REAL OPTIONS GROUP
Creating Value Through Flexibility!

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Valuation of Pharma R&D /Patent Rights
(Flexibility to Abandon Drug Development and Expand the Market)
Three-step Real Options Valuation Process

Introduction

I. Problem Structuring
II. Evaluation
III. Action Plan

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Introduction

- The Problem
- Background
- Project Milestones
- Management
- Strategy/Concerns
- Main Alternatives
The Problem

- Evaluate R&D investment (or patent rights) for a pharma drug (solving formation of antibacterial resistance that reduces efficacy of cures from long-term treatment)

Purpose:
- Value opportunity to invest in last stage of clinical trials
- Understand interactions among options to abandon development and expand the market
Background: The Company and its Strategy

- Glaxo is a pharmaceutical firm aimed to be world-wide leader in the research, development and marketing of drugs for human consumption.

- Since 1980, Glaxo concentrated its activities on prescription drugs, focusing its skills & resources on the development of safer and more effective drugs.

- An area of focus where Glaxo can have competitive advantage is antibiotics.
### Background: List of Products

<table>
<thead>
<tr>
<th>Launch Date</th>
<th>Drug</th>
<th>Therapeutic Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Flixotide</td>
<td>Respiratory</td>
</tr>
<tr>
<td>1993</td>
<td>Zofran</td>
<td>Antiemetic</td>
</tr>
<tr>
<td>1991</td>
<td>Imigran</td>
<td>Antimigraine</td>
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<tr>
<td>1991</td>
<td>Lacipil</td>
<td>Antihypertensive</td>
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<tr>
<td>1991</td>
<td>Cutuvate</td>
<td>Dermatological</td>
</tr>
<tr>
<td>1990</td>
<td>Serevent</td>
<td>Respiratory</td>
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<tr>
<td>1990</td>
<td>Flixonase</td>
<td>Antirhinitic</td>
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<tr>
<td>1987</td>
<td>Zinnat</td>
<td>Oral antibiotic</td>
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<td>1987</td>
<td>Volmax</td>
<td>Respiratory</td>
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<tr>
<td>1983</td>
<td>Fortum</td>
<td>Injectable antibiotic</td>
</tr>
<tr>
<td>1981</td>
<td>Zantac</td>
<td>Antiulcerant</td>
</tr>
<tr>
<td>1978</td>
<td>Zinacef</td>
<td>Injectable antibiotic</td>
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<tr>
<td>1977</td>
<td>Trandate</td>
<td>Antihypertensive</td>
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<tr>
<td>1975</td>
<td>Beconase</td>
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<td>1973</td>
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<td>1969</td>
<td>Ventolin</td>
<td>Respiratory</td>
</tr>
<tr>
<td>1964</td>
<td>Betnovate</td>
<td>Dermatological</td>
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</table>
Background: Therapeutic Problem

- Shortly after starting antibiotics in therapy, bacteria mutate faster producing enzymes that inactivate the drug reducing its therapeutic value ("b-lactamase" process)
- Glaxo’s research labs isolated a new synthetic compound (Tribactam) to prevent this effect
- The development enhances Glaxo’s strategy to be a leader in antibiotics
Project Milestones

1. Primary Research
2. Patent Filing
3. Pre-clinical Tests
4. 1st Stage Trials
5. Patent to Group
6. Transfer of Technology
7. 2nd Stage Trials
8. 3rd Stage Trials
9. Regulatory Approval
10. Launch Oral

Timeline:
- 1992: Primary Research
- 1994: Patent Filing
- 1995: Pre-clinical Tests
- 1996: 1st Stage Trials
- 1998: Patent to Group
- 2000: Transfer of Technology
- 2003: 2nd Stage Trials
- 2004: Regulatory Approval
- 2005: Launch Oral
The Patent Process

<table>
<thead>
<tr>
<th>Filing of patent application in United Kingdom</th>
<th>Completion of ascertainment of the compound's prerequisites and deadline for presentation of claims, if any</th>
<th>Publication of patent application: within 18 months competitors must file counter-applications, if any</th>
<th>After this, the newly discovered compound becomes technical, i.e., is produced by ordinary commercial processes</th>
<th>Granting of patent</th>
</tr>
</thead>
</table>

18 months after publication of the patent application, the patent is granted.

After this, the newly discovered compound becomes technical, i.e., is produced by ordinary commercial processes.
Project Milestones (A): Primary Research Stage

Medical Needs
Market Research
New Ideas
Financial Evaluation
Sensitivity
Computer Modeling

RESEARCH PROGRAM

RESEARCH PROJECTS

POTENTIAL CANDIDATES FROM SCREEN

Confirm Activity
Synthesis
Acute Toxicity
General Pharmacology
Genetic Toxicity
Patents

CANDIDATE DRUG

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Project Milestones (B): Exploratory Development Stage

CHEMISTRY
(Prepare raw drugs)

- TOXICOLOGY (Drug Safety)
- BIOCHEMICAL PHARMACOLOGY
- PHARMACY RESEARCH (Formulation)
- ANALYTICAL RESEARCH (Quality, Stability, Properties)
- MICROBIOLOGICAL PHARMACOLOGY

CLINICAL PHARMACOLOGY
(Profile on Volunteers)
PHASE I

FULL DEVELOPMENT

CLINICAL RESEARCH
(Profile on Patients)
PHASE II
Project Milestones (C): Full Development Stage

- Passing of PRE-CLINICAL TESTS
- Long-term Toxicology
  - CLINICAL TRIALS (Completion of PHASE II & III)
    - Primary Production
    - Secondary Production

APPLICATION FOR REGISTRATION

- PREPARE FOR LAUNCH
- LINE EXTENSIONS?
Management Comments/Concerns

CEO: “We are faced with fundamental questions which affect the whole project's structure. For instance, we have not yet solved the issue of the timing and sequence of launches”

Finance Director: “I often find myself having to make conditioned forecasts. For example, if the drug were also developed in an injectable dosage form, we could exploit the hospital channel as well, thus expanding our target market. As you can imagine, the project's value would increase enormously! So, which evaluation should I submit to our friends in London?”
CEO: “I think that optimizing the project value along the way is one of our most critical tasks. For example, the ability to postpone injectable form puts a tremendous source of flexibility in our hands!”

Project Manager: “What we need is to account for flexibility! It is simplistic to reduce a project with a complex, uncertain and contingent structure to a series of annual cash flow estimates”

CEO: “So, in the end, is there any way to see part of the uncertainty in a favorable light?”
Main Alternatives: Marketing Strategy

- Launch both oral (solid) and injectable version at same time (2005)

- Launch injectable version one year later (2006). Less risk since oral has wider market use; more informed expansion into injectable (hospital)
I. Identify Main Value Drivers

- Main risk driver is demand uncertainty (units sold) of oral (solid) version ($V = \text{PV cash inflows from oral launch}$)
- But management intervention/optionality to reduce downside risk and expand upside
  - Option to abandon (put) during 3rd stage (or sell rights to biotech firm)
  - Option to expand (call) into hospital market (launch injectable version) within a year following successful launch of oral version
I. Project Timeline (Milestones)

- **2000**: Begin 2nd stage of clinical trials (in humans)
- **2003**: Develop 3rd stage of clinical trials (if 2nd stage success) or abandon (sell rights to biotech)
- **2005**: Launch oral (solid) version to capture broad market base
- **2006**: Expand into hospital market with injectable form (if oral is successful)
I. Glaxo’s Decision Map

BEGIN 2nd STAGE  
$I_2 = 7.8$

DEVELOP 3rd STAGE  
$I_3 = 63.1$

LAUNCH ORAL

DEVELOPMENT PHASE

COMMERCIAL PHASE (Life = 6 years)

Technical uncertainty

Max(R-I_3, S)

Market demand uncertainty

Max (eV-I_e, 0)

ABANDON (SELL)

S = 5

0 2000

3 2003

5 2005

6 2006

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I. Specifying Options: Option to Abandon

- In 2000 project can be abandoned during development if PV from continuing (R) is less than planned (3rd-stage) investment (I₃) or if salvage value (S) (e.g., from selling rights to biotech firm) is higher.

\[
\text{BENEFITS FROM ABANDONING} \quad \text{Max} (R - I₃, S) \quad \text{or} \quad S + \text{Max}(R - (I₃+S), 0)
\]
I. Specifying Options: Option to Expand

- Success of oral (solid) version would enhance company image as leader in this antibiotics field and leverage expansion into hospital market (with injectable version)
- By investing extra costs (Ie) can expand (into hospitals) by e%

\[ R = V + \text{Max} \left( eV - Ie, 0 \right) \]

EXPANSION COSTS (Ie)

- Completing trials
- Filing costs
- Resetting facilities
- EXPAND (Injectable) e % of V

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I. Option Interactions

- Option to abandon planned 3rd stage development (or sell for salvage value) depends on follow-on option to expand (injectable)

There are states where project has negative NPV but is worth investing to capture value of option to expand later

- Exercising abandonment kills option to expand later
I. Option Interactions

- Begin 2nd stage
- Develop 3rd stage
- Launch Oral
- Expand Injectable
- End

- 2000
- 2003
- 2005
- 2006
- 2010

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Phase II. Evaluation

- DCF Analysis
- Option Inputs
- Results
- Sensitivity
- Value Breakdown

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II. Primary Input Data (DCF)
Estimates: Oral Version (Base-case)

- Unit price (P) = £1.90 until 2008, £2.00 after
- Project life (T) = 6 years (withdrawn 2011)
- COGS = 35% of Revenues
- Tax rate = 33% (of EBIT)
- WACC = 12%
- Depreciation: straight-line (£1.7 m/year)
- PV of capital expenditures (I₀) = £65.5 m, broken down as:
  - £7.8 m (2nd stage) in 2000
  - £63.1 m (3rd stage) in 2003
II. DCF (NPV) Analysis

**Base-case: NPV = -2.7**

Reject?

<table>
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<tr>
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<td>- DEPRECIATION</td>
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<td>CHANGE IN NET WORK CAP</td>
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<td>56,0</td>
<td>69,0</td>
<td>74,0</td>
<td>58,3</td>
</tr>
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</table>

**Present Value of cash inflows (V)**: 62,9

**Present Value of costs (I₀)**: -68,5

**NPV = V - I₀**: -2,6
II. Cash Flow Profile (Timeline)
II. Additional (Option) Input
Estimates

- Volatility (std dev) = 35%
- Riskless interest rate = 3%
- Salvage value = £ 5 m
II. Additional (Option) Input Estimates: Option to Expand (Launch Injectable)

- Expanded project value (with expansion option): \( R = V + \text{Max}(eV - I_e, 0) \)

- \( V = \) underlying project value (oral) following random walk \((V_0 = £62.8)\)
- \( e = 0.6 \) (60% expansion rate) [estimated by marketing department]
- \( I_e = £32 \text{ m} \) (follow-on cost to add capacity)
II. Additional (Option) Input Estimates: Option to Abandon During Development (or Abandon for Salvage/ Sell to Biotech)

- Project value with abandonment option: \( R' = \text{Max} (R - I_3, S) \)

\( R = \) value if continue development (including option value to later expand)

\( I_3 = £63.1 \) m (3rd stage development costs that can be abandoned)

\( S = £5 \) m (resale value guaranteed by a biotech firm interested in acquiring the scientific results)
II. Numerical (Binomial) Valuation Model (Accounting for Option Interactions)

Max (R - I₃, S) or S + Max(R - (I₃+S), 0)

R = V + Max(eV - Iₑ, 0)

ORAL (ONLY)

S (SALVAGE)

CONTINUE DEVELOPMENT

EXPAND

ABANDON

Begin 2nd stage
Develop 3rd stage
Launch Oral
Expand Injectable
End

2000  2003  2005  2006  2010
II. Results

Expanded NPV = +26.6

Real Option Value (ROV)

29.3

Base-case NPV

-2.7

E-NPV = Base-case NPV + Real Option Value = +26.6

😊 ROV makes the project worthwhile

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II. Impact Analysis/
Sensitivity to Primary Value Drivers

- Impact Analysis (view Bar Chart)
- Sensitivity of E-NPV to primary value drivers (know what variables to focus on)
  - Gross project value (driven by demand)
  - Volatility
  - Capex (2nd and 3rd stage development costs)
  - Expansion scale (e)
  - Salvage value
II. Sensitivity of Total Project Value (Expanded-NPV)

Sensitivity of E-NPV to relative changes in input parameters

- Interest rate
- Volatility
- Invest.1
- Invest.2
- Invest.3
- Expansion factor
- Gross project value

Relative change in input parameter

E-NPV

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II. Value Contribution/Breakdown (Incremental Value of Each Option/Strategy)

- Base-case NPV: -2.7
- Ability to Abandon: 14.7
- Option to Expand: 14.6

TOTAL VALUE: 26.6
II. Option Interaction (Breakdown)

Abandonment depends on expansion option.

- Exercising abandonment kills expansion.

SUM 31.7

Combined ROV
29.3

Expand
17

Abandon
14.7

-2.4
II. Option Interaction

- ABANDON
- EXPAND

Begin 2nd stage
Develop 3rd stage
Launch Oral
Expand Injectable
End
Phase III. Implementation/Action Plan

- Recommendations
- Contingent Decision Plan
- Operating Policy
III. Recommendation
(Based on E-NPV, Confidence Profile & Sensitivity Analysis)

- Now (2000) Glaxo should invest in the second stage of clinical trials
- In 2003, after technical uncertainty is resolved, Glaxo can decide whether to abandon based on the continuation value, the 3rd stage investment cost estimate, and resale value (to Biotech)
- In 2006, after knowing market demand for the oral (solid) version, Glaxo can decide whether to expand into the hospital market with injectable version
III. Contingent Decision Plan

BEGIN
2nd STAGE
I₂ = 7.8

Technical uncertainty
Max(R-I₃, S)

DEVELOP
3rd STAGE
I₃ = 63.1

LAUNCH
ORAL

Market demand uncertainty
Max(eV-Iₑ, 0)

ABANDON
(SELL)

EXPAND
(INJECTABLE)
Iₑ = 32

eₑ = 0.6

DEVELOPMENT PHASE

COMMERCIAL PHASE (Life = 6 years)

0 3 5 6
2000 2003 2005 2006

Max(R-I₃, S)

Max(eV-Iₑ, 0)

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Trigger values for the Abandon (year 2002) and Expand Decision (year 2005)
III. Musts for Capturing Option Value

- Assign management/team to monitor trigger decisions and exercise options
- Reassess value at future critical milestones
- Align managerial incentives to support/reward optimal exercise of major real options