Valuation of Patents

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The Nature of Patent Valuation
Uncertainty about the value of Patents is nothing new.

“Patents are like lotteries, in which there are a few prizes and a great many blanks.”
Valuation of Patents

**Patent Value Distributions from Interview Data**

Pareto Plot of US Patent Values ($N = 10^10$) (Scherer 1997)

The top 8.5% of patents comprised c80% of total value

Patent Values are highly skewed distributions
Little worth Lots, Lots worth little

Patent Valuation presents a dilemma

- To be patentable an invention must be unique
  - “absolute novelty” is a requirement of most patent systems

But for many methods of patent valuation

- To be valuable an invention must resemble others of known value
  - when correlating patent specification characteristics with value
  - when searching for suitable spanning assets for option valuation
Resolved the dilemma?

Frank Knight (1921) distinguished between

- Risk: calculable - either ‘a priori’ or statistically
- Uncertainty: incalculable - due to unique & inexplicable characteristics

There are two ways of dealing with these:

- Insurance: classifies uncertainties to turn them into calculable risks
- Expertise: uses the results of experience to make better judgements

Insurance concerns: risks of loss

IP valuation concerns: risks of missing the few prizes in the lottery

- The same approaches to risk apply though

<table>
<thead>
<tr>
<th>IP Valuation requires either</th>
<th>Expertise &amp; Judgement</th>
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<tr>
<td>and/or</td>
<td>Classification and Calculation</td>
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IP Valuations

• **Top Down - Company Intellectual Capital**
  – Residual based accounting measures
    • Relies on market’s implicit valuation - no use for valuing individual patents

• **Bottom Up - Valuation of individual patents - in-house**
  – from measures based on measuring features of the patent specification.
    • Useful for analysing patents owned by others
    • Relies on patent’s author’s implicit valuation - can’t be used decide about one’s own patents

• **Bottom Up - Valuation of individual patents - in-house**
  – from conventional DCF &/or Option valuation
    • Useful for analysing all patents but may be complex and/or costly to implement
    • may involve need to make a trade-off sophistication and simplicity.
IP Valuation Objectives

Accounting
- Raising Finance
- Valuing IP for use as security for debt

Management

- External Transactions
  - Licensing / Purchase / Sale / Joint Ventures

- Internal Management
  - First Filing, Foreign Filing, Examination, Renewal, Investment

IP valuations ought to be as objective as possible
IP Valuation Information sources

- Internal Experts
  - Patent Attorneys
  - Inventors / R&D Managers
  - Business and Marketing Managers

- External Experts
  - Valuation consultants
  - Accountants

- Published Patent Specifications
  - reflecting Internal Expert opinion

- Public Market / Technology / Legal data
  - relates to different inventions / relates to the past

All IP valuation involves subjective compromises…
Valuing Patents
What is the value of a Patent? - Patent & Project value

- Value of fully commercializing the underlying Invention
  - a) in the presence of patent protection
  - b) in the absence of patent protection

- Value of the Patent per se = a) - b) for all embodiments
  - the value of the potential extra profits obtainable from fully exploiting the invention in the patent’s presence compared with those obtainable without patent protection.

Patent and Project value are often confused
- but Project values including the value of any Patents are more common.
Why Value Patents within a company?

Continuous decision making is necessary:

- Whether to file a patent application
- Whether to continue with a patent application
- Whether to keep a granted patent in force
- Where to allocate R&D expenditure
Valuation of Patents

Patent Management Decisions:

<table>
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<tr>
<th>TIME from 1st application (months)</th>
<th>Application Process</th>
<th>Decisions involving Valuation</th>
<th>Costs to be Justified</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>1st FILING</td>
<td>Decision to File Patent Application</td>
<td>Cost of Application</td>
</tr>
<tr>
<td>12</td>
<td>FOREIGN FILINGS</td>
<td>Decision to continue and make Foreign Applications</td>
<td>Initial Cost of Foreign Applications Cost of prelimExam’n and Search</td>
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<tr>
<td>c15</td>
<td>SEARCH</td>
<td>Decision to continue Application in the light of the Search Report</td>
<td>ContinuedCost of Application(s)</td>
</tr>
<tr>
<td>18</td>
<td>Publication</td>
<td>Decision to continue applications and seek examination</td>
<td>ContinuedCost of Application(s) Substantive Exam’n Fee</td>
</tr>
<tr>
<td>c24 +6</td>
<td>EXAMINATION</td>
<td>Decision to continue Application in light of Examination</td>
<td>ContinuedCost of Application(s)</td>
</tr>
<tr>
<td>54</td>
<td>GRANT</td>
<td>ANNually Decision to maintain Patent by paying renewal Fees</td>
<td>Renewal Fees</td>
</tr>
<tr>
<td>20 Years</td>
<td>EXPIRY</td>
<td>Sale, Licensing or direct exploitation of Patented Invention</td>
<td></td>
</tr>
</tbody>
</table>

Valuation of Patents
Patent Management Decisions are complex

Patent management decisions involve accounting for:

- legal uncertainty
- technological uncertainty
- market uncertainty
- uncertainties which vary over time
- many possible decision paths
- many possible final financial outcomes

Do conventional valuations account for these?
Valuation Methods - Ignoring Flexibility

Features Accounted for:

- Costs: Cost based methods
- Market conditions: Market based methods
- Income: Projected cashflows
  - Time: DCF Methods allowing for the time value of money
  - Uncertainty: DCF Methods allowing for the riskiness of cashflows
    - changing risk is usually ignored

Such methods all ignore the value of flexibility
Valuation Methods - Including Flexibility

Flexibility to: Abandon, Continue, Expand etc.

Features Accounted for:

- Flexibility: DCF based Decision Tree Analysis
  Changing Risk -> Discount Rate Problems

- Changing Risk: Option Pricing Theory
  
a) Discrete time: Contingent Claim Analysis

b) Continuous time: Black & Scholes option pricing model
Option Valuation
Options

Options:

- A right but not an obligation,
- at or before some specified time (*the expiry date*)
- to purchase (a *call* option) or sell (a *put* option)
- at a prespecified price (*the exercise price*)
- an underlying asset whose price is subject to some form of random variation.
- *European* options can only be exercised at expiry *American* options may be exercised before expiry

Share Options:

- The underlying asset is a share
- The share price can be modelled as a Brownian Motion.
Black & Scholes Call Option Pricing Formula

\[ C = S N \left( \frac{\ln(S/E) + (r + \frac{1}{2} \sigma^2) t}{\sigma \sqrt{t}} \right) - E e^{-r t} N \left( \frac{\ln(S/E) + (r + \frac{1}{2} \sigma^2) t}{\sigma \sqrt{t}} \right) \]

Option valuation only requires:

- **S**: Current price of the underlying asset
- **E**: Exercise price of the option
- **t**: Time to expiry
- **\sigma**: Standard deviation of the underlying asset returns
- **r**: Risk free interest rate.
- **N**: Distribution function for the asset price.

(Black & Scholes 1973)

The option value increases:

- The higher the underlying asset value
- The longer the time to expiry
- The lower the exercise price
- The higher the variance of the underlying asset returns
- The higher the risk free interest rate.
Valuing Real Options

Real Option valuation only requires:

- $S$: Current price of the underlying asset
  - $= \text{Present value of Project Cashflows}$

- $E$: Exercise price of the option
  - $= \text{Investment cost of Project}$

- $t$: Time to expiry
  - $= \text{time left to invest in}$

- $\sigma$: Standard deviation of the underlying asset returns
  - $= \text{standard deviation of the Project value}$

- $r$: Risk free interest rate

- $N$: Distribution function for the asset price
  - $= \text{distribution function for the Project value}$
Patents comprise Real Options

**Application Process**
- Inventor & Patent Agent discuss invention and its Patentability
- 1st FILING
- FOREIGN FILING
- SEARCH
- Publication
- EXAMINATION
- GRANT
- EXPIRY

**Decisions involving Valuation**
- Decision to File Patent Application
- Decision to continue and make Foreign Applications
- Decision to continue Application in light of the Search Report
- Decision to continue applications and seek examination
- Decision to continue Application in light of examination
- ANNUALLY Decision to maintain Patent by paying renewal Fees
- Sale or Licensing of Patent

**Costs to be Justified**
- Cost of Application
- Initial Cost of Foreign Applications Cost of prelim Exam'n and Search
- Continued Cost of Application(s)
- Continued Cost of Application(s) Substantive Exam'n Fee
- Continued Cost of Application(s)
- Grant Fee(s)
- Renewal Fee(s)

**What Cost Buys**
- Application + Call Option on Foreign Appl'ns + Call Option on continuation
- Continuation + Foreign Applications + Call option on further cont'n
- Continuation + Call option on further cont'n
- Continuation + Call option on further cont'n
- Continuation + Call option on continuation
- This year's monopoly benefits + Call option on next year's
- This year's monopoly benefits + Call option on next year's (except final year)

Consideration as a put option to abandon is also possible
Potential Problems

• Assessing the volatility of returns to a patent
  – Does an asset of similar and known volatility exist?

• Determining the patent value distribution functions
  – Is assuming them to be lognormal adequate?
  – Scherer’s work suggests a paretian value distribution

• Accounting for any variations in the volatility

• Accounting for compoundedness interactions
  – Options on Options can interact and are complex

• Accounting for any interim cash inflows

• Assessing the present value of patent cashflows
  – How to account for the value of the patent per se
Valuation of Patents

**Practical Implications**

- Importance of the Option component of patent value
  - option values critical in early patent life & less so later
  - conservative filing / early renewal decisions justifiable
  - “When in doubt, file an application” (Grubb 1982)

- There will come a time for patents not producing current
  returns when the option value is too small to justify renewal

- Foreign filing decisions need to account for the fact that patents represent options on
  potential future market values which may be considerable in rapidly developing foreign
  markets

- Some patent systems increase patent application value
  - the option to defer examination in Japan (nb now 3 not 7 years)

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Option based valuation methods are now in commercial use e.g. PL-X.com
Valuation of Patents

**Examples of Implicit Real Options**

- Delays in paying national fees obtainable through using PCT applications
- Increasing value of Utility Models by subdividing renewal periods for renewal
  - How to divide European Utility Model renewal periods has been a subject of debate
- Systems allowing delays of almost any kind e.g. delayed examination systems
- Former “Submarine” patents
- Systems which confer an option to amend an application at some later date
- Speculative applications
  - made on the basis that future changes in interpretation or law will broaden protection
- Systems allowing opportunities to abandon applications or rights and avoid costs.

**Implicit Real Options are an often unrecognised part of IP Systems. They need to be considered in formulating IP policy and laws.**
Future Research
Future Research

- Define patent valuation problems in option pricing theory terms

- Quantify the key factors necessary for valuation
  - the variance of returns to patents
  - the current value of the patents
  - distribution functions which model patent returns

- Identify any potential complications (e.g. varying variance, compoundedness, etc.) & any justifiable simplifying assumptions

- Compare real option pricing methodology with existing less sophisticated methods to establish where the benefits are greatest

- Provide simple means for the practical application of the ideas to everyday patent and patent application valuations - Decision Triggers

Patent Valuation is not optional but inherent in patent management decisions and inherently about Options