# New Technology Indicator

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# Motivation

- Demand for internationally comparable measures of innovation and technology is increasing; however, it is difficult to develop such measures (Hall and Jaffe, 2012).

- Existing measures (Keller, 2010):
  1. R&D investments (input)
  2. Patents (output)
  3. Total Factor Productivity (TFP, effect of technology)

- All those measures have drawbacks. For example, it is difficult to construct comparable measures of TFP and comparable data are often not available.

# Methodology

- The paper proposes an alternative indicator of technology: R&D depreciation rate (Li and Hall, 2016 for detailed methodology)
- R&D depreciation rate depends on technological progress and degree of market competition (Hall, 1997)
- Technology leaders in the U.S. have smaller R&D depreciation rates than followers (Li, 2015).
- This paper shows that technological advantage is associated with lower R&D depreciation rates across countries when there is free trade between countries.

# Model for R&D Depreciation

- The paper proposes a model for estimating R&D depreciation rates.
- The estimates are derived from a profit maximization of a firm from investment in R&D.
- The firm chooses R&D to maximize the PDV of the future stream of income form R&D:
- Profit = PDV of future income from R&D– R&D

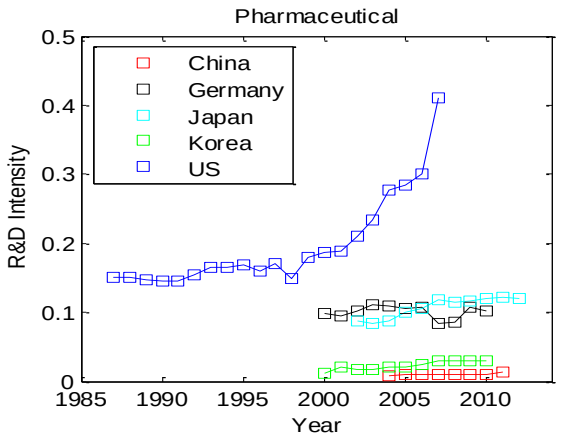
# Model for R&D Depreciation

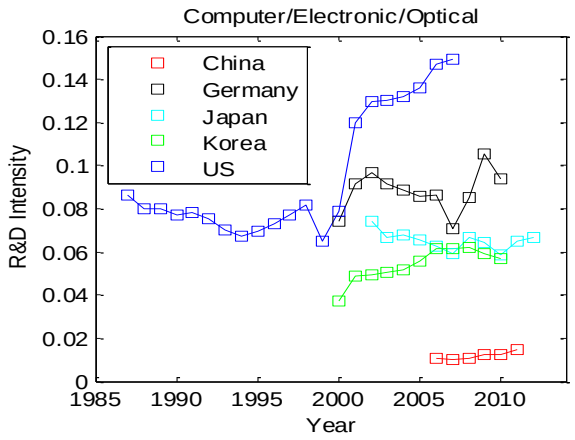
- It is assumed that future profits from R&D decline at a rate equal to R&D depreciation rate. (?)
- The depreciation can be solved from the profit maximization. It is a function of R&D intensity, output growth and R&D growth.

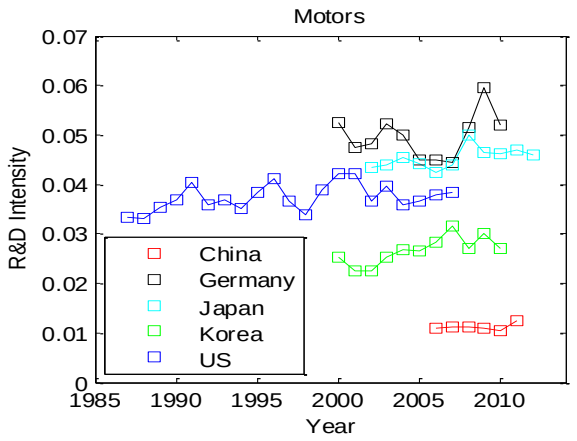
# Data

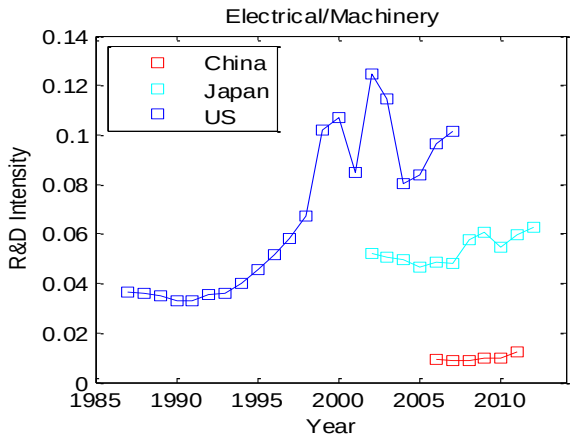
- Countries: the U.S., China, Germany, S. Korea, and Japan
- Industries: motors; pharmaceutical, computer; electronic & optical products; and electrical equipment industries.
- Period: The majority of the data cover the decade of the 2000s, but China's data is shorter because it started reporting R&D investments in 2006.
- Sources: BEA, Japan's Cabinet Office, OECD, and CEIC datasets.

# R&D Intensity



# Country Comparison: Pharmaceutical and Medical Device Industry

| Country | $\delta_{RD}$ | $\delta_{RD}$ Ranking | Forbes' Ranking |
|---|---|---|---|
| United States | 12% | 1 | 1 |
| Japan | 14% | 2 | 2 |
| Germany | 20% | 3 | 3 |
| China | 52% | 4 | 4 |
| South Korea | 89% | 5 | 5 |

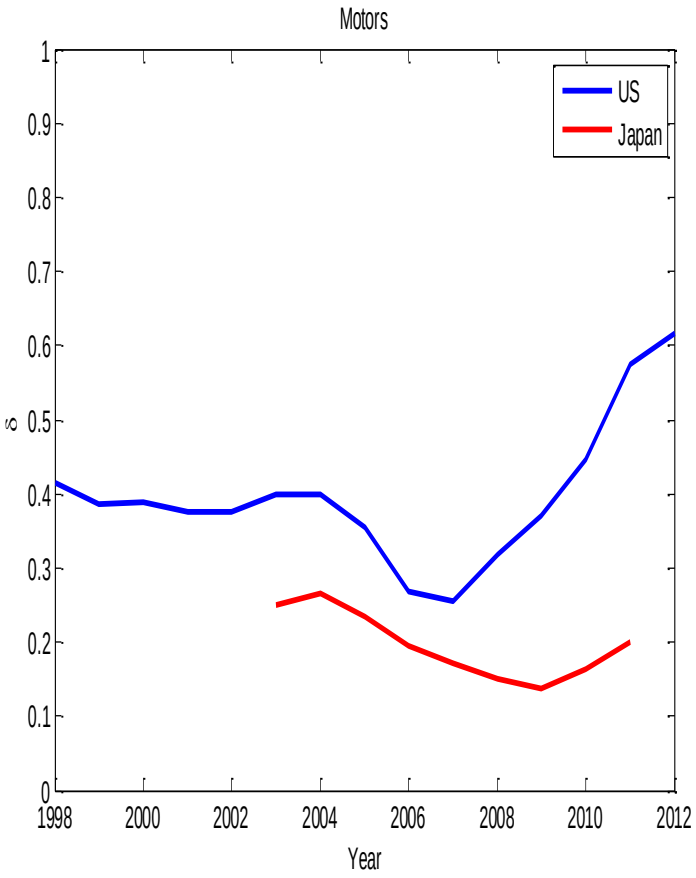
# Country Comparison: Motor Industry

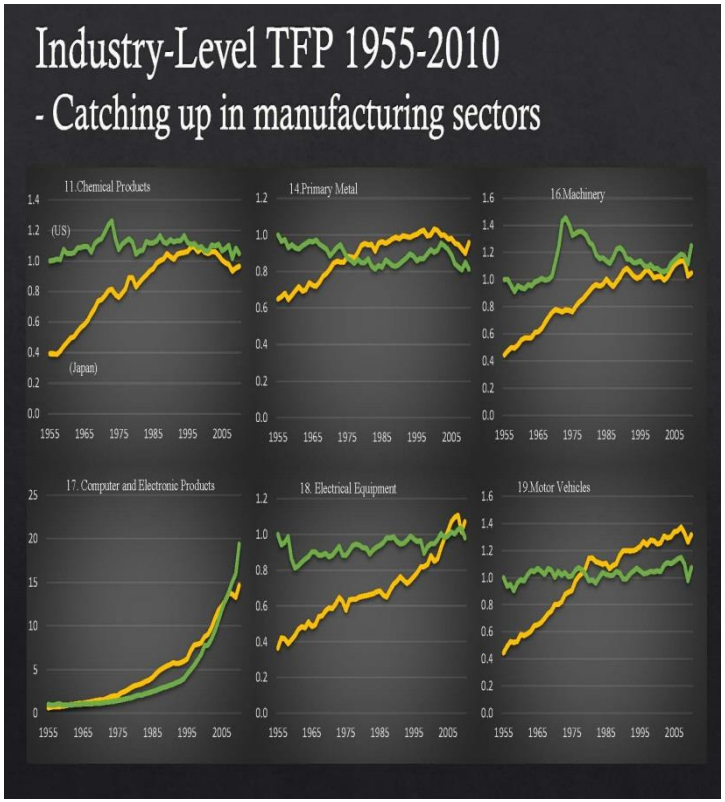
| Country | $\delta_{RD}$ | $\delta_{RD}$ Ranking | Forbes' Ranking |
|---|---|---|---|
| Germany | 19% | 1 | 2 |
| Japan | 20% | 1 | 1 |
| United States | 35% | 3 | 3 |
| South Korea | 43% | 4 | 4 |
| China | 52% | 5 | 5 |

# R&D Depreciation and TFP growth: the U.S. and Japan

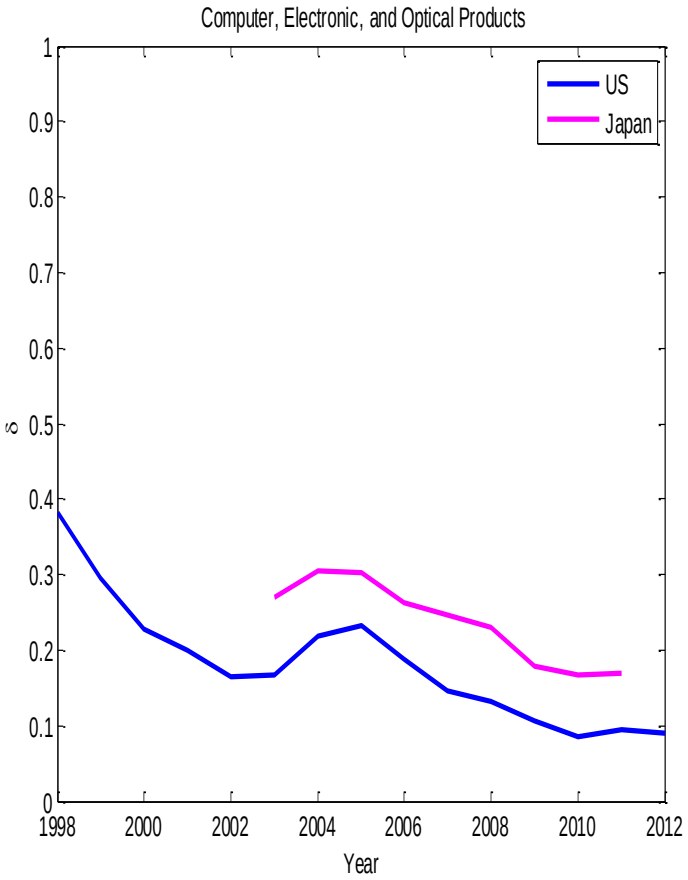
| Industry | $\delta_{RD, US}$ | $\delta_{RD, Japan}$ | $TFP_{US}$ | $TFP_{Japan}$ |
|---|---|---|---|---|
| Electrical equipment Industry | 20% | 26% | 1.3 | 1.1 |
| Computer, electronic, and optical products industry | 16% | 23% | 19.5 | 15 |
| Pharmaceutical industry | 12% | 14% | 1.05 | 0.9 |
| Motors industry | 35% | 20% | 1.1 | 1.3 |

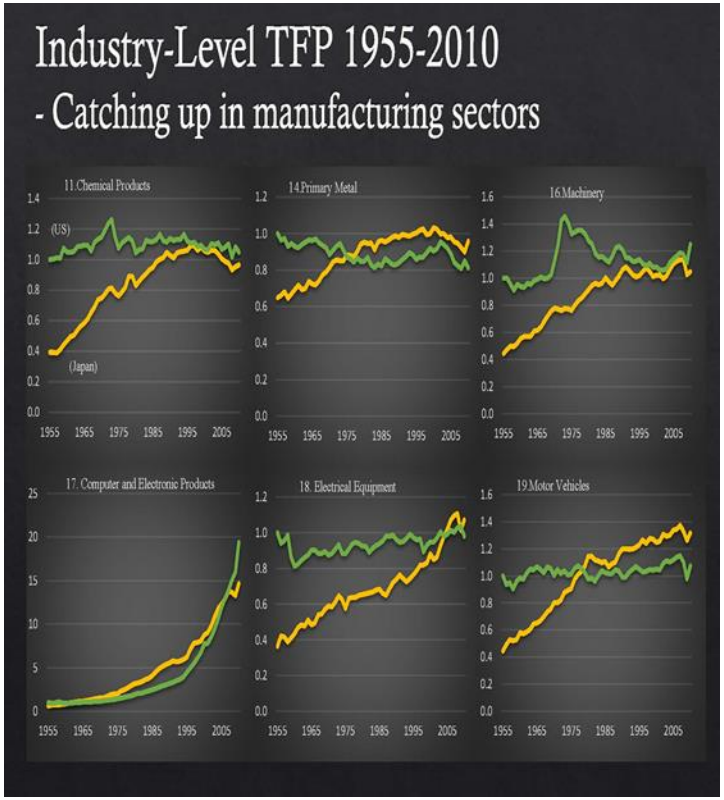
# Time-Varying R&D Depreciation vs. TFP



# Time-Varying R&D Depreciation vs. TFP



# Conclusion

- Countries are different in technology.
- Based on data for four high-tech industries in five countries, the new indicator shows promising results.
- The new indicator is easier to construct and provides of cross-country comparison of technology.

# Discussion of the Paper

# Main Findings of the Paper

- The paper shows that R&D depreciation provides an alternative indicator of technology.
- The paper shows that the indicator provides a sensible indicator of technology across countries.

# Comments and Suggestions

- Comments and suggestions on the model.
- Comments and suggestions on the results

# Comments on the Model

- The main assumption: profit rates decline over time at the constant rate which is equal to the depreciation rates of R&D asset.

- The paper should compare its definition with more standard definition of depreciation in the SNA: depreciation is the loss of R&D asset values as the asset ages. The depreciation occurs even when the profits are constant over the asset life as the service life of the asset becomes shorter with ages.

# Comments on the Results

- The paper derives an equation for the depreciation rate as a function of three main variables: R&D intensity, output growth and R&D growth.

- It will be useful to show how the depreciation changes with those 3 variables and the intuition behind the relationship. I did that: R&D depreciation is a function of R&D intensity (-), output growth (+), and R&D growth (+). The link on R&D intensity and R&D depreciation explains the sensible results in the paper.

# Comments on the Results

- It will be useful to provide more discussion about the main result that a lower depreciation rate is an indicator of more rapid technological progress.

- A counter example for that result: as rapid technological process makes old technologies obsolescence, deprecation rates tend to higher.

# Comments on the Results

- The paper should make it clear whether R&D depreciation is an indicator of levels or changes in technologies.