Patent Valuation in Theory and Practice

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Background: Today, an increased need to value patents is expressed in several different situations. For example, banks more frequently accept patents as collateral for loans and patents are being exchanged more often between companies. It is argued that a hindrance for the recognition of the value of patents, and other assets lacking physical form, is that the current methods of valuation are not developed for this type of assets.

Purpose: Our objective is to investigate the practical relevance of four theoretical valuation approaches in the context of patent valuation and to point out crucial factors affecting the choice of valuation approach.

Procedure: Interviews were conducted with professionals working in the field of corporate finance and with an expert in the field of patents and intellectual property rights.

Results: The respondents are not of the same opinion whether relevant approaches for patent valuation exist at all. Among the respondents who find it possible to value patents, the income approach is the dominating approach. The theoretical correctness of this approach, derived from the definition of value, is stressed as the primary argument for the use of it. Methods such as Decision Tree Analysis, within the income approach, and Relief from Royalty, a hybrid of the market- and income approach, are used as complements.

Table of Contents

1 INTRODUCTION ........................................................................................................................................ 1
  1.1 BACKGROUND .................................................................................................................................. 1
  1.2 PROBLEM DISCUSSION .................................................................................................................... 4
  1.3 PURPOSE .......................................................................................................................................... 5
  1.4 DISPOSITION .................................................................................................................................... 6

2 RESEARCH METHOD ........................................................................................................................................ 7
  2.1 THE SCIENTIFIC POINT OF DEPARTURE ......................................................................................... 7
  2.2 RESEARCH PROCESS .......................................................................................................................... 8
  2.3 RESEARCH METHOD .......................................................................................................................... 10
    2.3.1 Information collection ................................................................................................................. 11
    2.3.2 Conducting the Interviews ........................................................................................................... 13
  2.4 METHOD DISCUSSION ....................................................................................................................... 13
    2.4.1 Representation and generalization ............................................................................................... 14

3 FRAME OF REFERENCE ........................................................................................................................... 16
  3.1 INTANGIBLE ASSETS AND INTELLECTUAL PROPERTY ................................................................. 16
  3.2 PATENTS .......................................................................................................................................... 17
  3.3 VALUE ............................................................................................................................................. 19
  3.4 VALUATION APPROACHES ................................................................................................................ 20
    3.4.1 Cost Approach .............................................................................................................................. 20
    3.4.2 Market Approach .......................................................................................................................... 21
    3.4.3 Income Approach .......................................................................................................................... 23
      3.4.3.1 Discounted Cash-flow ............................................................................................................. 24
      3.4.3.2 Relief from Royalty ............................................................................................................... 25
      3.4.3.3 Decision Tree Analysis ......................................................................................................... 26
    3.4.4 Real options approach .................................................................................................................. 27
      3.4.4.1 The Binomial Model .............................................................................................................. 28
      3.4.4.2 The Black & Scholes model ................................................................................................. 31

4 EMPIRICAL STUDY ...................................................................................................................................... 33
  4.1 GENERAL VIEWS ON VALUATION OF PATENTS .............................................................................. 33
    4.1.1 Öhrlings PriceWaterhouseCoopers ............................................................................................ 33
    4.1.2 KPMG ......................................................................................................................................... 34
    4.1.3 Ernst & Young .............................................................................................................................. 34
    4.1.4 Deloitte & Touche .......................................................................................................................... 35
    4.1.5 AdviceIPR ................................................................................................................................... 36
### 4.2 Methods of Valuation

#### 4.2.1 Öhrlings PriceWaterhouseCoopers

#### 4.2.2 KPMG

#### 4.2.3 Ernst & Young

#### 4.2.4 Deloitte & Touche

#### 4.2.5 AdviceIPR

### 4.3 Crucial Factors Affecting Current Practice

#### 4.3.1 Öhrlings PriceWaterhouseCoopers

#### 4.3.2 KPMG

#### 4.3.3 Ernst & Young

#### 4.3.4 Deloitte & Touche

#### 4.3.5 AdviceIPR

### 5 Analysis

#### 5.1 The Value of Patents

#### 5.2 Cost Approach

#### 5.3 Market Approach

#### 5.4 Income Approach

- **5.4.1 Discounted Cash-flow**
- **5.4.2 Relief from Royalty**
- **5.4.3 Decision Tree Analysis**

#### 5.5 Option Based Approach

- **5.5.1 Binomial method**
- **5.5.2 The Black & Scholes model**

### 6 Conclusions

### 7 Final Discussion

### 8 Table of References

- **8.1 Books**
- **8.2 Articles**
- **8.3 Interviews**
- **8.4 Internet Resources**

### Appendix I

### Appendix II
1 Introduction

1.1 Background

Intellectual property (IP) is considered to be the main generator of value in many industries today. Companies are highly dependent on their IP in order to maintain a competitive advantage and to guarantee future profitability. The commercial value of IP has grown, and companies might in fact possess property that is the most valuable part of the enterprise without knowing it. A shift from capital resources to IP has taken place when it comes to the foundation of commercial power. It can also be argued that the definition of capital resources has shifted. Cash-filled balance sheets and enormous manufacturing plants are no longer associated with the term capital resources. Instead, IP is considered to be the dominating capital resource.

IP includes e.g. patents, trademarks and copyrights. Characteristic for this property is that it is valuable to the company despite the lack of physical form. IP has traditionally not been visible on the balance sheet. However, international legislation and accounting standards today, to some extent, allow capitalization of such assets, referred to as intangible assets. Intangible assets are one of the three fundamental elements contained in a company. These three basic components are monetary, tangible and intangible assets, and their aggregated value equals the total value of the business enterprise. As a consequence of this view, to be able to appreciate the value of the business, consideration of intangible assets such as patents is necessary. The following figure illustrates the relationship between the definitions:

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1 Landelius & Treffner, 1998
2 Smith & Parr, 2000
3 Ibid
4 Ibid
5 FARs samlingsvolym, 2002
6 Ibid
It is argued that patents can be seen as the most concrete of a company’s intangible assets\(^7\). Consequently, even within IP, patents are the more concrete than copyrights and other types of IP. We believe that the more tangible nature of patents can be related to the fact that the information provided by the patent is codified, registered, published and protected by law, and not as abstract as the concept of e.g. organizational knowledge. We have chosen to study patents in particular. Therefore, we always refer to patents when possible. Since many of the references discuss IP on an aggregated level, it has not been possible to always refer to patents in particular. We have used the term IP as valid for patents in those cases, since patents are included in the concept of IP.

For a long time, patents were treated as a decorative sign, indicating that a product had unique technical attributes and that the company was in the front line of technology. Patents were often seen as insurances, worthless until someone broke the patent rights and court proceedings made that party liable to pay damages. Before such a situation, the patent was considered to be worthless, or even to have a negative value. This view of patents can still be observed in some companies.\(^8\) However, we believe that this view is changing as a result of the increasing recognition of IP, as the main value generator in the company. The recognition of IP as the main driver for corporate success has led to a debate on the necessity of appreciating the value of a company’s IP\(^9\).

\(^7\) Petrash, 2000  
\(^8\) Landelius & Treffner, 1998  
\(^9\) Gosling, 2002
Before further discussing the value of patents, it is necessary to clarify what is meant by the term. A patent gives its owner the right to exclude others from commercially using and selling the patented product, technology or method\textsuperscript{10}. There are several advantages of patenting. For example, if a company has a patent on a specific product, it can use this monopoly position to sell the product at a higher price. Further, having exclusive rights to a cost-saving production technology may lead to a great competitive advantage in a mass-production industry. In addition, when negotiating a merger a well-developed patent portfolio can increase negotiating power, by offering the counterpart access to protected technology.\textsuperscript{11}

Today, an increased need to value patents is expressed in several different situations. IP, including patents, are being exchanged more often between companies. Banks more frequently accept patents as collateral for loans, which requires a valuation. Furthermore, a valuation of patents is also needed in the case of bankruptcy as supporting documents when compensating investors. License considerations, starting up new alliances for exploiting new technology, and acquisitions are all nowadays more often related to a need to value patents.\textsuperscript{12} The more frequent occurrence of these kinds of situations makes the necessity to face patent valuation inevitable.

In addition, today’s managers are more often called on to make decisions regarding patents. A decision has to precede a patent application as well as foreign patent applications. To be able to make a decision related to a patent, the value must be appreciated. The decision must be based on whether the costs related to the decision are justified or not. If the costs related e.g. to the renewal fees can not be justified, management should let the patent expire. Consequently, patents involve a high degree of managerial flexibility and decision making. The flexibility includes the possibility to e.g. abandon, continue or expand.\textsuperscript{13}

Another view expressing the importance of IP valuation comes from within the accounting profession, where there are strong advocates of the notion that IP can and should be valued on a regular basis. The argument for

\textsuperscript{10} PRV, 2002
\textsuperscript{11} ibid
\textsuperscript{12} Smith & Parr, 2000
\textsuperscript{13} Pitkethly, 2003
valuation in this case is to provide information to external stakeholders on the true value of the company, including the value of tangible, monetary and intangible assets.14

1.2 Problem discussion

Having emphasized the importance of patents and the necessity to value the property, the next step is to discuss whether or not it is possible to put a monetary value on it. In practice, valuations of patents are rarely done in most companies, partly due to lack of knowledge, but also due to the high level of skepticism as to whether or not patents can be valued at all, and the reliability of the results from such a valuation.15 Further difficulties related to the valuation situation arise due to the unique nature of patents and the technical, commercial and economic uncertainties involved. Even the advocates of the notion that IP can and should be valued, within the accounting profession, highlight the difficulties associated with a valuation of patents, as a hindrance for the recognition of the value. This group also states that the current methods of valuation are not developed for this type of assets.16

Literature on valuation, identifies four general valuation approaches that are considered as being relevant for valuation of IP, i.e. also valid for patents. (1) The cost approach considers the cost of replacing the patent with a comparable technology. (2) The market approach aims to appreciate the value of the patent by looking at the market value of related intangible assets. (3) The income approach aims to value future cash-flows related to the patent. These three approaches are viewed as traditional valuation approaches. Finally, some authors also argue that (4) an option based approach, where the patent is viewed as a call option, can be useful.17

The occurrence of technology intensive companies with substantial intangible assets and negative cash-flows that still generate a positive market capitalization has raised a debate on whether or not traditional valuation methods are applicable to these companies. Some experts argue that negative earnings and the increasing importance of IP have created a need for abandoning traditional valuation models and to search for new

14 Pitkethly, 2003
15 Eccles et.al, 2001
16 Samuel, 2002
17 Granstrand, 1999
18 Eccles et.al, 2001
19 Housel & Bell, 2001
ones. Others argue that the income approach is the golden method for valuation\textsuperscript{20}. In our opinion, there is an ongoing disagreement on how to meet the demand for functional methods for valuation of intangible assets like patents.

We argue that there is a trend indicating that situations where patents need to be valued will occur more often. The purpose of these valuations may be to provide information to stakeholders or to form the basis for the sale or licensing of a patent. However, the value of a patent can be very difficult to calculate, especially considering the future profitability relating to that patent. Another question is whether or not it is possible to assign a value to a specific patent, or if other components also must be taken into consideration. A final aspect related to patent valuation is the flexibility related to the property. To summarize, the need to value patents calls for appropriate valuation tools.

Considering the increasing need for valuation of patents and the articulated difficulties associated with it, we wish to investigate how relevant the above mentioned theoretical valuation approaches are for the valuation of patents, by investigating which methods that are being used in practice by professionals working in the field of corporate finance. A valuation approach is, in our opinion, considered to be relevant if it is supported in theory and found to be useful in practice by the respondents. If it turns out that none of the four theoretical approaches are used or considered to be useful in practice, they are all irrelevant in the context of patent valuation. We also aim to find out which the crucial factors are affecting the choice, or rejection, of a valuation approach. The following questions constitute the general guideline of the thesis:

- Which valuation approach(es) are being used for valuing patents in practice?

- Which are the crucial factors affecting current practice in patent valuation?

1.3 Purpose

Our objective is to investigate the practical relevance of four theoretical valuation approaches in the context of patent valuation and to point out crucial factors affecting the choice of valuation approach.

\textsuperscript{20} Damodaran, 2001
1.4 Disposition
The thesis consists of six chapters. After the introductory chapter (1), the method used for conducting the study is presented and discussed (2). In the frame of reference, the reader is introduced to current theoretical approaches to valuation (3). The purpose of the frame of reference is to provide the reader with an understanding of the theoretically approaches available for valuing patents. The findings of the empirical study (4) represent current practice in the field of corporate finance. In chapter 5, the empirical findings are analyzed using the frame of reference, using the research questions as general guidelines. Finally the results from the analysis are presented as conclusions in chapter 6.
2 Research Method

2.1 The scientific point of departure

One point of departure for discussing the theory of science lies in our assumptions of reality. When we are faced with a problem, the way we approach it is influenced by our beliefs and assumptions of cause and effect. In order to reduce the complexity of the problem at hand we turn to our assumptions of reality for deciding which course of action to take.

As business students we have gradually developed an understanding of how different actors behave in the world of business. This knowledge helps making complex concepts more comprehensible, by the use of assumptions. One example is the theory of rational behaviour, which states that an actor on the market acts in a rational way in order to maximize expected profits. Further, we have been introduced to a number of concepts and models used to simplify and explain or understand reality. As a consequence, we have developed mutual values for determining the credibility of the results of business research. The process described above has had an impact on how we chose to approach the research problem.21

The focus of this thesis is on valuation in the field of finance. In this area of research, mathematical and statistical models are often used in order to explain relationships of cause and effect. These models are the results of a deductive scientific approach, often supplemented by empirical verification. The deductive approach originated from the natural sciences and is characterized by logical reasoning.22 Further, the approach implies that reality is independent of its observer and that models can be developed as simplified reproductions of reality.23 In the field of finance, models which have been created using a deductive approach are used every day in order to make forecasts of the future. An example is the option pricing formula developed by Black & Scholes.24 This model was developed through the use of mathematics and statistics and it was developed for forecasting the future value of stock options.

Although the models developed using a deductive approach may be logically coherent, their practical use will result in questionable

21 Arbnor & Bjerke, 1996
22 Eriksson & Wiedersheim-Paul, 1997
23 Arbnor & Bjerke, 1996
24 Brealey & Myers, 2000
conclusions if the premises underlying the analysis are not consciously and critically chosen. In the case of the option pricing formula, an element of judgement and uncertainty is always present, as in the case of all other models of valuation.

We find that the concept of relevance is important in financial and accounting theory. One source of inspiration for this thesis has been the debate concerning relevance lost within management accounting. In that case, it was argued that methods for calculating and allocating costs had lost their relevance due to increasing indirect costs. In this thesis we ask ourselves if the studied valuation approaches have lost their relevance due to intangible assets making up a greater part of the company’s total value today.

2.2 Research process

The purpose of this thesis relates to the element of judgement and uncertainty stated above. The question is how professional actors choose between different models of valuation and how they deal with the element of judgement and uncertainty associated with the premises of the valuation.

Our research started when we read articles expressing the need for valuations of patents. After having searched in article databases and on the Internet, we found that there were no generally accepted methods for making such valuations. Although there are generally accepted approaches to valuation of tangible assets and whole companies, we began to wonder how patents were being valued in practice. This pre-study led to the draft of our research questions. The next step involved studying literature on the subject of valuation and patents, in order to get a better understanding of current approaches and methods of valuation in general. Further, we needed to relate these valuation approaches to the empirical findings in the pre-study. As a result we identified four theoretical approaches to valuation of patents and were able to formulate the final purpose and aim of the thesis.

The methodological approach used in this first part of the research project can be described as inductive. The inductive approach is based on empirical research. This means that information is not created, instead it is available in the form of facts that can be gathered and sorted by the researcher and used to make general statements.25

25 Hägg, 1994
The next part of the research process can be divided into two parts. First of all, a literary study was undertaken, where the four theoretical approaches to valuation of patents were thoroughly examined with respect to the situations in which they are applicable and the data sources used for calculation. We would like to point out that the income and real options approaches are quite extensively described compared to the cost and market approaches. In our opinion, these extensive descriptions are needed in order to be able to understand the consequences of applying the methods. As a result, the illustrative examples in the frame of reference will not be specifically used for the analysis, rather the outcomes of them.

The second part of the research process was the empirical study, where the aim was to find out which methods of valuation were actually being used in practice for the purpose of patent valuation. In order to be able to analyze why certain valuation approaches are being used in practice, the empirical study starts out with a presentation of the respondents’ general views on the value of patents and the situations in which a valuation may be needed. We believe that this background information is necessary since the choice of valuation approach depends on the object being valued and on the purpose of the valuation.

In the final analysis, theory met practice. The aim was to find out which of the theoretical approaches were regarded as being useful in practice for the purpose of valuing patents. As a consequence, the structure of the analysis was based on the frame of reference and each valuation approach was analyzed with respect to the respondents’ opinions regarding the applicability of the approach in the context of patent valuation. The following figure illustrates the research process:
2.3 Research Method

Once the research problem had been formulated and the research approach had been chosen, the next step involved determining an appropriate method for the investigation. As the method must be chosen to suit the purpose of the thesis, we had to ask ourselves what kind of results we aimed to produce. Holme and Solvang argue that, if the purpose of an investigation is to create a deeper understanding of a specific problem, a qualitative research method is often preferable.\textsuperscript{26} The deeper understanding is achieved by continuously working close to the problem and hence, seeing the problem from different points of view. Unlike the quantitative method, used for producing statistically reliable results, the qualitative method generates conceptual descriptions in the form of texts and models.\textsuperscript{27} Another feature of the qualitative method is the relatively higher degree of flexibility, which lets the researcher change or modify the research problem in case new knowledge and issues are found during the research process. This feature is referred to as progressive focusing\textsuperscript{28}. Further, using a qualitative method, the researcher may formulate interview questions differently to different respondents. The quantitative method, on the other

\textsuperscript{26} Holme & Solvang, 1997
\textsuperscript{27} Christensen, et al, 2001
\textsuperscript{28} Lundahl & Skärvad, 1992
hand, is more structured and formal since the results must be statistically reliable.

Our aim with this thesis was to gain a deeper understanding of valuation of patents and which of the theoretical models are being used in practice. Furthermore, the strict time limitation did not allow a drawn out empirical study. We concluded that a quantitative method, based on standardized data from a statistically reliable population, neither would provide the deeper understanding sought, nor would it be feasible with regards to the time limitation. The choice, therefore, fell upon the use of a qualitative research method.

The use of a qualitative method is also in line with the explorative purpose of the study. According to Lundahl & Skärvad, a study is considered to be explorative if the researcher has limited knowledge about the subject being investigated and aims at creating a more comprehensive understanding. The methods used for explorative studies are primarily literary studies, interviews with experts and case studies.\(^{29}\) In this thesis, no case study was undertaken due to the time limitation. Instead we relied on interviews and literary studies.

### 2.3.1 Information collection

Once the choice of using a qualitative method had been made, the next question was to decide which kind of information to collect and analyze in order to get a better understanding of valuation in general and specifically the valuation of patents. The secondary data used in this thesis includes literature describing different valuation models and their application. The concept of value and how it is used in the field of finance and in relation to intellectual property was also collected from literature, which we found to be relevant. Finally, we needed to deepen our understanding of patents, the process of patenting and how it relates to value in the sense of intellectual property rights. All this secondary data was gathered, comprised and structured in the following chapter called frame of references.

Regarding sources of primary data, qualitative studies are often, but not always, based on data collected from interviews. Again, looking back on the purpose of the thesis, we concluded that the best way of collecting relevant data was through the use of interviews with professionals working in the field of corporate finance, where the task of valuing patents may

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\(^{29}\) Lundahl & Skärvad, 1992
arise. Two possible groups of respondents were identified, the first one being analysts at investment banks in Sweden. After having been in contact with a number of potential respondents from this group we discovered that they were not interested in discussing the research questions, since they did not analyze companies’ assets on such a detailed level as separate patents. This lack of interest was not faced when we contacted the representatives from the corporate finance departments of the four leading assurance and business advisory firms in Sweden. These respondents showed a greater interest in discussing the research area. We believe that this interest stems from the fact that these firms have greater experience in valuation of specific assets, compared to investment banks where the focus is on a more aggregated level. Our respondents were (in chronological order based on interview date):

- Jan Treffner, Partner and member of the Intellectual Asset Management Group within Öhrlings PriceWaterhouseCoopers in Stockholm.
- Thomas Rynell, Partner at KPMG Corporate Finance in Stockholm.
- Thomas Lindgren, Life Science Director at Ernst & Young in Uppsala.
- Björn Gauffin, Senior Manager at Deloitte & Touche in Stockholm.

The reasons for choosing these respondents were many. First of all, together, these four firms offer their financial services to the majority of all Swedish companies. One major part of the services provided by these firms is valuation of companies or specific assets. Secondly, the respondents were chosen as a homogenous group before we contacted them independently and found out whether or not they had any experiences from valuation of patents. Another way could have been to only select respondents who argued that patents can be valued as separate assets, and had experience from such valuations. We argue that such a criteria for selection would have provided a single-sided view of reality. Hence, we believe that our choice of respondents was both valid and relevant, and that the method of selection led to a higher degree of reliability by limiting the risk of single-sided information bias.
A complementary interview was also conducted with Katarina Lundblad Pinnekamp, who was formerly head of the group patent council of ABB. She has over 20 years of experience in working with patents and Research and Development, and she is currently running her own consulting firm, AdviceIPR, as well as being a board member of the Swedish Patent and Registration Office (PRV). We chose to interview Lundblad Pinnekamp because of her knowledge of patents. As the other respondents are experts primarily on valuation, Lundblad Pinnekamp’s experience from working with patents adds a greater perspective to the study.

2.3.2 Conducting the Interviews
Lanz distinguishes between four different kinds of interview designs. The differences relate to the degree of standardization and to the purpose of the interview. In an open interview the respondents are free to discuss the questions they find relevant and interesting. When the purpose of the interview is explicitly defined and the interviewer is the one who determines which questions to be discussed the design is called directed-open. Further, the interview can be semi-structured, which means that the questions, and sometimes even some of the response alternatives, are predetermined. In the structured interview, all questions and response alternatives are predetermined, e.g. on a scale from one to ten.\(^{30}\)

In line with the purpose of the thesis and with regards to the relative complexity of the research questions, we chose to use a semi-standardized interview design. As the problem area was narrowly specified, the respondents could not be allowed to determine which questions to discuss. On the other hand, we did not want to limit their response alternatives. As a consequence, some of the valuation approaches were generally discussed more thoroughly than others, which, in our opinion can be seen as an indication on the relative relevance of the different approaches. The interview guide used during the interviews can be found in Appendix II.

2.4 Method discussion
The interviews with the representatives from the assurance and business advisory firms were conducted face to face at their respective offices. The interview with Katarina Lundblad Pinnekamp was conducted over the phone as she was situated in Switzerland at the time. During each interview, a tape recorder was used to record the answers, making the transcription easier and thus minimizing the risk of information loss. The

\(^{30}\) Lanz, 1993
entire interviews are not presented in the thesis; instead we have included
the parts that we found to be relevant regarding the research questions.
Furthermore, before publication, each respondent was given the
opportunity to read and comment on the material used from the interview.
In our view, this verification has minimized the risk of misinterpretation.

The aim when gathering the literature used in the frame of reference was to
create a broad basis of sources. For this purpose we searched in different
library catalogues and Internet search engines. Although many books and
articles were found on the subject of valuation in general, we only managed
to find a limited amount of literature regarding valuation of patents. As a
consequence, we were forced to use a few references quite thoroughly in
order to create a sufficient theoretical basis for analysis. Although it can be
seen as something negative, we believe that the relatively scarce amount of
literature regarding patent valuation further accentuates the importance of
conducting this study.

Concerning objectivity, we do not believe that it is possible to be totally
objective when writing a thesis. Instead we have strived at minimizing the
impact of our own opinions and values. Hence, the arguments in the thesis
are based on different reliable and verifiable sources, which are clearly
presented and accounted for. Different concepts and terms are explained in
order to clarify for the reader.

2.4.1 Representation and generalization

We have already explained and motivated our choice of respondents. Even
though a complementary interview was conducted with AdviceIPR, our
target group for this investigation is assurance and business advisory firms
in Sweden. The question still remains whether these respondents can be
seen as representatives for their respective companies and if the
conclusions of this investigation can be representative also for other actors
who are faced with the task of valuating patents.

In our view, the chosen respondents, and their opinions presented in the
empirical study, can be seen as representative for their respective companies
due to the fact that they were the persons recommended to us
when we contacted the companies. Furthermore, on each company’s
homepage, our respondents are listed as contacts for further information.
The fact that each respondent was either director, manager or partner,
indicates that they all have good insight in, or even develop company policy regarding valuation methodology.

Due to the fact that we have focused our study on companies in a specific industry we do not claim that our findings are representative for all actors facing the task of valuing patents. Our respondents can be seen as external advisors and their approaches to valuation of patents might be different to those chosen by other companies when they value patents internally.

Therefore, the conclusions of this investigation can not be viewed as general statements representative for all companies. Instead, the results should be seen as indications of how the task of valuing patents is approached by assurance and business advisory firms in Sweden.
3 Frame of Reference

3.1 Intangible assets and Intellectual property
One definition of an intangible asset is:

“...an identifiable non-monetary asset without physical substance used in the production or supply of goods or services, for rental to others, or for administrative purposes.”

(Lee, 2002, p. 42)

This view goes in line with the definitions presented by the International Accounting Standards Board (IASB)\(^{31}\) and the US Financial Accounting Standards Board (FASB)\(^{32}\), and may therefore be seen as generally accepted among accountants.

In order to be classified as an asset, a requirement stated in the definition above, the object must be identifiable, controllable and predicted to generate future economic benefits. The requirement of identification implies that it is possible to separate a certain intangible asset from internally generated goodwill. A property protected by law clearly meets this requirement. Control does not necessarily mean ownership, instead the requirement refers to the firm’s ability to control the future benefits associated with the asset. Finally the property must be predicted to generate future economic benefits. These benefits may be increased earnings or decreased production costs.\(^{33}\)

In general, intangible assets are considered to be objects such as patents, trademarks, and copyrights\(^{34}\), which is in line with our understanding. However, in a broader view, intangible assets can include a wide range of items such as customer lists, musical compositions, and databases\(^{35}\).

Intellectual property is the part of a firm’s intangible assets that is protected by law and hence, restricted from the use by others. This definition includes patents, trademarks and copyrights.\(^{36}\) Intellectual property can be

\(^{31}\) FARs samlingsvolym, 2002
\(^{32}\) Lee, 2002
\(^{33}\) Ekström & Lagerström, 2002
\(^{34}\) Lee, 2002
\(^{35}\) Ibid
\(^{36}\) Smith & Parr, 2000
created through registration at some authority or through establishment within a specific industry. The rights to some of this property may be time-limited, such as patents, while others are owned indefinitely, for example trademarks. \(^{37}\)

Since the aim of this thesis only relates to patents, a further presentation and examination of other kinds of intellectual property will not be conducted in this chapter.

### 3.2 Patents

“A patent can be described as an exclusive right of limited duration over a new, non-obvious invention capable of industrial application where the right to sue others for infringement, is granted in return for publication of the invention.”

(Pitkethly, 1997, p. 2)

According to the Swedish Patent and Registration Office (PRV), the possibility of patenting creates an incentive for inventors to disclose and publish the information related to inventions such as, products, methods and applications. What is granted, as mentioned earlier, is the right to exclude others from making, using and selling the invention. \(^{38}\)

In order to get approval to patent an invention it must meet certain requirements\(^{39}\). The invention must be:

1. **New.**
   
   This requirement states that a patent can not be approved for an invention that has been used, published or in any other way made public prior to the application date.

2. **Industrially applicable.**
   
   The invention must be something concrete, e.g. a product or a method of production, not a theory. The use of the product or method must yield the same result every time. Finally, the invention should solve a technical problem in a technical way.

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\(^{37}\) Smith & Parr, 2000  
\(^{38}\) PRV, 2002  
\(^{39}\) ibid
3. Unique.

The invention must differ from earlier inventions in a substantial way, which makes it difficult to get approval for an invention that combines two earlier inventions in a new way.

Even if the invention meets these criteria and is filed as a patent, this does not mean that the patent is valuable for the holder. Only a small minority of all the patents filed each year turn out to be commercial success stories, which indicates the need for methods of how to understand the value of patents.40

There is a distinction between the underlying invention, also called underlying intellectual asset, and the intellectual property right (IPR). The IPR confers the exclusive rights over the defined invention.41

![Figure 3.1: The two aspects of a patent](image)

The term patent is often used in a very loose sense, meaning either the underlying invention alone, the patent alone or both. Sometimes the term patent refers to the whole project leading up to the commercialization of the protected invention.42 The fact that there is a distinction between the underlying invention and the IPR can be illustrated by the following scenarios:

Even if the underlying invention proves worthless to one firm due to its inability to commercialize it, the IPR may still have a value, if the possibility to license or sell the IPR still remains. On the other hand, if the IPR turns out to be worthless, for example has expired or is otherwise invalid, the firm may still be able to commercialize the invention. To separate the project from the IPR may be a very difficult task, but in practice it is

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40 Pitkethly, 1997
41 Ibid
42 Ibid
usually not worth distinguishing between them. When we use the term patent, we refer to a general term including both the underlying invention and the IPR.

The value of a patent is, as mentioned, derived from the right to exclude others from using the protected property. According to Edwin Land, inventor of the Polaroid camera and founder of the Polaroid Company, the existence of patent laws makes the existence of innovative companies possible.

### 3.3 Value

“Value is the representation of all future benefits of ownership, compressed into a single payment.”

(Smith & Parr, 2000, p. 152)

This is the purely financial and narrow definition of value. With respect to other broader, less financial definitions of value, we deliberately use this one. The reason is that the purely financial definition of value is reflected, directly or indirectly, in the valuation approaches described later.

The definition implies that value changes over time, since benefits can increase or decrease. Thus, value can only be expressed in relation to a certain moment in time.

Not only are these benefits fluctuating over time, they are also unpredictable in the sense that they are not quantifiable unless it is defined who the owner is and for what purpose the valuation is undertaken. It is not possible to make a meaningful determination of the value unless all the conditions for the valuation are known.

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43 Pitkethly, 1997  
44 Smith & Parr, 2000  
45 Boer, 2002  
46 Smith & Parr, 2000  
To carefully define value is important when certain kinds of property are to be valued. The more a property is designed to suite a specific purpose, the more the value will differ due to the premises by which the valuation is undertaken. This is especially the case when it comes to valuation of intangible assets and intellectual property, since they often have a specific purpose and have a high value only within the entity in which they are included. Valuation in this framework of value means putting a quantitative monetary figure on an object.

### 3.4 Valuation Approaches

In general, a valuation approach is a way of estimating value by using one or more specific valuation methods. In most literature on business valuation, four generally accepted approaches to valuation are presented: the cost approach, market approach, income approach and the option based approach. A specific way to estimate value within a valuation approach is referred to as a valuation method.

A difficulty inherent in patent valuation is the task of estimating how much of the value that is associated with the patent and how much that is related to other property such as trademarks.

#### 3.4.1 Cost Approach

The cost approach aims to measure future ownership benefits through the costs of replacing the capability of the property in question and, thus, rests on the assumption that the price for new property equals the value of the future benefits from the service provided by the current property. The idea behind this approach is that if property was to be traded on the market at a price greater than the present value of the future benefits that it creates, then nothing would be sold. On the contrary, if it was traded at a lower price, the demand would make the price rise. Therefore, the cost for replacing any property with new property must equal the value of the property in question. Hence, the concept of value within the cost approach is related to the future benefits of the service provided from the property.

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48 Smith & Parr, 2000  
49 Boer, 2002  
50 Housel & Bell, 2001  
51 IVSC, 2002  
52 Landelius & Treffner, 1998  
53 Smith & Parr, 2000
The amount of the benefits, which might be achieved over the life-time of the property, is not directly considered in the cost approach. An inherent assumption of this approach is therefore that these benefits do exist and that they are sufficient to cover at least the development cost of the property.54

The central concept, substitution of existing capacity, can be interpreted in at least two ways. One way is to view the substitution cost as the market value of the costs for reproduction of identical property. Another way is to use the market value of the costs for replacing the capability through obtaining other property with exactly equivalent utility.55 In the context of the cost approach, market value is synonymous with fair market value. This term can be defined as follows:

“Fair market value is the amount at which property would be exchanged between a willing buyer and a willing seller, neither being under compulsion, each having full knowledge of all relevant facts and with equity to both.”

(Smith & Parr, 2000, p. 156)

Modifications as might exchange instead of would exchange and reasonable knowledge instead of full knowledge are often introduced in order to adapt the model to the reality. However, with or without modifications, the quotation highlights the core of the concept fair market value.56

Many important factors that are actually generating value are not directly taken into consideration in the cost approach. Such factors are e.g. the expected demand for the product or technology or risks associated with the property. Therefore, two different patents could be associated with the same amount of research costs and hence be valued equally through the cost approach, although one of the patents lacks commercial power.57

3.4.2 Market Approach

The market approach is based on consensus. In an active, public market the present value of the future benefits from a property is simply what the actors in the marketplace have agreed upon. This of course requires an

54 Smith & Parr, 2000
55 ibid
56 ibid
57 ibid
active exchange of comparable properties. The market approach is based on the following concept:

“The value of a privately held company can be reasonably estimated by examining, adjusting, and using the market multiples (such as price/earnings ratios) of “guideline” publicly held companies that bear enough similarity to the “subject” privately held company to make their multiples relevant.”

(Housel & Bell, 2001, p. 85)

The prerequisite of an active market comes from the fact that one or a few transactions do not make a market. If only a few pieces of property are traded every year, the price to which they are exchanged will have low validity as a measure of their value.⁵⁸

Comparability is also an important factor for the market approach to be valid. Sales of certain kinds of property, like common stocks, are easy to compare. In most cases, though, some adjustments need to be made in order for comparability to exist. Thus, quantifying the differences in property so that different sales can be compared is needed for the sale of one property to give an indication of the value of another.⁵⁹

When an information base about sales of property similar to the valuation subject exists, the market approach is a strong value indicator. On the other hand, when the activity and comparability conditions are not met, the market approach will include a high portion of subjective judgment, which makes the valuation unreliable.⁶⁰

Since the activity and comparability conditions discussed are absent in most cases of intangible asset and intellectual property valuation, the market approach technique is seldom used as a valuation tool for these kinds of property.⁶¹

Another reason that makes the market approach hard to use for valuation of intangible assets such as patents, is that they seldom are traded as separate

⁵⁸ Smith & Parr, 2000
⁵⁹ ibid
⁶⁰ ibid
⁶¹ ibid
entities. In most cases, where a transaction involving intellectual property is made in a market, the property is part of an entire enterprise. Market prices are therefore not directly disclosed. Examples of exchanges where e.g. a patent or trademark is traded as a separate entity are rare, and when they exist, the price is seldom explicitly disclosed to the market.62

Moreover, even if information about prices from former specific exchanges is available such prices will not have any bearing on the actual value of other patents unless the patents are somehow comparable. However, in general comparability is low with regard to patents since so many factors must be taken into consideration, e.g. industry, market share, profits, new technologies, barriers to entry, growth prospects, legal protection and remaining economic life. For example, two patents with similar characteristics of industry application, as well as market share and potential profit and growth, may still not be reasonable for comparison if one of them is just about to expire.63

### 3.4.3 Income Approach

As opposed to the cost- and market approaches, the income approach to valuation is based on estimates of future benefits. Therefore, many of the difficulties of the former approaches, such as comparability, are not as prominent using the income approach. On the other hand, estimates still have to be made, but this time it is not predominantly historical costs or key ratios that are in focus, but estimates on future cash-flows and events. The presentation of the income approach is structured into three parts, beginning with the Discounted Cash flow (DCF) method, which can be seen as the basic method of valuation within this approach, and it is incorporated in the following two methods, Relief from Royalty and Decision Tree Analysis (DTA).64

The income approach focuses on the property’s ability to produce income. The theory behind this is that the value of any property can be directly measured as a present value (PV) of the future net economic benefits from the property generated over its lifetime.65

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62 Smith & Parr, 2000
63 Ibid
64 Ibid
65 Ibid
3.4.3.1 Discounted Cash-flow

When using the discounted cash-flow method, two key factors need to be considered: the time value of money and the risk associated with the future cash-flows. Handling these two basic elements of the income approach could be done in two different ways. Either the discount rate is risk adjusted, a method often referred to as the Risk-Adjusted Discount Rate Method, or the certainty equivalent method is used.66

When applying the first of the two mentioned strategies, the first step is to determine a risk adjusted discount rate. This could be done in several ways, for example by using the Capital Asset Pricing Model (CAPM). The CAPM requires knowledge of the risk-free rate of return, the market premium for risk, and the beta-factor for the given property, which in turn includes estimation of the variance in the value from earlier valuations.67 The formula for determining the expected return with the CAPM can be seen in Appendix I. The resulting rate r would then be used in the standard DCF-formula where C is the expected cash-flow and t is the time:

\[ \text{Present Value} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} \]

In today’s practice, that same discount rate will then be applied to all future cash-flows.68

The second strategy has a slightly different angle of approach. In this case, the first step is to determine the certainty equivalent of the future cash-flows, and the next to discount that certainty equivalent using the risk-free rate of return as discount rate.69 When determining the certainty equivalent the question to be asked is: “What is the smallest certain payoff for which I would exchange the risky cash-flow?”70 The two strategies are illustrated in the following figure:

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66 Brealey & Myers, 2000
67 ibid
68 ibid
69 Ibid
70 Brealey & Myers, 2000, p. 244
When using the latter method, time and risk are separated from each other, since the cash-flows first are cut for risk and then discounted for the time value of money. This could be an advantage and a way to avoid problems when the risk adjustment varies over time.71

3.4.3.2 Relief from Royalty

One of the difficulties of patent valuation is to estimate how much of the projected gross revenue is associated with the patent and how much is related to other property such as a trademark. As a result, the valuator may have to use a more simplified method of valuation called Relief from Royalty. This method is based on the use of a hypothetical royalty rate which would have been paid if the property right had been licensed-in instead of owned.72

"The Relief from Royalty method values an intangible asset by reference to the amount of royalty expense saved from owning the asset rather than licensing it from a third party."

(Lee, 2002, p. 44)

Official information concerning conditions in different license agreements is available, including information about how many percent of the sales that are paid as royalty rates when a patent is licensed.73 With these royalty

71 Pitkethly, 1997
72 Gajland & Treffner, 2001
73 Ibid
rates as a guideline it is possible to estimate reasonable license fees that the current user of the patent would have to pay if he instead of owning the patent himself, would achieve the right to use it through a license agreement. Reasonable license fees must be estimated from one case to another. With this information it is possible to calculate backwards, and as a result receive the value that the patent would have had for the licensor, if the holder of the patent would have licensed it instead of owning it. With license fees as a tool, future cash-flows are calculated. These are then discounted with respect to a discount rate that is appropriate according to the life time of the patent.

This method includes elements from the market as well as the income approach. The features from the market approach come from the derivation of the license fees, and the income approach element is recognized through the discounted streams. Consequently, the Relief from Royalty method is a hybrid of the market- and income approach. This method of calculating backwards is used on a regular basis as a complement to the economic value calculated with the income approach.

3.4.3.3 Decision Tree Analysis

Various possibilities open to managers is not taken into account for using DCF methods. In different stages in the life of a patent it could be allowed to e.g. expire. Given that the number of such possibilities is limited and, in addition, the possibilities for management choice only occur at defined times, an alternative method to use is DTA. This method is based on an underlying DCF-analysis of each branch in a tree. The starting point in this analysis is in the end of the tree, and the procedure is to move backwards in time to give a present value. This procedure incorporates the value of flexibility encountered in a project or a patent. Through this type of analysis the ability to, for example, abandon the patent is built into the value. This does not mean that the DTA solves the discount rate problem. The rates have to have an appropriate relation to the risk involved at each stage. In practice, a constant rate is usually used. An illustrating example of how DTA can be used is found in Appendix I.

74 Gajland & Treffner, 2001
75 ibid
76 Lee, 2002
77 Gajland & Treffner, 2001
78 Pitkethly, 1997
The general point with the DTA is:

“If today’s decisions affect what you can do tomorrow, then tomorrow’s decisions have to be analyzed before you can act rationally today”.

(Brealey & Myers, 2001, p. 281)

Decision trees have the advantage of bringing the extra value of future decision flexibility into consideration in an explicit way. Especially, they visualize the connection between today’s and tomorrow’s decisions. However, they tend to grow complex very fast as the number of possible decisions increase. Hence, the DTA approach can be used only to show the most important links between decisions made today and tomorrow.79

DTA is just a convenient approach for summarizing cash-flows dependent on certain decision consequences. This approach does not at all value the actual option and shall not be confused with any option valuation methods.80

3.4.4 Real options approach

Most investment projects somehow involve options that can add considerable value to the project. Such options can be for example to sell or close down a project or to expand it. Options like these, where the value is not derived from a financial asset, are sometimes referred to as real options.81

Even the most complex financial derivative is somehow connected to a financial market and thus tangible and standardized. Real options, though, are most often deeply embedded in opportunities of a company and are therefore more complex. Such options may not have a fixed strike price. Mostly, they do not have a certain expiry date and have very limited liquidity. However, the analogy between real and financial options provides the possibility to use option valuation methods, and points out the value of flexibility and decision making ability in a way the DCF method cannot do.82

79 Brealey & Myers, 2000
80 ibid
81 Hull, 2000
82 Boer, 2002
The real options approach can be used as a capital budgeting technique with the objective to measure the value of a project in conditions of uncertainty, before the project begins. This approach has grown out of options theory. As the variability in the value of the underlying asset (cash-flow per unit) increases, the value of the option increases.\(^83\) Hence, first the value of the underlying asset is to be determined using a method within the income approach, and then it is possible to determine the value of the option.

A presumption for an option based approach is that the object to be valued can be treated as an option. A patent can be viewed as a call option with the product, i.e. the present value of expected cash-flows from the product, as the underlying asset. The total cost for introduction would then be the strike price.\(^84\)

![Diagram](Figure 3.7: The patent as a call option, Damodaran (2001, Chapter 11, p.32))

The problem with this approach is the essential information that is needed to put into the calculations. That information is usually held only by managers in the firm. Some of the information, like expected variance is not even available to insiders.\(^85\)

### 3.4.4.1 The Binomial Model

Once the patent has been transformed into a real option, the question is which method to use to value the option. One commonly used option-pricing model is the binomial model.

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\(^{83}\) Husel & Bell, 2001  
\(^{84}\) Damodaran, 2001  
\(^{85}\) ibid
One way to explain the fundamental structure of the binomial model is to demonstrate an example. Suppose an underlying asset is traded at $20 and that there is a call option on this asset with the strike price $21 and the exercise date is in three months. Assume that over the next three months the price of the underlying can either move up to $22 (which makes the option worth $1) or down to $18 (which makes the option worthless).

If we set up a portfolio consisting of a long position of \( \Delta \) shares and one call option short, we can choose \( \Delta \) so that on the exercise day, the value of the portfolio does not depend on whether the price of the underlying asset moves up or down. In this example, if we choose \( \Delta = 0.25 \), the portfolio will be worth $4.5 in each case. Since the future value is known, the portfolio must be risk free, and must, in absence of arbitrage opportunities, neither earn more nor less than the risk-free rate. Discounting $4.5 with a risk-free rate of 12% gives the present value of the portfolio equal to $4.367. Since the stock is traded at $20, the 0.25 stocks is worth $5, and the value of the option must be $5 - $4.367 = $0.633.

The same result can be obtained in another way. Previously, we said nothing about the probabilities of the price of the underlying asset moving up or down. Assume that we live in a risk-neutral world. This means that the expected return of all assets equals the risk-free rate. With the probability \( p \) for an upward movement, this means that \( 22p + 18(1-p) \) must equal the value of 20 capitalized with the risk-free rate of return. This gives \( p = 0.6523 \). Using this information to value the option in the example,

\[
\begin{align*}
\text{Stock price: $20} & \quad \text{Stock price: $22} \\
\text{Option price: $1} & \quad \text{Option price: $1} \\
\text{Stock price: $18} & \quad \text{Stock price: $18} \\
\text{Option price: $0} & \quad \text{Option price: $0}
\end{align*}
\]

86 Example from Hull, 2000, pp. 200-201
the option value will be $0.6523 \cdot 1 + 0.3477 \cdot 0 = $0.633$, which exactly equals the value from the first example.

This is a very important result, since it shows that the no-arbitrage arguments give the same answer as a risk-neutral approach. In fact, this is a principle called risk-neutral valuation, which states that when pricing options it can be assumed that the world is risk-neutral. This assumption can be made, not because it is realistic, but because the prices obtained from a risk-neutral valuation, as we have shown, are valid in the real world as well, assuming that there are no arbitrage possibilities.\textsuperscript{87}

With this information it is possible to build a tree, where from each node the value of the underlying asset either moves up with a factor $u$ or down with a factor $d$, where $d = (1/u)$. These factors are chosen so that together with the risk-neutral probability $p$, the expected return from the underlying asset is the risk-free rate.

$S =$ value of the underlying asset  
$d =$ factor for downward movement  
$u =$ factor for upward movement  
$p =$ risk-neutral probability for upward movement

\[ S \begin{cases} p & S \cdot u \\ 1-p & S \cdot d \end{cases} \]
\[ \begin{cases} p & S \cdot u^2 \\ 1-p & S \cdot u \cdot d (=S) \end{cases} \]
\[ \begin{cases} p & S \cdot d^2 \\ 1-p & \end{cases} \]

Since the value of the option on the exercise day is known, each stock value in the end of the tree corresponds to an option value. Working backwards through the tree, knowing that the option value in each node equals $p$ times the option value in the upper right node plus $1-p$ times the

\textsuperscript{87} Hull, 2000
option value in the lower right node, it is possible to work all the way back to time zero, the time of valuation. The value of the option, according to the binomial model, is the option value in the root of the tree.\textsuperscript{88}

When such trees are used in practice, the number of time steps must at least be 30 or more, not to give a too rough estimation of the option value. Further, the factors $u$, $d$ and $p$ must be determined, so that the expected return is the risk-free rate and so that the tree matches the volatility of the underlying asset. The only information needed to do this is actually the length of the time steps and the volatility of the underlying asset.\textsuperscript{89} For a closer description on how the factors $u$, $d$ and $p$ are determined and for more details on the binomial model, see Appendix I.

\subsection*{3.4.4.2 The Black & Scholes model}

The binomial model gives an intuitive feel of how option value is determined. However, in order to make calculations with satisfying precision, large trees with a large number of inputs are required. The binomial model is discrete, which means that there is a time interval between every price movement. If this interval is shortened so that it approaches zero, the probability distribution will approach the normal distribution and the price process will become continuous. This holds only under the assumption that when the time intervals get smaller, so will the price changes over those intervals. Assuming this, the Black & Scholes model applies.\textsuperscript{90} With this continuous method, only one calculation has to be done.

Not going into any details, we state that the information needed to value a call option with the Black & Scholes model is the same as in the binomial model. This information is the current value of the underlying asset, the strike price of the option, the time to expiration and the risk free interest rate. The volatility of the underlying asset is also needed, but in this case in the form of the variance in the $\ln($value$)$ of the underlying asset, rather than the normal variance. This is easiest explained by the fact that the value of this asset cannot drop below zero which makes the probability distribution of the stock prices lognormal instead of normal.\textsuperscript{91} The formula for determining the value of a call option using the information above can be seen in Appendix I.

\textsuperscript{88} Hull, 2000
\textsuperscript{89} Ibid
\textsuperscript{90} Damodaran, 2001
\textsuperscript{91} Ibid
The following table summarizes some of the characteristics of the approaches in the frame of reference.

<table>
<thead>
<tr>
<th>Valuation principle</th>
<th>Cost approach</th>
<th>Market approach</th>
<th>Income approach</th>
<th>Real options approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valuation principle</td>
<td>Current reproduction or replacement cost (i.e., market value)</td>
<td>Current market value expressed as multiples of the price of comparable goods.</td>
<td>Present value of future economic income</td>
<td>Value of an object = Value of a corresponding option</td>
</tr>
<tr>
<td>What is the value indicator?</td>
<td>Fair market value</td>
<td>Relevant market multiples</td>
<td>Present value of cash-flows</td>
<td>Present Value of the cash-flows from the underlying object</td>
</tr>
<tr>
<td>How is value measured?</td>
<td>From current market values</td>
<td>From public market data that are reasonable comparable to the valuation object</td>
<td>From estimation of future income streams</td>
<td>From project’s immediate return + projected value to be generated</td>
</tr>
<tr>
<td>How is the value of flexibility incorporated?</td>
<td>It is not incorporated</td>
<td>It is not incorporated</td>
<td>It is incorporated only in the DTA</td>
<td>The value of flexibility and uncertainty is quantified</td>
</tr>
</tbody>
</table>

Table 3.1: A summary of the valuation approaches, inspired by Housel & Bell, 2001, p.84
4 Empirical study

4.1 General views on valuation of patents

Here we present the respondents' views on the possibility of valuing patents as separate assets and if they have experience of such valuations. The respondents who did not value separate patents were asked to state the reasons for that and explain how they incorporate the value of patents in the valuation process. We have translated the empirical findings, including the quotations, from Swedish into English and the respondents have given their approval to use the material. If not otherwise stated, the text is based solely on the respondents’ opinions.

4.1.1 Öhrlings PriceWaterhouseCoopers

In 1998 Öhrlings PriceWaterhouseCoopers (PWC) set up a special line of service called the Intellectual Asset Management Group. As independent advisors, they assist companies on topics relating to intellectual property rights such as patents and brands.

According to Treffner, it is possible to value patents as separate assets by looking at the patented technology and identifying how this technology creates a competitive advantage for the company. When the patent is related to a process technology, making the manufacturing of a product cheaper, it is relatively easy to make a benchmark study of the competitors and hence identify the costs saved by using the patented process. On the other hand, if the patent is related to a consumer product, which is also coupled with a strong brand, it can problematic to separate the value of the patent from the value of the brand.

“Everybody knows what Losec is, but this far, the value is not in the trademark, but in the function, a unique effect. For Ipren, on the other hand, the value lies in the trademark; it is not a unique product.”

(Treffner, 2002-11-28)

Treffner could see a trend of increased licensing of patents, due to the rapid development of technology. For small companies in particular, it can be hard to commercially launch a patented product or process. In those cases licensing makes it possible for the entrepreneurs to develop ideas and then license them to the big players on the market. PWC has helped many small companies to write licensing contracts and to negotiate properly.
Other situations when PWC has been involved in valuation of patents are in the case of civil case law suits, due to patent infringement. In those cases PWC are hired to make an independent valuation of the patent in question. Furthermore, if the patent is to be transferred to another owner or country it has to be subject to taxation. The taxation should be based on the market value of the patent and hence, an independent valuation is needed.

**4.1.2 KPMG**

At KPMG they have got inquiries from clients wanting to value patents. These inquiries have come from companies facing a merger or from smaller companies that have developed an idea and need money from a venture capitalist. In these cases an independent valuation is needed.

However, KPMG does not offer the service of valuing patents as separate assets. According to Rynell, the value of patents is incorporated in the valuation process, even though the valuation is made on a more aggregated level. The reason for not valuing separate patents is, according to Rynell, that it involves too many assumptions and guesses about the future. It is difficult to say whether it is the patented technology or the marketing that creates value. Also, at KPMG they do not have the competence regarding the legal aspects of patents, which makes it difficult to value the element of protection of a patent.

Rynell finds that, regarding valuation, intangible assets have become more important relative to tangible assets, for better and for worse. They are much more difficult to capture, at the same time as they provide tremendous possibilities. Due to the difficulties, Rynell finds it more appropriate to view intangible assets as a whole.

**4.1.3 Ernst & Young**

Ernst & Young in Uppsala have not yet received any inquiries for valuation of specific patents. In Lindgren’s opinion, the majority of the life science companies in Sweden are relatively young, and have in most cases not yet a product ready for commercialization. As a result, the value of such companies or projects becomes very difficult to appreciate. To isolate and separately value a specific patent is even harder. Hence, at Ernst & Young, they do not have a specific method for valuing patents.
According to Lindgren, one has to consider the whole concept, the technology, in order to understand the commercial potential of it. The patent is one part of that concept and has to be included as one component in order to do a complete valuation. It is important to differentiate whether it is the product or the manufacturing process that is protected by the patent. Ernst & Young do not have the expertise to fully investigate how the protection is designed. Instead, they consult patent offices regarding such questions.

In Lindgren’s view, patents have always been important in the bio-tech industry, but they issue has been more accentuated during the past ten years due to an increased awareness of the value of protection.

“Today many companies develop products, pharmaceuticals and technologies that are very closely related. As a result it is ever more important to claim ones territory by patenting.”

(Lindgren, 2002-11-29)

### 4.1.4 Deloitte & Touche

Valuing a patent is like valuing an idea; it depends on how far it has come in the development process. If the patent is fully developed and generates money it is fairly easy to value it. On the other hand, it is very difficult to value a patent that is far from commercialization. If the patent protects a technology that is not available on the market, the valuation becomes much more uncertain.

Regarding patenting in general, Gauffin is of the opinion that, today, companies realize the value of patenting to some extent. At the same time, some might argue that by protecting a technology with a patent does not keep imitators away. This is especially true when a patent is held by a small company, lacking the financial resources for going through a drawn-out legal process. Instead many companies choose to develop the technology and keep it secret in order to be the first mover on the market.

On the other hand, banks and investors about to lend or invest in an innovative company, often want the company to patent the developed technology. They consider the patent as collateral, a realizable asset that can be sold in case of bankruptcy. A patent is more concrete than an idea, which means that many patent applications are filed in order to get access to venture capital and loans.
One situation when Gauffin has valued a patent as a separate asset has been due to a transfer of ownership. Either the patent owner was an individual selling the patent to his/her company in order to get venture capital, or the ownership was transferred to another country. In those cases a valuation is necessary as a basis for taxation, which according to Gauffin, does only require a valuation that ensures that the value is not unreasonable. Usually the value of patents is incorporated in a more aggregated valuation of an entire company. If the company is relatively newly founded around one or more patents, then these patents usually represent the major part of the company’s value. In these cases the valuation of the company becomes more difficult and thus time consuming depending on the purpose of the valuation. In case of a merger or a take-over the valuation needs to be more accurate than when it is done for tax reasons. Gauffin had never valued a patent in the light of a civil court suit, but he considered such a situation to be a requisite for a separate valuation of a patent.

4.1.5 AdviceIPR
As a consultant in the field of intellectual property rights, Lundblad Pinnekamp’s primary task is to increase the awareness of patents and the structuring of a company’s IPR. Hence, a valuation done by her does not necessarily result in a monetary value, as opposed to the other respondents in this investigation. According to Lundblad Pinnekamp, the level of accuracy needed depends on the purpose of the valuation. A valuation does not always have to be stated in monetary terms, but instead in more vague terms such as possibilities etc. A monetary value is needed for tax purposes or if the patent is to be used as collateral. Licensing of patented technology is increasing according to Lundblad Pinnekamp. In technology intensive industries it is also common with cross licensing between companies. In the latter case a monetary value is not always necessary to calculate.

In Lundblad Pinnekamp’s opinion, it is possible to value patents as separate assets, since it is possible to trade a patent or even use it as collateral for bank loans etc. Usually, a valuation of a patent is done facing some sort of transaction, but it may also be necessary when the property right has been violated and the amount of damages is to be assessed. In most cases one has to consider the product related to the patent. If the product has a value, then the patent is also valuable.
4.2 Methods of valuation

In this part the respondents were asked to explain which method(s) they use for valuing patents. Naturally, the respondents also had to justify their chosen methods. Those respondents who did not value separate patents were asked to explain which methods they use when valuing companies for which the value is highly dependent on one or more patents.

4.2.1 Öhrlings PriceWaterhouseCoopers

According to Treffner, DCF is the method predominantly used for any valuation, including patents. In order to determine the size of the cash-flows to be discounted, one has to look at the competitors on the market; what do they do? At what price can they sell their products? How much does their production cost? After having done a benchmark analysis of the competition, a cash-flow can be determined, which is then discounted.

The DCF method is used for valuing patents related to a product or process that is already in use. When it comes to technology that is not yet in use, a binomial-, or real option-approach is applicable. Treffner uses the development of a pharmaceutical as an example.

“During the development of a new drug, it has to pass different control stations. For every step in this control process there are statistical data on the probability of the drug passing. In such cases a binomial-approach is applied, presuming that the first step is based on discounted cash-flows”.

(Treffner, 2002-11-28)

When the stock market peaked in the late nineties, the value of many companies could not be justified using traditional valuation methods and hence, the methods were criticized. In Treffner’s opinion, that critique was nonsense:

“Anyone can see that as long as value is defined as future cash-flows, then the DCF-formula is the method to use; it is theoretically unimpeachable. This method has in turn been further developed by the use of different scenario analyses and that is nothing new either. 25 years ago I read about those binomial-methods, but no one knew what to use them for until now.”

(Treffner, 2002-11-28)
An advantage of using a scenario analysis is that it results in a visual decision tree, with different values depending on the relative probabilities of future events. According to Treffner, this adds an element of balance and visibility; e.g. what happens if a competing technology hits the market in three years? Many times, the entrepreneur owning the patented technology does not see the possible downsides and has exaggerated expectations regarding the patented technology’s commercial potential. In such cases, a scenario analysis adds perspective.

An alternative valuation method used by PWC is the Relief from Royalty method. In this case, comparable royalty rates are used to appreciate the value. Such rates are publicly available in databases, mainly in the US. Treffner argues that the Relief from Royalty method tends to underestimate the value of the patent due to the fact that the royalty rates that are publicly available are the result of negotiations between two parties. Hence, the whole value of the patent is not represented in the royalty rates, since the value is probably split between the parties. Otherwise the transaction would not have taken place.

In Treffner’s view, the methods of valuation have not changed very much over the years, but at PWC they have refined the way of determining different required returns for different types of assets. Assume that the required return for the whole of Ericsson is 10%; then there are methods for dividing this required return; e.g. real estate does not require as high return as a machine. The level of risk involved is reflected in the required return. Patents and trademarks are almost always given a high required return, depending on when it expires. If the patent expires in one year, then you know for certain that the market is open for competition in that time so the risk involved is quite low, and hence the required return is set low. On the other hand, if the patent has 10 years left, the required return is set higher than average, due to the fact that there is no alternative use for this asset, if a competing technology would take over the market. For real estate, machines and receivables there is always an alternative use.

4.2.2 KPMG

Basically, DCF is the method to use, according to Rynell. Looking at the past, it is obvious that this is the only correct method of valuation, even though the method often is used wrongly and without judgement.
“DCF is theoretically correct but of course there are pitfalls and it is often appropriate to use complementary methods in order to value processes that involve future decisions. There are option based approaches that can be used for such situations.”

(Rynell, 2002-11-29)

In Rynell’s view, the basis for option theory is to create risk-free positions, where normal distributions of outcomes can be calculated. These theories tend to become far too abstract when used for valuing intangible assets. On the other hand, Rynell considers the binomial approach to be applicable, since it adds an overview to the valuation process.

Before a cash-flow analysis is done, Rynell starts with a “common-sense test”, by looking at the demand side; Who are the expected consumers? What advantage do they get through this new product or service? How much are they willing to pay? The next step is to look at the costs, investments, supply-chain etc. that is needed to provide the product or service. The more extensive the analysis, the less uncertainty there is in the value calculations.

The risks involved in the project depend, according to Rynell, on how far in the development process the project is, from the idea-stadium to a proven sustained cash-flow. This relation is illustrated in the figure below:

![Figure 4.1: Illustration inspired by Thomas Rynell, 2002-11-29](image-url)
If there exists an active market, where a great number of transactions and valuations are made, Rynell finds that it might be unnecessary to do a cash-flow analysis. An example of this is real estate where ratios like price/m² can be used for valuation. Rynell points out that the use of key ratios is not a valuation method on its own, and such valuations require that the objects are standardized and frequently traded. Also, the use of ratios for valuation purposes can be very dangerous and constitutes the basis for stock bubbles. Rynell exemplifies with the case of internet consulting companies in the nineties, where the value per consultant became a valuation ratio, e.g. a consultant was valued at $2 million independent of how much he/she earned. Thus, Rynell did not consider the use of key ratios to be valid for valuing patents or developing technology, since there are no active markets or standards.

4.2.3 Ernst & Young
Lindgren finds the DCF method to be most useful for valuation but, in practice, the method may lead to quite uncertain results, specifically when valuing early-stage projects. In such cases one must rely on common-sense, the competitive environment, market potential of the technology etc. To use cash-flows in those situations requires many guesses. The DCF method is used for e.g. determining a licensing royalty and it is based on the future cash-flows over the coming 5 to 10 years.

Further, Lindgren also finds the binomial approach useful for dealing with the elements of risk involved in different projects. Being able to create different scenarios with varying probabilities is, in Lindgren’s view, a logical and sensible approach to valuation. As a complement, it is sometimes a good idea to compare the valuation to the value of similar companies in the same industry.

At Ernst & Young they do not differentiate the required return on different types of assets. Lindgren could not relate to any case where such a differentiation had been made, but he thought that it might be applicable in some cases.

“If, for example, a pharmaceutical company wants to sell off parts of its product range it might be applicable to set different required return rates, if the products differ in many aspects. But I do not see any point in consistently applying higher required return rates to patents than to other intangible assets.”

(Lindgren, 2002-11-29)
4.2.4 Deloitte & Touche

When it comes to valuation of patents, Gauffin argues that it is not the valuation methods that are the problem; it is the underlying data that is difficult to collect. DCF is the dominating valuation method also at Deloitte & Touche. Gauffin considers the binomial approach to be useful, not for calculating a specific numerical value, but for creating an understanding of the factors influencing the value. It may be difficult to determine the variables to put into the binomial tree, but the process offers the possibility to play with different probabilities and to compare how certain risks and opportunities affect the value.

“Patents are basically more like options, but since the probabilities are so difficult to appreciate, the DCF method is the most correct one to use.”

(Gauffin 2002-11-29)

If it is possible to get statistics in order to calculate probabilities, Gauffin might use a real-option approach as a complement to DCF. Although this method originated from the oil and mining industries, where these statistics were used for determining the probability of finding oil e.g. in the North Sea, it can be applicable for valuing patents in the pharmaceutical industry. In the pharmaceutical industry there are statistics on the probability of success for a drug depending on how far in the development it has come. In most other industries such data is unavailable.

Since every patent is unique in some way, it is difficult to find something to compare it to. Hence, Gauffin finds that it is seldom possible to use any kind of comparative valuation. Gauffin mentions valuation of real estate as one situation where that can be useful.

4.2.5 AdviceIPR

Normally, one has to start off by looking at the product and then try to isolate the patent’s part of the value. Lundblad Pinnekamp mentions Tech factor as a method of identifying the patent’s part of the cash-flow. Another way of valuation is to consider how much one would be willing to pay if the technology was to be licensed - the Relief from Royalty method. Two problems with this method are that a similar technology does not exist, or it is patented by a competitor. In the latter case, cross licensing is often preferred, which does not always require a monetary valuation.
Lundblad Pinnekamp argues that the DCF method is the basis for many valuations, and that it is the preferred approach amongst corporate finance analysts. Further, Lundblad Pinnekamp discusses real options and binomial trees. In her view, the methods are not very different; it is the way basic data is collected and treated that is important. The real options method is not one that Lundblad Pinnekamp recommends for valuation of intellectual property, since the method involves the variance in historical valuations. It might be useful for valuing assets traded on a market where the variance can be statistically appreciated. Since the method yields a higher value if the variance is high, it is not very practical for valuing patents.

Binomial trees on the other hand, are something that Lundblad Pinnekamp finds useful in the valuation process by adding an element of time and the possibility to set different outcomes for different actions; e.g. at this point we apply for a patent, what happens then etc.

All of the valuation methods mentioned above are, according to Lundblad Pinnekamp, very time consuming because of all the background data that has to be collected. In practice these major valuations are rarely done within the R&D departments for their development programs.

The market approach is another way of valuation and relates to situations where the patent is to be sold. In this case, a patent is considered to be like any other commodity; it is a question of finding the right buyer; how big is the buyer’s market share? In which ways can the buyer utilize the patent? The value of the patent depends to a great extent on who the buyer is.

### 4.3 Crucial factors affecting current practice

Which factors are most difficult to measure or demand a high degree of speculation and how do the respondents handle these elements of judgement and uncertainty?

#### 4.3.1 Öhrlings PriceWaterhouseCoopers

The result of any valuation depends to a great extent on for whom and why the valuation is done. Treffner mentions the case of civil law suits, where one party has a more positive opinion and the other a more negative opinion of the value of the patent.
“This is not an exact science; you can never say that the value is SEK 12.354.254, although some people might think so.”

(Treffner, 2002-11-28)

According to Treffner, one of the most difficult aspects with patent valuation is the fact that several patents often are used in the same product. Patent alpha may be a part of the products A, B and C. Patent Beta is used for the products B, C and D. The patents Gamma is used in the product A, C and D, etc. In such cases it might be difficult to value a specific patent or technology; instead one has to look at the cluster of patents and value them as one group. Further, it is also difficult to separate the value of the patent from the value of the brand, as stated in an earlier question. Generally, process patents are easier to value than product patents.

Treffner also thinks that the valuation of patents is more demanding than other valuations, due to the technical competence needed. For this competence the valuator is in the hands of the technicians in the company, who have a way of totally overestimating the market potential of the technology.

4.3.2 KPMG

As stated in an earlier question, Rynell does not value patents as separate assets due to the difficulties of separating the patent from other cash-flow generating assets. Also, in Rynell’s view, such valuations depend on too many assumptions and guesses to produce any reliable results.

4.3.3 Ernst & Young

Lindgren means that it can be almost impossible to collect sufficient information in order to do a proper valuation; especially in the early stage of development. The most difficult tasks are sizing up the total market and to appreciate how much the customers are willing to pay for the technology; how much better is this product than other products on the market?

Even if this patented product is proven to be the best, many obstacles remain in order to get the customer to buy it: price, distribution channels, marketing etc.

Lindgren argues that one also has to look internally; does the company have enough resources to finish the project? If those resources are not available, the patent is worthless.
4.3.4 Deloitte & Touche

According to Gauffin, the problems related to lack of information depends on the situation. Sometimes it might be quite easy, e.g. when there are comparable technologies or patents, or if the market is very limited and thus easier to size up. On the other hand, if the product has the ability to be introduced on several big markets it gets a lot more difficult to appreciate how big share of the market it is going to get etc. In those cases the valuation becomes much more uncertain due to gross estimations.

The patent owner rarely considers all the risks involved in the commercialization of a patented product. In Gauffin’s view, the entrepreneur, in most cases, only sees the positive market potential. Even if the product is the best one on the market, history tells us that it is not enough for surviving on the market. Gauffin gives the classic example with Betamax, a video technology that was superior to VHS but failed due to other factors.

In Gauffin’s opinion, the major difficulty is the estimations of future events. Often, there is no market for the patented product; it has to be created. It might be necessary to make the customers change their behaviour in order to succeed, as for the case of mobile telephony. In such cases is extremely difficult to make estimates of future cash-flows.

Concerning the subjectivity involved in patent valuation, Gauffin drew the following diagram, illustrating how the reliability of a valuation depends on at which stage in the development process it is undertaken:
Further, Gauffin points out that another aspect influencing the valuation is the fact that it is costly to administer and register patents. On this issue, there are differences between countries; in the US it is more complicated than in Sweden. Finally, the value of the patent might be dependent on the combination with a brand or a specific organization, which makes the task of separation very difficult.

**4.3.5 AdviceIPR**

In Lundblad Pinnekamp view, the reliability of a patent valuation depends on the purpose of the valuation. Valuations in general always involve assumptions about the future, and the future is always uncertain. In order to make sense of the result, understanding the purpose is vital. Further, the major problem is to collect and analyze background data. This includes data on the revenues and costs related to one specific patent. Even the most fundamental economic variables are difficult to appreciate. Then, the legal aspects of the patent must be considered which adds to the complexity. The patent is most often only one part of the whole concept and since it is difficult to make estimates on the whole concept, it is even harder to identify the value related to the patent.
5 Analysis

The starting point for undertaking this study included the identification of four theoretical approaches to valuing patents. The primary question we wanted to investigate was how relevant these theoretical valuation approaches were in practice. The empirical study shows that the income approach seems to be the dominating approach for valuation of patents. Even though all four approaches are mentioned in theory and to some extent discussed by the respondents, the income approach is the one that all respondents consider most useful in practice.

Why is the income approach so dominating, and why are the others hardly considered? We aim to seek explanations to these questions by analyzing the arguments provided by the respondents and by linking these arguments to the theoretical view. Before analyzing the theoretical valuation approaches specifically, we find it necessary to have a general discussion on whether or not a patent can be valued as a separate asset.

5.1 The value of patents

An interesting finding in the empirical study was the different opinions regarding the possibility to value a patent as a separate asset. In our opinion, it is possible to identify two groups among the respondents with widely different opinions regarding the possibility to separately value patents. Öhrlings PWC and AdviceIPR, as one group considers the patent as any other object to be valued, even though the valuation process becomes more time consuming compared to tangible valuation objects. The other group, consisting of KPMG and Ernst & Young, argues that patent valuation is coupled with too many assumptions and estimates, hence, it is not possible to come up with reliable results. Furthermore, the difficulty of separating the value of a patent from other assets is another argument for not valuing patents. Instead, the whole concept of product, trademark and patent has to be valued as one entity. These difficulties are also stressed by Öhrlings PWC and AdviceIPR, but they are not seen as reasons for not valuing patents. We have deliberately left out Deloitte & Touche from this grouping, due to our unwillingness to force any of the respondents into a group without clear arguments.

The discussion above further motivates an investigation of the practical relevance of the four theoretical approaches. We have chosen to analyze
each approach separately. We believe that this is necessary in order to make statements concerning their relevance in a simple and clear manner.

5.2 Cost Approach

The general view among the respondents is that patents are hard to value due to the external factors requiring assumptions and guesses. In our opinion and with regards to the theoretical description, this reasoning indicates that the cost approach is not even being considered, since many of these assumptions are never even needed within this approach. The respondents, however, see such assumptions, like estimating the market potential of the technology, as obvious tasks associated with patent valuation. We argue that market potential has to be considered when valuing a patent. If there is no demand for the product or process protected by the IPR, the patent is worthless. Even though it is not directly outspoken, we argue that the crucial factor making the cost approach irrelevant for valuing patents is the lack of consideration to market potential.

Although the cost approach is not regarded to be relevant for patent valuation, the value indicator within this approach can, according to us, be useful for understanding transactions involving patents. Transfer of ownership is one situation where e.g. Deloitte & Touche has valued a patent. In our opinion, this situation might be one in which the concept of fair market value is representative of the value of the patent being exchanged. Fair market value can in this case be seen as the result of a negotiation between the buyer and the seller, without requiring an active market. Another empirical finding was that royalty rates were also often the result of a negotiation. We argue that the concept of fair market value can be used to understand the size of the royalty rates in some of these cases.

5.3 Market Approach

Comparability is the basis for valuation when using the market approach. As argued by Smith & Parr, the approach is not commonly used for valuation of patents since comparability of such assets is difficult, if not impossible, due to the uniqueness of the assets. Deloitte & Touche and KPMG made it clear that they do not use the market approach for valuing patents, mainly due to the lack of comparable objects, which is a consequence of the unique nature of patents.
Smith & Parr point out a number of factors, such as industry, market share and remaining economic life, needed to be taken into consideration in order to make a meaningful comparison. If all these factors were being considered, we believe, in contrast to the respondents, that it is possible to decide whether or not two patents are comparable. On the other hand, we think that this process would probably be too time-consuming to be worthwhile, which justifies the respondents’ statements.

Since the value indicator within the market approach is relevant market multiples such as P/E (companies) and Price/m² (real estate), the approach requires historical data on earlier transactions of similar patents. Once again, the requirement of comparability is stressed, and in addition, an active market is a presumption for making the approach reliable. Even though there are signs that patents are traded more frequently today, we do not think that the number of transactions make up an active market. One of the respondents pointed out the market approach to be relevant for valuing tangible assets and can be seen as a substitute to the DCF method, if there is an active market, as for real estate. On the other hand, the lack of an active market for patents is a crucial factor making the market approach irrelevant for valuing patents.

Closely related to the market approach is the Relief from royalty method, which is considered as a hybrid of the market and income approach. We have chosen to categorize it under the income approach, with regards to the structure in the frame of reference. This turned out to be suitable, considering the dominance of this approach.

5.4 Income Approach

5.4.1 Discounted Cash-flow

Looking at the empirical study, it is obvious that DCF is the basic valuation method of choice among all of the respondents. It is argued that DCF is the most correct method of valuing any assets, since an asset that is not expected to generate future cash-flows is worthless, no matter how much was spent on its development. In this sense, market potential is considered, as opposed to the cost and market approaches.

We argue that the dominance of the DCF method, relative to the other methods discussed, can be found in the fact that the method directly reflects the respondents’ consideration of the concept of value. In the empirical study, it was clearly outspoken that value is defined as future cash-flows,
similar, but not equal, to the theoretical definition in the frame of reference, where value is defined as future benefits. Therefore, we can understand why the DCF method is seen as theoretically unimpeachable among the respondents. As a result, it comes as no surprise that if valuing a patent, the DCF method is preferred.

Although the method is considered by the respondents to be theoretically correct and the primary method used in practice, they point out that the practical application of the DCF method for the valuation of patents is not without drawbacks. Since the method focuses on future cash-flows, estimates must be made on those cash-flows, which naturally have not yet been realized and thus, the estimates include elements of uncertainty and risk. According to most respondents, the scope of the uncertainties involved when valuing patents makes the valuation process more complex and time consuming. Some respondents even argue that these uncertainties make the task of valuing separate patents impossible. This latter group of respondents is the same group arguing that it is not possible to value a patent as a separate asset. We believe that these respondents do not question the DCF method per se, but the possibility to value a patent, regardless of method.

According to Öhrlings PWC, Deloitte & Touche and Advice IPR, the task of identifying and valuing separate patents is possible; although the reliability of such a valuation depends on at which point in the commercialization process the valuation is undertaken. For a patented product which generates a stable cash-flow, it is argued that the identification of cash-flows related to the patent is relatively easy.

The risk associated with the future cash flows is one key factor to consider in the DCF method. Even though it was not mentioned in the empirical study, we think that the DCF formula can be seen as quite static, as it does not consider the element of change in risk over time. We base this argument on the fact that the discount rate, once set, is fixed in the DCF formula. In the empirical findings, the importance of taking the different development stages of a project or patent, which are associated with different levels of risk, into consideration was pointed out. When using the method for valuing patents, we argue that the method’s inability to handle change in risk can be seen as a weakness.
At Öhrlings PWC, the process of determining the discount rate has been refined over the years. As a result, discount rates are determined for specific assets, instead of using the required return rate for the entire company. This way the element of risk is considered more thoroughly. Since the estimates of future cash-flows related to a patent are viewed as uncertain, and because there is no alternative use for a patent, the discount rate is set higher than for other types of assets. We believe this is a way of further enhancing traditional valuation methods, to better suite the valuation situations they face today.

Even though the DCF method is evidently relevant for valuing patents already generating cash-flows, most respondents use some complementary method in order to capture the value of flexibility.

5.4.2 Relief from Royalty

Öhrlings PWC uses the Relief from Royalty method mainly as a complementary method of control, since DCF is the primary method of valuation. At Öhrlings PWC they have gathered publicly available data from historical licensing transactions involving patents and trademarks. Facing the valuation of a new patent, this database can be used to find comparable patents and see at which royalty rate they were licensed. These royalty rates are used in order to estimate the cash-flows to be discounted. As stated in the frame of reference, comparability is required in order to use methods within the market approach. Since the Relief from Royalty method can be seen as a hybrid of the market and the income approach, this requirement must be met even within this method. We think that the use of this method requires comprehensive data gathering, in order to be relevant in practice. This argument is also pointed out in theory and in practice, referring to Öhrlings PWC. As long as suitable information is available, the method is relevant for valuing patents.

AdviceIPR was the only other respondent who mentioned the Relief from Royalty method as being applicable for valuing patents. In our opinion, these two companies are the most experienced when it comes to patent valuation among our respondents, and since they both argued that the Relief from Royalty method is a useful tool for this purpose, we conclude that the method is relevant, at least as a complement to the DCF method.
5.4.3 Decision Tree Analysis

In a decision tree analysis the DCF method is supplemented in order to capture the effects of the flexibility of future decision possibilities, not considered in the DCF method. Although the number of decisions must be limited and the decisions can only be made at certain points in time, we think that the analysis opens up for fine-tuning the DCF method.

Several of the respondents see a potential in methods that allows for different scenarios to be evaluated. Öhrings PWC argues that one of the main advantages of using scenario analysis is that the result is an illustration in form of a decision tree, with different values depending on the relative probabilities of future events. Estimating probabilities and visualizing different possible outcomes is the central issue in DTA, and even though it is not clearly articulated, the argumentation of Öhrlings PWC goes in line with the theoretical description of DTA, and we assume that this is the intended method referred to.

In addition, the respondents mean that patent owners sometimes tend to be somewhat positive in their view and unwilling to see the downside risks, leading to exaggerated expectations considering the commercial potential of the patent. Through DTA, the whole spectrum, including the downside risks are being brought to the surface, eliminating some of the risk of blindness for negative outcomes. This is also illustrated in the A&J Inc. example in Appendix I.

Similar to the argumentation of Öhrlings PWC, Ernst & Young also highlights methods, including scenario building using different probabilities, as being useful. The respondent sees this as a logical and sensible approach to valuation. However, the method referred to is the binomial method. Since the option based method we have earlier referred to as the binomial method in the frame of references does not include any kind of estimated probabilities, we assume that Ernst & Young in this case means the DTA method. We draw this conclusion since decision trees can very well take the form of binomial trees, including different scenarios through estimated downward and upward probabilities. Thus, we believe that Ernst & Young refers to the tree structure, rather than any option valuation approach, when using the term binomial approach.
Deloitte & Touche follows a comparable line of argumentation. The respondent says that the binomial method is useful, not specifically for calculating numerical values, but to understand the different factors influencing the value. This comes from the fact that the method offers the opportunity to play with different probabilities and risks. Also Deloitte & Touche’s reasoning implies that the method mentioned is the one that we have referred to as the DTA. Since the DTA builds in flexibility through estimated probabilities, it is the only method that allows playing around with probabilities. The binomial method, as we have described it in the frame of reference, contains no estimated probabilities. The factors in the branches are deterministically calculated from the variance and are therefore nothing but pseudo-probabilities when used in the real world. Deloitte & Touche sees potential usefulness for methods containing estimated probabilities for example in the pharmaceutical industry. In this line of business there are statistical data at hand on success probabilities for drugs, depending on what development phase the drug has reached. In most industries such data is otherwise not available. Deloitte & Touche therefore argues that it might be difficult to determine the variables to put into the tree.

The possibility to set different results as consequences of different actions is something that also AdviceIPR finds useful in the valuation process. Decision trees are, according to her, suitable tools when taking into consideration, for example, at which point in time a patent application is filed.

Obviously, the crucial factors when using DTA are to know which probabilities to use and at which points in time decisions can be made. Despite of the fact that the probabilities are hard to estimate and that the moments for decision making are seldom fixed, the DTA is a method considered as useful in practice by the majority of the respondents.

5.5 Option Based Approach

5.5.1 Binomial method

In general, the use of terms is not uniform. Especially when it comes to the binomial method definitions are not clear-cut. What the respondents often have referred to as the binomial approach is what we have presented as the DTA. One exception is KPMG, whose description of option based methods goes in line with the theoretical description.
The important result that is achieved by using option based methods is that neither probabilities nor any expected returns have to be estimated. Instead, the risk free rate corresponding to the lifetime of the patent has to be known and the volatility in the expected future cash-flow from the product has to be estimated. However, KPMG’s opinion is that the option theory based on risk free positions with normal distributed outcomes are too abstract to use when intangible assets are to be valued. As we see it, patents are a part of intangible assets and therefore, the arguments stated above also holds for patents. Even if the method requires less estimations regarding probabilities and expected returns, we agree that the method can be seen as abstract. One reason for this is the task of calculating the variance in value of the underlying asset.

As a parenthesis, if using the capital asset pricing formula to calculate the expected return on an object, which is the most common way of estimating the discount rate within the income approach, this also includes an estimation of the variance. Thus, the difficulty of estimating the variance is also apparent in the income approach.

Since option based methods require an appreciation of variance, commonly through variance in historical data, Advice IPR does not recommend such methods to be used for valuation of patents. Such a course of action requires an active market where the variance can be estimated through statistically relevant methods. As discussed in the frame of reference, patents are relatively seldom traded as separate entities, and the market for patents is still immature. One of the crucial factors in order to use the real option based methods, as also presented in the theoretical chapter, is thus the estimation of the variance. This is hard, even for insiders in the company. However, if a more active market evolves, such an appreciation will become slightly more convenient. In such a scenario, option theory will be applicable to valuation of patents, since they actually can be seen as call options with the product’s expected cash-flows as underlying asset. Deloitte & Touche agrees that patents have characteristics that make it possible to treat them as options, which goes in line with our understanding.

5.5.2 The Black & Scholes model
The Black & Scholes (B&S) model was not mentioned during any of the interviews. This might seem remarkable, since it is the predominate model for option valuation, also with respect to real options. However, it is
reasonable to assume that the respondents, when mentioning real option valuation, also include the B&S model. The fact that B&S was never part of the empirical discussion only further emphasizes that the income approach, rather than the real options approach, is the most commonly used patent valuation model.
6 Conclusions

The respondents are not of the same opinion whether relevant approaches exist at all. However, among the respondents who find it possible to value patents, the income approach is the dominating approach. The DCF method is seen as the most theoretically correct method of valuation. This view is derived from the definition of value. In addition, the incorporation of the market potential, necessary to consider when valuing patents, is a crucial factor for the choice of this valuation method. A disadvantage of the DCF method is its lack of consideration to changes in risk and the value of flexibility.

To fine-tune the valuation process, complementary methods as the Relief from Royalty method and DTA are used. The Relief from royalty method is considered as useful for estimating future cash-flows if suitable information is available. The determining factor for using the DTA is the incorporation of the value of flexibility.

An option based approach, coherent with the theoretical description is not used for valuing patents. The crucial factor making this approach irrelevant for patent valuation is the lack of information needed.

The market approach is not used by the respondents for valuing patents, primarily due to the problems of comparability and the lack of market data. These reasons were also identified as disadvantages in the literature on patent valuation.

The cost approach is not considered to be useful for valuing patents. The main factor making the cost approach irrelevant is that it does not include considerations about the demand side, such as market potential. These disadvantages of the cost approach were also found in the literature.
7 Final discussion

We have argued that situations calling for patent valuation occur more often today, and that the trend is increasing. As we see it, this trend has only been registered as important by one group of respondents. Therefore it might be possible that these firms have decided to develop their valuation processes in order to be able to deal with these new valuation situations and thereby enhancing their competitive advantage. Through this movement, they are forced to be more open-minded and they have to recognize the possibilities, rather than the limitations, of current valuation methods. We would find it interesting to investigate the attitudes towards valuing intangible assets as separate assets and in addition, this service provided as a potential competitive advantage.

Another interesting track to follow, as we see it, is to further investigate general crucial factors affecting the valuation of intangible assets as separate assets. If we are not experiencing a loss of relevance when it comes to valuation approaches, what is the reason for not valuing these kinds of assets? Is the lack of data perhaps the reason for not valuing intangible assets separately?
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Appendix I

CAPM\textsuperscript{92}

The Capital Asset Pricing Model can be concluded in the following formula:

\[ r_i = r_f + \beta_i (r_m - r_f) \]

where

- \( r_i \) = the expected return on the object \( i \),
- \( r_f \) = the risk-free rate of return,
- \( r_m - r_f \) = the market risk premium and
- \( \beta_i = \frac{\sigma_{im}}{\sigma_m^2} \), where

\( \sigma_{im} \) = covariance between the object \( i \) and the market and
\( \sigma_m^2 \) = market variance

DTA\textsuperscript{93}

A&J Inc. is a new corporation active on the Swedish market. The company manufactures a unique coffee maker, which is a patented product in Sweden. The strategy is to move forward and enter new markets. The founder believes that the product has potential on the international market and has done estimations of the market potential. However, the founder is aware of the fact that the venture is not a sure thing. There is a 60 percent chance that demand in the first year will be high. If it is high, there is an 80 percent chance that it will remain high in the years to come. On the other hand, if the initial demand is low, there is a 60 percent chance that it will stay low. These possibilities are based on estimations made by the founder, but in the end nature decides the real outcome.

The problem first faced is to decide which market to enter. To enter the American market costs $550,000. The cost to enter the Nordic market is only $250,000 but the market potential is limited compared to the American market. On the other hand, the decision to enter the Nordic market entails the possibility to expand on the European market. This expansion would cost $150,000, even less than the costs for entering the Nordic market. With these possibilities at hand, the founder gets an idea. Why not start with the Nordic market, and then, if the demand is still high,

\textsuperscript{92} Brealey & Myers, 2000
\textsuperscript{93} With inspiration from Brealey & Myers, 2000, - Magna Charter example, pp. 277-280
expand on the European market? Of course, before deciding this, calculations have to be made. It will cost only $150,000 to expand and if demand is low, the initial investment was $250,000 instead of $550,000. The decision tree helps the founder to decide what to do today. The only decision the founder has to make, except from the initial decision, is whether to expand to the European market or not, in case of high demand. The following figure illustrates the three choices in the decision tree.

![Decision Tree Diagram]

**Figure 3.6: Decision tree, based on Brealey & Myers (2000, p. 278)**

The dark square on the left marks the company’s initial decision. After the company has made its decision, nature decides the first year’s demand. The probabilities, estimated by the founder, can be seen in the parenthesis. The illustration also shows the expected cash-flow for each combination. At the end of the year the company has a second decision to make if it enters the
Nordic market: It can either expand or not expand. This decision point is marked by the second square. Then nature takes over again and selects the demand for year 2. The probability of high or low demand estimated by the founder is once again shown in the parenthesis. Bear in mind that the probabilities for the second year depend on the outcomes from the previous period.

As mentioned, the only decision the founder needs to make next year is whether to expand, if the introduction on the Nordic market is succeeded by high demand. This is the only decision that has to be made in the decision tree. One of the elements in the DTA is to choose the best option when a choice situation occurs. If expanding, an initial investment of $150,000 has to be made. The expected payoff, when expanding, is:

\[ D = \text{demand} \]

\[
(0.8 \cdot 800') \cdot (0.2 \cdot 100') = 660', \text{or } $660,000
\]

probability high D payoff with high D probability low D payoff with low D

Assuming that the opportunity cost of capital for this venture is 20 percent, the following net present value (NPV) for the project, when expanding, can be calculated (with the index representing the tree node number):

\[ \text{NPV}_4 = -150' + \frac{660'}{1.20} = 400', \text{or } $400,000 \]

It can be discussed if a higher discount rate is more appropriate to use in the initial, more risky, part of the project. As a simplification, 20 percent is used as the discount rate throughout this example.

If the company does not expand, the expected payoff is:

\[
(0.8 \cdot 410') \cdot (0.2 \cdot 180') = 364', \text{or } $364,000
\]

probability high D payoff with high D probability low D payoff with low D

With the same assumption, that the opportunity cost of capital for this venture is 20 percent, the following net present value for the project, when not expanding, can be calculated:

\[ \text{NPV}_5 = 0 + \frac{364'}{1.20} = 303', \text{or } $303,000 \]
So, given that market demand was high in the phase before deciding whether to expand or not, it pays to expand. This is a consequence of the higher present value ($400' > $303').

But what we aim for, using the DTA, is to roll back to today’s decision. To enter the European market would generate cash worth $500,000 in year 1 if demand is high ($100,000 cash-flow plus $400,000 present value). If demand is low the cash-flows would be worth $173,000 ($50,000 cash-flow plus the NPV of \[0.4 \cdot 220' + 0.6 \cdot 100' \div 1.20\]).

The Net Present Value of this project is:

\[\text{NPV}_1 = -250' + \frac{0.6 \cdot 500' + 0.4 \cdot 173'}{1.20} = 58', \text{ or } $58,000\]

If the company enters the American market, there are no future decisions to analyze. The Net Present Value is:

\[\text{NPV}_0 = -550' + \frac{0.6 \cdot 150' + 0.4 \cdot 30'}{1.20} + \frac{0.6 \cdot [0.8 \cdot 960 + 0.2 \cdot 220] + 0.4 \cdot [0.4 \cdot 930 + 0.6 \cdot 140]}{(1.20)^2} = 0', \text{ or } $0\]

This shows that the company’s expansion on the Nordic market is a better bet, since this project has the highest NPV.

The decision tree shown above recognizes that if A&J Inc. enters the American market, it is stuck with that decision. The decision tree also illustrates that entering the Nordic market is linked with the possibility to expand on the European market, if demand turns out to be high. The tree also assumes that, if the company enters the American market, there is nothing to do if demand turns out to be high. The examples of expansion are extreme simplifications of the sequential decision problems that financial managers face.

**THE BINOMIAL MODEL**

Here we present the ideas behind the binomial model in more general terms.

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94 Hull, 2000
Assume that the price process of the underlying asset (S), which in the example is a stock, can be described like this:

\[
\begin{align*}
\text{S} & \quad \xleftarrow{\text{S} \cdot u} \\
& \quad \xleftarrow{\text{S} \cdot d}
\end{align*}
\]

Corresponding, the price path of the call option would be:

\[
\begin{align*}
\text{C} & \quad \xleftarrow{\text{Cu = max(0, S \cdot u - K)}} \\
& \quad \xleftarrow{\text{Cd = max(0, S \cdot d - K),}}
\end{align*}
\]

where K is the exercise price. The call option can be replicated with a portfolio consisting of \( \Delta \) shares of stock and \( \$Y \) of borrowed money, which gives the replicating tree, where \( R = e^{r \cdot dt} \), the continuous discount factor corresponding to the risk-free rate of return \( r \):

\[
\begin{align*}
\Delta S + Y & \quad \xleftarrow{\Delta S \cdot u + Y \cdot R} \\
& \quad \xleftarrow{\Delta S \cdot d + Y \cdot R,}
\end{align*}
\]

For replication, this means that:

\[
\begin{align*}
C_u &= \Delta \cdot S \cdot u + Y \cdot R \\
C_d &= \Delta \cdot S \cdot d + Y \cdot R \\
C &= \Delta \cdot S + Y
\end{align*}
\]

Solving this system gives:

\[
C = \left[ \frac{R - d}{u - d} C_u + \frac{u - R}{u - d} C_d \right] / R ,
\]

which can also be expressed as:

\[
C = \left[ p C_u + (1 - p) C_d \right] / R ,
\]

where \( p = \frac{R - d}{u - d} \).

A tree is then constructed where the root is the time of the valuation and the top is the expiry date:

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95 Gibson, 1991, p. 56-57, modified
On the expiry date, the value of \( C \) is known as a function of \( S \), and then the tree can be backwards worked through, using the formula above.

However, the factors \( u \) and \( d \) must be chosen to satisfy the relation between expected value and variance, which makes it necessary to determine the variance of the underlying asset.\(^{96}\)

Combining the facts that the expected return on the stock is the riskfree rate of return, expressed as

\[
Se^r dt = pSu + (1 - p)Sd
\]

and that the variance of any variable \( Q = E[Q^2] - (E[Q])^2 \), gives the equation

\[
\sigma^2 dt = pu^2 + (1 - p)d^2 - [pu + (1 - p)d]^2.
\]

Solving this gives the expressions for \( u \) and \( d \):

\[
u = e^{\sigma \sqrt{t}}, \quad d = \frac{1}{u} = e^{-\sigma \sqrt{t}}
\]

to summarize, the important factors \( u \), \( d \) and \( p \), needed to use the binomial model are expressed as:

\[
u = e^{\sigma \sqrt{t}}, \quad d = e^{-\sigma \sqrt{t}} \quad \text{and} \quad p = \frac{e^{r \sqrt{t}} - d}{u - d}
\]

**BLACK & SCHOLLES\(^{97}\)**

The formula for calculating the value of a call option is the following:

\[
C = S \phi \left( \frac{\ln \left( \frac{S}{K} \right) + \left( r + \frac{\sigma^2}{2} \right) t}{\sigma \sqrt{t}} \right) - Ke^{-r t} \phi \left( \frac{\ln \left( \frac{S}{K} \right) + \left( r - \frac{\sigma^2}{2} \right) t}{\sigma \sqrt{t}} \right)
\]

\(^{96}\) Hull, 2000, p. 393

\(^{97}\) Hull, 2000
Appendix II

INTERVIEW GUIDE

1. Please describe the valuation process when valuing patents.

2. Are patents significant when valuing a company?

3. Does the existence of patents make a company more difficult to value?

4. Which approaches/methods do you use for valuing patents?

5. Do you use different approaches/methods to value different types of assets?

6. Has the choice of approaches/methods for valuating patents changed over the years?

7. To what extent do you think the valuation process differs between valuers regarding patent valuation?

8. How does the purpose of the valuation influence the valuation process?

9. Which are the most crucial factors affecting the valuation of patents?

10. Is it possible to collect sufficient information to do a reliable valuation of patents?