ON THE FINANCIAL EVALUATION OF SOME INTANGIBLE ASSETS*

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Abstract
Technology-related intangible assets are considered, with emphasis being placed on the 4 main evaluation methods, i.e. the cost, market, income, and real option method. A concise overview of those methods is provided, with their strengths and weaknesses being contrasted. This lays the foundations of a case study about the financial evaluation of a patent. Resort is made to the income approach only, suitably expanded by performing a sensitivity analysis. As few forecasts prove critical, a range of feasible values can be obtained for the net present value of the patent. In other words, the usual outcome of the evaluation process is reached without using and reconciling one another different evaluation methods.

1. Introduction

The evaluation of intangibles is an important topic in many streams of literature, from accounting to technology management, from economic policy to strategy, since intangible assets have been widely recognized as a primary source of companies' competitive advantage as well as of industrial systems' economic and social growth.

In this paper, the topic is dealt with from a microeconomic perspective, i.e. from the point of view of companies. In fact, in recent years, the topic has become of greater concern for companies because of the growing importance of intangible assets in the generation of economic value (Tseng and Goo, 2005; Cravens et al., 2003; Chiesa et al., 2008). As a consequence, improving the companies' ability to understand the value of their intangible assets is critical in many different contexts, among which (just to quote the most relevant ones) (Chiesa et al., 2005; Andriessen, 2004; Lev, 2003; Matsuura, 2004):

- accounting issues;
- buy-sell decisions concerning intangible assets (including licensing);
- collaborations and partnerships in which the intangible asset is involved;
- acquisitions and mergers;
- evaluation of damage in lawsuits;
- evaluation and selection of innovative (R&D) projects.

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As already pointed out, the literature on the evaluation of intangible assets in the above-mentioned contexts is very rich and describes many different methods that can be used, among which, for example, the traditional cost, market and income methods, or the most sophisticated real option method. What is still less discussed in the literature is the operationalization of these methods, i.e. how they can be actually implemented in real cases, where the lack of data and information, the pressure on the evaluation timeliness and the limited resources and competences available severely limit the possibility to apply the techniques as described in the theory.

The aim of this paper is to present a study of a real application of theory, in which the main problems and difficulties emerging are brought into evidence and discussed, and in which the validity of theoretical models is revisited in line with the empirical evidence emerged.

However, intangible assets are quite a general term including several different types of assets, such as brands, patents, designs, licenses, goodwill, clients lists, trade secrets and many other. Hence, it is very difficult to deal with the topic of intangible assets evaluation in very general terms, since evaluating a trade secret is obviously very different from the case of a client database or a brand. That is why in this paper the boundaries of the study have been clearly defined in order to be able to perform a detailed analysis of the problem; in particular, we consider a sub-set of intangible assets, the so called technology-related intangible assets (Chiesa et al., 2005). More precisely, the application presented specifically concerns a patent.

In coherence with its aim, the paper is structured as follows: Section 2 provides a concise overview of the most relevant methods proposed in literature for the evaluation of technology-related intangible assets; Section 3 presents and discusses the case study; and, finally, Section 4 provides the main conclusions and managerial implications.

2. Methods for valuing technology-related intangible assets

When it comes to the evaluation of such intangible assets as patents, technical know how, technical drawings, computer software and databases, different evaluation methods are available. According to a well received classification, the standard one (see Munari-Oriani, 2011, chapts. 5 and 6), evaluation methods can be grouped into 4 classes, listed in an increasing order of complexity: cost, market, income, and real option methods, with cost, market, and income methods being traditional and the real option one being more innovative. All available evaluation methods are adaptations of those basic methods.

According to the guidelines provided by some consulting companies, the evaluation process of the above-mentioned intangible assets is made up of 4 stages:

- *problem statement*, where the intangible assets to be valued and the aim and scope of analysis (e.g., licensing or selling a patent) are described;
- *preliminary analysis,* whereby the most appropriate evaluation methods are identified, with data being selected and collected. Owing to a gap between necessary and available data, too expensive to fill, the range of feasible evaluation methods could prove restricted;
- *financial evaluation*, by applying the most appropriate (traditional) evaluation methods;
- *reconciliation of values*. As each evaluation method is likely to result in a different outcome, a range of feasible outcomes has to be defined.

The 4 evaluation methods are introduced below, whereas an evaluation process takes place in Section 3.

The cost method is analytical and retrospective in essence. It is based on the costs incurred in developing the technical asset, i.e. on sunk costs that are suitably accumulated to take inflation into account. Sunk costs are due to material and labour and include overheads and an entrepreneurial incentive as well. However, the notion can be made slightly more prospective, if either reproduction or replacement is considered. A reproduction cost would be incurred, if the existing technology were developed from scratch. A replacement cost would be incurred, if a different state of the art technology were used to obtain the technical asset under examination. Reproduction and replacement costs are most used in practice.

The cost method is easy to apply. Its main drawback is that it neglects all the benefits following from the exploitation of the technical asset under examination. Moreover, it disregards the efficiency of past investments. Nonetheless, the application of the cost method is widespread in the first stage of the product life cycle, i.e. that of initial development, when uncertainty about all subsequent benefits is very high, since the potential business is still unknown. Moreover, resort is made to the cost method for accounting purposes.

The market method is empirical. It is based on the prices paid for comparable (or similar) intangible assets in previous deals. Multiples are computed, i.e. the ratio between the value of each deal and, say, sales of the corresponding technical asset, or EBIT, or the number of users. Multiples are then applied to obtain the value of the technology under examination. Multiples can be either trailing or leading according to whether the denominator of the ratio is made up of either past data or forecasts about the future.

Leading multiples are more appealing in theory, trailing ones are easier to compute in practice and less subjective as well. The market method is easy to grasp and consequently well received. Nonetheless, the question of whether data on previous deals are available is critical indeed. As a matter of fact, comparable intangible assets can be hard to find, as most technical assets are seldom traded, usually being part of a larger business so that it is difficult to consider them isolated from it.

The income method is analytical and prospective. The benefits following from the exploitation of the technical asset under examination take the form of net cash flows, with NCF_t being the net cash flow due at time *t*. Such an income stream is discounted at a required rate of return *r* that takes both business and credit risk into account; in other words, a risk premium is added to a risk-free rate of interest that depends on both business and credit risk, with the latter being measured by leverage. According to the Capital Asset Pricing Model, a popular reference indeed, the risk premium can be modeled by making use of suitable β coefficients. The intangible asset value PV_0 is the present value at time 0 of the future stream of such net cash flows

$$PV_0 = \sum_{t=0}^{T} NCF_t \left(1+r\right)^{-t}$$

where *T* is the time horizon and time *t* is measured in years.

The income method allows one to realize how patents and other intangible assets create value. However, as the valuation setting is more accurate than previously, problems are likely to arise, when it comes to forecast each net cash flow NCF_t, i.e. the bottom line of a *pro-forma* cash flow statement. Moreover, the calibration of *r*, i.e. of the risk premium, is a difficult task as well. If use is made of equity cash flows, we have

$$NCF_t = \text{net income}_t + \text{depreciation}_t - \Delta\ \text{net working capital}_t - \text{investment}_t + \Delta\ \text{debt}_t$$

where Δ represents a change with respect to the previous year. Therefore, forecasting each net cash flow NCF_t entails forecasting all entries of a *pro-forma* cash flow statement.

Although scenarios could be considered, as NCF_t is an expected value in financial theory, only point estimates are made in practice, as forecasting expected values proves too difficult. However, a semideterministic approach can be taken, whereby all NCF_t are semicertain; in other words, they are supposed to be certain, even if they are not so. In addition, as shown in Borgonovo-Peccati (2004), a local sensitivity analysis is performed to assess the impact of uncertainty on the net present value PV_0. It is a *simple coeteris* paribus procedure involving all entries of the income (cash flow) statements under scrutiny; each entry, e.g. sales, is given a, say, ±5% percent change so that 2 different perturbed PV_0 are computed by leaving all other entries unchanged. As a consequence of such “what if” analysis, each entry is matched by some ranges and the most critical forecasts are detected, namely those most affecting PV_0.

The real option method is analytical and prospective. It extends the income method by taking uncertainty thoroughly into account by means of a probabilistic approach. If time is discrete, the evaluation problem takes the form of a decision tree so that some decisions about the real options to exert can be deferred and taken at different times. For instance, if the scale of an investment can be expanded, expansion is the real option, which can be exerted only when the initial investment proves successful. Deferring or converting an investment are real options too (see Jacob-Kwak, 2003). Therefore, when determining the intangible asset value, future investment opportunities are explicitly considered, which wasn’t the case earlier. As a matter of fact, the income method assumes tacitly that all decisions are taken once and for all at time 0.

Each path between the initial node at time 0 and a terminal node at time *T* is a scenario. As explained by Trigeorgis (1996, chapt. 5), risk-adjusted (or risk-neutral) probabilities and a risk-free rate of interest are used to compute an expanded net present value EPV_0 at time 0 by starting from the final nodes of the decision tree and proceeding recursively backward in time toward the initial node. The expanded net present value EPV_0 includes the net present value of the technical assets in place as well as the net present value of the real options, i.e. of the subsequent investment opportunities, with the former being an input and the latter the output of the evaluation procedure. The evolution forward in time of the former is portrayed by the decision tree under the assumption that there exists a traded security that behaves in the same manner. As the net present value of the technical assets in place is the only state variable, the decision tree is binary. Suppose no real option can be exerted in node *k* at time *t*, the end of year *t*, with $0 \le t < T$; to compute the net present value of the real options in node *k*, the 2 adjacent nodes at time $t+1$, the end of year $t+1$, are considered, the risk-adjusted expected value of their present values is then computed and eventually discounted at the risk-free rate of interest. In some instances, a short cut can be provided by an educated use of a valuation formula such as the well known one by Black-Scholes.

Risk-adjusted probabilities are a function of appropriate standard deviations (or volatilities) among other inputs, with the latter being the risk-free rate of interest in the Black-Scholes model. For instance, if the comparable investments are sizable and performed by listed companies, reference can be made to the standard deviations of the rates of return on their stocks. Unfortunately, those standard deviations are likely to be noisy, as bull-bear cycles and hence persistent over- and undervaluation take place in stock markets, which are not fundamentally efficient, a point made by Shiller (1981) and Shleifer-Summers (1990) among others.

Although the most complete in theory, the real option method proves involved in practice, as the emphasis placed on standard deviations rather than means clashes with intuition. Indeed, its application to patents and other intangible assets is still restricted by its complexity. This is why it is disregarded in the sequel. Note that 2 different discounting procedures have been mentioned so far, which can be reconciled on a theoretical ground, i.e. in a dynamic programming framework. According to the income method, expected values are discounted at a required rate of return, made up of a risk-free rate of interest and a risk premium. According to the real option method, risk-adjusted expected values are discounted at a risk-free rate of interest.

3. Case study

Problem statement. Our analysis expands on Chiesa et al. (2008). We consider a patented medical device that improves muscular strength and rehabilitates muscular hypotrophy. The medical device is based on up-to-date medical research and has undergone extensive trials for 3 years in a row.

As the inventor wants to licence his patent, he needs to appraise it. The inventor wants to licence rather than sell his patent so as to be able to reap the benefits of further medical research. The patent ensures legal protection for the next 15 years; in other words, as there are no similar medical devices on the market, a temporary monopoly has been granted for the next 15 years.

The patent comes along with technical drawings, a bill of materials, and a prototype. The candidate licensee is one of the 21 Italian firms that produce orthopedic devices, which are fairly similar to one another. It is a small-middle size firm located in the North of Italy, which has shown interest in the patented medical device. It was chosen owing to its geographical location, size, and attitude to innovation.

Preliminary analysis. The patent cost was € 5.900, the trial cost was € 2.000 per year, and the prototype cost was € 340. However, neither the cost method nor the market method seems to suit the case study well. As explained in the previous section, the former neglects all the benefits following from the exploitation of the patented medical device under examination. Moreover, the latter is not viable, as there are no similar devices on the market. As use is made of the income method, net cash flows have to be forecast and a required rate of return has to be chosen; needless to say, the time horizon is 15 years from now.

The inventor and patentee collected data by using such external sources of data as Kompass Italia (a database on Italian firms, private and public entities), the National Institute for Statistics and the International Yearbook of Industrial Statistics. Those data are reported in Table 1 below; they fit the case of the candidate licensee rather than a generic Italian firm. According to

Table 1, the price is equal to the full cost of the patented medical device plus a mark up of 70%, whereas sales grow and costs drop as time goes by; moreover, marketing expenses are incurred to promote the medical device in the orthopedic community. The required rate of return is set at 10% per year, in line with the case of a mature business.

Price (€/unit)		= cost of production (1 + mark up)
Mark up (%)		70%
Cost of production (€/unit)	1st- 5th years	75
	6th -10th years	70
	11th -15th years	65
Marketing expense (€)	1st- 5th years	10.000
	6th -10th years	6.000
	11th -15th years	4.000
Number of units sold 1st year		400
Number of units sold, growth rate (%)	2nd-5th years	2
	6th-10th years	1
	11th-15th years	0
Required rate of return (%)		10
Time horizon (years)		15

Table 1. Data and forecasts about the candidate licensee.

Financial evaluation. The income approach is applied in Table 2, where a *pro-forma* income statement is projected for 15 business years in a row. Net cash flow is the same as net income, as depreciation is nought, the change in net working capital is disregarded, investment is nought, and an all equity financed firm is considered. Discounting the net cash flows at a 10% rate obtains a net present value of €86.021.

A sensitivity analysis is performed in Table 3. As sales are more uncertain than productions costs, marketing expenses, and the required rate of return, the number of units sold is given a 20% change, whereas the cost of production, marketing expense, and required rate of return are given a 10% change. According to Table 3, only the production cost (1st-5th years) and the number of units sold (1st year) matter. Indeed, they are the most critical forecasts, as they come along with the largest changes in the net present value, with all other forecasts having a much smaller impact on the net present value. As few forecasts are critical, forecasting proves to be a less demanding task than usually stated.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Price (€/unit)	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
Number of units sold	400	408	416	424	433	437	442	446	451	455	455	455	455	455	455
Proceeds of sales (€)	51.000	52.020	53.060	54.122	55.204	55.756	56.314	56.877	57.446	58.020	58.020	58.020	58.020	58.020	58.020
Production cost (€/unit)	75	75	75	75	75	70	70	70	70	70	65	65	65	65	65
Production cost (€)	30.000	30.600	31.212	31.836	32.473	30.611	30.917	31.226	31.539	31.854	29.579	29.579	29.579	29.579	29.579
Marketing expense (€)	10.000	10.000	10.000	10.000	10.000	6.000	6.000	6.000	6.000	6.000	4.000	4.000	4.000	4.000	4.000
Operating income (€)	11.000	11.420	11.848	12.285	12.731	19.145	19.396	19.650	19.907	20.166	24.441	24.441	24.441	24.441	24.441
Corporate tax (32%)	3.520	3.654	3.791	3.931	4.074	6.126	6.207	6.288	6.370	6.453	7.821	7.821	7.821	7.821	7.821
Net income (€)	7.480	7.766	8.057	8.354	8.657	13.019	13.190	13.362	13.537	13.713	16.620	16.620	16.620	16.620	16.620
Net cash flow (€)	7.480	7.766	8.057	8.354	8.657	13.019	13.190	13.362	13.537	13.713	16.620	16.620	16.620	16.620	16.620

Net present value at a 10% rate = 86.021 €

Table 2. Pro-forma income statements and discounted net cash flows.

		±10%	±20%
Cost of production (€/unit)	1st- 5th years	±23,79%	
	6th -10th years	∓5,80%	
	11th -15th years	∓3,42%	
Marketing expense (€)	1st- 5th years	∓3,00%	
	6th -10th years	∓1,12%	
	11th -15th years	∓0,46%	
Number of units sold 1st year			±29,15%
Number of units sold, growth rate (%)	2nd-5th years		+1,75%; -1,73%
	6th-10th years		± 0,59%
	11th-15th years		± 0,00%
Required rate of return (%)		-6,49%; +7,16%	

Table 3. Sensitivity analysis. Each entry is the percent change in the net present value due to the reported percent change in the corresponding forecast.

Reconciliation of values. The definition of the patent value follows from the negotiation between licensor and licensee, with the outcome of the income approach, €86.021, being a starting point.

Interestingly enough, the sensitivity analysis of Table 3 provides us with a range for the net present value. If the production cost (1st-5th years) and the number of units sold (1st year) are given a -10% and a -20% change simultaneously, the net present value takes its lower bound of €44.572; in contrast, if the production cost (1st-5th years) and the number of units sold (1st year) are given a +10% and a +20% change simultaneously, the net present value takes its upper bound of €135.656.

Therefore, although only the income approach has been applied, a worst case of the negotiation and a best one go along with the estimate of the net present value of the discounted net cash flows.

The net present value of the licence is to be split between licensor and licensee, with the contractual payments by the licensee taking the form of an upfront fee (or lump sum) and a stream of royalties. In principle, the upfront fee is a reward for the licensor’s previous efforts, provided that the technology is mature enough. According to a well received rule of thumb, the licensor should benefit from 25% of the forecast profits from the exploitation of the licence. Needless to say, a percentage other than 25% may be agreed upon by the 2 counterparts. In general, industry standards are a useful reference; they are the royalty rates set in previous comparable transactions, with some commercial databases being available (see Munari-Oriani, 2011, chapt. 9). However, as mentioned earlier, there are no similar medical devices on the market.

4. Final remarks

An outline of the 4 main approaches to the financial evaluation of technology-related intangible assets has been put forward, with their strengths and weaknesses being contrasted. Such a concise presentation has been complemented with a case study about the evaluation of a patented medical device, which is to be licensed. The latter was meant as an opportunity to have a feel for the relevant practicalities.

The case study has been based on the income approach only, as the other approaches proved to be not viable. The educated use of a sensitivity analysis has allowed us to show that few forecasts about the income statement are critical. As a consequence, a range of feasible values has been obtained for the outcome of the analysis, the net present value of the patent. As few forecasts are critical, forecasting proved to be a less demanding task than usually stated.

In our opinion, the resort only to the income approach is likely to be appropriate in general. As we have explained,

- the cost method has a limited scope, as it neglects all the benefits following from the exploitation of the technical asset under examination;
- the market method is unlikely to be viable, as comparable intangible assets can be hard to find;
- the real option method is too complex to use in practice.

As we have shown, the reconciliation of values, i.e. the 4th stage of the evaluation process can be replaced with a sensitivity analysis. As a consequence, one can tell whether the outcome of the analysis is reliable or not by checking whether the range of the net present value is small or large. Nonetheless, a question is still to be addressed: what actions can be taken and remedies can be found, when many forecasts turn out to be critical, with the outcome of the analysis being unreliable. This is left as an opportunity for future research.

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