A Quantitative Macroevolutionary Approach to Exploring the Pharmaceutical Drug Crisis

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The Pharma “Productivity Crisis”

IS THERE A PRODUCTIVITY CRISIS IN PHARMACEUTICAL R&D?
Massimo Riccaboni, Professor of Economics and Management, University of Trento, Trento, IT

Is the Pharmaceutical Industry in a Productivity Crisis?
Iain M. Cockburn, Boston University and NBER

Researchers say pharmaceutical ‘innovation crisis’ is a myth
Updated: AUGUST 10, 2012 — 10:12 AM EDT
A macroevolutionary approach

• Examining productivity is a question of diversification
  – Innovation = Origination
  – Discontinuation = Extinction

• Research Questions
  – What is the rate of drug origination and extinction over the history of the drug industry?
  – What are the main factors that influence origination and extinction rates?
Data

- **Drugs@FDA**
  - Online database of all FDA approved drugs
  - 1,263 New Molecular Entities (NMEs)
    - 1,092 drugs used in our analysis (completeness)

- **Origination** = FDA approval date for a New Drug Application

- **Extinction** = Date of last correspondence from FDA for discontinued drugs
  - No extinction date for existing drugs (85%)
<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Sponsor</th>
<th>Origination Date</th>
<th>Extinction Date</th>
<th>ATC</th>
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<tr>
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<td>acarbose</td>
<td>Bayer</td>
<td>20.33</td>
<td>0</td>
<td>A10BF01</td>
</tr>
</tbody>
</table>

*Dates are in years from present*
An occurrence based approach

• Model drugs as stratigraphic lineages with the approval and discontinuation dates as the times of first and last occurrence

• Advantages to cultural evolutionary research
  – Dates of origination and extinction are easier to obtain and more reliable than trait list
  – Does not require constructing a tree topology
  – Models rates in continuous time
• Jointly estimates rates of origination and extinction from occurrence data

• Utilizes a birth-death model
  – More accurately reflects process of innovation

• Can compare correlations between various factors that might influence diversification rates
  – PyRate Continuous
• What factors might influence rates of origination?

1. Research & Development
2. # of Drug Companies
3. # of Existing NMEs
4. # of Prescriptions Filled
5. # of New Drug Applications
6. Medicaid Enrollees
• What factors might influence rates of origination?

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Conclusions

• What is the rate of drug origination and extinction?
  – Declining origination rate, stable extinction rate

• What are the main factors that influence origination rates?
  – Research and Development costs

• Not a “innovation crisis” but a soaring R&D cost crisis
Contributions to Cultural Evolutionary Research

• A quantitative & model-based perspective on the dynamics of diversification
  • Incorporates both origination and extinction
  • Can better utilize the growing amount of “big” cultural data

• Ability to test specific hypotheses about what might be influencing these diversity dynamics
Questions?

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