Valuation of R&D Intangibles – A Physicist’s Approach

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# Chemistry/Physics and valuation: some similarities

- Chemical transformations
- Added value etc.

- Mass and Energy Flows
- Cash Flows
- «What goes in goes out or accumulates»
  - Cash balances/NPV
  - Compare «with deal» vs. «without deal»
  - Future cash flows

- Conservation Principles
  - Material/Energy balances
  - State Functions
  - Forward-looking predictions
  - «What goes in goes out or accumulates»
  - Cash balances/NPV
  - Compare «with deal» vs. «without deal»
  - Future cash flows

- Thermodynamics/Stat Mechanics
  - Probabilities
  - Sensitivity to initial conditions
  - Entropy
  - Non-linear systems
    - Turbulence
    - Chaos
  - Probabilities/Discount rates
    - First years hypothesis/growth rates
    - Money & Information
    - e.g. Production Functions
      - Information & Money
      - Turbulence theory applied to Stock Price
A typical Company
Functional Analysis: Customers, Business and R&D

Business funds R&D

R&D generates Results

Business Acquires Intangible
So what?

• Many parameters and assumptions are needed for (R&D) Intangible Valuations
• Most commonly, future cash flows are deduced from (some) functional analysis
How to analyze the discount rates?

• Basic hypothesis: different risks (on cash flows) imply different discount rates
  
  • Example 1: R&D costs cash flow:
    • Decided by management
    • Bears a risk comparable to that of the whole business
    • Discount rate: \( r_L \) - e.g. WACC or a little bit lower
  
  • Example 2: R&D-generated value creation
    • Function of future markets behaviour
    • Function of the success of R&D (an Innovation Projects Portfolio’s typical success probability: is around 20-50%)
    • Discount rate : \( r_H = r_L + \Delta r \)

• The present approach to compute \( \Delta r \)
  • Analyze two comparable settings (Material/Cash Balances)
  • Equate the relative NPVs (Conservation Equation)
  • Deduce a first-order approximation (Asymptotic behaviour)
Analysis scheme

• Arbitrarily split the R&D/Business model in two separate components
  • Each R&D component operates in close relationship with the other
  • Each R&D component generates results for each of the separate Business components

• Compare two situations (I) vs (II)
  • (I) : Dual-licensor/licensee:
    • Each Business ([A] resp. [B]) licenses the results of its’ controlled R&D operation [A] resp. [B])
    • Each Business is licensed by the other ([B] resp. [A]) for the results generated by the other R&D component ([B] resp. [A])
  • (II) : [A] fully finances the whole [A]+[B] R&D operation, and licenses [B] for the results

• The R&D and Business people do not notice the difference between (i and (II) on a day-to-day basis (management and operation unchanged)
Analysis: let us split arbitrarily the activities
The IP & R&D costs cash flows in situation (I): dual licensor

- R&D Costs
  - Rh [A] R&D
    - IP [A] R&D creates
  - IP [A] to [A]
    - IP [A] Uses
    - [A] Business
        - IP [B] to [A]
        - IP [B] R&D creates
  - IP [B] Uses
    - IP [B] to [B]
      - [B] R&D
        - R&D Costs
“Net IP” brought into [A] from [B]

• The total IP generated in [A] R&D benefits both [A] and [B]

• The total IP used by [A] comes from [A] R&D and [B] R&D

• Taking the difference:
  The net IP flow to [A] is equal to the difference between the total IP used by [A] and the total IP generated by its R&D.

This relationship allows to compute the “Net Royalty Due by [A] to [B]” (>0 or <0) without having to compute the individual IP flows, which is generally very difficult.
The R&D costs and IP flows under situation (II): single licensor

Transaction #1
[A] pays [B] a Royalty

Transaction #2
[B] pays R&D

[A] gets IP it uses

[B] gets IP it uses

Closed Box

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Comparison of the two situations for [A]

• Situation (I) : double Licensor
  • [A]’s R&D creates a value V
  • [A] fully funds its R&D
  • [A] owes to [B] the « Net Royalty Due » = IP used by [A] – IP created by [A]’s R&D
    \[ \text{Ebitda } [A] = X - (\text{IP used by [A]} - \text{IP created by [A]’s R&D}) \]

• Situation [(II): single licensor
  • [A]’s R&D creates a value V
  • [A] gest reimbursed by [B] of its R&D Costs RD[A]
  • [A] pays to [B] a royalty R, which value is determined by [A]’s IP usage
    \[ \text{Ebitda } A = X - R + RD[A] \]

• Both situations are equivalent when, on an NPV basis;
  \[ X - R + RD[A] = X - (\text{IP used by [A]} - \text{IP created by [A]’s R&D}) \]

Since R = IP used by [A], this simplifies to \textbf{IP Created by [A] = RD[A]}

Since the original split was arbitrary; this should hold for any split; in particular, for the whole initial business
\textbf{IP Created by the whole business is commensurate with Total R&D costs}
Some mathematical considerations

• Closed box

• Equality sign is a leading order approximation of « real world » values
  • Integration in time form a given date has to be done: all values are NPVs
  • The situation being analyzed supposed stationary cash flows

• To compute the value of an asset at a given time, the relationship holds only
  at times when all pre-existing IP has been replaced by a new one

• Practically, simple situation:
  • A constant % R Royalty vs Sales represents value creation
  • Value creation lasts M years after stop of R&D spendings
  • Cash flows are growing at a constant rate g from t > N years
  • Several g’s can be assumed; for simplicity, only one is used here

\[
\frac{\%_R}{r_L+\Delta r-g} \left[ 1 - \left( \frac{1+g}{1+r_L+\Delta r} \right)^{N+M} \right] - \frac{R&D/Sales}{r_L-g} \left[ 1 - \left( \frac{1+g}{1+r_L} \right)^N \right] \]

\[
N \to +\infty \iff \Delta r \sim (r_L - g) \left[ \frac{\%_R}{R&D/Sales} - 1 \right]
\]
Examples - 1

- Veritas Corp. Vs IRS – Dec 10, 2009

- Cost Sharing Agreement – Initial Buy-in Payment
  - IRS: $2.5 Billion then $1.7 Billion
  - Taxpayer: $100-$200 Million ($94M - $315M)

- Contested assumptions
  - Royalty Rate
  - Discount Rate (IRS=14%)
  - Terminal Value
  - Trademarks Value

Rapid evaluation from asymptotic formula:
  - IRS is wrong (14% DR)
  - An even higher Discount Rate (24%) makes sense
Examples - 2

- **Real Purchase Price Allocation exercises**
  - Valuations by external assessors
  - Compute pre-existing and in-development IP
  - Discount rates computed from CAPM models (*)
  - This model based on
    - Before/after purchase comparison and asymptotic discount rate formula
    - Assumes purchaser continues to fund R&D forever (simple perpetuity formulas)

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- **CAPM uses Beta to compute the « risk premium » Δr**
  - Beta = covariance of rate of return « asset » vs « portfolio »
Conclusion and Path Forward

• Conclusions
  • Simple model to determine discount rates of risk-carrying assets
    • Based on few assumptions, mainly conservation of value
    • Ab-initio (mostly analytical) computations give results analogous to more detailed models
  • Allows short-cut rapid order-of magnitude assessments
  • Critical issue is assessment of value creation
    • Residual Profit Methods
    • Direct assessment of R&D portfolio
  • Other examples welcome

• Path forward
  • Study consequences
    • Quick tests on %Royalties etc.
  • Release stationnarity
    • Time-lag between spendings and IP usage
    • In-service ramp-ups
  • Introduce risk-assessment
    • Insurance-type risk premiums for R&D
    • Monte-Carlo simulations
  • Etc…. 
Example of Monte-Carlo simulation

- Non-decided cash flows (example: revenues) are random
- Monte-Carlo simulations