# Discussion of "The research university, invention and industry: evidence from German history"

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Can we attack the same question using modern data?

# How do you measure knowledge?

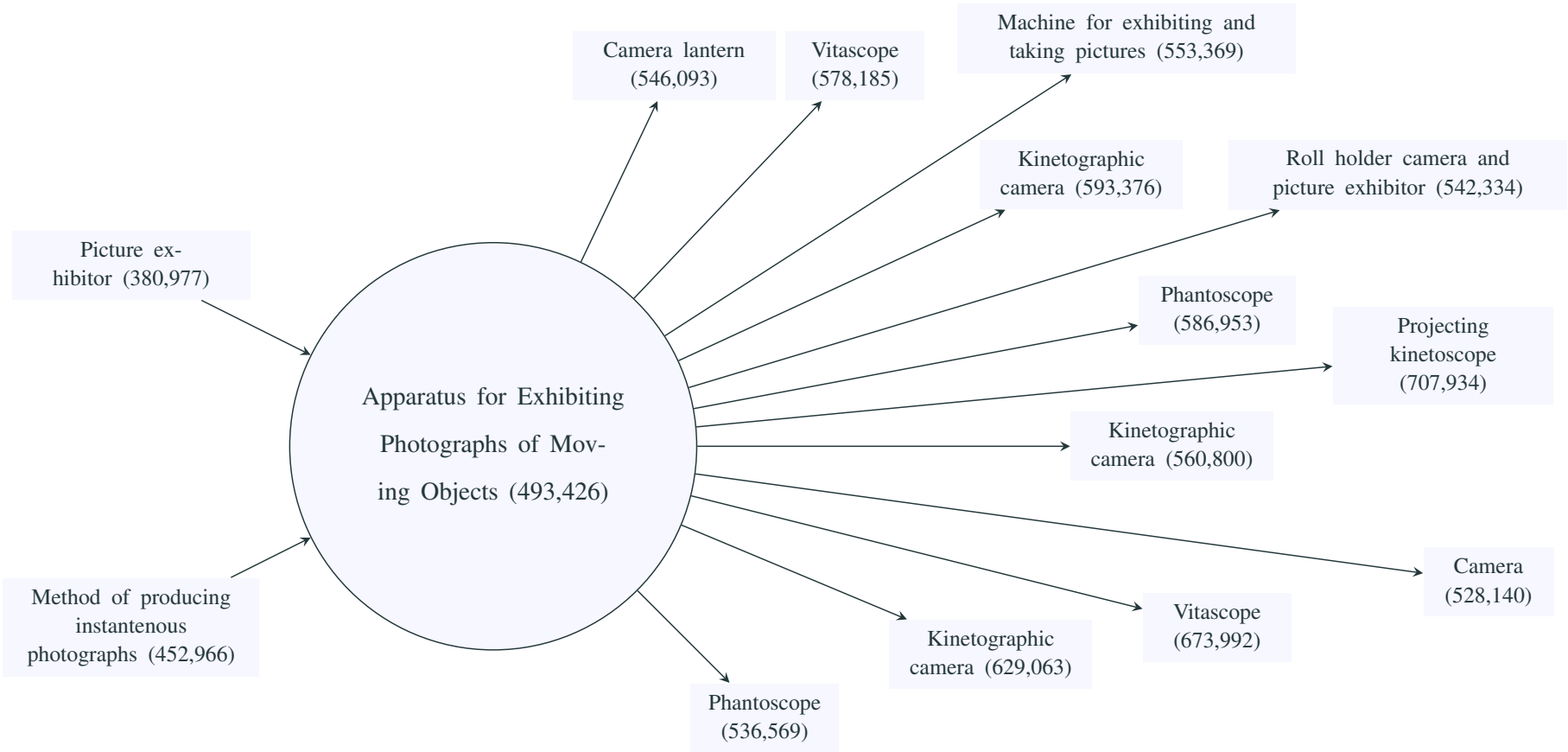
Patents seem like a natural candidate. But, not all patents are equally valuable inventions:

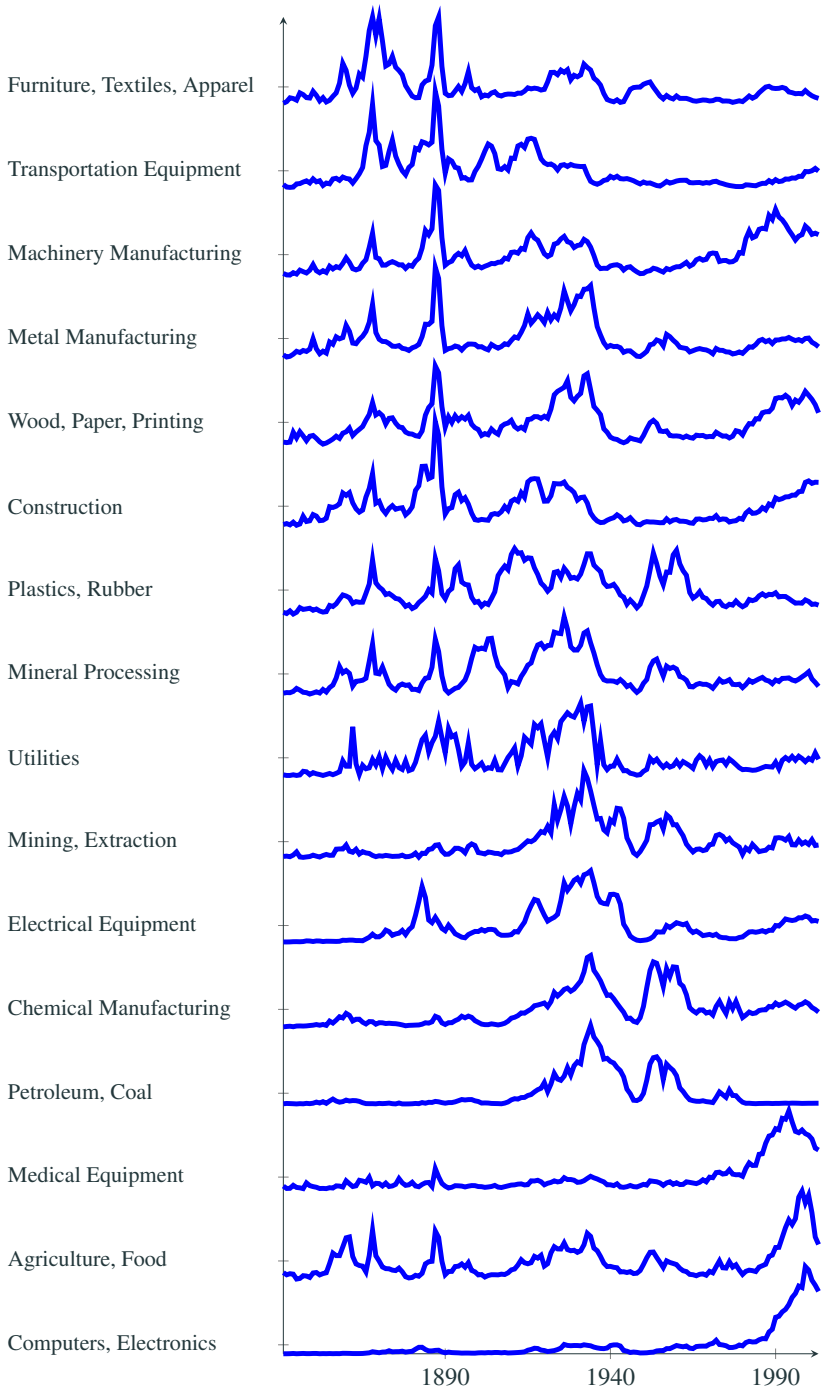
- proliferation of patents with no value (Jaffe & Lerner 2004)
- pro-patent shift in US policy (Hall and Zeidonis 2001)

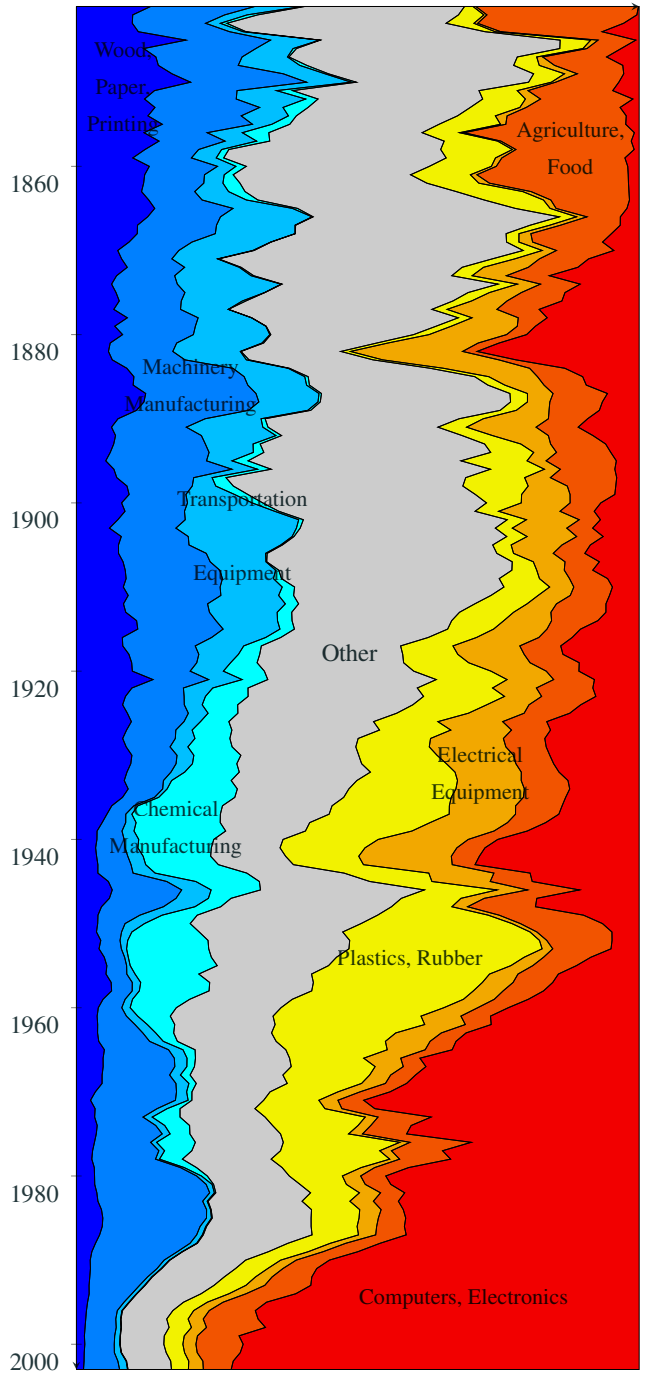
Use breakthrough patents to measure innovation. Kelly, Papanikolaou, Seru, and Taddy (2021) identify important patents as those that:

- Novel and impactful: are distinct from previous patents but are related to subsequent patents based on textual similarity
- Breakthroughs: patents in the top 10 percent of the unconditional distribution of impact/novelty

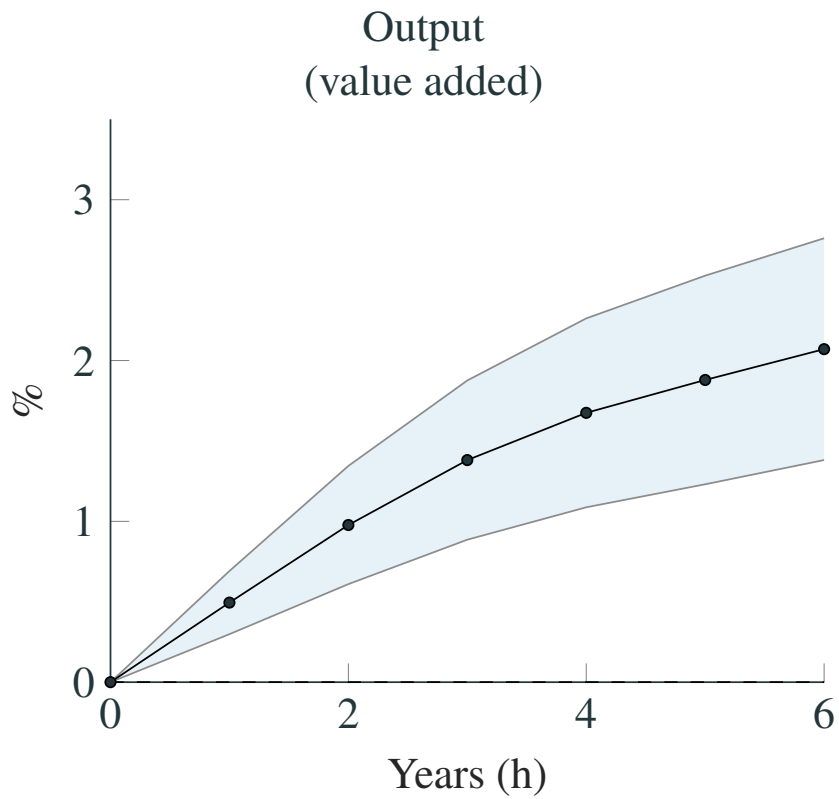
# Patent-patent similarity example: Moving Pictures

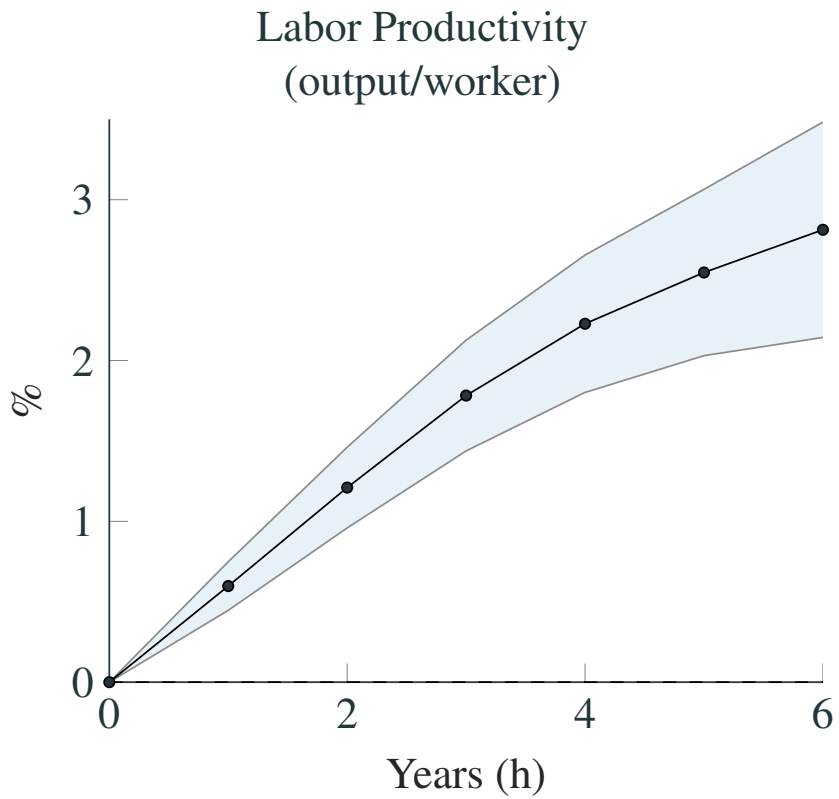



Furniture, Textiles, Apparel
Transportation Equipment
Machinery Manufacturing
Metal Manufacturing
Wood, Paper, Printing
Construction
Plastics, Rubber
Mineral Processing
Utilities
Mining, Extraction
Electrical Equipment
Chemical Manufacturing
Petroleum, Coal
Medical Equipment
Agriculture, Food
Computers, Electronics
1890
1940
1990


Wood,
Paper,
Printing
Agriculture,
Food
1860
1880
Machinery
Manufacturing
Transportation
1900
Equipment
Other
1920
Electrical
Equipment
Chemical
Manufacturing
1940
Plastics, Rubber
1960
1980
Computers, Electronics
2000

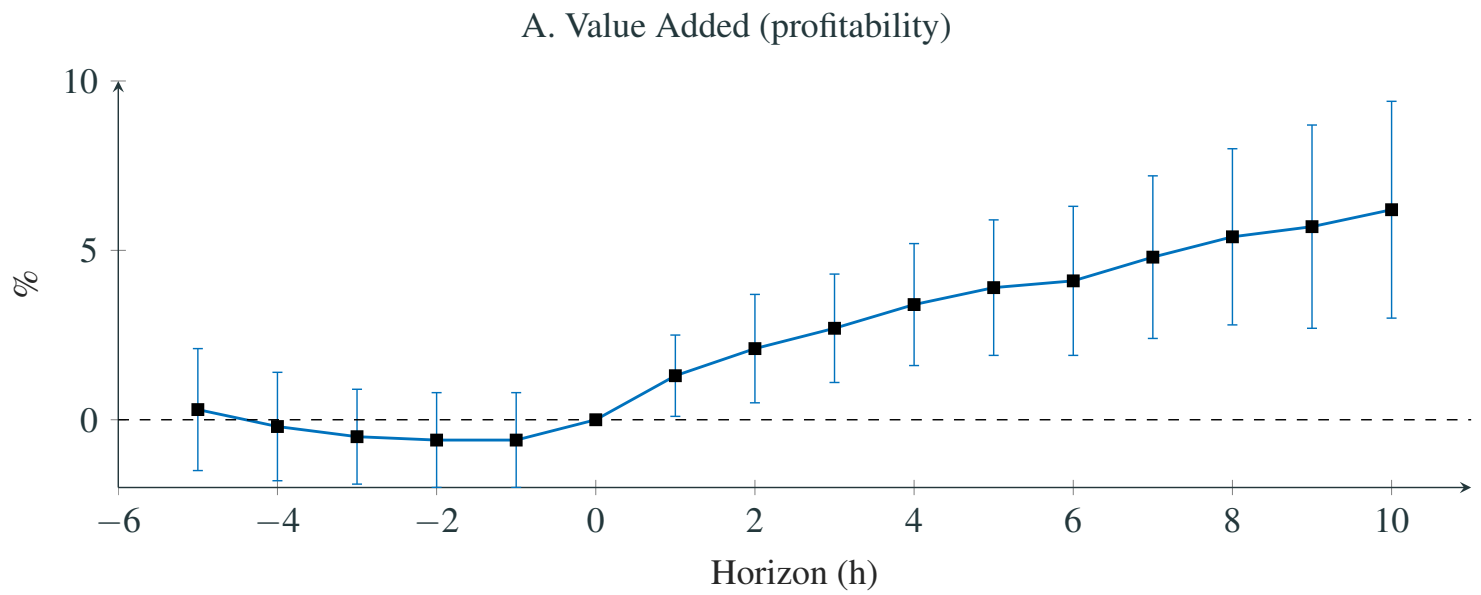
# Breakthrough patents and growth

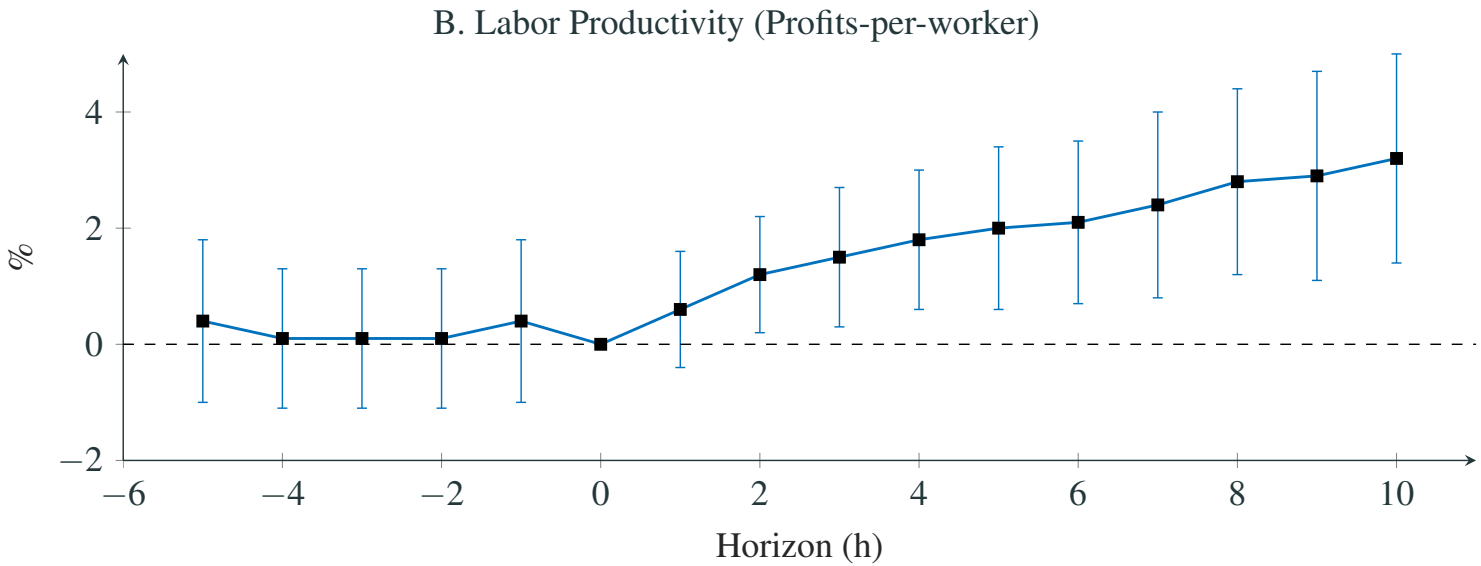



- Breakthrough patents predict industry output and labor productivity.
- Sample: Manufacturing, 1958–2018

# Breakthrough patents and Firm Productivity



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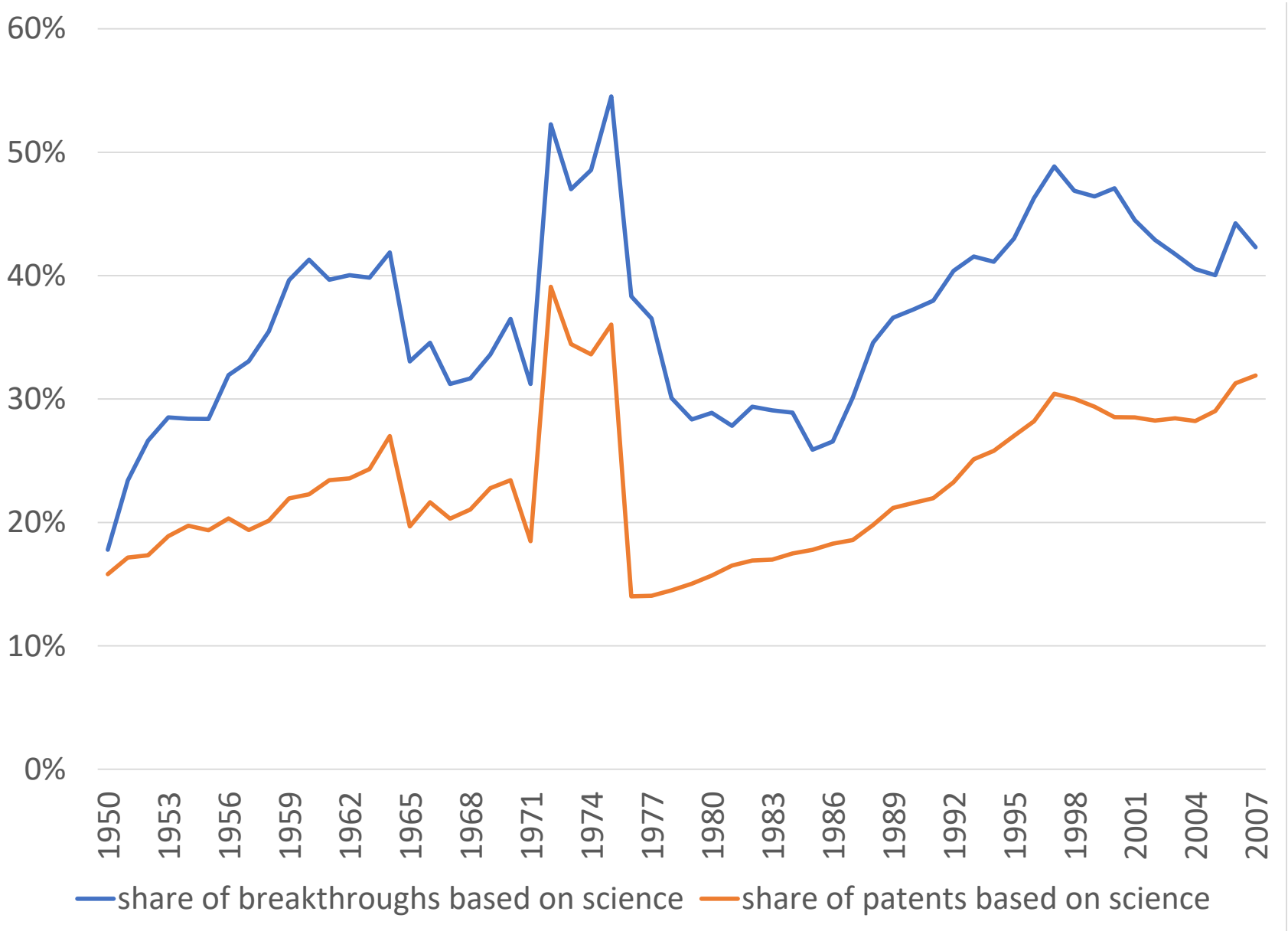
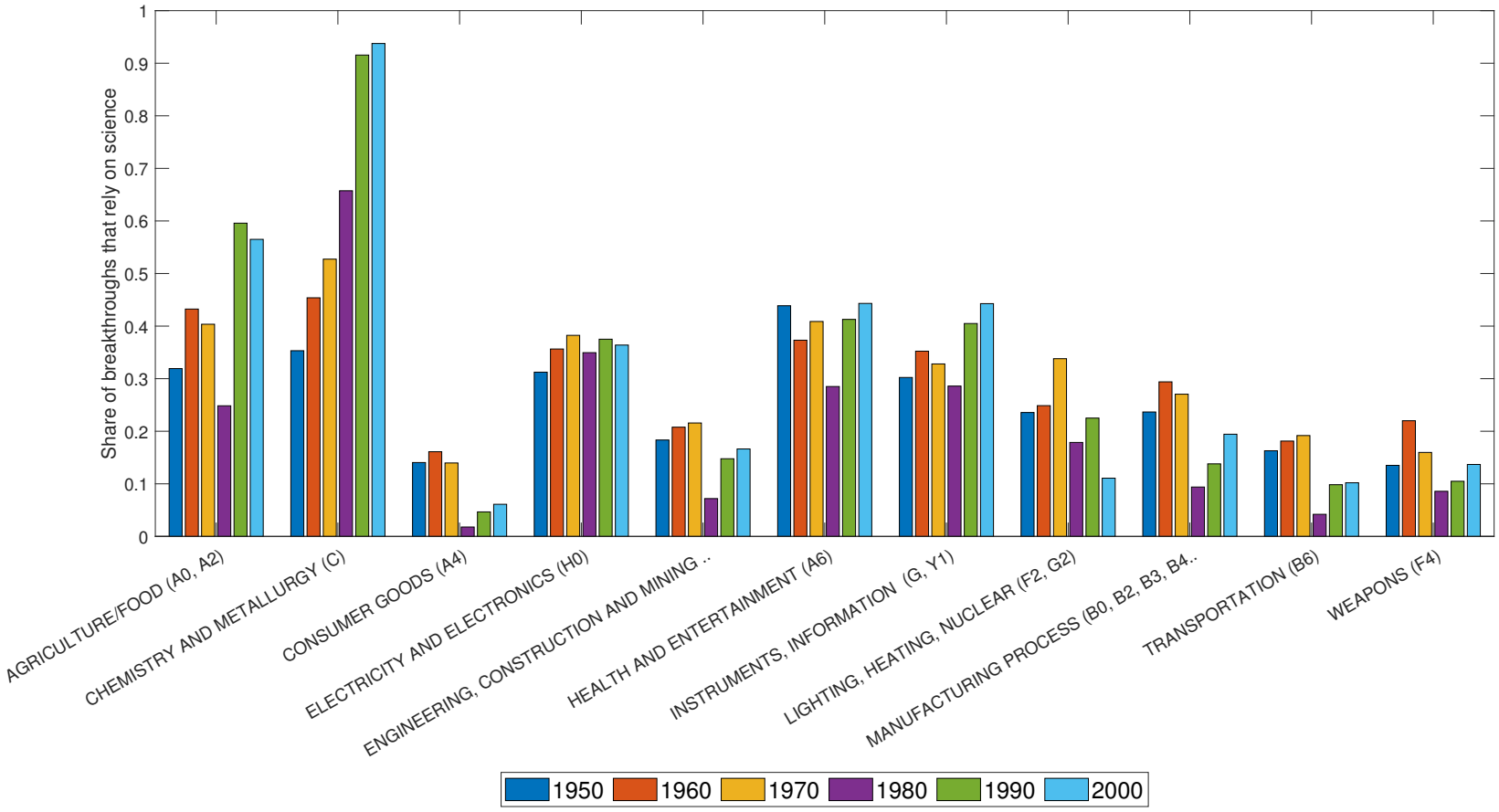
Using patents, we can trace knowledge spillovers from academia to the industry.

# Distribution across time



# Distribution across technology classes



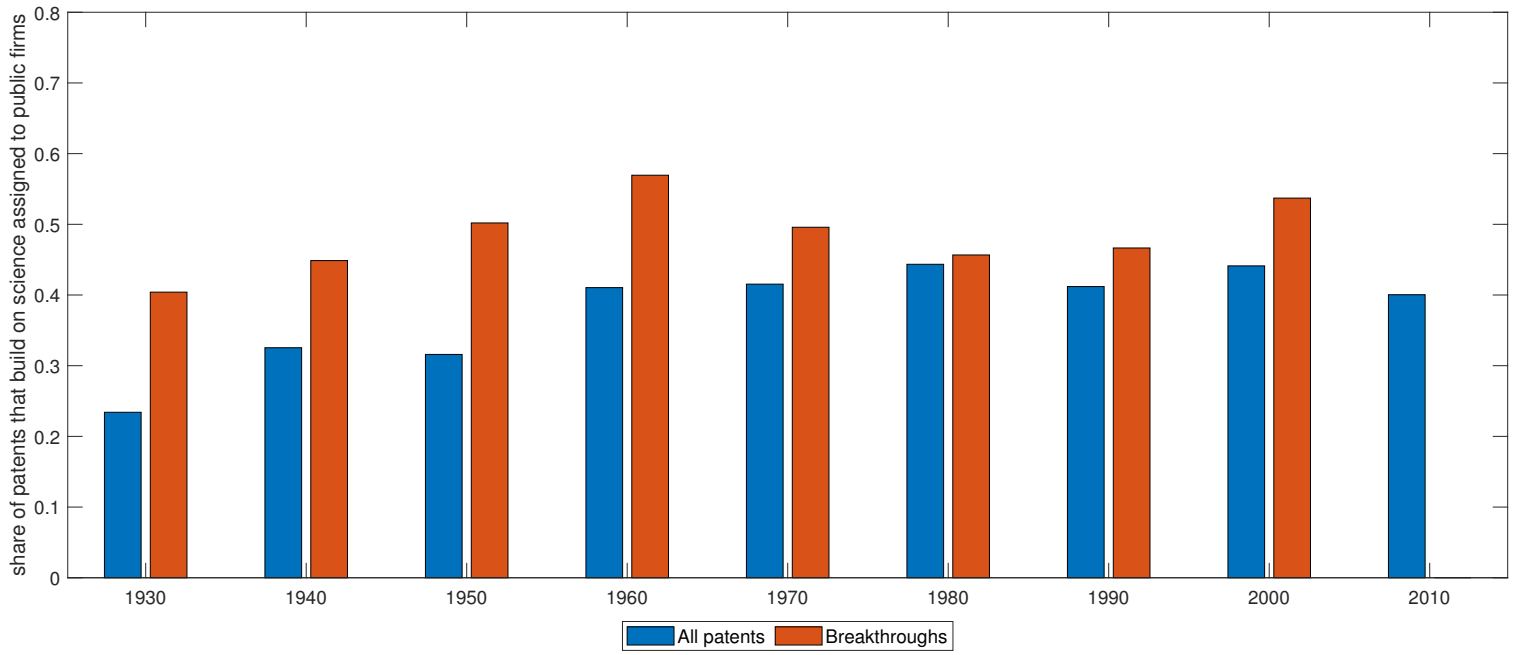

- Approximately 40% of all breakthroughs cite a scientific paper (compared to 26% for all patents)

# Distribution across product categories

| Product Category | Share of breakthroughs relying on science | |
|---|---|---|
| | pre-1990 | post-1990 |
| Industrial Manufacturing and Processing Machinery and Accessories | 17% | 13% |
| Medical Equipment and Accessories and Supplies | 41% | 32% |
| Information Technology Broadcasting and Telecommunications | 18% | 34% |
| Computer Equipment and Accessories | 6% | 8% |
| Data Voice or Multimedia Network Equipment or Platforms and Accessories | 5% | 10% |
| Software | 4% | 10% |
| Other | 25% | 21% |

- Shift from Manufacturing and Medical Equipment to IT
- (Patent to product mapping based on Caunedo and Papanikolaou, 2023)

# Distribution across firms



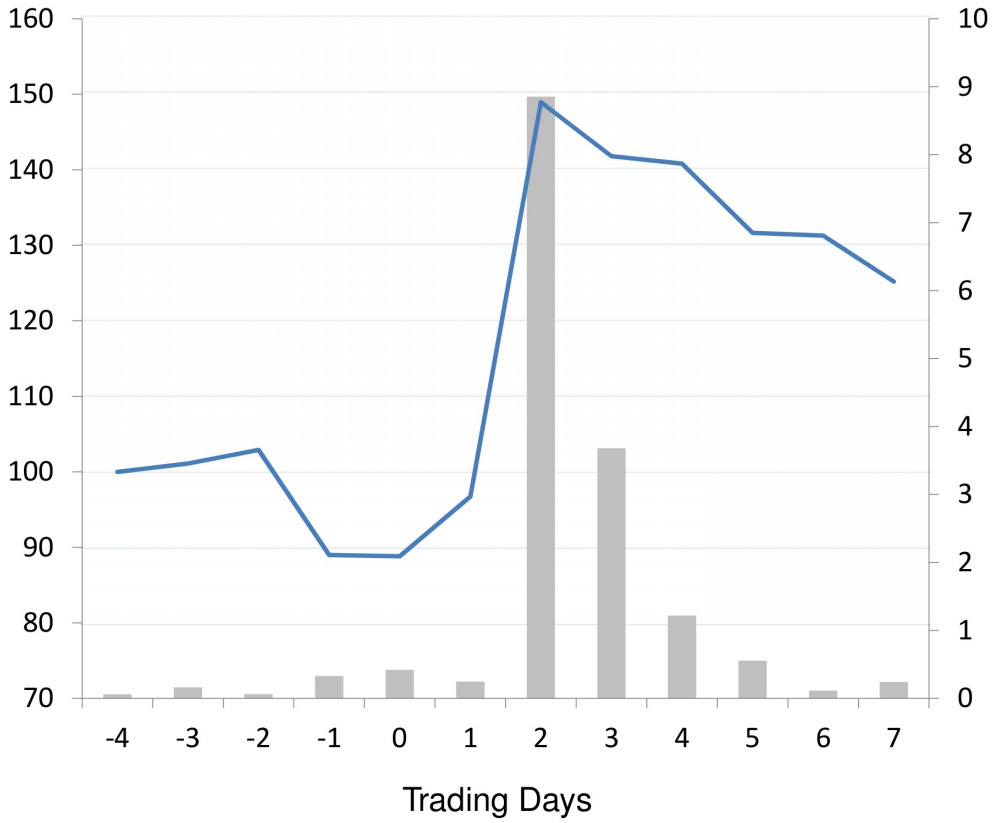

- Approximately 40% of all patents that build on science are assigned to a publicly traded firm.
- Share is even larger for breakthrough patents.

# Measuring technological innovation

Can we measure the economic value of these patents?

- Kogan, Papanikolaou, Seru, and Stoffman (QJE, 2017) estimate the value of patents using firm's stock market reaction to patent issues as an estimate of the (private) value of patents.

# Example: Stock market and patent issues




- **Stock price (left axis) and trading volume (right axis) of GENEX Co on August 7, 1990, after award of patent no. 4,946,778 for ”Single-Chain Polypeptide Binding Molecules”**

| | Patent Importance (Novelty/Impact) | | | Economic Value (KPSS) | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| science_cite | 0.057*** | 0.036*** | 0.025*** | 0.586*** | 0.376*** | 0.003** |
| | (16.28) | (15.42) | (18.24) | (15.89) | (14.07) | (3.07) |
| Observations | 6,612,051 | 6,612,051 | 3,143,982 | 2,059,011 | 2,059,011 | 1,945,933 |
| Fixed Effects: | | | | | | |
| Issue Year | Y | Y | Y | Y | Y | Y |
| Tech Class × Issue Year | | Y | Y | | Y | Y |
| Firm × Issue Year | | | Y | | | Y |

- Patents that build on science are both more important but also more economically valuable.

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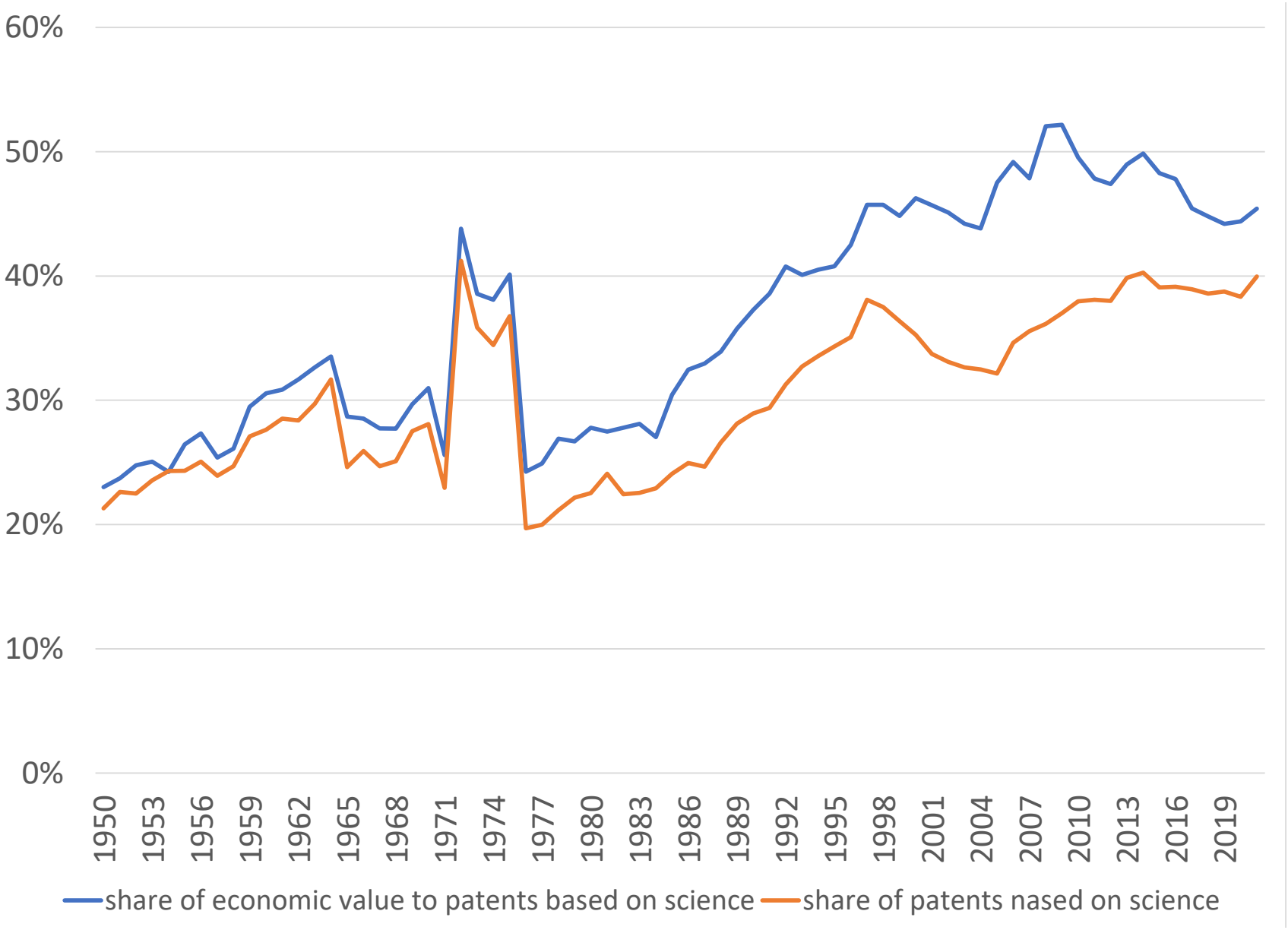

# Summary

- Paper is great in providing convincing evidence of spillovers from academia to firms, yet evidence is somewhat indirect.
- Patents allows us to identify direct linkages from universities to firms.
- Next step is to quantitatively assess the magnitude of these spillovers.