VALUATION AND EVALUATION OF INVENTIONS AND PATENTS

Project Paper

Patentit Teollisuus Tekniikka –course

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BACKGROUND AND ACKNOWLEDGEMENTS

This text is a project paper for the TKK Dipoli's "Patentit, Teollisuus, Tekniikka" course I took in 2008 and 2009.

The report collects thoughts that have arisen when thinking about the patenting strategies of corporations, also related to my employer, Beneq Oy. My MBA studies in Aalto Executive Education (formerly TKK Executive Business School) have greatly influenced the outcome of this text.

I would like to thank the staff of Beneq Oy, my MBA course mates, the participants of the "Patentit, Teollisuus, Tekniikka" training, and family for inspiration, perspiration and support.

Tapiola Feb 16th, 2011

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TABLE OF CONTENTS

TERMS AND ABBREVIATIONS

Term	Explanation	For further information, consult…
CAPEX	Capital expenditures (CAPEX or capex) are expenditures creating future benefits.	http://en.wikipedia.org/wiki/Capital_expenditure
Cardinal	A number that has both relative and absolute significance. Normal numbers are cardinal, indicating that 3 is three times 1, and it is two units more than 1. Adding them together makes sense.	
Cost of Capital	Cost of Capital is usually the risk free interest rate, topped with some company or business area related requirement for yielding more than the risk-free interest rate. Usually taken as the WACC, the "weighted average cost of capital"	http://www.investopedia.com/terms/w/wacc.asp
DCF	Discounted CashFlow	An analysis method that tries to predict future cashflows by taking into account also the cost of the cash. The further in the distance the cashflow is, the less value this cashflow item has today.
FO	Financial Option	http://en.wikipedia.org/wiki/Option_(finance)
FTO	Freedom to operate – ability of a company to perform its business without infringing the intellectual property rights of another parties (usually patents).	http://www.patentlens.net/daisy/patentlens/2768.html
IPR	Intellectual Property Rights – certain types of creations of mind to which some sort of exclusivity can be obtained (by application or automatically). Also, in this context, Industrial Property Rights (that, more or less, equal Intellectual Property Rights minus copyright).	http://en.wikipedia.org/wiki/Intellectual_property
NPE	Non-practicing entity; a company that owns assets but has no related manufacturing/production/service operations. Sometimes referred as a "patent troll".	http://en.wikipedia.org/wiki/Patent_troll
OPEX	An operating expense, operating expenditure, operational expense, operational expenditure or OPEX is an ongoing cost for running a product, business, or system. Its counterpart is a capital expenditure (CAPEX). For example, the purchase of a photocopier involves CAPEX, and the annual paper, toner, power and maintenance cost represents OPEX.	http://en.wikipedia.org/wiki/Operating_expense
Option	The right, but not the obligation, to do something in some later time.	http://en.wikipedia.org/wiki/Real_options_valuation
Ordinal	A number that has only relative meaning wrt. other numbers. The only we know about 5 is that is	

	more than 1, but we do not know how much more. E.g. adding 1 and 5 makes no sense.	
PTT	Patentit Teollisuus Tekniikka (the course for which this report is written)	http://www.dipoli.tkk.fi/teollisoikeudet/patentit_teollisuus_tekniikka/index.html
WACC	See "Cost of Capital"	http://www.investopedia.com/terms/w/wacc.asp
WIPO	World Intellectual Property Organization.	http://www.wipo.int/about-wipo/en/what_is_wipo.html

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INTRODUCTION

"We are living in a material world / and I'm a material girl"

- Madonna

Every day, the signal keeps getting stronger: The manufacturing arm of the world economy is steadily drifting to emerging economies like China and other Asian "tiger economies". To maintain balance, activities of more immaterial nature must be increased in the developed countries.

Important pieces in this puzzle are Intellectual Property Rights, IPRs, and therein, patents in particular. Patent is an enforceable right (but not the obligation) to say "stop" to someone utilizing an invention as disclosed in the patent claims. This right is both regionally and time limited. The right can be passed along (assigned) or it can be suppressed in various ways (for example, licensed against some remuneration).

Following the ancient proverb "seeing is believing", the determination of the value of IPR is difficult. Paradoxically, the value of immaterial and industrial property rights is increasing steadily and rapidly in the world economy, and also as assets of companies.

To illustrate the value of IPR in real terms, consider Figure 1 which shows the trend of the price/book value of US S&P 500 companies in years 1979-2009 [1]. The P/B value shows how much someone would have to pay for the entire company by buying all the traded stock at the stock market price compared to the asset value of the company's balance sheet [2]. Clearly, around year 2000 people were willing to pay, on average, almost five times more for a stock than what was value of that stock derived from the things that the company actually owned as reflected in the balance sheet. Of course, year 2000 was remarkable (and irrational) in terms of investor behavior - it was the year of the dot com boom. However, throughout the presented time period of 1980 to 2003, investors have been willing to pay more for companies than what they are "worth" when measured through their balance sheet assets.

We would be stretching the truth if we said that this extra value is only stemming from IPR or patents in particular: Based on the theory of elementary corporate finance, the extra value comes from the projected future free cash flows, discounted to the time of measurement [2]. However, IPR is an important mechanism for realizing this prosperity.

Figure 1: P/B of S&P500 Index 1979-2009

VALUATION AND EVALUATION – CLOSE COUSINS

Wikipedia defines valuation (in finance) as "the process of estimating the potential market value of a financial asset or liability. Valuations can be done on assets (for example, investments in marketable securities such as stocks, options, business enterprises, or intangible assets such as patents and trademarks) or on liabilities (e.g., bonds issued by a company)" [3]. Thus, valuation yields a monetary ($, €) amount. This is good in a sense that it enables interested parties "compare uncomparables" by stating their value in a common denominator, money.

On the other hand (per Wikipedia), "evaluation is systematic determination of merit, worth, and significance of something or someone using criteria against a set of standards. Evaluation often is used to characterize and appraise subjects of interest in a wide range of human enterprises, including the arts, criminal justice, foundations and non-profit organizations, government, health care, and other human services" [4]. Thus, with evaluation the outcome can be a figure of merit, e.g. an ordinal number indicating the ranking of inventions related to one another.

It is possible that the evaluation yields no knowledge how much something is better than the other, e.g. in terms of money. Despite of this, the ranking of inventions can be very useful for example in a situation where there are 100 patented cases and budget to keep only 70 of them (we usually know the costs of patents very exactly). In that case, based on the said rank, 30 of the smallest ranking cases could simply be cancelled. Clearly, the ranking should reflect the overall strategic situation of the company.

VALUATION

"Patent valuation is just smoke and mirrors – what others pay for your patent is the value of your patent."

- Patric O'Reilly, LESI President (LES Pan-European Conference welcoming speech, May 2010, Budapest, Hungary)

Valuation of IPR tries to connect a monetary value to a piece IPR. Thus, a huge amount of data is crammed into a single financial number. For various reasons, this is not an easy task for anything immaterial, IPR in particular.

PRACTICAL DIFFICULTIES IN PATENT VALUATION - EXAMPLE

Everything should be made as simple as possible. But not any simpler.

- Albert Einstein

Before we start examining the ways of IPR valuation, let's look into a practical (but imaginary) example where we value an apartment and a patent.

VALUING THE APARTMENT

Let's assume that there is an apartment in address Maatamokuja 6M36, 02200 Espoo, with 87m^2, located in the third floor of a building (built: 1973) with brick walls. The plumbing has been completely renovated year 2008.

A prospective buyer notices an advertisement for the Maatamokuja apartment, with price 230 000EUR. He goes out to see the flat – it looks promising. Everything is at least in a mediocre shape, and the connections with public transport are excellent. The buyer goes back home to check some offers in related. He discovers that most requests for flats start at 220 000EUR when translated to the said 87m2 size. Buyer's mind is made up – he offers 228 000EUR to bargain a bit, only to find out that the flat was sold 30 minutes ago.

VALUING THE PATENT

Let's assume that there is a patent for coating the sewer lines of a building, published as FI0123456 to prevent copper leaching from the plumbing lines by the means of the well known ALD method. The advantages of this method are: lower starting material usage and thinness of coating.

A prospective buyer (company X) of the patent performs a brief FTO patenting study and runs across the FI123567, owned by company Y. Similar patent with the same owner is also in force in USA, Germany, Taiwan and Australia. On average, the patent has 11 years worth of life left. The ALD method mentioned in the patent publication is not well known to X, but it appears to be technically feasible. Based on closer scrutiny, an opposition was lodged against the application year 2004 but this was not successful. Based on back of the envelope calculations, X estimates that turnover of the business based on the method examination would be 300 000EUR in two year's time, with annual growth of 8%. However, X cannot find any related data of the price for a license of such methods, or for methods related to plumbing, for that matter. For a short while, X considers paying the license to Y as a royalty. But things start getting complicated, and there are more pressing business issues. Finally the case is dropped without even X introducing the licensing idea to Y - X is concerned that expressing interest to the patent might imply a potential infringement.

DISCUSSION ON THE EXAMPLE

Based on the above, we can make following observations:

DEFINITION OF ITEM FOR SALE

In case of the apartment, "what" is being sold is well defined. This is not the case with patents. Patent's scope is defined in the independent claims of the patent, supported by the basis and figures.

- Consequence: patent scope requires very careful scrutiny and business cognition to arrive in any sensible estimate for the price.
- Analogue in apartments: the location of the apartment for sale would be defined as "the flat located 150 meters from the bus stop to the north east and at the height of the four meter long branches of a nearby birch".

MARKET ACTIVITY

Apartments have active markets where the price is simply set by the laws of supply and demand. For patents, active markets are virtually nonexistent.

- Consequence: markets for patens are small, and their price and value is dependent on context
- Analogue to apartments: there is no direct analogy; by limiting the sales of apartments we would only push their price up

POSSIBILITY TO USE COMPARATIVES

If not identical, there usually are similar apartments available that give a very good ballpark estimate of the realistic price. This ballpark figure can then be adjustment based on e.g. the exact condition and location of the apartment. Such comparatives are again almost nonexistent for patents – the terms of the related transactions are almost always confidential, and if available, often depend on other financial performances, e.g. royalties.

- Consequence: comparatives related pricing/valuing is very difficult for patents.
- Analogue to apartments: to arrive in a more similar situation, the apartments would be sold in secrecy, without disclosing the price asked (the actual price paid is not necessarily disclosed. However, the upper limit for the price is known as it is usually the asked price (in some rare cases the bidder offers more than the asked price just to secure the deal)). Also the definition of "an apartment" would have to be obscured.

AVAILABILITY OF SIMILAR ITEMS FOR MARKET

There is no obligation for someone owning an apartment to sell the apartment, but substitutes abound for someone willing to buy a flat. In stark contrast, a patented method or device can be a superior way of producing something, and there is (almost) no obligation for the patent holder to sell/license any part of the IPR.

- Consequence: broad quality patents can alter several technology trajectories (but upside is that the patents are regionally and time limited).
- Analog to apartments: It appears that there is no good analogy for this; perhaps the situation in some centrally run nation like North Korea would resemble this: winters are freezing cold, building activity is completely governmentally regulated and thus severe shortages of housing can emerge, with no possibility to seek shelter elsewhere.

CONGNITIVE NEEDS OF THE SELLER AND BUYER

Said ALD method is only one of many ways to coat objects. Thus, to value the benefits of ALD method in particular, company X must establish an estimate of the specific benefits of the ALD method, and adjust this upside with the downside of having to spend time and money when, in particular, taking the ALD method into use.

- Consequence: assessing the value of a patent accurately requires good cognition and knowledge of the technological area in question

- Analogy to apartments: As a distant analogy, nomadic cultures do not even live in houses, but instead in tents or other temporary shelters. This is because their livelihood depends on changing factors like fertility of the land, trade, etc. To stay in one place, nomads would have to radically alter their way of living.

COMMON CONTRACTUAL OBLIGATIONS

Immaterial rights are often licensed to third parties, with only marginal possibility to terminate this contract. This will cut down the price of the IPR, but it is not easy to say how much.

- Consequence: adjusting baseline price of IPR is very unsystematic
- Analogy to apartments: Apartment is to be sold, but it is rented for five years to an outside party without the possibility to terminate → the price of the apartment is reduced with a hard-to-determine factor.

LIFE OF VALUED ITEMS

Patent is always time limited. The related monopoly will always cease to be (of course, it is possible that the superior position created by the monopoly of the patent for a company cannot be ever realistically captured, extending the life of a patent to perpetuity).

- Consequence: Valuation of patent is always done in the shadow of termination. However, this fact can also improve the possibility of forecasting as there is only a certain number of years that have to be taken into account e.g. in cash flow analysis.
- Analogy to apartments: It would be certain that the apartment would be demolished in 20 years. This, of course, would affect the apartment price.

RISK OF ENGAGING INTO BUSINESS

When buying a flat, it is difficult to see how the offer could be held against you. But when buying patents, expressing interest can be taken as a clue of infringement.

- Consequence: Direct offers for patents are rare, and made even rarer by the fact that the offer can be held against the offering party. This gives rise to brokers, making the transaction more costly, again cutting down their occurrence.
- Analogy to apartments: In some virtual society, making an offer for the apartment could somehow be construed as a criminal act. Of course, this would cut down the market activity, usually with the tendency of lowering the price.

CONCLUDING NOTES FOR THIS CHAPTER

As discussed above, there are several factors causing uncertainty in the patent valuation. The only sure moment in the valuation is the moment when the patent is actually sold (and assigned) for cash. At that time, the value of the patent is the price paid.

In all, coming up with ways of predicting the value of patents is important. At the end of the day, as the relative portion of the "immaterial" increases among the corporate and organizational assets, we are ultimately dealing with the health of the entire innovation and IPR-system. There are also implications in accounting and financing. By the same token, the financial figure that pops out of the analysis is not the only important outcome – the discussion and methodology created for assessing the financial can be very valuable for any organization as it reflects the different strategic aspirations, culture and values of those involved.

REASONS FOR VALUING PATENTS

"A horse, a horse, my kingdom for a horse!"

- "Richard III" by William Shakespeare

As already discussed, several different reasons for valuing patents can be indicated. As given in [5] and [6], the following motivations can be mentioned:

- Raising the awareness of the importance of intellectual property. Like death and taxes, the sure thing about any IPR is that they cost money to acquire. To counter balance this spending, sometimes we must be reminded that, indeed, patents also carry positive value.
- Assessment of the value of the intellectual property, and patents in particular, promotes technology transfer. Patent can be seen as a "certificate" of technology. Certified goods are usually easier to transact than their non-certified counterparts, especially in a multi-cultural, global business arena.
- Assessment of the value of intellectual property assets facilitates investment in industry. Investors, of course, want to see payback for their equity investment. Because equity of the company equals assets less liabilities (in terms of accounting), the investors would appear to have a direct incentive for the IPR valuation. Patents can also be used as a security for debts and other financial instruments.
- In legal disputes (litigations), the value of a patent is touched e.g. when assessing the fair amount or royalty.

SOME WORDS ON ACCOUNTING AND IPR

"Giving the name 'investors' to institutions that trade actively is like calling someone who repeatedly engages in one-night stands a 'romantic'"

- Warren Buffett

The balance sheet of a company is a very important indicator of a health and vitality of any company. The balance sheet is divided into two sections, assets and liabilities & equity. Asset shows what the company owns, and liabilities and equity shows how much the company owes to the creditors (liabilities) and to the owners (equity). In other words, liabilities and equity show the capital structure of the company.

The balance sheet does just what the name says – it balances. For each transaction and for any business period (e.g. quarter or business year) change in assets equals the change of liabilities and/or equity. In other words, again the balance balances, euro for euro, cent for cent.

As IPR and patents is something that the company owns, this "material" appears in the asset side of the balance. Thus, for the sum of the patents (or even patent applications) there exists an exact figure for the asset value of the patents. However, the way this valuation is done is taken on a cost base – the more the application has incurred costs, the more valuable it is (if it is still not abandoned). We will discuss this valuation method and its shortcomings in more detail below.

Thus, accounting standards are able to create a very trivial and very accurate assumption for the value of the entire patent portfolio. This demonstrates the odd nature of accounting and accountants in general - they are much rather "accurately incorrect" than "roughly correct".

Patents are so-called "identifiable intangible assets" as they can be easily listed and told apart. In contrast, e.g. the brand and management team skills appear as unidentifiable intangible assets like discussed e.g. in [7].

METHODS FOR VALUING PATENTS

The patent valuation has been under tremendous interest in the last couple of years. For example, in the WIPO homepages alone, at the time of writing this, 17 different documents are available discussing valuation of IPR and patents. In the following we will dwell into the main themes of patent valuation.

INCURRED COST BASED VALUATION

The cost based valuation is the simplest idea of them all, and we already discussed it when reviewing assets of a company. It is based on the idea that what you put into something equals the amount you will get out of it, perhaps taking a time value of money into play. It is a straightforward method, but extremely very error prone for patents: Most of the costs associated are expert costs (related to attorneys, translations, official costs…) that have no material counterpart. Contrast this with building a ship – in that context, at least you can always sell the vessel body for scrap metal.

It is more or less a logical fallacy to use this method for valuation: patents are not a piggy bank with the balance of the amount of coins deposited. However, as this method is the way accountants use for valuing IPR in corporate assets, it is used in many contexts.

EXAMPLE

Assume that a patent in some country has taken 25 000EUR to create in total, 20 000EUR at first year and 5000EUR during the second year. Furthermore, assume that the cost of capital is 10%. Thus, after two years, the cost and therefore the value of the patent is

$$V = C = 20\,00 \times 1.10 \times 1.10 + 5000 \times 1.10 = 29\,700 EUR.$$

REPLACEMENT COST BASED VALUATION

This method is a close cousin to the incurred cost method. However, here we try to estimate how much it would to cost to come up with a corresponding IPR if it would be developed from scratch. This approach is more tied to reality than the incurred cost method, but it suffers a bit from the fallacy of neglecting the fact that patent can well cover an area that cannot be replaced, at least not within the duration of the temporal monopoly merited by the patent in question. If a patent cannot be replaced and the patent holder refuses to license it out, it would seem that the efforts needed to replace it would be infinite, leading to an infinite replacement cost. Of course, in reality, nothing is infinite, and instead, the following can happen:

1) the refused licensee usually tries to circumvent the patent somehow, and the cost of doing this can be taken as the value of the patent.
2) the refused licensee abandons the particular business area. The loss of abandonment (the cashflows that never happened) are the value for the patent
3) the refused licensee can start legal actions to gain access to the technology (e.g. compulsory license). In this case, the value of the patent must be determined by game theoretic methods (more of this below).

COMPARABLE MARKET VALUATION

We have already met the Comparable Market Valuation ("CMV") in our example of comparing apartment and IPR valuation. The CMV method does just that – tries to find closest matches among the publicly available licensing transactions.

Such data is, to some extent, available from different commercial vendors [9] [10]. Sometimes the transaction has to be disclosed into the market authorities, e.g. US Securities and Exchange Commission (SEC). Also business newspapers and newscreens like the Wall Street Journal, Bloomberg News or more locally, Kauppalehti or Taloussanomat, provide, every once in awhile, such information [11].

Key in this valuation method is to really make sure that the comparables are comparables. Following our apartment analogy, a price for a very large tent placed on some property is probably quite a bit smaller than the price of a house of similar size and location, for obvious reasons. Here the difference is easy to spot, but how is it with patents?

However, for licensing negotiations, benchmark royalties give a solid ground on which to push the licensing proposal forward, especially when the parties are of different sizes.

A very rough estimate is the 25/75 rule. This means that the licensee should be compensated for 75% of the profit, and licensor 25% of the profit (related to the licensed product). This is to compensate the manufacturing, marketing and overall higher risk taking of the licensee. Of course, this rule is not usable if the product incorporates many (patent) licenses; e.g. a modern mobile phone with literally thousands of essential, standard-baked IPRs is such an example. Moreover, "profit" is a surprisingly esoteric number in accounting as it is based on a series of interpretations that could alter the result in a whim. The treatment of depreciation, the scheduling of expense accruals, or the allowances for bad debts, for example, can be altered (under some rules) by the management of the company, thus arriving in different values for profit. Even harder this is when the profit of one out of many products should be determined – what amount of costs should be allocated to a certain product line is a difficult question [12].

ECONOMIC BENEFITS

With the Economic Benefits scheme, we try the arduous task of valuing the revenue the invention will bring in and compare it to what reaching all this will cost us. In other words, we perform a classical investment appraisal calculation. As usual, the costs are known way better than the income stream, especially as with patents. On the other hand, the costs are usually very well known in advance for IPR (unless e.g. litigation costs emerge) [12].

One of the key shortcomings in Economic benefits scheme is that it assumes a certain route from this moment to a future moment. This route is very probably not true in its entirety.

Moreover, with IPR there is always an option to abandon the case. Thus, both the positive and negative cashflows can be eliminated. The possibility to execute this option will, of course have an effect to the net present value of the undertaking.

As a numerical example, consider an undertaking with 6 years' duration. The initial investment with no income (on year 0) is -100,000EUR. Thereafter, the investment yields a positive cashflow of 25,000EUR (the negative and positive cashflows can be anything, but their aggregate is 25,000EUR). For each of the upcoming years, the discount factor "damps" the effect of the cashflow (usually the discount factor is the WACC of the corporation). In other words, e.g. in year 6, the cashflow of 25,000EUR is only "worth" 14,112EUR. Other way around, the 14,112EUR could be invested, in year 0, into any other project, that should, based on the company's cost of capital, turn into 25,000EUR.

Year	0	1	2	3	4	5	6
WACC	10 %						
cashflow (CF)	-100 000 €	25 000 €	25 000 €	25 000 €	25 000 €	25 000 €	25 000 €
discount factor	1	1,1	1,21	1,331	1,4641	1,61051	1,771561
discounted CF p.a.	-100 000 €	22 727 €	20 661 €	18 783 €	17 075 €	15 523 €	14 112 €
aggregate DCF	**8 882 €**						

STATISTICAL MODELS

Statistical models attempt to value patents by finding common characteristics between patents, codifying (scoring) this characteristics, and then connecting this score to a monetary value of an IPR. Thus, statistical valuation methods connect an evaluation (emphasis added) method with some monetary value, and arrive in a monetary value. To work, the scheme requires that the statistical analysis gives a cardinal, not an ordinal number that merely illustrates some rank or order of a set.

For example, if it is known that a certain patent with a certain set of characteristics is traded at a certain price, this price can, with some level of certainty, be attached to similar patents with the same characteristics (or correlation of characteristics). Such characteristics can be for example, number of forward & backward citations, number of claims, geographical scope, prosecution history etc. Thus, characteristics should usually be easily codifiable and numerical in nature. Of course, in some cases their breadth and ability to truly illustrate the patent invention is questionable. Moreover, if evaluation results are used as a basis of valuation ($V = V_B \times E(m)$, value V_B is a function of some benchmark value and evaluation result E, relative to the merit of the patent/invention m), the function E should be linear, or the benchmark value V_B should also take into account the merit m.

A prominent example of a statistical approach is the IPQ Score® scheme created by OceanTomo® which is discussed in more detail in chapter dealing with patent evaluation.

METSO VALUATION METHOD

Metso Oyj [13] uses a valuation method for assessing the merits of the invention or pa patent. This method is presented in the lecture material of the PTT course [14].

The purpose of the method is to evaluate inventions, and to arrive in a reasonable compensation to an employed inventor in the light of the Finnish patenting and employment laws, under the so-called "special reward" regime. This also illustrates the license analogy method.

The basis of this method is the formula $R_S = f \times V$ where R_S is the special reward (for the inventor(s)), f is the fraction belonging to the inventor(s) and V is the value of the invention. Clearly, in this formula, we have to have a way to determine V.

First, to arrive in f, a table in used where three factors are summed together, and then f is obtained.

The factors are

a: relation between the task and the employment (a = 1…6)

- 1 → the inventors is given the solution along with the task
- 6 → the inventor has determined the problem (solved by the invention) so that the task is not part of the inventor's normal work.

b: relation between the solution and the employment (b = 1…6)

- 1 → in finding the solution, the inventor has utilized (i) knowledge and experience related to his profession, (ii) knowledge and experience related to

his employment and (iii) resources, equipment and information of the employer.

- 6 → inventor has utilized none of the above

c: relation between the inventor and the employment (c = 1…8)

- directors, top managers → 1
- research managers, chief designers → 2
- planners, thesis workers → 3
- work supervisor → 4
- skilled production worker → 5
- secretary, janitor → 7.

Now, by adding the scores together, the following table connects the sum with the fraction f.

$a+b+c$	f
3	2%
6	8,5%
11	29%
14	48%
20	100%

This data can be readily plotted in into a chart as given in Fig 2.

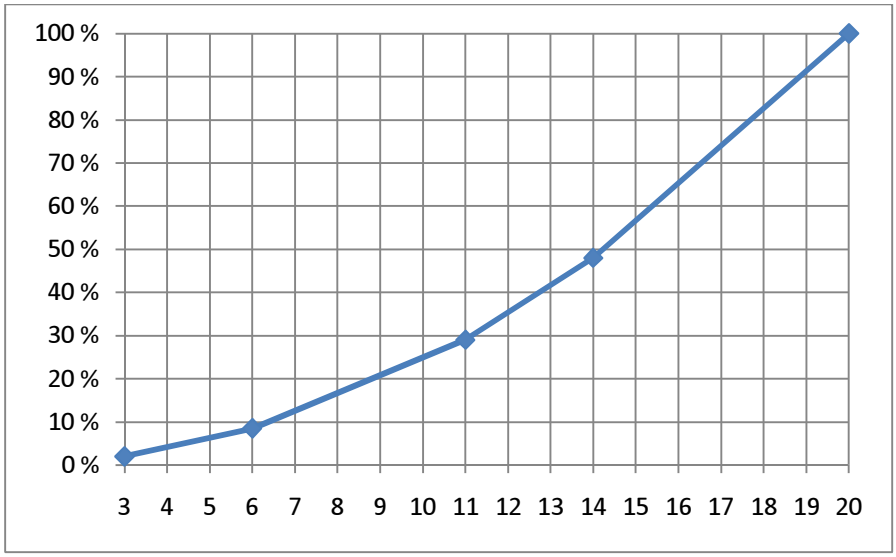

Figure 2: Sum of abc values vs. fraction

The other term, V, becomes available with the following formula

$$V = T_P \times f_T \times f_S \times r_T \times m - C$$

Above,

- T_P is the turnover achieved by the invention, the turnover of all the products incorporating the invention (but not others). Unit is €.
- f_T is the fraction of how much technical merits cause the achieved turnover. Unitless, between 0 and 1.
    - 0 indicates that the sales are solely achieved by non-technical factors like brand, trademark, image, fashion etc.
    - 1 indicates that the buyers stampede to the factory because of the technical superiority of the product, even though the manufacturer is not known at all.
- f_S is the share of the invention among the different technical solutions of the product. Unitless, between 0 and 1.
    - 0 means that there is an infinite number of technical solutions in the end product of which the invention is one.
    - 1 means that the invention is the end product.
- r is the typical royalty percentage in the industry area (usually between 0.5%...5%)
- m is the maturity of the invention in relation to the end product.
    - 0 means that a the inventor has originally presented an idea that took a lot to prove as a viable solution
    - 1 means that the inventor has presented ready production documents that were directly used to manufacture the end product/products.
- C denotes all the CAPEX and OPEX incurred in the prosecution of the applications and patents related to the invention, in €.

Worth noting is that T_P is turnover, not the profit. This is beneficial as profit is very often an opinion. Thus, we start at a very large number (of €), and then scale it down with different fractions. To get the formula right, it needs calibration to the company context. As a side product, it yields one representation for the value of the invention, V.

EXAMPLE:

Assuming $f_S = f_S = m = 0{,}5$ and r = 0,05 (these indicate quite high values), we are at $V = 0{,}00625 \times T_P - C$. Assuming a corporate turnover of 100M€ of which product incorporating the invention makes 50% (again a very, very large number) and patenting costs of 50 000€, V = 262 500€. Assuming an experienced, trained inventor with a = 3, b = 2 and c = 2, the graph above yields f = 12,6%. This means that the inventor's / inventors' should receive 33 075€. As the turnover figures are annual, this compensation should be paid annually, and of course all variables should be updated to reflect the most recent information.

OPTIONS

Option based methods are perhaps one of the most promising methodology in valuing patents. But what are options and how to apply them for patents?

Option is the right, but not the obligation to do so something. Usually this right comes with a price, and usually this right can be exercised in the future, perhaps only on a certain date. So far patents have fit into this description very well.

To understand option based patent valuation, the matter is best approached by analyzing financial options ("FOs", that you can buy from a stock exchange subject to some value of a security (e.g. stock)) and then examine what similarities and differences exist between FOs and patents. The motivation of this is mostly the fact that the theory of FOs is well known and developed. However, this is also to highlight the (striking) differences between FOs and patents, and to avoid getting sidetracked in the train of thought when patent option pricing is developed the following comparison is given:

The right:

- A financial option gives you the right to buy or sell an underlying asset (e.g. stock of company ABC), released
- Patent gives you the right to execute the enforcement actions allowed under local patent and other laws.

The price of the underlying asset:

- For securities, the price of the underlying asset is subject to some form of random or pseudo-random variation (e.g. change in stock's price in stock exchange of company ABC). This variation, in fact, is the value driver of the option:
    - if there would be no variation, there would be no uncertainty
    - …and with no uncertainty, what would we need the option for!
- For patents, the underlying asset is the enforcement right, subject to a multitude of technological, legal and business events. Are these events random? At least to a degree – they contain uncertainty but perhaps they also have certain qualities that make things less random.

The volatility:

- For securities, the magnitude of variation (often called volatility) is a main driver in the value of option. The larger the volatility, the higher the price of the option (because option shields the holder from this volatility as it gives a fixed right, but not the obligation, on the price on which to exercise the option).

- The volatility is a lot more esoteric concept for patents, but such a number can be derived if different outcomes of the enforcement of the patent are modeled, and the variability of outcomes is determined and presented as the volatility.

The emergence of randomness:

- The uncertainty of FOs can be modeled by a process called "random walk". Therein, at a discrete timesteps, the value of the underlying asset can increase or decrease. The probability of increase/decrease can be equal (0,5) or not. The volatility gives the spread how much the value can go up or down within a certain time span. If the volatility is zero, the random walk reduces to a straight line with no randomness. After a certain number of time steps, the value has arrived into a value between a maximum and a minimum. The further away we probe in time, the larger this variation is.
- The uncertainty of a patent can under some circumstances be modeled by a random walk. It depends a lot on what type of enforcement value is sought. In all, the path of the patent towards the future from some current point of time should be analyzed carefully, and its nature (random walk or not) should be portrayed in the process of value analysis. Of course, the further away in time, the more uncertainty can come into play.

Closed form solution:

- For securities, in some cases, the value of the option can be expressed in a closed form (with a formula that pops out the value, in money terms). Most famous is the Black-Scholes formula discussed in more detail below.
- For patents, no such formula exists, solely because the underlying world is not random in a well behaving way, but instead dependent on several technological, business and legal events, possibly coupled, "messing up" the randomness of the process. One example of "coupling" is competition where two companies engage in heads-on battle over some field of technology, using patents as weapons.

At this point, we should point out the difference of "risk" and "uncertainty".

- Uncertainty is resolved as time goes by – something uncertain today (like the temperature at your balcony, tomorrow morning 8:00AM) is not necessarily uncertain tomorrow anymore (provided you can glimpse the thermometer at your balcony).
- Risk is the outcome of uncertainty – something "bad" we bear in relation to the uncertainty (like the risk of our flowers freezing in the balcony if the temperature reaches below zero) [15].

OPTION EXAMPLE

To illustrate "real options" in practice, consider a drug development project [17] in a pharmaceutical company A. To hedge the risk, the company has decided to create an option to abandon the project by agreeing, with company B, to sell the development project at any time, within five years, at a fixed price, to company B. For this, certain remuneration must be paid from A to B.

Clearly, such a setup is an option – it gives company A a right but not an obligation to sell, at a fixed price. Let's assume a price tag of $160M to this (the strike price of the option). But what is the value *of this option*? How much should company A pay to company B for the right to sell the project to B just by a matter of announcement?

To start this analysis, we should establish a baseline value (e.g. using a DCF method) of the project. Let's assume this is $220M. This illustrates the first "hurdle" in the options analysis – the random walk process inherent to the value of the options has to have a starting point, which can be hard to conceive in its own right.

The second "hurdle" is even more esoteric. To be able to use the real options analysis, you must possess the (implied) volatility of the process in question. Volatility is the measure of uncertainty; from a statistical viewpoint it corresponds to the standard deviation σ (small Greek letter sigma) of observations around a mean. To get things going, let us assume a value of 30% for (annual) volatility for the value of the project.

Given these two numbers, we can now device a way to see "how the future might look like". We do not know the exact outcome within one year, but we do know (based on mathematical theory) that there is a *very good chance* that the outcome will be, after one year, *between* expectation values of

$$\$220M \times u = \$220M \times e^{\sigma} = \$220M \times 2{,}718282^{0{,}3} = \$220M \times 1{,}349859 = \$297\text{M}$$

and

$$\$220M \times d = \$220M \times e^{-\sigma} = \$220M \times 2{,}718282^{-0{,}3} = \$220M / 1{,}349859 = \$163\text{M}$$

Thus, note how we try to cushion the uncertainty – we make a bracket of "things to come" with the *u* and *d* multipliers. Of course, *u* stands for up (how much the value might go up in one year) and *d* stands for down. Note that *d* is the inverse of *u, d = 1/u*. Mathematically, this splitting of a value at a given year (or mathematically stated, at a given timestep) to two expectation values on next year (or next timestep) is called a bifurcation.

Thus, after one year (from year zero to year one), if all goes well, the value of the project is $297M, and if all goes… uh… not so well, we are at a value of $163M. This "not well -value" is still above the value company A can sell the project to company B (163M > 160M). Thus, value

for on option to be able do so would be negative, and company A would be wise not to buy such an option at all if the option would *expire only in one year*.

Now, consider time on "year zero", T=0. At this instant we know that the value of the project is 220M (in Dollars, the baseline value). But at what probability this 220M holds as the expectation value of the next years bifurcated at year one, T=1, 163M and 297M? Well, let's try 50%/50%. The expectation value of 297M and 163M at equal probabilities is

$$E_{T=0} = 50\% \times 297M + 50\% \times 163M = 230M$$

As our original 220M has turned into 230M, we have a problem - the expectation value yields a 10M gain without doing anything, and something is wrong.

The trick here is that the expectation value is created through a "risk neutral probability", P. We can solve from

$$220M = P \times 297M + (1 - P) \times 163M \rightarrow P = \frac{220-163}{297-163} = 42{,}5\%.$$

With this probability of 42,5% "up" and 1-42,5%=57,5% down, the bifurcated expectation values of T=1 yield the correct value at T=0 of 220M.

As given above, the term of the option was five years. Thus, we must compute forward in our "bifurcating random walk sequence". The possibilities are on year two:

- move "up" from first year's "up" position → value is (two "ups" in a row): $\$220M \; x \; u^2 = \$401M$
- move "down" from first year's "up" position → value is (go up, then down): $\$220M \; x \; u \; x \; d = \$220M \; x \; \frac{u}{u} = \$220M$ (the two movements cancel out)
- move "up" from first year's "down" position → value is (go down, then up): $\$220M \; x \; d \; x \; u = \$220M \; x \; \frac{u}{u} = \$220M$ (note that this value is the same as in the bullet above)
- move "down" from first year's "down" position → value is (two "downs" in a row): $\$220M \; x \; d^2 = 121M$

OK, after two years we have four potential outcomes of which two have recombined to one (220M position). If things have gone repeatedly well, however, we are at 401M and if repeatedly poorly, we are only at 121M. Reasoning similarly into the future, the following tree-like-network is created (each value to the right is computed by bifurcating the node to the left). Note now the values on the same line are equal – the tree (or option lattice in finer terms) "recombines" as $u = 1/d$.

Year	0	1	2	3	4	5
						985,97
					730,43	
				541,11		541,11
			400,87		400,87	
		296,97		296,97		296,97
	220,00		220,00		220,00	
		162,98		162,98		162,98
			120,74		120,74	
				89,45		89,45
					66,26	
						49,09

Thus, if everything goes very well for five years in a row, we are at 986M. And if things go wrong for a long time, year after year, we are at only 49M.

Now comes the magic moment! Given the option company A has purchased, it never has to be at a position e.g. only worth 121M on year 2, or 89M on year 3 or a measly 49M on year 5 - *because it can sell the project at 160M, by the means of the option*! Thus, the value of the option is in any of the lattice positions at year 5 is simply the larger of the difference of the value of the lattice point less the strike price, or zero. Now, our lattice for year 5 looks like the following (assuming that the management is wise and executes the option when it is advantageous to do so). Note that each of the numbers equals the numbers in the lattice above less 160M, or zero in case the difference is negative (in this case, the option is executed).

Year	0	1	2	3	4	5
						825,97
						381,11
						136,97
						2,98
						0,00
						0,00

Now it is a simple matter of computing back from T=5 to T=4, from T=4 to T=3 etc. To do this, we simply collapse the bifurcations of up and down values to the expectation values with the formula

$$Value_{expectation\ at\ T=N} = P \times Value_{up\ at\ T=N+1} + (1-P) \times Value_{down\ at\ T=N+1}$$

at each of the nodes of the lattice, and arrive at

year	0	1	2	3	4	5
						825,97
					570,4257	
				381,1127		381,11
			240,8661		240,8661	
		144,6516		136,9689		136,97
	83,28468		73,37413		60	
		37,82294		26,26194		2,98
			11,48598		1,268165	
				0,539677		0,00
					0	
						0,00

OK, we started at T=0 with $220M, went into the future, into T=5, substituted the lattice values on T=5 with the option value, and computed back, obtaining $83,3M.

It is interesting to compare this result with the famous closed form Black-Scholes formula [17]:

$$C(S,t) = SN(d_1) - Ke^{-r(T-t)}N(d_2)$$
$$d_1 = \frac{\ln(\frac{S}{K}) + (r + \frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}}$$
$$d_2 = d_1 - \sigma\sqrt{T-t}.$$

This formula ($C(S,t)$)is readily computed e.g. with Excel's NORMSDIST-function for function N above. We get $85,2M which is within 2,3% of the value computed by a simple 5 step lattice. Such accuracy is excellent and quite sufficient for predictive purposes, given the usually poor accuracy of the input parameters (e.g. volatility).

Of course, our example was done at a very poor resolution with a timestep of one year. For more exact results, the year can be split into arbitrarily many sections. When doing so, note that the volatility has to be adjusted accordingly.

RELATION TO PATENTS

Above a simple "call" option was discussed. How is this information used in the context of patents? As already discussed, the optional value of an asset is meaningless without volatility in the value setting mechanism. To arrive into this value, usually Monte Carlo simulations are performed. Therein, the life from inception to abandonment of a patent is simulated with different pseudo random input parameters, leading to different outcomes. This process is repeated tens of thousands of times, after which the volatility (or standard deviation) of the value becomes available. With this knowledge, we can use the mechanism described above for the value determination.

As a concluding remark, one thing we did not take into account is the "risk free interest rate". This concept simply states that money in your pocket at T=0 is more value, as already discussed in the DFC example in the Economic Benefits chapter. The risk free rate can be accounted for by adjusting the risk neutral probability accordingly.

GAME THEORY

Game theory is a close cousin of the optional pricing models. However, here the moves into the future follow some defined set of rules instead of being a random walk, and thus the model is more deterministic and even better suited for the analysis. However, this valuation method assumes "a game" – a scenario where the there is a number (usually two) players that are engaged somehow in relation to the patent. Such an engagement can be, for example, a patent litigation or the threat of it.

Usually, in a game, there are two players, both trying to maximize their benefit (and/or the loss of the other – usually this is beneficial for the first party). Because games have rules, the both parties try to outguess the other, operating under the rules. When neither of the parties can improve their payoff by moving to another position (as any move might create more downside than upside because the other party will retaliate), an equilibrium is reached. This equilibrium is the best possible situation for both parties, and thus yields the value for the position. For patents, the outcome is the value of a patent or a group of patents, e.g. for a party in a litigation.

An important process in game theoretic valuation is the Nash bargaining process[1] [18]. This is a two-player game where the players want a *portion* (*GP1* and *GP2*) of some *good* (e.g. money). If the sum of the player's request is equal or lower than *total good GT*, then *P1* gets *GP1* and *P2* gets

[1] named after John Forbes Nash, Jr. an American mathematician who shared the 1994 Nobel Memorial Prize in Economic Sciences with two other prominent game theorists Reinhard Selten and John Harsanyj.
Nash is currently mostly recognized among general public since the Hollywood movie "A Beautiful Mind", a vivid tory on Nash's mathematical genius and dramatic account of the paranoid schizophrenia he suffered from.

GP2 ($G = GP1+GP2 < GT$). Otherwise, they get the disagreement good, *Gd*. Often, *Gd* is zero (or even negative number, taking into account the resources devoted to the game that yielded a zero).

The Nash bargaining solution is a "Pareto efficient" solution to this game. This means, by and large, that it is impossible to make one player better off without necessarily making the other worse off. This kind of outcome is, from the overall perspective, the best.

If the Nash bargaining results in $G = GT$, the players have arrived in Nash equilibrium. By following the simple rules set above, any attempt to improve the position by either one of the players makes them both receive Gd, possibly nothing. A corollary is that the players split the good, but not necessarily evenly. The uneven distribution is characterized by the Nash bargaining power. We denote P1's bargaining power by $\beta \in [0,1]$, so *P1* a fraction β of *G*. Likewise, *P2* gets $1-\beta$ of the good *G*.

EXAMPLE

Consider a simple example, following [19] and [20], where there are two players, *P1* holding a patent ("holder") and *P2* potentially infringing it, perhaps a downstream manufacturer, assess the value of the patent from the game theoretical perspective. *P1* can now, by means of promising not to sue, get something out of *P2*, usually money (but can be equally well an access to *P2*'s other assets like technology, knowhow etc). Value of license to the licensee is thus the avoided costs related to litigation, injunction, damages, and adjusted by the possibility e.g. to design around. It is said that such negotiations are carried out in the shadow of litigation. Through this "shadow", the litigious situation is reflected into the outcome. This is a Nash bargaining situation, and to find the price, the equilibrium must be found. The price, in this context, is the royalty the *P2* must pay to *P1*.

To derive this fee, we have to do a certain assumptions:

- The players of the licensing game are "rational" – they wish to maximize their gain, not to maximize other player's loss (unless this loss adds to their gain)
    - In other words, there is no "punishment" aspect. In practice, this means that neither of the players wish to enter litigation, as this would create loss for both parties.
    - The specific assumption of the US legal system is worth noting, in e.g. Finnish system, loser pays, and the rules of the game would be different.
- Symmetrical knowledge is assumed; both sides know all the facts having impact on the matter. Moreover, they perceive these facts similarly.

Given the rationality aspect, now the question becomes: how to compute the gain, and then split the gain rationally to arrive in the value of the royalty, and thus, patent.

Assuming that litigation costs are equal for both parties (denoted as *L*, total cost being *2L*), the payoff for the patent holder, relative to the *threat point* (*-L* = having to spend money on the litigation) is

$$P_{TP} = E - L + \beta(L + L) = E + (2\beta - 1)L.$$

Above, *E* is the expected payoff from *P2* to *P1*,

$$E = \theta\beta\nu X$$

also known as the "benchmark" level. Above, θ measures the probability of the patent found valid in the court (the "patent strength"), and β is the Nash bargaining power of the patent holder P1. ν is the somewhat esoteric measure of how much the patented invention increases the value of the product.

Now, in this scenario (no litigation), the revenues (= payoff) to patent holder *P1* are the payments from *P2*, and as there are no costs, P_{TP} must measure the total negotiated payment from *P2* to *P1*, rX , where r is the negotiated royalty (per unit), under Nash bargaining. Under these conditions we get for r

$$r = \theta\beta\nu - (1 - 2\beta)L/X.$$

This kind of formula is typical for game-theoretic observations. We have a baseline price (here, $\theta\beta\nu$), which is offset by a game theoretic shadow term (here, the shadow of the litigation).

Such a simple sounding formula is very interesting at closer scrutiny. Let's try it out with a couple of scenarios:

- Let's assume that *P2*, the downstream manufacturer, has the "upper hand". This is indicated by either low θ (weak patent) or low β (poor bargaining power of the patent holder) or both. In such a case, ν gets multiplied with a very small multiplier, and this value is further diminished by the expression nL/X, where n is close to 1. Further, the cost of the litigation shrinks the royalty, which matches intuition. But note that litigation cost comes into play through β, not θ.
- Assuming, on the contrary, that *P1* reigns, we have large β and large θ. Multiplier of ν is a large number, directly increasing the royalties. Interestingly, if $1 - 2\beta < 0 \rightarrow \beta > 1/2$, the second term also starts to increase the royalties. Thus, if *P1* is a strong bargainer, the cost of the litigation starts benefitting *P1* and being adverse to *P2*.

The formula above can be further be refined by taking into account e.g. cost and time lag to redesign the product (to avoid infringement). For a more complete disclosure, see e.g. [20].

GAME THEORETICAL OUTCOMES

Based on scientific evidence [20], the game theoretical perspective also yields non-intuitive results

- Weak patents, when skillfully used, have the highest leverage. This is especially true in the information sector where one small patented feature in a complex product (e.g. a mobile phone) can, per the existing laws and regulations, ban the sales of the entire product. A famous example of this is the NTP vs. RIM case ("RIM to Pay NTP $612.5 Million to Settle BlackBerry Patent Suit," Wall Street Journal, March 4, 2006.)

- As a result of the bullet above, [20] quotes the General Counsel of Intel Corp.: "A fundamental invention deserves greater value than a relatively minor tweak to work that went before it. A broad application of the injunction remedy makes all patents "crucial, whether they are or not." In other words, injunction remedy has a tendency of compressing the valuation of patents to a higher level.

- For the potential infringer, early negotiations are not necessarily a good idea. In addition to the US legal system's treble damages (negotiations, of course, prove that the other party is aware of the patent), negotiations make it hard to utilize any weakness of the patent (in other words, factor θ appears only in the game theoretic, late stage negotiations but it is hard to incorporate early on). Of course, savvy negotiators acknowledge this, and act accordingly.

ECONOMIC MODELS ON DAMAGES - WHAT DO US COURTS HAVE TO SAY?

Especially in US, legal courts have to handle a huge number of lawsuits related to patent infringements. For example, in 1999, there were 1600 lawsuits in this field, and the number was rapidly rising [21]. Unsurprisingly, the courts are under pressure to devise systematical methods for awarding damages in patent related cases.

US statute, in 35 U.S.C. §284 awards damages "in no event less than a reasonable royalty for the use made of the invention by the infringer." Reasonable royalty is thus the lowest award possible for patent infringement, and in no way bounds what infringement should cost [22] [23]. By the same token, to find a minimum level of damage, court must find, with legal rigor, the reasonable royalty rate. For this end, the most famous method is the so-called Georgia Pacific approach that

used 15 different factors for determining the "reasonable royalty". Clearly, this is a valuation method for (infringed/litigated) patents.

The approach's origins are in a hallmark legal case "Georgia-Pacific Corp. v United States Plywood Corp., (Southern District of New York 1970)". In this method, the infringer and the patent holder enter hypothetical negotiations over the reasonable (accepted by both parties) royalty rate.

The negotiations are run through a set of 15 factors. Of the 15 factors, not all are necessarily used in any given case. Some factors can lower the damages, other raise it. However, the outcome can never be below the statutory lower limit, which is, in a way, the last factor (#15). Thus, in damage assessment, it is customary to start with the last factor, and then tune then numbers with other applicable factors. Of course, it is far from clear what kind of argumentation with happen in "hypothetical arm's length negotiations".

1. Royalties patentee receives for licensing the patent in suit
2. Rates licensee pays for use of other comparable to the patent in suit
3. Nature and scope of license in terms of exclusivity and territory / customer restrictions
4. Licensor's established policy and marketing program to maintain patent monopoly by not licensing others to use the invention
5. Commercial relationship between licensor and licensee, such as whether they are competitors or inventor and promoter
6. Effect of selling the patented specialty in promoting sales of other products of the licensee; the existing value of the invention to the licensor as a generator of sales of his non-patented items; and the extent of such derivative or convoyed sales
7. Duration of patent and term of license
8. Established profitability of the products made under the patent, its commercial success and its current popularity
9. Utility and advantages of patent property over old modes and devices
10. The nature of the patented invention; the character of the commercial embodiment of it as owned and produced by the licensor; and the benefit of those who have used the invention
11. The extent to which the infringer has made use of the invention and the value of such use
12. The portion of profit or selling price customarily allowed for the use of the invention
13. The portion of realizable profit attributable to the invention as distinguished from non-patented elements, significant features / improvements added by the infringer, the manufacturing process or business risks
14. Opinion testimony of qualified experts
15. Outcome from hypothetical arm's length negotiation at the time of infringement began.

In all, the 15 factors above are an excellent list of the forces affecting the value of a patent. Especially worth noting are the close ties to the commercial and financial figures of merits e.g. in factors 4, 5, 6 and 8.

TEACHINGS OF ACCOUNTING STANDARDS

As discussed above, financial accounting is also connected with patent valuation as patents form one segment of the company assets. This matter is dealt in International Financial Reporting Standards (IFRS) substandard IAS 38 that covers intangible assets (defined as non-monetary asset without physical substance).

The IAS 38 standard requires an entity to recognize an intangible asset if, and only if, specified criteria are met [24].

The recognition of an item as an intangible asset requires an entity to demonstrate that the item meets:

a) the definition of an intangible asset; and
b) the recognition criteria.

To be "identifiable", an asset must be either:

a) separable (capable of being separated or divided from the entity and sold, transferred, licensed, rented or exchanged, either individually or together with an other asset), or
b) arise from contractual or other legal rights, regardless of whether those rights are transferable or separable from the entity or from other rights and obligations.

Clearly, patents fit both of these definitions.

An intangible asset shall be recognized if, and only if:

a) it is probable that the expected future economic benefits that are attributable to the asset will flow to the entity; and
b) cost of the asset can be measured reliably.

The probability recognition criterion is always considered to be satisfied for intangible assets that are acquired separately or in a business combination. As a rule, an intangible asset shall be measured initially at cost. The cost of a separately acquired intangible asset comprises:

Thus, again in terms of valuating things, it is easier to purchase it and pay a certain price, which then becomes an anchor for the valuation thereon.

INTERNALLY GENERATED INTANGIBLE ASSETS

With no transaction in place (when things are done internally), things get a bit more complex.

a) Internally generated goodwill shall not be recognized as an asset.

b) No intangible asset arising from research (or from the research phase of an internal project) shall be recognized. Expenditure on research (or on the research phase of an internal project) shall be recognized as an expense when it is incurred.

c) However, an intangible asset arising from development (or from the development phase of an internal project) shall be recognized if, and only if, an entity can demonstrate all of the following:
    - the technical feasibility of completing the intangible asset so that it will be available for use or sale.
    - its intention to complete the intangible asset and use or sell it.
    - its ability to use or sell the intangible asset.
    - how the intangible asset will generate probable future economic benefits. Among other things, the entity can demonstrate the existence of a market for the output of the intangible asset or the intangible asset itself or, if it is to be used internally, the usefulness of the intangible asset.
    - the availability of adequate technical, financial and other resources to complete the development and to use or sell the intangible asset.
    - its ability to measure reliably the expenditure attributable to the intangible asset during its development (not research!).

In IFRS standards, it is explicitly stated that internally generated brands, mastheads, publishing titles, customer lists and items similar in substance shall not be recognized as intangible assets. Moreover, it is stated that reinstatement of expenditure previously recognized as an expense is not possible.

MEASUREMENT AFTER RECOGNITION ("REVALUATION")

An entity shall choose either the cost model or the revaluation model as its accounting policy. If an intangible asset is accounted for using the revaluation model, all the other assets in its class shall also be accounted for using the same model, unless there is no active market for those assets.

- Cost model: After initial recognition, an intangible asset shall be carried at its cost less any accumulated amortization and any accumulated impairment losses.

- Revaluation model: After initial recognition, an intangible asset shall be carried at a revalued amount, being its fair value at the date of the revaluation less any subsequent accumulated amortization and any subsequent accumulated impairment losses. For the purpose of revaluations under the IFRS standards, fair value shall be determined by reference to an active market. Revaluations shall be

made with such regularity that at the end of the reporting period the carrying amount of the asset does not differ materially from its fair value.

An active market is a market in which all the following conditions exist:

a) the items traded in the market are homogeneous;
b) willing buyers and sellers can normally be found at any time; and
c) prices are available to the public.

Again, here we note the challenges of valuing IPR in accounting sense with other than direct cost based methods – for example, it is virtually impossible to state with accounting accuracy that two patents would be "homogeneous", find buyers and sellers at arm's length, or have public price information available.

DIFFERENT MODES OF LICENSING – STICKS, CARROTS AND BUNDLES

Basic economic theory asserts that for a "market", price is set when the demand of a good or service meets the supply of the good or service. By increasing supply, the price will drop unless demand is changed ("the supply curve slopes upwards") and by increasing demand, the price will rise unless supply is changed ("the demand curve slopes downwards") [25].

For patents, things are more complicated as the patent supply exists in different licensing regimes that are denoted in the following as "stick licensing", "carrot licensing", "bundled licensing" and "licensing to avoid selling" [26].

The discrepancy for the "markets" stems from the fact that the patent right is a "negative right", the option to say stop. The way to enforce this right happens, ultimately, in a court of law, but of course the mere threat of a court action can make things not happen.

STICK LICENSING

With stick licensing, the patent license is "sold" with a force to the buyer. This kind of licensing is present in most industry sectors. Recently, so called "patent sharks", "patent trolls" or "non-practicing entities", NPEs, have emerged as major players in the field of stick licensing.

This emergence is explained with the following: For "normal" companies that produce goods and services, the stick licensing carries a danger of "exposure". This means that the "buyer" forced to buy the license might revenge and counter sue the seller, possibly hampering the product business of the seller and, in particular, spoiling the economic benefits for the stick license seller.

To work, the seller of the stick licenses must also have a large and litigation-ready patent portfolio, "deep pockets", ability to prevail in court and the ability to protect thoroughly the own product portfolio. Preferably, the seller has entered the technology area early with enough breadth in the portfolio.

Thus, stick license is a "legal weapon" enabling to reap remuneration from the buyer. By setting the remuneration high enough, the weapon can prove lethal. And as with normal weapons, it can backfire, causing more harm than good.

Famous cases of patent sharks cases include e.g. the NTP vs. Research in Motion (RIM; the makers of BlackBerry handsets) [27].

The price setting mechanism in this context is the value of avoiding the legal actions (potentially or factually) imposed by the seller of the license - "to keep the bad guys from shooting". Clearly, game theoretic methods are best suited for this kind of scenario.

CARROT LICENSING

Carrot licensing prevails especially in the ICT sector. In this regime, patents, especially essential patents that are related deeply to a certain standard, are often "pooled", and then access and rights are offered to that pool in exchange of some license remuneration. As the pool forms an intermediate layer between the buyer and seller, the threat of exposure is diminished. Because of the pooling mechanism, at least some level of co-operation must exist between the buyer and seller (carrots make somewhat poor weapons).

The price setting mechanism in this context is the value of avoiding the legal actions (potentially or factually) imposed by the patent pool members or the authority running the patent pool. Clearly the risk of this is smaller than in the case of a stick licensor. On the other hand, the pool usually contains more IPR, rendering the license price substantial, at least if paid with cash.

BUNDLE LICENSING

With bundle licensing, access is provided for the patent portfolio in addition to the access of technology (e.g. plant for the treatment and a license to 20 patents related to waste water treatment). This kind of licensing is present in many fields of technology, but might have its problems in terms of laws that promote free competition (threat of monopoly, locking the market position etc.). With bundle licenses, the size of the portfolio is especially important, not the exact contents of the portfolio. Companies mastering the bundle licensing include Qualcomm and IBM.

The price setting mechanism is related to the amount of options an external company has for acquiring and using the technology in question, and the amount of alternative technologies. Thus, the analogue is to keep the bad guys happy by purchasing a bundle of items from them.

LICENSING TO AVOID SELLING

Sometimes it is smart for a licensee to license in a group of patents "soon", especially if the alternative is to license the patents later from another party, with a higher price.

A famous case in this context is the Robert Bosch-IPCom case in which Robert Bosch AG, the well known automation and automotive technology manufacturer and ("IPR originator") sold its telecom related patents to a non-practicing entity IPCom. Especially interesting is that the deal was backed by a NYSE listed investment bank Fortress Investment Group. IPCom then sued prominent handset manufacturers like RIM and Nokia in the hope of substantial licensing revenue (4-5% royalty of the handset sales) [28]. It is probable that Nokia and RIM would have rather dealt with Robert Bosch AG directly, had this kind of business been in the Bosch strategy and operations agenda.

Of course, in this context one might argue that selling patents for their later licensing at a higher price is no different from buying deep freeze French fries instead of potatoes and vegetable oil – it is a value chain proposition. But the patents were probably not "refined" in any way as they were passed from Bosch to IPCOM.

The price setting mechanism is the incentive for the IPR originator not to sell the portfolio. This is a complex question as money in the bank is more valuable than future, uncertain cashflows for the same amount. Thus, the analogue is to stop the bad guy from handing over the guns to an even more bad guy.

WILL THERE BE A STANDARD FOR PATENT VALUATION?

There is an ISO standard, on the trademark / brand valuation (ISO10668) [29]. The standard has, in various places, a lot in common with already discussed, patent related methods. But if trademarks have their standard, what about patents – will there be a patent related valuation standard?

In 2008, it was stipulated in IAM Magazine's website [30] that turning patents into money (outside of the traditional fields of carrot and stick licensing and technology transfer) suffers from the lack of a well recognized method for measuring their value. Not knowing the true and fair price of something (for both seller and buyer) is a surefire way to stop the transaction process.

In 2008, DIN (Deutsche Industrie Normen, the German standards organization) was active on establish just such a standard by establishing a working group that would push the standardization effort to ISO.

Theoretically, the development of a standard could prove very useful to companies that own patent rights, especially smaller ones which have few tangible assets. Of course, it could also be highly beneficial to IP services providers, who could do business around valuation methods that have been given an international stamp of approval. For those that have developed proprietary valuation techniques there could be a considerable downside, however, unless what they offer complies with the standard.

However, as argued e.g. by Dr. Stephen Potter in the IAM Magazine: "*My personal feeling is that this is a very dangerous and misleading approach. The lead economist of the EPO is quoted to have given a mean value of $300K for a European patent and at a recent meeting in France it was said that the mean value of ~$300K for patents bought at the London auction of OceanTomo provided justification for his figure..... This is wrong! - the patents chosen for the auction had already been heavily selected on an individual basis and didn't represent any "normal" portfolio . To quote Lord Justice Jacob, Justice of Appeal and Privy Councillor from the talk he gave to the UK LES in 2005:*

- nearly all patents "don't matter"

- many patents that have been granted are not valid

One of the future dangers is that an ignorant CEO or politician will take this figure seriously - "after all it is an official Euro number" - and start making judgments and creating strategy on that basis.

To me the only true basis for the valuation of a patent is what somebody will be prepared to pay for it and, for me, this is based on a particular situation at a particular time: a patent can vary in value from essentially zero and in the process of being abandoned to hundreds and thousands of dollars when, perhaps in conjunction with others, it can be used to defend against a major IP attack.... Everybody should read (Nassir Nicholas) Taleb's book on "The Black Swan - the impact of the highly improbable"[2]...."Improbable" is the value of a patent!"

Subsequently (according to [31]), the ISO new standard proposal was rejected in 2008 by Japan, Canada, Finland, Netherlands, Spain, South Africa, UK and USA, 16 other countries being in favor). Arguments against the new ISO standard on patent valuation included: "it is difficult to understand how the complexities of the subject matter can be mastered sufficiently to develop any useful standard", "standards development committee was not an appropriate forum for doing

[2] This book is a fabulous journey into the known and unknown factors of mostly financial sector decision making. The key takeaway of the book probably is: it is better to work with no model than with a wrong model: A wrong model gives you a false sense of security of the things that you do not really know. Without a model, you at least know that you do not know. With massively coupled money and financial markets, working with wrong predictions can lead to catastrophic outcomes as witnessed in fall 2008 credit crunch meltdown of the global financial sector.

the kind of the work needed to develop and evaluate new patent valuation methodologies" and overlap in work with the International Accounting Standards Board (IASB).

WHAT WILL ACADEMICS TEACH US?

LES mini seminar on patenting valuation was arranged by LES Scandinavia in Helsinki Roschier attorneys at law office on Jan 27th, 2010. Academically, the valuation question is stated as the "economics of patents".

The field of patent economics is relatively new, first formalism was created by Nordhaus in 1969. Summary work is from early 2000s, e.g. Menell and Scotchmer. There appears to be very little work on management perspective.

A very interesting talk was given by Prof. Tuomas Takalo. The presentation material is available for LES members at [32].

One of the key points in Takalo's presentation was as follows: the value of a patent for a company (the private value) is the incremental value of the patent. The value is derived from the ability to exclude other parties, or to sell/license the exclusion right to other parties. The incremental value only exists relative to the counterfactual – alternative ways of profiting from the innovation (from other "appropriability mechanisms" like keeping the innovation secret).

Thus, "academically", we need a counterfactual against which we should compare the patent. Such constructs are e.g.

- value of patentable invention before publication (best alternative appropriability mechanism, e.g. keeping the invention secret)
- renewal value of patent (counterfactual is to let the granted patent lapse (not pay the annuities) and save the annual fees)
- asset value of patent (counterfactual: if patent holder would sell the patent, there would no longer be an exclusive access to the patent rights (of course, the bid price for the patent would constitute another estimate for the patent value))

In the presentation, Takalo points out that the value of a portfolio is more than the sum of the individual patents due to scale effects – the bigger the player, the more credible it is in the field.

Patent can be seen as a construct of a series of real options. The annuity/renewal fee is the exercise price of the option. Through this we can start to build up a model of assessing the price of a patent. An important assumption therein is "rationality" – patent renewing is done only when future benefits exceed the renewing costs.

Thus, a following graph can be crafted (see Fig 3): the revenue potential ($R(t)$) of the invention over the years (reflecting the price of the invention) can be drawn as a group of downward

sloping lines. The costs ($C(t)$) of the renewal is an upward sloping graph. The upside of this model is that we know the renewal behavior of millions of patents, possibly reflecting some statistically significant correlation of their value given their set of characteristics. The downside is that we do not really know the slope of the R (we only know the dots at 5, 9 and 14 years).

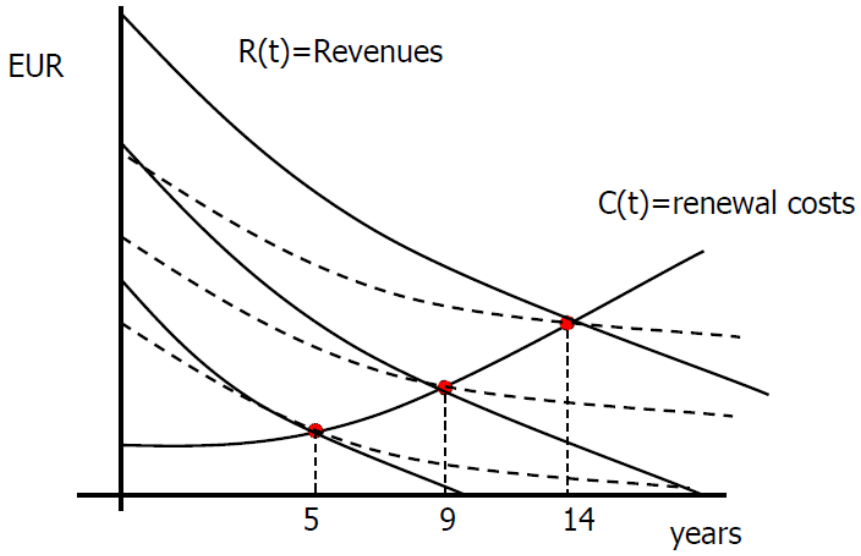

Figure 3: Renewal costs imply the value of patent

However, we can try to go around this problem by assuming a distribution for the initial returns that patents generate at t = 1, model the depreciation of those returns, estimate the parameters using renewal data and then compute the *average* renewal value at the desired point of time. This model, of course, is subject to many uncertainties - the assumed distribution can and will change over time, the technology can get obsolete etc. But the basic assumption is sound: The patent is renewed only if the renewal fee in the current period is less than the returns for this year, plus the option value of the patent for any upcoming years. The scheme is now to start at t=20 (the last possible year of having the patent in force) and then work recursively towards t=1, yielding the value for paying the first annuity.

With this, several interesting findings can be presented:

- the renewal model gives an asymptotic (1/x-like) value distribution with no sensible mean: most patents are of very small value and few patents are of very large value. This observation is, of course, with excellent qualitative agreement with reality.

The presented model has many benefits:

- There is no need to forecast accurately annual returns (cash-flows) over the life-time of patent, but instead of point-forecasts, and work with the distribution of returns. Of course, to get the distribution of returns, some information of the returns must be available.
- Allows for valuation uncertainty. As discussed above, this should be seen as a critical "sanity check" for any method of valuation. Patents are bets in a certain technology trajectory with inherent uncertainty. Without ways to take this uncertainty into account, one should be extra careful in understanding the basis of the evaluation method.
- One can use industry's or company's historical renewal data as the starting point. This data is usually readily available.

The downsides are

- the model is sensitive to tail distribution,
- it is hard to value a single patent, and
- model is involved and difficult to take into operations.

In all, from the economics perspective, there appears to be quite a bit literature available for the patent valuation. From the operations/business perspective, this is less so.

METHODS FOR EVALUING PATENTS

"*If you cannot be good, be colorful!*"

- Apollo 12 commander Charles "Pete" Conrad

Wikipedia defines evaluation as the "systematic determination of merit, worth, and significance of something or someone using criteria against a set of standards". Thus in "evaluation", we have relaxed the need to arrive in some Euro/Dollar value, and instead arrive in some other figure of merit.

In the following, we discuss three such methods

- "Lex van Wiik" method
- Metso method
- IPQScore® rating by OceanTomo®

THE LEX VAN WIJK METHOD

Lex van Wijk is a patent expert at DeltaPatents [33] who published, in 2005, a book (booklet) "There might be trouble ahead - a Practical guide to an effective asset management" [34].

The book contains a very well thought invention & patent evaluation scheme where the merit of an invention or a patent can be expressed in terms of four distinct areas:

A) Employee competence
   a. Understanding of the technical scope
   b. Amount of work remaining before commercialization
   c. Ability to implement and develop (~ relation to current products)

B) Internal Structure
   a. Patentability
   b. Scope of protection
   c. Related Patent position

C) External Structure
   a. Proof of infringement (can it be proven someone infringes…)
   b. Attractiveness to others
   c. Alternatives available

D) Alignment of Strategies
   a. In-house interest existing
   b. Cost savings
   c. Revenue Impact

To use this scheme, the invention or a patent is scored (e.g. 0 indicating a very low score, 5 indicating a high score). Then, by summing up the different scores, a figure of merit enabling to compare the inventions/patents becomes available. Scoring is a matter of judgment, best done by several experts related to the patenting process.

The areas can also be weighted. For example, if licensing of patents is considered very important, area C) should be given more weight (e.g. score it from 0 to 10).

In terms of traditional patent management, area B), the Internal Structure, is usually overvalued (we want to maximize the scope of the claims). However, if areas A), C) and D) are neglected, the ability to capture value with such an invention/patent is badly compromised.

In particular,

- If area A) scores poorly, the inventions are perhaps guesses. They can look good on paper and promise a great future, but nasty surprises can emerge when they are taken towards the paying customer - the cashflow sunk into patenting such inventions is perhaps never recovered. However, as patent applications are options, wise execution or abandonment the option mitigates this problem. Poor scores in A) can lead to so-called late-time-failures: projects bases on guesses can slouch into the future for a long time before it is discovered that the foundations are badly rotten.
- If area B) scores poorly, the patent can be perhaps circumvented in the marketplace, thus making the patent irrelevant. This is usually not a problem in a sense that poor scope is often discovered early in the process by the prior art presented in the written opinions of the application. Sometimes, prior art is hidden, destroying the patent in a litigation later. It is also possible that formalities destroy an already granted patent.
- If area C) scores poorly, it is possible that nobody cares about the patent (or invention). It is not easy to capture value with something that is not interesting or cannot be made interesting. It is worth thinking about how to proof, beyond reasonable doubt, that the patent/invention is infringed.
- If area D) scores poorly, the company lacks a top-level commitment of commercializing the invention. It is possible that the business area has shifted after the filing of the patent. Or perhaps the company should have believed potential low score in A). Perhaps the patent could be licensed elsewhere or sold.

The special benefit of the Lex van Wijk-method is that it couples business and legal interest in a compact, yet broad fashion.

Metso ® Inc. uses also an evaluation method for assessing the merits of the invention or patent. Also this method is presented in the lecture material of the course [14]. The purpose of the method is to evaluate inventions, and arrive in a reasonable compensation to an employed inventor in the light of the Finnish patenting and employment laws.

For evaluation, Metso Inc. uses the following criteria:

A) In Use: **1. not in use**; 2. not in use, but…; 3. in use)
B) Scope: 1. detail; 2. important component; 3. process or lay-out
C) Market/Competitor Interest: **0. no interest; 1. maybe**; 2. interesting; 5. highly interesting
D) Area coverage: 1. limited; 2. at least 2 countries, one major market, 3. wide
E) RTD category: A: short term; B) product with 2-3 yrs, C) product > 5 yrs, research required

The criteria marked with bold are especially important – if score is low in there, the case is simply abandoned. Thus, the invention/patent must be in use or there has to be a very good "but", and the market/competitors must be interested in it.

IPQSCORE® RATING BY OCEANTOMO®

As discussed above, creating a marketplace for patents would enable a firm(er) mechanism for setting their value - value would simply be the price of the transaction. But still the purchaser runs the risk of paying too much and the seller the risk of selling too cheap, and to mitigate this risk, ways to analyze the commercially traded value of the patent are needed.

One example of such a method is created by Ocean Tomo, "the leading Intellectual Capital Merchant Banc® firm" [35]. OceanTomo's services include IPR expert testimony, valuation, investments, risk management and transactions. In general, OceanTomo's name for the value of patents is "Intellectual Capital Equity® value".

In assessing the patent value, OceanTomo uses a so-called IPQ® score method. IPQ score is a numerical measure of patent quality with a median value set at 100 that rates patent assets based on statistical methods with a patented (!) and, as you might have guessed it, proprietary rating system.

The IPQ score system has a median of 100. Patent assets with higher IPQ scores are statistically more likely to generate economic returns (returns that exceed the cost of capital employed in creating them). Patent asset's IPQ score can be used by IP professionals, investors, and corporate strategic planners to determine value and quality. IPQ® Scores are unique to each particular patent examined and are updated monthly. Scores are based on certain identified predictive variables determined to have statistically significant correlation to patent quality and value. These "variables" or "metrics" include, for example:

- Number, length and type of patent claims,
- Amount and type of prior art cited,
- Number of forward citations or references made by later-issued patents,
- Presence or absence of limiting claim language,
- Patent prosecution history

In all, there are some 60 other factors affecting the IPQ score [36].

Patents are one of the most reliable and critical indicators of companies "strategic intent" as patents are legal rights given to inventions that are direct result of years of valuable R&D activities on the parts of companies who created and own them. Furthermore, those who hold valuable patents (protectable inventions) and in sufficient quantity are likely to shape the industry direction with their core technologies and influence and control industry margin structure. Examples would be Microsoft in Software, Qualcomm in wireless, Apple in consumer devices, Intel, Samsung in semiconductors, etc.

Therefore, by studying the "collective quality (proxy for value)" of recent patents (5 years) owned by the firm in this case, we can deduce, from the data, how inventive a firm is. Ranking companies based on their collective patent strength is critical as not all patents are created equal; some are worth hundreds of millions of dollars in the market place while many of them hold very little value. So simply counting how many patents a firm holds can lead to very misleading view of the top inventive firms.

CONCLUDING REMARKS

"*Strategy means maintaining the control of your destiny.*"

- Robert A. Burgelman

With all this knowledge, were do we stand? As IPRs are turning from cost center based treasures in the vault into a more traded commodity, the price of the IPR is probably easy to conceive – it is the price someone is willing to pay for your patent. But determining the value, as we have seen, is an immensely more difficult proposition, and if a benchmark value is not known, the entire market is hampered and the trading is blocked at the outset.

Value depends on the context, like a bottle of water for a badly dehydrated man in the middle of a scorching desert vividly illustrates. IPR has a baseline value (usually stemming from the everyday usage of protecting the products and services of the patent holder and giving leeway to the freedom to operate) and optional value stemming from uncertainty and the nature of patents (they give the right but not an obligation to do something, e.g. litigate). Any such action is fogged with uncertainty and dynamic reactions of the other parties involved, eventually leading to game theoretical schemes.

The basic problem with "valuation" is that the entire history and future outlook of a patent is squeezed into a single monetary value. Without knowledge of the valuation process, such a number is very difficult to interpret, especially if the value is "modest". And also very "high" values require a healthy dose of background information.

The following table can be created, comparing some of the more discussed valuation methods.

Method	**Basic idea**	**Strategic value & accuracy**	**Effort**
Cost based	The value is the cost	Very poor; cost has some relation to value as better cases are usually maintained longer; accuracy is poor	Directly available from accounting
25% rule	25% of the profit belongs to the patent	Poor; Often used e.g. by US courts; an easy rule of thumb that depends a lot on the technology; accuracy is poor, but high if this is what the court awards	Available from finance statements
Replacement value	Reverse engineer the patent	Moderate; finding a way to reverse engineer is not always straightforward; accuracy is moderate	High
Discounted cashflow	Patent is an investment	From poor to moderate; accuracy suffers from neglecting the ability to take different paths.	Moderate; needs guessing on the income stream
Options	Patent is a real option	High; Accuracy is good if statistical data is available	High; needs an estimate for the volatility
Game theory	Patent is a ticket for a game	High; accuracy is good but depends a lot on the context	High; needs good guesses on the

			parameters (bargaining power…)

So is patent valuation just smoke and mirrors? If taken lightly, it is. Put garbage in, and get garbage out. But a clever and well communicated utilization of valuation and evaluation methods can be extremely beneficial for any company possessing IPR, patents in particular. By understanding the different background and theories related to the value *generation* (investing, options, game theory…), value *capture* is also considerably improved. It will not be easy, but ultimately any company involved in IPRs will have to connect IPR valuing considerations into its strategy process.

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