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THE USE OF VALUATION MODELS BY EUROPEAN BIOTECHNOLOGY ANALYSTS

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The Use of Valuation Models by European Biotechnology Analysts

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Abstract

This paper aims at examining the practical use of valuation models by European biotechnology analysts. The study is based on a self-administered questionnaire with 39 sell-side analysts, and is complemented with semi-structured face-to-face interviews. We find that most professional analysts prefer the risk-adjusted net present value (rNPV) model. The main reasons to the popularity of the rNPV model seem to be driven by both client-driven preferences and the ability of the analyst not to be restricted in changing its forecasts. We also find evidence, using a non linear variant of the Principal Components Analysis, of four ways of valuing biotechnology firms. These variations in valuation models seems to some extent be driven by the maturity stage of the company, but also by preferences of the users (analysts). The preferences of the users become even more apparent when analysts determine critical input parameters to the valuation models. Some of these clearly deviate from what classical financial theory suggests. We conclude that the stock price determined by analysts' valuation models is only part of the entire valuation story and subjective factors play a crucial role in the investment recommendations.

Keywords: Rational expectations, Valuation, rNPV, Biotechnology

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"Estimate how much profit a company's pipeline of new drugs will generate in 1990, when presumably, they will be out of the lab and in the market. Then apply a P/E multiple of 25 to those earnings to derive a likely price for the stock in 1990. To figure a reasonable current price for the stock, discount the stock's future value back to the present using a 25% discount rate. The discount rate is intentionally steep, to take into account the special risks of biotechnology".

[Peter Drake, Kidder Peabody, 1987][2]

[2] Source: http://money.cnn.com/magazines/fortune/fortune_archive/1987/07/06/69213/index.htm

Table of Contents

1 Introduction

In this chapter, the authors give the historical background to valuation in the biotechnology industry and introduce the problem that motivated the research. Thereafter, the aim of the study is specified. At the end of the chapter, a disposition of the study is given.

1.1 Background

General knowledge holds that corporate valuation is not an exact science. Instead it is considered to be *part science* and *part art*. This is understandable given that the market value (or trading value) of a company seldom match the fundamental value (fair value) determined by analysts. Whilst the market value is a quantifiable measure of supply and demand, and observable in the market place, the fair value is a subjective measure, depending on the perception of risk and potential in the eyes of the investors (e.g. Bennett et al., 2004). This opens the door to many different valuation approaches to exist.

The issue of valuation has a bad name in biotechnology (Stewart, 2002). The early attempts to find a proper method to determine the fundamental value of a biotechnology company were quite primitive. In the early 1980s, in the absence of credible metrics, some biotechnology analysts estimated a biotech company's value by counting the total square footage of lab space, the number of scientists employed, the number of PhDs hired, and, how much money the company had spent (Papadopoulos, 1998; Stewart et al., 2001). This so called *valuation enigma* stemmed from the concern that early-stage biotech companies were not amenable to traditional methods of financial analysis applied to profitable and sales-generating companies. The introduction of an alternative discount model in 1986, in which a so-called terminal stock price was discounted, provided investors with a, at that time, credible framework, by which they could make rational buy-sell decisions. However, the lack of a general accepted standard for valuation was in the large part responsible for the tremendous volatility that has characterized trading in biotechnology stocks (Persidis and Menzel, 1997). Following the stock market collapse in 2001 in general, and the biotechnology sector in particular, heavy criticism was directed to the research quality of stock market analysts (mostly on the sell-side). This forced also the biotech companies to reveal more information about existing product pipelines, i.e. to become more transparent, in order to attract investors since many biotech firms up to that date were considered as a "black-box".

While putting a price on biotech companies appeared to be more guesswork than science, the introduction of the risk-adjusted Net Present Value (hereafter, rNPV[3]) model by Stewart et al. (2001) was a milestone in biotechnology valuation. It has been argued that following the introduction of the rNPV model, valuations finally started to make sense (Keating, 2002). However, the rNPV model has been criticized for its simplicity at the expense of some drawbacks, i.e. the return of a single number etc. (Villiger and Bogdan, 2005a; 2005b; 2005c). This has forced the development of alternative valuation approaches. For example, the real options model was in turn developed to overcome the shortcomings of the DCF model. On the other hand, real options have been dismissed by the financial community in the past because of eye-catching, but often misleading, case studies that yielded unrealistically high results (Fernández, 2005).

1.2 Research issue

Valuation of biotechnology firms is important in many situations. For example, in situations when a biotechnology firm considers to raise external funds, engage in license contracts with potential partners, plan to go public via an initial public offering or are subject to mergers or acquisitions (Villiger and Bogdan, 2005b), one need to assess a value to the firm. However, general knowledge holds that valuing biotechnology firms are difficult. This is understandable given due to, especially, two reasons. First, the features of the core business, i.e. the drug development process, is characterized by high attrition rates, complexity, high costs, long timelines and for being highly regulated (Kaitin and Healy, 2000; Kaitin and DiMasi, 2000; DiMasi, 2001a; DiMasi, 2001b). In general, only one to two projects out of ten in clinical trials goes the entire way to the market. In addition, the cost of drug development is USD 1,241 million and takes on average 8-12 years to complete (ibid). Secondly, there is at present no golden standard or standard methodology in the academic literature on how to apply valuation in life sciences (Villiger and Bogdan, 2008). While the academic literature has focused on the technical aspects of developing new valuation methods in life sciences, such as real-options, practitioners have criticized real options of being too theoretical. In addition, it has been questioned to what degree traditional financial theory can be used for valuing biotechnology companies. For example, loss-making firms, which comprise most of the European biotechnology sector, may make the use of earnings based multiples irrelevant,

[3] In the rNPV model, the risk adjustment enters into the valuation through success rates, i.e. by risk-adjusting the net cash flows (e.g. sales revenues, milestones, royalties, R&D costs, selling-, general- and administrative costs, marketing costs etc.) by the probability (or success rate) by which they occur. The resulting risk-adjusted cash flows are then discounted at an appropriate discount rate (Bode-Greuel and Greuel, 2005).

forcing analysts to use other valuation models. Furthermore, beta values of some firms are negative, indicating that the capital asset pricing would yield a value smaller than the risk-free rate of return (Villiger, 2008). Moreover, it has also been suggested that multiple investment techniques, such as product NPVs, DCF valuation and real options analysis, rather than one single method are used in biotechnology company valuation (Keegan, 2008).

While the general approach in the academic literature to study the behavior of investment analysts has been capital market-based studies, few studies have examined the practical use of valuation methodologies by financial analysts. In fact, only the studies by Barker (1999a, 1999b), Bradshaw (2002), Demirakos et al. (2004) and Imam et al. (2008) have examined analysts' use of valuation methodologies. These studies have proposed different explanations to what impacts the rationale behind the analysts' valuation approach.

Liu et al. (2002), Lee (2003), Palepu et al. (2004) and Imam et al. (2008) advocate that analysts covering similar industries may use different models, suggesting it is a matter of preference of the users. In contrast, Barker (1999b) and Demirakos et al. (2004) emphasize industry-related factors. Furthermore, Barker (2001) argues that analysts and fund managers[4] share a common approach to valuation and suggests an inter-dependence in the working patterns of the two groups. Stowe et al. (2002) and Cowen et al. (2005) argue that valuation models have to be consistent with the analysts' valuation purpose and perspective. Demirakos et al. (2004) conclude that analysts appear to vary the choice of valuation methodology in understandable ways with the context in which the valuation is made, but that 'analyst familiarity with a valuation model and its acceptability to clients is a strong driving force'. However, they do not offer any straight evidence on the client-driven factor.

In summary, it remains unclear what kind of valuation models that professional analysts use in order to value biotechnology firms. In addition, do professional analysts' use multiple investment techniques? If this is the case, what kind of different patterns in the use of different models can be observed? Moreover, practitioners may have developed alternative valuation models, not present in the academic literature, if such a model is perceived to better meet their needs. Alternatively, following the biotech stock market crash in 2001, a development towards the use of sophisticated models with a clear risk profile may have been required by investors, indicating the presence of a client-driven factor. Furthermore, analysts

[4] A more detailed description of the two roles (analysts and fund managers) and their interaction is given in section 2.1.

covering biotechnology firms may use different models, as suggested by e.g. Liu et al. (2002), indicating that it is a matter of preference of the users.

The main research question is to study the rationale behind the analysts' valuation approach, i.e. how is the analyst allocating his effort or resources when valuing biotechnology firms. In order to do this, we focus on the following three questions:

1. What valuation models do European biotechnology analysts use when they value publicly listed biotechnology firms?
2. What different complementary models do analysts use in order to value biotechnology firms?
3. Which are the most important parameters in biotechnology firm valuation and how are these parameters determined?

1.3 Aim of the study

The aim of this paper is to create an understanding how professional analysts practically go about when they assess publicly listed companies in the biotechnology sector. Using a survey-based questionnaire, we ask questions regarding the use of different valuation models and key input parameters in these models, such as how to estimate discount rates, R&D expenses and terminal value. We also ask industry-related questions concerning how to interpret the probability of getting a product to the market, the duration and costs of different phases etc. The intention with this study is not to identify best practice, but to create an understanding how personal and organizational factors influence the use of valuation methodologies.

The motivation of the study stems from the concern that the actual use of different valuation models are not very well understood in the academic literature (e.g. Imam et al., 2008). In addition, there is a general and widespread interest in the academic literature in the practical use of sophisticated versus unsophisticated valuation models. Prior survey-based research has suggested that analysts use unsophisticated' valuation models such as price/earnings ratio (PE) and dividend yield (DY) in preference to the more sophisticated and supposedly rational DCF (e.g. Demirakos et al., 2004). Furthermore, Imam et al. (2008) argue that simple models have remained important over a prolonged period of time.

1.4 Disposition

The remainder of the paper is organized as follows. In section 2.1, we briefly discuss the role of the sell-side analyst and introduce the theory of rational expectations. In section 3, we discuss the three research methods that we have used in this study, i.e. content analysis, survey-based questionnaires and interviews. In section 4, the results and the findings from the survey-based questionnaire and the interviews are presented, analyzed and discussed. In section 5, we briefly summarize the major findings in the study and conclude the paper. We also provide some suggestions to further research.

2 Literature review

In this chapter, we briefly introduce the role of the main subject of our study, i.e. the sell-side analyst. Thereafter, we describe the main theory used in the paper, the rational expectations hypothesis (REH) and discuss it in relation to our research setting.

2.1 The sell-side analyst

Sell-side analysts (hereafter 'analysts') are specialist advisers working for brokerage firms, who seek and process company related information and then 'sell' it to fund managers (Arnold and Moizer, 1984). In turn, buy-side analysts (hereafter 'fund managers') rely on advice from analysts and are responsible for buying, holding and selling shares, and thereby determining share prices (Barker, 1998). In other words, analysts act as information intermediaries in a three-party structure between management of a company and fund managers. Referring to principal-agent (hereafter, 'agency') theory, Jensen and Meckling (1976) argued that the role of analysts as an information intermediary helps to reduce the agency costs (information asymmetries) associated with the separation of ownership and control in firms.

2.2 Rational expectations hypothesis (REH)

According to the rational expectations hypothesis, economic agents are rational optimizers, i.e. they make efficient use of all the information available to them (Mohanty and Aw, 2006). Deardorff (2001) define rational expectations as follows: "In forming opinion about future events, the use of all available information to assess the probabilities of the possible states of the world. More simply, expectations that are as correct as possible with available information".

With this definition in mind we need to determine whether one can expect analysts to act rationally when creating their earnings forecasts. According to Brown, Foster and Noreen (1985) it is hard to see that the work of analysts would still be in demand if they did not forecast optimally. In other words, since analysts' livelihoods and reputation is dependent on the accuracy of their forecasts, there are reasons to believe that these forecasts are their best estimates (Mohanty and Aw, 2006). On the other hand, Brown, Foster and Noreen (1985) also state that failure to use all available information including previous forecast errors in their forecasts play a less important role than most economist think. The main purpose why analysts produce earnings forecasts is because they are paid to generate trades and business for their firms. Therefore it is not necessarily the highest priority that the reports are totally unbiased and correct (Ackert and Hunter, 1994; Dorfman, 1991). Ackert and Hunter (1994),

however, make it clear that an analyst that consistently produce biased and unreliable earnings forecasts will lose credibility and clients in the long run. For that reason they argue that the competition between analysts firms provides the necessary discipline and incentive for an analyst to remain rational. This rationality is confirmed by Givoly (1985) who studied over 6000 earnings forecasts made over 11 years. The results from time-series tests show that analysts' annual earnings forecasts are rational because they make the most of the information contained in the earlier periods of earnings and their own estimates.

According to Mohanty and Aw (2006) it is not clear if financial analysts would make statistically optimal forecasts for two major reasons. The first reason is that analysts might be tempted to produce subjective forecasts because of economic incentives and/or conflicting interests from investment banks' dual function as financial and information intermediaries. The second reason is, as previously mentioned, that analysts may not be efficient users of all accessible information.

Lin and McNichols (1998) also points to the possibility that earnings forecasts might be biased because of investment banks' dual role, as mentioned above. However, they do not find their forecasts less correct than for example Standard and Poor's or other actors in the market. Moreover, in a study made by Agrawal and Chen (2004) the authors tried to determine if independent analysts make better earnings forecasts than the analysts working in firms involved with investment banking or brokerage. Their research found no such evidence. They therefore argued that independent analysts' forecasts were neither more correct nor less biased than other analysts who had to deal with a potential conflict of interest.

When trying to determine whether analysts efficiently used all available information Mohanty and Aw (2006) found mixed empirical support in the academic literature. While the studies by Brown and Rozeff (1978), De Bondt and Thaler (1990), Lys and Sohn (1990), Klein (1990), Abarbanell and Bernard (1992), Ali et al. (1992), Ackert and Athanassakos (1997), Das et al. (1998), Easterwood and Nutt (1999), and Lim (2001) reject the rationality of analysts' forecasts, the studies by Fried and Givoly (1982), Givoly (1985), Ackert and Hunter (1994, 1995), and Keane and Runkle (1998) do not reject the rationality of analysts' earnings forecasts. Mohanty and AW (2006) argue that the reason behind this may lie in dissimilarities in samples, data sets, forecast horizon, and time periods observed and the statistical tests employed by the authors.

There are also a few studies that have proposed different explanations to what impacts the rationale behind the analysts' valuation approach. Capstaff et al. (1995) suggest that analysts might be unwilling to publish repetitively pessimistic forecasts, since this may damage relationships with the firm as this source of information possibly also is the most important for analysts. Trueman (1990) provides another explanation that analysts may be hesitant to significantly change forecasts when they receive new information because of the negative signal it gives about the accuracy of their previous information. Consequently, analysts' forecasts may not fully reflect the information available. Barker (2001) argues that both analysts and fund managers have a common approach in valuation and suggests an inter-dependence in the working patterns of the two groups, i.e. analysts' reports may influence fund managers' behavior and fund managers' model preferences may influencing analysts' behavior or both groups possibly being influenced by general valuation methods. Barker (1999b) and Demirakos et al. (2004) emphasize industry-related factors. In contrast, analysts covering similar industries use different models, suggesting it is a matter of preference of the users (Liu et al., 2002; Lee, 2003; Palepu et al., 2004; Imam et al., 2008). Furthermore, valuation models have to be consistent with the analysts' valuation purpose and perspective (Stowe et al., 2002; Cowen et al., 2005). Demirakos et al. (2004) conclude that analysts appear to vary the choice of valuation methodology in reasonable ways with the context in which the valuation is made. Furthermore, Demirakos et al. (2004) also argue that analyst familiarity with a valuation model and its acceptability to clients seems to be a driving force. However, they do not offer any straight support on the client-driven factor.

2.3 Are analysts' earnings forecasts rational?

To determine whether a biotech analyst's earnings forecast is rational is a little more complicated to answer if one compare with analysts covering other industry sectors. What makes it more difficult in the biotech sector is, as mentioned earlier, the lack of previous reported earnings. Most biotech firms in Europe are relatively small and are loss-making because very few of their products have reached commercial stage. This would in theory allow a biotech analyst to more freely speculate about the future potential of each biotech company he or she covers. Lim (2001) argues that the degree of forecast bias is related to the characteristics of the company in question. For instance, companies that are large and are covered by many analysts would most likely have less forecast bias than small companies covered by only a few analysts. The latter being the case for biotech companies. Thus, the lack of reported earnings and the relatively poor coverage of the company in question from

different analysts will make it possible for an analyst to be more subjective in his or her findings. On the other hand the requirements from investors have increased quite substantially since the beginning of this century. Following the biotech stock market collapse in 2001, biotech companies are now forced by the investment community to reveal more information about existing product pipelines to attract investors and that information is vital for analysts to use in order to make more accurate earnings forecasts.

3 Methodology

In this chapter, the authors detail the chosen research approach and the research procedure. We introduce the chapter with a description on how the sample was selected. We then discuss the three research methods that have been applied in this study; content analysis, a survey-based questionnaire and personal interviews. At the end, we discuss reliability and validity aspects of the study and end up with a brief discussion about criteria for conclusions.

3.1 Sample selection

We use Reuters 3000Xtra to identify all publicly listed European biotechnology companies in the European biotechnology sector. We find 137 publicly traded companies classified as biotechnology companies, either according to GICS (106) and/or FTSE (68) classification.

Given the heterogeneity in operations among biotechnology companies, we focus on the largest homogeneous group of biotech firms, namely drug development companies. Therefore, we require that the firm has operations within drug development and exclude all companies within other areas (e.g. medical devices, information technology etc). The final sample consists of 78 companies.

We then use company homepages, annual reports and the Google search engine to identify the name of the analysts and the investment bank that each analyst is associated to. In total, 188 analysts from 103 investment banks (or research institutions) are found. The largest number of analysts covering one company is the Danish company Genmab with 18 analysts. We also find a number of companies with no analyst coverage at all.

3.2 Research methodology

Analysis of the practical use of valuation methodologies by financial analysts in general is an unexplored area within academic research. Only the studies by Barker (1999a, 1999b), Bradshaw (2002), Demirakos et al. (2004) and Imam et al. (2008) have examined analysts' use of valuation methodologies. Of these studies, only Demirakos et al. (2004) and Imam et al. (2008) have provided a comprehensive comparison of the use of different models.

While Demirakos et al. (2004) only use the content analysis methodology applied to equity research reports, Imam et al. (2008) adapt a triangulation approach by using semi-structured interviews together with content analysis to investigate the practical use of analysts' preferences of valuation models across different industries. Using the combined approach by Imam et al. (2008) revealed not only the drawback of only conducting content analysis, but also provided a more in-depth understanding by answering the questions how the models were used and why they did use the following models. On the other hand, the study by Imam

et al. (2008) also included a small number of buy-side analysts, which may cause potential inter-dependence problems.

In this paper, three research methodologies are employed. The first research methodology, content analysis, is used as a basis for the second, and main, research methodology, i.e. a survey-based questionnaire. We believe that content analysis serves as an appropriate method for purposes of constructing the questionnaire when the academic literature provides little or no guidance of existing valuation methodologies. The survey-based questionnaire, in turn, offers the possibility to be evaluated using advanced statistical techniques, such as Principal Component Analysis.

However, Holland (1998) argues that semi-structured interviews provide a richer and more complex insight into analysts' views. In addition, Denzin, (1970) and Easterby-Smith et al. (2002) suggest that semi-structured interviews appear to be more reliable than questionnaires. Therefore, we also conduct a few semi-structured interviews. These are primarily used to validate the responses in the survey-based questionnaire. We find that the responses for this subgroup are valid.

We have also evaluated the possibility to conduct telephone interviews. Given the large number of questions and alternatives in each question, we find it difficult to conduct this type of study by telephone interviews. Moreover, we do not believe that the analyst would provide us with the extensive amount of information that we have received in the open-ended questions in the questionnaire.

3.2.1 Content analysis

Content analysis is the study of recorded human communications and is essentially a usable tool for the examination of the presence of different types of contentable categories in a material (Babbie, 2007). It provides a quick and easy research methodology for data collection. Content analysis has both advantages and disadvantages in terms of validity and reliability. Furthermore, content analysis is limited to the examination of recorded communications (ibid).

In order to construct the survey-based questionnaire, we employed content analysis of equity research reports. This is mainly due to the fact that the literature on the subject is limited. It becomes apparent that content analysis is unable to answer our research question directly. A major part of the valuation models that are included in the equity research reports are

considered as “not important” (see Table 4.1). This is a quite interesting finding in itself. However, we find content analysis as an appropriate method in order to construct the survey-based questionnaire when the theory in the academic literature is limited.

Some firms publish analysts equity research reports on the firms’ company homepage. To conduct content analysis, we selected all equity research reports that were available on the biotechnology firms’ homepages in our sample. In total, we collected and analyzed 42 different equity research reports. Once a valuation model was found, it was included in our questionnaire. We will not go into further detail into this methodology, since it was only used in order to build up the questionnaire. However, at first glance, an experienced analyst may see many of the valuation methodologies in question 1 and input parameters in question 2 as irrelevant. This is on the other hand something that we by construction cannot take for granted.

3.2.2 Survey-based questionnaire

Self-administered surveys, e.g. questionnaires, make large samples feasible, which is very important for both descriptive and explanatory analysis. This is especially important when several variables are to be analyzed simultaneously. Questionnaires with ranking alternatives offer the possibility to be evaluated using advanced statistical models (see section 3.2.3). In addition, respondents are sometimes reluctant to reports deviant attitudes or behaviors in interviews, but are willing to respond to an anonymous self-administered questionnaire (Babbie, 2007). Moreover, questionnaires offer the flexibility that they can be filled in at any time. Conducting this type of study during a financial crisis needs also to be taken into account. This was reflected in a response from one analyst: “In happier times I would have helped, but in these job-challenged times I hope you appreciate that I have to devote my energies to revenue-generating activities”. Furthermore, conducting face-to-face interviews with a sample of analysts all across Europe would not only be difficult to conduct, but also costly and time-consuming. Additional advantages and disadvantages of questionnaires as a research methodology are discussed further in Erdos (1983), Moser and Kalton (1985) and Babbie (2007).

The survey-based questionnaire contained ten questions, both open-ended and closed ended questions. Including open-ended questions offer the possibility for the respondent to add information not present in the close-ended question. In the close-ended questions, the respondents were asked to rank each alternative on a 5-point “Likert scale” In order to open-

up the questions, each close-ended question were followed by a question where respondents were asked to fill in if he/she for example use another valuation model not given as an alternative in the prior question.

We first pre-tested the self-administered questionnaire in full on three students in Finance at the University of Gothenburg. We sent the questionnaire accompanied by a letter of explanation to all selected analysts. We stressed on the fact that all answers will be treated with confidentiality and that all respondents are kept anonymous. In our background research, we had collected statistics about which company/companies that every analyst at that date was covering. Therefore, in order to increase the response rate, we personalized every Email by mentioning the companies that he/she covered and asked them to fill in the questionnaire from the perspective of those companies. As a number of analysts also cover other type of biotechnology companies, such as medical devices etc, valuation of these companies differs significantly from valuation of drug development companies. Inclusion of these companies would therefore invalidate the entire study.

We monitored the varying rates of return among respondents by constructing two return rate graphs; one showing the number returned each day and the second reports the cumulative number. The graphs served as a useful guide to how the data collection was going and provided a clue about when follow-up mailings should be launched. As completed questionnaires were returned, they were opened, scanned and assigned an identification (ID) number. This identification was especially useful for purposes of follow-up mailing. Follow-up mailings were administered by sending non-respondents a new copy of the self-administered questionnaire with a follow-up letter with additional encouragement to participate. Since no principal guideline is given for the timing of follow-up mailings, we used the return rate curves to see when the response rates slowed down in pace. In total, two mailings (an original and one follow-up) were conducted over a total period of four weeks. In some cases, we identified up to three analysts from one company that on paper cover a company. Usually, one analyst (e.g. lead manager) has a major responsibility for the coverage of the company, while the other analyst/analysts has/have a secondary role. Since each investment bank produce one equity research report per company, we assume that they use the same valuation methodology and that it does not differ within a team. The questionnaire (see Appendix A) was sent to 103 investment banks (or research institutions). We received 39 responses, which corresponds to a return rate (i.e. the percentage of questionnaires sent out that are returned) of 38 percent. The geographical distribution of the responses is given as

follows: Two from Austria, one from Belgium, two from Denmark, three from France, four from Germany, two from the Netherlands, four from Norway, one from Singapore, four from Spain, five from Sweden, three from Switzerland, seven from the UK, and, one from the USA. The attentive reader may observe the presence of USA and Singapore. This is due to the fact that the analysts are located in those countries, but cover European companies.

3.2.3 Evaluation of the survey-based questionnaire

In order to summarize how important analysts value different valuation models, we have calculated a balance score for each item /question. This score is derived by subtracting those consider an item to be important with those who think it is not important. A positive value indicates that there are more analysts that consider the item to be important than those who consider it to be unimportant. Thus, it is easily displayed which valuation models that are considered to be important.

The relationships among the different ways to value the biotechnology companies are identified by a non linear multivariate statistical method. Since the variables have been measured at an ordinal level, the non linear variant of the Principal Components Analysis (PCA) have been used, so called NLPCA. NLPCA is most suitable when the question is categorical ordered (Gower and Blasius, 2005).

NLPCA has the main advantage to condense the information contained in the original dataset with a minimum loss of information by reducing the initial variables to a smaller set, called components. NLPCA reveals the underlying structure of the variables included in the analysis.

In line with PCA, the eigenvalues technique for component extraction was applied. Thus, only those components that generated eigenvalues greater than 1.0 were included in the model; these variables signify components with variance greater than one. The coefficients (loadings) fluctuate between -1 and +1. The next step was to calculate the component loadings, presenting of each item within the component category. A component loading of + or – 0.50-0.55 is considered strong (Tabachnick and Fidell, 1998). Therefore, loadings higher than 0.55 are highlighted by a box (see Table 4.2). In order to maximize the variances of variables and to obtain an interpretable pattern of loadings, components were then rotated using the Varimax algorithm, which is an orthogonal vector rotation method (Gower and Blasius, 2005). The rotation of the NLPCA has been conducted by programming the SPSS Syntax.

3.2.4 Interviews

Interview surveys provide an alternative method of collection survey data (Babbie, 2007). The interviews are primarily used as a validation tool, but also to give additional insights into how personal and organization factors influence how valuation models are used. This methodology is, however, not the main focus in this study. We conducted five semi-structured interviews with six sell-side analysts in Scandinavia. Out of six firms, five agreed to participate.

The interviews were about 40 to 60 minutes long. We used a tape recorder and collected individual notes during the interviews. All respondents agreed to record the interviews. The entire interview material was then gathered in one single document from which findings and results later could be drawn. Each analyst was asked to answer our questionnaire before the interview took place. The questionnaire was used as a starting point for each interview.

Qualitative data analysis of the interview data was proceeded by first transcribing the interviews and then highlighting illustrative quotations. When analyzing the data, both complete and partial analysis was used. Complete analysis means that all the data collected from the interviews are being examined and it is first after examining the complete set of data that any conclusions can be drawn from the material. After gathering all the information we selected relevant focus areas to analyze. Partial analysis implies that the interview material from the interviews contain information that in varying degree is related to the focus of our research. An interpretation could then be drawn from this data of individual statements (Holme and Solvang, 1997).

3.2.5 Reliability and validity of the study

In most studies, the two general concepts reliability and validity play an important role when evaluating the accuracy and the usefulness of the study. The reliability concept refers to the degree to which a measure is consistent, i.e. the level of trustworthiness of chosen method (Bryman, 1989). Validity refers to the issue of whether the measure represents the concept it is claimed to measure (ibid).

In order to obtain high validity of this type of study, as many responses as possible are needed. In survey literature, there is no general guideline about what is a high or low response rate. In addition, due to the limited amount of literature in this area using this methodology, it is impossible to directly compare it to other studies. It is, however, more important to study the lack of response bias. A low response rate is a danger signal, because the non-respondents are likely to differ from the respondents in ways other than just their willingness to participate

in the survey (Babbie, 2007). Moreover, non-respondents may have developed what they think are superior valuation models, and thus, are not willing to share their knowledge. We do, however, believe that the use of a combined open-ended and close-ended questionnaire provides a good methodology for respondents to reveal information not present in the literature. Furthermore, all respondents were guaranteed to be anonymous and all answers were promised to be treated with confidentiality. Thus, we have no reason to believe that the respondents did not respond with their best knowledge. Another aspect of validity is that survey questions are clearly formulated. Using a combination of open-ended and close-ended questions has provided many advantages in this study. For example, respondents were able to comment if they had problems to interpret a question, which would not have been feasible in a close-ended questionnaire. We also find that the interviews serve as a method to ensure high validity by discussing their responses.

The reliability aspect of the study is also taken into account by analyzing potential misinterpretations that analysts can make in the questionnaire (see Appendix A). In order to receive reliable and stable measurements we first thoroughly tested and made changes to the questionnaire before sending it out to the analysts. The results are based upon the assumptions that analysts tick the right box. However, question 2c is used as a control question. In this question, respondents were asked to order the three most important parameters in question 2a and 2b. This means that we easily can detect if they have used the opposite rating system to what we have suggested. The results are also based on the assumption that analysts are well familiar with the model terminology.

3.2.6 Characteristics of this study

This paper differs from previous studies in several ways. First, we use another methodological approach. While prior studies within this area of research use content analysis (e.g. Demirakos et al., 2004), interviews (e.g. Glaum and Friedrich, 2006) or content analysis and semi-structured interviews (e.g. Imam et al., 2008), we use content analysis and a survey-based questionnaire. We argue that this triangular approach of using content analysis to construct the questionnaire provides an alternative way in explorative studies, where the theoretical foundations are weak. Secondly, in contrast to the study by Imam et al. (2008), we only focus on sell-side analysts. The main reason is that Demirakos et al. (2004), conclude that analysts appear to vary the choice of valuation methodology in understandable ways with the context in which the valuation is made and that the valuation models have to be consistent with the analysts' valuation purpose and perspective (Stowe et al., 2002; Cowen et al., 2005).

Third, the responses are evaluated in relation to the rational expectations hypothesis, as outlined in section 2.2. Fourth, we focus on a single sector, namely the biotechnology industry. This allows us to address more specific individual research issues and industry-related factors, as suggested by Barker (1999b) and Demirakos et al. (2004), on a much lower level of aggregation because the objects of observation and the institutional framework are the same for all survey participants (Glaum and Friedrich, 2006).

4 Empirical findings

This chapter contains the results and the analysis of the study. The chapter is divided into two parts. In the first part, we discuss valuation models that analysts use. In the second part, the importance of different input parameters to the valuation models is presented.

4.1 Valuation models used by European biotechnology analysts

In order to examine the use of different valuation models or measures (hereafter 'valuation models), analysts were asked to rate the importance of valuation models on a scale from 1 to 5, where 5 represent *"very important",*1 *"not important"*. The valuation models that were included in the first question were collected using content analysis of equity research reports. In order to summarize how important analysts value different valuation models, we have calculated a balance score for each item (model). The balance score measure is explained in section 3.2.3. Table 4.1 reports the findings.

Table 4.1 Valuation models

Model	Type of model	Important	Neither nor	Unimportant	Balance score	Number of analysts
Discounted cash flow (DCF)	D	78.1	12.5	9.4	+68.7	32
Risk-adjusted DCF (rDCF)	D	90.6	6.3	3.1	+87.5	32
Dividend discount model	D	4.5	0.0	95.5	-91.0	22
Real-option models	O	27.3	36.4	36.4	-9.1	22
Dividend yield	O	8.3	8.3	83.3	-75.0	24
P/E	M	22.6	25.8	51.6	-29.0	31
PE/Growth (PEG)	M	18.5	33.3	48.1	-29.6	27
Price/Cash flow	M	7.7	30.8	61.5	-53.8	26
Price/Free cash flow	M	20.0	32.0	48.0	-28.0	25
Price/BV	M	18.5	25.9	55.6	-37.1	27
Price/Sales	M	18.5	25.9	55.6	-37.1	27
EV/Sales	M	21.9	21.9	56.3	-34.4	32
EV/BV	M	15.4	15.4	69.2	-53.8	26
EV/EBIT	M	21.4	28.6	50.0	-28.6	28
EV/EBITDA	M	31.0	17.2	51.8	-20.8	29
EPS	M	30.7	41.4	37.9	-7.2	29
EVA	O	18.2	18.2	63.6	-45.4	22
Monte Carlo simulation	O	17.6	5.9	76.5	-58.9	17
Scenario analysis	O	75.0	10.7	14.3	+60.7	28
Decision-tree analysis	O	63.6	9.1	27.3	+36.3	22
Sum-of-the-parts (SOTP)	O	90.6	0.0	9.4	+81.2	32

Note: Analysts' responses on a 5-point Likert scale ranging from "not important" (1) to "very important" (5). The balance score is derived by subtracting those who consider a model (methodology) to be important (i.e. those who have answered 4 or 5 on the 5-point Likert scale) with those who think it is not important (i.e. those who have answered 1 or 2) adjusted by the number of responses. The models have been classified as: "Discount-based" (D), "Multiple-based" (M), or "Other" (O).

In general, we find that analysts use valuation models such as discounted cash-flow, scenario analysis, decision-tree analysis and sum-of-the-parts (SOTP). Of these models, the risk-

adjusted discounted cash-flow model (rDCF or rNPV)[5] and sum-of-the-parts (SOTP) are most frequently used. Given the fact that most of the publicly listed biotechnology firms in the sample are non-profitable and/or do not pay any dividends, many of the multiples-based models become irrelevant. This was confirmed by the high frequency of the response that static ratios or multiples are not used because biotech companies usually do not have positive earnings. However, it becomes apparent that content analysis is unable to answer our research question directly. While analysts consider many of the models as 'not important' in the questionnaire, they tend to indeed be included in equity research reports.

Instead of financial ratios, analysts use other comparables such as pipeline comparison, in which they compare similar phase companies at similar phase of development.

Furthermore, real-option models in general seem to be unimportant. One potential reason to this might be that analysts are influenced by the clients' preferences, i.e. its acceptability to clients, which is illustrated by the following quote:

> *"We generally use NPVs. However these don't give value to the options open to management. We find real option models too complex, impractical and difficult to understand for most investors/management teams"*

Analysts were then asked to specify the key advantages or disadvantages with the valuation model(s) that they use. This seems to be a key question in terms of explaining the frequent use of the rNPV model. Many analysts argue that it is a good tool that allows a valuation per project. One analyst points out that the rNPV model gives a complete vision of the portfolio valuation with a risk assessment per project. Another analyst states that it is the assessment of risk, which is the tough one, and that it takes a lot of insight into the process of drug development. It seems as if the risk perspective tends to play a major role when analysts choose valuation methodology. This focus on the risk perspective tends to favour the rNPV model. This is similar to the view of another analyst:

> *"When using risk adjusted net present value its more easy to get an overview of the companies projects and the impact of each project on the total share value. Hence, it is easier for an investor to determine the risk of each project and for them to decide to invest or not"*

[5] This model (discounted cash-flow) appears in the academic literature under different names. These are: discounted cash flows (DCF), net present value (NPV), risk-adjusted net present value (rNPV) or expected net present value (eNPV) (Villiger and Bogdan, 2005b).

It seems as if the clients' preferences play an important role in the choice of valuation model by the analyst. Barker (2001) argues that both analysts and fund managers share a common approach to valuation and suggests an inter-dependence in the working patterns of the two groups. In this case, it may indicate that fund managers' model preferences influence analysts' behavior. One analyst meant that the rNPV model best reflect the growth opportunities in these non-profitable companies.

One frequently observed response was that the key advantage with the rNPV model is that it can value the firm from a "bottom-up approach" and that the model offers flexibility of determining what the value of the company is if a compound fails clinical trials or is not approved.

Trueman (1990) argues that analysts may be reluctant to significantly revise forecasts when they receive new information because of the negative signal it gives about the accuracy of their prior information. However, it seems as if this would speak in favour for the rNPV-model:

> *"Risk-adjusted DCF allows for flexible adjustments of target price as risks associated with the product candidates change over time"*

The interviews also confirmed this finding. These analysts are generally restrictive in changing their models. What trigger a change is when the company in question for different reasons gets substantially higher or lower costs and when the liquidity situation changes significantly. Two examples that were mentioned in relation to this were whether a company succeeds or not in their clinical trials or when a new partner gets into the picture.

We also asked analysts to specify if there are other valuation methods, not mentioned in the previous question, that they use when valuing biotechnology companies. This strategy to combine closed-ended questions with open-ended questions aimed to capture modifications and own developed models, not previously mentioned in the academic literature.

It turns out that the outcome of valuation models are not necessary the basis for the stock recommendation. This is illustrated by the following quote:

> *"(I use a) simplified probability weighted NPV model. This is a rough proxy to get an idea of the value. I forecast peak sales five-year post launch, get a profitability ratio (often royalty rate for Biotech), I then get my EBIT, use a 14x PE (E being assumed equal to EBIT in that case) and discount back the value to today using a 15% discount rate. I*

do not add the cash as I assume that all cash is to be used to drive the pipeline and get these cash flows. Note that this methodology is not used to derive my target price, more to get a flavor"

This alternative approach highlights the difference between fair value and trading value. This was even more clearly illustrated in the following quote:

"(The) key advantage is to produce a single valuation of a company's product development portfolio and other assets that can be compared with the share price. Monte Carlo approach is preferable but does not produce an outcome that can easily be compared with share price"

Another analyst highlights the limitation with a valuation model:

"The key disadvantage is, of course, a large uncertain of the long-term cash flow, particularly of projects that have no current commercialized examples, like stem cells. So, this makes DCF valuation exposed to high downside/upside risk. My universe is largely early stage biotech companies with negative operating margins, so I can rely only on EV/Sales multiple or DCF valuations. In general, I have not yet found a proper valuation model in setting the fair value of the biotech company. This could be I guess risk-adjusted cash flow analysis, but the most tricky thing is setting proper transition probabilities for separate projects, as most of the companies do not provide enough information"

One more shortcoming with the model was highlighted by one analyst:

"NPV cannot valuate preclinical molecules because it's a statistic based tool and the success rate for preclinical molecules is <1%"

Therefore, a rational analyst using the rNPV model would not put effort in valuing pre-clinical projects since this would add very little to the valuation. In a similar way, but from a time value of money concept, another analyst argued that the planning or forecasting horizon beyond 10 years from today does not add much quality to a valuation.

The rationale for the valuation purposes is especially evident in the following case:

"We do not probably adjust as clinical trial outcomes/regulatory approval is binary. We thus take a view and then use both DCF based and PE based valuations. EV/Sales provides a quick method for valuation"

One frequently observed response of the disadvantage was the high uncertainty and that there are a lot of assumptions or guesswork that goes into the model. One analyst argued that since models are reflections of reality, the more assumptions that are used, the more debatable the outcome. Another response highlighted the fact that current valuation models are not satisfactory in terms of reflecting the current market value of the firm.

> *"Risk adjusted DCF and SOTP still remains garbage in / garbage out. Outcome will always be binary so average valuation in the end is always wrong, but still best tool to value company's current price"*

Another analyst states that there are no other ways to value these firms when cash-flows promise to be negative for 2 to 6 years.

In summary, we observe that biotechnology analysts use different valuation approaches suggesting it is a matter of preference of the users. However, the risk perspective seems to play a crucial role. Therefore, it becomes apparent that one of the major reasons why the rNPV model is used is due to the client-driven factor. The model offers the possibility for the investor to get an overview of the impact of each project on the total share value and thereby, more easily, determine whether to invest or not.

4.2 Different ways to value biotechnology firms

From Table 4.1, we conclude that the rNPV model and SOTP are the most important valuation models in biotechnology valuation. However, this does not reveal if analysts prefer to use some of the different valuation models together rather than separately. Imam et al. (2008) argue that valuation models are complementary to each other, i.e. valuation models are important in combination rather than in isolation. In order to examine whether analysts use different alternative ways to value biotechnology firms exists, i.e. if analysts use valuation models in combination, we applied NLPCA (see section 3.2.3). The results are illustrated in Table 4.2. The solution from the NLPCA displays four underlying ways to value European biotechnology companies. The first one can be classified as Multiples-based and the other three as Dividends-driven, Scenario-driven and Product-NPV.

Table 4.2 Non linear component loadings (NLPCA) – Four ways of analyzing biotechnology firms

Item	Multiples	Dividends	Scenario	Product NPV
				-0.12
EV/EBIT	0.95	-0.12		-0.11
EV/Sales	0.95		-0.13	
EV/EBITDA	0.88	-0.10	-0.11	-0.17
Price/Cash flow	0.82	0.29	0.26	
Price/Free cash flow	0.79	0.31		
P/E	0.78		0.19	
Price/BV	0.72	0.49	0.17	
EV/BV	0.70	0.63		-0.11
PE/Growth (PEG)	0.61	0.25	0.54	
Price/Sales	0.59			
Dividend yield		0.94	0.20	
Dividend discount model		0.94	0.20	
Discounted cash flow (DCF)		-0.93	0.30	
EVA	0.42	0.61	0.15	-0.56
Decision-tree analysis		0.27	0.93	
Scenario analysis			0.89	0.24
Monte-Carlo simulation	-0.13		0.71	
Real-option models		-0.17	0.57	0.56
Risk-adjusted DCF (rDCF)		-0.28		0.92
Sum-of-the-parts (SOTP)		0.26	0.32	0.82
EPS	0.27	0.13	0.54	0.13
Variance explained	36%	18%	17%	9%

Note: Component loadings higher than 0.55 are considered as strong and are highlighted by a box. Loadings less than + or – 0.10 are excluded from the Table.

Component 1: *Multiples*. This component includes models that can be characterized as multiples-based models.

Component 2: *Dividends*: This component expresses the connection among EV / BV, Dividend Yield, Dividend Discount Model and EVA. Those analysts who use these parameters to value the biotech companies do not include Discounted cash flow (DCF) Model into their analysis.

Component 3. *Scenario*: This component expresses the connection among Decision-tree analysis, Scenario analysis, Monte-Carlo simulation and Real-option models.

Component 4. *Product NPV*: This component expresses the connection among risk-adjusted NPV, Sum-of-the-parts (SOTP), Real-option models and EVA. Those analysts who use these parameters to value biotechnology companies do not include EVA in their analysis.

In order to try to explain why we observe the different ways of analyzing biotechnology firms, there are a few potential reasons. It is, at first sight, and to a certain extent surprising that multiples-based models are used in biotechnology firm valuation. However, one potential reason is, as some analysts argue, that the choice or adequacy of valuation model depends on the maturity degree of the company, i.e. in which stage of development that the company is in. For example:

> *"You will be using a different valuation model with a BioPharma company like Genzyme as opposed to a Biopharma company like MediGene, 4SC et al."*

One must also keep in mind that larger firms in general are covered by more analysts, which are not controlled for in this study.

According to component 4 (Product NPV) analysts tend to use risk-adjusted NPV and SOTP in combination with Real-option models. One analyst points out that an analyst will assess most angles to valuation, where each and every method has strengths/weaknesses and valuation conclusion is based on impressions from all. Another analyst argues that:

> *"Consistent and detailed expected value of cash flow valuation for the duration/lifecycle of the whole R&D pipeline on one hand and option models/Monte-Carlo simulation to back the outcome. Valuations are typically more conservative and realistic than usual DCF models, discount rates higher and closer to the real risk"*

However, comparing Table 4.1 and Table 4.2, the high balance score of rNPV in the former table and the low variance of the fourth component (i.e. Product NPV) in the latter, may indicate that analysts in general prefer to use the rNPV model in isolation rather than together with other models. Overall, we are careful in concluding from Table 4.2, because the correlation coefficient between rNPV and SOTP is only 0.525. Reliability aspects are discussed in section 3.2.5.

The interviews also reveal that all analysts were in agreement that subjective factors play an important role when valuing biotech companies, and when it comes to giving recommendations they are even more important. According to them, DCF calculations and other related calculations are particularly difficult to use in the biotech sector due to the fact that most of the biotech companies in the Nordic region are early stage companies without positive earnings and cash flow. The general consensus was therefore that one basically could generate whatever outcome one want from a DCF model due to each analyst's subjective outlook of future earnings. No one did, however, rule out the use of a DCF model as an important starting point for their valuation. Subjective factors then helped the analysts to get a more complete picture about the company. They did not want to go as far as to say that the subjective factors influenced their valuations directly. They rather had an indirect influence on the estimates and probabilities used in the DCF calculations. According to them the DCF gives a fundamental value to the company. It is, however, not uncommon that the recommendation on whether to buy, hold or sell and the target stock price differ substantially from the fundamental value. When providing short term recommendations two analysts from different banks said that subjective factors in combination with current news flow play a vital role.

One analyst that we interviewed had a different approach. According to the analyst, qualitative aspects are superior to quantitative aspects when valuing a biotech company. Qualitative aspects provide the first filter that is later followed by quantitative analyses. The analyst argued that one should never spend more time and energy on models than existing data allows you to. Instead the analyst tries to get a feeling for the innovative culture in the company and would like to see an entrepreneurial spirit within the company that is encouraged throughout the whole company. Management's ability to deliver on set targets, negotiate favourable agreements and forming beneficial partnerships are also very important. The analyst generally looks at projects in phase one to three but sometimes even look at preclinical projects.

The interviews revealed that less specified analysts, i.e. analysts who not necessarily only cover biotech companies but also other small companies, may differ in valuation approach. Because of time restraint the analyst do not put a lot of time into creating valuation models. Instead close contact with management and getting a feel for the quality of the projects is of greater importance. Interesting partners also play an important role.

4.3 Most important parameters in biotechnology valuation

In the second question from the questionnaire, analysts were asked to rank the three most important parameters in biotechnology firm valuation. The most frequently observed parameters that were mentioned are (without ranking): Cash (or net debt) and cash burn rate, discount rate, peak sales, R&D expenses, success rates and terminal value (or terminal growth rate). Other important parameters mentioned include duration of phases and net sales (royalty rates, milestone payments). They were not discussed in further detail by the analysts. The former parameters are, however, evaluated in more detail in the rest of this paper.

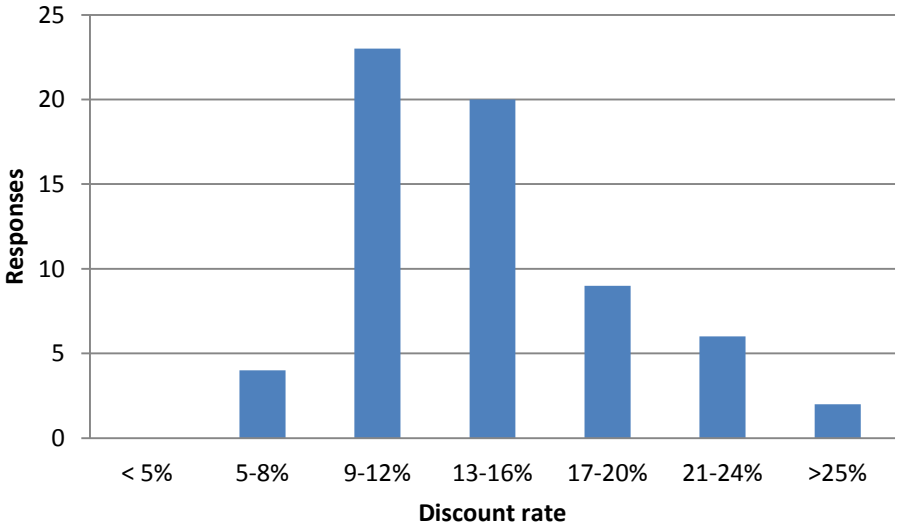
4.3.1 Cash

Many analysts consider cash (and cash equivalents) or net debt as one of the most important parameters. Closely related to this parameter is the cash burn rate. Cash burn rate refers to how long the firm can operate before it runs out of cash. This measure is usually calculated on a monthly basis, i.e. number of months remaining before break-even, rather than on yearly basis. Analysts argue that also the cash burn rate is a key indicator and that it is important to have a detailed analysis for how long the company has sufficient cash position. Some analysts argue that the cash position is especially important in the current environment, as refinancing is difficult. This was also confirmed from the interviews, where all analysts consider the cash burn rate to be of major importance. The analysts we met generally do not change the fundamental value of the biotech companies they cover but they all are extra sensitive with how they communicate with their customers in times of economic decline. This means that relatively stable companies with low cash burn rates and/or strong partners or owners gets favoured during economic down turns compare with companies with high cash burn rates.

4.3.2 Discount rate

Analysts were asked to specify the range for the average discount rate that is used when valuing biotechnology companies. The results are presented in Table 4.3.

Table 4.3 Discount rates used in biotechnology valuation



Most analysts use a discount rate in the range of 9-16%. However, the widespread use of different discount rates may indicate a lack of a consistent model that is applicable for these firms or that the firms differ a lot in terms of risk. In order to try to explain these variations in discount rates, analysts were asked to describe how they determine an appropriate discount rate. We observe widespread responses, which in some cases strongly deviate from what classical financial theory suggests. This use of different models for analysts covering firms within the same industry may indicate that it is a matter of preference of the users (e.g. Liu et al. (2002) and Imam et al. (2008)).

Many analysts, using the rNPV model, apply a standard value of discount rate in the range of 9-12% by the argument that every project is already risk-adjusted by success rates (depending on clinical stage, available clinical data and therapeutic area). For example, one of these analyst states:

> *"We use a WACC of 10% for all projects and probability-adjust each project depending on clinical stage, available clinical data and therapeutic area"*

One of these analysts also argued that since the DCF is already probability weighted by the chance of success, the WACC is assumed to be higher than a Large Cap Pharma as the capital

structure is not leveraged and the company relies on only a handful of projects. Another analyst (discount range in the range of 9-12%) use normal models for discount rates and argue that company specific risk should be reflected in the estimates, not the discount rate.

Interestingly, we also observe the prevalence of the client-driven factor, i.e.

> *"Depends on investor - Investor hurdle rate, generally for new mechanism 15-20% and if proven mechanism 10%, for a trade buyer where cost of capital is lower ca 7% hurdle rate. We do not explicitly probability weight"*
>
> *(Analyst, discount rate in the range 9-20%)*

Another analyst uses a forward-looking approach, in which the WACC is based on a target capital structure of 7% debt. This analyst uses a hurdle rate of 15%.

In general, many analysts point out difficulties to determine the risk-premium and the beta value. One analyst (discount range in the range 13-24%) use comparable listed biotech companies' beta value. A second analyst (discount range in the range 9-12%) use the capital asset pricing model and argue that the choice of the beta is subjective and depends very much on other stocks under coverage. A third analyst derives a fundamental beta from cyclical exposure of business, transparency, size/liquidity, leverage and technology, instead of a historical beta derived via CAPM. Cost of capital is then derived via forward rates and an equity risk-premium according to size of the company.

We observe other alternatives and have decided to just briefly mention a few of these.

> *"Normal WACC calculation is useless for those companies that still do not have sales. Therefore, on top of applying the standard risk premium to calculate it, we apply more 200 (than) additional p.p. as Terminal Value in these companies accounts for c100% of the valuation. This case is for those products still below phase 3"*
>
> *(Analyst, discount rate in the range 9-16%)*

> *"I apply different subjective factors that I try to quantify and that I add to the normal cost of capital of the firm because of the uncertainty of the cash-flows. Such factors are: experience of the management team, specialized pipeline in one area or more, number of products approved in the past, uniqueness of the products etc."*
>
> *(Analyst, discount rate in the range 13-24%)*

"Modification of the Capital asset pricing model. We use a risk free rate dependent on the local market for the companies investors and products i.e. ten year government bond yield and an equity risk premium of 4-6%. Our betas are based around an estimate of the historic beta of the Nasdaq biotech versus the S&P 500 (around 1.5) which we believe represents a proxy for an industry beta. We then adjust for individual companies market/systemic risk profile i.e. requirement for additional capital, leverage etc. Many people make the mistake of including a factor for unsystemic risk into a discount rate. In my eyes this is a mistake. This should be taken into account in the "Expected profits" in your model i.e. clinical risk adjustment used in rNPVs etc not in the discount rate"

(Analyst, discount rate in the range 9-16%)

"Based on Ibbotson surcharge rates for the cost of equity: risk free rate (4.8%), equity risk premium (4.2%), country risk premium (0.5%), size risk premium (0.5%), industry risk premium (7%), risk differential (based on the internal credit rating of the company - 0.35%) - total 16.65%. cost of debt: risk free rate, credit risk premium (0.35% - implied a AAA rating for small and risky companies), tax shield - total 4.24%"

(Analyst, discount rate in the range 9-20%)

4.3.3 Peak sales

Analysts were asked to explain how peak sales of a project in R&D are determined. Many analysts argued that estimation of peak sales is tricky, which also the heterogeneity in the responses may indicate. One potential reason for this seems to be due to the many assumptions that the analysts have to make. This is illustrated in the following two responses:

"(Peak sales) is actually a parameter that can make or break a valuation. Moreover, for a product not having finished phase II, it is impossible to give any estimate of peak sales"

"A long story. On the surface it is simple, you have to estimate the size of the population that match the indication for the drug. Then assess the total market (competitors / alternatives / medical need / willingness to pay) within that indication. Then look at the new drug - what will it add in terms of Health / Risks / Convenience of Use / Health Economy. Based on that you have to estimate a likely price level and assume a market share. You really need somebody on your team with pharma industry experience and broad pharma network in order to make good estimates"

Most analysts use a bottom-up approach, in which the number of patients (prevalence/incidence) is multiplied by potential penetration rate, market share and price of treatment. This is exemplified by the following response:

*"(I use a) bottoms up analysis of treatments * peak percentage (20-70%) penetration * price and I use a sigmoid curve that allows for the input of peak sales penetration, and time to peak of 3-5 years"*

Another analyst used a modeling approach, by modeling the market and determining how long it would take the product to reach peak market penetration from launch. Factors that were considered as important were existing and emerging competition and IP situation.

Some analysts use an epidemiology model, in which efficacy and safety profile, competition, pricing etc. are taken into account, i.e.:

"Most often using an epidemiologic model indication by indication, assuming similar pricing to products on the market. I usually avoid assuming price increase in order to be conservative. I often assume that the product is launched 2 years post Phase 3 read-out. I always back-up my peak sales using products already on the market in that indication and do not assume off-label use, except for obvious treatments such as oncology treatments in 3rd line NSCLC which are likely to be used in 2nd line and maybe 1st line. For antibiotics, running an epidemiologic model for instance would lead to peak sales above US$1bn, which is unrealistic when one sees what antibiotics on the market sale for. This is the perfect example of products for which one need to assess the relative efficacy of the drug and assess its potential relative to other drugs on the market. For indications smaller than US$100m, I assume that the product will not be marketed in such an indication as the economic benefit cannot be reached"

When a biotechnology firm will reach peak sales seems to be a matter of preference among the analysts. One analyst expect peak sales to be reached 4 years after launch, while another analyst set peak sales at the end of its expected exclusivity. Another analyst argues that:

"Peak sales is achievable 3 to 5 years after launch date it's a combination of several factors 1/ the added value of the product vs competition and 2/ the commercial penetration of the partner (big pharma or not). Of course it's linked with the size of the targeted market"

A more extensive response was given by another analyst:

> *"In relation to the life of the underlying patent a drug achieves peak sales dependent on the following factors:*
>
> *1.) Receiving approval in the various different jurisdictions where sales approvals are applied for*
> *2.) Size of the sales fore to introduce the product*
> *3.) Attractiveness of the product as required in the market (substitution or novelty effect)*
> *4.) USP's of the product vis-a-vis competitive products/compounds*
> *5.) Number of competitive products in the market*
> *6.) Incidence rates of the targeted disease(s)*
> *7.) Number of competitive products in the market*
> *8.) In general terms: peak sales can not be achieved earlier than 3 years after launch; peak sales should be achieved after 50% of the product life cycle has elapsed"*

In order to estimate market size (potential) of a product/project, analysts derive it from discussion/talks with the management of the company, peers/competitors, general (external) market research and analyst reports. Discussions with management deal with their expansion plans and also the reasonableness of peak sales.

4.3.4 R&D expenses

Analysts were asked to explain how costs for a project in R&D are determined. The vast majority of the analysts receive this information via talks with the management of the company (CEO, CFO, COO). Otherwise other sources are used. For example, analysts attach historic costs from other examples (i.e. use experience derived from similar R&D projects), try to get an understanding of the company's cost structure, use external market studies (comparable industry or company data) or study clinical development plans and protocols. Some analysts estimate the number of patients (i.e. "size" of trials) and apply a standard price per patient, while other analysts apply a standard cost per phase (i.e. a phase III costing usually US$50,000 per patient and a phase II more around US$20,000-30,000 per patient). Another approach (i.e. the cost per patient approach) is built upon the arguing that the cost per patient is a function of the disease concerned (i.e. therapeutic area) and the location of the survey (e.g. developed or emerging countries). Some analysts also consider the countries where trials are executed, but also countries where applications are filed. One analyst estimate personnel hours in R&D and add related costs and following trial cost per (pre) clinical phase. Some analysts also take the duration of program (years) and the speed of drug development.

Another analyst use in-house databases and resources, industrial contacts and industrial references.

4.3.5 Success rates

Analysts were asked if they use success rates when they value projects in R&D. Four analysts do not consider success rates. 20 analysts use their internal estimations based on specific projects, while ten analysts use their internal estimations based on general information for all projects. Three analysts do only rely on external sources on success rates. Two analysts use their internal estimations based on both specific projects and based on general information for all projects. Six analysts use their internal estimations based on specific projects and external sources. Three analysts use all three alternatives.

Analysts, in general, seem to consider success rates as a vast subject. It is generally based on industry statistics and some subjective elements like industry knowledge of the analyst, management elements etc., i.e. it is a mix of using average success rates per phase (which have been published) and tailoring it to the project that is being valued. An example is given in the following response:

> *"Success rates depend on the indication targeted and the mechanism of action. For antibiotics, we know the rate of success of clinical trials are pretty high. For RRMS, they are pretty low. I usually assume a rate of success for a Phase III between 45% and 65%. For regulatory approval, I now assume 80% once filed as regulators have become increasingly tough on approval"*

Some analysts also adjust the probability of success to factors such as senior management, quality of scientists and research partners.

Analysts also referred to several industrial references, such as the studies by DiMasi at Tufts Center for the Study of Drug Development (Authors note: DiMasi, 1995; 2001a; 2001b), but also to articles in Nature Biotechnology, the Milken papers, the Parexel Pharmaceutical Statistical R&D guide, Pharmaceutical Manufacturing and Research Association PhRMA) and also to internally developed databases.

4.3.6 Terminal value

Analysts were asked if they determine a terminal value when they value a biotechnology company. 19 respondents argue that they do, while 15 argue that the do not, suggesting it is a matter of preference of the users (Liu et al., 2002; Lee, 2003; Palepu et al., 2004; Imam et al.,

2008). The large heterogeneity of the different answers also to some extent confirms this. The analysts in the first category assume that the R&D can yield terminal growth rates varying in the range 1-5%. One analyst argues that a terminal growth rate larger than 1% is unrealistic because too much value is derived from the terminal value anyhow. A second analyst argues that a terminal growth rate between 1-3% is used depending on the growth potential of the company (or sustainability in the business). A third analyst states that they assign some terminal value if a company has a comprehensive R&D department that aims to generate ideas for long term revenue generations. A similar explanation is given by a fourth analyst, who argues that the most relevant factors or assumption in order to determine the terminal growth rate are pipeline considerations (value) and degree of innovation available in the firm. The respondents in the second category did not further explain the reason to why they neglect the terminal value of the firm. Only one analyst argued that they generally assume a high level of fade and therefore do not factor in new drugs until after proof of concept (authors note: the earliest point in the drug development process at which the weight of evidence suggests that it is "reasonably likely" that the key attributes for success are present and the key causes of failure are absent (Cartwright et al., 2010)).

4.3.7 Summary of the importance of input parameters

It becomes apparent that determination of input parameters to the valuation models to a large extent is driven by subjective assessments made by the analyst, i.e. it is a matter of preference of the users. This give rise to an infinite number of alternative ways to estimate different input parameters. Given the large number of assumptions that has to be made, the peak sales parameter seems to be the most difficult one. In addition, given the large variety observed in ways to estimate discount rates indicates that classical financial theory is non-satisfactory for these firms.

4.4 Subjective findings from interviews

During the interviews many interesting subjective findings were revealed that helped us to even further grasp how complex valuating biotech firms can be. We believe this chapter can add vital information when it comes to understanding the abundance of factors analysts consider when valuating biotech companies.

4.4.1 Management's historical track record and experience

All analysts from the interviews found it very important to keep regular contact with the upper management in each biotech company they cover. All of them confirmed that they had good access to management whenever needed. A key factor that all of them pointed out was the need to be able to trust statements made by management. It is vital to be able to trust what the CEO and other influential persons are communicating to the market. Trust is as a role hard to retain if the CEO for example fails to deliver on his own promises and estimates. The longer good historical track records, when it comes to deliver on prognosis, and the more experience the management posses, the more likely the analysts are to trust the management's current prognosis for the future. One analyst place special attention on how the management communicates with the market. The analyst states that it is important that they deliver clear messages that can't be misunderstood. According to another analyst the trust for upper management and how they have been able to deliver on prognosis in previous job roles are even more important for a young company with little or no historical data to analyse.

A third analyst prefers an unsentimental attitude taken by the upper management implying that they should be ready to "kill its darlings" if they find projects unlikely to be successful.

Furthermore all analysts were in agreement that a constant and seemingly unending need for funding from its owners reflected poorly on the management if it couldn't properly motivate the need for the extra funding. The need for funding in order to be able to go forward to the next stage after showing successful results in a clinical trial is a justifiable reason to ask for more money. However, it is a warning signal when management needs more money without showing any measurable results. Statements such as: "we have learned a lot in the last few months", is far from a justifiable reason to get more money according to one analyst.

4.4.2 Importance of management owning shares in their own company

The interviewed analysts had different opinions about ownership. Two analysts argued that management and other key personal who invest their own money into a project have the right incentive to work hard in order to make profit on their investment. By purchasing stocks they

also send a signal to other investors that they truly believe that they have good projects in their product pipeline. One of them underlined that it was a stronger incentive when the money came straight from their own pockets compared with, for example, an incentive program paid by the company.

The other analysts had a more ambivalent approach to management ownership. One analyst talked about both positive and negative aspects with a wealthy owner in a key management position. The analyst concluded that it is a great advantage with strong ownership among management in times when the company needs more funding since the individual or individuals can guarantee new issues of shares. However, there is a risk that personal agendas may come in between. Examples include when an influential owner in management position decides to fire and hire people because of personal reasons instead of dealing with it in a professional manner or when sound purchasing offers gets rejected because there is an unwillingness to lose influence in the company. One analyst also mentioned a case when a biotech company bought another company in the same sector. The two companies were however, fundamentally different from one another. The CEO in question was a major owner in both companies and forced together the two companies even though there weren't much synergy to realize from the deal.

4.4.3 Importance of partnerships and Intellectual property

All analysts were in agreement that an alliance or partnership between a relatively small biotech company and a larger player in the market can have an important impact on how the they value the biotech company. A partnership with a well established biotech company can according to one analyst send a very positive signal about the quality of the projects in the smaller company's pipeline. The knowledge of the bigger partner is often great within the field. Another analyst concludes that attracting strong partners are important because this not only signals that the small biotech company has good projects in place but also a good and reliable leadership. Furthermore, well established biotech companies always perform careful due diligence. They do not only evaluate whether the company has promising patents, they also check if the patents are strong enough to rule of the possibility of walking around them or simple stealing the idea without paying for it. The same analyst states that it is important to determine how long the Patents will last and also get a picture of how strong they are.

Most analysts briefly talked about how costly it is to take a project the whole way singlehandedly and that it requires deep pockets to make it possible. One analyst talked about

the advantage of having a partner in more detail; the experience and knowhow from the larger firm allows the smaller company to develop and gain experience faster. It learns how to handle regulatory issues, understand best praxis and how to design contracts.

4.4.4 Relevant news and other information

All analysts considered news with information relating to clinical trials and license agreements with partners to be the most important triggers for biotech companies. All of them read all the news they come across related to the company they cover. This generally includes information from news vendors and company reports. Moreover, one analyst also considers meetings with specialist physicians an important source of information. Furthermore, another analyst considers findings from patient organisations to be a good source of information when one to consider the existing competition.

5 Conclusion

In this final chapter, we briefly summarize the major findings in the study and develop the implications of these findings. At the end of this chapter, we provide some suggestions to further research.

In this paper we have investigated the rationale behind the analysts' valuation approach when valuing biotechnology firms in the European sector. This is analyzed by asking professional sell-side analysts what valuation models they use, as well as what different complementary models they use in order to value publicly listed biotechnology firms. In order to try to explain the findings, we ask questions of input parameters to the valuation model(s) and focus on how these parameters are determined.

The study is based on a self-administered questionnaire with 39 sell-side analysts, and is complemented with five semi-structured face-to-face interviews. We find that most professional analysts prefer the risk-adjusted net present value method (rNPV). It seems as if clients' preferences have forced the development of the rNPV model, in which an investor get an overview of the companies' projects and the impact of each project on the total share value. In addition, the rNPV model allows for flexible adjustments of target price. Thus, analysts may not be reluctant to significantly revise forecasts when new information is received.

We also find evidence, using a non linear variant of the Principal Components Analysis, of four different ways of valuing biotechnology firms. These variations in valuation models seems to some extent be driven by the maturity stage of the company. In addition, these results confirms that analysts covering similar industries use different models, which implies that it is a matter of preference of the users.

By analyzing different industry-related factors (e.g. cash (or net debt), cash burn rate, discount rate, success rates, terminal value and R&D expenses, it becomes apparent that the individual subjectivity, i.e. the preferences of the users, becomes especially evident when analysts' determining critical input parameters to the valuation models. However, it turns out that, due to the limitations in generally accepted models, analysts use alternative approaches, which in many cases clearly deviate from what classical financial theory suggests.

We conclude that the stock price determined by the valuation model only is part of the entire valuation story and that subjective factors play a crucial role in the investment recommendations.

One of the contributions to the academic literature in this paper of study is the research methodology using another methodological approach. We argue that the triangular approach of using content analysis to construct the questionnaire provides an alternative way in explorative studies, where the theoretical foundations are weak.

The second contribution of this study deals with the focus on a single sector, namely the biotechnology industry. This allows us to address more specific individual research issues and industry-related factors, as suggested by Barker (1999b) and Demirakos et al. (2004), on a much lower level of aggregation because the objects of observation and the institutional framework are the same for all survey participants (Glaum and Friedrich, 2006).

Focusing on one single industry, especially the biotechnology industry with typical characteristics, as well as on industry-related factors automatically limits the generalizability of the findings. However, the main findings may to some extent be transferable to other high-growth sectors such as the IT- and the software industry.

Further studies could also include US biotechnology analysts, and examine if there exists differences in valuation methodologies. The US biotechnology sector is considerable larger and more mature than the European biotechnology sector, and this may open up for additional ways of using valuation methodologies.

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7 Appendix

7.1 Appendix A. Questionnaire

Q U E S T I O N N A I R E

“Understanding the mind of the biotechnology analyst”

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Aim of study

This study aims at creating an understanding of how professional analysts practically go about when they value biotechnology companies within drug development and drug targets R&D[6].

This questionnaire comprises one part of the master thesis in Finance at the University of Gothenburg and considers analysts covering all publicly listed companies in the European biotechnology sector as of February 24th, 2009.

It is important that as many as possible answer this questionnaire in order to obtain high validity. This questionnaire contains 10 questions and should not take longer than 15-20 minutes to complete. **All answers will be treated with confidentiality.** All respondents are kept anonymous and hence it is impossible to reveal your identity and your responses.

Please send the questionnaire in this pdf-file once you have completed it, **no later than Friday the 20th of March 2009**.

Please tick the following:

☐ I would like the master thesis to be sent to me
☐ I am happy to be expressly thanked in the master thesis

If you have any questions or problems editing this pdf-file, please contact:

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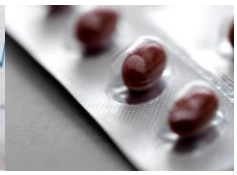
Phone: +47 95 888 497

Thanks in advance for completing this questionnaire.

We are looking forward to your answers!

[6] This questionnaire should only be filled in from the perspective of valuation of companies within 1) Drug development 2) Drug targets R&D, and thus, excludes the perspective of valuation of companies within Medical devices, Diagnostics, Information technology and Tools & Equipment

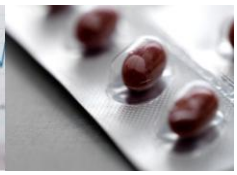



Question 1a. *When valuing biotechnology companies, how important are the following valuation methodologies/models on a scale from 1-5, where 5 represent very important and 1 not important.*

	Not important				Important	Don´t know/ Never use
Discounted cash flow (DCF)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Risk-adjusted DCF	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Dividend discount model	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Real-options models	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Dividend yield	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
P/E	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
PE/Growth (PEG)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Price/Cash flow	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Price/Free cash flow	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Price/BV	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Price/Sales	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EV/Sales	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EV/BV	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EV/EBIT	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EV/EBITDA	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EPS	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EVA	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Monte Carlo simulation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Scenario analysis	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Decision-tree analysis	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Sum-of-the-parts (SOTP)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9

Question 1b. *Are there other valuation methods, not mentioned in question 1a, that you use when valuing biotechnology companies?*

Question 1c. *Please specify the key advantage/disadvantage with your valuation model(s)?*

Question 2a. *How important are the following parameters when you value a biotechnology company on a scale from 1-5, where 5 represent very important and 1 not important.*

	Not important				Important	Don´t know/ Never use
Net sales	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Operating profit (EBIT)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Net profit	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Success rates	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Discount rate	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
R&D expenses	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Terminal growth rate	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Terminal value	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Duration of phases	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Capital structure	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Depreciation and amortisation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Capital expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Net change in working capital	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Expected future dividends	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Market capitalization	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Interest bearing debt	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Minority interest	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Preferred shares	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Cash & cash equivalents	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
EBITDA	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Taxes	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Net operating profit after tax (NOPAT)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Invested capital	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9

Question 2b. *Are there other parameters, not mentioned in question 2a, that you use when valuing biotechnology companies? Please also rate each factor on a scale from 1-5, where 5 represent very important and 1 not important.*

Question 2c. *Which three parameters in question 2a and 2b would you say are the most important when determining company value. If possible, please rate them in order, where 1 is the most important.*

1.
2.
3.

Question 3a. *When valuing biotechnology companies, which phases do you include?*

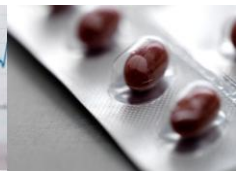
☐ Pre-clinical
☐ Clinical phase I
☐ Clinical phase II
☐ Clinical phase III
☐ Regulatory approval
☐ Existing products on the market
☐ Other(s), please specify

Question 3b. *When valuing biotechnology companies, what forecast period do you use?*

From now	☐ < 5 yrs	☐ 5-10 yrs	☐ 10-15 yrs	☐ 15-20 yrs	☐ > 20 yrs
From launch	☐ < 5 yrs	☐ 5-10 yrs	☐ 10-15 yrs	☐ 15-20 yrs	☐ > 20 yrs

☐ Other(s), please specify

Question 4a. *How do you determine an appropriate discount rate? Please describe in detail.*

Question 4b. *In what range is the average discount rate that you use when you value biotechnology companies? It is possible to tick more than one alternative.*

☐ < 5 %
☐ 5-8 %
☐ 9-12 %
☐ 13-16 %
☐ 17-20 %
☐ 21-24 %
☐ > 25%
☐ Other, please specify

Question 5. *Do you determine a terminal value when you value a biotechnology company?*

☐ Yes
☐ No

If your answer is Yes, what assumptions are you making regarding the terminal growth and what is this based upon?

Question 6. *How do you determine peak sales of a project in R&D?*

Question 7. *When you value biotechnology companies, do you value projects separately in the R&D portfolio?*

☐ Yes

☐ No

If your answer is No, please go to question 10a.

If your answer is Yes, please rate how important the following factors are when valuing the R&D portfolio on a scale from 1-5, where 5 represent very important and 1 not important.

	Not important				Important	**Don´t know/ Never use**
R&D budget	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Balance between phases	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Steady flow of products	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Number of compounds	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Uniqueness of products	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Follow-up compounds	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Dosage advantages	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Duration of phases	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Success rates of the phases	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Other(s), please specify						

Question 8. *When you value projects in R&D, do you use success rates?*

☐ Yes

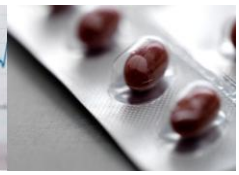
☐ No

If Yes, success rates are based upon:

☐ Your own company's internal estimations based on specific projects

☐ Your own company's internal estimations based on general information for all projects

☐ External sources. Please specify the source.

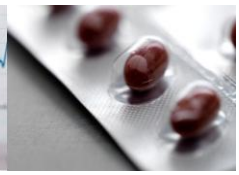



Question 9a. *How do you forecast product sales of a project in R&D?*

☐ Using a bottom-up approach (patient number, population, epidemiology etc)
☐ Using forecast peak sales and standard sales evolution curves
☐ Using a market based approach
☐ Other(s), please specify

Question 9b. *When determining future sales potential of a project in R&D, how important are the following factors on a scale from 1-5, where 5 represent very important and 1 not important.*

	Not important				Important	**Don´t know/ Never use**
Size of market	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Market growth	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Market share	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Therapy area	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Pricing and reimbursement	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Dosage and formulation	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Relative efficacy compared with						
- other drugs in R&D	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
- marketed treatments	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Lead time over competitors	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Launch phasing – countries, uses, competitors	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Company priorities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Blockbuster potential	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Other(s), please specify						

Question 10a. *How much analysis goes into the analysis of the expenditures in your model on a scale from 1-5, where 5 represent very detailed analysis and 1 a broad estimate.*

	Broad estimate			Detailed analysis		**Don´t know/ Never use**
Pre-clinical expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Clinical expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Reg. approval expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Manufacturing expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9
Selling and marketing expenditures	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 9

Question 10b. *How do you determine costs for a project in R&D?*

THANK YOU FOR COMPLETING THE QUESTIONNAIRE!