Methodologies for Pricing Intellectual Property:

Application to a Solar Patent

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Abstract

One of the most valuable assets for companies originated from academia in the fields of technology are patents. Start-ups typically base their activity in scientific work and novelty technologic advancements and frequently use industrial property rights to protect their inventions. In contrast to most tangible assets, the value of intangibles such as trademarks, or patents, is harder to estimate. This work's objective is to contribute to this field by showcasing the application of a combined approach of Monte Carlo simulation and Real Options analysis to estimate the value of a patent acquired from EFACEC by Dyesol, an Australian solar company. The applied methodology derives the patent value from a series of positive cash flows considered to be a result of additional sales due to the patent, subtracted by its acquisition costs. In addition, the option to the delay the incorporation of the patented technology in the Dyesol production process thus postponing the royalty payment is also computed and added to the project value. The resulting Net Present Value (NPV) is compared to the value attributed to the patent by the stock market as measured by the difference in Dyesol's market capitalization after the press release of the transaction.

Keywords: Patent Valuation, Real Options, Monte Carlo, Solar Cells, Dyesol, FEUP, EFACEC

1. Introduction

Intangibles valuation in general and specially patent valuation constitute a challenge due to several reasons, for instance: i) patents are by definition unique and novel hindering a comparison with other comparable assets, ii) patents are frequently used in products/processes in fast shifting markets hurting the predictability of the income derived from the patent, and iii) the patent validity may be contested in Court adding more uncertainty to its value.

2. Case Presentation

In January of 2015, Dyesol, an Australian solar company agreed to acquire a patent from EFACEC. Dyesol is a pre-revenue company focused on trying to develop a commercial version of a perovskite solar cell (PSC). The patent covers a solar cell sealing technology with the potential to improve the durability and reliability of PSC. The price can reach € 5 million of which $ 2.8 million is a royalty paid when the product starts to be commercialized.

3. Literature Review

It is possible to organize the wide array of available methods into categories, Langrost et al. (2010) summarizes the methods for IPR valuation dividing these methods into two categories: quantitative approach methods, and qualitative approach methods. While the first approach relies on numerical data to output an economic value of the IPR, the qualitative approach perspective is based on the characteristics and the uses of the intellectual property.

In Flignor & Orozco (2006) and other similar literature quantitative approaches are grouped into four methods: cost-based method; market-based method; income-based method; option-based method.

In a case showcased by van Triest & Vis (2007), the authors use Monte Carlo simulation to estimate the value of a patent which is considered to be the difference between the Net Present Values (NPV) of the R&D project in two scenarios, one with and other without the patent protection. The input parameters are estimated from historical values or by the company's executive's experience.

Ernst et al. (2010) construct their valuation model based on the assumption that the patent will result in a reduction in operational costs from the viewpoint of the company that holds the patent. The approach consists on a Discounted Cash Flow of the licensing fees less the patent maintenance fees. The licensing fees are calculated based on the savings it can generate for the potential licensees.

Collan & Heikkilä (2011) also models a case of a cost reducing innovation and applies an income-based principal, but models each parameters as a triangular distribution with a best guess, pessimistic and optimistic values. This results in a pay-off distribution for the NPV which can be used to value of a real option. The income from the patent is assumed to come from licensing fees and from a competitive advantage.

4. Methodology

The model developed for the valuation is a combined approach of the income and option methods using stochastics variables for the cash flows estimation. The results of the model are computed using Monte Carlo simulation through an Excel add-in called @Risk developed by Palisade.

One of the underlying assumptions for the construction of the valuation model is that the patent, which provides more durability and stability to the solar cells, will improve the product quality, thus having the potential to generate sales. The patent value can be expressed as the difference in the Net Present Values (NPV) between the operating cash flows obtained with and without the patent.

$$Patent\ Value = NPV_{with\ patent} - NPV_{without\ patent} \qquad (1)$$

The difference between the two scenarios are i) the cost to acquire the patent and ii) the additional operating income generate by the surplus of sales. The patent value can be rewritten as:

$$Patent\ Value = PV_{additional\ operating\ income} - PV_{patent\ acquistion\ cost} \qquad (2)$$

The Net Present Value of the cost is calculated by discounting each scheduled payment to the present, i.e., when the agreement was sealed, 22 of January of 2015. Dyesol is an Australian company so any cash flow should be denominated in Australian dollars.

$$PV_{patent\ acquisition\ cost} = \sum_{t=0}^{m} \frac{payment_t \times AUD,EUR\ exchange\ rate}{(1+r)^t} \qquad (3)$$

The cash flows generated by the patent correspond to the added sales, subtracted by the associated costs (costs of goods sold, general and administrative expenses, etc.) and the patent renewal fees, plus the tax shield given by the reduction in the taxable income from the depreciation cost. Because the available market forecasts are provided in us dollars the cash flow map was developed in that currency so the final cash flow in each period t must converted as well.

$$PV_{additional\ operating\ income} =$$

$$\sum_{t=0}^{n} \frac{(\Delta Sales_n - \Delta Costs_n + Tax\ Shield_n - Patent\ Renewal\ Fees_n) \times AUD,USD\ exchange\ rate}{(1+r)^t} \qquad (4)$$

Since Dyesol is a pre-revenue company the traditional organic growth assumption could not be used. Instead Dyesol’s revenues will be estimated from the Building Integrated Photovoltaic (BIPV) market size. The market size shoud be obtained from market forecasts. Two other assumptions are used to calculate the surplus of sales: the PSC share in the BIPV market - to calculate Dyesol’s sales, and the percentage of additional sales. The first has a very high dregree of uncertainty because PSC is not commercially available yet. To account for this uncertainty different scenarios for this parameter should be tested. The latter assumption could be estimated from available customer surveys. The cost can be projected by using the average EBITDA margin in a peer group. The tax shield is given by:

$$tax\ shield = depreciation(1-t) \qquad (5)$$

The depreciation in each period is given by the patent book value in the beginning of the year divided by the remaing years of the patent. Renewal fees should be estimated based on the number of countries and classes covered.

Since there is a great amount of uncertainty in the problem the management option to delay the commercialization of the technology postponing the € 2.8 million royalty payment should have a noteworthy value. The case study draws a significant resemblance with Aswath Damodaran's Biogen example (Aswath Damodaran 2001). In his case study the company in question is trying to value the option to delay the development of a patented drug called Avonex which is already patented. The method estimates the present value of the cash flows from the sale of the product to be the strike of an American call option and the development costs as being the exercise price. Similarly, our case situation can be modeled by a call option of value C with a strike price equal to net present value of the operating income cash flows (S) generated from 2018 to 2029 and an exercise price equal to the royalty that has to be paid (E). Instead of using the industry average, since the model incorporates the uncertainty related with the project, it is more appropriate to use the variance (σ) from our models' Monte Carlo simulations than using industry averages. The yield used to incorporate the dividends when applied to stocks in this case represents the delay cost from not using the patent while its life is being reduced.

$$C = Se^{-yt}N(d_1) - Ke^{r_f}N(d_2) \qquad (6)$$

$$d_1 = \frac{ln\left(\frac{S}{K}\right) + \left(r_f - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \qquad (7)$$

$$d_2 = d_1 - \sigma\sqrt{t} \qquad (8)$$

$$y = \frac{1}{years\ until\ patent\ expires} \qquad (9)$$

Considering the additional value of holding the option to delay the commercialization of the technology the patent value should be updated to:

$$Patent\ Value = PV_{additional\ operating\ income} - PV_{patent\ acquistion\ cost} + Value\ of\ Option\ to\ Delay \qquad (10)$$

The calculation will result in a value or a set of reasonable values for the patent which must be compared to our market price. The market price will be given the increase in the market capitalization of Dyesol after the acquisition announcement.

5. Case Study

The Net Present Value of the project, given by subtracting the present value of the acquisition costs to the present value of the operating income cash flows plus the value of the option to delay, has a mean of AUD 245,699 for scenario A, AUD 2,772,513 for scenario B and 5,266,962 in scenario C (Table 1). The result of 2000 trials for each scenario reveals a significant dispersion expressed by substantial standard deviations (Table 2).

Table 1- Summary of the results

Project Net Present Value (mean values, AUD)			
Scenario	**A**	**B**	**C**
PV Operating Income	4 906 233	6 746 632	8 587 031
PV Acquistion Cost	6 436 624	6 436 624	6 436 624
Value of the option to delay	1 776 090	2 462 504	3 116 555
Net Present Value	**245 699**	**2 772 513**	**5 266 962**

Table 2 – Standard deviation for each scenario

Simulations Standard Deviations (AUD)			
Scenario	**A**	**B**	**C**
Standard deviation	8 303 073	12 436 211	17 528 404
Iterations	2 000	2 000	2 000

5.1. Sensitivity Analysis

The most critical parameters as measured by the impact in the mean Net Present Value are the EBITDA margin and BIPV market growth, for any of the scenarios. The EBITDA margin becomes increasingly important in time due to the sales increase while the BIPV market growth causes more impact earlier because its effect is multiplied by the growth in the following years.

Table 3 – Ranking of the inputs to which the NPV is more sensitive to

Rank	Input
1	EBITDA Margin / 2029
2	EBITDA Margin / 2028
3	EBITDA Margin / 2027
4	EBITDA Margin / 2026
5	EBITDA Margin / 2025
6	BIPV Market growth / 2021
7	BIPV Market growth / 2020
8	EBITDA Margin / 2024
9	BIPV Market growth / 2022
10	EBITDA Margin / 2023
11	BIPV Market growth / 2023
12	BIPV Market growth / 2026
13	BIPV Market growth / 2019
14	BIPV Market growth / 2024

The EBITDA margin sensitivity is especially problematic since from all the parameters included in the model it is the one which can vary the most. A value of 15% for the EBITDA margin would be admissible which would represent a 585% increase to the average of this parameter used in the model. It is not likely that any other input could realistically suffer such increase. Table 4 compares the impact of a 20% increase and decrease in the inputs with the least and the most impact on NPV, the EBITDA margin of 2019 and 2029 respectively. A small 20% drop or increase, about 0.5 percentage points, in 2029's result in a circa 80% impact on NPV.

Table 4 - Sensitivity analysis

	Variation in input	Variation in NPV
EBITDA margin 2029	20.0%	80.3%
	-20.0%	-80.3%
EBITDA margin 2019	20.0%	1.2%
	-20.0%	-1.2%

6. Conclusions

The application of a Discounted Cash Flow model using stochastic variables together with a real options approach resulted in valuation values in the same order of magnitude of the stock market valuation but still substantially different (86%, -64% and -211% compared to the mean values of scenario A, B and C). Such difference was expected given the uncertainty and sensitivity of the model.

This valuation method, in contrast with a simple income based approach, allows the incorporation of uncertainty and managerial flexibility to the model. However, given the underlying uncertainty of the case study the model is very sensitive to variations in its input parameters which negatively affects the confidence level with which the NPV outcomes can be interpreted.

This work also highlights many of the difficulties of patent valuation mentioned in the literature namely in the cash flow estimation for a technology that is novel and will be used in a market which has not matured. Many parameters used in the model are derived from the traditional solar industry, which bears the most similarity to the BIPV market, but is struggling to be profitable.

Another difficult task when using this approach is to balance the model complexity and its adequacy to reality: if one tries to incorporate every possible parameter in the model it will be difficult to use it as a management tool and take any conclusion, on the other hand, if it is too simplistic the predictions may not be the most accurate. In this case factors such as working capital investment, economies of scale from additional sales, the possibility of entrance of new players or competing technologies in the market, for example, were disregarded because it would be difficult to provide a good estimate for them.

The aforementioned conclusions suggest that in scenarios with a very high degree of uncertainty a more practical approach might be more suitable. However, when applied to more stable markets, in industries with higher predictability this approach should produce good results.

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