuating interest and exchange rates. In order to survive a firm should maximise its shareholder returns and utility functions subject to internal and external constraints. Table 2.2 lists these constraints and shows that financing is required to fund internal constraints such as the a) growth in a company's asset base and level of earnings necessary to support the demand for products, and b) liquidity based on the availability of suitable financial products in the market[10]. The funds in a) do not include internal sources such as retained earnings and growth that is in excess of the level which can be financed by the current level of funding. The type of security used will depend on the external constraints of government regulations and changes to tax laws. These constraints define the parameters of supply and demand for the products being developed and also limits the policy tools the firm can use to fund its operations.

Table 2.2: Firm's Internal and External Constraints
The type of internal and external constraints confronting the firm which define the parameters of supply and demand for financial innovations leading to changes to the design of securities

Internal	External
Target growth rate (assets) Liquidity constraints Level of company earnings Transaction and agency costs	Securities regulations Price levels and volatility Taxation issues Risk reduction reallocation

(Adapted from Silber, 1983).

Most of the products are not intrinsically new but represent improvements or refinements to existing products. Some of these adaptations arose as a result of improved technology (ie. computer hardware and software) and academic research which led to the development of mathematical models. Therefore, although many of the innovations existed they were not promoted until the financial environment was ready to accept the

[9] Tufano, P, "Securities Innovations: A Historical Perspective", *Journal of Applied Corporate Finance*, Winter 1995, **7**(4), pp 90-104.
[10] Silber, W L "The Process of Financial Innovation". *American Economic Review*, May 1983, **73**, pp 89-95.

securities[11]. This environment arose in some cases when a) variations in income tax rates encouraged the transmutation of one security into another in order to ensure that a lower level of tax was paid by both investor and issuer, b) Government regulations caused innovations to occur "around prohibited types of profitable transactions" (p. 461)[12] and c) new, or potential, ceilings on interest rates were anticipated. That is, most innovative securities were developed in order to circumvent regulatory restrictions.

Finnerty (1988)[13] lists transaction and agency costs, risk reduction and reallocation, increases in asset liquidity, price levels and volatility, academic research on security risk and return, and accounting benefits as additional factors which can be responsible for amendments to existing securities. Hence, the design of a security evolves from a need to solve a problem that is present in the financial markets, or, as shown in Figure 2.1, a requirement by a company for a certain type of security.

In fact, there are three separate inputs which are required to construct a new security. In the first place there should be a company (the issuer) with specific financing requirements; secondly the financial markets must be receptive to the type of security being proposed; and thirdly there must be sufficient demand from investors to acquire the instrument. Figure 2.1 depicts the process of constructing a new financial instrument from these inputs culminating in the financial markets acting as an intermediary between the issuer and investor. This model differs from the one developed by Marshall and Bansal (1992)[14] which does not consider the issuer's requirements at the outset.

Security innovations improve the efficiency of the financial markets by increasing liquidity and the flow of information[15] which in turn reduces the spread between what the investor receives and the borrower pays for financial transactions. The evolution of new securities is costly and tailored to a particular issuer's (or investor's) needs. Over time the marketing costs fall and the instrument becomes standardised so that economies of scale reduce the bid/ask spread. Unfortunately the more standardised a product becomes the

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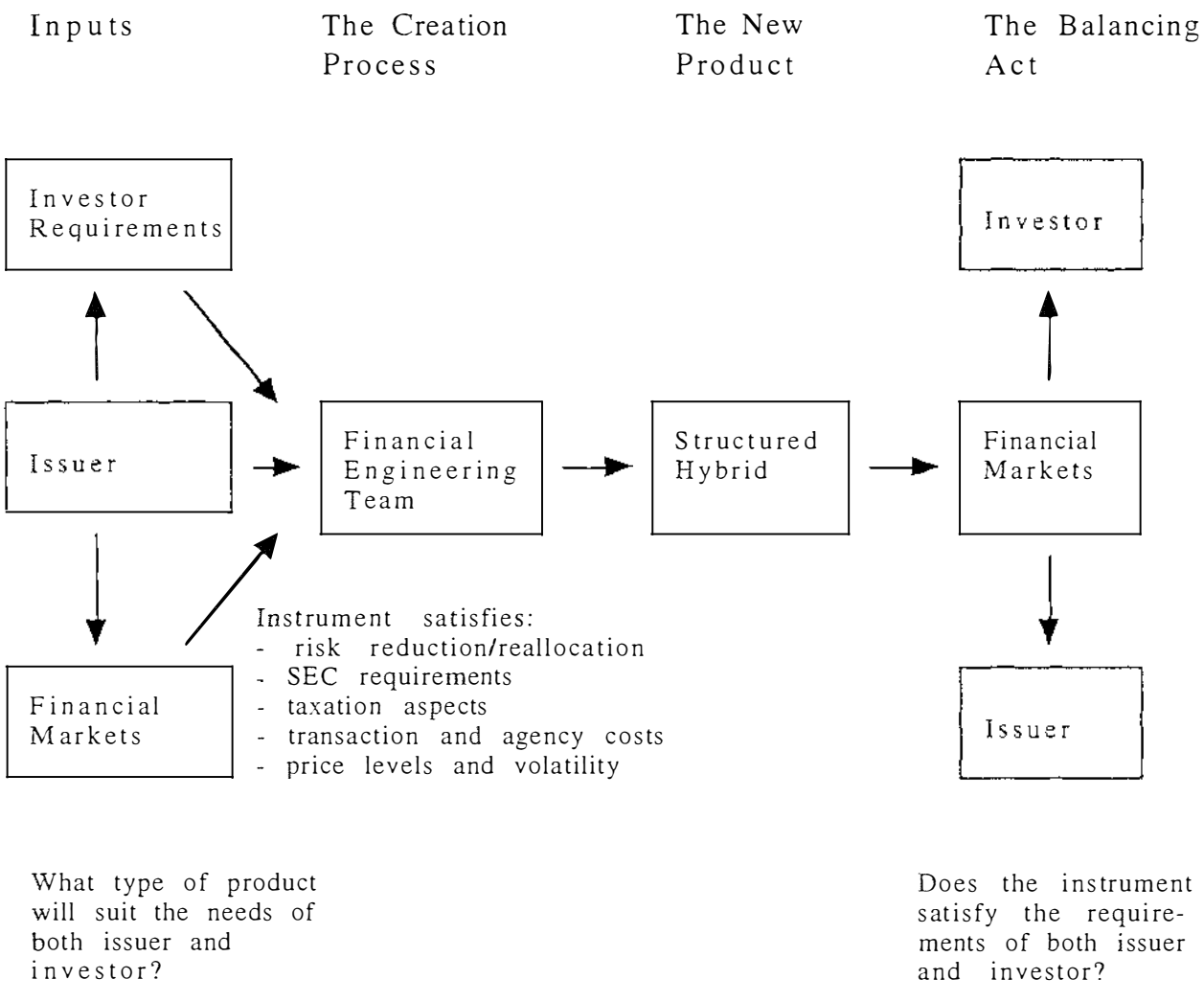
[11]Miller, M H "Financial Innovation: The Last Twenty Years and the Next", *Journal of Financial and Quantitative Analysis*, 1986, **21**(4), pp 459-471.
[12]Ibid.
[13]Finnerty, J D, Winter 1988, op cit.
[14]Marshall, J F and Bansal, V K, *Financial Engineering: A Complete Guide to Financial Innovation*, 1992, New York: Allyn & Bacon, Inc.
[15] Boot, A W A and Thakor, A V, "Financial System Architecture", *Review of Financial Studies*, 1997, **10**(3), pp 693-733.

Figure 2.1: Process of Developing a Financial Security
The diagram shows the process of constructing a new financial security that meets the needs of the issuer, investor and financial intermediaries.



Adapted from Appendix 19.1 Marshall, J F and Bansal, V K, *Financial Engineering: A Complete Guide to Financial Innovation*, 1992, New York: Allyn & Bacon, Inc.

less appealing it tends to be to institutional investors with specific requirements even though the costs of trading the security are reduced (p. 553)[16] .

Investment banks which develop new products cannot patent them because Securities and Exchange Commission (SEC) regulations require full disclosure of product design details. Banks state that as a result it would cost imitators 50 to 75 percent less than the innovators to create the same product. However, innovating banks appear to be able to recoup their financial outlay in the brief monopoly period before imitators offer products. These banks also obtain a larger market share in the short-term and are able to charge lower prices for underwriting the issues even at the outset. It should be noted that although the monopoly period is short the information concerning the type of investors and their preferences is valuable and provides the basis for future product developments which allows these banks to underwrite more new products than their imitators[17].

As shown in Figure 2.1, a successful product will satisfy the demands of investors thereby ensuring financial markets are complete - ie. that "every contingency in the world corresponds to a distinct marketable security"[18]. The securities offered should be able to clear the market at a price both buyers and sellers agree on.

A market is incomplete if the number and type of securities does not satisfy the needs of some investors. In the real world a complete market is an unrealistic phenomenon because it is unlikely that the available securities will satisfy all the requirements of investors. This is due to the investor's requirement for different maturities, coupon rates, call features, cash flow characteristics, level of investor protection, or some other aspect of the investment function.

For financial innovation to occur there must be profitable opportunities to capture, inefficiencies in financial intermediation and incomplete financial markets. These innovations in turn have a life cycle which may be shortened by competition and access to a market of similar products. Financial innovation may at times be defensive - this situation arises when a change in, say, a regulatory constraint occurs and affects the

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[16]Ross, S A, "Institutional Markets, Financial Marketing, and Financial Innovation", *Journal of Finance*, July 1989, **XLIV**(3), pp 541-556.
[17]Tufano, P, "Financial Innovation and First-Mover Advantages, *Journal of Financial Economics,* 1989, **25**, pp 213-240.
[18]Van Horne, J C, "Of Financial Innovations and Excesses", *Journal of Finance*, July 1985, **XL**(3), p. 622.

balance of a portfolio causing adjustments to be made in order to restore the previous profitability and level of risk.

Unfortunately some innovations have no substance, do not produce physical commodities and hence are non-productive. These securities do not assist the markets to become more efficient and complete. In addition, a number of financial products are promoted and tried, some are flawed and unsuitable for many investors or financial institutions and, because they do not satisfy the requirements of both parties, do not last very long.

For financial innovation to assist financial markets, those products which do not improve the efficiency and completeness of these markets should be avoided because they are dysfunctional. Rationally functioning markets, however, would not permit such products to succeed.

The adaptations made to securities during the 1970s through to 1991 were required to assist issuers fund their operations in a constantly changing economic environment. The development of improved data collection and information technology systems assisted the introduction of the new securities. However, it has been predicted by Merton (1995)[19] that future innovations will be introduced to reduce asymmetric information and agency costs so that the opportunity for risk sharing between issuers and investors will improve. The vast range of securities introduced during 1970-1991 will be described below.

2.2 RANGE OF FINANCIAL SECURITIES

Most of the literature concerning the range of innovative securities which have been traded in the financial markets has evolved from the United States. An extensive review of these products has been carried out by Finnerty (1988)[20] and Tufano (1989)[21]. However, as shown in Table 2.3, the level of innovation in the UK and Australian financial markets is more conservative, due primarily to

[19] Merton, R C, "Financial Innovation and the Management and Regulation of Financial Institutions", *Journal of Banking and Finance*, 1995, **19**, pp 461-481.
[20] Finnerty, J D, Winter 1988, op cit.
[21] Tufano, P, 1989, op cit.

"the apparent antipathy of even the largest institutions to many of the advances in financial engineering that have appeared in the past 4 or 5 years and their unwillingness to deal with the firms that have done most to develop them."[22]

Table 2.3: Securities Offered in the British and Australian Financial Markets
The table lists the securities offered in Britain and Australia. The range of products is considerably less than those offered in the US.

Security	Great Britain	Australia
Eurobond	Yes	Yes
Convertible debt	Yes	Yes
Convertible preferred debt	Yes	No
Corporate bonds	Yes	Yes
Debentures	Yes	Yes
Equities	Yes	Yes
Equity index secured bonds	Yes	Yes
Equity warrants (options)	Yes	Yes
Permanent interest bearing securities	Yes	No
Perpetual debentures	Yes	No
Preference shares	Yes	No
Warrants	Yes	Yes
Zero coupon bonds	Yes	Yes
Zero coupon convertible bonds	Yes	No

Source: Author generated.

The US market is unique as far as financial innovations are concerned[23] and so this section does not intend to repeat the efforts of the above authors but will concentrate on products which will satisfy one of the three activities comprising financial engineering, ie. security innovation or the design of a security which will satisfy the requirements of investors as well as companies domiciled in Britain and Australia seeking a new form of financial instrument (p. 15)[24].

Tables 2.4, 2.5 and 2.7 describe a range of innovative securities which may suit the needs of financial institutions in Great Britain and Australia, as well as the effect of these securities on the company and its investors. These tables are discussed in the following sections and give reasons why securities were adapted to circumvent inefficiencies which

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[22]Brady, S, "UK Investors Miss Out on New Products", *International Bond Investor,* March 1993, pp 34-35.
[23]Vittas, D, "How Far is the US Ahead in Financial Innovation", *The Banker,* May 1985, **135**(711), pp 47-53.
[24]Finnerty, J D, 1988, op cit.

existed in the financial markets that had detrimental affects on the operations of the company (the issuer) and the investor.

2.2.1 Innovative Securities

The securities shown in Table 2.4 have been adapted from one or more existing securities such as debt[25] or equity[26]. None of the products is unique but modifications have been introduced to meet a need which existed either in the financial markets, with companies, or with investors. Most of the securities have been designed to provide tax benefits to both investors and issuers or to permit the risks associated with fluctuating interest rates to be hedged.

For example, a zero coupon bond is an instrument which has no coupon cash flows over the life of the bond. It is a discounted security whose yield provides a true measure of the "supply and demand conditions for loanable funds of a given maturity due to its single payment at maturity" (p. 431)[27]. The bond has no price or reimbursement risk as long as it is held to maturity as these are offset due to the maturity and investment horizon dates being the same. Depending on the tax regulations of each country, deductions for interest will be made either when the bond matures or on an annual basis[28].

The income bond has no bankruptcy risk because the coupon is linked to the level of accounting earnings. For example, if company earnings do not reach a certain level interest will not be paid. Interest in this case is a contingent expense, not a fixed one and is tax deductible. If the company is liquidated income bond holders rank equally with other creditors[29]. However, due to coupon payments not being mandatory there is some reluctance to issue or acquire these bonds.

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[25] Debt represents a certain sum of money borrowed from investors for a set period of time at an agreed interest rate and is a contractual obligation. The company must service the loan by making regular interest payments and at maturity it repays in full the funds borrowed. The loan can be secured over assets and in the event of the company defaulting debt is repaid before equity.

[26] Equity represents a claim on the firm by its owners. Shares are issued by the company to investors (ie. owners) and they can be traded on the sharemarket. There is no requirement for the company to pay dividends but when sufficient profits are generated dividends are usually paid. Equity, or common shares, represent a residual claim on the company's assets and in the event of a default shareholders receive what is left after all creditors have been paid.

[27] Marshall, J F and Bansal, V K, *Financial Engineering: A Complete Guide to Financial Innovation*, 1992, New York: Allyn & Bacon, Inc.

[28] Whittingham, M, "The Canadian Market for Zero-Coupon Bonds", *Bank of Canada Review*, Winter 1996-1997, pp 47-52.

[29] De, S and Kale, J R, Contingent Payments and Debt Contracts", *Financial Management*, Summer 1993, **22**(2), pp 106-122.

Table 2.4: General Characteristics of Innovative Securities[30]

The securities below have been adapted from an existing security such as debt or equity. The products are not unique and have been modified to satisfy requirements in the financial markets or those of the issuers and/or investors. The characteristics of each product is described, as well as the reason why the security is innovative. In addition, details of any reduction in costs and the impact on the security's price are noted

Security Name	Key Characteristics	Uniqueness	Cost Reduction	Pricing
Zero Coupon Bonds	Discounted instrument with face value received at maturity	Security existed but interest treatment innovative	Lower transaction costs but high front end fees	Dependent on level of current interest rates
Income Bonds	Debt instrument with coupons paid only when earnings reach a certain level. Cumulative interest payments are possible	Security existed but interest treatment innovative	Some transaction cost savings	
Interest Rate Swaps	Fixed rate payments swapped for floating rate debt payments	Product existed but methodology innovative	Interest payments may be lower for one party	
Market Index Certificate of Deposit	Interest rate set at a fixed percent of market index price appreciation over certificate of deposit's life	Combination of existing instruments (index options and riskfree bonds)	No fees or commissions	Affected by riskfree rate, index price, remaining time to maturity, volatility, implicit exercise price
Indexed Sinking Fund Debenture	Interest rate contingent sinking fund. Principal repayments vary inversely with market interest rates	Combination of bond plus conventional bond plus strips of European put and call options		Affected by sinking payments, option variables, maturity, interest rate structure

(Continued p.27)

[30] Appendix 2 contains the references for this table.

Security Name	Key Characteristics	Uniqueness	Cost Reduction	Pricing
Convertible Debt	Debt converts to equity. Specific combination of debt and warrants	Securities exist but conversion from debt to equity innovative	Reduction in cost of raising equity funds. Lower interest rate than straight debt	Affected by business and financial risks, dividend policy, size of issue, maturity, redemption issues, coupon rate conversion premium. Negative reaction to existing share price when issue is announced
Exchangeable Debt[31]	Debt is exercised into equity of another company. Is a combination of debt and call options	Minor modifications	Underwriting fees less than secondary offerings	As for convertible debt
Units of Debt with Warrants	Warrants and debt are redeemable separately. Exercised by cash or associated debt. Debt represents larger part of unit's value	Innovative combination and conversion	None. Premia higher than for convertible debt	As for convertible debt plus warrant's maturity, redemption provision, conversion premium and acceptable scrip
Exchangeable Units of Debt with Warrants[31]	Debt is exercised into equity of another company. Is a combination of debt and call options	Securities existed. Methodology innovative		As for units of debt with warrants
Preferred Stock	Fixed income security. Annual payment (ie. dividend) is not legally binding and is voted each year	Legally equity but has characteristics of debt and equity		Affected by level of annual payment and credit rating

(Continued p. 28)

[31]Both securities are preferable to convertible debt and units of debt with warrants and straight debt for raising cash.

Security Name	Key Characteristics	Uniqueness	Cost Reduction	Pricing
Adjustable Rate Preferred Stock	Security with a dividend rate adjusted quarterly to reflect changes in money market yields	Modification of preferred stock		Volatile prices
Auction Rate Preferred Stock	New dividend yield set by auction every ~49 days	Modification to above security		Not as price volatile as above security
Monthly Income Preferred Stock	Equity rated product which is tax efficient. Benefits of debt and equity in a single instrument. Security has a finite, usually 50 year life with possibility of extension. Dividends are paid monthly.	Modification of preferred stock	Low cost security	Prices fluctuate but issuer can redeem security after five years which restricts price appreciation. Downside prices are not restricted
Sinking Fund Preferred Stock	Preferred stock with a sinking fund feature	Modification of preferred stock		
Liquid Yield Option Note	Zero coupon, convertible, puttable/callable, redeemable bond	None of the features are new		Difficult to price accurately. Early conversion means issuer's EPS is diluted and potential tax savings disappears

Source: Author generated.

In contrast, the market index certificate of deposit has a minimum interest rate that is guaranteed[32]. Early redemption of the security is possible although some penalty (which is a function of the time remaining to maturity) may be incurred. Another variation is the indexed sinking fund debenture which requires a proportion of the principal to be paid each year. These repayments vary inversely with market interest rates so that the amount being repaid increases when interest rates fall and decreases when interest rates rise relative to a specified base rate. The objective of this mortgage-based security is to match interest rate sensitivities and assist the management of assets and liabilities[33].

Table 2.4 lists a number of securities which convert into equity. The most common of these is convertible debt which, at maturity, converts into a predetermined number of the company's shares. Convertible bonds are widely used for venture capital financing as they provide an option to the issuer to abandon the project if its NPV turns negative or adverse information is received[34]. As a result these bonds can be considered a form of deferred equity financing which should be analysed as a combination of stock and a put option[35].

In the early 1970s a minor modification to this was proposed to enable companies to convert the debt of one company into the stock of another. This was done when one company decided to divest an intercorporate holding. The instrument was developed in order to exploit tax or reporting rules so that the investor could receive the benefit of a tax shield on the interest paid[36]. Because lower underwriting fees were charged it was a cheaper alternative for companies seeking to dispose of a large block of securities than would be possible through the secondary market[37].

Further refinements to convertible securities were the units of debt with warrants and the exchangeable units of debt with warrants. The former security was considered to be equivalent to convertible debt with conversion into cash or associated debt and the latter was equivalent to exchangeable units of debt where conversion was into the common

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[32]Chance, D M and Broughton, J B, "Market Index Depository Liabilities: Analysis, Interpretation and Performance", *Journal of Financial Services Research*, 1988, **1**, pp 335-352.
[33]Finnerty, J D, 1988, op cit.
[34] Cornelli, F and Yosha, A, "Stage Financing and the Role of Convertible Debt", Institute of Finance and Accounting Working Paper, London Business School, August 1997.
[35] Jolan, P and Barone-Adesi, G, "Equity Financing and Corporate Convertible Bond Policy", *Journal of Banking and Finance*, 1995, **19**, pp 187-206.
[36] Schneider, D K, Schisler, D, McCarthy, M G and Hagler, J L, "Equity Classification of Convertible Debt?: Tax and Cash Flow Considerations", *Journal Applied Business Research*, Fall 1995, **11**(4), pp 64-72.
[37]Barber, B M, "Exchangeable Debt", *Financial Management*, Summer 1993, **22**(2), pp 48-60.

stock of a different company. According to Jones and Mason (1986)[38] exchangeable debt with warrants were preferred to units of debt with warrants and convertible debt due to a more favourable tax treatment. For example, "the difference between the market value of the third party stock and the exchange price constitutes an ordinary income loss for the issuing corporation" (p 54)[39]. In addition, units of debt with warrants were considered preferable to convertible debt because of their higher coupon and conversion premia[40].

While a tax benefit exists in the US for dividends paid to corporations, a demand developed for a security which could overcome share price fluctuations. The original product was preferred shares, which had characteristics of both debt and equity, although legally it was deemed an equity security because payment of dividends was a Board of Directors' decision. Failure to pay a dividend did not cause liquidation of the company[41]. However, due to a fixed dividend rate preferred stock will never receive the upside benefits of equity.

A first generation product designed to do this was the adjustable rate preferred stock which offered more flexibility than the original security. The security was structured to have a steady prespecified spread between its dividend yield and the highest yield of three different treasury securities. Hence, it could be deemed a money market instrument that offered a higher more stable return than equity. Building on this security was a second generation product - the auction rate preferred stock[42] - which was designed to overcome the problems[43] associated with the interest rate rises of adjusted rate preferred stock. This instrument used the auction process to set a new dividend yield every 49 days so that the yield could adjust fully to interest rate movements and to any change in credit risk associated with the issue (p 62)[44]. The maximum yield was between 110 to 150 percent of the 60 day AA commercial paper rate.

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[38]Jones, E P and Mason, S P, "Equity-Linked Debt", *Midland Corporate Finance Journal*, Winter 1986, pp 47-58.
[39]Ibid.
[40]Ibid.
[41] Crabbe, L E, "Estimating the Credit-Risk Yield Premium for Preferred Stock", *Financial Analysts Journal*, September/October 1996, **52**(5), pp 45-56.
[42]Also known as Dutch auction preferred stock, short-term auction rate stock, Dutch auction rate transferable securities, market auction preferred stock, money market preferred stock or auction market preferred stock.
[43]The problems with adjusted rate preferred stock are that i) the tax advantage which existed when the securities were developed had declined; ii) investors do not like the possibility that an auction may fail; iii) the securities appeal to a small clientele seeking high-quality preferred stock; and iv) the introduction of regulatory changes designed to affect institutions that offered auction rate preferred stock through subsidiaries designed for this purpose (Alderson, M J and Fraser, D R, Summer 1993, op cit.).
[44]Alderson, M J and Fraser, D R, Summer 1993, op cit.

Monthly income preferred stock are offered by a foreign or domestic special purpose limited life company owned by a US parent company. The security obtains equity treatment from rating agencies and also provides the issuer with tax-deductible dividend payments, thereby providing some of the benefits of debt and equity in the same instrument[45]. The product was developed to incorporate prevailing tax changes, accounting conventions, and other regulations in addition to fundamental economic and capital market conditions. Issuers use "a complex of inter-company loans that [take] advantage of the tax deductibility available on interest payments" (p 10)[46] to issue a low cost security. However, issuers are concerned that this tax loophole will be closed at some stage.

The sinking fund preferred stock securities do not have dividend growth potential or long-term capital appreciation. If the company fails to pay a number of quarterly dividends the preferred shareholders can elect a majority on the Board of Directors so that, in extreme cases, preferred shareholders may gain control of the company. The sinking fund payment is mandatory and commences usually five years after the security is issued. Five percent of the issue is retired each year which means that 20 years will be required to retire the entire issue[47]. No penalty is incurred if a payment is missed. The security suits companies with heavy capital requirements and a debt level near capacity such as property and casualty insurers. The low returns offered by these companies makes equity unattractive to investors and the preferred stock alternative is not a viable one because of its infinite time horizon. As a result, the advantage of the sinking fund provision means that the cash flow is sufficient to retire the stock[48].

The liquid yield option note (LYON) is a zero coupon, convertible, callable, redeemable bond - a very complex security which is difficult to price accurately (p. 561)[49]. If the bond is converted into equity too soon after issuance then the issuer's earnings per share will be diluted and any potential tax savings lessened. Apart from the complexity associated with the instrument other problems concerning interest rate uncertainty also exist such as the assumption of a flat term structure of interest rates. If, in reality, interest rates rose suddenly then the LYON's prespecified redemption feature would become valuable so that investors would redeem the security and invest

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[45] Crain, J L and Jackson, G, "Monthly Income Preferred Securities: A New Hybrid that Combines the Best of Equity and Debt", *The Cpa Journal*, May 1996, **66**(5), pp 68-71.
[46] Crain, J L and Jackson, G, May 1996, op cit.
[47] However, no penalty is incurred if a sinking fund payment is missed.
[48] McDaniel, W R, "Sinking Fund Preferred Stock", *Financial Management*, Spring 1984, pp 45-52.
[49] McConnell, J J and Schwartz, E S, "LYON Taming", *Journal of Finance*, July 1986, **XLI**(3), pp 561-577.

the funds elsewhere. If, on the other hand, interest rates fell the issuer would call in the security and issue another one at a lower interest rate. Therefore, "ignoring interest rate uncertainty tends to overstate the value of the LYON" (p. 567)[50].

The discussion of the securities above has been undertaken to show how they have been adapted in order to meet the requirements of both parties. As shown in Figure 2.1 the issue of successful products assists the financial markets to become complete and ensure that all securities offered are accepted by investors. The different perspectives of the company and the investor in relation to these securities are considered in sections 2.2.2 and 2.2.3.

2.2.2 Innovative Securities - Company Perspective

Table 2.5 shows that a company's cash flows are reduced when interest or preferred dividend payments are made. There is also a reduction in cash flows when a debt security matures or sinking fund payments are made. Variations from this occur in a) preferred stock securities which are deemed to have an infinite maturity; b) zero coupon bonds which are discounted at the time of issue and have no cash flows until the principal is paid at maturity; and c) securities which are converted into equity.

The effect on shareholders' wealth is diluted if debt or units of debt securities are converted into equity in the same company. The wealth of shareholders of the issuing company is not affected if the security is converted into shares in another company. However, if the company had difficulty meeting its contractual debt obligations then a funding shortfall may impact on the level of dividends paid to shareholders. The wealth of the investors in the latter company, however, will be affected detrimentally.

The introduction of debt instruments will increase the proportion of debt in the company's capital structure. If this debt is subsequently converted into equity then the level of debt will fall and the level of equity will rise thus altering the firm's capital structure. This could impact negatively if the conversion caused it to move away from its optimal level.

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[50]Ibid.

Table 2.5: Company-related Characteristics of Innovative Securities[51]

The table shows the impact on company cash flows when interest or preferred dividend are made. The effect on shareholders' wealth and the company's capital structure is also noted when a debt security is converted into equity in the same company. Any risks or tax benefits associated with the security are also listed.

Security Name	Cash Flow	Shareholder's Wealth[52]	Capital Structure	Risk	Tax Benefits
Zero Coupon Bond	No interest cash flow required so no decrease in cash flow. Some debt is retired at regular intervals. Less funds are received at the outset but principal repaid in full at maturity		Increases debt component	Early repayment: (call) at an unknown date. Purchasing power risk remains	Tax deferred until security matures
Income Bonds	Falls if coupon paid and when principal is paid	Level of cash flow may affect dividend payment	As above	Poor company performance	Interest payments are fully deductible
Interest Rate Swaps	Fluctuates depending on spread between fixed and floating interest rates. Cash flow reduction at maturity		No change	Some reduction: no beginning or maturity principal at risk. Bilateral default risk exposure	

(Continued p. 34)

[51] Appendix 2 contains the references for this table.

[52] This column was included here in preference to Table 2.7 because shareholders are the owners of the company and any change in the securities used to fund operations may impact on the value of their holding.

Security Name	Cash Flow	Shareholder's Wealth	Capital Structure	Risk	Tax Benefits
Market Index Certificates of Deposit	Falls when interest and principal are paid		Increases debt component	No principal risk. Offers an uncovered option	
Indexed Sinking Fund Debenture	As above	Level of cash flow may affect dividend payments	As above	Relatively illiquid. Investor's prepayment risk reduced	
Convertible Debt	Falls when interest paid although coupon is less than straight debt. Income rises on conversion	Diluted upon conversion	Debt component reduced and equity increased on conversion		Interest payments are fully deductible
Exchangeable Debt	Interest payments required	No change	Debt reduction on conversion		None
Units of Debt with Warrants	Falls when interest and principal paid	Diluted	Increases debt component		Interest payments are deductible
Exchangeable Units of Debt with Warrants	Interest payments only if exchanged for equity	No change in issuing company. Dilutes share-holder wealth of other company	Debt reduction on conversion		More favourable tax treatment than units of debt with warrants
Preferred Stock	Falls when dividend pay-ment is made		Increases equity component		Occurs if company has a below average expected tax rate

(Continued p. 35)

Security Name	Cash Flow	Shareholder's Wealth	Capital Structure	Risk	Tax Benefits
Adjustable Rate Preferred Stock	Dividends paid which can be higher or lower depending on interest rate movements		Increases debt component	Not able to hedge credit risk. Imperfect hedge against interest rate volatility. Price volatility risk reduced	Low tax paying issuers could realise a lower after tax cost of funds
Auction Rate Preferred Stock	Falls when dividends paid		Increases debt component	Auction would fail. Liquidity risk due to lack of formal secondary market	Tax advantage to corporate issuers on low marginal tax rates
Monthly Income Preferred Stock	Falls when dividends paid. Company can defer dividends sometimes up to five years although income is paid to holders		Increases equity component	More risky than debt	Achieves low cost source of funds by using a network of intercompany tax deductible loans
Sinking Fund Preferred Stock	Falls when dividends and sinking fund payments made		Increases equity component	Company pays no penalty if sinking fund payment is missed. Share price can be manipulated by company. If dividend not declared share price falls and sinking funds become cheaper	
Liquid Yield Option Note	No interest cash flows required. Sold at a deep discount to face value	Diluted when conversion occurs	Debt component reduced and equity increased on conversion	Puts and calls protect investors. Bond holders protected against increases in company risk. Company also benefits from risk neutralisation	Tax savings are possible unless early conversion occurs. Issuers can deduct imputed security interest costs without offsetting cash outflows to investors

Source: Author generated.

There are a wide range of risks associated with the securities listed in Table 2.5. For example, poor company earnings may impact on the performance of most of the securities listed but its effect on income bonds is significant. This is due to the requirement that interest payments will only be made if company earnings reach a certain level. Other securities have price, rate and liquidity risks associated with them and the auction rate preferred stock has an additional risk associated with it due to the possibility that the auction may fail. This situation occurs if insufficient shares are available to satisfy the demand and the new dividend yield was set at the maximum dividend rate. When this situation occurs the existing sellers are only permitted a part divestiture so that demand is satisfied (p. 62)[53].

A number of the securities were developed to take advantage of loopholes in the current tax regulations. However, over time these regulations were changed to close the loopholes so that the original benefit was eroded or eliminated. The main tax advantage occurred with those companies which had a low marginal tax rate.

While the advantages to the investor (see Section 2.2.3) are primarily of a taxation, risk reduction nature there are a large number of diverse benefits from the securities as listed in Table 2.6 which accrue to the issuer. An examination of the benefits show that the majority reduce the risks associated with cash flows.

2.2.3 Innovative Securities - Investor Perspective

As shown in Table 2.7 the risk inherent in a company is the main piece of information provided to investors. The liquid yield option note provides the investor with the decision of when the optimal time to convert the security into equity occurs.

The 'Information Provision' and 'Risk Reduction' columns are interrelated although the former relates primarily to micro risk whereas the latter covers the macro risks which affect the securities. These are mainly price and reinvestment risks which can be eliminated if the security's maturity and the investor's horizon date match. The creditworthiness of the company the security converts into affects the exchangeable debt products whereas changes in the quality of the auction and adjustable rate preferred stocks must be maintained.

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[53] Alderson, M J and Fraser, D R, Summer 1993, op cit.

Although there are a number of tax benefits listed, these have been eroded over time by changes to the tax regulations. Some investors have been able to claim a 70 or 80 percent tax exemption on dividend income. A significant benefit to corporate investors on high tax rates has been provided by the auction rate preferred stock due to the capital loss that can be incurred as a result of the auction process used to determine the level of dividend yields.

Table 2.6: Company-related Benefits from the Issue of Innovative Securities
The table notes the benefits accruing to the issuer which arise from the securities listed below. Most of the benefits are in the reduction of the risks associated with the company's cash flows

Product	Benefit
Convertible debt	No cash outflow at maturity if investors convert
Exchangeable debt	Provides a cheaper form of disposing of a stock holding than by offering a secondary distribution
Income bonds	No penalty or restriction is placed on the issuer if periodic interest payments are not made
Interest rate swaps	The issuer can obtain the type of security which suits their needs
Liquid yield option notes	• Lower interest payments which reduce the risk of financial distress • the right to call the issue if interest rates fall and to issue a new security at a lower interest rate • a valuable tax shelter occurs when imputed interest costs are deducted without any compensating cash outflow
Preferred stock	The omission of dividend payments has a less serious consequence for the firm than if interest payments are missed
Sinking fund preferred stock	A yield advantage accrues to the issuer because the yield is 50-150 basis points less than equivalent perpetual securities
Units of debt with warrants	The issuer can use cash or debt to exercise the warrants

Source: Author generated.

2.3 CONCLUSION

This chapter considered the development of financial products and the reasons why the need to innovate occurred. Successful innovations are products which have been offered to meet a demand in the marketplace and which exist for a number of years. The development of these products will only occur when a problem (such as tax or regulatory changes) exists in the financial markets.

A number of products which may be acceptable to investors in Australia and Great Britain were described. The impact of these securities on a company's cash flows, capital structure, risks and taxation were discussed as well as the amount of information provided, risk reduction and taxation which apply to investors in order to make the securities an attractive investment proposition. An understanding of the reasons for security innovations and the effect of these changes on both the issuer and investor provided the information required to develop a questionnaire which was sent to institutional investors in the UK and Australia.

The next chapter will investigate the type of information institutional investors require in order to be able to make an informed investment decision when analysing securities offered by biotechnology companies. In addition, the type of products they would be prepared to purchase will be ascertained so that a number can be selected for further analysis in order to determine the most cost-effective security for an emerging biotechnology company to issue.

Table 2.7: Investor-related Characteristics of Innovative Securities[49]

Investors are primarily interested in the risks associated with the company. The table notes the type of information which would be provided by the securities and also the benefits from the risk reduction associated with them. These two columns are interrelated as 'Information Provision' relates to micro risks whereas 'Risk Reduction' relates to macro risks. Any tax benefits are also noted but these tend to be eroded over time by amendments to the tax regulations

Security Name	Information Provision	Risk Reduction	Tax Situation
Zero Coupon Bond	Amount of discount indicates level of security risk	Removal of reinvestment risk if maturities matched. Also interest rate and default risks if maturities/horizons matched	Tax paid on excess redemption value above purchase price. Tax on interest payments deferred until maturity or charged annually depending on tax regulations
Income Bonds	High level of risk associated with issuing company	If no coupons are paid there is no risk of bankruptcy	Tax paid then interest is received
Interest Rate Swaps		Interest rate risk reduced. Banks act as intermediary and reduced problems of bankruptcy	
Market Index Certificate of Deposit		Security is a riskfree pure discount bond	
Indexed Sinking Fund Debenture	Security is relatively illiquid with higher yield and lower price	Duration matching so price and reinvestment risk is reduced	
Convertible Debt	Level of dividends and interest rates indicate company's risk	Equity participation at a reduced level of risk	No significant tax considerations

(Continued p.40)

[49]Appendix 2 contains the references for this table.

Security Name	Information Provision	Risk Reduction	Tax Situation
Exchangeable Debt	Indicates company wishes to divest its holding in a poorly performing company	Depends on other company's credit standing	Exchangeable issues are favourably priced for investors due to tax arbitrage benefits
Units of Debt with Warrants	Level of dividends and interest rates indicate company's risk		Warrants not treated as a security issue but as a transaction until expiry or exercise. If exercised they are not taxed
Exchangeable Units of Debt with Warrants		Depends on other company's credit standing	As for exchangeable debt but there is also a tax disadvantage because warrant premium is considered ordinary income if warrants are unexercised. Loss incurred on exercise is treated as a capital loss
Preferred Stock		Lower risk than straight equity	Is a tax advantaged investment in some areas if the 70% tax deduction for corporate investors applies. Popular with investors on high tax rates
Auction Rate Preferred Stock		Interest rate volatility reduced. Eliminates risk of falling credit quality by allowing investors to adjust for risk regularly	Capital loss incurred on auction rate shares. Tax benefit compared with commercial paper interest. Benefit to corporate investors on high tax rates
Adjustable Rate Preferred Stock		Interest rate volatility reduced. Eliminates risk of falling credit quality	Corporate tax purchasers had an 80% tax exemption on dividend income
Monthly Income Preferred Stock			Tax deductible dividend payment
Sinking Fund Preferred Stock		Some reduction in interest rate risk due to sinking fund payment	In some US states dividend income is tax exempt

(Continued p. 41)

Security Name	Information Provision	Risk Reduction	Tax Situation
Liquid Yield Option Note	Alleviates information problems between management and investors about company's risk. Investor controls when the security can be converted	Due to requirement of quality of issuer risk of default reduced and security provides call protection	If security converted early then issuer's EPS becomes diluted and potential tax savings disappear

Source: Author generated

Chapter 3: INVESTORS' REQUIREMENTS FOR THE TYPE OF SECURITIES OFFERED BY EMERGING BIOTECHNOLOGY COMPANIES

3.0 INTRODUCTION

In this study the type of companies being considered are biotechnology companies that do not as yet have any products on sale, they have completed preclinical and phases I, II and III clinical trials and have filed, but not yet received, regulatory approval for a new drug. Seeking regulatory approval is the final step before manufacturing and marketing activities can commence. The companies have been financed solely by equity and options until this time but are now in a position to consider an alternative, cheaper form of financing.

Although there is a 93 percent[1] chance of a product reaching the market when an application for regulatory approval has been filed, considerable uncertainty still exists concerning the company's future operations. That is, although the fixed development costs and the period of time before the products can be offered for sale are known with some certainty, the level of net revenues and market share are not known. Therefore, additional funds will be required to finance the manufacture, distribution and marketing of the product[2].

A number of securities listed by Finnerty (1988)[3] and Tufano (1989)[4] are mortgage-based or asset-based. However, due to the riskiness associated with pharmaceutical companies many of these securities will not be covered because generally their premises have not been purchased but are leased. Therefore, until cash flows become established the company usually cannot meet contractual obligations and has no collateral to offer as security. In addition, commodity indexed and foreign-currency denominated instruments are not appropriate to use as funding tools given the nature of the company's line of business.

A wide range of securities available to investors were described in Chapter 2 and the benefits for both the issuer and investor were discussed. As a result, this chapter will

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[1] Struck, M M, "Biopharmaceutical R&D Success Rates and Development Times", *Bio/Technology*, July 1994, **12**, pp 674-677.
[2] Nicholson, I J and Latham, P, "When 'Make or Buy' means 'Make or Break'", *Bio/Technology*, May 1994, **12**, pp 473-477.
[3] Finnerty, J D, 1988, op cit.

cover the investor's requirements, concerning the type of security offered by an emerging biotechnology company based in the UK or Australia, that would finance the launch of a new product onto the market. Any security offered by these companies that was not acceptable to the investor would deprive the issuer of the funds they require.

A description of the financing problems facing these companies provides the basis for a questionnaire which was sent to analysts in the United Kingdom and Australia. The objective of the survey was to determine the type of information these analysts use to analyse biotechnology companies and also their familiarity with and use of a number of securities that are available in the US. From the information obtained from the questionnaire a number of securities will be selected for further analysis in order to determine the most cost-effective product for the company to issue.

3.1 COMPANY SITUATION

Due to their lack of sales and hence the ability to service debt, the companies currently have been funded by equity and options (or warrants) on equity. To date none have paid dividends and any milestone payments received have been used to finance further research and/or development initiatives.

While it may be difficult to estimate the length of time prior to the commencement of cash flows, the companies need to be able to have sufficient cash on hand so that they can be in a negative cash situation for at least a year once regulatory approval has been granted[5]. Therefore, at this time alternative financing methods could be appropriate although pure debt may not be feasible due to the company's lack of collateral and lack of cash flow from operations.

The pharmaceutical industry is inherently complex and biotechnology companies are risky investments so that in order to attract investors a simple capital structure is required. Therefore, any new financing instrument should be simple in structure and easily understood by investors. Off-balance sheet securities are not appropriate for the British pension fund or life insurance companies. The Australian investment market is also very conservative and if an issue of securities was to be successful then only traditional products would be acceptable[6].

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[4] Tufano, P, 1989, op cit.
[5] J Noble, Finance Director, British Biotech, personal communication.
[6] Comments made by respondents.

In order to determine the type of security that would appeal to institutional investors in the United Kingdom and Australia a questionnaire was developed. Details of this survey follow in the next section.

3.2 QUESTIONNAIRE DEVELOPMENT

There are two parties to all financing arrangements as shown in Figure 2.1. However, the type of securities used to finance risky projects will depend on the type of firm seeking funds as well as the security offered. Therefore, in order for the firm seeking funds to successfully launch a security, they must be aware of the type of instrument an investor would be prepared to invest in.

A copy of the questionnaire forms Appendix 3 and was piloted by three analysts working in the UK, Australia and New Zealand and their suggestions incorporated. The questionnaire was divided into three parts with each section seeking specific information. The first part sought demographic information from the respondents concerning their personal details and also those of the organisation they worked for. Information regarding the level of investment in the biotechnology industry in particular was requested.

The second section requested details about the type of information the analysts use and the relevance of the data received to support their analysis of biotechnology companies was elicited. The results from this section would indicate if the issuer was providing the information required by analysts in order to enable them to make informed investment decisions.

The objective of the third section was to ascertain the level of institutional investors' familiarity with and use of a range of securities as well as the attributes a security should possess that would make it attractive to investors. The information obtained from this section would assist the company in its selection of a product that would meet its requirements and also be acceptable to investors.

3.2.1 Survey Sample

A list of members from the Australian Investment Managers' Association (AIMA) and the Institutional Fund Managers' Association (IFMA) in the United Kingdom was obtained. Member firms for the AIMA totalled 60, three of which were not domiciled in Australia. Therefore, in order to ensure that responses were only received from Australian-based organisations, these non-domiciled firms were removed from the list

and every third company selected. The IFMA list contained 81 organisations from which every fourth company was selected.

Once a company was selected phone contact was made to the analyst/fund manager dealing with the pharmaceutical/biotechnology companies[7] to seek their agreement to participate in the survey. If consent was not obtained the firm immediately below the selected company on the list was contacted. If a second negative response was obtained the firm directly above the original selection was chosen. This procedure was repeated if necessary.

A total of 19 Australian and 20 British member organisations agreed to participate in the survey and the first posting was sent out on 31 October, 1996. Seven (36.8 percent) questionnaires were received from Australia and seven (35 percent) from the United Kingdom (UK). A second posting was made on 10 January, 1997 which resulted in a final response rate of eight (42 percent of the total) from Australia and eight (40 percent of the total) from the UK. In addition, three analysts (two from UK and one from Australia) subsequently declined to participate in the survey stating that it was not their firm's policy to complete questionnaires.

Although the response rate was satisfactory, the number of respondents was not large. Nevertheless, the number was similar to surveys undertaken in other papers[8].

3.2.2 Profile of Respondents

The respondents were primarily male (87.5 percent), approximately 34 years of age, and all had completed post-secondary education. Seven had completed an undergraduate qualification while eight had completed post-graduate degrees. Six had other tertiary qualifications in addition to their degrees.

The average time spent in their current position was 4.8 years and they had on average 9.7 years industry experience. Generally, the Australian respondents had spent longer in the industry and had worked for more financial institutions than their British

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[7] These managers analyse the equity securities of companies which did not currently have a product on the market.

[8] Eg. Murray, G, "The Second 'Equity Gap': Exit Problems for Seed and Early Stage Venture Capitalists and Their Investee Companies", *International Small Business Journal*, 1993, **12,** pp 59-76; Jones, T, "The Chances of Market Success in Pharmaceutical R&D", **in** *Risk and Return in the Pharmaceutical Industry*, Office of Health Economics, 1997; Cockburn, I, "Racing to Invest - Patent Races in Pharmaceutical Research?", **in** *Risk and Return in the Pharmaceutical Industry*, Office of Health Economics, 1997.

counterparts. This could be indicative of the higher mean age of the Australian respondents.

Fifty percent of the respondents held middle management positions with titles ranging from Director or Head of Equities to Analyst. Responsibilities were primarily to research, select and allocate securities from certain industry sectors which included the pharmaceutical sector.

Approximately 94 percent of the analysts had their performance assessed against an index but only 56 percent had their remuneration directly aligned to their performance.

Hence, most respondents had a) a tertiary education, b) nearly ten years experience in the industry, c) a middle management position and d) their performance assessed against an index.

3.2.3 Organisation Details

The size and activities of the organisations represented in the survey varied significantly. For example, the total funds managed by these companies ranged from $AUD1.8bn to $AUD13.06bn and from £9.8bn to £175bn. Six of the companies operated solely for institutions and two had only 10 percent of their funds managed on behalf of private clients. At the other end of the scale 25 percent of the companies had more than 67 percent of their funds invested for non-institutional parties. Most of the funds managed were in the pension/ superannuation and life insurance classes. There was a greater emphasis on pension/superannuation funds in Australia compared to the UK where management of pension/superannuation and life insurance funds both dominated.

Only one organisation did not invest in all sectors of the market. This company omitted the investment and financial services industries because they considered that the goals of the companies in this sector were the same or similar to their own.

Table 3.1 shows that the proportion of the total funds invested in the pharmaceutical sector falls into distinct country specific categories. That is, the Australian funds surveyed invested between 0.2 and 1.4 percent of their total funds in this industry whereas the investment by UK firms was between 4.6 and 11 percent. When this investment was further broken down into the proportion invested in established or development stage biotechnology companies the differences between the two countries became larger. Two of the Australian companies invested heavily in development stage companies whereas three invested solely in established pharmaceutical companies.

In contrast, the maximum investment by UK institutions in developing biotechnology companies was 18 percent with 62.5 percent of the companies investing less than 10 percent in the segment. The reasons for the distinction could be due to the larger number of these companies in the UK and also the higher profile given to these companies by the UK Stock Exchange. For example, there are two industry sectors into which pharmaceutical-related companies can be placed compared to none in Australia[9]. In addition, the low level of funds allocated to this industry by Australian companies could be the reason behind the larger investment in the more speculative development stage companies.

Table 3.1: Breakdown of Investment in the Pharmaceutical Industry (%)
The pattern of investment undertaken by Australian and UK companies in the Pharmaceutical Industry differs considerably. Australian companies place a lower level of total funds in the Pharmaceutical Industry but invest a higher percentage of these funds in development stage companies compared to their UK counterparts.

Australia

Proportion of Total Funds Invested (%)	0.2	0.24	0.4	0.5	1.0	1.0	1.0	1.4
Established Company	0.0	80.0	100.0	100.0	25.0	70.0	100.0	70.0
Development Stage	100.0	20.0	0.0	0.0	75.0	30.0	0.0	30.0

United Kingdom

Proportion of Total Funds Invested (%)	4.6	5.0	5.0	6.0	8.0	9.0	10.0	11.0
Established Company	99.0	90.0	99.0	95.0	87.5	98.0	95.0	82.0
Development Stage	1.0	10.0	1.0	5.0	12.5	2.0	5.0	18.0

Source: Author generated.

[9] The two sectors in the UK are the Health/Household Sector and the Pharmaceutical Sector. In Australia the companies are placed in the Miscellaneous Sector.

Although the number of responses was not large, having the same number from each country permits some comparisons to be made between Australia and the UK. For example, the size of the funds managed by the firms was much larger in the UK than in Australia with the emphasis given to pension/ superannuation funds. In addition, the UK organisations invested a greater proportion of their funds in the pharmaceutical industry but placed a lower percentage of these funds in development stage biotechnology companies than their Australian counterparts.

The UK organisations had a) more funds under management, b) a greater proportion of their funds invested in the industry and c) a lower percentage invested in development stage biotechnology companies.

3.3 SOURCES OF INFORMATION FOR ANALYSING BIOTECHNOLOGY COMPANIES

There are a range of information sources which can be used by analysts to assess the feasibility of investing in biotechnology companies. Thirteen sources were listed and ranked[10] by the respondents as to their usefulness. In terms of the overall sample there were only three sources which were not considered to be important, ie. professional company databases, information provided by the Stock Exchange and broker recommendations. Of the remaining sources the top five, ranked by means, were visits by the company, cash flow statements, financial analyst meetings, company balance sheets and income statements. In contrast, when considered on a country basis the ranking of the top five sources differed in each instance as shown in Table 3.2. The table indicates that the most preferred source of information used in Australia are visits by company personnel whereas in the UK financial analysts meetings were deemed to be the most important.

When asked if there was sufficient information available to assist with the analysis of these companies, 75 percent responded positively. Other information sources suggested by the other 25 percent were company research (including potential markets, assumptions on penetration and potential competition), independent expert commentary, management discussions, site visits and facility inspections, and discussions with scientists.

[10] A Likert scale was used for ranking purposes. Any discussion from this point on concerning means and frequencies relate to scores obtained from these scales.

The importance of taxation advantages accruing from R&D activities was not considered to be particularly important by the respondents although it was ranked more highly by the Australian participants.

The lack of concern with taxation was also indicated by the poor ranking given for dividend tax credits. Other variables which were not considered to be particularly important when analysing these companies were the ability to arbitrage the security, the size of the dividends and company size. Table 3.3 shows that the emphasis placed on the importance of the variables by the analysts, combined and by country, differed when ranking by means. However, when frequencies were considered only slight variances in the ranking occurred.

Table 3.2: Five Most Preferred Sources of Information
The ranking of the five most useful sources of information differed in each instance when separated by country. When this has been done, each country has one item which is not contained in the combined list.

Combined	Australia	United Kingdom
Company visits Cash Flow Statements Financial analysts meetings Balance Sheet Income Statement	Company visits Cash Flow Statements Balance Sheet Financial analysts meetings Site visits by analysts	Financial analysts meetings Company visits Cash Flow Statements Income Statements Broker research

Source: Author generated.

When asked to rank the importance of variables used to analyse emerging biotechnology companies the least important variables were essentially the same as those for more established companies. However, there was a significant change in the variables considered to be the most important. These variables are listed in Table 3.4 and show that the company's plans and future prospects[11] were deemed to be the most important. The benefits of milestone payments as a source of funds for further research were highlighted, whereas the returns from investment in R&D were not considered to be as important. However, the risks associated with a developing company received greater emphasis.

When asked if their organisation had, or currently holds, investments in pharmaceutical companies at varying stages of development, all who responded indicated that

[11] This variable replaced "Senior Management Remuneration" in the previous section.

Table 3.3: Variables Considered Important when Analysing Pharmaceutical Companies

The variables analysts found useful when analysing these companies differed between Australia and the UK when ranked by means[12]. However, when frequencies were used only slight variances in ranking occurred. In addition, frequencies for both Australia and the UK were identical.

Means

Combined	Australia	United Kingdom
Level of cash flows Level of profitability Return on investment - forecast Risk - liquidity Risk - operating	Level of cash flows Risk - operating Return on investment - forecast* Level of profitability* Risk - liquidity	Level of profitability Return on investment - forecast Level of cash flows Return on investment - historical* Milestone payment facility*

*Same means

Frequencies

Combined	Australia	United Kingdom
Return on investment - forecast* Level of cash flows* Milestone payment facility* Level of profitability* Company profitability*	Return on investment - forecast* Level of cash flows* Risk - operating* Risk - liquidity* Company profitability* Milestone payment facility*	Return on investment - historical* Return on investment - forecast* Level of cash flows* Level of profitability* Economic value added* Milestone payment facility*

*Same frequencies
Source: Author generated.

[12]The means (and the frequencies mentioned below) refer to those obtained from the ranking on the Likert scale of the questionnaire.

Table 3.4: Variables Considered Important when Analysing an Emerging Pharmaceutical Company

The variables were similar to those considered important for the analysis of these companies. However, a new variable "Business plan and future prospects" was considered to be the most important when analysing the emerging companies. In addition, the benefits received from "Milestone payments" was deemed to be of greater importance than "Return on Investment".

Means

Combined	Australia	United Kingdom
Business plan and future prospects Milestone payment facility Risk - financial Risk - liquidity Company profitability	Business plan and future prospects Level of cash flows* Risk - financial* Risk - liquidity* Milestone payment facility*	Business plan and future prospects* Milestone payment facility* Risk - liquidity Risk - financial* Risk - operating*

*Same means

Frequencies

Combined	Australia	United Kingdom
Milestone payment facility* Risk - financial Risk - liquidity Business plan and future prospects Risk - operating	Risk - financial* Risk - liquidity* Milestone payment facility* Risk - operating Business plan and future prospects	Business plan and future prospects* Milestone payment facility* Risk - liquidity Risk - financial Risk - operating

*100 percent frequency
Source: Author generated.

investments had occurred once regulatory approval had been sought. The positive responses progressively declined through each phase with only 58.3 percent of those responding investing at the preclinical stage.

The same trend occurred when participants were asked how much importance they placed on the information obtained for analysis at each stage of the drug development phase. A high level of importance (mean 4.46) was placed on information obtained to analyse companies seeking regulatory approval. Conversely, the lowest level of importance (mean 3.63) occurred at the preclinical stage of drug testing. This trend reflects the amount and quality of information that is available at each stage of drug development. Interestingly, however, the amount of information[13] that these companies consider should be provided to analysts is greater and more detailed at the preclinical and early phase stages, than it is at the phase III and regulatory approval stages[14]

Salient points from this section indicate that a) analysts prefer to do their own analysis of this type of company rather than receive information from other sources, b) sufficient information is available to permit this to be done, c) cash flow and return on investment are important variables when analysing pharmaceutical companies although the company's plans and future prospects are ranked highest for emerging companies, and d) the level of investment and the requirement for quality information increased at each stage of development.

3.4 SECURITIES

There were two parts to this section of the survey. In the first part, respondents were asked to list the attributes they considered a security (being offered by a company that has its first product ready for submission for regulatory approval) would have to satisfy in order to be accepted by investors. The second part endeavours to assess the analysts' familiarity with and use of a range of securities.

3.4.1 Attributes

Question 28 in the questionnaire was an open ended one asking respondents to list the attributes in a security which would make an issue attractive to them. The responses indicated that it was important for the security to provide upside potential in the form of capital gains, to be liquid and preferably Stock Exchange traded. It should be classed as

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14 Comment made by J Noble, Finance Director, British Biotech plc and by one of the questionnaire respondents.

an "Approved" security with an attractive entry price, but should not be offered to the detriment of existing shareholders, ie. there should be no dilution in value of the securities held by current investors. Although there should be the expectation of an income stream to reward investors for the risks associated with the investment, some tax benefits should also be available.

While investors should be able to participate in the success of a new product and consequently the success of the company, one concern raised by analysts was that the company had not yet had a successful product. In addition, some security or protection against failure of the either product or the company was required.

It was noted that such companies would lack the collateral to provide security for interest-bearing debt but once the drug was approved, debt could be used. This debt could be equity-based in the form of a convertible debt issue. However, the cost of raising equity would need to be considered as well.

Hence the requirements were for a security that a) was an "Approved" listed security, b) would increase in value, c) would produce an income stream and d) not dilute the value of current investors' shareholdings.

3.4.2 Familiarity and Use

This question sought to determine how familiar analysts in the UK and Australia were with securities offered in the US and more particularly, if they had invested in them. Not all participants in the survey responded to these questions and a higher response rate was received from the Australian analysts. The maximum number of respondents was 13 and the minimum three. The low responses were primarily for securities for which there was little familiarity and no previous or current investment. Table 3.5 shows that none of the respondents were familiar with liquid yield option notes (LYON) or stock warrant off-balance sheet R&D (SWORD) securities[15]. However, after breaking the sample into their country components it was found that the Australian analysts were not familiar with auction rate preferred stock, market index certificate of deposits (CD) and sinking fund preferred stock in addition to the LYON and SWORD.

[15] This security was developed in the US to assist biotechnology companies fund their operations by floating "a research-and-development (R&D) outlay as a distinct project and then have the option to gain ultimate control over successfully developed products and technologies" (Thakor, A V, "Corporate Investments and Finance", *Financial Management*, **22**(2), p. 142). The product was included in the range of securities in order to ascertain the level of awareness for it.

Table 3.5: Respondents' Familiarity and Use of Securities[16]

There were a number of securities analysts did not use even though they were familiar with them. Analysts were not familiar with liquid yield option notes or stock warrant off-balance sheet R&D securities and concentrated their investments in well-known securities. Australian analysts were not familiar with auction rate preferred stock, market index certificates of deposit, market index certificates of deposit and sinking fund preferred stock. These analysts were also not investing in collateralised mortgage obligations, units of debt with warrants, adjusted rate preferred stock or capital notes.

Security	Familiarity (%)	Previous Investment (%)	Current Investment (%)
Common stock	100	100	100
Equity options	100	100	100
Preferred stock	100	100	100
Corporate debt	100	100	82
Convertible debt	100	100	82
Interest rate swaps	100	60	30
Zero coupon bond	100	50	40
Adjustable rate preferred stock	100	14	0
Income bond	90	75	75
Zero coupon/convertible income bonds	89	43	14
Units of debt with warrants	78	33	17
Collateralised mortgage obligation	71	13	13
Market index CD	67	14	14
Capital notes	67	43	14
Auction rate preferred stock	60	0	0
Exchangeable debt	57	0	0
Indexed sinking fund debentures	50	0	0
Exchangeable units of debt with warrants	50	0	0
Monthly income preferred stock	50	0	0
Sinking fund preferred stock	25	0	0
Liquid yield option note	0	0	0
Stock warrant off-balance sheet R&D security	0	0	0

[16] Three nonparametric tests (ie. sign, Wilcoxon's rank-sum and Spearman's rank correlation tests) were conducted on data in Table 3.5. The results showed that: the distributions for Familiarity and Investment were not identical; and the level of familiarity with the top 10 securities is significantly greater than with the next group of securities. The tests were conducted using $\alpha = 0.05$.

Table 3.5 shows that a total of eight securities had not been used by the respondents in the past nor were they currently being used. In addition, adjusted rate preferred stock had not been used previously but were now being offered. Market index CDs had never been used by any respondents and the Australians were currently not investing in zero coupon bonds or zero coupon/convertible income bonds. Collateralised mortgage obligations, units of debt with warrants, adjustable rate preferred stock and capital notes had not been used by the UK respondents.

The conclusions that can be drawn from these results are that a) some securities are country specific; b) the demand for securities may change over time; and c) some security innovations have little demand[17].

3.4.3 Suitable Securities for Developing Pharmaceutical Companies

There were a number of securities which respondents did not consider to be suitable for a pharmaceutical company seeking regulatory approval for their first drug, or as an alternative for equity securities[18]. The top five securities (ranked using frequencies[19]) are shown in Table 3.6. The security most preferred by all respondents was common shares. However, when considered on a country basis, there were another three securities recorded by Australian analysts which also had frequencies of 100 percent. These were zero coupon bonds, convertible debt and equity options. The UK analysts had a strong preference for corporate debt as well as zero coupon bonds, convertible debt and equity options.

When considering an appropriate security to use as an alternative to equity a total of 13 securities were deemed to be inappropriate by UK analysts[20] common stock was the most preferred security whereas equity options had a lower ranking, especially in the UK. A form of interest paying security, such as corporate debt, convertible debt, preferred stock or adjustable rate preferred stock, was considered a suitable alternative to equity. There was still a strong equity link in the securities chosen. The choice of the zero coupon bond reflected the potential benefits to the company of receiving funds but

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[17] Finnerty, J D, "An Overview of Corporate Securities Innovation", *Journal of Applied Corporate Finance*, Winter 1992, **4**, pp 23-39.
[18] These were interest rate swaps, market index CDs, indexed sinking fund debentures, collateralised mortgage obligations, exchangeable units of debt with warrants, LYONS and SWORDS.
[19] Responses for these questions were in the form of "Yes" or "No".
[20] These were market index CDs, indexed sinking fund debentures, LYONS, SWORDS (discounted by Australian analysts as well), interest rate swaps, collateralised mortgage obligations, exchangeable units of debt with warrants, adjustable rate preferred stock, auction rate preferred stock, monthly income preferred stock, sinking fund preferred stock and capital notes.

not having any contractual obligations in the immediate future which would provide time to establish sales.

Table 3.6: Top Five Securities Preferred for Pharmaceutical Companies
The securities listed are those analysts consider would be suitable investments to be offered by a company which had a product ready to proceed to regulatory approval and which could be considered as an alternative to equity investment. Australian analysts ranked equity options, zero coupon bonds and convertible debt equally with common stock (ie. frequency of 100) whereas UK analysts had a strong preference for corporate debt, zero coupon bonds, convertible debt and equity options.

Regulatory Approval Stage*	Alternative to Equity*
Common stock	Common stock
Equity options	Convertible Debt
Zero coupon bonds	Equity options
Convertible debt	Zero coupon bonds
Zero coupon/convertible income bonds	Preferred stock

* Ranked by frequencies
Source: Author generated.

When asked what type of security they consider would be most suitable for the company to offer investors, most analysts recommended common stock or equity-type securities. Two analysts stated that interest bearing debt would be appropriate if regulatory approval was certain and the drug profitable. A list of the reasons why the analysts considered these securities would satisfy the company's requirements can be found in Appendix 4. From the comments made emphasis was placed on the upside benefits which would flow from an increase in the value of share prices and investors' participation in the company's growth opportunities if the product reached the market. Equity was considered to be liquid, market priced, and understood by investors due to its simplicity and lack of complication.

Analysts considered that the payment of interest put pressure on companies' future earnings which would not permit a short-term injection of capital. It was felt that cash flows would be protected if debt securities were not used, especially as the future profits were not proven. However, equity was considered to be an expensive form of finance so that debt could be used if management believed approval would be prompt.

This section showed that respondents were not familiar with a number of securities that had been offered in the United States and they ranked as the four most preferred, those securities which had been in existence for many years. In the main these securities were equity-based and readily understood by investors thereby satisfying the requirements of a product that was a) simple and easy to understand by institutional investors, and b) may not require a certain cash flow initially or an outflow at maturity.

3.5 CONCLUSION

The objective of this chapter was to ascertain the type of security investors would acquire if they were issued by biotechnology companies. The securities included in the questionnaire developed to elicit this information were selected from those described in Chapter 2 and were representative of products issued in the US.

Although the level of response was not particularly high, the survey did achieve the objective for which it was designed. That is, to a) determine the type of information and the variables required by analysts in order to be able to make informed investment decisions; and b) assess their familiarity with the vast range of new products that have been developed in the US. It transpired that analysts in the UK and Australia were not familiar with a number of securities which had been used in the United States.

A number of securities satisfied the analysts' requirements for an emerging biotechnology company and hence had the potential for being used to fund the company once it was ready to apply for regulatory approval. These securities were common stock, equity options, zero coupon bonds, convertible debt, zero coupon/convertible income bonds and preferred stock. These securities will be tested in Chapters 5, 6 and 7 in order to determine which of them would be the most cost-effective for this type of company to issue. However, prior to this, a description of the development phase of a successful drug will be undertaken so that readers will have an understanding of the risks and problems facing these companies.

Chapter 4: ISSUER REQUIREMENTS FOR DEVELOPING BIOTECHNOLOGY COMPANIES

4.0 INTRODUCTION

The process of researching and then developing a new pharmaceutical product is very expensive and requires a substantial investment in R&D. In addition, due to the lengthy testing procedures required by the regulatory authorities, the length of time devoted to ensuring that all safety aspects of the product are considered means that the time to product launch is significantly longer than other industries that develop innovative products[1]. Before any pharmaceutical product is submitted for regulatory approval, a high level of statistical evidence of efficacy must be gathered.

The estimated costs of bringing the product from innovation through to profitability range from USD250-500M[2] . The cost of these funds depends in turn on the size of the company. For example, if the company's value is less than USD200M in size then the cost of capital is 30 percent, if it is greater than USD400M it is considered to have a lower propensity for financial distress and the cost of capital falls to 20 percent - between these two extremes 25 percent is charged on funds[3]. The high cost of capital reflects the risks associated with these companies. Companies which, in aggregate, generated in excess of USD16 billion in revenues, spent USD7 billion on R&D and reported combined losses of nearly USD3 billion for the year ended December 1997[4].

This chapter will describe the stages a drug must pass through prior to its submission for regulatory approval and portrays the requirements of the other party involved in the development of a financial security as shown schematically in Figure 2.1. It will also describe how the securities selected by the institutional investors in Chapter 3 would be suitable for biotechnology companies to issue in order to fund the launch of their first product. Tests to determine the most cost-effective security will be undertaken in Chapters 5 to 7.

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[1] Mitchell, S K and Stonecase, R E, "The Role of Economies of Scale in Australian R&D", *Prometheus*, 1996, **14**(2), pp 152-167.
[2] Nicholson, I J and Latham, P, "When "Make or Buy" means "Make or Break" ", *Bio/Technology*, May 1994, **12,** pp 473-477.
[3] Nicholson, I J and Latham, P, May 1994, op cit.
[4] Lahteenmaki, R, Michael, A and Hodgson, J, "Public Biotech: The Numbers", *Nature Biotechnology*, May 1998, **16**, pp 425-427.

4.1 TIME FRAME AND PROBABILITY OF PRODUCT SUCCESS

Table 4.1 below depicts the time frame for the successful launch of biopharmaceutical drugs[5] and vaccines[6] and the probability of success at each stage of development. The average development time for a company manufacturing biopharmaceutical drugs to bring a product from the preclinical stage to regulatory approval is between 5-12 years with an average of eight years[7]. There can be up to a two year reduction in development time for vaccines because, apart from some animal tests, these drugs are only tested on affected patients in Phase III and there is little, if any, testing during Phases I and II (ie. there is no benefit to be gained from testing the vaccine on healthy patients). The development of biopharmaceutical drugs, however, commence in test tubes in laboratories and then progress to animal toxicology tests before tests on humans are conducted. If at any point these tests are unsuccessful the project is abandoned[8].

Table 4.1: Development Times and Probabilities of Successful Market Launch for Vaccines and Biopharmaceutical Drugs
The table shows that the average development times for biopharmaceutical drugs and vaccines to reach the stage of seeking regulatory approval. The average development time for biopharmaceuticals is eight years, whereas the development of vaccines takes, on average two years less. In addition the probability of reaching this stage is higher for biopharmaceuticals than it is for vaccines.

Stages	Vaccines	Probability to Launch	Biopharma-ceuticals	Probability to Launch
Preclinical to Phase I	2.4 years	0.22	2.3 years	0.40
Phase I to Phase II	2.0 years	0.39	1.8 years	0.71
Phase II to Phase III	1.8 years	0.54	2.2 years	0.80
Phase III to preregistration	1.4 years	0.68	2.0 years	0.93
Preregistration to registration	1.1 years	---	2.0 years	---
Registration to launch	1.3 years	0.96	1.6 years	1.00
TOTAL:	10.0 years		11.9 years	

(Adapted from Struck, 1996, p. 594)[9].

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[5] Biopharmaceutical drugs have a single active ingredient and can be used as antibiotics. They are "therapeutic protein drugs derived either through recombinant DNA technology ... or through hybridoma technology (monoclonal antibodies)" (Bienz-Tadmor, B, DiCerbo, P A, Tadmor, G and Lasagna, L, "Biopharmaceuticals and Conventional Drugs: Clinical Success Rates", *Bio/*Technology, May 1992, **10**, pp 521-525.

[6] Vaccines use multiple active ingredients and build immunity or lifetime protection against disease.

[7] Nicholson, I J and Latham, P, May 1994, op cit. and Hamers, M N, May 1993, op cit.

[8] Struck, M-M, "Vaccine R&D Success Rates and Development Times", *Nature Biotechnology*, May 1996, **14,** pp 591-593.

[9] Ibid.

Phase I tests are safety checks on healthy volunteers and if they are successful, pilot efficacy tests are undertaken in Phase II to assess the timing, amount and combination of dosage before moving to large scale tests in Phase III. These latter tests provide the data for the statistical proof required to file for regulatory approval.

As indicated in Table 4.1 preclinical biopharmaceuticals have double the probability of being launched successfully compared to vaccines. This higher probability continues at each stage of the development process, so that when registration is applied for, there is an absolute certainty of success compared to a 96 percent probability of success for vaccines[10].

Research by Bienz-Tadmor et al. (1992)[11] showed that the clinical success rate

> "for biopharmaceutical drugs developed by a single biotechnology company is much higher than that for biopharmaceuticals developed by a single pharmaceutical company. ... In the case of joint ventures, the pharmaceutical company may carry out clinical testing, but the biotechnology company is always involved in the preclinical work." (p. 524).

Hence one of the reasons why a product may not succeed during its preclinical phase could be due to the pharmaceutical company that conducts this stage of testing.

It is in the early stages of drug development that the company commences planning the development and subsequent launch of the potential products. As a result, a number of decisions have to be made at a relatively early stage concerning the three stages of the development process that have to occur prior to its successful launch. These stages are depicted in Figure 4.1 below and represent the innovation, registration and commercialisation of successful drugs. The Figure is a schematic only and is included to show the progress of a product from preregistration through to commercialisation. Each of these stages will be discussed below.

4.2 INNOVATION

The innovation phase covers the period from preclinical development through to preregistration. It is during this time that most of the decisions concerning compounds which may possess the characteristics required for a marketable product are made - even though a number of the decisions relate to the registration/commercialisation stages.

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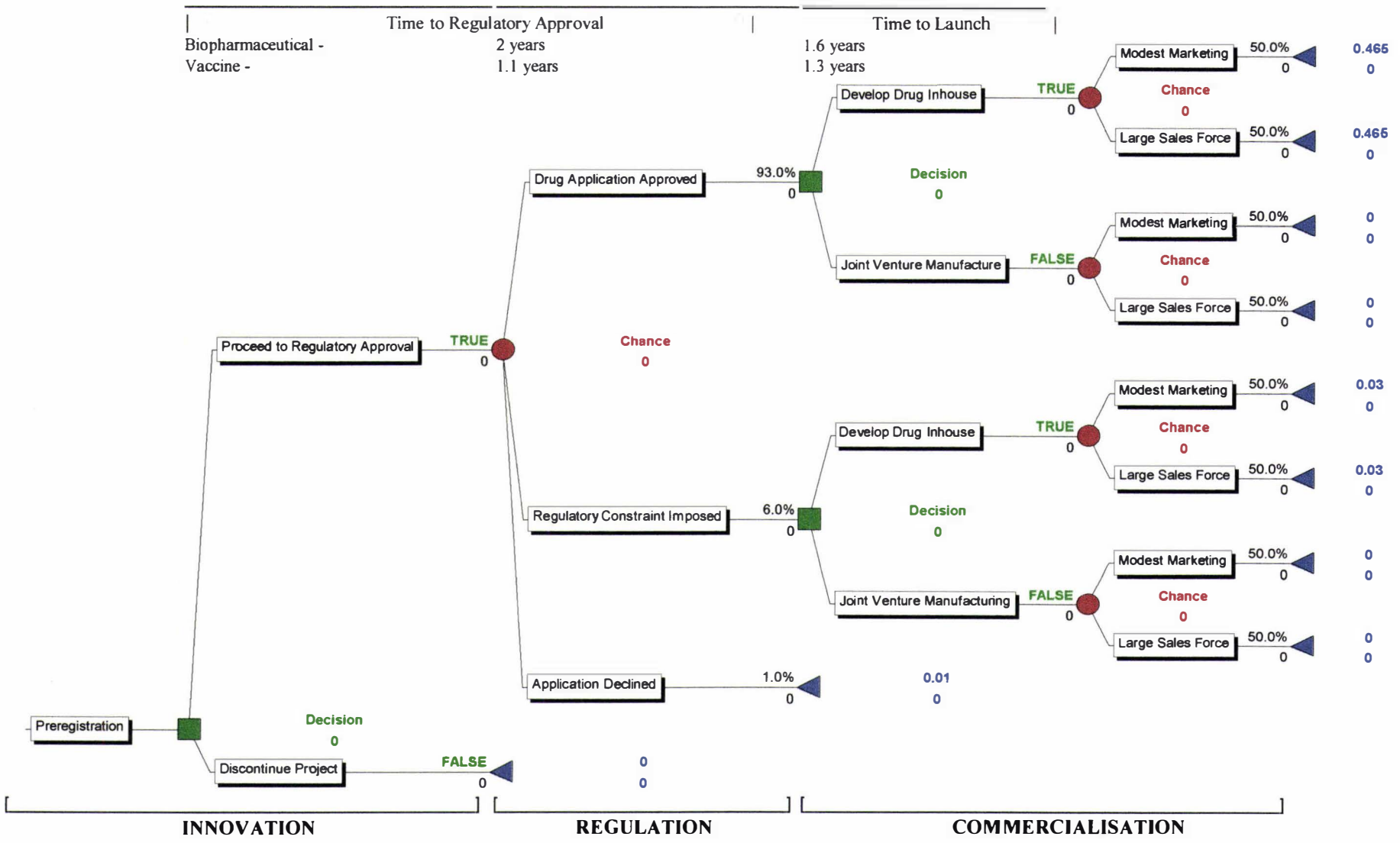
[10] Ibid.
[11] Bienz-Tadmor, B, et al, May 1992, op cit.

Figure 4.1: Decision Tree Depicting the Stages of a Drug moving from Preregistration to Commercialisation

The decision tree shown below depicts the stages a drug must pass through before it reaches the market.



These decisions concern issues of manufacture, joint ventures or partnerships as well as how to market the product. For example, the decision to manufacture the drug inhouse (in preference to contracting it out) is made approximately three years before the facilities are expected to be used and funds are allocated at this time so that the facilities can be completed and fitted-out in time[12]. In addition, the company must ensure that the facility satisfies the regulatory bodies' strict safety requirements by showing that good laboratory and manufacturing practices are adhered to.

The decision to develop inhouse will depend on the type of drug being produced. For example, if the company is developing a yeast or genetically engineered type of drug then these could be produced internally as little laboratory space is required. However, if drugs are to be manufactured using more traditional chemical technologies significantly more space is required, and the decision to contract out could be made. A disadvantage of this latter decision is that some control of the procedures will inevitably be lost.

The use of a multiuse facility to produce a range of products for either a single company or for a number of companies could also be considered. These facilities enable manufacturing economies of scale to be achieved[13] and, due to the improvements in purification which have occurred, satisfy the US Food & Drug Administration requirements. In fact the regulatory bodies prefer drugs to be manufactured using the same environment and procedures that were used in the production of the drug for the clinical trials to ensure "control of cross-contamination, control of working areas, air, equipment and personnel, and the avoidance of every conceivable mix-up in each stage of the manufacturing process"[14].

Joint ventures or partnerships usually do not occur during the manufacturing process. However, the use of multiuse facilities would enable the company to postpone this decision until after approval to market the product has been received so that the company's financial risk would be reduced in the short-term.

Joint venture or partnership deals usually occur during clinical trials. Initially these arrangements are made between a biotechnology company and a large pharmaceutical company to conduct large-scale clinical trials so that sufficient data can be collected to support an application for regulatory approval. The same type of arrangement may

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[12] Hamers, M N, May 1993, op cit.
[13] Antibiotics are produced primarily in small volumes but require a sterile environment to ensure their purity.
[14] Hamers, M N, May 1993, op cit.

occur whereby a marketing network already established by one company is used so that a large sales force can be employed to market the drug to general practitioners. Alternatively, the company may decide to implement a modest marketing infrastructure inhouse and market the drugs to hospitals and specialist centres.

Finally, as indicated in Table 4.1, when biopharmaceutical drugs reach preregistration they have a 93 percent probability of being successfully launched compared to 68 percent probability of a successful launch for vaccines. The process of obtaining regulatory approval is discussed in the next section.

4.3 REGISTRATION

Prior to 1995 there were two main regulatory authorities, the Food and Drug Administration in the US and the Medicines Control Association based in the United Kingdom. However, in 1995 the European Medicines Evaluation Agency was established with its headquarters in London. The US regulatory process takes 1.7 years to complete compared with one year for the European authority. Consequently drugs, even though they may have originated in the US, tend to become available first in the European market[15].

Once Phases I to III have been completed the company will submit full details of timing, dosage, and patient side effects resulting from the use of the drug to the regulatory body(s). If the drug is a biopharmaceutical then it generally takes approximately two years for regulatory authority approval to be granted. However, once approval has been granted then the product can be expected to reach the market. The time taken to approve vaccines is 1.1 years but only 96 percent of these progress to the product stage[16]. One reason for the lower success rate is that vaccines are only tested on healthy volunteers and as a result, some of the prior tests may have produced misleading information.

As shown in Figure 4.1 some drugs are granted unencumbered approval while others have restrictions placed on them or the company by the regulatory authority. Therefore, companies try to predict what (if any) constraints may be placed on the product and if the constraint will affect the time taken to launch the drug.

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[15] Bienz-Tadmor, B, "Biopharmaceuticals go to Market: Patterns of Worldwide Development", *Bio/Technology*, February 1993, **11,** pp 168-172.
[16] Struck, M-M, May 1996, op cit.

If the product is particularly innovative then the possibility of imitation by others is high. It could be assumed that the granting of a patent would prevent this situation from occurring. However, as a result of the use of design approaches substitute products are being produced very quickly with a subsequent reduction in product life cycles. Of the approximately 50 drugs produced annually worldwide, 8.6-9.0 percent represent novel therapies[17] which show true benefits to Mankind, 14.3-32.3 percent possess important therapeutic improvements[18] and 56.6-77.0 percent are 'me-too' or imitation drugs[19] marketed after the patent expires.

The final stage of development is commercialisation and the launch of the new drug. Because it takes only approximately one month from the time regulatory approval has been granted for the national control authority to start releasing batches of vaccines (or biopharmaceuticals) onto the market[20] the companies must have sufficient product/s and supporting material on hand to satisfy demand. The company also must be aware of a number of factors which can impinge on the success of the launch of the product. There are restrictions imposed by regulatory authorities, the granting of a Government patient subsidy, the cost of the drug and funding implications, the level of demand for the product and whether a joint venture arrangement or an inhouse manufacturing/ marketing arrangement has been put in place. In addition, manufacturing inefficiencies such as consistency or problems arising as a result of the time that elapses between the late clinical trials to receipt of regulatory approval, must be overcome.

Once a company has a product to sell, positive cash flows will be generated. As a result the company can consider an alternative form of financing to the equity and options/ warrants on equity securities the biotechnology companies have used to fund their operations previously. A description of a number of securities was undertaken in Chapter 2 and a number of them were included in the questionnaire sent to institutional analysts in order to determine an acceptable type of product for a biotechnology company to issue. The benefits to the company of the six securities selected by the analysts are discussed in section 4.4.

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[17] These are truly innovative forms of treatment hitherto not available (Drews, J, "The Impact of Globalization on Pharmaceutical Research and Development", *Drug Information Journal*, 1993, **27**(4), pp 1059-1064).

[18] Examples of these improvements could be a more convenient form of application, more efficient with fewer side effects, etc. (Ibid).

[19] That is, the same type of product as the original innovative drug (Ibid).

[20] Bienz-Tadmor, B, February 1993 op cit. and Struck, M-M, May 1996, op cit. The period of one month cited by Bienz-Tadmor contradicts with the timing stated by Struck.

4.4 SECURITIES SUITABLE FOR DEVELOPING BIOTECHNOLOGY COMPANIES

Figure 2.1 showed that a security has five requirements which must be satisfied if it is to be a suitable investment product, ie. it must reduce and reallocate risk, meet the Securities and Exchange Commission regulations, minimise taxation to both parties, reduce transaction and agency costs, and maintain price levels. The products selected by analysts in Australia and the UK which they consider would be appropriate to use as funding once a drug is submitted for regulatory approval are discussed below.

4.4.1 Equity and Options (or Warrants) on Equity

These securities will be considered together because of their similarity. Their issue will not impact on the firm's cash flows unless the existing share price does not reach the price set by the underwriters when the new issue or options are due to be taken up. Shareholder wealth is reduced whenever the options are taken up and new shares are issued. The company is under no obligation to pay dividends but the shareholders will benefit from any increase in share price.

Equity is a more expensive and riskier form of financing than debt, and when dividends are paid they are paid from tax paid earnings. Shareholders receive the benefit of an increase in share price and from the payment of dividends if the company succeeds and achieves a high level of growth.

4.4.2 Zero Coupon Bonds

This security does not require any cash flow over the life of the bond, and as it has been on issue for a number of years it is familiar to investors. The lack of interest payments provides both issuer and investor with a deferred tax benefit (depending on taxation regulations) because there is no tax payment required until the security matures. In addition, due to no interest payments being made, the investor does not have any reinvestment rate risk associated with the security. Although front-end fees are high the bond has low transaction costs which would appeal to investors.

The company is able to retire portions of the debt at intervals throughout the life of the bond which would minimise the impact on its cash flows when the principal is repaid at maturity. If this is not done then the company is faced with a large cash outflow when the security matures. The bond's low transaction costs would appeal to investors but

the high front-end fees may act as a deterrent to issuers[21]. The security would also introduce debt into the company's capital structure.

4.4.3 Convertible Debt

While the company's cash flows are affected each time interest payments are made, the large cash outflow required to repay principal when the bond matures may not occur if the share price is sufficiently high to encourage investors to convert their bonds into shares. If this conversion occurs, shareholders' wealth is affected by the dilution associated with the increase in shares and the company's capital structure will alter due to the reduction in debt and the corresponding increase in equity.

The covenants associated with the issue of convertible debt are less restrictive than straight debt which means that the firm's projects can possess a higher level of risk. Therefore, due to its debt and equity components, agency costs associated with maximising shareholders' wealth will be minimised[22].

Although equity is an expensive form of financing the firm's operations convertible bonds do provide a cheaper form of raising new equity than a new issue of shares would. The new shareholders benefit from being able to participate in the capital gains arising from holding equity.

4.4.4 Zero Coupon/Convertible Income Bond

This security could be designed to take account of the future cash flows of the company during the period of manufacture, distribution and initial sales. For example, the zero coupon segment of the security would satisfy the period of development from regulatory approval through to manufacture and distribution. The income bond segment would mean that if the level of sales were insufficient to generate the required level of cash flow, then interest payments could be postponed. Once profits are being made, investors would have the option of converting into income bonds and receiving interest payments.

The benefits to investors are low transaction costs, the same ranking as other creditors, deferral of tax until the zero coupon segment matures and interest payments commence.

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[21] Lee, C F and Finnerty, J E, *Corporate Finance: Theory, Method, and Applications*, 1990, New York: Harcourt Brace Jovanovich, Inc., p. 93.
[22] Ross, S A, Westerfield, R W and Jaffe, J F, *Corporate Finance*, 2nd Ed., 1990, Homewood, Ill.: Richard D Irwin, Inc., p. 614.

4.4.5 Preferred Stock

These securities fall between debt and equity. For example, legally they are considered to be equity and a perpetual investment which receives payments from tax paid profits, although the dividend payments are not a contractual obligation and are recommended by the company's Board of Directors. The securities rank senior to equityholders but junior to debtholders when payments are to be made and in the event of a liquidation. Therefore, an advantage to investors is that they have a lower risk associated with them than equity but their risk is higher than an investment in debt. This risk is compensated for by the higher level of return investors receive compared with those obtained by unsecured creditors. However, the return is lower than that given to equityholders.

Although preferred shares do not have the advantage of debt in relation to the interest tax shield, the cost to the issuer should be less than debt due to the ability of these dividends to be franked in Australia[23]. The investor also receives the advantage of receiving tax-free dividends once the company is paying tax. The investor must balance this advantage against the risk of rising interest rates which could affect the returns on a perpetuity with a fixed return[24].

4.5 CONCLUSION

In order to provide an understanding of the complex issues surrounding the development of biopharmaceuticals this chapter described the process a successful product must pass through prior to being submitted for regulatory approval. In addition, the securities which were selected for further investigation as a result of the questionnaire survey, discussed in Chapter 3, were described from the perspective of both the issuer and the investor.

Figure 4.1 was developed to show the stages a drug must follow once it reaches preregistration and therefore provides the background leading up to the model developed in Chapter 5 which uses the cash flows of a biotechnology company for the first five years of marketing its first product. In addition, the cash flows relating to the securities selected from Chapter 3 will be incorporated into the model and analysed further in chapters 6 and 7 in order to determine which security provides the most cost-effective form of financing for these companies.

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[23] Van Horne, J, Davis, K, Nicol, R and Wright, K, *Financial Management and Policy in Australia*, 3rd Ed., 1990, Sydney: Prentice Hall of Australia Pty. Ltd.

[24] Finnerty, J D, "Financial Engineering in Corporate Finance: An Overview", *Financial Management*, Winter 1988, pp 14-33.

Chapter 5: SECURITY ANALYSIS: A NPV APPROACH

5.0 INTRODUCTION

Due to the one month time frame between regulatory approval[1] and product launch significant preparatory work must have been completed so that new products are available for immediate supply. In order to permit this situation to arise, funds will be required to finance the production, promotion and delivery of the drugs. It is at this time that alternative sources of financing can be considered due to the sale of drugs generating cash inflows. The range of securities that could be used to finance these companies was described in Chapter 2, and on the basis of a questionnaire sent to Australian and UK institutional investors, six securities were selected for further analysis. Chapter 4 described the operations of a biotechnology from the development of a new product through to commercialisation. It is during this latter period that a different type of security to equity and equity options/warrants may prove to be a more cost-effective product for the company to offer investors.

The analysis of the suitability of these securities was undertaken for an Australian and a UK fledgling biotechnology company and introduced three levels of sophistication. Firstly, a simple model was conducted using a net present value (NPV) approach for each security and used as the basis for comparison of each of the subsequent models. This base model enabled the present value of each security's cash flows to be determined in its precise state so that the security(s) which would provide the greatest NPV to the company could be resolved. Secondly, simulations were performed on the simple model so that the uncertainty associated with a number of variables could be tested to assess their impact on each security's cash flows and NPV. Thirdly, a sophisticated model was used to determine the optimal security for each company. This model included all six securities for each country and used a decision tree approach based on the cash flows of the base model. The decision tree model also incorporated a simulation of, firstly, the variable which had the most impact on the annual cash flow of each security and secondly, the two variables which had a significant effect on each security's cash flows each year. The first model, using NPV analysis, will be described in this chapter.

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[1] Bienz-Tadmor, B, February 1993, op cit, Aschoff, T., Researched Medicines Industry, Wellington, personal communication.

5.1 NPV ANALYSIS

NPV analysis is undertaken in order to assess the future cash flows arising out of strategic business decisions. The technique discounts the stream of cash flows originating from a project or, in this case, a funding strategy to determine if the firm's value could be enhanced by a decision to alter the form of financing. In other words

NPV = PV Cash Inflows - PV Cash Outflows (5.1)

ie. cash inflows and outflows are discounted back to the present time at a risk adjusted discount rate or opportunity cost. If the result is positive the strategy will add value to the firm, whereas a negative NPV will indicate that the strategy should not be pursued.

The relationship between the cash flows can be shown as follows:

$$NPV = C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+K)^t} \qquad (5.2)$$

where: C_0 = initial cash flow
C_t = expected cash flow generated in time t
K = discount factor or opportunity cost
n = time horizon under consideration

The initial cash flow is usually negative but in the case being considered here five of the six securities had a cash inflow arising from the issue of securities in C_0.

5.1.1 The NPV Model

A computer spreadsheet model was developed using Microsoft® Excel to assess the impact on the firm if the security was issued. In order to construct the spreadsheet a number of assumptions that relate to all securities were required and are listed below for each of the variables included in the model. However, assumptions concerning the interest rate applicable to zero coupon bonds, convertible debt, zero coupon/ convertible income bonds and preferred stock are discussed in section 5.1.1.12.

5.1.1.1 Time frame

A period of five years was chosen for the analysis because a) both Grabowski and Vernon (1994)[2] and Smith (1997)[3] showed that the breakeven point between revenues and expenses occurs prior to the third year after the launch; and b) two further years would permit sufficient funds to be raised for redemption of the security if it was required.

5.1.1.2 Level of sales

There appears to be a wide range of sales figures reported, ie. between $20M and $1Bn[4], depending on the demand for the drug. For the purposes of this study the cash flows reported from Lehman Brothers Pharmaceutical Research[5] (hereinafter referred to as the Lehman model) were used after being converted from US dollars (USD) to Australian dollars (AUD) and British pounds (GBP). In order to determine the stability of the AUD against the GBP cross rates for the period 1 August to 2 September 1997 were calculated and showed minimal variation. As a result the following conversions were obtained from Datastream, Inc. for 1 September 1997, ie. USD0.73210/AUD1.0000 and USD1.6200/GBP1.0000.

5.1.1.3 Size of issue

The size of the issue was determined in relation to previous security issues for British Biotech plc (UK) and Biota Holdings Ltd (Australia). It was decided to keep the issue to a reasonable level so that it would not distort the cash flows very much but would assist the company's operations in the first year of a product's launch.

5.1.1.4 Cost of issue

Flotation costs cited by MacKie-Mason (1990)[6] showed that significant deviations from these figures occurred over time. The proportion of seasoned equity and convertible debt that is lost through raising finance in the US was obtained from Lee et al. (1996)[7] with adjustments made if the costs of issuing equity could be determined from British Biotech or Biota annual reports. The average direct costs associated with raising seasoned equity was 7.1 percent. However, an equity issue by

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[2] Grabowski, H G and Vernon, J M, "Returns to R&D on New Drug Introductions in the 1980s", *Journal of Health Economics*, 1994, **13,** pp 383-406.

[3] Smith, I, "Biotechnology Industry-Diversifying Risk, Raising Capital and Takeovers", **in** *Risk and Return in the Pharmaceutical Industry*, 1997, London: Office of Health Economics.

[4] Vagelos, P R, "Are Prescription Drug Prices High?", *Science*, May 1991, pp 1080-1084.

[5] These were disclosed in Smith, I, 1997, op cit.

[6] MacKie-Mason, J K, "Chapter 3: Do Firms Care Who Provides Their Financing", **in** Hubbard, R G (Ed.) *Asymmetric Information, Corporate Finance and Investment*, 1990, Chicago: University of Chicago Press.

British Biotech in 1995 cost approximately 5 percent, so this figure was used for the UK and Australian equity issues. Five percent was also used for the issue of equity options and preferred shares.

Lee et al. (1996) reported that average costs for convertible debt was 3.8 percent whereas straight debt was on average 2.2 percent of the total funds raised. Therefore the zero coupon bond issue and the zero coupon bond/convertible income bond issue were assumed to have direct costs halfway between 2.2 and 3.8 percent, ie. 3.0 percent.

5.1.1.5 Gross Profit

Grabowski and Vernon (1982)[8] estimated that the cost of producing drugs was 30 percent of sales: this figure was increased to 40 percent in the authors' 1994 publication. Other researchers[9] have indicated a range of pretax margins between 25-45 percent. However, these margins include a number of costs such as interest, R&D contributions, marketing and administration which are not contained in the calculation of Gross Profit in this study. Therefore, based on the Lehman model mentioned above, which shows Gross Profits in the first five years post launch of a product to be between 76-90 percent of sales, a constant figure of 62.5 percent has been used which is approximately halfway between the 40 and 76-90 percent range quoted in the literature. The reason that the figure is less than that indicated by the Lehman model is because additional costs, R&D Expenses and Capital Expenditures, are included below Gross Profit in this study but are not shown either above or below Gross Profit in the Lehman model.

5.1.1.6 Promotion Expenses

While the Lehman model showed promotion costs of 200 percent in year 1 of the launch dropping to 30 percent in year 5, it was decided to follow those used in the Grabowski and Vernon (1990)[10] study. These promotion expenses of 100 percent of sales in year 1, 50 percent in year 2 and 25 percent in year 3 appeared a more realistic reflection of cash flows in the early stages of marketing a drug which incurs a number

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[7] Lee, I, Lochhead, S, Ritter, J and Zhao, Q, "The Costs of Raising Capital", *Journal of Financial Research*, Spring 1996, **XIX**(1), pp 59-74.

[8] Grabowski, H and Vernon, J, "A Sensitivity Analysis of Expected Profitability of Pharmaceutical Research and Development", *Managerial and Decision Economics*, 1982, **3**(1), pp 36-40.

[9] Joglekar, P and Paterson, M L, "A Closer Look at the Returns and Risks of Pharmaceutical R&D", *Journal of Health Economics*, 1986, **5**, pp 153-177; Grabowski, H G and Vernon, J M, 1994, op cit.

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

of heavy launch expenses[11]. Costs of twenty-five percent of sales were allocated to year 4 and 20 percent for year 5 for the naive model.

5.1.1.7 General, Administration and Overhead Expenses

Myers and Howe (1997)[12] used Monte Carlo simulations to obtain an average percentage of General, Administration and Overhead expenses. The percentage obtained (approximately five percent) matched a similar figure for a sample of large pharmaceutical companies. The Lehman model indicated a figure of about 10 percent by year 5. As a result 7.5 percent was used for this stage of the research.

5.1.1.8 R&D Expenses

Due to the vast amount of research that has been done on the costs associated with bringing a drug to market and also the wide range of figures associated with this activity (ie. between $250-600M), it was decided to allocate a proportion of sales to R&D expenditure within the firm so that the sales of the product could support the ongoing research within the company. A range of between 8-14 percent has been reported[13] in the literature and a figure of 11 percent was selected for use in the spreadsheet.

5.1.1.9 Capital Expenditure

In order to support ongoing capital expenditure the estimates used by Grabowski and Vernon (1994) were followed, ie.

> "capital expenditures for plant and equipment to be equal to 40% of tenth year sales. Half of these outlays were assumed to occur in the first two years before marketing and the other half during the first 10 years after marketing." (p. 392)

It is the post-launch allocation that has been used in this study.

5.1.1.10 Taxation

A tax rate of 30 percent was charged on Profits before Tax in line with the Joglekar and Paterson (1986) and Grabowski and Vernon (1990, 1994) studies. The effective tax rate for pharmaceutical companies is less than the normal company tax rate due to

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[11] The choice of the promotion expenses in this section are for illustrative purposes only. The two ranges of expenses will be used in the simulation section.

[12] Myers, S C and Howe, C D, *A Life-Cycle Financial Model of Pharmaceutical R&D*, April 1997, Mass. Inst. of Technology: Program on the Pharmaceutical Industry.

[13] Sully, R, "Managing Risk - Glaxo Wellcome Approaches", **in** *Risk and Return in the Pharmaceutical Industry*, 1997, London: Office of Health Economics, Drews, J, 1993, op cit., Smith, I, 1997, op cit., and Myers, S C and Howe, C D, 1997, op cit.

tax credits resulting from R&D expenditure received by these companies and also tax losses carried forward to future years.

5.1.1.11 Dividends

End of year dividends were paid whenever positive net profits before tax were generated. There were two dividend payout ratios cited in the literature (ie. 40 and 50 percent)[14] and for this part of the study a 40 percent payout ratio was selected.

5.1.1.12 Interest Expense

There were four securities which required a form of interest expense, ie. zero coupon bonds, convertible debt, zero coupon/convertible income bonds and preferred stock. Due to the difficulties associated with obtaining interest rate information on these securities, some of which have not been issued by Australian or British companies, US information was used. As a result of the flow of funds between countries which now occurs, it was assumed that purchasing power parity exists and that the premiums calculated from US securities could be applied to securities in other countries. A complete list of all US fixed interest securities was obtained from Datastream, Inc. and the relevant information extracted as follows:

a) Zero Coupon Bonds: A list of US zero coupon bonds was obtained from Datastream and recent issues investigated further. Unfortunately in a number of cases more detailed information was not available. Three companies, Coleman, Valhi Inc. and Waste Management Inc. provided yield information as at 3 November 1997. However, the yields for Valhi and Waste Management Inc. were less than the US Intermediate Treasury Bond rate and hence these companies were discarded. The yield for Coleman was 7.667 percent.

In order to determine the premium required for zero coupon bonds, the yield on 20 year US Intermediate Bonds was obtained[15] and an inflation premium for this period deducted from it. An average 20 year liquidity premium was calculated and added onto this figure, ie.

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[14] Myers, S C and Howe, C D, 1997, op. cit. and Finnerty, J D, *Corporate Financial Analysis*, 1987, New York: McGraw-Hill International Editions, , pp. 197, 223.

[15] Ibbotson Associates, *Stocks, Bonds, Bills and Inflation 1995 Yearbook*, 1995, Chicago: Ibbotson Associates, Inc.

US Intermediate Treasury Bonds	9.25%
Less Inflation	5.44
	3.81
Plus Liquidity premium	2.31
	6.12%

The premium to be attached to the riskfree rate for these securities was 1.547 percent (ie. 7.667 - 6.12).

b) Convertible Debt: No five year convertible debt securities could be obtained from Datastream, Inc. but data on three companies offering 10 year convertible debt was extracted. The coupons of these companies were averaged and when an average of US Treasury Notes of a similar period was deducted, a premium of 0.791 percent resulted.

c) Zero Coupon/Convertible Income Bonds: None of these securities were listed on Datastream, Inc. However, a number of income bond securities were shown. These securities were issued mainly by railway companies and had a maturity of 30-50 (or more) years. The St. Louis-San Francisco Railway and Virginia Railway bonds provided sufficient information. These securities had an average coupon of 5.5 percent and the excess over US Treasury Notes was two percent.

d) Preferred Stock: No preferred stock data could be obtained from Datastream so the Internet was used to find US companies issuing these securities. Three companies were found, BankAmerica, Digital Equipment Corporation and Gabelli Convertible Securities Fund, Inc., and an average interest rate of 8.4166 percent calculated. The premium over five year US Treasury Notes was 2.0166 percent.

The risks associated with the companies above and the pharmaceutical companies being studied differ. However, research by Myers and Howe (1997) showed that as a pharmaceutical company's R&D progresses towards the finished product the level of risk associated with the company declines until it reaches the level associated with a company producing mature products. Therefore, the impact of variations in risk should not affect this research significantly.

5.1.1.13 Risk adjusted discount rate and opportunity cost

Three discount factors were used in the study. The first two were calculated using the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964)[16] but with different beta values. The CAPM model is used to calculate an asset's required rate of return which can then be used to compare the returns that other securities are generating in the marketplace. The expected return (E(R)) model is:

$$E(R_i) = RFR + \beta(R_M - RFR) \qquad (5.3)$$

where: RFR = riskfree rate of interest

β = standardised measure of systematic risk

R_M = return on the market portfolio

Riskfree rates of 4.87 percent (Australia) and 6.87 percent (UK) were obtained from Datastream. The first beta was obtained by regressing company share prices against a market index. Weekly data were obtained from the Datastream database for the period 1 June 1994 to 29 August 1997 for British Biotech and the FT-SE All Share Index, and Biota Holdings and the Australian Small Company Index. All data were adjusted for issues and dividends and betas of 1 (Australia) and 0.99 (UK) were obtained. The second beta was 1.75 as reported by Myers (1997)[17] for companies with products in the advanced clinical testing phase.

The market return was calculated using the geometric mean return for the market index for the period 2 January 1995 to 2 June 1997. Returns of 12.7 percent (Australia) and 7.4 percent (UK) were obtained and the following CAPM equations compiled:

$E(R_i) = 4.87 + \beta(12.7 - 4.87)$ Australia

$E(R_i) = 6.87 + \beta(7.4 - 6.87)$ UK

The third discount factor was an opportunity cost or an alternative rate that investors could make by investing in another security[18]. This was also done by Myers and Howe (1997)[19] who calculated a discount rate that could be applied to each stage of a

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[16] Sharpe, W F, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance*, September 1964, **19**(3), pp 425-444.

[17] Myers, S C, "Measuring Pharmaceutical Risk and the Cost of Capital", **in** *Risk and Return in the Pharmaceutical Industry*, 1997, London: Office of Health Economics.

[18] Smith, I, 1997, op cit.

[19] Myers, S C and Howe, C D, 1997, op cit.

drug's development so that a comparison against alternative investments was possible. The ten year Benchmark Bond rate for Australia and UK for 29 August 1997 was obtained from Datastream, Inc. for this purpose and the discount rates used in the NPV calculations were 12.7, 18.57 and 6.528 (Australia) and 7.4, 7.8 and 7.078 (UK). The reason for the small variations in the UK discount rates was due to the low market premium which prevailed.

5.1.1.14 Number of shares on issue

The initial information concerning the number of shares on issue was obtained from the Annual Reports of British Biotech and Biota. The number of shares subsequently issued was ascertained by dividing the funds raised, or to be converted, by a slightly discounted current share price to control for price dilution on issue.

5.1.2 Analysis of the Results from the NPV Models

The spreadsheet models are contained in Appendix 5 and the NPV results are presented in Table 5.1. The Table shows that the rankings of the securities differed between countries with the spread between the highest and lowest NPVs greater in Australia than in the UK. The UK figures for each NPV are very similar due to the small variation in the discount rates used and reflected the small spread between the market return and riskfree rate.

The high interest rates had a detrimental effect on the cash flows of these instruments, particularly when negative cash flows were being generated and the company could not receive the benefit of a tax shield. These cash flows occurred in the initial stages of generating sales and hence were affected detrimentally by the higher discount factors used at this time. The two securities which required repayment of principal at maturity had the lowest rankings indicating the impact this has on a company's cash flows even when sales have risen 16-fold over the period.

Convertible debt was ranked second in Australia and first in the UK, which reflected the benefit of the tax shield on the companies' cash flows and the low repayment of principal at maturity due to the option to convert debt into equity. However, the ranking dropped to fourth for Australia when the low opportunity cost discount factor was used. The other convertible security (convertible into income bonds, not equity) was only able to pay interest on the debt in year 5 when the principal was repaid and consequently was unable to receive tax shields.

Table 5.1: NPV Results for Securities Tested

NPVs for the six securities considered suitable by analysts for a biopharmaceutical company (which has a product about to enter the regulatory approval stage) to issue. Three different discount rates were used to discount the cash flows; two were obtained using the CAPM model with varying betas and the third represented the opportunity cost of an alternative, safe investment. The results show that equity and convertible debt were ranked highest in both countries whereas securities (ie. zero coupon and zero coupon/convertible income bonds) which required principal to be repaid at maturity ranked lowest.

Security	Australia		UK		Australia		UK		Australia		UK	
	Rank[1]	NPV β = 1	Rank	NPV β = 1	Rank	NPV β = 1.75	Rank	NPV β = 1.75	Rank	NPV Opp.cost	Rank	NPV Opp.cost
Equity	1	$10.48	2	£32.44	1	$ 6.85	2	£32.14	1	$16.59	2	£32.68
Options/Warrants	4	4.01	3	25.41	6	(1.22)	3	24.82	2	12.61	3	25.90
Zero Coupon Bonds	5	1.51	5	13.26	4	(0.90)	5	13.17	5	5.84	5	13.33
Convertible Debt	2	8.33	1	46.45	2	4.83	1	45.90	4	8.46	1	46.91
Zero Coupon/Conv. Income Bonds	6	1.15	6	12.16	5	(1.13)	6	12.09	6	5.29	6	12.22
Income Bonds	3	5.87	4	19.36	3	2.84	4	19.26	3	10.75	4	19.44

[1]Where 1 refers to highest NPV and 6 lowest.
Source: Author generated.

The small constant income stream that arises from the exercise of options had an adverse effect on cash flows, especially in Australia when a higher discount rate was used. This was due to the security having a negative cash flow in year 0 and a small cash flow in year 1 when discounting is more beneficial. Those securities which had their full issue paid in year 0 benefitted from this although the securities which were discounted to face value had the lowest rankings.

Although the companies received the full issue of preferred stock in year 0, this security requires a fixed interest payment to investors to be made each six months. These funds are paid from after tax earnings which had an adverse effect on cash flows.

These spreadsheets formed the foundation for the next stage of the research which used Monte Carlo simulation to determine those variables that had an effect on the cash flows and NPVs of the company. This will be discussed in more detail in the next chapter.

Chapter 6: SECURITY ANALYSIS: A SIMULATION APPROACH

6.0 INTRODUCTION

After an evaluation of a number of financial products, a survey of institutional analysts showed that there were six securities they would be prepared to purchase from a biotechnology company that was close to launching its first drug onto the market. In order to ascertain which of the six securities was the most cost-effective for these companies to issue, spreadsheets replicating the level of sales and expenses for the first five years were developed.

The next stage of the research considered the impact of change on the variables which made up the cash flows described in Section 5.1. Monte Carlo simulation is one technique that can be used to overcome the problem of forecasting the cash flows associated with (in this case) the launch and marketing of a new drug. The procedure is a computer-driven process whereby some of the components of the spreadsheet are exposed to the random generation of values so that the impact of these changes on the project or company's NPV can be examined. That is, the model enables decision-making to be made in an uncertain environment and thus avoids the need for arbitrary assumptions. A description of the technique is provided below before a discussion of the inputs to the model and an analysis of the results is undertaken.

6.1 MONTE CARLO SIMULATION

Monte Carlo simulation has been used in business for approximately 30 years. Seitz and Ellison (1995) describe the technique as one which "draws its name from the use of values that are randomly drawn, but with [the] probability of each draw controlled to approximate the actual probability of occurrence" (p.344)[1]. The method consists of changing the values of certain inputs (such as revenues, expenses, etc.) and noting the effect on an outcome (such as NPV). As such it is a descriptive and not an optimization model. It differs from sensitivity analysis through its greater sophistication and its incorporation of probability distributions of the random variables. The value of each selected input is changed by a randomly selected figure

[1] Seitz, N and Ellison, M, *Capital Budgeting and Long-Term Financing Decisions*, 2nd Edn, 1995, New York: The Dryden Press.

and the output recalculated. This procedure is repeated several hundred, or maybe thousand, times so that the output represents an expected value. The process thus provides information on the riskiness of the project being considered in the form of a probability distribution of NPV.

There are six steps which must be followed in order to develop a simulation model:
(1) the problem and its objectives should be defined so that the reason for the simulation can be determined. Once this has been done the objectives that are to be modelled (such as the stochastic inputs) are identified and the techniques to measure the objectives are selected;
(2) data must be collected in order to design and build the model;
(3) the model is tested and validated to ensure that it works as it is intended to do and that the outcomes are in the direction expected;
(4) the simulation experiments are designed so that a least-cost method of solving the problem identified can be found. Sometimes it is necessary to remove some of the data covering the initial or transient stages of a simulation if these data are not representative of the problem under investigation. That is, if a project was to be simulated in operational mode any data used to model it during its start-up phase would not be relevant to the study and therefore should be removed;
(5) a number of simulations are performed on the model; and
(6) the results generated are analysed and interpreted[2].

The Monte Carlo method permits a large number of experiments to be conducted so that a number of different strategies can be tested. The results of the tests will estimate the expected value of the strategy or outcome as well as the probability distribution of these outcomes, ie. it will permit a problem to be analysed and a result to be determined. The procedure used to do this selects a range of random numbers from a uniform distribution for each element and allocates them to the stochastic input so that a representation of the mean for the input can be obtained.

A simulation is not an optimisation procedure but will show what could happen in a certain situation. The method's greatest benefit is to permit the observation of a complex system's dynamic behaviour in an experimental environment so that the operation can be tested under a number of different conditions in order to determine the advantages and disadvantages of certain actions. In some instances it will allow experiments of systems to be undertaken which would be impossible or not feasible

[2] [2] Dannenbring, D G and Starr, M K, *Management Science: An Introduction*, 1981, New York: McGraw-Hill Book Company.

to do otherwise. The method does not require an extensive database because it allows adjustments to occur through sensitivity analysis[3] and hence shows great versatility. Simulations are efficient because they are able to compress real time, they are simple to use and they provide information about the risks and returns associated with a specific project[4].

However, a number of disadvantages have also been reported. These include the expense required to construct the model. These costs concern the development of probability distributions, the development and verification of the computer programme[5] and the large amount of computational power required to run the simulation[6], especially if the model is complex, in order to ensure that the margin of error is sufficiently low[7]. The method is not an optimisation technique so it can only evaluate a solution - it cannot generate the solution to the problem. In addition, the model ignores nondiversifiable risk which is the risk that investors deem most important[8]. Finally, it must be remembered that the decision or interpretation of the results is a subjective one based on a manager's judgment.

Simulations have been used by researchers to solve problems in the pharmaceutical industry as well as analysing the risks associated with specific projects. Some of this research will be discussed in the next Section.

6.1.1 Simulations in the Pharmaceutical Industry

A number of studies using simulations have been undertaken in an effort to assist decision-making in the pharmaceutical industry. For example, a spreadsheet model was developed by Nicholson and Latham (1994)[9] to analyse a decision to manufacture drugs inhouse or to contract this stage of development out to another company. Although sensitivity analysis was performed on a number of variables and the outcome analysed it was not clear if a computer simulation was undertaken.

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[3] Yeager, G, "The Best Method for Accurate Risk Management", *Corporate Finance*, November 1996, **144**, pp 32-34.
[4] Hertz, D B, "Risk Analysis in Capital Investment", *Harvard Business Review*, January-February 1964, **46**, pp 95-106.
[5] Seitz, N and Ellison, M, 1995, op cit.
[6] Yeager, G, 1996, op cit.
[7] Anonymous, "Is Monte Carlo Bust?" *Economist*, 12 August 1995, **336**(7927), p. 63.
[8] Seitz, N and Ellison, M, 1995, op cit.
[9] Nicholson, I J and Latham, P, 1994, op. cit.

Joglekar and Paterson (1986)[10] developed a base-case model which depicted a decision to invest in R&D for 36 years. The investment would result in a new chemical entity that would be ready for sale 12 years later. Sensitivity analysis was used to assess the historical long-term changes in R&D costs and sales levels worldwide, as well as economic- and industry-specific inflation on the investment decision. The model tested the robustness of the base-case model and found on average that the investment would match the return from an investment in bonds over the same period.

Sensitivity analysis has been used by other researchers trying to resolve the uncertainties inherent in the development of new chemical entities in the pharmaceutical industry. Grabowski and Vernon (1982)[11] performed sensitivity analysis in order to assess the relationship between the protection patents provided for drugs and the impact of this protection on company profitability. In later studies[12] these researchers used the same method to assess the level of returns generated by pharmaceutical R&D from the increase in drug prices and the increase in competition resulting from generic products. The impact of changes in contribution margin, effective tax rates and cost of capital were also examined under different scenarios such as efforts by some European countries to contain the cost of pharmaceuticals and changes to the duration of the regulatory review period for new drug applications. Grabowski (1997)[13] extended this work to consider the many uncertainties associated with innovative drugs on the return from investment in R&D through all stages of drug development. The research by DiMasi et al (1991)[14] examined the sensitivity of R&D costs to a) clinical success and economic discount rates, b) changes in the length of time taken to complete Food and Drug Administration regulatory reviews, and c) new chemical entity development.

Myers and Howe (1997)[15] developed a Monte Carlo model to simulate the progress of a portfolio of drugs from development through to the marketing of one or more end-products. The model included the probability of success and failure, the cost of the R&D facility, the facility's establishment and operational costs, the costs of pre-clinical and subsequent clinical trials, regulatory drug approval costs, and finally the

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[10] Joglekar, P and Paterson, M L, 1986, op cit.
[11] Grabowski, H and Vernon, J, 1982,op cit.
[12] Grabowski, H and Vernon, J, July 1990, op cit.; and 1994, op cit.
[13] Grabowski, H, "The Effect of Pharmacoeconomics on Company Research and Development Decisions", *Pharmacoeconomics*, May 1997, **11**(5), pp 389-397.
[14] DiMasi, J A, Kaitin, K I, Fernandez-Carol, C and Lasagna, L, "New Indications for Already-Approved Drugs: An Analysis of Regulatory Review Times", *Journal of Clinical Pharmacology*, 1991, **31**, pp 205-215.
[15] Myers, S C and Howe, C D, 1997, op cit.

manufacture and marketing of successful drugs. In other words the model simulated the life-cycle of a number of drugs at various stages of development and incorporated all the uncertainties that would impact on one or more variables at each stage of the process.

A simulation model was also used by Glaxo Wellcome as part of their method of rating projects[16]. They developed NPVs for projects discounted at the company's weighted average cost of capital. Monte Carlo simulation formed one part of the model and was used to assess the impact of commercial risk on the product when it reached the marketplace. The company considers this activity important because only approximately 30 percent of R&D expenses are recouped post-marketing.

While the variables used in the simulation described here were the same for each security studied, the inherent differences in the securities enabled one security to dominate the others in terms of their cash flow. The objective of this part of the research was to determine which of the variables that were simulated had the greatest effect on the securities' cash flows. A computer package, called @Risk[17], which works as an add-in to either Microsoft® Excel or Lotus® 1-2-3 was used to simulate the uncertainties of forecasting revenues and expenses associated with the launch and promotion of a new drug. A discussion of the variables which were selected for simulation and the formulae used will be undertaken in the next Section.

6.1.2 Simulation Inputs

Seven inputs were selected in the simulation of each security and another input was included as a random variable for those two securities which required the repayment of principal at the end of five years. The variables chosen were the amount of the Security Issued, the level of Sales, Competition, Gross Profit, Promotion Expenditure, R&D Expenditure, Capital Expenditure, and the amount of Debt Repayment (if required). The outputs selected were the annual cash flows and NPV for each security. Three alternative probability distribution functions were attached to the inputs to replicate the uncertainty associated with that particular variable. These were:

Discrete($\{x_1,x_2\},\{p_1,p_2\}$)
Triang(minimum value, most likely value, maximum value)
Uniform(minimum value, maximum value)

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[16] Sully, R, 1997, op cit.
[17] @Risk is a risk analysis program developed by Palisade Corporation, New York.

These probability distributions will be discussed in relation to the relevant inputs in Sections 6.1.2.1 to 6.1.2.5 and the relationship between these inputs is described in Section 6.2.

6.1.2.1 Issue of security

When issuing any security to the public the potential exists for the offer not to be fully subscribed or, alternatively, it could be over-subscribed. As a result, a range of 50 percent above or below $25 million (Australia) or £40 million (UK) was selected. Due to the selection of a minimum, maximum and most likely level of funds raised, the Triang (or triangular) probability distribution was used. This distribution implies that the probability of any random variable falling within the area under the triangle has a distribution of[18]

$$F(x) = 0 \qquad \text{if } x < a \qquad (6.1)$$

where: a = minimum value

$$F(x) = \frac{(x-a)^2}{(c-a)(c-b)} \qquad \text{if } a \le x \le b \qquad (6.2)$$

where: b = most likely value

c = maximum value

$$F(x) = 1 - \frac{(c-x)^2}{(c-a)(c-b)} \qquad \text{if } b < x \le c \qquad (6.3)$$

$$F(x) = 1 \qquad \text{if } c < x \qquad (6.4)$$

The formulae above depict the value for the issue of the security if it is a total failure (6.1), if the total amount of funds received is between the minimum and most likely value (6.2), the most likely and maximum value (6.3) and if the issue is a total success (6.4). Therefore, the parameters a, b and c for the distribution are such that

$$a \le b \le c \qquad (6.5)$$

and represent a triangular distribution of values.

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[18] Formulae taken from *@Risk: Advanced Risk Analysis for Spreadsheets*, September 1996, Newfield, NY: Palisade Corporation, p. 248.

Two of the securities, ie. zero coupon bonds and zero coupon/convertible income bonds made principal repayments at maturity. The same procedure was undertaken for the repayment indicating that a range of the original securities issued may have been made and were now being redeemed.

6.1.2.2 Level of sales

There is always a level of uncertainty associated with the launch of any new product and, depending on the demand for the drug, sales could range between $20M and $1Bn. As a result, the sales figures associated with the Lehman model were adjusted downwards by the entry of a potential competitor in years 2, 4 and 5.

Generic products, when introduced, undercut the price of brand products by approximately 20 percent[19]. The reason for this is that these drugs are 40-50 percent cheaper than their brand-name equivalents to produce[20]. The impact of competitive entry was obtained from Myers and Howe (1997)[21] who make the assumption that one competitor will reduce sales revenue by 25 percent, two competitors by 43.8 percent and a reduction of 57.8 percent could eventuate if three competitors entered the market and offer a generic product. The timing of this entry was obtained from Cockburn (1997)[22] with the first competitor entering the market in year 2, the second in year 4 and the third in year 5.

Due to the 'minimum, most likely and maximum' distribution of this series the Triang probability distribution function was also used for this input.

6.1.2.3 Competition

The impact on sales and the timing of competitor entry has been discussed in 6.1.2.2 above and indicates that generic product/s may, or may not, compete with the new drug. Therefore, in year 2 it is assumed that there may be a 50/50 chance of a competitor, in year 4 there may be a 70 percent chance that two competitors may be in the marketplace and finally by year 5 the probability of three generic drugs competing with the company's product could be 80 percent. The distribution had two outcomes which indicated that either no competitor would enter the marketplace or that one or more competitors would arrive - these outcomes were valued 0 and 1

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[19] Thwaite, E W, "Beat the Generics by Joining Them", *Medical Marketing & Media*, September 1992, pp 110-122.
[20] Robinson, A, "After Years of Steady Growth, Winds of Restraint Blowing on Prescription-Drug Industry", *Canadian Medical Association Journal*, July 1, 1995, **153**(1), pp 85-88.
[21] Myers, S C and Howe, C D, 1997, op cit.
[22] Cockburn, I, 1997, op cit.

respectively[23]. Hence a discrete distribution function F(x) was defined such that the outcomes (x_i) were weighted appropriately (p_i). The number of outcomes, in general, ranged from 1 to i. Thus, the expression for F(x) takes the form, ie.

$$F(x) = \sum_{j=1}^{i} p_j \qquad (6.6)$$

where $p_j = f(x_j) > 0$

and $x_i \leq x < x_{i+1}$

In other words, the number of outcomes must be more than zero with the probabilities of these outcomes occurring being above or equal to zero.

6.1.2.4 Gross Profit

The third form of probability distribution function was linked to Gross Profit. As discussed in Section 5.1.1.5 a range of contribution margins have been reported in the literature. From this information, 40 percent and 85 percent were selected as the minimum and maximum values to apply to the level of sales each year. It was assumed that because each value could have an equal chance of occurring across the minimum-maximum range of 40-85 percent the uniform probability distribution function was the appropriate one to use in this case. This function, which varies uniformly between a minimum and a maximum value, is assumed to have a distribution of the form

$$F(x) = \frac{x - \min}{\max - \min} \qquad (6.7)$$

with the parameters being min ≤ max. In contrast to a normal distribution, this type of distribution has a uniform probability of the result lying anywhere between the minimum and maximum value, ie. there is no peak around a mean value.

6.1.2.5 Promotion, General, Administration and Overhead, and R&D Expenditures

The procedure for these three variables was identical and followed the method described in 6.1.2.4 above. The proportion of expenses ranged uniformly between a minimum and a maximum value as described in 5.1.1.6, 5.1.1.7 and 5.1.1.8. The

[23] For example, if there was a 50 percent chance of a competitor entering the market in year 2 then the distribution would take the form of {0,1},{0.5,0.5}, in year 4 the distribution would be {0,1},{0.3,0.7} indicating that there would be a 30 percent chance of no competitors and a 70 percent probability that one or more competitors would be present.

values for General, Admin and Overhead, and R&D Expenditures remained the same in each of the five years being studied whereas the values for Promotion costs fell each year after the product was launched.

The adjustments described above were incorporated (using the @Risk computer package) into the Excel spreadsheet described in Section 5.1.1 in order to introduce the uncertainties surrounding these forecast variables. The annual cash flows and NPVs for each security were selected as output results which ultimately incorporate the risks associated with these inputs. Ten thousand iterations were performed on the modified spreadsheets with the output results described in Section 6.2 below and multivariate stepwise regressions run for each output variable[24]. The resultant beta coefficients were displayed in tornado graphs[25] and these showed the variables that had the greatest influence on the annual cash flows. From the information provided from these graphs two variables would be selected to be included in the decision tree model described in Chapter 7.

6.2 ANALYSIS OF RESULTS

The analysis of the results of the Monte Carlo simulation run on each spreadsheet for all securities will be conducted by firstly describing the distribution of the results arising from the simulation. Secondly, the most significant variables which impact on the annual cash flows and subsequent NPVs will be identified using the information from the tornado graphs. Thirdly, the impact on the security issued and the effect of competition or the repayment (where required) of the security will be addressed. The spreadsheets referred to above are included in Appendix 7.

6.2.1 Analysis of Simulated Outputs

Due to the similar trends for the securities issued in both Australia and the UK the discussion of the outputs from the simulation will be done from a general perspective as shown in Tables 6.1 and 6.2. The only variation appears to be due to the difference in the amount of funds raised and the interest rates prevailing in each country.

The information contained in Table 6.1 shows that mean cash flows followed the same pattern and were negative from years 1 to 3 before becoming positive and

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[24] The information from the regressions for all securities form the data for Tables 6.1 and 6.2.
[25] Examples of the tornado graphs for the equity and options/warrants annual cash flows are contained in Appendix 6.

Table 6.1: Simulation Statistics - British Biotechnology plc
A Monte Carlo simulation was conducted on the spreadsheets for all six UK securities. The statistics for the output variables encompassing annual cash flows and NPVs showed that the mean Cash flows became positive in year 4 although options/warrants became positive a year earlier due to their regular cash inflows. The distributions were in the main normal but with some skewness, the largest of which occurred in year 3 when cash flows became positive. The securities' NPVs were negative for all but the UK equity-related ones.

Outputs	Mean	Mode	Standard Deviation	Skew
Equity				
Cash flow Year 0	37.94	31.38	7.75	3.89E-03
Cash flow Year 1	-36.19	-42.59	9.09	-0.61
Cash flow Year 2	-28.54	-47.71	11.47	-0.30
Cash flow Year 3	-2.19	-7.44	10.89	-1.06
Cash flow Year 4	10.26	13.30	6.68	9.75E-02
Cash flow Year 5	33.30	44.30	14.68	0.67
NPV Beta = 1	8.14	-11.71	19.56	-6.45E-02
NPV Beta = 1.75	7.91	21.86	19.30	-6.74E-02
NPV Opp.Cost	8.34	4.16	19.77	-6.21E-02
Options/Warrants				
Cash flow Year 0	-2.00	-2.00	0.00	0.00
Cash flow Year 1	-28.02	-36.80	9.33	-0.62
Cash flow Year 2	-19.74	-22.22	12.23	-0.26
Cash flow Year 3	6.48	19.64	11.13	-1.07
Cash flow Year 4	18.73	10.87	7.73	1.53E-02
Cash flow Year 5	42.83	25.96	16.20	0.68
NPV Beta = 1	3.80	23.49	19.36	-8.28E-02
NPV Beta = 1.75	3.24	3.82	19.07	-8.67E-02
NPV Opp.Cost	4.27	-15.94	19.60	-0.08
Zero Coupon Bonds				
Cash flow Year 0	21.38	21.40	9.56	-0.23
Cash flow Year 1	-35.84	-52.93	9.10	-0.64
Cash flow Year 2	-27.78	-33.13	12.07	-0.29
Cash flow Year 3	-1.54	-26.86	11.02	-1.12
Cash flow Year 4	10.84	9.01	7.48	2.44E-02
Cash flow Year 5	22.32	19.24	16.76	0.48
NPV Beta = 1	-12.62	-35.50	19.87	9.41E-03
NPV Beta = 1.75	-12.66	-19.44	19.59	6.91E-03
NPV Opp.Cost	-12.58	-16.01	20.09	1.15E-02
Convertible Debt				
Cash flow Year 0	38.48	33.31	7.83	-5.07E-03
Cash flow Year 1	-39.04	-53.76	9.14	-0.62
Cash flow Year 2	-30.78	-39.24	12.06	-0.28
Cash flow Year 3	-3.46	1.32	14.42	-0.58
Cash flow Year 4	9.80	11.08	14.38	0.01
Cash flow Year 5	32.80	33.84	32.08	0.11
NPV Beta = 1	2.97	-0.11	15.54	-4.96E-02
NPV Beta = 1.75	2.79	17.54	15.38	-5.11E-02
NPV Opp.Cost	3.12	-18.74	15.68	-4.83E-02

(Continued p.89)

Outputs	Mean	Mode	Standard Deviation	Skew
Zero Coupon/ Conv.Inc.Bonds				
Cash flow Year 0	21.28	16.07	9.36	-0.12
Cash flow Year 1	-35.94	-35.90	9.11	-0.65
Cash flow Year 2	-27.66	-39.05	12.13	-0.31
Cash flow Year 3	-1.93	6.63	10.89	-1.19
Cash flow Year 4	10.12	5.31	7.05	4.03E-02
Cash flow Year 5	21.59	7.64	16.97	0.41
NPV Beta = 1	-14.05	-16.52	19.71	-5.95E-02
NPV Beta = 1.75	-14.07	-28.21	19.44	-6.15E-02
NPV Opp.Cost	-14.04	-27.89	19.93	-5.79E-02
Preferred Stock				
Cash flow Year 0	38.03	31.29	7.82	7.36E-03
Cash flow Year 1	-39.40	-48.18	9.06	-0.62
Cash flow Year 2	-31.22	-45.88	12.08	-0.30
Cash flow Year 3	-5.22	-8.74	13.94	-0.57
Cash flow Year 4	8.36	10.42	14.40	0.05
Cash flow Year 5	31.02	6.68	31.84	0.27
NPV Beta = 1	-2.52	-2.21	15.13	-5.68E-02
NPV Beta = 1.75	-2.62	2.97	14.97	-5.89E-02
NPV Opp.Cost	-2.43	5.78	15.27	-5.51E-02

Source: Author generated.

Table 6.2: Simulation Statistics - Biota Holdings Limited
A Monte Carlo simulation was conducted on the spreadsheets for all six Australian securities. The statistics for the output variables encompassing annual cash flows and NPVs showed that the mean Cash flows became positive in year 4 although options/warrants became positive a year earlier due to their regular cash inflows. The distributions were in the main normal but with some skewness, the largest of which occurred in year 3 when cash flows became positive. The NPVs were negative for all securities.

Outputs	Mean	Mode	Standard Deviation	Skew
Equity				
Cash flow Year 0	23.79	19.51	4.87	-1.91E-02
Cash flow Year 1	-75.81	-96.58	17.16	-0.53
Cash flow Year 2	-61.13	-67.47	23.87	-0.22
Cash flow Year 3	-4.88	4.84	23.14	-1.07
Cash flow Year 4	26.42	18.50	17.84	0.33
Cash flow Year 5	75.97	65.94	34.12	0.74
NPV Beta = 1	-32.70	-76.33	32.51	-6.59E-02
NPV Beta = 1.75	-34.38	-42.46	26.74	-0.11
NPV Opp.Cost	-28.01	-26.24	40.35	-1.18E-02
Options/Warrants				
Cash flow Year 0	-1.25	-1.25	0.00	0.00
Cash flow Year 1	-70.10	-73.24	17.30	-0.52
Cash flow Year 2	-53.65	-96.64	25.09	-0.21
Cash flow Year 3	1.13	7.36	23.89	-1.09
Cash flow Year 4	32.95	51.43	19.31	0.26
Cash flow Year 5	83.60	53.52	36.91	0.77
NPV Beta = 1	-34.16	-50.42	33.97	-4.83E-02
NPV Beta = 1.75	-38.38	-62.78	27.76	-9.51E-02
NPV Opp.Cost	-25.91	-37.08	42.41	7.27E-03
Zero Coupon Bonds				
Cash flow Year 0	8.65	19.94	11.91	-0.99
Cash flow Year 1	-75.26	-86.27	17.18	-0.52
Cash flow Year 2	-58.76	-90.26	25.06	-0.21
Cash flow Year 3	-4.10	2.41	23.96	-1.13
Cash flow Year 4	28.07	19.99	19.65	0.23
Cash flow Year 5	37.52	90.04	37.52	0.72
NPV Beta = 1	-44.43	-71.74	32.81	3.00E-02
NPV Beta = 1.75	-45.55	-49.03	26.85	1.87E-02
NPV Opp.Cost	-40.68	-91.08	41.66	8.94E-02
Convertible Debt				
Cash flow Year 0	24.04	16.29	4.85	-1.80E-02
Cash flow Year 1	-76.81	-93.72	17.31	-1.07
Cash flow Year 2	-60.28	-83.86	24.88	-0.43
Cash flow Year 3	-4.46	2.32	25.53	-2.20
Cash flow Year 4	27.64	14.44	25.28	-0.30
Cash flow Year 5	78.21	18.70	62.11	1.46
NPV Beta = 1	-32.03	-66.53	35.63	0.19
NPV Beta = 1.75	-35.87	-44.67	29.00	0.15
NPV Opp.Cost	-25.30	-55.22	44.45	0.23

(Continued p.91)

Outputs	Mean	Mode	Standard Deviation	Skew
Zero Coupon/ Conv.Inc.Bonds				
Cash flow Year 0	17.94	17.71	3.71	1.63E-02
Cash flow Year 1	-75.10	-48.86	17.22	-0.53
Cash flow Year 2	-59.09	-64.91	24.84	-0.20
Cash flow Year 3	-4.15	10.59	23.88	-1.11
Cash flow Year 4	27.50	17.90	19.36	0.29
Cash flow Year 5	70.22	31.06	37.08	0.76
NPV Beta = 1	-37.67	-26.14	33.84	-1.49E-02
NPV Beta = 1.75	-38.83	-45.46	27.71	-5.89E-02
NPV Opp.Cost	-33.35	-21.41	42.80	4.18E-02
Preferred Stock				
Cash flow Year 0	23.78	18.23	4.86	-2.09E-04
Cash flow Year 1	-38.53	-45.41	8.66	-0.53
Cash flow Year 2	-30.22	-40.84	13.51	-0.22
Cash flow Year 3	-2.75	3.02	14.98	-0.61
Cash flow Year 4	13.19	14.98	19.03	0.16
Cash flow Year 5	38.76	26.85	37.09	0.25
NPV Beta = 1	-34.40	-45.45	26.42	7.78E-03
NPV Beta.75	-37.85	-56.60	22.39	-2.48E-02
NPV Opp.Cost	-28.17	-31.09	31.65	4.49E-02

Source: Author generated.

rising from year 4. This trend occurred for all securities apart from options/warrants whose cash flows became positive a year earlier due to the annual exercise of options.

Normal or very slightly skewed distributions were observed. These were negatively skewed when cash flows were negative and positively skewed when cash flows were positive. Usually when a positively skewed distribution exists it indicates that the expected outcomes are higher than the modal ones and vice versa for negative skews. This also indicates that when naive, as opposed to sophisticated, discounted cash flows are calculated the value of the investment is over-/understated depending on whether the skew was negative/positive. The degree of skew was greatest in year 3 for all securities apart from the fixed interest-type securities in the UK which indicates that the regular interest payments had an effect on the dispersion of cash flows around the mean year 3 cash flow. The reason for this would be due to the larger sum required to service the greater issue of funds in the UK. However, in the main the skew for the NPVs of each security was close to zero.

The standard deviations of the cash flows and NPVs generated from the various inputs reflect the risks associated with the cash flows, ie. they were large when cash flows were negative; small when cash flows became positive and rose as the level of cash flows increased. This trend was due primarily to the inverse relationship between sales and promotion, ie. when sales were low the promotion costs were high and when sales rose, funds spent on promotion fell. However, eventually the level of sales rose to such an extent that the spread between the minimum and maximum level of sales increased causing the standard deviations to rise.

The standard deviations in year 1 were slightly lower than year 0 for the UK discounted securities (ie. zero coupon bonds and zero coupon/convertible income bonds) whereas they rose for those issued in Australia. As discussed previously, this could be due to the higher interest rate used for discounting the issue and also to the larger amount of securities issued. In addition, the standard deviations for the fixed interest securities (ie. convertible debt and preferred stock) rose in year 3 in contrast to the other securities which reflects the impact of the financing requirements of these securities on the company's cash flows.

The size of the issue and discount rate caused negative mean (ie. expected) NPVs to occur for all Australian securities, whereas in the UK, equity-type securities were positive with straight equity benefitting the most due to the initial year 0 float. Options/warrants had positive mean cash flows each year arising from their annual

exercise whereas convertible debt's positive NPVs reflected the reduction in interest payments from year 4 and the low repayment of debt at maturity. The zero coupon bonds and zero coupon/convertible income bonds for each country required repayment of the security at the end of year 5 which affected the cash flows for year 5 and caused large negative NPVs to occur.

Hence, the examination of the outputs showed that the mean cash flows became positive in year 4 although for options/warrants they became positive a year earlier due to their regular cash inflows. The distributions of the outputs were in the main normal but with some skewness. The securities' mean NPVs were negative for all securities apart from the UK equity-related ones, although due to the presence of some negative modes there was a probability that these NPVs could become negative.

6.2.2 Sensitivity Analysis

Sensitivity analysis was performed for each annual cash flow and NPV in order to identify those inputs which had a significant impact on them. Graphs were created by running a multiple regression for each output or NPV (the dependent variable) against the input values (the independent variables) ie. Sales, Competitors, Gross Profit, etc., for each iteration. The @Risk package then graphed the regression (beta) coefficients showing the effect of each independent variable on the output. The correlations between the input and output values were very high (R^2 was between 0.89 and 1.00) indicating that a strong linear relationship existed between these two values. Tables 6.3 and 6.4 detail the normalised regression coefficients for each input for all securities.

The independent variable, or beta coefficient, shows the number of standard deviations the dependent variable will need to increase if the independent variable rises by one standard deviation (providing the other independent variables do not change)[26]. For example, consider the Equity Promotion Expenses in Table 6.4: the figure shows that if Promotion Expenses were to increase one standard deviation then the cash flow for year 1 would decrease 0.92 standard deviations. Conversely, if Gross Profit were to rise one standard deviation then the cash flow for year 1 would increase by 0.37 standard deviations.

[26] Winston, W L, *Simulation Modeling Using @RISK* , 1996, New York: Duxbury Press.

Table 6.3: Sensitivity of Inputs to Outputs - British Biotechnology plc
Sensitivity analysis was performed for each output in order to determine the impact of each input on a set output variable. The results showed that apart from the Issue of the security, the most significant inputs were Promotion Expenses, Gross Profits and Sales. There is a shift in dominance from Promotion Expenses to Gross Profits in year 3 and an increase in importance of Sales from year 4. Year 5 Gross Profits was optimal followed by year 2 Promotion Expenses for all NPVs but convertible debt.

Outputs	Inputs[27]				
	Issue	Sales	Gross Profit	Promotion Expenses	R&D Expenses
Equity					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.26	0.37	-0.92	
Cash flow Year 2			0.79	-0.98	-0.13
Cash flow Year 3			0.80	-0.84	-0.13
Cash flow Year 4		0.25	1.13	-0.63	
Cash flow Year 5		0.40	1.22	-0.45	
NPV Beta = 1			0.60(5)	-0.47(2)	
NPV Beta = 1.75			0.59(5)	-0.47(2)	
NPV Opp.Cost			0.60(5)	-0.47(2)	
Options/Warrants					
Cash flow Year 0	0.00				
Cash flow Year 1		-0.26	0.39	-0.91	
Cash flow Year 2	0.13		0.81	-0.92	
Cash flow Year 3	0.15		0.81	-0.80	
Cash flow Year 4		0.23	1.09	-0.56	
Cash flow Year 5		0.37	1.20	-0.42	
NPV Beta = 1			0.65(5)	-0.48(2)	
NPV Beta = 1.75			0.65(5)	-0.48(2)	
NPV Opp.Cost			0.66(5)	-0.48(2)	
Zero Coupon Bonds					
Cash flow Year 0	0.83		-0.43(3)	0.44(3)	
Cash flow Year 1		-0.26	0.40	-0.92	
Cash flow Year 2			0.82	-0.94	-0.13
Cash flow Year 3			0.83	-0.81	-0.12
Cash flow Year 4		0.23	1.10	-0.57	
Cash flow Year 5		0.38	1.18	-0.42	
NPV Beta = 1			0.66(5)	-0.46(2)	
NPV Beta = 1.75			0.65(5)	-0.46(2)	
NPV Opp.Cost			0.66(5)	-0.46(2)	

(Continued p. 95)

[27] Number in brackets refers to the year in which the significant input occurred.

Outputs	Inputs				
	Issue	Sales	Gross Profit	Promotion Expenses	R&D Expenses
Convertible Debt					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.26	0.39	-0.92	
Cash flow Year 2			0.81	-0.93	-0.12
Cash flow Year 3			0.80	-0.79	-0.11
Cash flow Year 4		0.19	0.92	-0.46	
Cash flow Year 5		0.11	0.96	-0.34	
NPV Beta = 1	0.39(0)		0.46(4.5)		
NPV Beta = 1.75	0.39(0)		0.46(4.5)		
NPV Opp.Cost	0.38(0)		0.46(4.5)		
Zero Coupon/Conv. Income Bonds					
Cash flow Year 0	0.85		-0.40(3)	0.40(3)	
Cash flow Year 1		-0.26	0.40	-0.92	
Cash flow Year 2			0.81	-0.94	-0.12
Cash flow Year 3			0.83	-0.80	-0.12
Cash flow Year 4		0.24	1.10	-0.56	
Cash flow Year 5		0.39	1.15	-0.42	
NPV Beta = 1			0.65(5)	-0.47(2)	
NPV Beta = 1.75			0.65(5)	-0.47(2)	
NPV Opp.Cost			0.65(5)	-0.47(2)	
Preferred Stock					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.26	0.40	-0.92	
Cash flow Year 2			0.82	-0.93	-0.12
Cash flow Year 3			0.80	-0.84	-0.13
Cash flow Year 4		0.19	0.90	-0.45	
Cash flow Year 5		0.30	0.96	-0.34	
NPV Beta = 1			0.46(5)	-0.33(2)	
NPV Beta = 1.75			0.46(5)	-0.33(2)	
NPV Opp.Cost			0.47(5)	-0.33(2)	

Source: Author generated.

Table 6.4: Sensitivity of Inputs to Outputs - Biota Holdings Limited
Sensitivity analysis was performed for each output in order to determine the impact of each input on a set output variable. The results showed that apart from the Issue of the security, the most significant inputs were Promotion Expenses, Gross Profits and Sales. There is a shift in dominance from Promotion Expenses to Gross Profits in year 3 and an increase in importance of Sales from year 4. Year 5 Gross Profits was optimal followed by year 2 Promotion Expenses for all NPVs but convertible debt.

Outputs	Inputs[28]				
	Issue	Sales	Gross Profit	Promotion Expenses	R&D Expenses
Equity					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.25	0.38	-0.92	
Cash flow Year 2			0.74	-0.92	-0.12
Cash flow Year 3			0.80	-0.74	-0.12
Cash flow Year 4		0.32	1.25	-0.71	
Cash flow Year 5		0.41	1.22	-0.46	
NPV Beta = 1			0.65(5)	-0.47(2)	
NPV Beta = 1.75			0.56(5)	-0.49(2)	
NPV Opp.Cost			0.70(5)	-0.44(2)	
Options/Warrants					
Cash flow Year 0	0.00				
Cash flow Year 1		-0.24	0.39	-0.92	
Cash flow Year 2			0.78	-0.89	-0.12
Cash flow Year 3			0.77	-0.78	-0.12
Cash flow Year 4		0.30	1.23	-0.65	
Cash flow Year 5		0.38	1.21	-0.43	
NPV Beta = 1			0.64(5)	-0.46(2)	
NPV Beta = 1.75			0.58(5)	-0.48(2)	
NPV Opp.Cost			0.71(5)	-0.43(2)	
Zero Coupon Bonds					
Cash flow Year 0	0.34		-0.67(3)	0.71(3)	
Cash flow Year 1		-0.24	0.40	-0.92	
Cash flow Year 2			0.77	-0.89	-0.12
Cash flow Year 3			0.77	-0.77	-0.11
Cash flow Year 4		0.30	1.22	-0.65	
Cash flow Year 5		0.37	1.21	-0.42	
NPV Beta = 1			0.67(5)	-0.47(2)	
NPV Beta = 1.75			0.61(5)	-0.49(2)	
NPV Opp.Cost			0.74(5)	-0.44(2)	

(Continued p. 97)

[28] Number in brackets refers to the year in which the significant input occurred.

Outputs	Inputs				
	Issue	Sales	Gross Profit	Promotion Expenses	R&D Expenses
Convertible Debt					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.24	0.40	-0.92	
Cash flow Year 2			0.78	-0.89	-0.12
Cash flow Year 3			0.69	-0.69	-0.11
Cash flow Year 4		0.13	0.11	-0.19	
Cash flow Year 5		0.38	1.22	-0.43	
NPV Beta = 1			0.80(4.5)		
NPV Beta = 1.75			0.75(4.5)		
NPV Opp.Cost			0.85(4.5)		
Zero Coupon/Conv. Income Bonds					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.24	0.39	-0.92	
Cash flow Year 2			0.78	-0.90	-0.12
Cash flow Year 3			0.76	-0.77	-0.12
Cash flow Year 4		0.29	1.22	-0.65	
Cash flow Year 5		0.38	1.21	-0.43	
NPV Beta = 1			0.64(5)	-0.46(2)	
NPV Beta = 1.75			0.58(5)	-0.48(2)	
NPV Opp.Cost			0.71(5)	-0.43(2)	
Preferred Stock					
Cash flow Year 0	1.00				
Cash flow Year 1		-0.24	0.40	-0.92	
Cash flow Year 2			0.78	-0.88	-0.11
Cash flow Year 3			0.69	-0.75	-0.11
Cash flow Year 4		0.23	0.98	-0.52	
Cash flow Year 5		0.31	0.97	-0.34	
NPV Beta = 1			0.45(5)	-0.31(2)	
NPV Beta = 1.75			0.39(5)	-0.32(2)	
NPV Opp.Cost			0.51(5)	-0.30(2)	

Source: Author generated.

The trends are the same for all securities regardless of country of issue. In year 0 the issue of securities was significant for all securities apart from options/warrants which had a small cash outflow in year 0[29], and three of the four discounted securities which were affected negatively by the level of Promotion Expenses and Gross Profit in year 3.

When Promotion Expenses were high the impact on the cash flows from years 1 to 3 was very significant but from year 4 Gross Profit became the dominant input. Sales had a negative relationship with cash flows in year 1 and from year 4 they became positive and rising. R&D Expenses had a small effect on company cash flows in years 2 and 3 only for all securities apart from the UK options/warrants indicating that the exercise of options in these years had some significance. Australian options/warrants did not report any sensitivity due to the small amount of funds raised from the exercise of the security.

While UK Gross Profit correlation coefficients were rising annually, this situation was not occurring for those Australian securities which did not require fixed servicing costs. In year 5 the Gross Profit for these securities had started to decline and from this point on the level of Sales became the input with the greatest effect on cash flows.

The tables also show the two main inputs that affect the two NPV and Opportunity Cost outputs - in each case the correlation with year 5 Gross Profits predominated while year 2 Promotion Expenses was of less significance. The figures show that for those securities which required an annual financing charge the percentage variation that could be explained by the linear relationship was lower than for the other securities.

The results show that apart from options/warrants the issue of all other securities was found to be important. The issue of three of the four discounted securities[30] was affected in year 0 by the Gross Profit and Promotion Expenses occurring in year 3. In addition, the issue of UK convertible debt was the only security to have a significant impact on its NPVs.

The repayment of a security had a minor impact on the outputs in year 5 for the discounted securities which indicates that by the time the debt was required to be

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[29] Due to the small cash outflow the data were insufficient to graph.
[30] Note that Australian zero coupon/convertible income bonds were not affected in year 0.

paid the level of Sales and hence Gross Profits was sufficient to enable the repayment to be made with little effect on the annual cash flows.

Because of the possible reduction of sales by up to 57.8 percent if competitors succeeded in launching generic products it was interesting to find how little effect competition had on the company's cash flows (see Table 6.5). The table shows that the level of importance was in fact minimal and also that equity was not affected at any time. In addition, competition had no effect on the Australian zero coupon bonds cash flows or those of British preferred stocks.

Apart from the Issue of the security, the most significant inputs were Promotion Expenses, Gross Profits and Sales. The trends are similar for all securities and show the shift in dominance from Promotion Expenses to Gross Profits by year 3 and an increase in significance occurring in Sales from year 4. As far as the NPVs for each security were concerned, year 5 Gross Profits were the most important variable, followed by year 2 Promotion Expenses for all but convertible debt.

Due to the significance of Gross Profit and Promotion Expenses on company NPVs these two inputs were incorporated into the decision tree model firstly on an individual basis and then together so that their impact on the securities each year could be assessed. The objective of this was to move from a passive model whereby decisions were made at the outset, based on information generated by the simulation, to an active model which permitted funding decisions to be made each year. The development of this model is discussed in Chapter 7.

Table 6.5: Significance of Competition
In spite of the possible reduction of sales by up to 57.8 percent from competitors launching generic products the table shows that in fact there was little impact on security Cash flows from Competition.

Security	Year of Cash flow	Company	Year of Relevant Competition	Level of Significance
Options/Warrants	3	Biota Holdings	5	0.006
	4	British Biotech.	4	-0.003
Zero Coupon Bonds	3	British Biotech.	4	0.007
Convertible Debt	3	British Biotech.	2	-0.002
	4	Biota Holdings	4	0.012
	4	British Biotech.	2	-0.001
Zero Coupon/Conv. Income Bonds	3	Biota Holdings	4	0.007
	4	British Biotech.	5	0.002
Preferred Stock	3	Biota Holdings	4	-0.005
	4	Biota Holdings	4	-0.001

Source: Author generated.

Chapter 7: SECURITY ANALYSIS: A DECISION TREE APPROACH

7.0 INTRODUCTION

This chapter will conclude the research initiated in Chapters 5 and 6. A base model was developed in Chapter 5 which portrayed the cash flows of a biotechnology company following the launch of its first product. Three risk adjusted discount rates were used to calculate the company's NPV so that the security that was the most cost-effective for the company in a static state could be determined. In each case Equity (Australia) and Convertible Debt (UK) were the securities found to be the most cost-effective for the company to issue. In the second part of the study, simulations were performed on the base models in order to find those variables that had the greatest effect on each security's cash flows and NPVs. The use of these variables, ie. Gross Profit and Promotion Expenses, in this part of the study is explained below.

The final section of the research used a decision tree approach in order to determine which of the six securities was the most appropriate for an emerging biotechnology company to use as it moved from being a research-only company to one with a product to market. Two decision trees were developed for each company. The first model used the most significant input each year whereas the second model incorporated the two most significant inputs into it. The decision tree was then simulated in order to determine which security was the most cost-effective for the company during its first five years of having a marketable product.

The chapter commences by describing the construction and use of decision trees before detailing the advantages and disadvantages associated with the model. Finally the models used in this study are described and the results emanating from them are discussed.

7.1 DECISION TREES

Since 1983 decision trees have been found to be particularly useful when evaluating the ongoing risks associated with a wide range of medical problems. The method forced decision-makers to make a statement of relevant variables which would have an impact on the outcome. Decision trees are, in effect, a convenient means of

modelling the uncertainties associated with a medical problem[1], particularly if there are certain events which may occur more than once. Therefore, when considering the range of strategies which could be followed, an expected utility for each branch of the decision tree can be calculated according to the probability that an event may occur. In this way an optimal strategy may be found for the problem being investigated[2].

In order to assist with the analysis of decision trees a number of computer packages have been developed to test the various assumptions relating to decisions concerning the management and treatment of patients. Some of these packages, such as Expert Choice 8.0[3], Decision Maker 6.0[4], Smltree V2.9[5], DATA™ 3.0[6], also permit simulations of key inputs to be undertaken in order to determine an optimal solution to a problem.

Although a number of articles reported research undertaken in the biotechnology, pharmaceutical and medical areas using decision trees, sensitivity analysis and Monte Carlo simulation, no evidence was found of any research applying these techniques to securities.

Decision trees permit strategies to be depicted for different courses of action. Each course of action depends on the events in the preceding period. That is, if a certain situation occurs then one path should be followed, if another situation occurs then a different path should be undertaken. Each strategy is conditional upon a certain event occurring and, depending on the outcome, one of a number of courses of action can be selected. Each variable under consideration has its own probability distribution which is relevant to the situation for that particular period. Hence, it shows clearly all elements of the project being considered by portraying its interactions sequentially over the period under consideration in the order selected by the decision maker and therefore encompasses the known uncertain parameters.

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[1] Sonnenberg, F and Beck, J R, "Markov Models in Medical Decision Making", *Medical Decision Making*, 1993, **13**, pp 322-338.
[2] DeKay, M L and Asch, D A, "Is the Defensive Use of Diagnostic Tests Good for Patients, or Bad?", *Medical Decision Making*, 1998, **18,** pp 19-28.
[3] Dolan, J G and Bordley, D R, "Isoniazid Prophylaxis: The Importance of Individual Values", *Medical Decision Making*, 1994, **14,** pp 1-8.
[4] Ritchey, N P, Caccamo, L P, Carter, K J, Castro, F, Erickson, B A, Johnson, W, Kessler, E and Ruiz, C A, "Optimal Interval for Triple-lumen Catheter Changes: A Decision Analysis", *Med. Decis. Making*, 1995, **15,** pp.138-142.
[5] Freedberg, K A, Hardy, W D, Holzman, R S, Tosteson, A N A and Craven, D E, "Validating Literature-based Models with Direct Clinical Trial Results: The Cost-Effectiveness of Secondary Prophylaxis for PCP in AIDS Patients", *Medical Decision Making*, 1996, **16,** pp 29-35.
[6] Hood, S C, Annemas, L and Rutten-van Molken, M, "A Short Term Cost-Effectiveness Model for Oral Antidiabetic Medicines in Europe", *Pharmacoeconoics*, March 1998, **13**(3), pp 317-326.

Basically, decision trees are a method of displaying the

> "anatomy of a business investment decision and of showing the interplay among a present decision, chance events, competitors' moves and possible future decisions and their consequences" (p. 79)[7].

In addition, the

> "use of the Decision Tree concept as a basis for investment analysis evaluation and decision is a means for making explicit the process which must be at least intuitively present in good investment decision making" (p. 96)[8].

The decision trees can be complex or merely a simple choice between alternatives so that alternative cash flows can be analysed. More complex situations require additional stages and alternatives in order to reflect the complexity of the model and may include additional branches in order to depict all scenarios. Conversely, decision trees can be consolidated so that one branch replaces two or more branches previously in existence making the model more simple, concise and easier to understand and test[9].

The procedure required to develop a decision tree is to a) identify the problem and its decision alternatives; b) identify the relevant outcomes associated with each alternative; c) obtain the required data and build the model; and d) evaluate each alternative course of action[10]. Each of these steps will now be considered in more detail.

7.1.1 Development of a Decision Tree

The first step in this process is to select the planning period, ie. the present to the end of the investment project/s' economic life. After this, a number of decision variables are determined, some of which are inputs under the control of the decision maker and therefore should assist them to make the optimal decision. An example is whether the company undertakes the project alone or with a partner. More difficult to quantify are those parameters beyond the control of the decision maker and which exist in the external environment. Examples of these are forecast cash flows for the project,

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[7] Magee, J F, "How to Use Decision Trees in Capital Investment", *Harvard Business Review*, September-October 1964, **42**, pp 79-96.
[8] ibid.
[9] Kung, D C, "On Decision Tree Verification and Consolidation", *Information & Software Technology*, August 1994, **36**(8), pp 485-494.
[10] Hax, A C and Wiig, K M, "The Use of Decision Analysis in Capital Investment Problems", *Sloan Management Review*, Winter 1976, pp 19-48.

capital expenditure requirements, production projections, associated fixed costs and the project's cost of capital.

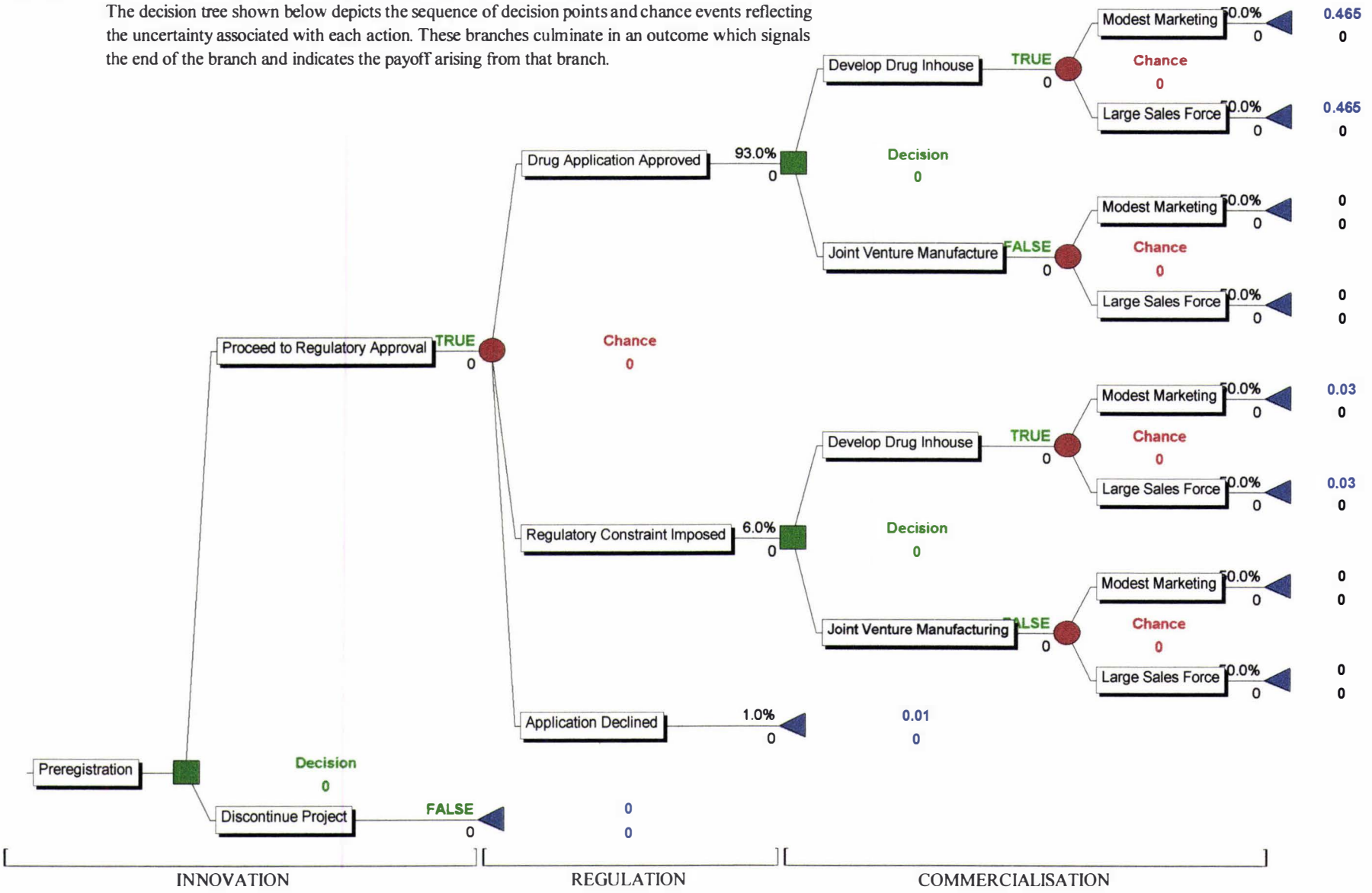
When developing a decision tree model Hax and Wiig (1975)[11] recommend classifying the parameters mentioned above into two groups in order to account for the different effects that each may have on the model. The first group are those that may be treated as if they were deterministic parameters, since they cover those uncertainties that can be ignored without over-simplifying the analysis of the project. These parameters have a low variability and hence the change in value is not large. The second group are uncertain parameters which are critical to the model and have recognised uncertainties which require attention in order to ensure that the correct decisions are made. Due to the importance of classifying the parameters correctly, there are two methods which can be used to do this. In some situations the decision maker will be able to use subjective classification to separate the parameters into the two groups intuitively, or subjectively, based on previous experience or marketing and feasibility studies. If this cannot be done because the problem is too complex then sensitivity analysis of the forecast cash flows developed at this point will be required.

Once the uncertain parameters have been defined the decision tree can be constructed. This will assist the decision maker to see graphically how the decision variables interact with the defined uncertainties. The decision tree portrays these interactions sequentially over the planning horizon in the order selected by the decision maker. The model moves from one decision point to the next and the path to each decision point is affected by previous decisions and the results emanating from them. Hence, the diagram shown in Figure 7.1 illustrates a sequence of decision points (o) with chance events (❑) reflecting the uncertainty associated with each action branching from them culminating in an outcome (◁) which signals the end of the branch and indicates the payoff arising from that branch. The chance event nodes indicate the level of expected outcome, such as demand for the product, being achieved. Therefore, there is a probability associated with each node, with the total of all probabilities emanating from the node equalling one[12].

[11] Hax, A C and Wiig, K M (1976), op cit.
[12] Hespos, R F and Strassmann, P A, "Stochastic Decision Trees for the Analysis of Investment Decisions", *Management Science*, 1965, **11**(10), pp B-244-B-259.

Figure 7.1: Decision Tree Depicting the Stages of a Drug moving from Preregistration to Commercialisation

The decision tree shown below depicts the sequence of decision points and chance events reflecting the uncertainty associated with each action. These branches culminate in an outcome which signals the end of the branch and indicates the payoff arising from that branch.



At this point, possible outcomes of the uncertain parameters can be assessed using probability distributions. If the parameters are independent of one another then each probability distribution can be determined individually. However, if the parameter is dependent on another then conditional and marginal probability distributions may be required which can make the estimation of probabilities complex.

There are two ways of approaching the measurement of these probability distributions; firstly, the classical (ie. clinical) approach which "equates the probability of a given outcome of an uncertain event with the relative frequency of occurrence of that event after a large number of independent trials" (p. 32)[13]. For example, in order to bring a drug to the preregistration stage a large number of tests must be conducted on the product in the expectation that a particular result, A, will result. This is represented as P(A) and indicates the proportion of the time that event A will occur, or

$$P(A) = \frac{n_A}{N} \qquad (7.1)$$

Where: n_A = number of experiments resulting in A

N = total number of times an experiment is repeated

The result of the test, ie. event A, will fall between $0 \leq P(A) \leq 1$.

Some events may be mutually exclusive so that only one event can occur. For example, the Regulatory Authority may decline the drug application so that the event A will not occur because event B has occurred. In this case

$$P(\text{either A or B}) = P(A) + P(B) \qquad (7.2)$$

Conversely, the Regulatory Authorities may impose a constraint on the drug which means that event A, approval without any constraint, will not occur, is given by

$$P(\tilde{A}) = 1 - P(A) \qquad (7.3)$$

Where: $\tilde{A}$ means not A

For example, in Figure 7.1 there is a 0.93 probability that the drug will be approved without any amendments but there is also a 0.07 probability that it will fail to obtain approval or will require some constraint.

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[13] Op. cit.

If there is the probability that event A and B will both occur then P(AB) will be the same as P(BA). However, Figure 7.1 shows that if some minor modifications were required to the drug before approval could be given, then event A could occur if the modification for event B was completed. On the other hand, if event B cannot be modified satisfactorily then event A will not eventuate, ie.

$$P(A|B) \neq P(B|A) \qquad (7.4)$$

In other words events A and B are not independent of each other.

This approach can be used when access to past information or data is available or a sample can be collected of data similar to the scenario being modelled. However, due to the uniqueness of most investment projects a Bayesian (subjective) approach which "considers the probabilities [which] reflect the state of mind or current knowledge of the decision maker regarding the outcome of an uncertain event" (p. 32)[14] can be used.

Once the decision tree has been constructed incorporating the uncertainties associated with the project the calculation of each alternative course of action can be undertaken and the impact of the project on the firm measured using either NPV or ROI[15]. Essentially there are two methods which can be used to perform the calculations for the model, ie. the backward induction process or, the method used in this study, ie. Monte Carlo simulation. The first calculates the terminal values from the righthand side of the model to the lefthand side. In other words it rolls back the calculations from the last period (ie. decision) to the next to last period (ie. decision), etc. calculating the expected value of each outcome originating from the chance event node and choosing the alternative which leads to the highest expected value, or certainty equivalent, at the decision node. The second method is used when the decision tree has become too large or complex to calculate using backward induction.

7.1.2 Advantages and Disadvantages of Decision Trees

The main advantage of the decision tree model is its ability to depict strategies associated with projects over a set period of time where some actions are conditioned on outcomes of random variables in earlier periods. This forces decision makers to consider current and future scenarios associated with new projects or products. The

[14] Ibid.

model also permits full analysis of possible future events and decisions and the impact of these decisions on the company to be assessed[16].

Kung (1994)[17] reported that decision trees could be used to portray the conditional logic of a software system. The desirable features of the model in this context were that a) each combination of conditions led to one particular action sequence; b) normal actions were derived from only combinations of a specific condition that were significant; c) if all combinations of conditions were covered then the model was complete; and d) nonredundancy was present to ensure that only a minimal number of branches was used.

The most significant disadvantage of the model is that it can become cumbersome and complex to such an extent that refinement becomes necessary. In addition, only the high/low aspects of decisions are usually incorporated, the mid-point is not considered and only some, not all, of the future events and decisions will be included. Finally, the model assumes a single discount rate and not one that reflects all variations of the risks associated with the project[18].

7.1.3 Decision Tree Models

The final stage of this research incorporated two decision tree models which were developed to show which security provided the company with the best - and most cost-effective - source of funds. The decision tree, as shown in Appendix 8, used the annual cash flows for each security emanating from the model discussed in Chapter 5 and also incorporated the most significant inputs (ie. Gross Profit and Promotion Expenses) obtained from the Monte Carlo simulations undertaken in Chapter 6. Therefore, the fundamental part of developing the decision tree model was to use the forecast cash flows associated with the project so that the annual cash flows after tax were known for the entire planning period. The equation which depicts the relationships that exist between the decision variables and the parameters of the model on an annual basis is shown below:

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[15] ROI refers to the rate of return on an investment. It is also known as the internal rate of return or the project's actual yield.

[16] Brealey, R A and Myers, S C, *Principles of Corporate Finance*, 5th Ed., New York: McGraw-Hill, Inc., 1996.

[17] Kung, D C, 1994, op. cit.

[18] Brealey, R A and Myers, S C, 1996, op. cit.

(Net Cash Flow After Tax) = (Revenue) - (Capital Investment or Capital Charges) - (Operating and Financing Costs) - (Tax) (7.5)[19]

The decision tree was developed so that sequential decision-making could occur at the end of each year. That is, at each decision node a decision to retain or change the method of financing the company's operations could be made. In order to do this, a computer package, called Precision Tree[20], was used in conjunction with the @Risk package, used in Chapter 6, to perform a Monte Carlo simulation on the decision tree. Inputs (ie. Gross Profit and Promotion Expenses) were incorporated into the annual cash flows.

The model was developed so that when each iteration occurred, one of the branches would indicate it was optimal, ie. one of the decision nodes would indicate "TRUE" showing that this security had been selected. Selection would only occur if the value of that branch was greater than those of the other branches. In order to determine the security that received the most "TRUE" signals during a simulation, a formula was developed to aggregate these signals[21]. This process was undertaken for the full five year period and also for years 1 through 4 so that a picture of the most applicable security could be obtained. Hence by developing the model in this way chance nodes were not required because randomness was incorporated into the decision nodes each time an iteration occurred[22].

The simulation was conducted by performing 5000 iterations on the decision tree. The number of iterations differed from the 10,000 chosen for the Monte Carlo simulations performed in Chapter 6 where convergence was important. However, in this segment of the research it was the number of "TRUE" signals being generated by the securities and not convergence that was being investigated.

The first model which was developed simulated the input found to be the most significant variable each year, ie. Promotion Expenses from years 1 to 3 and Gross Profit for years 4 and 5, in order to assess its impact on the securities being analysed. The second model incorporated the two inputs mentioned above for all five years being considered.

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[19] Ibid., p. 25.

[20] Precision Tree is a decision analysis program developed by Palisade Corporation, New York as an add-in for Microsoft® Excel.

[21] The formula took the form of an 'IF' statement which summed the values depending on what the decision outcome for the security was.

[22] Hespos, R F and Strassmann, P A, 1965, op. cit.

The results of the simulation of the decision tree models can be found in Tables 7.1 to 7.4. The Tables show the number of times a security received a "TRUE" signal during the simulations and their ranking according to the number of signals generated. The means and standard deviations for each security have been included in the brackets beneath this number. The means indicate that the results were slightly skewed whereas the standard deviations are representative of the number of signals each security received.

Tables 7.1 and 7.3 record the details of the simulations performed using either Promotion Expense or Gross Profit as the input. Table 7.1 shows that in year 3 equity and preferred shares did not trigger a "TRUE" signal. The reason for this was because these securities had Promotion Expenses as their significant input whereas the input for the other securities had changed to Gross Profit. This change meant that the securities using Gross Profit as their input would have their cash flows enhanced because the input being simulated was income related and not expense-related. As a result, the equity and preferred stock's cash flows were affected detrimentally compared to the other four securities. In Table 7.3 equity was the only security to change from Promotion Expenses to Gross Profit and as a result was the only security to record "TRUE" signals.

It can be seen from Figures 7.2 to 7.5 that some of securities show that the number of "TRUE" signals each year were increasing compared with the declining trend associated with options/warrants. This indicates a mean reverting trend and that an alternative security, such as convertible debt or preferred stock, may be more appropriate to use at some time in the future.

Although there are some deviations over the five year period a trend was observed from Figures 7.6 to 7.9. For example, in year 5 options/warrants was the optimal security[23] followed by equity in each case. However, in years 1 through 4 those securities requiring interest payments (or dividends in the case of preferred stock) were ranked very high due to the negative effect these payments had on cash flows. The two zero coupon securities received lower rankings due to their more favourable cash flows but were affected detrimentally in year 5 when principal was repaid.

[23] This was determined by ranking the securities from 1 to 6 depending on the number of "TRUE" signals each received. The security receiving the highest number of signals was allocated 1, the next highest 2 etc.

Table 7.1: BBL Security Optimality (1 variable)

The table depicts the number of times each year that a security triggered a "TRUE" signal when 5000 iterations were run. The results show that options had the highest number of signals each year although this dominance was declining with equity, followed by convertible debt and preferred stock rising. The 0 ratings for equity and preferred stock occurred because the other securities had changed their significant inut to Gross Profit thereby increasing this figure rather than an expense item which had an adverse effect on the cash flows.

Security	Year 1	Year 2	Year 3	Year 4	Year 5
Equity	384 (198.5)[24](109.1)[25]	269 (138.3)(79.4)	0 (0)(0)	699 (348.9)(202.2)	1011 (511.3)(297.1)
Options/Warrants	3644 (1819.6)(1062.8)	4164 (2085.4)(1200.5)	2988 (1495.9)(866.2)	1847 (928.3)(529.7)	1797 (896.0)(520.7)
Zero Coupon Bonds	378 (186.2)(107.97)	267 (125.8)(78.5)	723 (364.3)(209.6)	747 (374.5)(216.4)	310 (151.2)(90.1)
Convertible Debt	66 (34.7)(17.6)	21 (11.3)(6.8)	576 (280.9)(161.5)	579 (286.4)(167.1)	861 (438.7)(245.8)
Zero Coupon/Conv. Income Bonds	335 (168.8)(95.1)	276 (139.0)(76.9)	715 (361.3)(206.4)	720 (359.1)(206.0)	282 (137.7)(81.3)
Preferred Stock	23 (13.5)(7.2)	4 (1.7)(1.6)	0 (0)(0)	411 (206.1)(122.2)	740 (366.5)(208.7)

[24] The figures in the first bracket represent the mean value for the security's distribution.

[25] The figures in the second bracket represent the standard deviation of the mean.

Table 7.2: BBL Security Optimality (2 variables)

The table shows the number of times a security triggered a "TRUE" signal each year when 5000 iterations were conducted on the decision tree model. Options were the optimal security each year with equity ranked second in years 2, 3 and 5. Fixed interest securities received the lowest number of signals each year until year 5 when the number of their signals rose compared to the zero coupon securities which were affected at this time by the repayment of these bonds.

Security	Year 1	Year 2	Year 3	Year 4	Year 5
Equity	413 (203.4)[26](120.9)[27]	515 (256.7)(146.4)	624 (320.3)(179.2)	709 (347.0)(200.1)	1048 (544.4)(300.5)
Options/Warrants	3612 (1808.5)(1044.4)	3195 (1591.9)(927.4)	2444 (1226.4)(708.5)	1869 (942.9)(535.1)	1780 (878.3)(520.0)
Zero Coupon Bonds	423 (204.2)(118.6)	479 (237.6)137.3)	610 (303.0)(170.9)	704 (356.9)(203.4)	317 (155.4)(87.5)
Convertible Debt	102 (50.9)(30.5)	188 (96.8)(53.6)	476 (241.4)(139.7)	609 (295.8)(182.0)	824 (408.0)(237.3)
Zero Coupon/Conv. Income Bonds	387 (199.3)(108.4)	484 (246.8)(139.4)	601 (287.4)(172.9)	720 (359.9)(209.6)	266 (136.0)(76.4)
Preferred Stock	56 (31.8)(18.4)	140 (71.7)(39.7)	246 (123.0)(72.7)	390 (199.0)(113.7)	766 (379.4)(222.4)

[26] The figure in the first bracket for each security represents the mean value of the distribution.

[27] The figure in the second bracket for each security represents the standard deviation of the mean.

Table 7.3: Biota Holdings Limited Security Optimality (1 variable)
The table shows that options received the highest number of "TRUE" signals during the simulation each year apart from year 3 when equity was the only security to trigger the signal. The reason for this was due to equity being the only security to change to the Gross Profit input from Promotion Expenses. This had the effect of increasing the level of the end of year cash flows whereas the other securities were affected by an increased expenditure which lowered end of year cash flows. The signals for options was declining by year 5 whereas the number of signals for equity (in particular) and preferred stock signals were rising.

Security	Year 1	Year 2	Year 3	Year 4	Year 5
Equity	503 (406.1)[28](231.0)[29]	738 (361.2)(211.2)	5000	922 (474.4)(268.9)	957 (494.5)(276.4)
Options/Warrants	1592 (808.3)(456.9)	1820 (901.8)(526.1)		1291 (643.1)(370.5)	1097 (552.5)(312.9)
Zero Coupon Bonds	776 (382.5)(227.8)	710 (354.9)(210.4)		939 (465.7)(273.6)	650 (324.9)(188.8)
Convertible Debt	545 (264.3)(153.0)	491 (246.4)(137.2)		0	855 (428.6)(244.7)
Zero Coupon/Conv. Income Bonds	730 (364.8)(211.5)	748 (380.0)(214.6)		995 (495.1)(279.9)	587 (291.9)(172.9)
Preferred Stock	555 (275.5)(163.9)	486 (253.7)(141.6)		854 (423.2)(251.2)	855 (409.2)(248.4)

[28] The figure in the first bracket for each security represents the mean value for the distribution.
[29] The figure in the second bracket for each security represents the standard deviation of the mean.

Table 7.4: Biota Holdings Limited Security Optimality (2 variables)
The table shows that options received the highest number of "TRUE" signals during the simulation each year although the number of signals was declining. In contrast the number of "TRUE" signals for equity, convertible debt and preferred stock was rising. The other two securities experienced a decline in year 5 due to the requirement to repay principal at this time.

Security	Year 1	Year 2	Year 3	Year 4	Year 5
Equity	756 (385.0)[30](212.4)[31]	726 (364.8)(204.7)	801 (407.5)(230.2)	833 (424.0)(239.7)	956 (485.6)(281.7)
Options/Warrants	1660 (821.5)(482.9)	1411 (697.6)(413.0)	1222 (595.3)(351.4)	1073 (530.2)(309.4)	1096 (555.6)(313.6)
Zero Coupon Bonds	753 (372.1)(220.2)	829 (417.1)(237.1)	761 (377.5)(222.3)	785 (403.1)(227.7)	675 (339.8)(195.4)
Convertible Debt	560 (275.9)(159.3)	663 (349.2)(191.7)	726 (359.9)(209.7)	793 (401.1)(227.6)	861 (427.1)(246.6)
Zero Coupon/Conv. Income Bonds	750 (387.0)(218.4)	767 (375.5)(219.3)	807 (413.7)(232.1)	845 (412.0)(245.2)	564 (277.6)(159.3)
Preferred Stock	522 (260.0)(150.8)	605 (297.3)(178.3)	684 (347.6)(198.1)	672 (331.1)(194.3)	849 (415.8)(247.3)

[30] The figure in the first bracket for each security represents the mean value for the distribution.
[31] The figure in the second bracket for each security represents the standard deviation of the mean.

These results show firstly that the funding and financing cash flows associated with securities have a significant effect on the decision concerning the type of security an emerging biotechnology company should use in its first few years of marketing its initial drug. These cash flows are further affected by the Promotion Expenses required to market a new product and the level of Gross Profit generated by the company. Secondly, the type of financing used by these companies to fund their operations prior to the launch of their first product, ie. options and equity, are still the appropriate source of funds to meet their goal of maximising shareholders' wealth in the first five years after market launch.

The results of the three stages of security analysis will be brought together and fully discussed in Chapter 8 in order to integrate the various phases of the research.

Figure 7.2: **British Biotech plc Security Optimality (1 variable)**
The figure shows that options/warrants had the most "TRUE" signals during the simulations of the decision tree for all five years under consideration. Options/warrants had a significant decline in years 3 and 4 but this has now become very slight, whereas equity, convertible debt and preferred shares show strong upward movements.

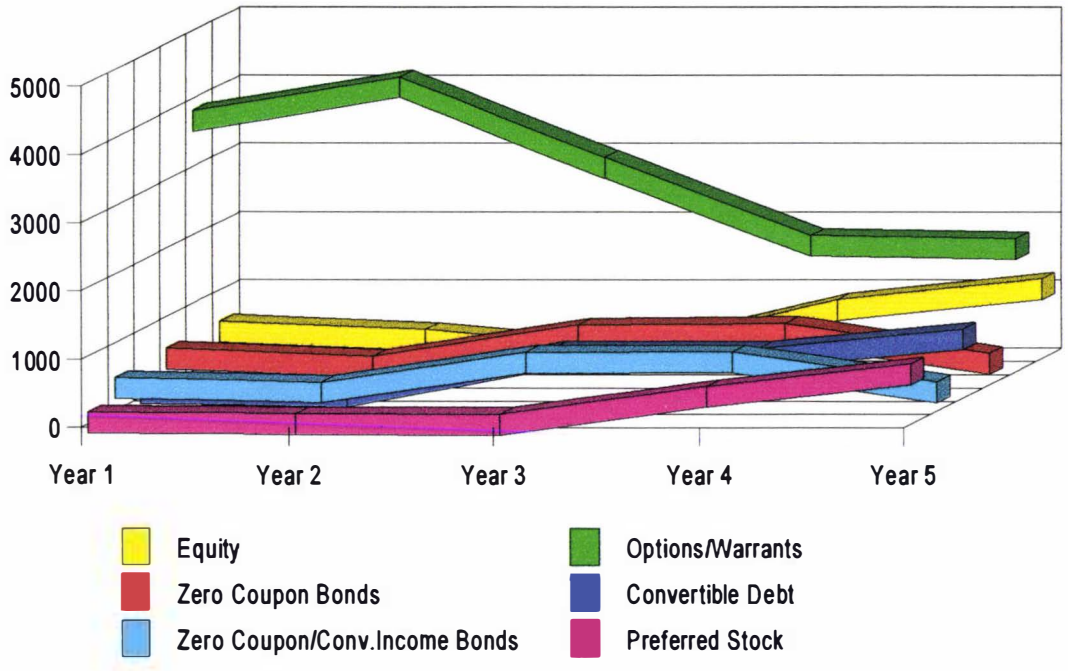


Figure 7.3: British Biotech plc Security Optimality (2 variables)
The figure shows that options/warrants had the most "TRUE" signals during the simulations of the decision tree for all five years under consideration, although the decline in the trend for this security had levelled off in year 5. Convertible debt and preferred stock securities showed an upward trend although the increase in equity in year 5 was greater.

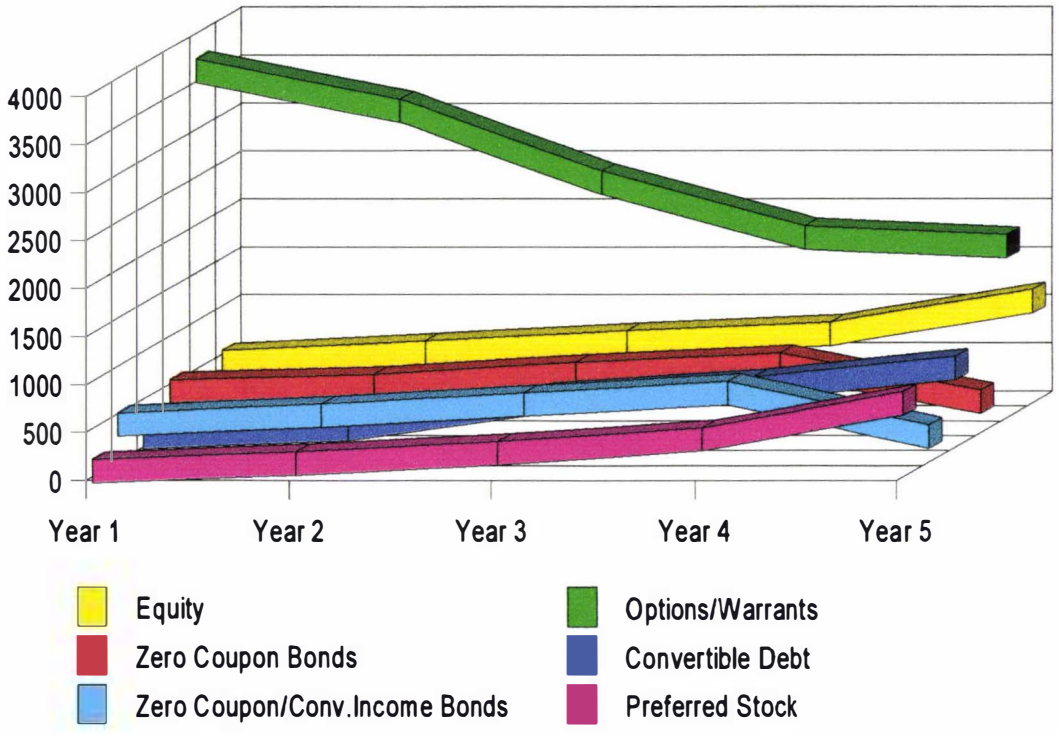


Figure 7.4: Biota Holdings Ltd Security Optimality (1 variable)
The figure shows that options/warrants had the most "TRUE" signals during the simulations of the decision tree in the first two years the company had marketable products. Year 3 showed that because equity was the only security to change to the Gross Profit input it was the only security to record a signal. In year 5 options/warrants are shown to be declining while equity, convertible debt and preferred shares are rising.

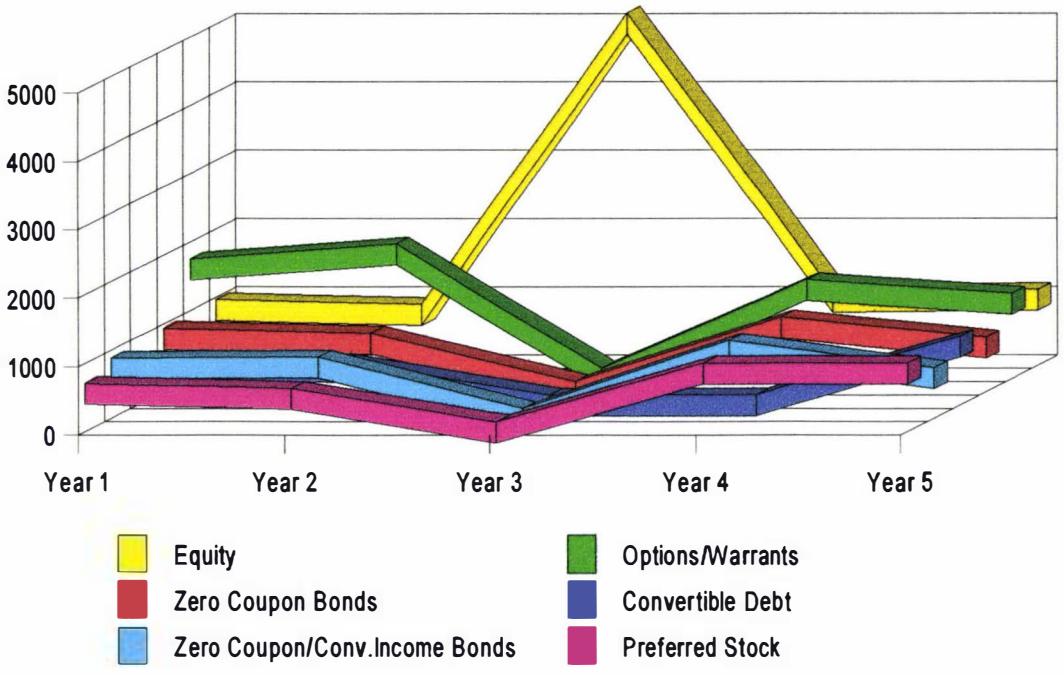


Figure 7.5: **Biota Holdings Ltd Security Optimality (2 variables)**
The figure shows that options/warrants had the most "TRUE" signals for Years 1 to 5 although the number of signals was declining over time. Equity and preferred stock showed a greater increase than convertible debt. The two zero coupon securities reflect a downturn as a result of principal repayment at maturity.

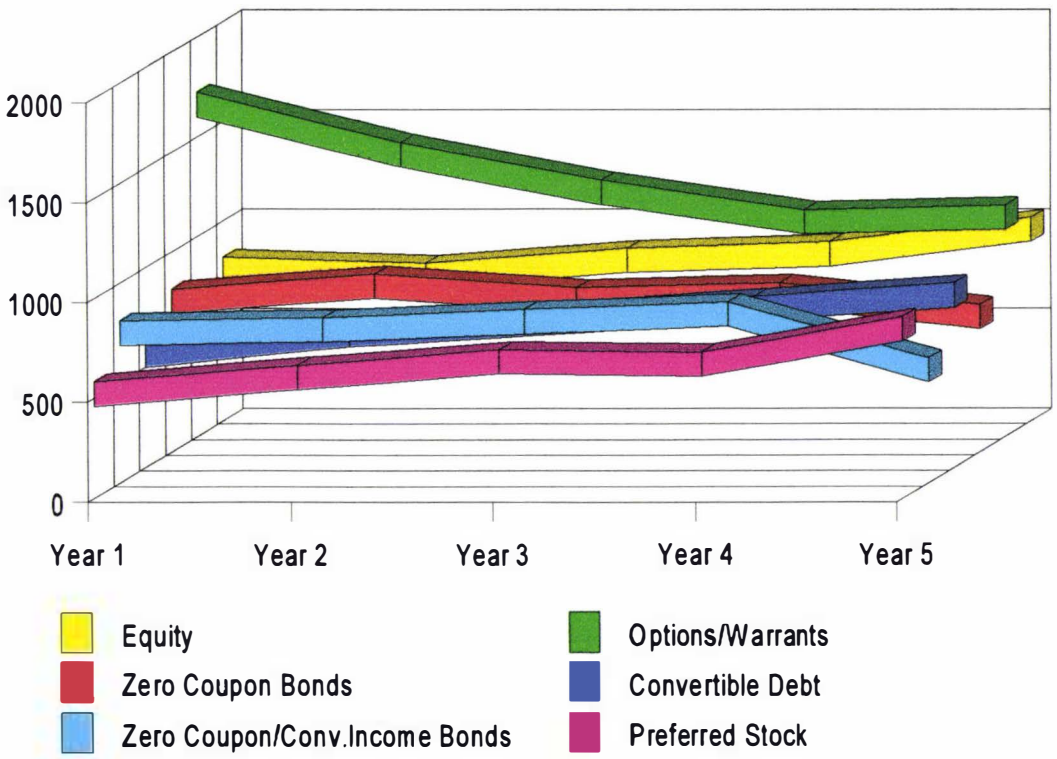


Figure 7.6: British Biotech plc Ranking of Securities (1 variable)
The figure shows that options/warrants had the lowest ranking of all securities over the 5 years being examined. The zero coupon securities received the highest rankings in year 5 due to the impact on the company cash flows of principal repayments.

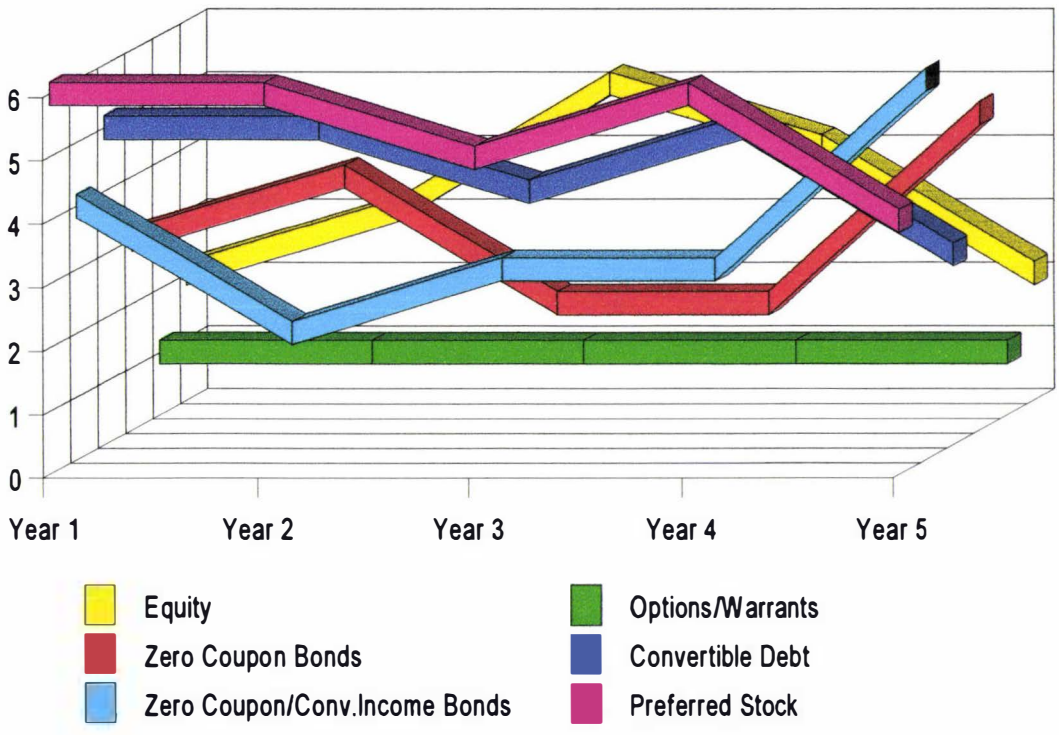


Figure 7.7: British Biotech plc Ranking of Securities (2 variables)
The figure shows that options/warrants were ranked lowest of all six securities during the period being considered. The ranking for preferred stock and convertible debt was 6 and 5 respectively until year 5 when they declined two places each. Zero coupon/convertible income bonds had a significant rise in year 5 moving up from 2 to 6, in comparison, the ranking for zero coupon bonds was only from 4 to 5. These increases were due to the repayment of principal for these securities.

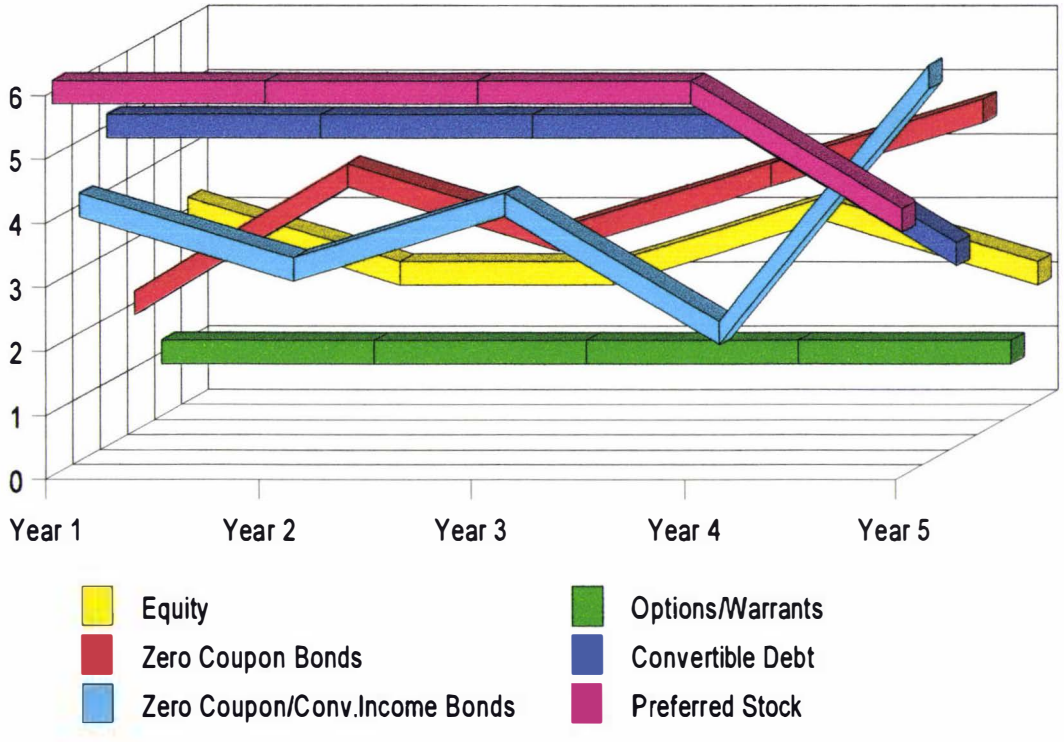


Figure 7.8: Biota Holdings Ltd Ranking of Securities (1 variable)
The figure shows that options/warrants had the highest ranking of all securities apart from in year 3 when equity was the only security ranked. The figure shows very volatile rankings over the period for all securities apart from options/warrants.

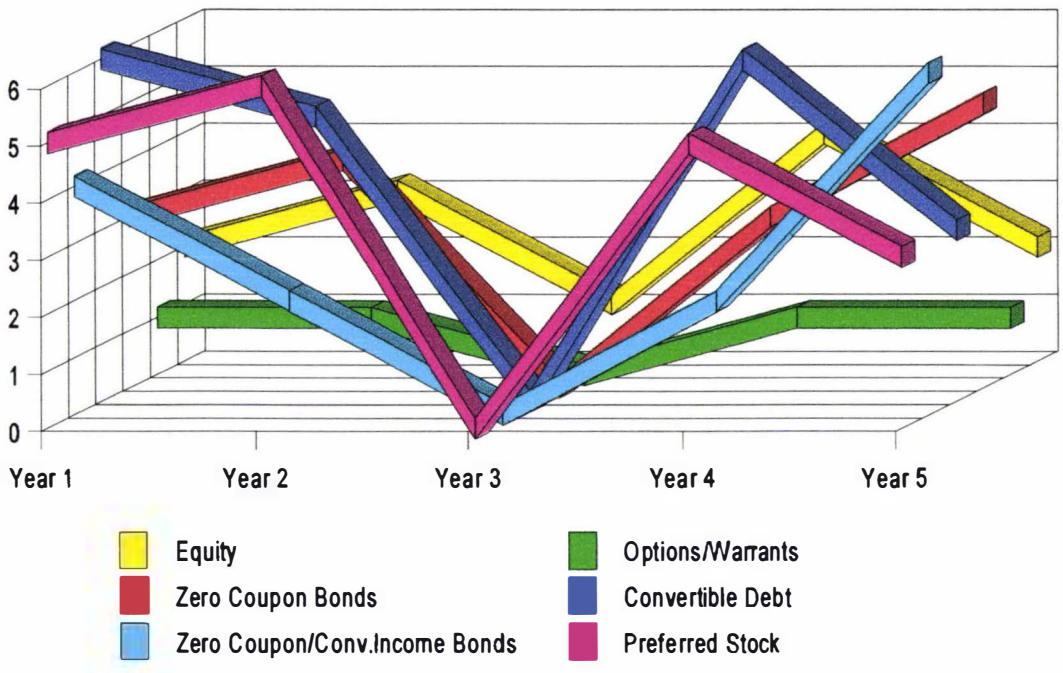
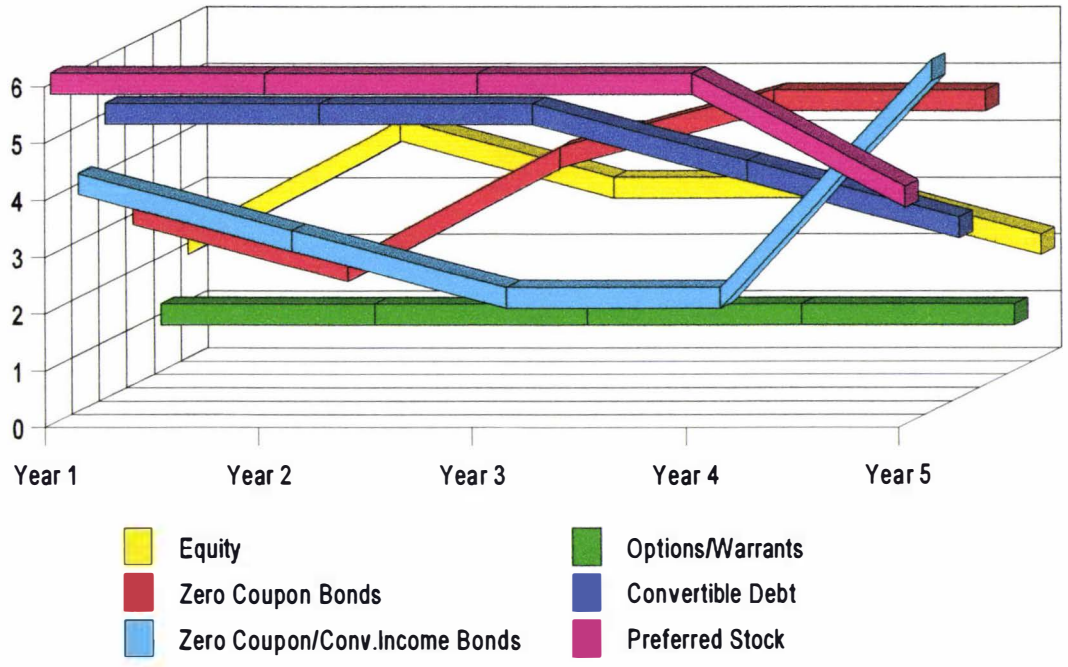


Figure 7.9: Biota Holdings Ltd Ranking of Securities (2 variables)
The figure shows that options/warrants had the lowest ranking of all securities for the five year period, whereas the other two equity-related securities were also ranked low in year 5. The zero coupon bond rankings did not change in years 4 and 5 whereas the increase during this period was significant for the zero coupon/convertible income bonds.



Chapter 8: CONCLUSION

8.0 SUMMARY AND CONCLUSIONS

This project investigated the selection of alternative sources of funds for a biotechnology company situated in either Australia or the UK that is about to launch its first product onto the market. Once the company gets to the stage of seeking regulatory approval for, say, a biopharmaceutical drug it has a 93 percent chance of obtaining the required approval to manufacture and market the new product. In order to achieve its objectives, these companies require funds to finance this new stage of development which will lead, hopefully, to a constant stream of income. As a result of the positive cash flows and the acquisition of assets, a type of security different from equity and options/warrants can be considered. However, in order for the issue of an alternative security to be successful it will require the approval of and the acquisition by interested investors as well as one that is more cost-effective as far as the issuer is concerned.

This research has shown that although financial innovation in the form of security design has been present for centuries, the extent of adaptation undertaken in some countries has been considerably greater than in others. In the US, for example, there are a vast range of securities which have been amended in order to circumvent changes to regulations (notably tax), adapted to overcome volatility in the financial markets and improved to increase the level of liquidity in these markets while at the same time minimising those costs associated with trading activities. This was found not to be the case in Australia or the United Kingdom where a more limited array of financial instruments were used.

The institutional analysts, who participated in the survey, preferred to do their own research when analysing biotechnology companies and considered that they received sufficient information to permit them to do so with confidence. However, they acknowledged that the amount of information provided was greater when the company was in the early stages of developing a product than when the company progressed towards the regulatory approval stage when less information was divulged by the company. The major reason for the change in information flow was to safeguard the company's intellectual property from competitors but based on the results obtained in this study, it would appear that the impact of competition on the company's sales during the first five years was minimal. As a result it could be argued that there should be no reduction in the amount of information provided to analysts and investors right through to the introduction of the product onto the market.

Because of the complexity of the information emanating from biotechnology companies, it was found that the analysts believed that investors would prefer a security which was simple and easy to understand. In addition, they considered that it should be an "approved" listed security that would increase in value, provide an income stream and cause minimum dilution to the wealth of current shareholders.

Based on information obtained from the questionnaire sent to analysts in the UK and Australia the six securities ranked the highest were selected for further analysis. Each security offered a range of advantages and disadvantages for the issuer and also for the investor. The level of simplicity ranged from straight equity through to the more complex zero coupon/convertible income bonds. The latter had the advantage of being able to be developed to match the cash flows generated by a biotechnology company about to market its first product. In order to determine if this provided the company with the maximum benefit in terms of cost-effectiveness three models were used to assess each security's suitability.

Firstly, an NPV model was developed in order to provide a foundation for subsequent Monte Carlo simulations. This NPV model showed that the higher interest rates in existence in the UK had a detrimental effect on the cash flows and NPVs of those securities requiring interest payments. This was due partly to the negative cash flows which occurred during the first couple of years and prevented the company from receiving any advantage from the tax deductibility of interest. In addition, the requirement to repay principal at maturity also affected these securities adversely. However, convertible debt did not require repayment of principal and this security could be converted into equity progressively towards the end of the period being studied. Both equity and convertible debt achieved the highest NPVs and hence were able to add the most value to the company, whereas options/warrants did not perform as well because their cash flows were affected by a negative cash flow right at the beginning and by small annual cash inflows. The cash flows of the other five securities, on the other hand, received the benefit of a significant inflow of funds from the outset.

Secondly, Monte Carlo simulations were used to ascertain those inputs which had the greatest effect on each security's cash flows. The cash flows followed the same pattern of turning from negative to positive as those in the NPV model. The most significant variable to affect sales in the first couple of years of marketing a drug were those costs associated with promoting the product. However, as the proportion of Sales allocated to Promotion Expenses declined each year by the third year after launching the drug it was found that the most significant variable on the spreadsheet was Gross Profit. This

situation changed yet again by the end of the period being studied when it was found that the impact of Gross Profit was declining in favour of Sales thereby indicating that within a couple of years the level of Sales would have the greatest effect on company cash flows.

The third model used a decision tree approach to determine which of the six securities was the most cost-effective instrument for the company to use. Two models were developed, one of which incorporated the most significant variable obtained from the simulations whereas the second model included the two most significant inputs. After simulating the decision trees it was found that options/warrants were the most cost-effective security for these companies to use in all but one year. However, this dominance declined towards the end of the period under investigation whereas the importance of equity and the equity-linked securities increased. However, the requirement to repay principal at maturity had a negative effect on the two discounted securities.

Biotechnology companies in the UK and Australia currently use equity and options/warrants to fund their operations and are likely to continue to do so until they acquire sufficient collateral and cash flows to permit securities requiring a regular payment to be used. This study showed that under the NPV model equity-linked products received the highest ranking in all but one instance. In this case, the Australian options/warrants had a negative NPV and a beta of 1.75. Equity and convertible debt dominated the rankings on all but one occasion when the Australian options/warrants were ranked second to equity. The reason for this was due to the higher discount rates relating to the Australian financial markets compared to those prevailing in the UK. Similar results favouring equity-linked products were obtained from the decision tree model indicating that discounted securities which required the repayment of principal at maturity provided a lower level of cash flows to the company.

In the first five years of marketing their first product, those securities (ie. equity and options/warrants) that both biotechnology companies were using were still found to be the most cost-effective. However, the results also showed that the trends were mean reverting and the dominance of equity and options/warrants was declining in favour of convertible debt and preferred stock.

The securities selected by the institutional analysts matched the requirement of investors ie. a simple security that is easy to understand. This was in agreement with the findings above, which indicated that once the companies had sufficient collateral and a regular

stream of positive cash flows they could offer investors an alternative form of security to the ones they were currently using.

8.1 AREAS OF FUTURE RESEARCH

This study found that the range of securities offered in the US are more extensive than those offered in either Australia or the UK. In fact, even in today's global marketplace, analysts in these two countries were not familiar with a number of financial instruments used in the US. A number of articles have been published by Tufano and Finnerty based on the US market in which they analysed innovative securities and provided the reasons for their innovation. Finnerty has also shown that the need for innovation has tended to come in waves. Studies along these lines could be replicated in both Australia and the UK. This would permit a greater indepth understanding of the reasons for security design in these countries and whether waves of innovation occur in countries other than just the US.

In addition, the NPV spreadsheets could be extended for another five years in order to determine at what point an alternative security could be issued. This would allow the two fixed interest discounted securities to roll-over for another five year period and provide an examination of the impact of refinancing on the company's cash flows. An advantage of this would be to pinpoint the level of sales which need to be reached to allow the company to issue another (possibly cheaper) security. If sales reach this point at an earlier stage then a change to another security could be considered.

Finally, while inflation has been controlled to some extent in recent years it is, in fact, still high in some countries: therefore an analysis using a range of interest rates could be undertaken. This would also permit the impact of a change in interest rates at the time securities mature to be taken into account.

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Appendix 1: PROFILES OF AN AUSTRALIAN AND A UK BIOTECHNOLOGY COMPANY

Biota Holdings Limited

Biota[1] commenced operations in Melbourne in 1985 when an extensive study was undertaken to identify high quality R&D projects that were being led by internationally recognised research teams. The objective of the new company was to support and develop three main pharmacological projects through to commercialisation.

At this time the company was supporting research activities at CSIRO Division of Biomolecular Engineering and the Victorian College of Pharmacy in Parkville as well as at the Australian National University in Canberra. The primary research project was in the diagnosis and treatment of influenza.

In May 1990 the company signed an agreement with the Glaxo Group of companies regarding the development and future commercialisation of a potential drug. Under the terms of this agreement Glaxo was to a) provide milestone payments whenever certain targets were met; b) pay an annual fee; c) receive a royalty of seven percent of sales as well as an advanced royalty on sales; finance R&D; and d) provide co-marketing rights for Biota.

In December 1994 the Biota Chemical Laboratory was opened at Monash University, Clayton where the research focus was on the influenza therapeutic and diagnostic in addition to a number of cancer projects. By 1998 the company had seven ongoing research programmes in progress with their influenza drug[2] expected to be filed for registration later in the year. The other products include an influenza diagnostic kit which has been developed in partnership with BioStar Inc. in the US. The commercial release of this product is expected in early 1999. Other projects, such as cancer (2 projects), Alzheimer's disease, an oral application of insulin and respiratory viral diseases (2 projects) are in the early stages of development.

Merrill Lynch's Indepth Report notes that the company has no debt, including very low levels of creditors and provisions, and hence is funded by shareholders' equity

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[1] Sources: Biota Holdings Limited Annual Reports, Merrill Lynch Indepth Report dated 17 February 1998 and www.biota.com.au/ataglanc.htm.

[2] Developed under licence by Glaxo-Wellcome.

including options on equity. As a result financial risk is negligible although risks associated with getting products products onto the market are present.

British Biotech plc

British Biotech plc[3] was formed in 1986 by Drs Keith McCullagh and Brian Richards using venture capital financing. The company was established with the objective of identifying innovative, patentable drugs. The company is based in Oxford and in 1993 clinical and regulatory operations based in Annapolis, Md were acquired to coordinate the development of the company's products in North America. The company plans to expand into Europe in the expectation of launching its first product there and in 1996 entered a collaborative agreement with Tanabe Seizaku Co. a leading pharmaceutical company in Japan.

The company will not manufacture or distribute its products but will contract a manufacturer to produce the drugs on a commercial scale. This means that close monitoring of the selected manufacturer by British Biotech will be necessary to ensure that all regulatory manufacturing standards requirements are met. British Biotech has products in the clinical development phase for the treatment of acute pancreatitis, as well as an oral inhibitor for treating cancer tumours.

The company receives revenues from collaborative agreements (including milestone payments), grants and funds invested. Operations have been funded primarily by private placements and public fund-raising so that the company carries very little debt.

Unfortunately the company has been the subject of a ministerial inquiry in the UK, as well as by Stock Exchanges in the UK and US, after an employee leaked information to institutional investors concerning serious problems with the cancer and pancreatitis drugs prior to the completion of clinical trials. As a result of this 'inside information' and the subsequent legal costs associated with producing an independent report answering the allegations for shareholders, a substantial loss has been reported for 1998 and the share price has fallen from 360p to 33.5p.

[3] Sources: British Biotech plc Annual Reports, www.bribio.co.uk/overview.html and www.industrywatch.com/story/19880717.

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Appendix 3: EXAMPLE OF THE QUESTIONNAIRE SENT TO INSTITUTIONAL INVESTORS IN AUSTRALIA AND UK

MASSEY UNIVERSITY
DEPARTMENT OF FINANCE

SECURITY QUESTIONNAIRE

PERSONAL DETAILS

Qcode [1-2]

In this section of the questionnaire I would like to ask you some questions about yourself. [Please tick the box, where appropriate, which represents the most appropriate response to the following questions.]

1. What gender are you? [3]

   Male [1]
   Female [2]

2. What is your year of birth? ..... [4-5]

3. What is the highest level of education you have completed? [6]

   Completed secondary [1]
   Completed undergraduate degree [2]
   Completed postgraduate degree [3]
   Other post-secondary qualification (please specify) ..... [4]
   .....

4. How many years have you been in your current job? ..... [7-8]

5. How many years have you been employed in investment related industry?
   ..... [9-10]

6. How many other financial institutions have you worked for prior to joining this organisation? [11]

   None [1]
   One [2]
   Two [3]
   Three [4]
   Four or more [5]

7. What level of management are you in? [12]

   Upper management [1]
   Middle management [2]
   Lower management [3]

8. What is your present title? [13-14]

.....

9. Please give a brief description of your main responsibilities?

..... [15-16]

..... [17-18]

..... [19-20]

..... [21-22]

10. Is your performance directly aligned to remuneration? [23]

Yes [1]

No [2]

11. If your performance assessed in relation to a market index? [24]

Yes [1]

No [2]

ORGANISATION DETAILS

In this section I would like to obtain some details about the organisation you work for. [Please tick the box, where appropriate, which represents the most appropriate response to the following questions.]

12. What is the value of the total funds (to nearest million) managed by your organisation?

..... [25-27]

13. What proportion of institutional funds to private funds are managed by your organisation?

..... [28-30]

14. Please write in the box provided below the percentage of total funds managed for the different institutional investor classes listed.

	%	
Pension/superannuation funds	[1]	[31-32]
Insurance - Life funds	[2]	[33-34]
- Non-life funds	[3]	[35-36]
Unit trusts	[4]	[37-38]
Investment trusts	[5]	[39-40]
Other (please specify)	[6]	[41-42]

.....

15. Does your organisation invest in all sectors (ie. industries) in the market? [43]

Yes [1]

No [2]

16. If you answered "No" to question 15 please list in the space provided the sectors (ie. industries) your organisation does not invest in.

..... [44-45]

..... [46-47]

..... [48-49]

..... [50-51]

..... [52-53]

..... [54-55]

17. If there is a reason for not investing in the sectors (ie. industries) listed in question 16 above please state them in the space provided below:

..... [56-57]

..... [58-59]

..... [60-61]

..... [62-63]

..... [64-65]

..... [66-67]

18. What proportion of the total funds managed by your organisation is invested in the pharmaceutical industry?

..... [68-69]

19. If your organisation has invested in the pharmaceutical industry, what proportion (or estimated proportion) of the total funds in this industry are divided between

	%	
a) established pharmaceutical companies (ie. pharmaceutical companies which have products on sale), and	[1]	[70-72]
b) development stage pharmaceutical companies (ie. those companies whose first prototype products are being tested or are proceeding through regulatory approval)?	[2]	

SOURCES OF INFORMATION FOR ANALYSING PHARMACEUTICAL COMPANIES

The purpose of this section is to find what information sources are used by your organisation when assessing the feasibility of an investment in pharmaceutical companies. [Please tick the appropriate box/es.]

Card 2
Qcode
[1-2]

20. When analysing pharmaceutical companies a range of information sources are used. Using the scale below please rate the range of information sources listed below according to their usefulness. [Where 1 = of no use and 5 = extremely useful.]

	Of no use				Extr. use.	
Company financial statements						
- Income Statement	1	2	3	4	5	[3]
- Balance Sheet	1	2	3	4	5	[4]
- Cash Flow Statement	1	2	3	4	5	[5]
- Proforma Statement	1	2	3	4	5	[6]
Mission/strategy statements	1	2	3	4	5	[7]
Professional company databases	1	2	3	4	5	[8]
Stock Exchange information	1	2	3	4	5	[9]
Broker recommendations	1	2	3	4	5	[10]
Broker research	1	2	3	4	5	[11]
Financial analyst meetings	1	2	3	4	5	[12]
Visits by the pharmaceutical company	1	2	3	4	5	[13]
Site visits by analysts	1	2	3	4	5	[14]
Press releases concerning product progress	1	2	3	4	5	[15]

21. Do you consider the information that is available is sufficient to permit an informed investment decision to be made?

[16]

Yes	1
No	2

22. If you answered "No" to question 21 above, what information do you consider could be provided to assist you with your analyses?

..... [17-18]

..... [19-20]

..... [21-22]

..... [23-24]

..... [25-26]

23. There are often taxation advantages that accrue from R&D activities in the pharmaceutical industry. How important do you consider these advantages are when making investment decisions concerning companies in this industry? [Where 1 = not important and 5 = extremely important.]

Not impt				Extr. impt	
1	2	3	4	5	[27]

24. Using the scales below please indicate the importance of each variable when analysing pharmaceutical companies. [Where 1 = not important and 5 = extremely important.]

	Not impt				Extr. impt	
Broker research	1	2	3	4	5	[28]
Dividend tax credits	1	2	3	4	5	[29]
Size of dividends	1	2	3	4	5	[30]
Growth of assets	1	2	3	4	5	[31]
Return on investment - historical	1	2	3	4	5	[32]
- forecast	1	2	3	4	5	[33]
Level of cash flows	1	2	3	4	5	[34]
Level of profitability	1	2	3	4	5	[35]
Risk - financial	1	2	3	4	5	[36]
- operating	1	2	3	4	5	[37]
- liquidity	1	2	3	4	5	[38]
Company size	1	2	3	4	5	[39]
Capital structure (ie. debt/equity mix)	1	2	3	4	5	[40]
Cost of capital	1	2	3	4	5	[41]
Economic value added	1	2	3	4	5	[42]
Company profitability	1	2	3	4	5	[43]
Ability to arbitrage security	1	2	3	4	5	[44]
Off-balance sheet activities	1	2	3	4	5	[45]
Milestone payment facility with major drug co.	1	2	3	4	5	[46]
Senior management remuneration (including bonuses, stock options, etc.)	1	2	3	4	5	[47]

25. Does your organisation currently invest in (or has it in the past invested in) pharmaceutical companies at the stages of development listed below?

	Yes	No	
Stage of testing drug, i) preclinical	1	2	[48]
ii) phase I	1	2	[49]
iii) phase II	1	2	[50]
iv) phase III	1	2	[51]
Regulatory approval sought	1	2	[52]

26. If you answered "Yes" to any part of question 25 what degree of importance was placed on the information obtained for the analysis? [Where 1 = not important and 5 = extremely important.]

	Not impt				Extr. impt	
Stage of testing drug, ie. preclinical	1	2	3	4	5	[53]
phase I	1	2	3	4	5	[54]
phase II	1	2	3	4	5	[55]
phase III	1	2	3	4	5	[56]
Regulatory approval sought	1	2	3	4	5	[57]

27. Please place a tick in the relevant boxes below to indicate how important you consider each of the variables listed are when analysing emerging pharmaceutical companies. [Where 1 = not important and 5 = extremely important.]

	Not impt				Extr. impt	
Broker research	1	2	3	4	5	[58]
Dividend tax credits	1	2	3	4	5	[59]
Size of dividends	1	2	3	4	5	[60]
Growth of assets	1	2	3	4	5	[61]
Return on investment - historical	1	2	3	4	5	[62]
- forecast	1	2	3	4	5	[63]
Level of cash flows	1	2	3	4	5	[64]
Level of profitability	1	2	3	4	5	[65]
Risk - financial	1	2	3	4	5	[66]
- operating	1	2	3	4	5	[67]
- liquidity	1	2	3	4	5	[68]
Company size	1	2	3	4	5	[69]
Capital structure (ie. debt/equity mix)	1	2	3	4	5	[70]
Cost of capital	1	2	3	4	5	[71]
Economic value added	1	2	3	4	5	[72]
Company profitability	1	2	3	4	5	[73]
Ability to arbitrage security	1	2	3	4	5	[74]
Off-balance sheet activities	1	2	3	4	5	[75]
Business plan and future prospects	1	2	3	4	5	[76]
Milestone payment facility with major drug company	1	2	3	4	5	[77]

SECURITIES

In this section I would like to ask you a few questions concerning a) the attributes a security should have to satisfy the financing requirements of a developing pharmaceutical company, and b) your familiarity with a number of securities. These securities are listed below and in order to assist you, a description of them is contained in the Glossary attached to the end of this questionnaire.

28. A pharmaceutical company has developed its first product to the stage where it will shortly be submitted for regulatory approval; the company is currently financed entirely by equity and is seeking an alternative form of financing. What do you consider would be the most important attributes in a security that the company could offer investors which would make an issue attractive to them?

Card 3
Qcode
[1-2]

..... [3-4]

..... [5-6]

..... [7-8]

..... [9-10]

..... [11-12]

..... [13-14]

29. From the securities listed below, firstly indicate whether you are familiar with the security. If your answer is "Yes" then I would like you to indicate if your company has previously invested, or is currently investing, in this security. If you are not familiar with the security, I would like you to go to the next security on the list.

	Familiar with security	Previous Investment Yes	Previous Investment No	Current Investment Yes	Current Investment No	
Zero coupon bonds	1	2	3	4	5	[15-17]
Income bonds	1	2	3	4	5	[18-20]
Interest rate swaps	1	2	3	4	5	[21-23]
Market index certificate of deposit	1	2	3	4	5	[24-26]
Indexed sinking fund debentures	1	2	3	4	5	[27-29]
Collateralised mortgage obligations	1	2	3	4	5	[30-32]
Corporate debt	1	2	3	4	5	[33-35]
Convertible debt	1	2	3	4	5	[36-38]
Exchangeable debt	1	2	3	4	5	[39-41]
Units of debt with warrants	1	2	3	4	5	[42-44]
Exchangeable units of debt with warrants	1	2	3	4	5	[45-47]
Preferred stock	1	2	3	4	5	[48-50]
Adjustable rate preferred stock	1	2	3	4	5	[51-53]
Auction rate preferred stock	1	2	3	4	5	[54-56]
Monthly income preferred stock	1	2	3	4	5	[57-59]
Sinking fund preferred stock	1	2	3	4	5	[60-62]
Liquid yield option note	1	2	3	4	5	[63-65]

SWORD (stock warrant off-balance sheet R&D sec.)	1	2	3	4	5	[66-68]
Capital notes	1	2	3	4	5	[69-71]
Common stock (ie. ordinary shares)	1	2	3	4	5	[72-74]
Equity options (ie. equity warrants	1	2	3	4	5	[75-77]
Zero coupon/convertible income bonds	1	2	3	4	5	[78-80]

30. Which of the securities listed below (that you are familiar with) do you consider would be appropriate for a pharmaceutical company seeking i) regulatory approval for their first drug or ii) an alternative to equity-type financing? [Please place a tick in the box/es which reflects "Yes" or "No" for each category where applicable.]

Card 4
Qcode
[1-2]

	Regulatory Approval		Alternative to Equity		
	Yes	No	Yes	No	
Zero coupon bonds	1	2	3	4	[3-4]
Income bonds	1	2	3	4	[5-6]
Interest rate swaps	1	2	3	4	[7-8]
Market index certificate of deposit	1	2	3	4	[9-10]
Indexed sinking fund debentures	1	2	3	4	[11-12]
Collateralised mortgage obligation	1	2	3	4	[13-14]
Corporate debt	1	2	3	4	[15-16]
Convertible debt	1	2	3	4	[17-18]
Exchangeable debt	1	2	3	4	[19-20]
Units of debt with warrants	1	2	3	4	[21-22]
Exchangeable units of debt with warrants	1	2	3	4	[23-24]
Preferred stock	1	2	3	4	[25-26]
Adjustable rate preferred stock	1	2	3	4	[27-28]
Auction rate preferred stock	1	2	3	4	[29-30]
Monthly income preferred stock	1	2	3	4	[31-32]
Sinking fund preferred stock	1	2	3	4	[33-34]
Liquid yield option note	1	2	3	4	[35-36]
SWORD (stock warrant off-balance sheet R&D security)	1	2	3	4	[37-38]
Capital notes	1	2	3	4	[39-40]
Common stock (ie. ordinary shares)	1	2	3	4	[41-42]
Equity options (ie. equity warrants)	1	2	3	4	[43-44]
Zero coupon/convertible income bonds	1	2	3	4	[45-46]

31. What type of security do you consider would best meet your company's requirements for an investment in a pharmaceutical company which is seeking regulatory approval?

..... [47]

32. Why do you consider this security satisfies your company's requirements in this situation?

..... [48-49]

..... [50-51]

..... [52-53]

..... [54-55]

..... [56-57]

..... [58-59]

If there are any additional comments you would care to make please write them in the space provided below.

Thank you for your assistance in completing this questionnaire. Your efforts are greatly appreciated. Please return the completed questionnaire in the enclosed envelope to J R Parry, Department of Finance, Massey University, Palmerston North, New Zealand.

GLOSSARY

Zero Coupon Bonds (or Deep Discount Bonds) - are a discount security which pays no interest over the life of the bond. The interest payments are deferred and the principal is repaid at maturity and represents the face value of the bond.

Income Bonds - have similar principal and interest characteristics as corporate bonds but interest payments will only be made if the issuers earn sufficient income by a specified date so that interest payments can be made. If the firm does not generate sufficient income the interest payments can lapse and will not force the company into bankruptcy.

Interest Rate Swaps - are derivative financial instruments that permit both parties to enter into an agreement to pay each other a stream of interest payments calculated as interest on a notional principal. For example, one party may exchange a fixed interest stream for a series of floating interest payments. Each party is committed to either fixed or floating rate debt but would prefer the opposite. Therefore, the fixed rate party agrees to accept the floating interest payments and the floating party accepts fixed interest payments. The end result is that their financing arrangement is what they originally wanted.

Market Index Certificate of Deposits - are variable rate certificates of deposit which have a guaranteed minimum interest rate in addition to an interest rate which is linked to the increased value of the S&P 500 index.

Indexed Sinking Fund Debentures - are intermediate term securities with sinking fund payments which are made semiannually. The securities are issued against the portfolio of assets of a mortgage based financial organisation and has a sinking fund which is contingent on interest rates. If interest rates fall (rise) then repayment of the principal will rise (fall) in relation to a specified base rate.

Collateralised Mortgage Obligation - are a multiclass pay-through bond using mortgage collateral. The stream of mortgage payments are prioritised and compartmentalised into various classes based on their right to receive payment of principal. Each series is fully repaid before the holders of the next series can receive payments.

Corporate Debt - are securities issued by organisations such as industrial and public utility corporations paying a fixed interest payment schedule and principal repayment at maturity.

Convertible Debt - contains the features of straight bonds but carry the option to convert at the investor's behest, usually into a fixed number of the firm's equity, after a predetermined period of time.

Exchangeable Debt - is a type of convertible debt where the investor has the option to exchange the debt for shares in another company that is not the issuers.

Units of Debt with Warrants - are similar to convertible debt although the debt and warrant segments separate into two distinct securities.

Exchangeable Units of Debt with Warrants - are similar to exchangeable debt although the debt and warrant segments of the security separate to become two different securities with the warrants able to be exchanged for the common stock of a company that is not the issuers.

Preferred Stock - is a fixed income type of security. The annual payment is set as a percent of face value but is legally a dividend. Although directors vote to pay the preferred stock dividend they can also vote to withhold it. If the terms of the stock permitted, this dividend could accumulate so that it is paid in full at a later date.

Adjustable Rate Preferred Stock - the dividend rate is adjusted each quarter in line with changes in interest rates plus or minus a specified spread. This procedure recognises changes in market rates and stabilises the value of the security.

Auction Rate Preferred Stock - the dividend rate is reset every 49 days by a Dutch auction process and paid at the end of each dividend period.

Monthly Income Preferred Stock - is a modification of preferred stock which receives equity treatment from rating agencies and provides issuers with tax deductible dividend payments thereby combining the advantages of equity and debt in a single instrument.

Sinking Fund Preferred Stock - has sinking fund provision whereby after, say, five years a percentage of the issue is retired annually.

Liquid Yield Option Notes - are zero coupon convertible bonds with put and call option features. Investors have the option to convert and a put option whereas the issuer has the right to call the bond.

SWORD (Stock Warrant Off-Balance Sheet R&D Security) - consists of a set of contracts which define the relationship and the property rights accruing to each party. The firm creates a research sponsor with an option to repurchase.

Capital Notes - are interest bearing bonds which convert into equity or rolls over for a further period as debt at maturity. The issuer determines how the principal is to be repaid.

Common Stock (ie. Ordinary Shares) - represent ownership of a firm, which entitles the holders to a share of the firm's profits (in the form of a dividend). In the event of liquidation the owners receive what (if anything) remains.

Equity Options (ie. Equity Warrants) - are issued by the company which gives the holder the right to convert them into equity (ie. the firm's common stock) at a specified price within a set period of time.

Zero Coupon/Convertible Income Bonds - are discounted securities which will convert into an income bond on a predetermined future date.

Appendix 4: RESPONDENTS' SECURITY PREFERENCES

Respondents most preferred security and the reasons for this preference. The securities below have been ranked in order of importance.

Equity (or Equity Options)

- Capital appreciation and growth opportunities
- Simple, uncomplicated security
- Ability to share in the long-term potential of the company
- Full exposure to risk and rewards
- Liquid, listed security
- Does not require contractual cash flows
- Some form of cash flow

Interest Bearing Debt[1]

- Cheaper than equity

Exchangeable Units of Debt with Warrants

- Limited capital risk with upside potential

[1] Debt was recommended as a preferred security only if the drug was certain to be approved.

Appendix 5: SPREADSHEETS FOR EACH SECURITY SHOWING ANNUAL CASH FLOWS AND NPVS

British Biotech NPV calculations - Equity				(Figures in LM's)									
Year from	Sales	Security	Issue	Gross Profit	Promotion	Gen.Admin	R&D	Capital	Profit	Taxation	Dividend	Cash Flow	
launch	1.62	Issue	Expenses		Expenses	O/hd Exp.	Expense	Expenditure	Before Tax	(30 percent)	Expense		
0	0.00	40.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	38.00	
1	15.00			9.38	15.00	1.13	1.65	6.24	-14.64	0.00	0.00	-14.64	
2	51.00			31.88	25.50	3.83	5.61	6.24	-9.30	0.00	0.00	-9.30	
3	85.00			53.13	21.25	6.38	9.35	6.24	9.91	2.97	3.96	2.97	
4	153.00			95.63	38.25	11.48	16.83	6.24	22.83	6.85	9.13	6.85	
5	244.00			152.50	48.80	18.30	26.84	6.24	52.32	15.70	20.93	15.70	
										NPV beta = 1		$32.44	
										NPV beta = 1.75		$32.14	
										NPV opp.cost = 7.078		$32.68	
		Assume:	Number of shares previously on issue =				58000000						
			Number of shares offered in this issue =				23000000						
					Total shares =		81000000						
			Final dividend payable if profit positive =				0.4	Payout ratio					

British Biotech NPV calculations - Options/Warrants					(Figures in $M's)							
Year from	Sales	Security	Issue	Gross Profit	Promotion	Gen.Admin	R&D	Capital	Profit	Taxation	Dividend	Cash Flow
launch	1.62	Issue	Expenses		Expenses	O/hd Exp.	Expense	Expenditure	Before Tax	(30 percent	Expense	
0	0.00	0.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	-2.00
1	15.00	8.00		9.38	15.00	1.13	1.65	6.24	-14.64	0.00	0.00	-6.64
2	51.00	8.00		31.88	25.50	3.83	5.61	6.24	-9.30	0.00	0.00	-1.30
3	85.00	8.00		53.13	21.25	6.38	9.35	6.24	9.91	2.97	3.96	10.97
4	153.00	8.00		95.63	38.25	11.48	16.83	6.24	22.83	6.85	9.13	14.85
5	244.00	8.00		152.50	48.80	18.30	26.84	6.24	52.32	15.70	20.93	23.70
										NPV beta =1		$25.41
										NPV beta = 1.75		$24.82
				Assume:	Total value of options issued =				40000000	NPV opp.cost = 7.078		$25.90
					Percent of options exercised annually				20			
					Number of shares exercised =				23000000			
					Number of shares previously issued =				58000000			
							Total shares =		81000000			
					Final dividend payable if profit is positive =				0.4	Payout ratio		

British Biotech NPV calculations - Zero Coupon Bonds							(Figures in $M's)						
Year from launch	Sales 1.62	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Bond Repaymen	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flows
0	0.00	26.60	0.80	-0.80	0.00	0.00	0.00	0.00	0.00	-0.80	0.00	0.00	25.80
1	15.00			9.38	15.00	1.13	1.65	6.24	0.00	-14.64	0.00	0.00	-14.64
2	51.00			31.88	25.50	3.83	5.61	6.24	0.00	-9.30	0.00	0.00	-9.30
3	85.00			53.13	21.25	6.38	9.35	6.24	0.00	9.91	2.97	3.96	2.97
4	153.00			95.63	38.25	11.48	16.83	6.24	0.00	22.83	6.85	9.13	6.85
5	244.00			152.50	48.80	18.30	26.84	6.24	40.00	12.32	3.70	4.93	3.70
											NPV beta = 1		$13.26
											NPV beta = 1.75		$13.17
		Assume:	Number of shares on issue =					58000000			NPV opp.cost = 7.078		$13.33
			Final dividends payable if profits positive =					0.4	payout ratio				

British Biotech NPV calculations - Convertible Debt						(Figures in $M's)								
Year from launch	Sales 1.62	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Int.Exp. + Repayment	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flows	
0	0.00	40.00	1.52	-1.52	0.00	0.00	0.00	0.00	0.00	-1.52	0.00	0.00	38.48	
0.5	7.50			4.69	7.50	0.56	0.83	3.12	1.53	-8.85	0.00	0.00	-8.85	
1	7.50			4.69	7.50	0.56	0.83	3.12	1.53	-8.85	0.00	0.00	-8.85	
1.5	25.50			15.94	12.75	1.91	2.81	3.12	1.53	-6.18	0.00	0.00	-6.18	
2	25.50			15.94	12.75	1.91	2.81	3.12	1.53	-6.18	0.00	0.00	-6.18	
2.5	42.50			26.56	10.63	3.19	4.68	3.12	1.53	3.42	1.03	1.37	1.03	
3	42.50			26.56	10.63	3.19	4.68	3.12	1.53	3.42	1.03	1.37	1.03	
3.5	76.50			47.81	19.13	5.74	8.42	3.12	1.53	9.88	2.96	3.95	2.96	
4	76.50			47.81	19.13	5.74	8.42	3.12	1.53	9.88	2.96	3.95	2.96	
4.5	122.00			76.25	24.40	9.15	13.42	3.12	1.30	24.86	7.46	9.94	7.46	
5	122.00			76.25	24.40	9.15	13.42	3.12	4.92	21.24	6.37	8.50	6.37	
											NPV beta = 1		$25.87	
											NPV beta = 1. 75		$25.69	
Assume:		Revenues and expenses are equal at half year and end of year									NPV opp.cost = 7.078		$26.02	
		Interest rate payable on the debt is .791% > the riskfree rate = 7.661%												
		Par value is L500 and bond can be converted into 264.55 shares valued at L1.89 each												
		Conversion can occur from year 4 to year 5												
		Conversion will take place as follows: 15 percent at year 4, 25 percent at year 4.5, 50 percent at year 5,												
		the balance redeemed at year 5.												
		Final dividends are paid if profits are made						0.4	payout ratio					
		Number of shares on issue year 4 =						58000000	(NB dividends will not be paid on shares converted					
		Number of year 5 shares eligible for dividend payment =						67200000	in year 4 until year 5.)					

British Biotech NPV calculations - Zero Coupon/Convertible Income Bonds										(Figures in $M's)				
Year from	Sales	Security	Issue	Gross	Promotion	Gen.Admin	R&D	Capital	Profit bef.	Int. Exp. +	Profit	Taxation	Dividend	Cash
launch	1.62	Issue	Exp.	Profit	Expenses	O/hd Exp.	Exp.	Expend.	Int.& Tax	Repayment	Bef. Tax	(30%)	Expense	Flows
0	0.00	26.15	0.78	-0.78	0.00	0.00	0.00	0.00	-0.78	0.00	-0.78	0.00	0.00	25.37
1	15.00			9.38	15.00	1.13	1.65	6.24	-14.64	0.00	-14.64	0.00	0.00	-14.64
2	51.00			31.88	25.50	3.83	5.61	6.24	-9.30	0.00	-9.30	0.00	0.00	-9.30
3	85.00			53.13	21.25	6.38	9.35	6.24	9.91	0.00	9.91	2.97	3.96	2.97
4	153.00			95.63	38.25	11.48	16.83	6.24	22.83	0.00	22.83	6.85	9.13	6.85
5	244.00			152.50	48.80	18.30	26.84	6.24	52.32	43.55	8.77	2.63	3.51	2.63
												NPV beta = 1		$12.16
												NPV beta = 1.75		$12.09
	Assume:		Total amount of security issued =					40		million		NPV opp.cost 7.078		$12.22
			Zero coupon bonds will convert into Income bonds once Net Profits are made											
			Interest rate payable on conversion is 2.0% > the riskfree rate, ie.								8.87	percent		
			Interest will be paid on the bonds once Profits before Tax exceeds L25 million											
			Once conversion has occurred interest in arrears will be paid as soon as profits permit											
			Number of shares on issue =					58000000						
			Final dividends payable if profits made					0.4	payout ratio					

British Biotech NPV calculations - Preferred Shares					(Figures in $M's)							
Year from launch	Sales 1.62	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent)	Int. & Div. Expense	Cash Flows
0	0.00	40.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	38.00
0.5	7.50			4.69	7.50	0.56	0.83	3.12	-7.32	0.00	1.78	-9.10
1	7.50			4.69	7.50	0.56	0.83	3.12	-7.32	0.00	1.78	-9.10
1.5	25.50			15.94	12.75	1.91	2.81	3.12	-4.65	0.00	1.78	-6.43
2	25.50			15.94	12.75	1.91	2.81	3.12	-4.65	0.00	1.78	-6.43
2.5	42.50			26.56	10.63	3.19	4.68	3.12	4.96	1.49	3.76	-0.29
3	42.50			26.56	10.63	3.19	4.68	3.12	4.96	1.49	3.76	-0.29
3.5	76.50			47.81	19.13	5.74	8.42	3.12	11.42	3.42	6.34	1.65
4	76.50			47.81	19.13	5.74	8.42	3.12	11.42	3.42	6.34	1.65
4.5	122.00			76.25	24.40	9.15	13.42	3.12	26.16	7.85	12.24	6.07
5	122.00			76.25	24.40	9.15	13.42	3.12	26.16	7.85	12.24	6.07
										NPV beta = 1		$19.36
										NPV beta = 1.75		$19.26
										NPV opp.cost = 7.078		$19.44
	Assume:	Interest is paid semiannually										
		Interest rate is .7661 greater than the riskfree rate of 6.87 =7.661										
		Number of shares on issue =					58000000					
		Final dividends payable in years 4 and 5 =					0.4	payout ratio				

Biota NPV calculations - Equity				(Figures in $M's)								
Year from launch	Sales 0.7321	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30%)	Dividend Expense	Cash Flow
0	0.00	25.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	23.75
1	34.00			21.25	34.00	2.55	3.74	13.69	-32.73	0.00	0.00	-32.73
2	113.00			70.63	56.50	8.48	12.43	13.69	-20.47	0.00	0.00	-20.47
3	188.00			117.50	47.00	14.10	20.68	13.69	22.03	6.61	8.81	6.61
4	339.00			211.88	84.75	25.43	37.29	13.69	50.72	15.22	20.29	15.22
5	541.00			338.13	108.20	40.58	59.51	13.69	116.15	34.85	46.46	34.85
										NPV beta = 1		$10.48
										NPV beta = 1.75		$6.85
										NPV opp.cost = 6.528		$16.59
		Assume:	Number of shares previously on issue =				65000000					
			Number of shares offered in this issue =				5800000					
					Total shares =		70800000					
			Final dividend payable if profit is positive =				0.4	Payout ratio				

Biota NPV calculations - Options/Warrants				(Figures in $M's)								
Year from launch	Sales 0.7321	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00	0.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	-1.25
1	34.00	5.00		21.25	34.00	2.55	3.74	13.69	-32.73	0.00	0.00	-27.73
2	113.00	5.00		70.63	56.50	8.48	12.43	13.69	-20.47	0.00	0.00	-15.47
3	188.00	5.00		117.50	47.00	14.10	20.68	13.69	22.03	6.61	8.81	11.61
4	339.00	5.00		211.88	84.75	25.43	37.29	13.69	50.72	15.22	20.29	20.22
5	541.00	5.00		338.13	108.20	40.58	59.51	13.69	116.15	34.85	46.46	39.85
										NPV beta = 1		$4.01
										NPV beta = 1.75		($1.22)
	Assume:	Total value of options issued =				25000000				NPV opp.cost = 6.528		$12.61
		Percent of options exercised annually =				20						
		Number of shares exercised =				5800000						
		Number of shares previously issued =				65000000						
				Total shares =		70800000						
		Final dividends payable if profits made =				0.4	payout ratio					

Biota NPV calculations - Zero Coupon Bonds					(Figures in $M's)								
Year from launch	Sales 0.7321	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Bond Repayment	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00	18.32	0.55	-0.55	0.00	0.00	0.00	0.00	0.00	-0.55	0.00	0.00	17.77
1	34.00			21.25	34.00	2.55	3.74	13.69	0.00	-32.73	0.00	0.00	-32.73
2	113.00			70.63	56.50	8.48	12.43	13.69	0.00	-20.47	0.00	0.00	-20.47
3	188.00			117.50	47.00	14.10	20.68	13.69	0.00	22.03	6.61	8.81	6.61
4	339.00			211.88	84.75	25.43	37.29	13.69	0.00	50.72	15.22	20.29	15.22
5	541.00			338.13	108.20	40.58	59.51	13.69	25.00	91.15	27.35	36.46	27.35
											NPV beta = 1		$1.51
		Assume:	Number of shares on issue =					65000000			NPV beta = 1.75		($0.90)
			Final dividends payable if profits made =					0.4	payout ratio		NPV opp.cost = 6.528		$5.84
			Interest rate payable on the bond is 1.547% > the riskfree rate, ie.							6.417	percent		

Biota NPV calculations - Convertible Debt				(Figures in $M's)									
Year from launch	Sales 0.7321	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Int. Exp. + Repayment	Profit Before Tax	Taxation (30%)	Dividend Expense	Cash Flow
0	0.00	25.00	1.25	-1.25	0.00	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	23.75
0.5	17.00			10.63	17	1.28	1.87	6.85	0.71	-17.08	0.00	0.00	-17.08
1	17.00			10.63	17	1.28	1.87	6.85	0.71	-17.08	0.00	0.00	-17.08
0.5	56.50			35.31	28.25	4.24	6.22	6.85	0.71	-10.95	0.00	0.00	-10.95
2	56.50			35.31	28.25	4.24	6.22	6.85	0.71	-10.95	0.00	0.00	-10.95
2.5	94.00			58.75	23.50	7.05	10.34	6.85	0.71	10.30	3.09	0.00	7.21
3	94.00			58.75	23.50	7.05	10.34	6.85	0.71	10.30	3.09	8.24	-1.03
3.5	169.50			105.94	42.38	12.71	18.65	6.85	0.71	24.65	7.39	0.00	17.25
4	169.50			105.94	42.38	12.71	18.65	6.85	0.71	24.65	7.39	19.72	-2.46
4.5	270.50			169.06	54.10	20.29	29.76	6.85	0.60	57.47	17.24	0.00	40.23
5	270.50			169.06	54.10	20.29	29.76	6.85	2.92	55.15	16.54	45.05	-6.44
											NPV beta = 1		$8.33
											NPV beta = 1.75		$4.83
		Assume:	Revenues and expenses are equal at half year and end of year								NPV opp.cost = 6.5		$8.46
			Interest rate payable on the debt is .791% > the riskfree rate, ie.						5.661	percent			
			Par value is $1000 and bond can be converted into 218.34 shares valued at $4.58 each										
			Conversion can occur from year 4 to year 5										
			Conversion will take place as follows: 15 percent at year 4, 25 percent at year 4.5, 50 percent at										
			year 5, the balance redeemed at year 5.										
			Final dividends are paid on shares if profits positive =					0.4	Payout ratio				
			Number of shares on issue year 4 =					65000000	(NB dividends will not be paid on shares converted				
			Number of year 5 shares eligible for dividend paymen					75000000	in year 4 until year 5)				

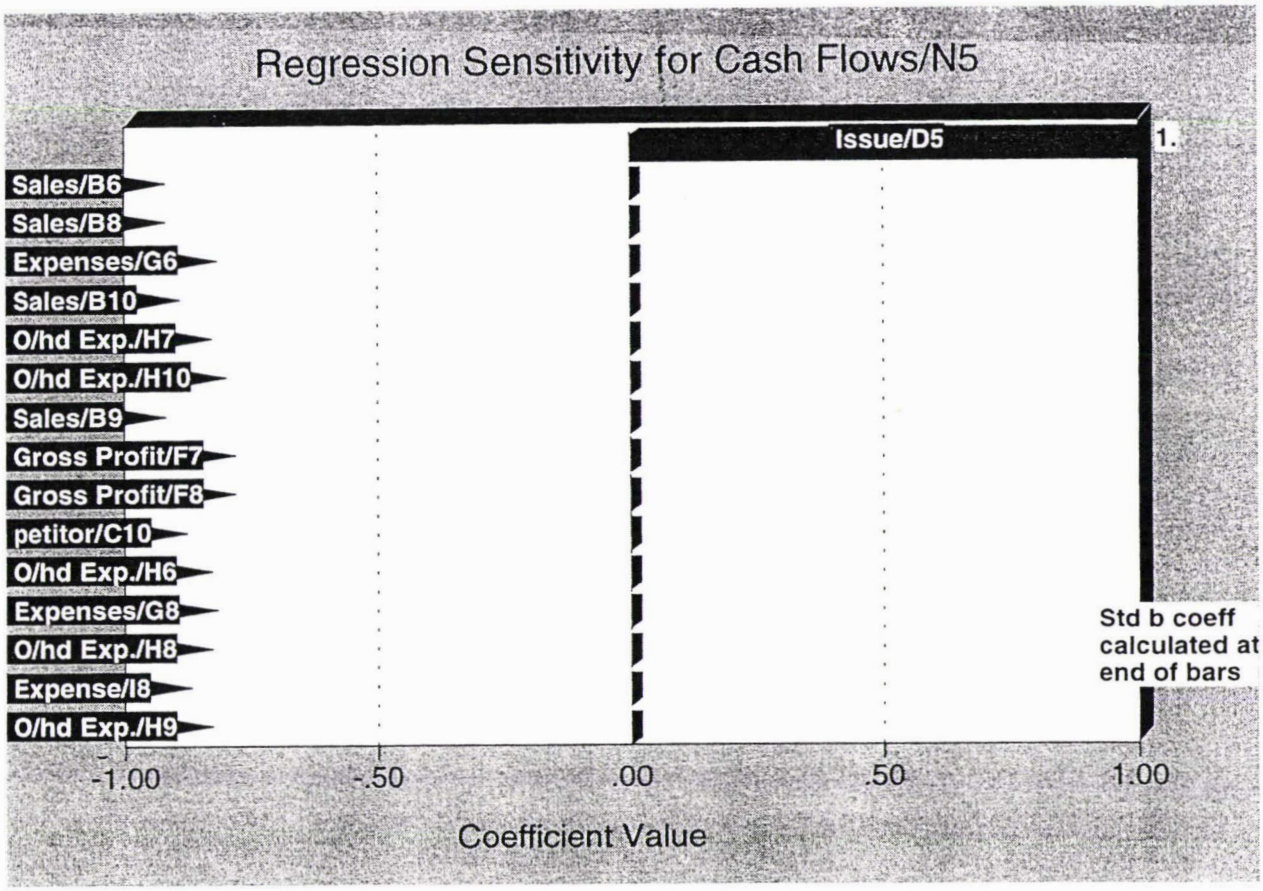
Biota NPV calculations - Zero Coupon/Convertible Income Bonds							(Figures in $M's)						
Year from launch	Sales 0.7321	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Int. Exp. + Repayment	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00	16.30	0.49	-0.49	0.00	0.00	0.00	0.00	0.00	-0.49	0.00	0.00	15.81
1	34.15			25.61	34.15	1.71	4.78	13.69	0.00	-28.72	0.00	0.00	-28.72
2	113.37			85.03	56.69	5.67	15.87	13.69	0.00	-6.89	0.00	0.00	-6.89
3	188.50			141.37	47.12	9.42	26.39	13.69	0.00	44.74	13.42	17.90	13.42
4	338.75			254.06	84.69	16.94	47.43	13.69	2.62	88.70	26.61	35.48	26.61
5	540.91			405.68	108.18	27.05	75.73	13.69	2.62	178.42	53.53	71.37	53.53
											NPV beta = 1		$35.69
											NPV beta = 1.75		$26.19
Assume:	Total amount of security issued =					25	million				NPV opp.cost = 6.528		$50.29
	Zero coupon bonds will convert into Income bonds once Net Profits are made												
	Interest rate payable on conversion is 1.75% > straight bond rate of 8.73 percent, ie. 10.48%												
	Interest will be paid on the bonds once Profit before Tax exceeds $62.5 million												
	Once conversion has occurred interest in arrears will be paid as soon as profits permit												
	Number of shares on issue =					65000000							
	Final dividend payable if profit is positive =					0.4	Payout ratio						

Biota NPV calculations - Preferred Shares				(Figures in $M's)								
Year from launch	Sales 0.7321	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent)	Int. + Div. Expense	Cash Flow
0	0.00	25.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	23.75
0.5	17.00			10.63	17.00	1.28	1.87	6.85	-16.37	0.00	0.86	-17.23
1	17.00			10.63	17.00	1.28	1.87	6.85	-16.37	0.00	0.86	-17.23
0.5	56.50			35.31	28.25	4.24	6.22	6.85	-10.24	0.00	0.86	-11.10
2	56.50			35.31	28.25	4.24	6.22	6.85	-10.24	0.00	0.86	-11.10
2.5	94.00			58.75	23.50	7.05	10.34	6.85	11.01	3.30	0.86	6.85
3	94.00			58.75	23.50	7.05	10.34	6.85	11.01	3.30	9.67	-1.96
3.5	169.50			105.94	42.38	12.71	18.65	6.85	25.36	7.61	0.86	16.89
4	169.50			105.94	42.38	12.71	18.65	6.85	25.36	7.61	21.15	-3.40
4.5	270.50			169.06	54.10	20.29	29.76	6.85	58.07	17.42	0.86	39.79
5	270.50			169.06	54.10	20.29	29.76	6.85	58.07	17.42	47.32	-6.67
										NPV beta = 1		$5.87
										NPV beta = 1.75		$2.84
										NPV opp.cost = 6.528		$10.75
		Assume:	Interest is paid semiannually									
			Interest rate is 2.017 percent > riskfree rate, ie.					6.887	percent pa			
			Number of shares on issue =					65000000				
			Final dividends payable if profits positive =					0.4	payout ratio			

Appendix 6: TORNADO GRAPHS FOR THE EQUITY AND OPTIONS/WARRANTS SECURITIES SHOWING THE REGRESSION RESULTS

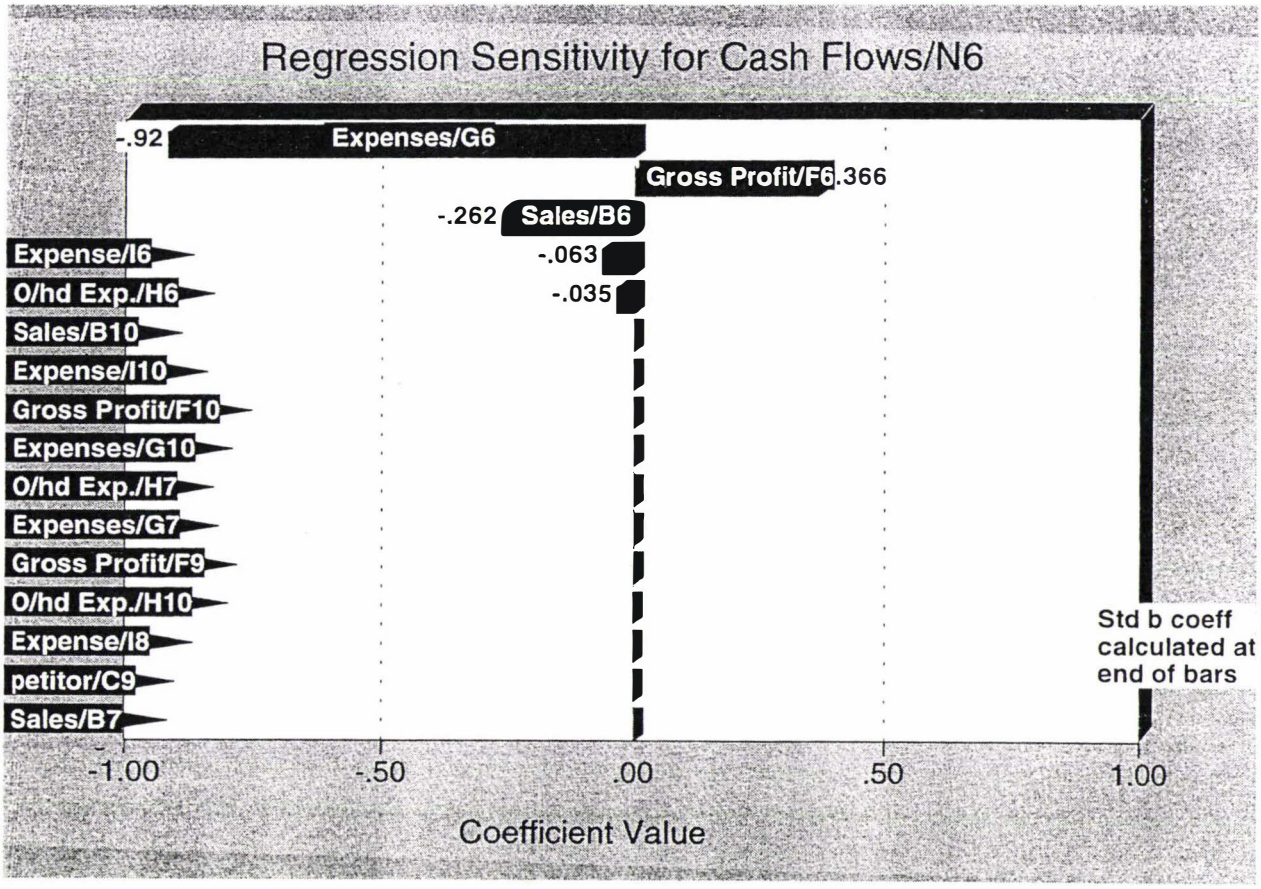
British Biotech plc

Equity Security - Year 0



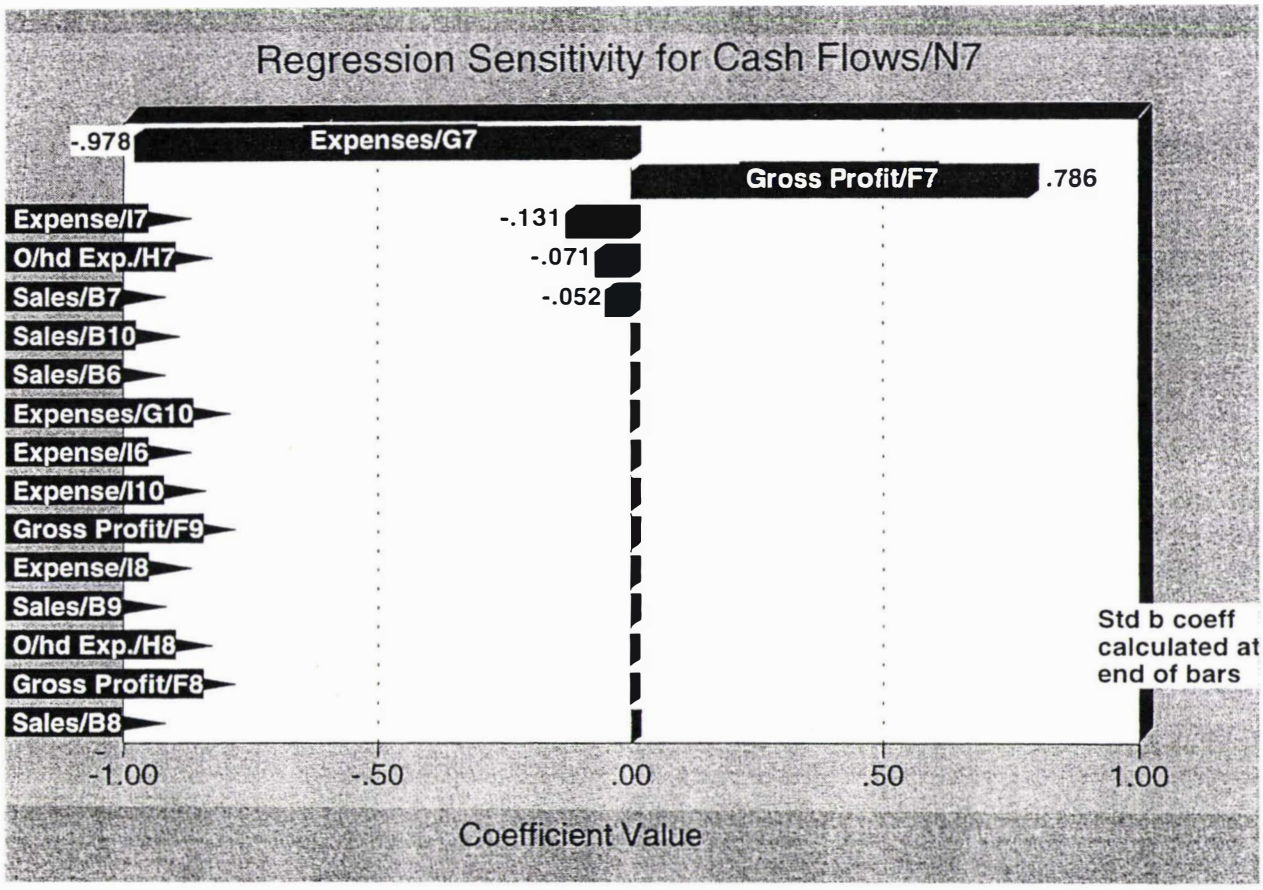
British Biotech plc

Equity Security - Year 1



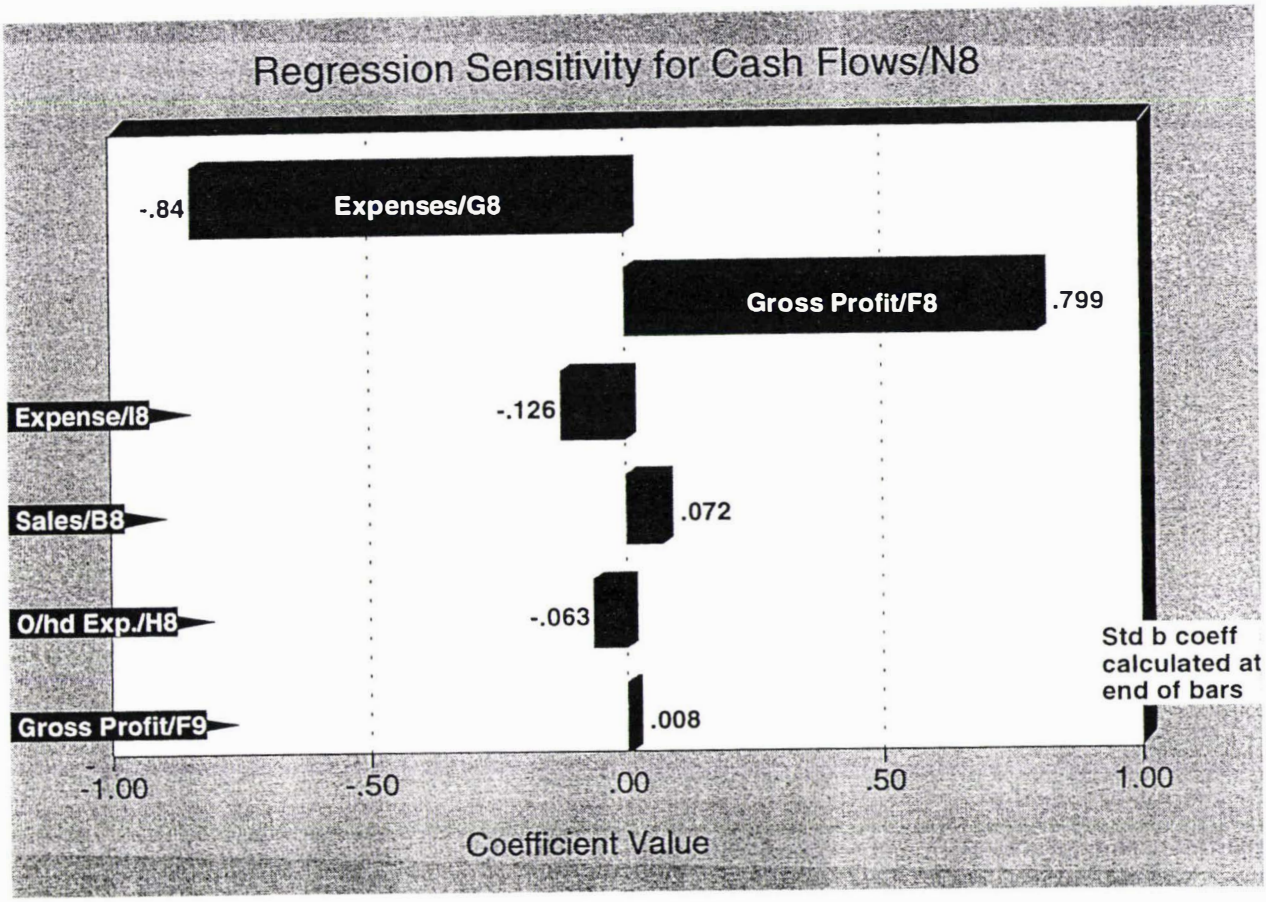
British Biotech plc

Equity Security - Year 2



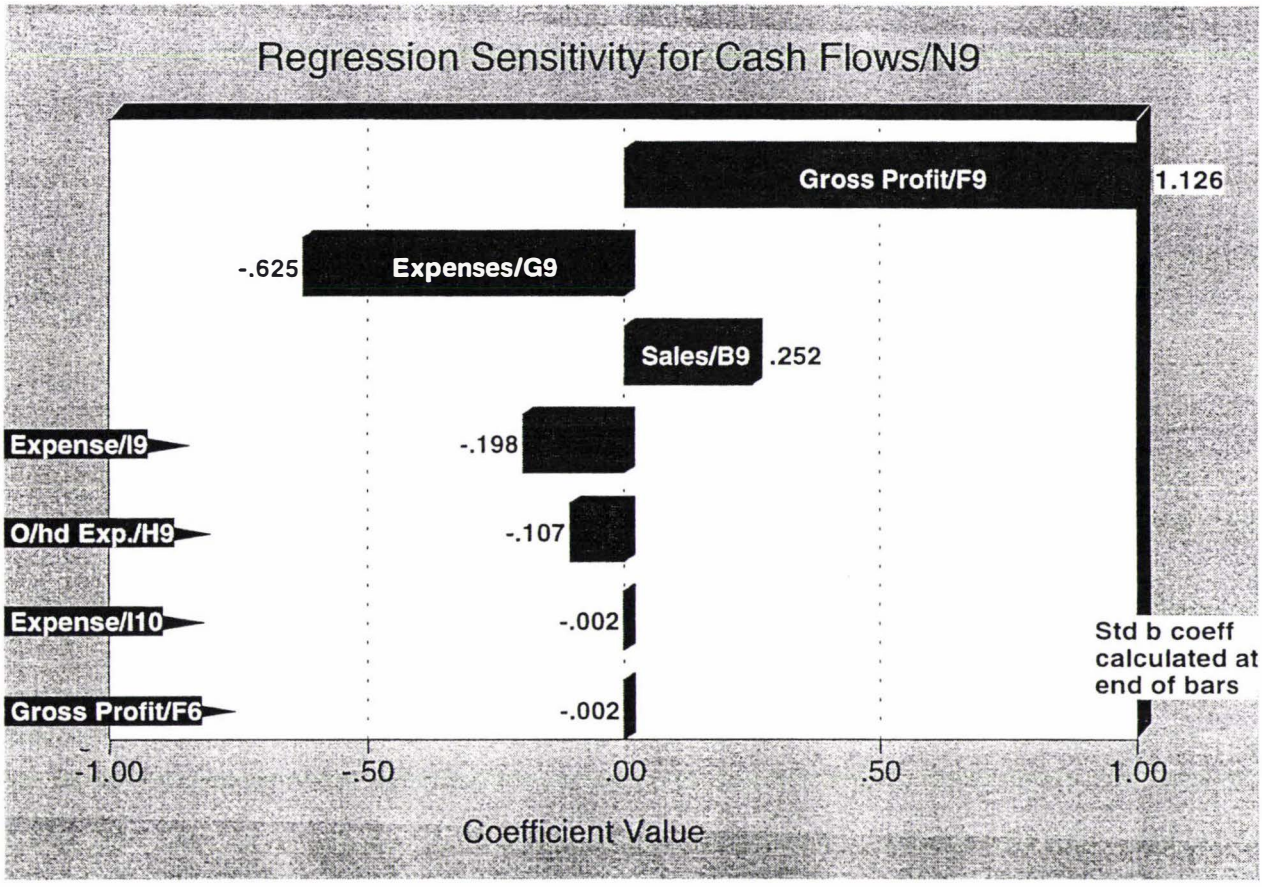
British Biotech plc

Equity Security - Year 3



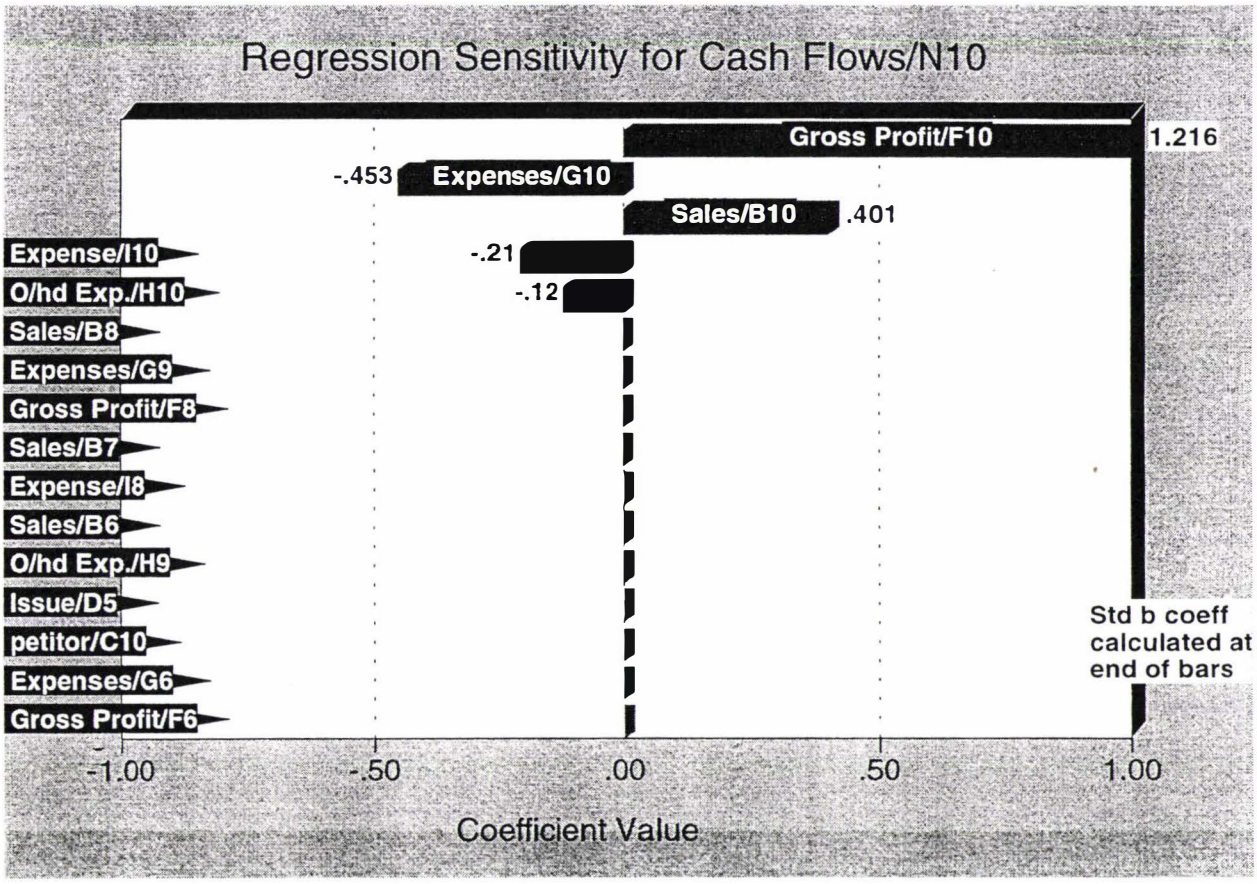
British Biotech plc

Equity Security - Year 4



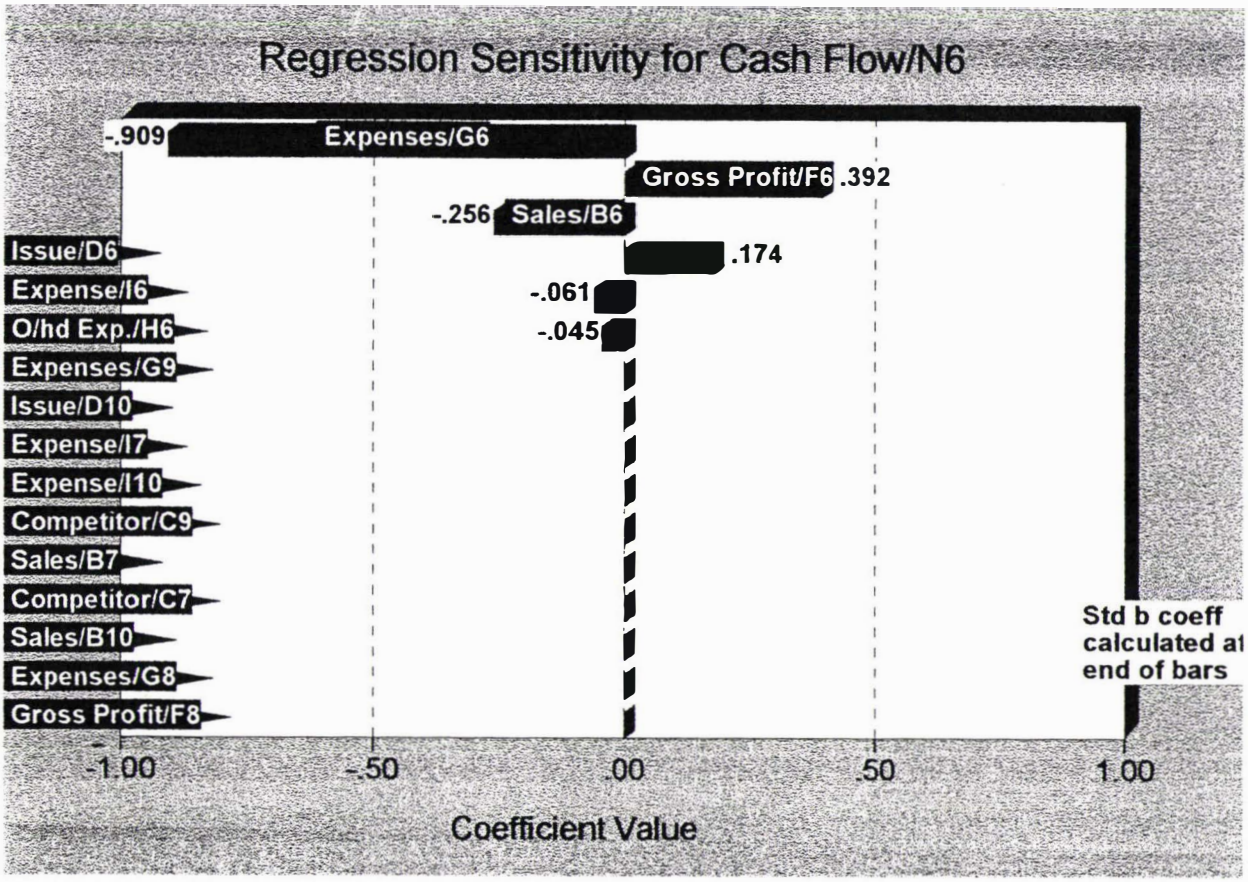
British Biotech plc

Equity Security - Year 5



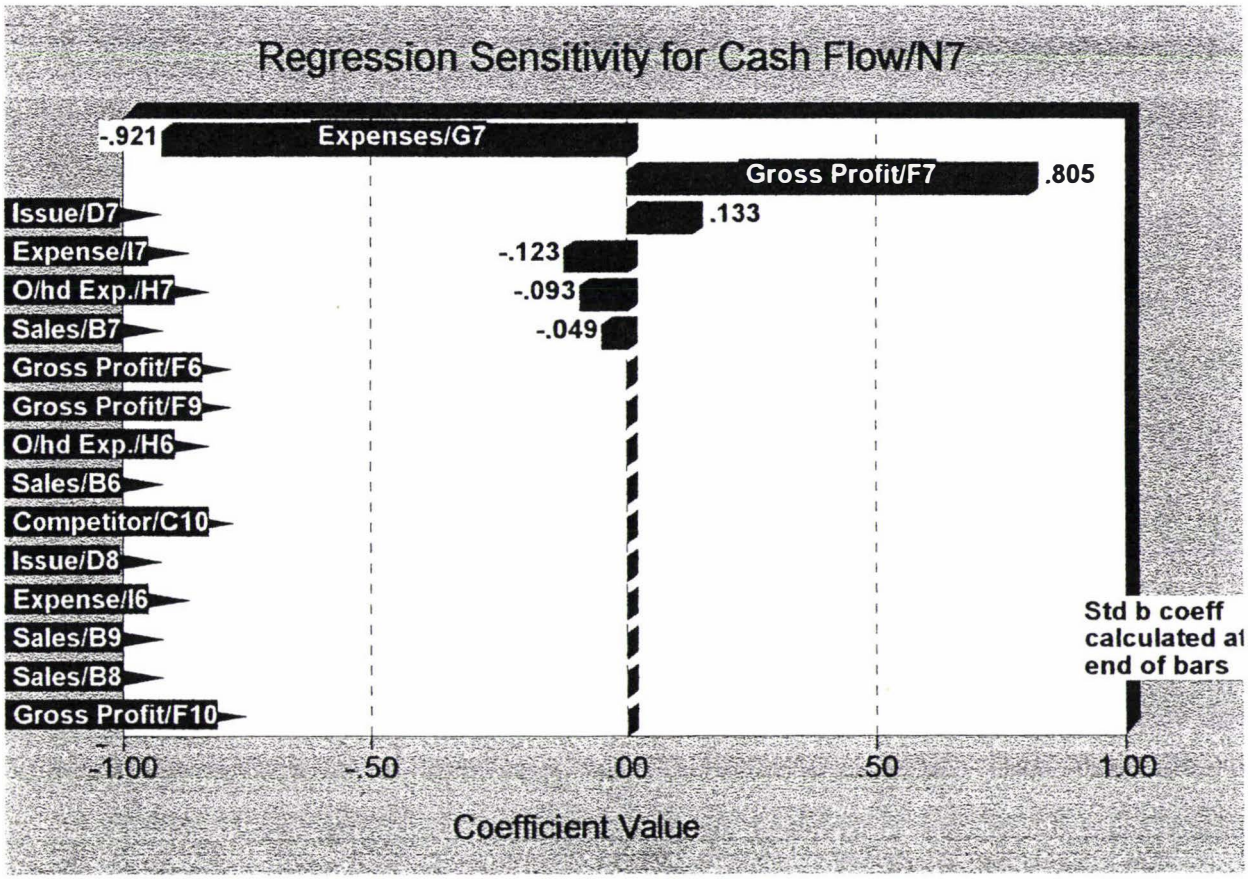
British Biotech plc

Options/Warrants Security - Year 1



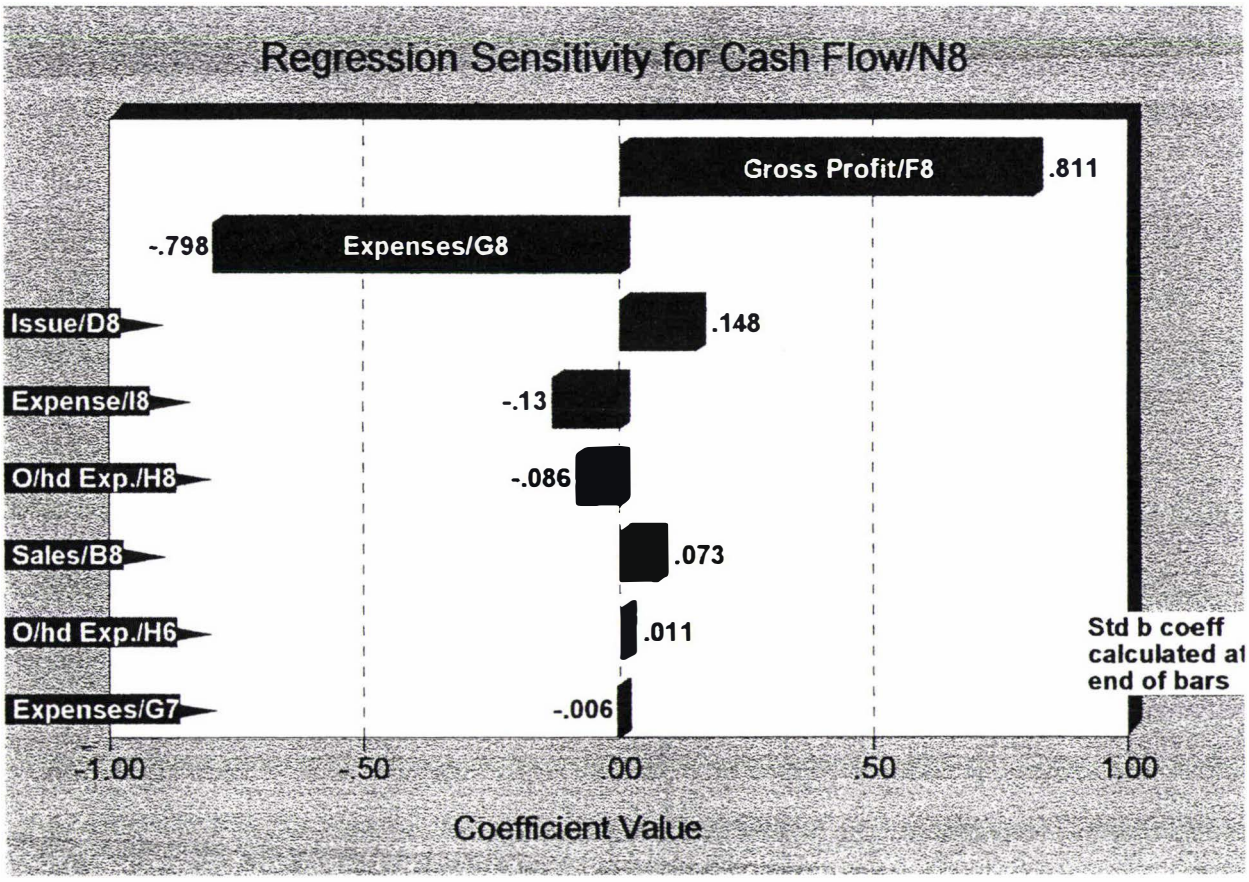
British Biotech plc

Options/Warrants Security - Year 2



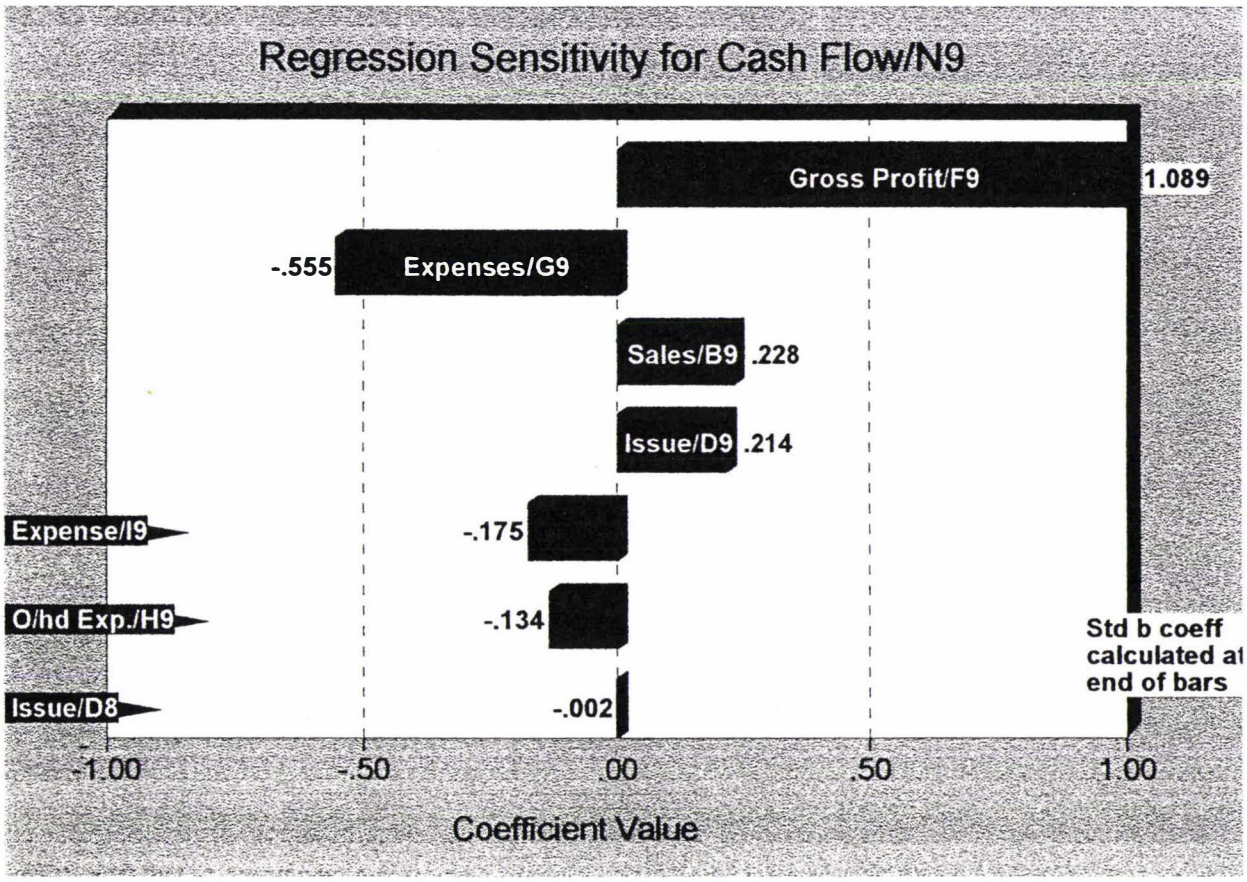
British Biotech plc

Options/Warrants Security - Year 3



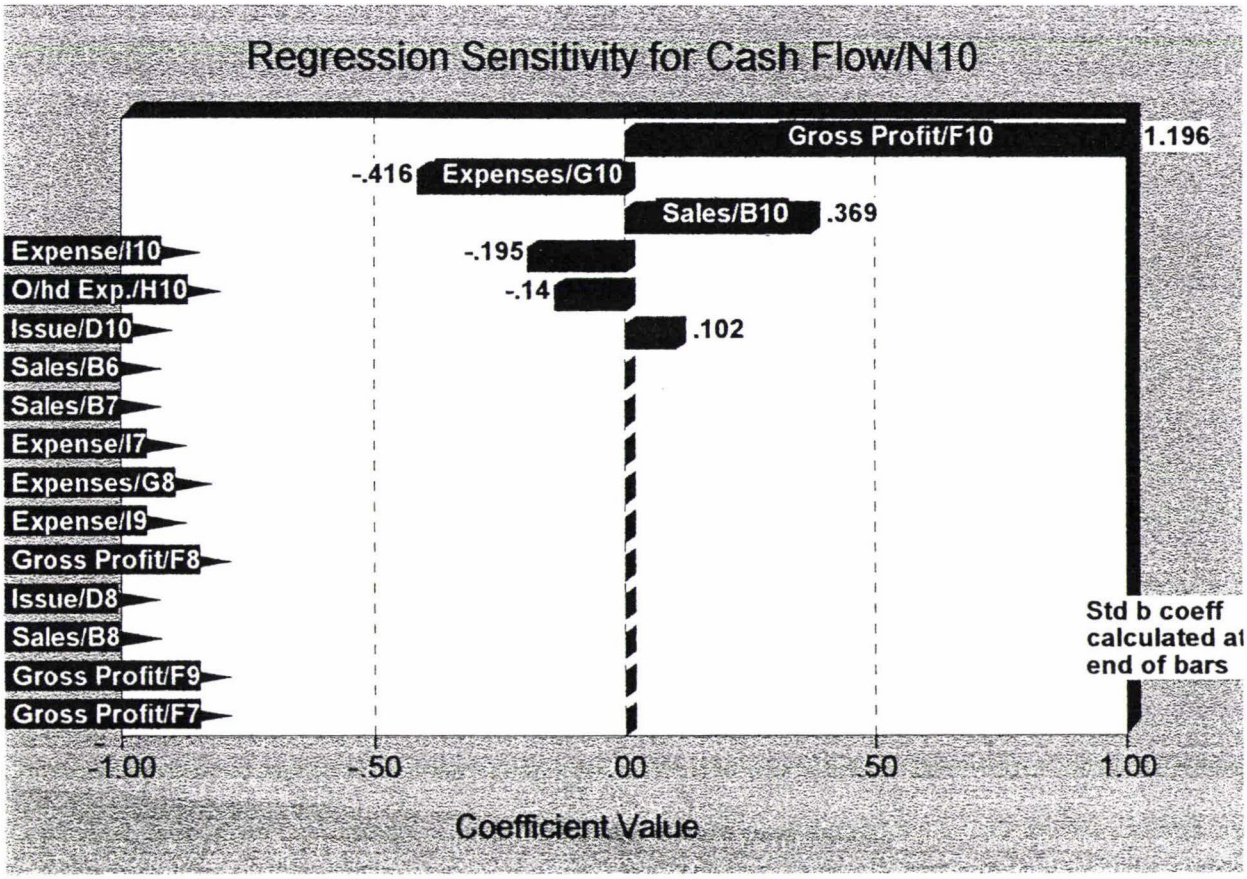
British Biotech plc

Options/Warrants Security - Year 4



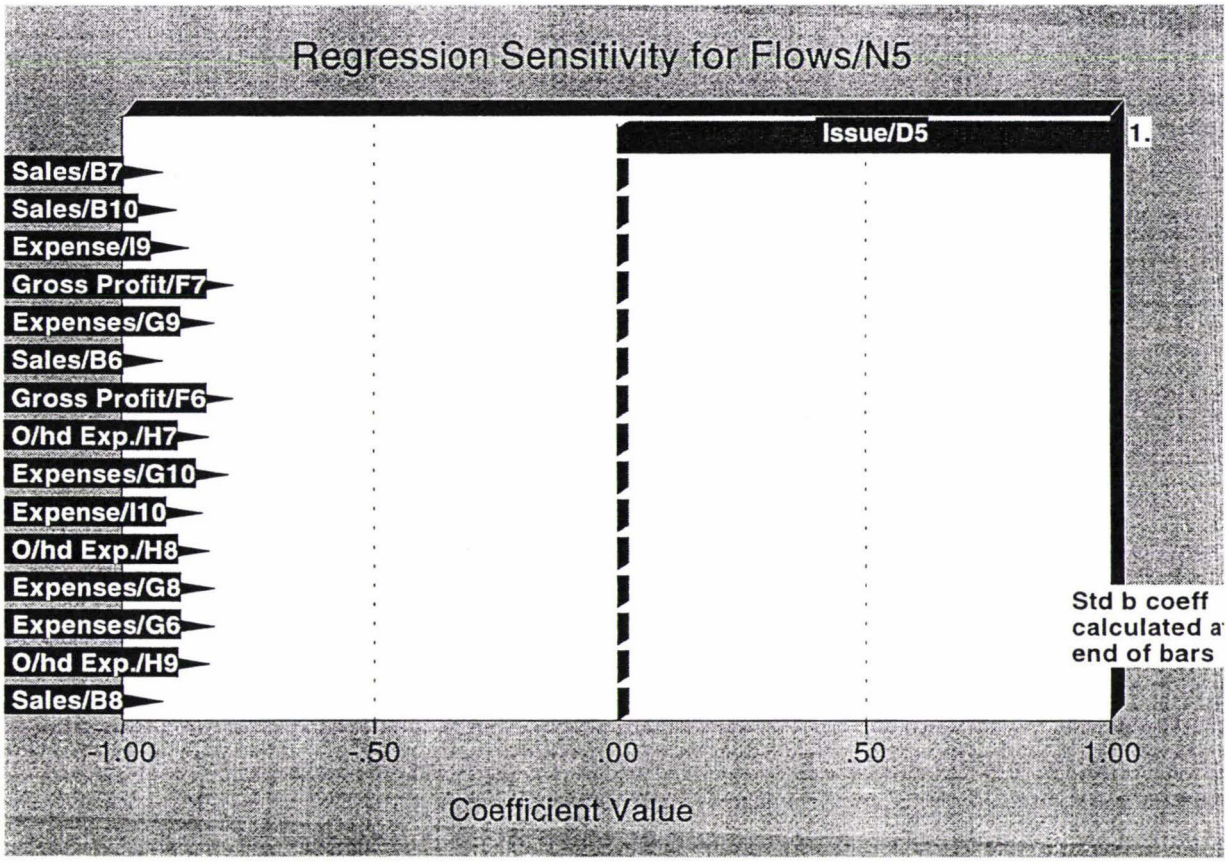
British Biotech plc

Options/Warrants Security - Year 5



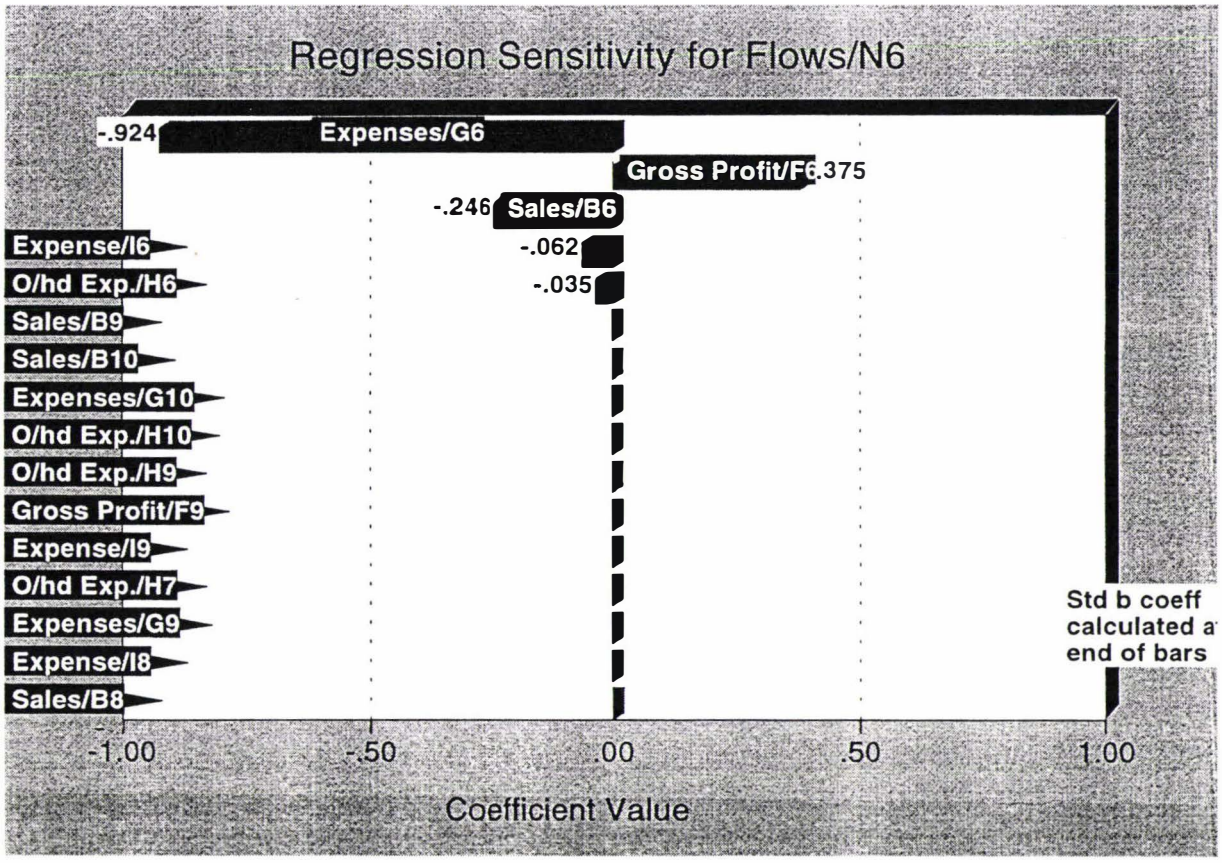
Biota Holdings Ltd

Equity Security - Year 0



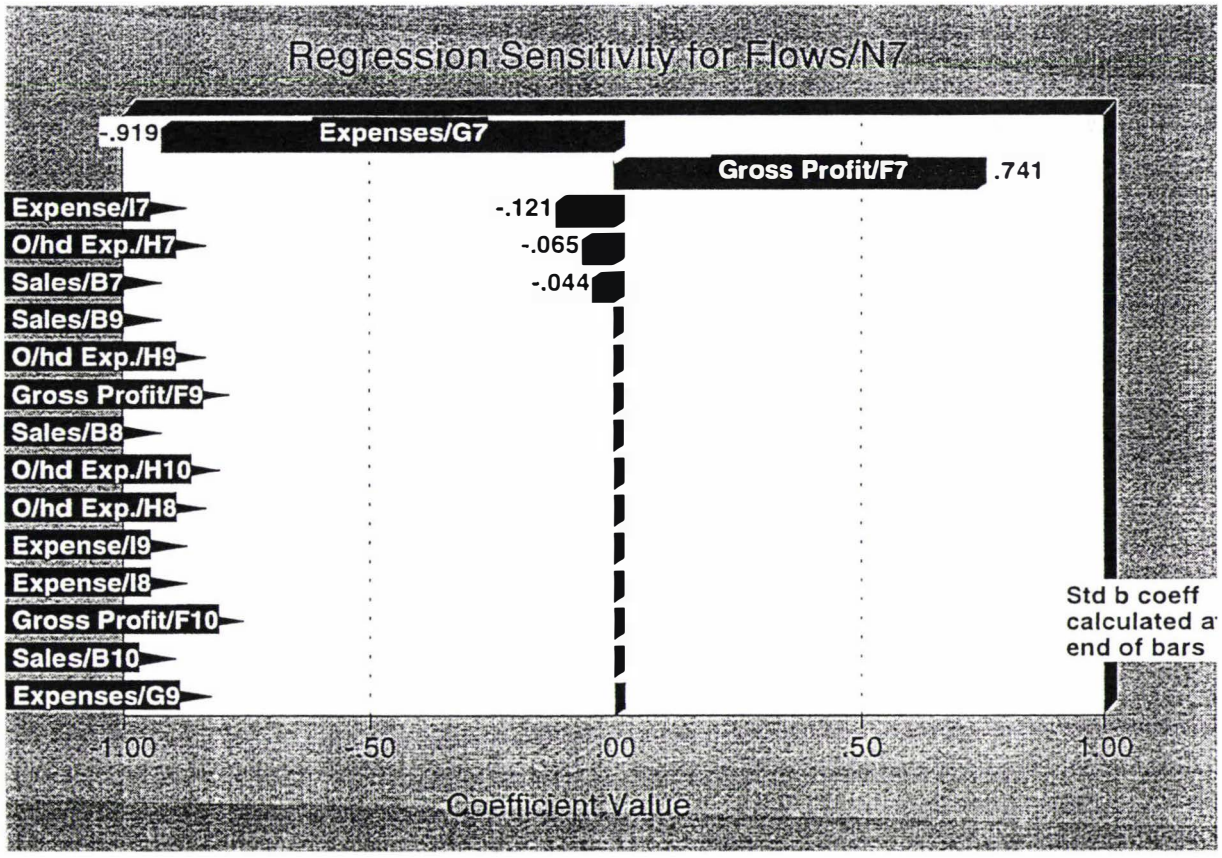
Biota Holdings Ltd

Equity Security - Year 1



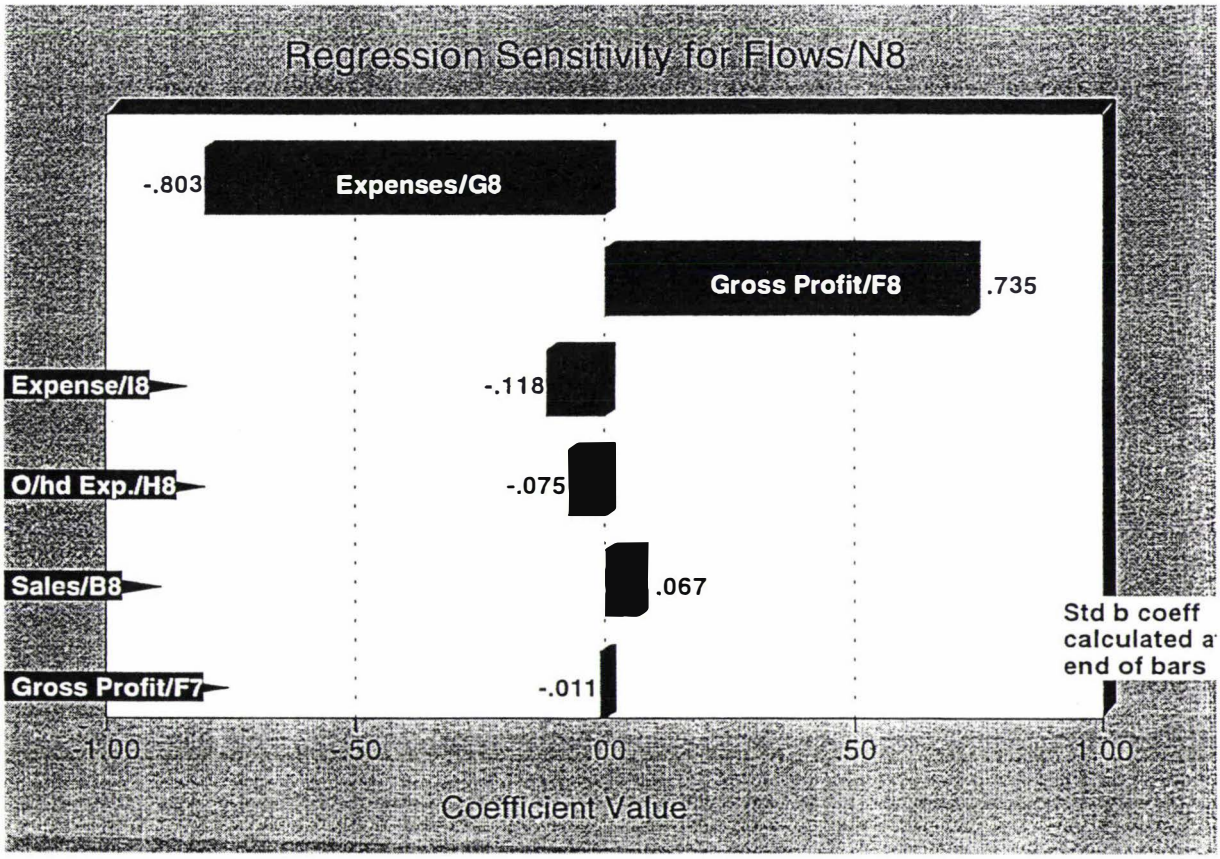
Biota Holdings Ltd

Equity Security - Year 2



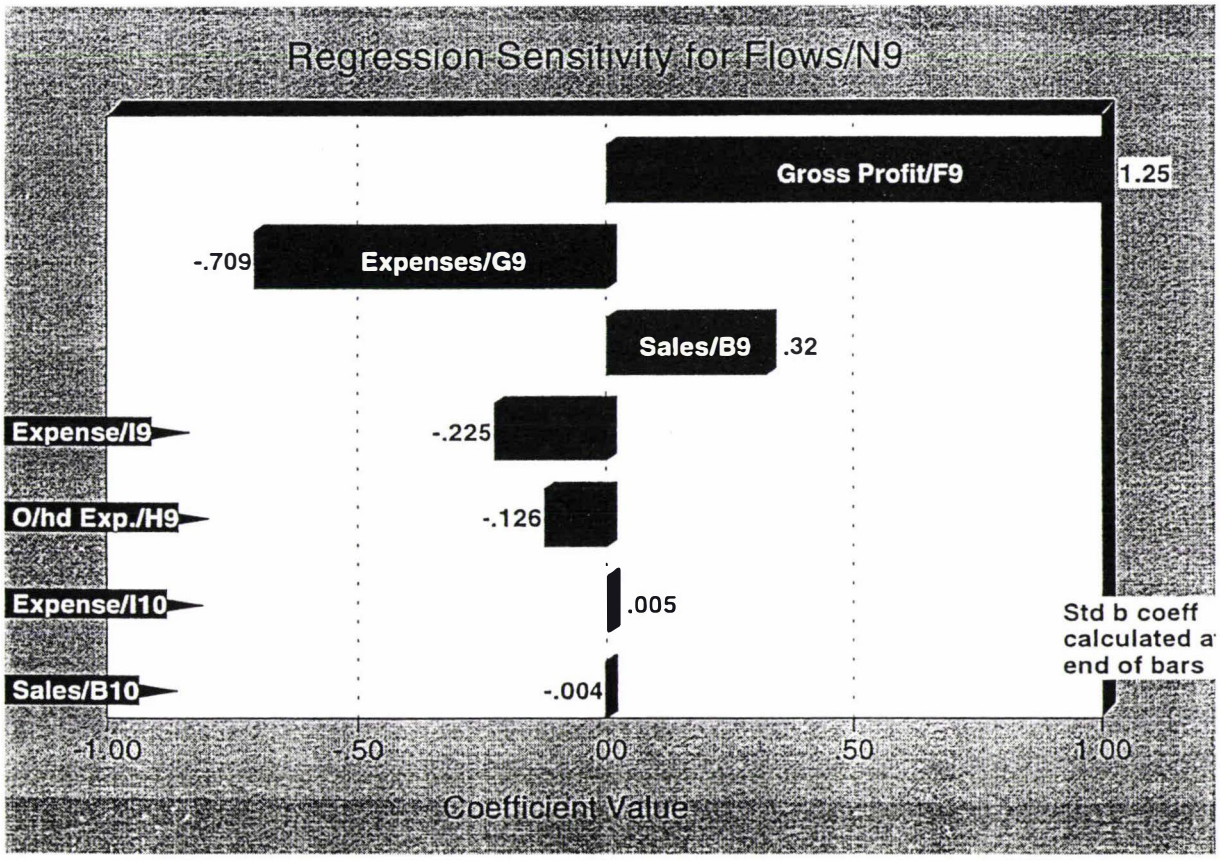
Biota Holdings Ltd

Equity Security - Year 3



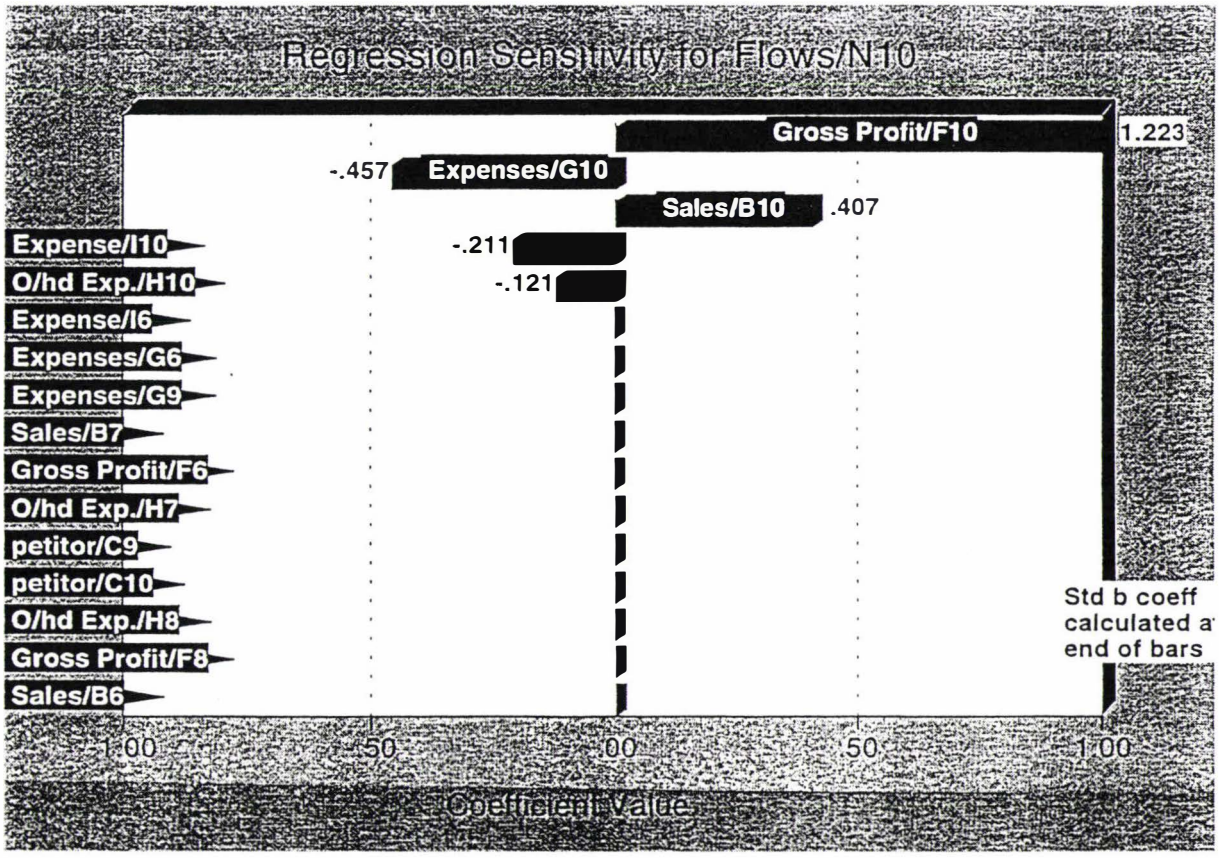
Biota Holdings Ltd

Equity Security - Year 4



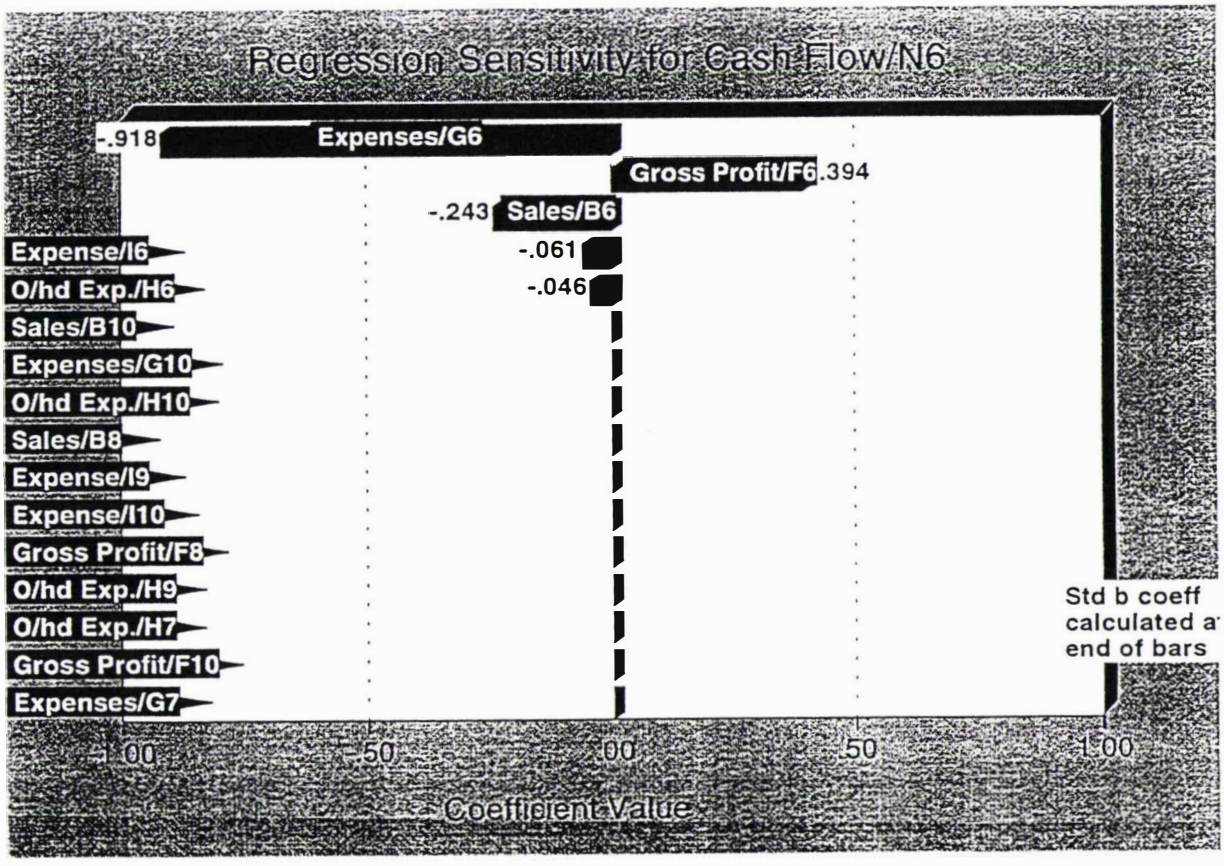
Biota Holdings Ltd

Equity Security - Year 5



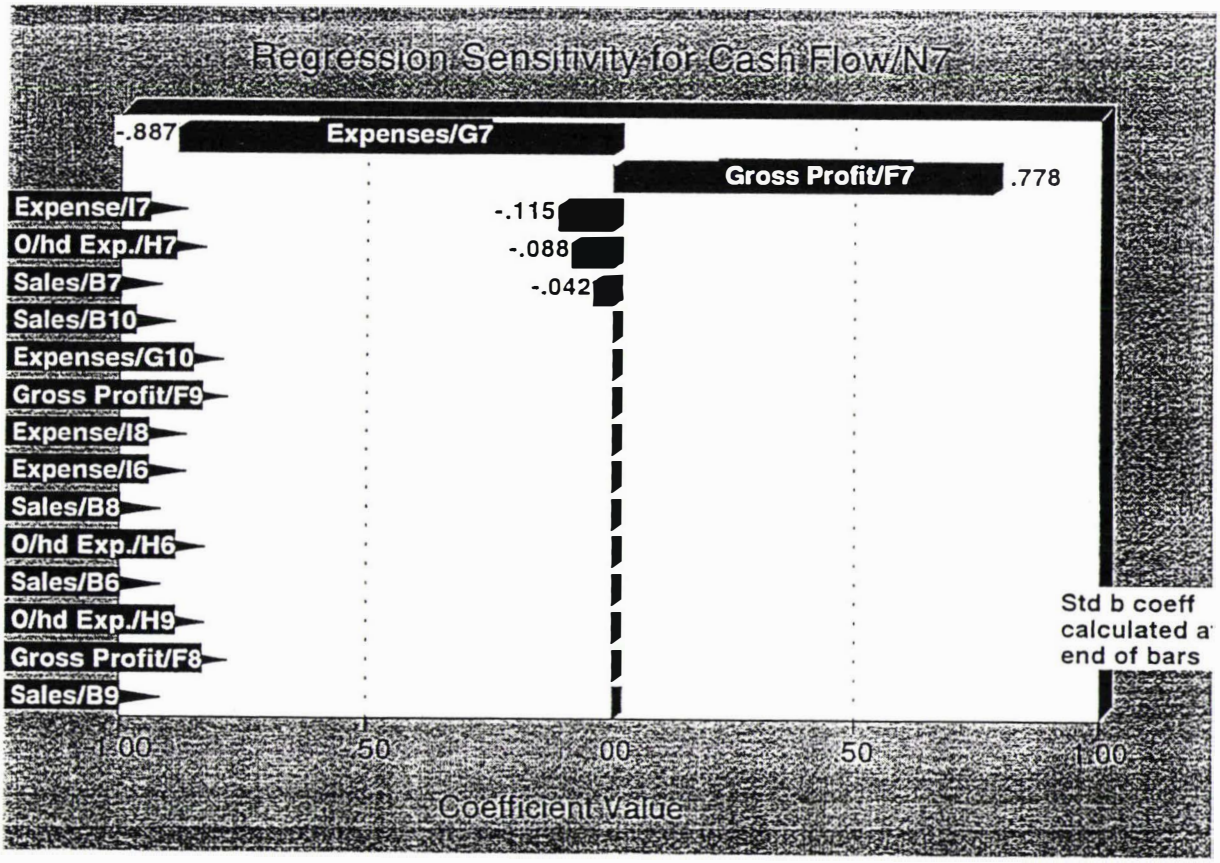
Biota Holdings Ltd

Options/Warrants Security - Year 1



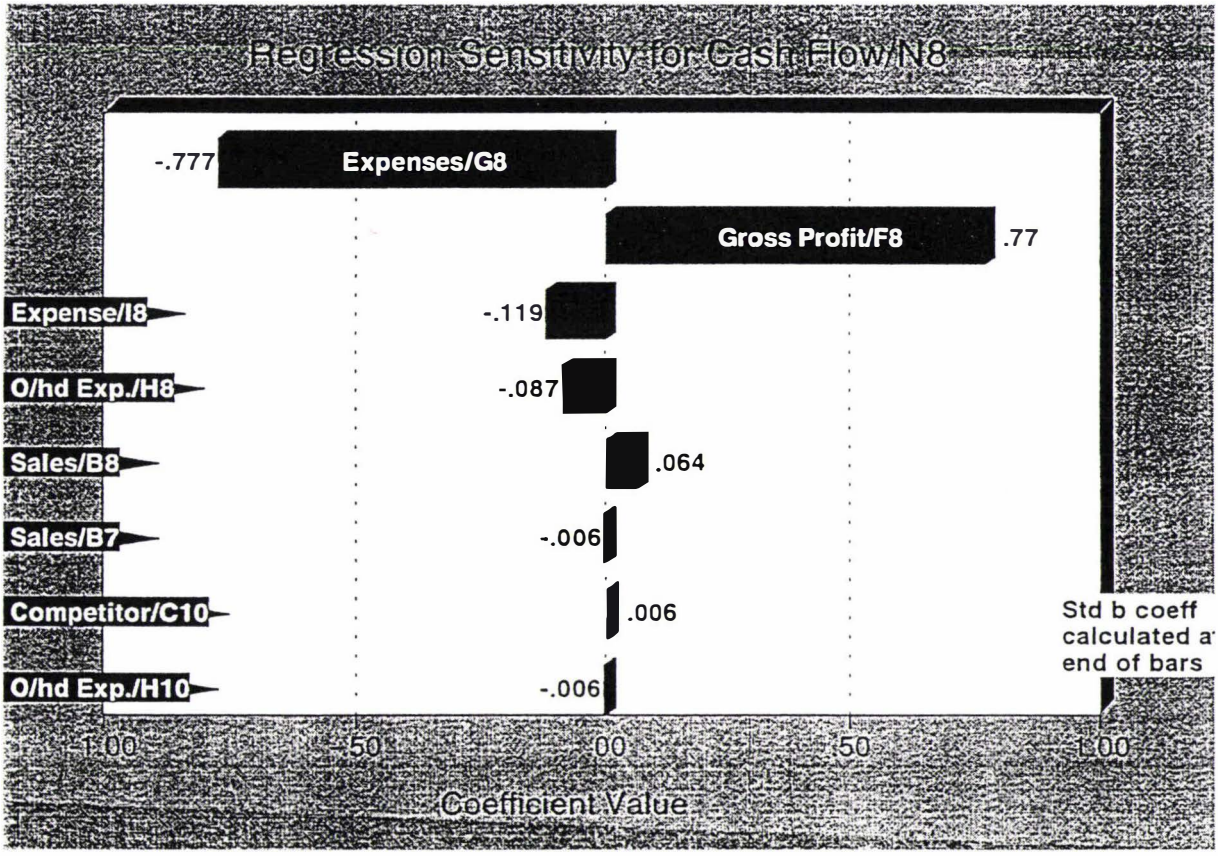
Biota Holdings Ltd

Options/Warrants Security - Year 2



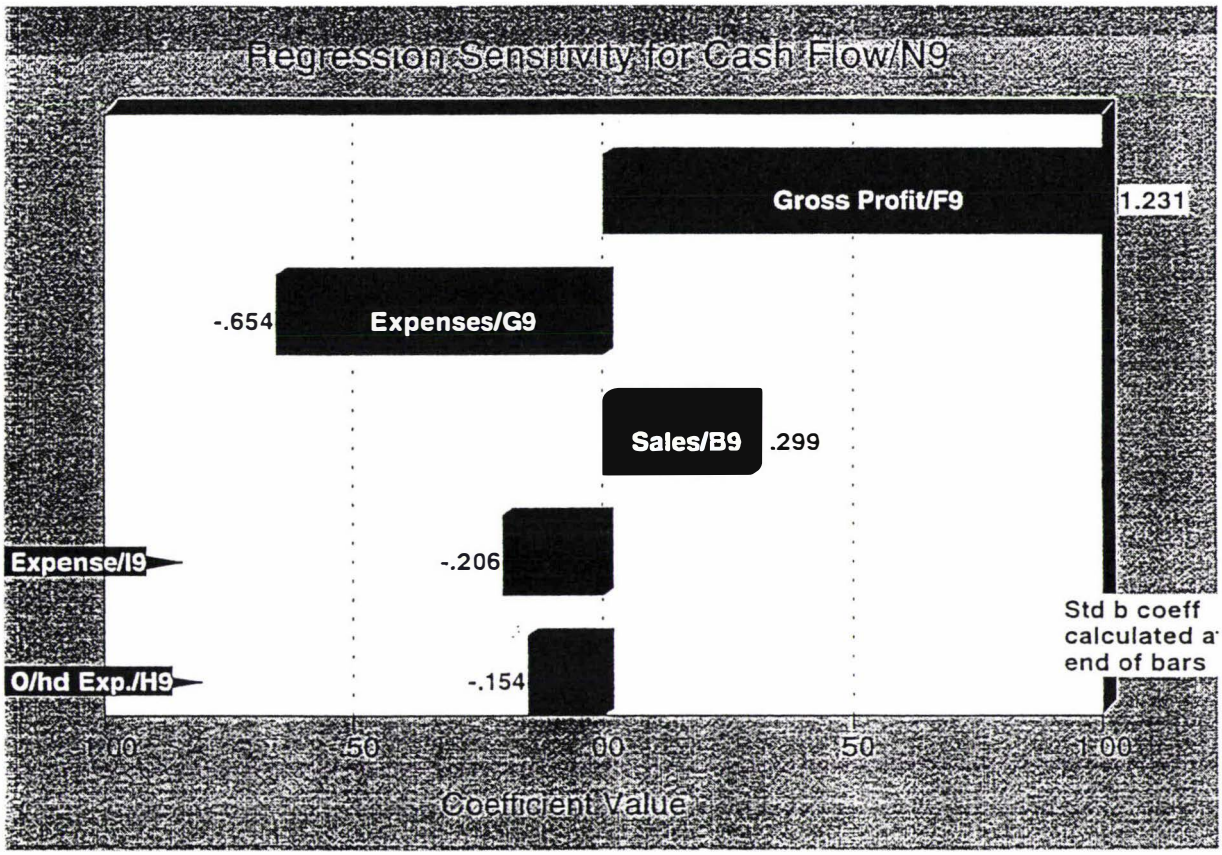
Biota Holdings Ltd

Options/Warrants Security - Year 3



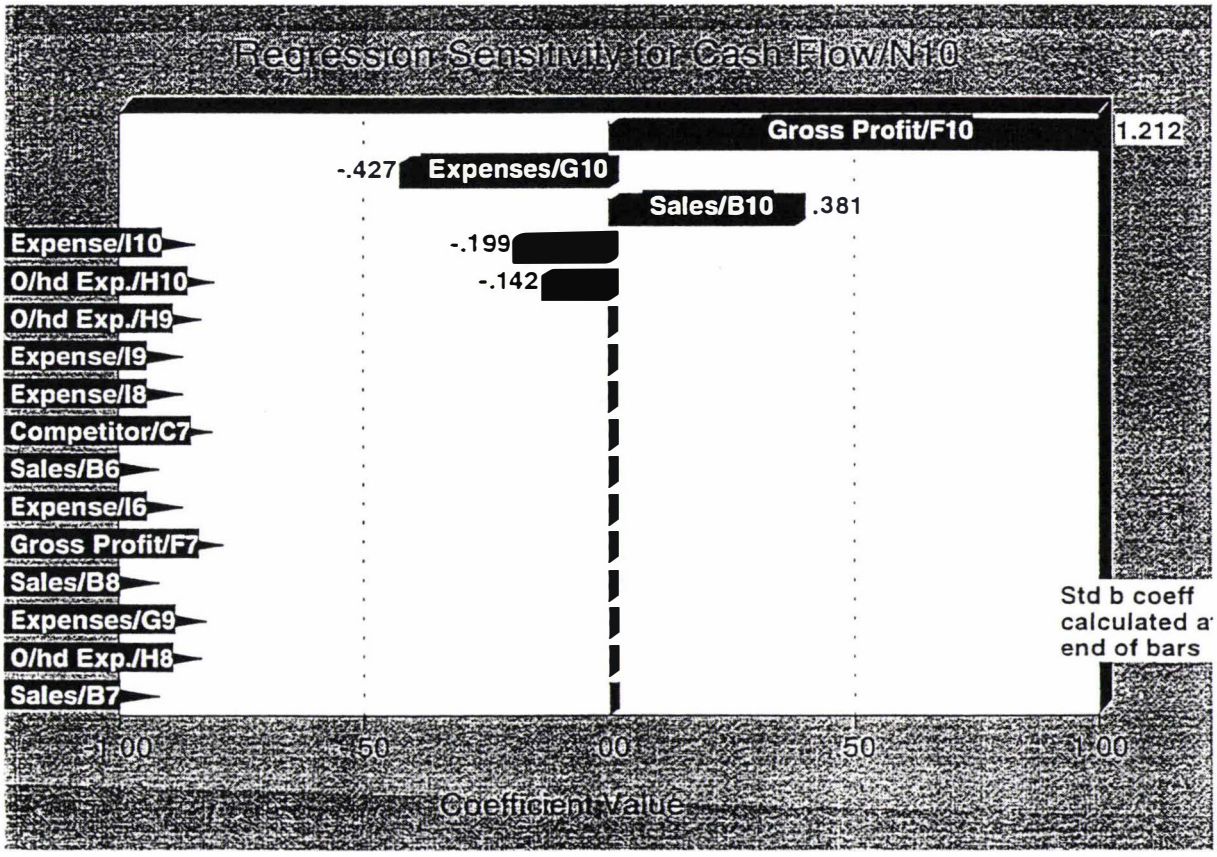
Biota Holdings Ltd

Options/Warrants Security - Year 4



Biota Holdings Ltd

Options/Warrants Security - Year 5



Appendix 7: SPREADSHEETS FOR EACH SECURITY INCORPORATING THE INPUTS REQUIRED FOR THE SIMULATIONS

British Biotech NPV calculations - Equity					(Figures in $M's)								
Year from launch	Sales	Com-petitor	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flows
0	0.00		40.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	38.00
1	18.33				22.46	45.83	2.57	4.03	6.24	-36.22	0.00	0.00	-36.22
2	58.00	0.00			71.05	72.50	8.12	12.76	6.24	-28.57	0.00	0.00	-28.57
3	95.00				116.38	71.25	13.30	20.90	6.24	4.69	1.41	1.87	1.41
4	153.00	0.00			187.43	91.80	21.42	33.66	6.24	34.31	10.29	13.72	10.29
5	282.33	0.00			345.86	127.05	39.53	62.11	6.24	110.93	33.28	44.37	33.28
											NPV beta = 1		$10.87
											NPV beta = 1.75		$10.60
											NPV opp.cost = 7.078		$11.09
			Assume:	Number of shares previously on issue =				58000000					
				Number of shares offered in this issue =				23000000					
						Total shares =		81000000					
				Final dividend payable if profit positive =				0.4	payout ratio				

British Biotech NPV calculations - Options/Warrants						(Figures in $M's)							
Year from launch	Sales	Competitor	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent	Dividend Expense	Cash Flow
0	0.00		0.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	-2.00
1	18.33		8.00		22.92	45.83	2.75	4.03	6.24	-35.94	0.00	0.00	-27.94
2	58.00	0.00	8.00		72.50	72.50	8.70	12.76	6.24	-27.70	0.00	0.00	-19.70
3	95.00		8.00		118.75	71.25	14.25	20.90	6.24	6.11	1.83	2.44	9.83
4	153.00	0.00	8.00		191.25	91.80	22.95	33.66	6.24	36.60	10.98	14.64	18.98
5	282.33	0.00	8.00		352.92	127.05	42.35	62.11	6.24	115.16	34.55	46.07	42.55
											NPV beta =1		$6.41
											NPV beta = 1.75		$5.81
					Assume:	Total value of options issued =				40000000	NPV opp.cost = 7.078		$6.91
						Percent of options exercised annually				20			
						Number of shares exercised =				23000000			
						Number of shares previously issued =				58000000			
								Total shares =		81000000			
						Final dividend payable if profit is positive =				0.4	Payout ratio		

British Biotech NPV calculations - Zero Coupon Bonds								(Figures in $M's)						
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Bond Repaymen	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00		26.60	0.80	-0.80	0.00	0.00	0.00	0.00	0.00	-0.80	0.00	0.00	23.36
1	18.33				22.92	45.83	2.75	4.03	6.24	0.00	-35.94	0.00	0.00	-35.94
2	58.00	0.00			72.50	72.50	8.70	12.76	6.24	0.00	-27.70	0.00	0.00	-27.70
3	95.00				118.75	71.25	14.25	20.90	6.24	0.00	6.11	1.83	2.44	1.83
4	153.00	0.00			191.25	91.80	22.95	33.66	6.24	0.00	36.60	10.98	14.64	10.98
5	282.33	0.00			352.92	127.05	42.35	62.11	6.24	40.00	75.16	22.55	30.07	22.55
												NPV beta = 1		($8.01)
												NPV beta = 1.75		($8.10)
			Assume:	Number of shares on issue =					58000000			NPV opp.cost = 7.078		($7.94)
				Final dividends payable if profits positive =					0.4	payout ratio				

British Blotech NPV calculations - Convertible Debt							(Figures in $M's)							
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Int.Exp. + Repayment	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00		40.00	1.52	-1.52	0.00	0.00	0.00	0.00	0.00	-1.52	0.00	0.00	38.48
0.5	9.17				11.46	22.92	1.38	2.02	3.12	1.53	-19.50	0.00	0.00	-19.50
1	9.17				11.46	22.92	1.38	2.02	3.12	1.53	-19.50	0.00	0.00	-19.50
1.5	29.00				36.25	36.25	4.35	6.38	3.12	1.53	-15.38	0.00	0.00	-15.38
2	29.00	0.00			36.25	36.25	4.35	6.38	3.12	1.53	-15.38	0.00	0.00	-15.38
2.5	47.50				59.38	35.63	7.13	10.45	3.12	1.53	1.52	0.46	0.00	1.07
3	47.50				59.38	35.63	7.13	10.45	3.12	1.53	1.52	0.46	1.22	-0.15
3.5	76.50				95.63	45.90	11.48	16.83	3.12	1.53	16.77	5.03	0.00	11.74
4	76.50	0.00			95.63	45.90	11.48	16.83	3.12	1.53	16.77	5.03	13.41	-1.68
4.5	141.17				176.46	63.53	21.18	31.06	3.12	1.30	56.28	16.88	0.00	39.40
5	141.17	0.00			176.46	63.53	21.18	31.06	3.12	4.92	52.66	15.80	43.58	-6.71
												NPV beta = 1		$6.55
												NPV beta = 1. 75		$6.33
Assume:			Revenues and expenses are equal at half year and end of year									NPV opp.cost = 7.078		$6.74
			Interest rate payable on the debt is .791% > the riskfree rate = 7.661%											
			Par value is L500 and bond can be converted into 264.55 shares valued at L1.89 each											
			Conversion can occur from year 4 to year 5											
			Conversion will take place as follows: 15 percent at year 4, 25 percent at year 4.5, 50 percent at year 5,											
			the balance redeemed at year 5.											
			Final dividends are paid if profits are made						0.4	payout ratio				
			Number of shares on issue year 4 =						58000000	(NB dividends will not be paid on shares converted				
			Number of year 5 shares eligible for dividend payment =						67200000	in year 4 until year 5.)				

British Biotech NPV calculations - Zero Coupon/Convertible Income Bonds											(Figures in $M's)				
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expend.	Profit bef. Int.& Tax	Int. Exp. + Repayment	Profit Bef. Tax	Taxation (30%)	Dividend Expense	Cash Flows
0	0.00		26.15	0.78	-0.78	0.00	0.00	0.00	0.00	-0.78	0.00	-0.78	0.00	0.00	22.92
1	18.33				22.92	45.83	2.75	4.03	6.24	-35.94	0.00	-35.94	0.00	0.00	-35.94
2	58.00	0.00			72.50	72.50	8.70	12.76	6.24	-27.70	0.00	-27.70	0.00	0.00	-27.70
3	95.00				118.75	71.25	14.25	20.90	6.24	6.11	0.00	6.11	1.83	2.44	1.83
4	153.00	0.00			191.25	91.80	22.95	33.66	6.24	36.60	3.55	33.05	9.92	13.22	9.92
5	282.33	0.00			352.92	127.05	42.35	62.11	6.24	115.16	43.55	71.62	21.48	28.65	21.48
													NPV beta = 1		($9.86)
													NPV beta = 1.75		($9.92)
	Assume:			Total amount of security issued =					40		million		NPV opp.cost 7.078		($9.81)
				Zero coupon bonds will convert into Income bonds once Net Profits are made											
				Interest rate payable on conversion is 2.0% > the riskfree rate, ie.								8.87	percent		
				Interest will be paid on the bonds once Profits before Tax exceeds L25 million											
				Once conversion has occurred interest in arrears will be paid as soon as profits permit											
				Number of shares on issue =					58000000						
				Final dividends payable if profits made					0.4	payout ratio					

British Biotech NPV calculations - Preferred Shares						(Figures in $M's)							
Year from launch	Sales	Com-petition	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent)	Int. & Div. Expense	Cash Flow
0	0.00		40.00	2.00	-2.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	38.00
0.5	9.17				11.46	22.92	1.38	2.02	3.12	-17.97	0.00	1.78	-19.75
1	9.17				11.46	22.92	1.38	2.02	3.12	-17.97	0.00	1.78	-19.75
1.5	29.00				36.25	36.25	4.35	6.38	3.12	-13.85	0.00	1.78	-15.63
2	29.00	0.00			36.25	36.25	4.35	6.38	3.12	-13.85	0.00	1.78	-15.63
2.5	47.50				59.38	35.63	7.13	10.45	3.12	3.06	0.92	1.78	0.36
3	47.50				59.38	35.63	7.13	10.45	3.12	3.06	0.92	4.22	-2.08
3.5	76.50				95.63	45.90	11.48	16.83	3.12	18.30	5.49	1.78	11.03
4	76.50	0.00			95.63	45.90	11.48	16.83	3.12	18.30	5.49	16.42	-3.61
4.5	141.17				176.46	63.53	21.18	31.06	3.12	57.58	17.27	1.78	38.53
5	141.17	0.00			176.46	63.53	21.18	31.06	3.12	57.58	17.27	47.84	-7.54
											NPV beta = 1		$0.09
											NPV beta = 1.75		($0.05)
											NPV opp.cost = 7.078		$0.20
	Assume:		Interest is paid semiannually										
			Interest rate is .7661 greater than the riskfree rate of 6.87 =7.661										
			Number of shares on issue =					58000000					
			Final dividends payable in years 4 and 5 =					0.4	payout ratio				

Biota NPV calculations - Equity					(Figures in $M's)								
Year from launch	Sales	Com-petitor	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30%)	Dividend Expense	Cash Flow
0	0.00		25.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	23.75
1	38.00				46.55	95.00	5.32	8.36	13.69	-75.82	0.00	0.00	-75.82
2	122.33	0.00			149.86	152.92	17.13	26.91	13.69	-60.79	0.00	0.00	-60.79
3	203.67				249.49	152.75	28.51	44.81	13.69	9.73	2.92	3.89	2.92
4	388.33	0.00			475.71	233.00	54.37	85.43	13.69	89.22	26.77	35.69	26.77
5	645.33	0.00			790.53	290.40	90.35	141.97	13.69	254.12	76.24	101.65	76.24
											NPV beta = 1		($27.35)
											NPV beta = 1.75		($30.03)
											NPV opp.cost = 6.528		($20.86)
			Assume:	Number of shares previously on issue =				65000000					
				Number of shares offered in this issue =				5800000					
						Total shares =		70800000					
				Final dividend payable if profit is positive =				0.4	Payout ratio				

Biota NPV calculations - Options/Warrants						(Figures In $M's)							
Year from launch	Sales	Competitor	Security Issue	Issue Expenses	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Expense	Capital Expenditure	Profit Before Tax	Taxation (30 percent	Dividend Expense	Cash Flow
0	0.00		0.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	-1.25
1	38.00		5.00		47.50	95.00	5.70	8.36	13.69	-75.25	0.00	0.00	-70.25
2	122.33	0.00	5.00		152.92	152.92	18.35	26.91	13.69	-58.95	0.00	0.00	-53.95
3	203.67		5.00		254.58	152.75	30.55	44.81	13.69	12.79	3.84	5.11	8.84
4	388.33	0.00	5.00		485.42	233.00	58.25	85.43	13.69	95.04	28.51	38.02	33.51
5	645.33	0.00	5.00		806.67	290.40	96.80	141.97	13.69	263.80	79.14	105.52	84.14
											NPV beta =1		($29.14)
											NPV beta = 1.75		($34.34)
					Assume:	Total value of options issued =				25000000	NPV opp.cost =6.528		($19.63)
						Percent of options exercised annually				20			
						Number of shares exercised =				5800000			
						Number of shares previously Issued =				65000000			
								Total shares =		70800000			
						Final dividend payable if profit is positive =				0.4	Payout ratio		

Biota NPV calculations - Zero Coupon Bonds								(Figures in $M's)						
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Bond Repaymen	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00		18.32	0.55	-0.55	0.00	0.00	0.00	0.00	0.00	-0.55	0.00	0.00	12.66
1	38.00				47.50	95.00	5.70	8.36	13.69	0.00	-75.25	0.00	0.00	-75.25
2	122.33	0.00			152.92	152.92	18.35	26.91	13.69	0.00	-58.95	0.00	0.00	-58.95
3	203.67				254.58	152.75	30.55	44.81	13.69	0.00	12.79	3.84	5.11	3.84
4	388.33	0.00			485.42	233.00	58.25	85.43	13.69	0.00	95.04	28.51	38.02	28.51
5	645.33	0.00			806.67	290.40	96.80	141.97	13.69	25.00	238.80	71.64	95.52	71.64
												NPV beta = 1		($36.18)
												NPV beta = 1.75		($38.33)
			Assume:	Number of shares on issue =					65000000			NPV opp.cost = 6.528		($30.41)
				Final dividends payable if profits positive =					0.4	payout ratio				
				Interest rate payable on the bond is 1.547% > the riskfree rate, ie.							6.417	percent		

Biota NPV calculations - Convertible Debt							(Figures in $M's)							
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expenditure	Int.Exp. + Repayment	Profit Before Tax	Taxation (30 percent)	Dividend Expense	Cash Flow
0	0.00		25.00	0.95	-0.95	0.00	0.00	0.00	0.00	0.00	-0.95	0.00	0.00	24.05
0.5	19.00				23.75	47.50	2.85	4.18	6.85	0.71	-38.34	0.00	0.00	-38.34
1	19.00				23.75	47.50	2.85	4.18	6.85	0.71	-38.34	0.00	0.00	-38.34
1.5	61.17				76.46	76.46	9.18	13.46	6.85	0.71	-30.19	0.00	0.00	-30.19
2	61.17	0.00			76.46	76.46	9.18	13.46	6.85	0.71	-30.19	0.00	0.00	-30.19
2.5	101.83				127.29	76.38	15.28	22.40	6.85	0.71	5.68	1.70	0.00	3.98
3	101.83				127.29	76.38	15.28	22.40	6.85	0.71	5.68	1.70	4.54	-0.57
3.5	194.17				242.71	116.50	29.13	42.72	6.85	0.71	46.81	14.04	0.00	32.77
4	194.17	0.00			242.71	116.50	29.13	42.72	6.85	0.71	46.81	14.04	37.45	-4.68
4.5	322.67				403.33	145.20	48.40	70.99	6.85	0.62	131.28	39.38	0.00	91.90
5	322.67	0.00			403.33	145.20	48.40	70.99	6.85	2.92	128.98	38.69	104.10	-13.82
												NPV beta = 1		($26.60)
												NPV beta = 1. 75		($31.35)
Assume:			Revenues and expenses are equal at half year and end of year									NPV opp.cost = 6.528		($18.75)
			Interest rate payable on the debt is .791% > the riskfree rate = 5.661%											
			Par value is $1000 and bond can be converted into 218.34 shares valued at $4.58 each											
			Conversion can occur from year 4 to year 5											
			Conversion will take place as follows: 15 percent at year 4, 25 percent at year 4.5, 50 percent at year 5,											
			the balance redeemed at year 5.											
			Final dividends are paid if profits are made						0.4	payout ratio				
			Number of shares on issue year 4 =						65000000	(NB dividends will not be paid on shares converted				
			Number of year 5 shares eligible for dividend payment =						75000000	in year 4 until year 5.)				

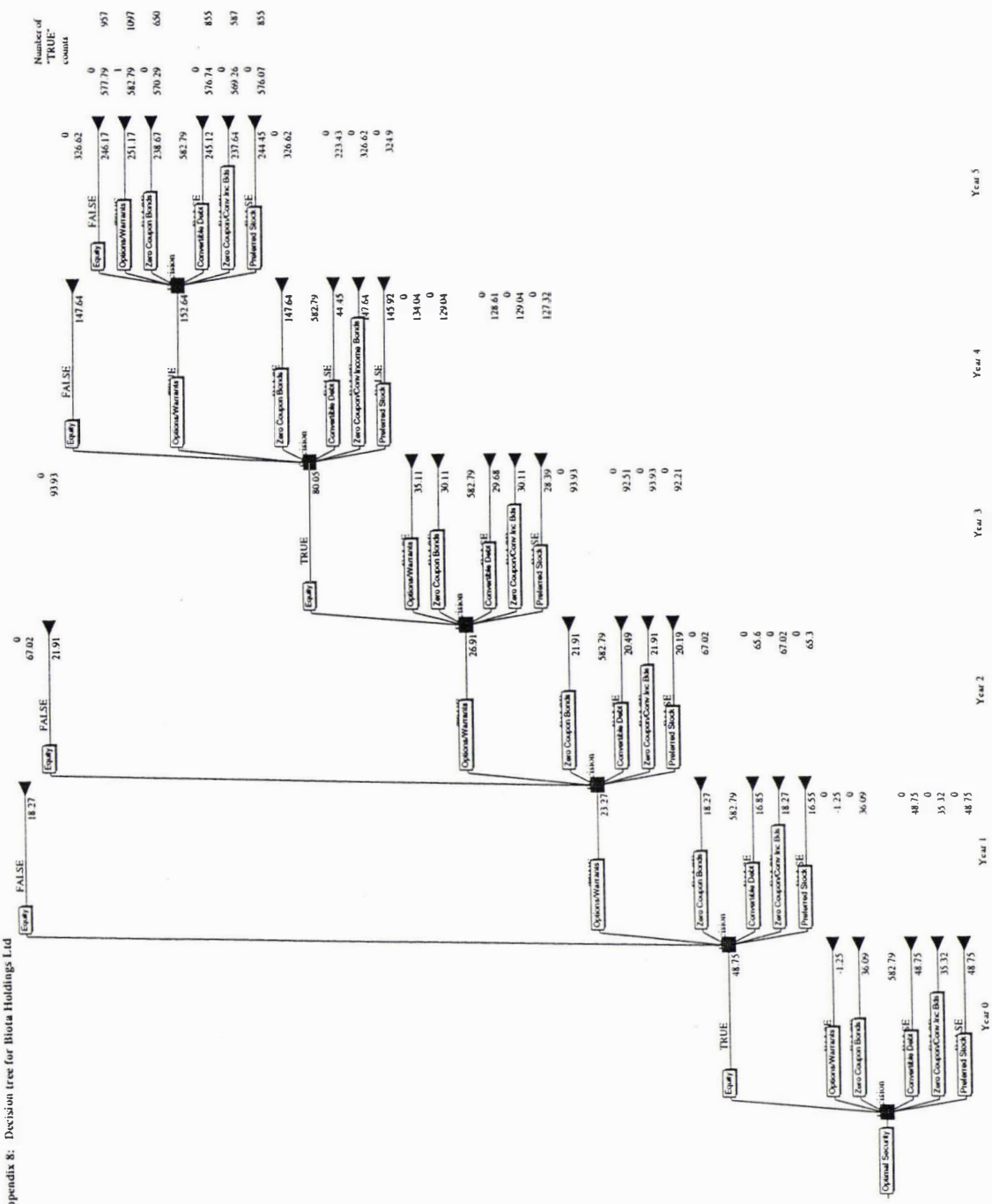
Biota NPV calculations - Zero Coupon/Convertible Income Bonds											(Figures in $M's)				
Year from launch	Sales	Com-petitor	Security Issue	Issue Exp.	Gross Profit	Promotion Expenses	Gen.Admin O/hd Exp.	R&D Exp.	Capital Expend.	Profit bef. Int.& Tax	Int. Exp. + Repayment	Profit Bef. Tax	Taxation (30%)	Dividend Expense	Cash Flows
0	0.00		17.93	0.54	-0.54	0.00	0.00	0.00	0.00	-0.54	0.00	-0.54	0.00	0.00	17.39
1	38.00				47.50	95.00	5.70	8.36	13.69	-75.25	0.00	-75.25	0.00	0.00	-75.25
2	122.33	0.00			152.92	152.92	18.35	26.91	13.69	-58.95	0.00	-58.95	0.00	0.00	-58.95
3	203.67				254.58	152.75	30.55	44.81	13.69	12.79	0.00	12.79	3.84	5.11	3.84
4	388.33	0.00			485.42	233.00	58.25	85.43	13.69	95.04	1.72	93.33	28.00	37.33	28.00
5	645.33	0.00			806.67	290.40	96.80	141.97	13.69	263.80	26.72	237.09	71.13	94.83	71.13
													NPV beta = 1		($32.51)
													NPV beta = 1.75		($34.74)
	Assume:			Total amount of security issued =					25	million			NPV opp.cost 6.528		($26.69)
				Zero coupon bonds will convert into Income bonds once Net Profits are made											
				Interest rate payable on conversion is 2.0% > the riskfree rate, ie.								6.87	percent		
				Interest will be paid on the bonds once Profits before Tax exceeds $60 million											
				Once conversion has occurred interest In arrears will be paid as soon as profits permit											
				Number of shares on issue =					65000000						
				Final dividends payable if profits made					0.4	payout ratio					

Biota NPV calculations - Preferred Shares					(Figures in $M's)								
Year from	Sales	Com-	Security	Issue	Gross Profit	Promotion	Gen.Admin	R&D	Capital	Profit	Taxation	Int. + Div.	Cash Flow
launch	0.7321	petitor	Issue	Expenses		Expenses	O/hd Exp.	Expense	Expenditure	Before Tax	(30 percent)	Expense	
0	0.00		25.00	1.25	-1.25	0.00	0.00	0.00	0.00	-1.25	0.00	0.00	23.75
0.5	19.00				23.75	47.50	2.85	4.18	6.85	-37.63	0.00	0.86	-38.49
1	19.00				23.75	47.50	2.85	4.18	6.85	-37.63	0.00	0.86	-38.49
0.5	61.17				76.46	76.46	9.18	13.46	6.85	-29.48	0.00	0.86	-30.34
2	61.17	0.00			76.46	76.46	9.18	13.46	6.85	-29.48	0.00	0.86	-30.34
2.5	101.83				127.29	76.38	15.28	22.40	6.85	6.39	1.92	0.86	3.61
3	101.83				127.29	76.38	15.28	22.40	6.85	6.39	1.92	5.97	-1.50
3.5	192.50				240.63	115.50	28.88	42.35	6.85	47.05	14.12	0.86	32.07
4	192.50	0.00			240.63	115.50	28.88	42.35	6.85	47.05	14.12	38.50	-5.57
4.5	324.33				405.42	145.95	48.65	71.35	6.85	132.61	39.78	0.86	91.97
5	324.33	0.00			405.42	145.95	48.65	71.35	6.85	132.61	39.78	106.95	-14.12
											NPV beta = 1		($29.28)
											NPV beta = 1.75		($33.57)
											NPV opp.cost = 6.528		($21.38)
			Assume:	Interest is paid semiannually									
				Interest rate is 2.017 percent > riskfree rate, ie.					6.887	percent pa			
				Number of shares on issue =					65000000				
				Final dividends payable if profits positive =					0.4	payout ratio			

Appendix 8: DECISION TREES FOR BIOTA HOLDINGS LTD AND BRITISH BIOTECH PLC

The decision trees depict the end of year cash flows for the two companies for the securities under investigation. The most cost-effective security in each year is shown by a "TRUE" flag. In years 3 and 4 some of the cash flows are significantly less than those for other securities. This has occurred due to the significant input not changing to Gross Profit and hence having a detrimental effect on the cash flows for that year.

Appendix 8: Decision tree for Biota Holdings Ltd



Appendix 8: Decision tree for British Biotech plc