Council for Chemical Research

CCR – A Leadership Organization

Improving Chemical Innovation Through Collaboration and Advocacy

Assessing the Economic Impact of Nanotechnology

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Council for Chemical Research

The Council for Chemical Research (CCR) was created in 1979 to improve trust and collaboration between the public and private research sectors.

- Represents research leadership in 3 sectors
  - *Industry, Academia, Government Labs*
- Institutional members, represented by thought leaders who can influence policy and practice
- 501(c)(3) “not-for-profit” corporation

Improving Chemical Innovation Through Collaboration and Advocacy

CCR Studies

- **Results were published in 3 reports:**
  - ***"Measuring Up: R&D Counts for the Chemical Industry"*** *– 2001*
  - ***"Measure for Measure: Chemical R&D Powers the U.S. Innovation Engine"*** *– 2005*
  - ***Assessing and Enhancing the Impact of Science R&D in the United States: Chemical Sciences*** *–* 2010

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CCR Study: Phase I

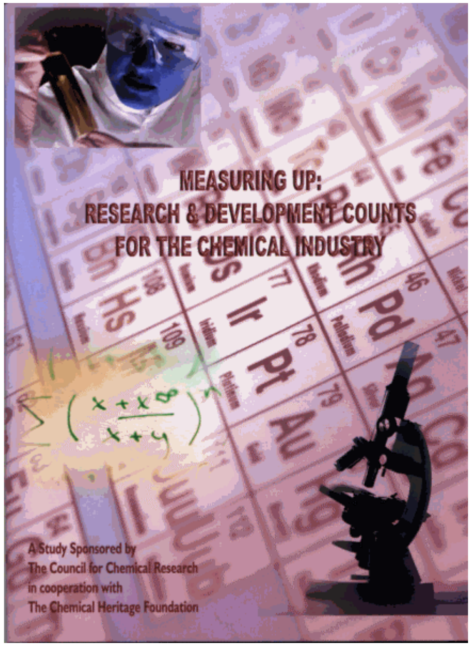
Measure the impact (return or payoff) of chemical research and development

- Provide comprehensive and quantitative results
- Use leading edge methodologies
  - Econometric production function (Dr. Baruch Lev, NYU)
  - Bibliometric analysis (Dr. Francis Narin, CHI Research, now ipIQ)

Phase I Results

- **$2 Operating income per $1 R&D invested**
  - **17% after tax return**
- **Publicly funded science links highly to chemical patents, 6 citations per patent**

"Measuring Up: R&D Counts for the Chemical Industry"



Phase II Questions

1. What are the financial payoffs for technology quality, innovation speed and strong scientific links?

2. What industries are significantly impacted by the chemical sciences?

3. How long does it take for public funded science to yield commercial innovation?

"Measure for Measure: Chemical R&D Powers the U.S. Innovation Engine"

Approach to Question 1

What are the financial payoffs for technology quality, innovation speed and strong scientific links?

Determine any correlations between chemical companies' patent holdings and their financial performance

Financial measures included:

- **Sales**
- **Market to book value**
- **Stock price**

Bibliometric methodology (Patrick Thomas and Michael Albert, ipIQ)

Patent Portfolio Indicators

Current Impact Index (CII)

– a measure of the impact of a company's patents, based on how frequently its patents are cited by subsequent patents

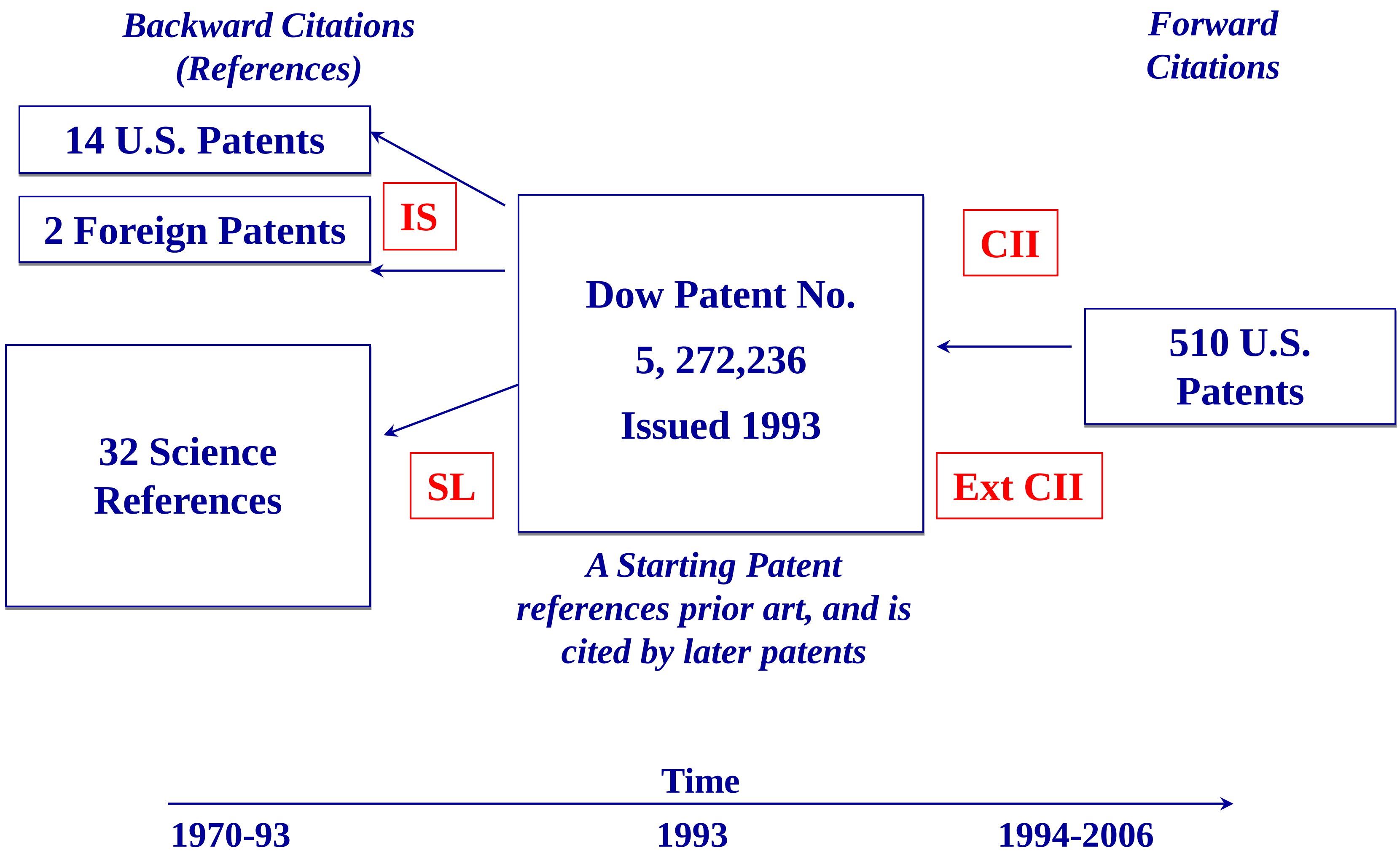
Science Linkage (SL)

– average number of citations a company's patents make to scientific papers, a measure of its links to scientific research

Innovation Speed (IS)

– measures median age of the patents cited by a company's patents, an indicator of its speed of innovation

Introduction to Patents and Patent Citation Analysis



Strong Technology Pays Off

Chemical companies with strong patent portfolio indicators tend to exhibit consistently strong financial performance, such as higher stock market valuations (35-60% higher on average)

- **Correlation between CII (patent impact) and financial performance is particularly strong**
- **Correlations between financial performance and SL (science linkage) and IS (innovation speed) are also positive**

Approach to Question 2

What industries are significantly impacted by the chemical sciences?

Examine patent database to determine which industries

- **Patent chemical technology vs. other technologies**
- **Reference chemical technology patents vs. other technology patents**
- **Reference chemical science literature vs. other sciences**

Bibliometric methodology (Michael Albert, Diana Hicks and Peter Kroll, ipIQ)

15 Industries (1151 companies)

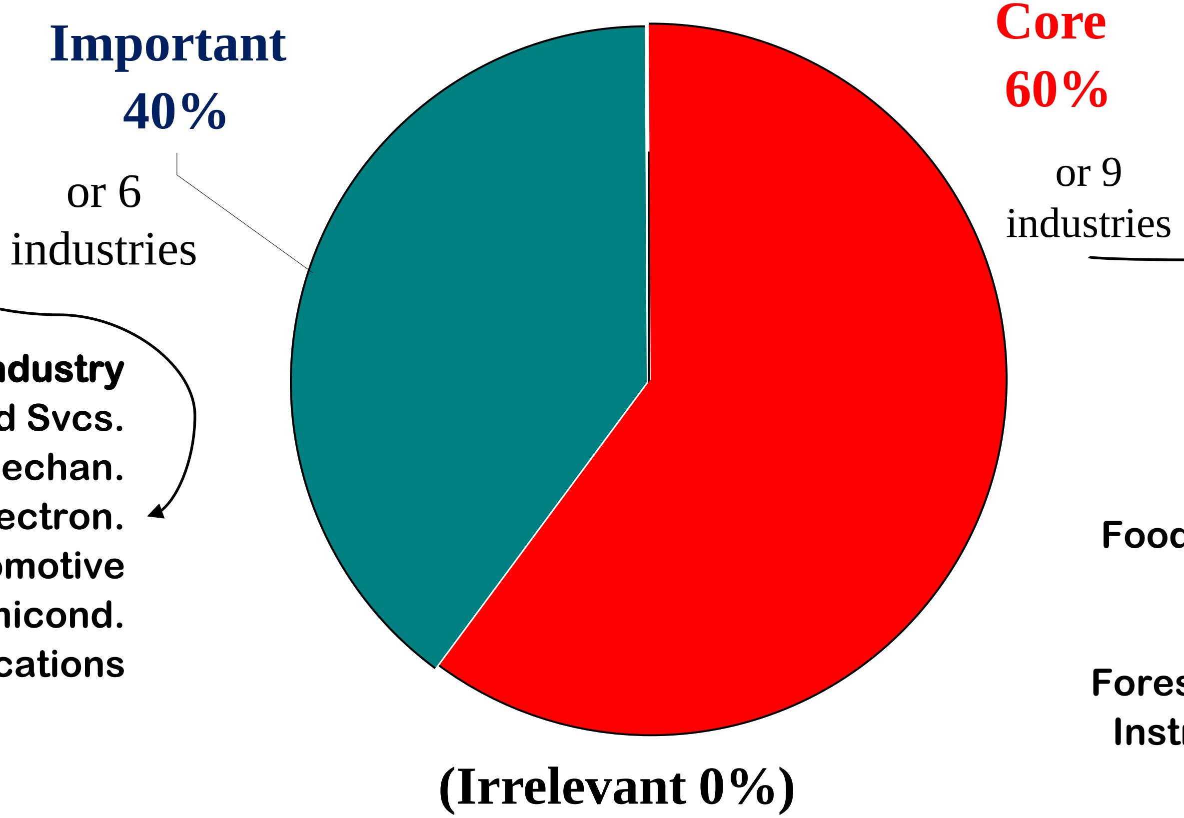
- Automotive (90)
- Biotechnology (41)
- Chemicals (143)
- Computers & Semiconductors (164)
- Electrical & Electronics (116)
- Energy (34)
- Engineering, Oil Field Services (5)
- Food, Beverage & Tobacco (28)
- Forest, Paper, Textiles (37)
- Health Care (78)
- Instruments & Optical (49)
- Materials (24)
- Metals & Mechanical (238)
- Pharmaceuticals (58)
- Telecommunications (46)

How many industries build on chemical technology?

- **Definitions:**
  - – ■ **Core technology: Technology accounts for at least 10% of patents or citations for an industry**
  - – ■ **Important technology:Technology accounts for between 1% and 10% of patents or citations for an industry**
  - – □ **Irrelevant technology: Technology accounts for less than 1% of patents or citations for an industry**

Core or important in all 15 indust.

Chemicals, Plast., Polym., Rubber



Industry
Engrng., Oil Field Svcs.
Metals & Mechan.
Electrical & Electron.
Automotive
Computers & Semicond.
Telecommunications

Industry
Chemicals
Energy
Pharmaceuticals
Biotechnology
Food, Bev. & Tobacco
Health Care
Materials
Forest, Paper, Textiles
Instrument. & Optical

No other technology are comes close!

Chemistry is the most enabling science / technology

More than any other technology:

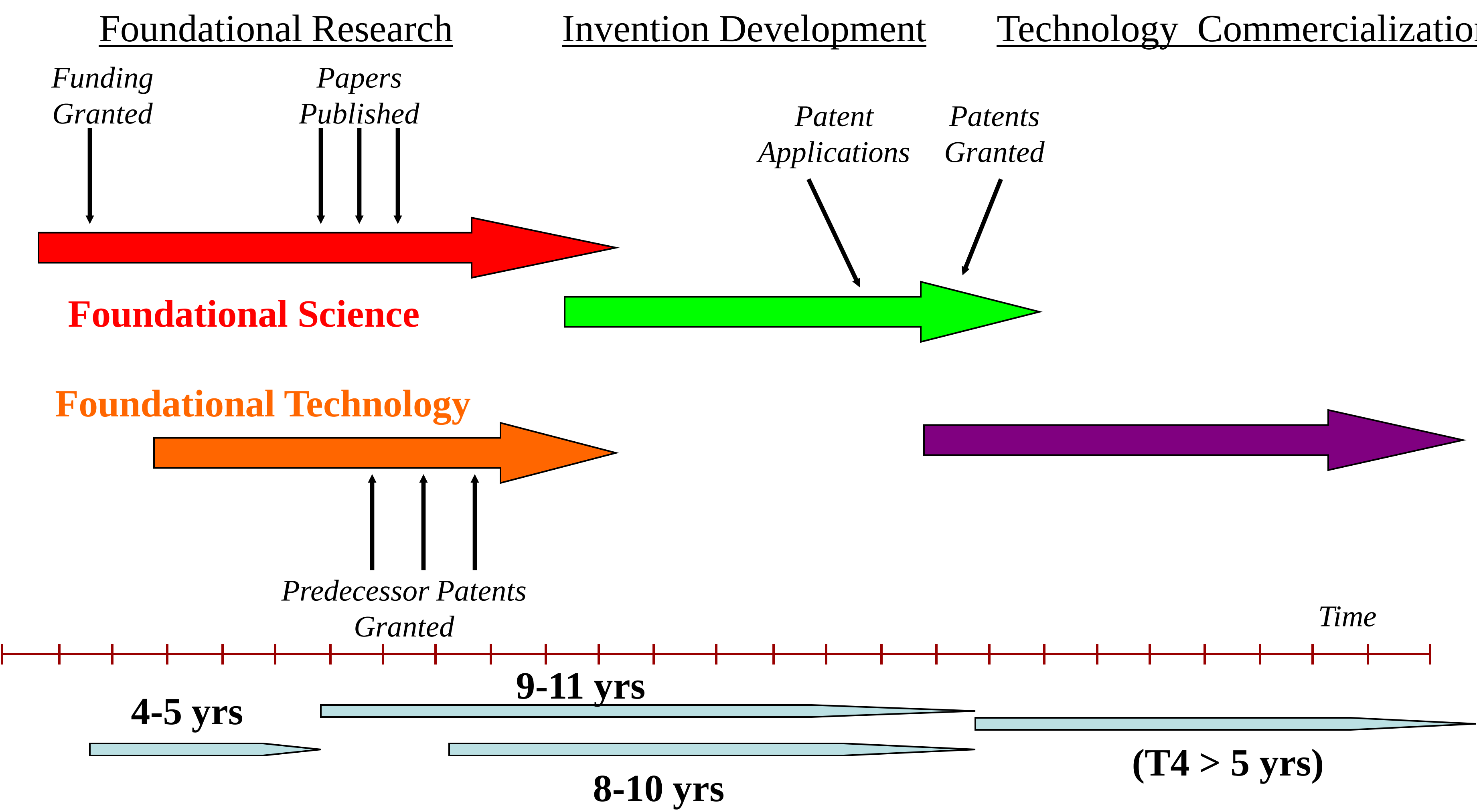
- **All industries create chemical technology.**
  Evidence: patent counts
- **The underpinning of all industries' technology relies on chemical technology.**
  Evidence: industry-to-technology patent citations
- **Chemistry is an important part of the science base of all industries.**
  Evidence: patent-to-paper citations

Approach to Question 3

How long does it take for public funded science to yield commercial innovation?

- Trace the average time spans from successful commercial innovations back to originating patents and scientific literature citations.
- Determine start of funding from literature acknowledgements.
- Time intervals to determine:
- Bibliometric methodology (Peter Kroll, ipIQ)

Conception to Market



Big Opportunity to Reduce Innovation Cycle Time

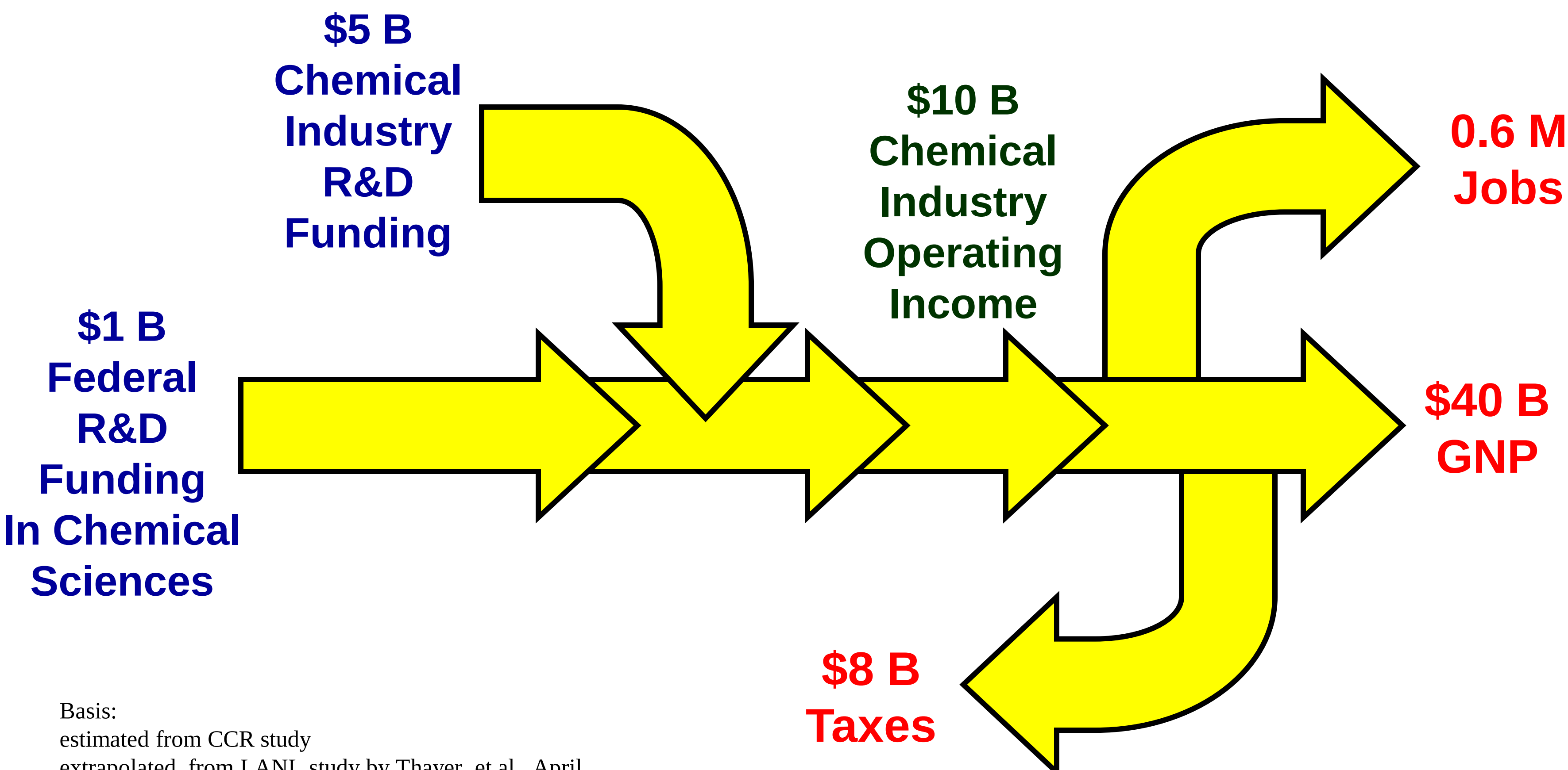
- **Industry focused on later stages of innovation, in particular, applied research and patenting to commercialization**
- **Limited collaboration at basic research stage**
- **Significant upside financial value if 20 year innovation cycle is shortened**

- **My personal view – Long time cycle is partially attributed to the high capitalization required for commercializing chemical technology**

Overall Study Conclusions

- Chemical companies get $2 of operating income for every $1 of R&D invested - a 17% after-tax return
- U.S. economy gains roughly $40 dollars in GDP growth and $8 in increased tax revenues for every dollar of federal investment in chemical sciences research
- Chemical technology is highly dependent on publicly funded chemical science research
- Technology quality, innovation speed and strong scientific links deliver greater shareholder value
- All industries are significantly impacted by the chemical sciences. It is the most enabling science and technology
- The big opportunity is to reduce the 20-year innovation time lag from initial public research funding to commercialization

Macroeconomic Implications



Basis:
estimated from CCR study
extrapolated from LANL study by Thayer, et al., April 2005 using REMI economic model

Phase III

Assessing and Enhancing the Impact of Science R&D in the United States: Chemical Sciences

1. How can we measure the broad (economic, social and scientific) impact of scientific research?
2. What is the nexus between industrial and federal investments in science R&D?
3. How can an optimal portfolio of (public and private) science R&D investments be characterized?
4. How can economics inform the accountability process related to federal R&D investments

Limited funding: Identified areas for further scholarly analysis

Workshop on Translation R&D

- 2010 at the Fall Meeting
- American Chemical Society
- All sectors participated

Translational R&D (Agreement)

- Invention alone does not create value
  - Innovation does
- Invention is necessary but not sufficient
  - You need to understand the market
- Timing is critical
  - of the invention/innovation
  - of the path to market
- A strong feeder system education, discovery research, pilot is essential
- The U.S is a world leader in discovery science
- Our competition (other countries) are far more effective and translating invention to innovation

Translational R&D (Differences)

- University spin-offs into small companies is the most successful route
  - Funding of a large number discovery science project is the choice to increase the chance of success
- Understanding of the market is the best way to translate invention to innovation
  - Moving projects at the right time is critical
- Mission-driven R&D is the best way to succeed at innovation

Acknowledgements

- **Funding provided by**
  - National Science Foundation
  - National Institutes of Health
  - CCR member organizations

- **Preparing for a major update to all studies**
  - ***Need better analysis of globalization, IT, recession, energy***
  - ***Stay tuned***

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