Discussion of Kawaguchi on Robots and of Shinozaki on AI

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Background for the Discussion

- Economic research on robots and AI is growing faster than their influence on the economy
- Techno-optimists have predicted a 4th industrial revolution starting tomorrow as robots and AI replace human workers
- No revolution, just a slow evolution
- Most important fact about robots is their unimportance: IFR total 2017 worldwide investment in robots outside China: $11b
  - Nonres fixed investment in US $2,900b

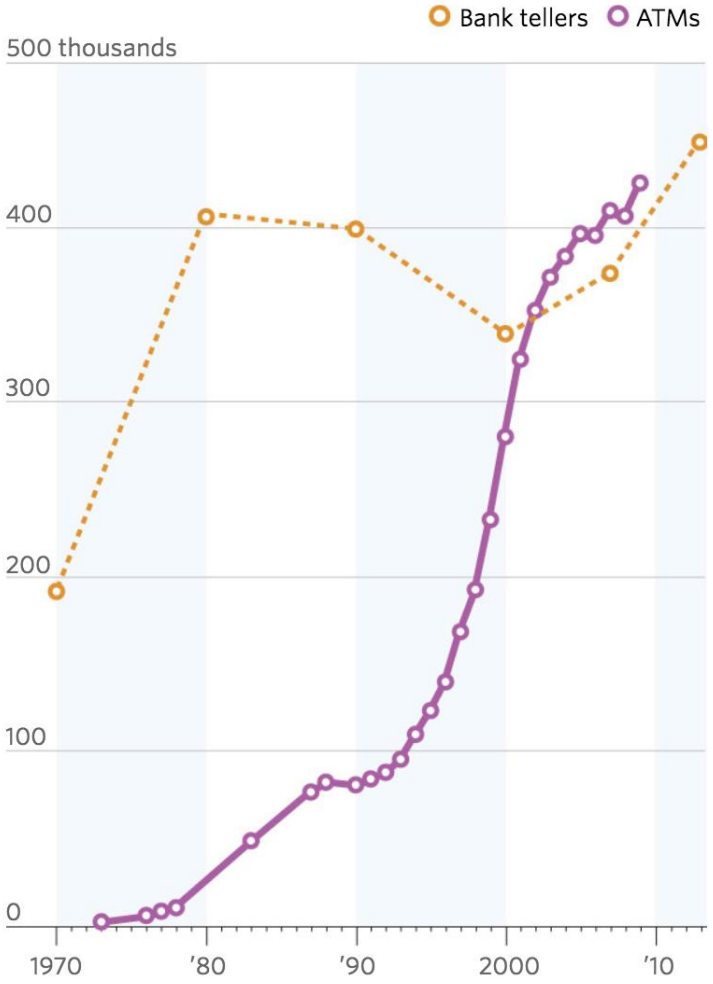
Robots and AI Are Old News

- First industrial robot installed by GM in 1961.
- NBER group viewed U.S. auto factories in 1995 where robots were for welding and painting
- Artificial intelligence (AI) is not new:
  - has already been replacing jobs for at least 20 years
  - predominant uses of big data analytics are in marketing, a zero-sum game
  - Evolutionary change: use of AI for voice recognition, language translation, radiology diagnosis, legal searches

Frey and Osborne (2013): Automation Destroys 47% of Jobs

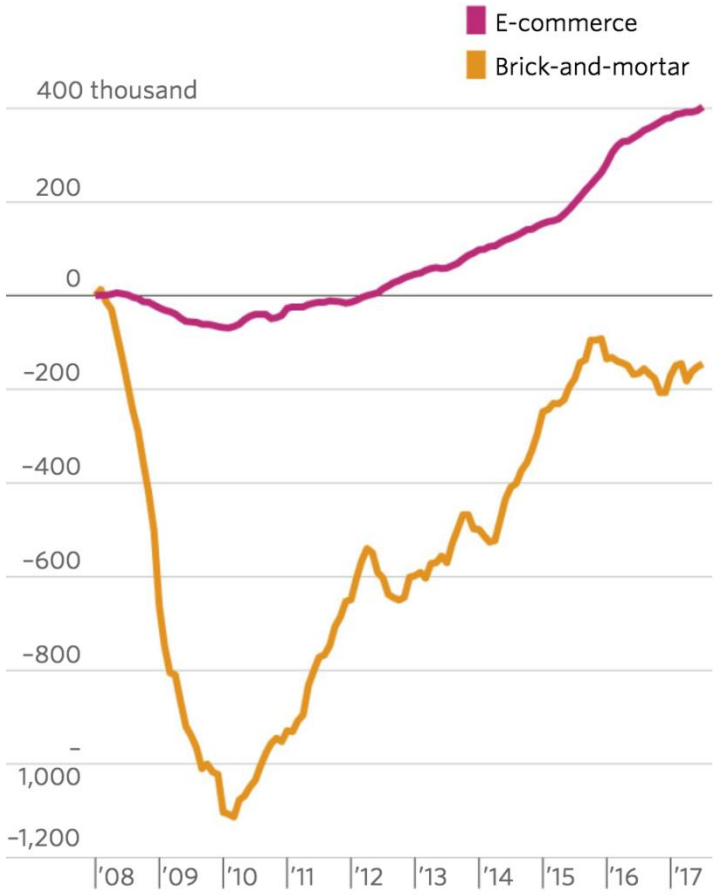
- **Frey-Osborne 2013 is cited by both papers**
- **Prediction: 47% of U.S. jobs will be replaced by "computerization" by 2033**
- **In contrast U.S. economy has *created* 20m jobs since 2010. We're 1/3 through F-O interval.**
- **Their forecasts for computer replacement of jobs (they do this for 700 jobs):**
  - **Bank tellers (98%), restaurant cooks (96%), refuse collectors (93%), retail salespersons (92%), construction labor (88%), real estate sales agents (86%) ==========airline pilots (55%)!**

ATM Machines and Bank Teller Jobs



Source: James Bessen, Boston University School of Law

Brick and Mortar Retail Job Losses versus e-Commerce Job Gains

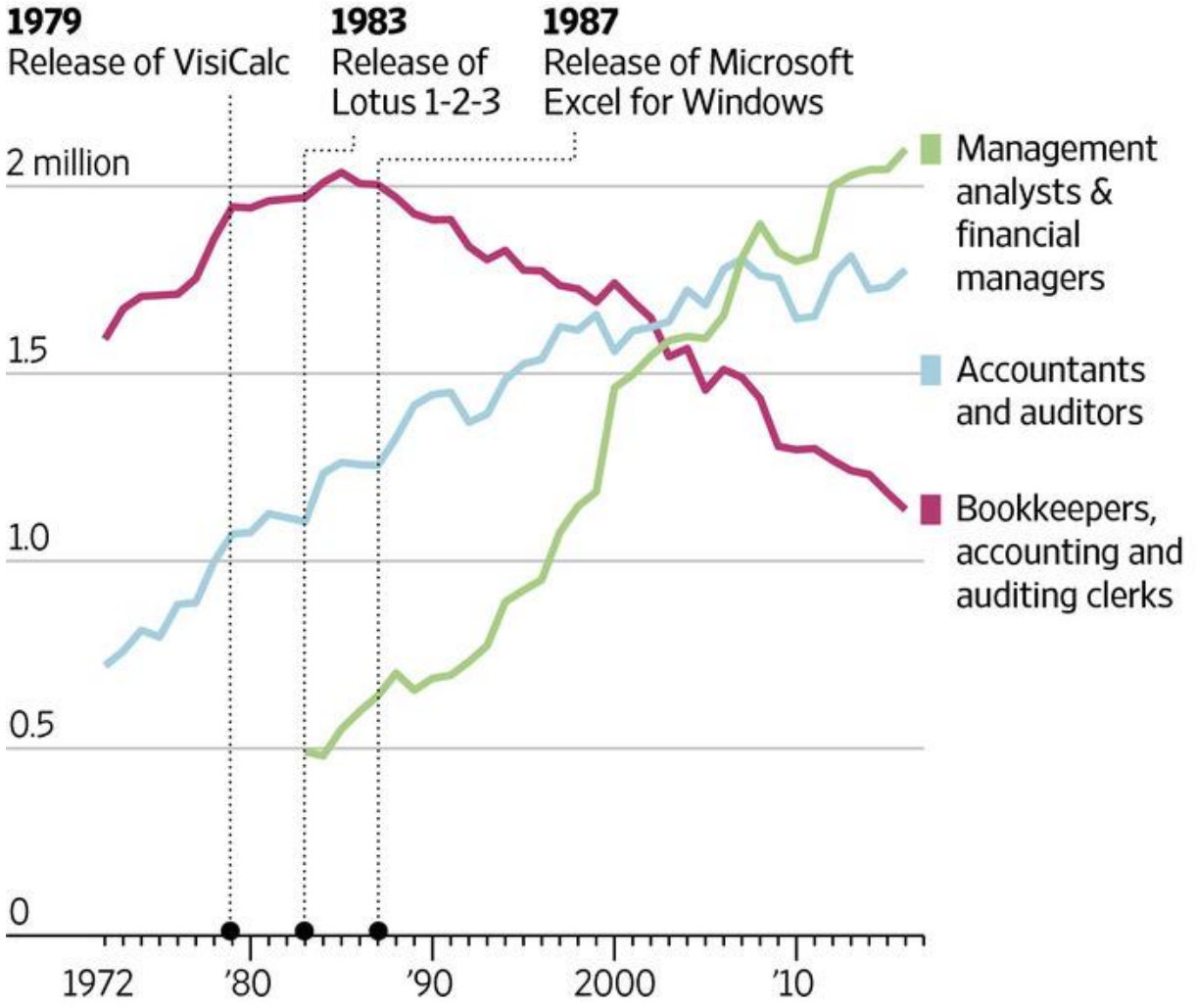


Note: Full-time equivalent employment, three-month average. E-commerce includes electronic shopping and mail-order houses; and warehousing and storage.

Source: Michael Mandel, Progressive Policy Institute

The Spreadsheet Apocalypse, Revisited

Jobs in bookkeeping plummeted after the introduction of spreadsheet software, but jobs in accounting and analysis took off.



Notes: There is no data for 1982. Changes in occupational definitions in 1983, 2000 and 2011 mean that data is not strictly comparable across time. There was no category for management analysts or financial managers prior to 1983.

Source: Bureau of Labor Statistics

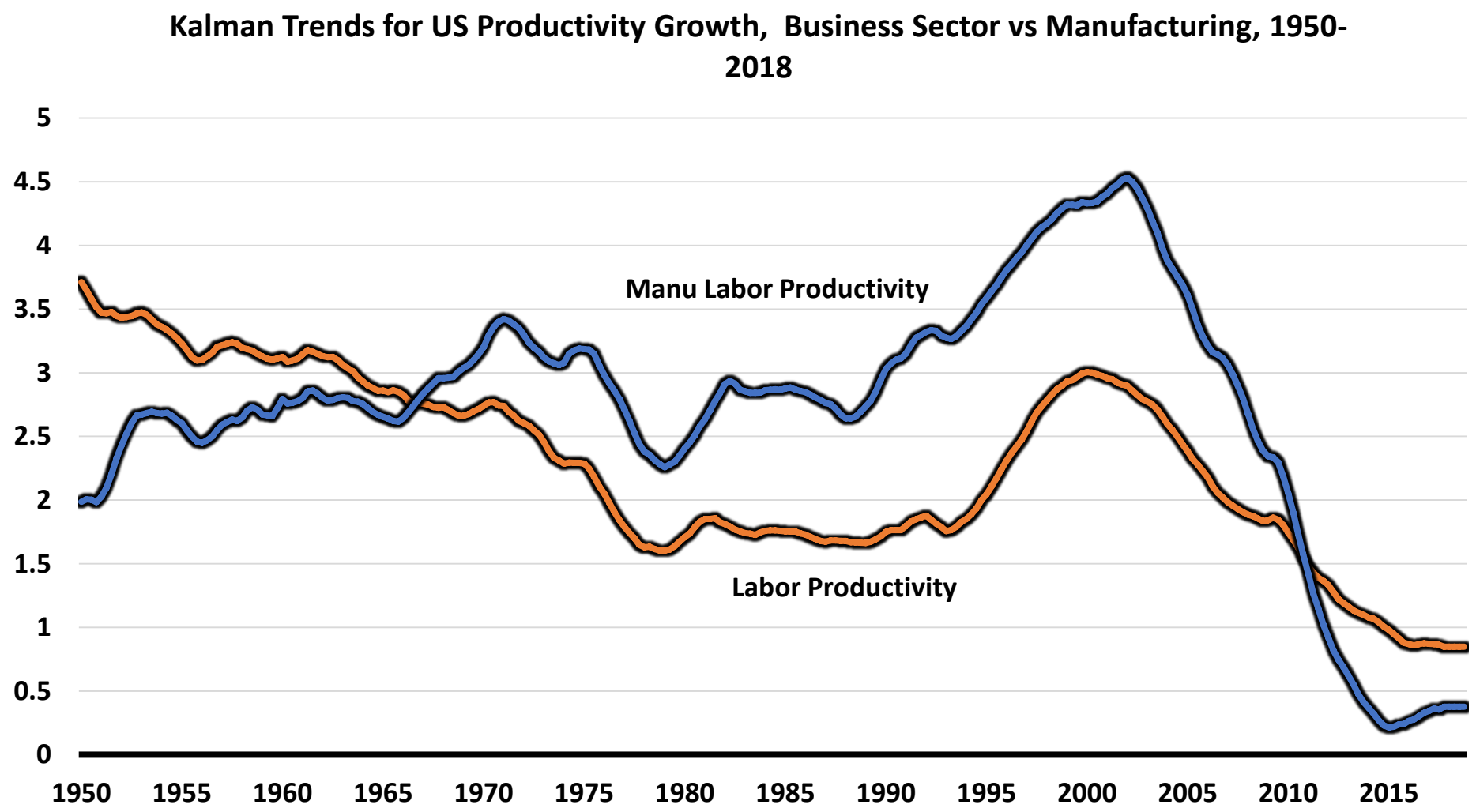
THE WALL STREET JOURNAL.

If Robots and AI Kill Jobs, They Must Raise Productivity Growth

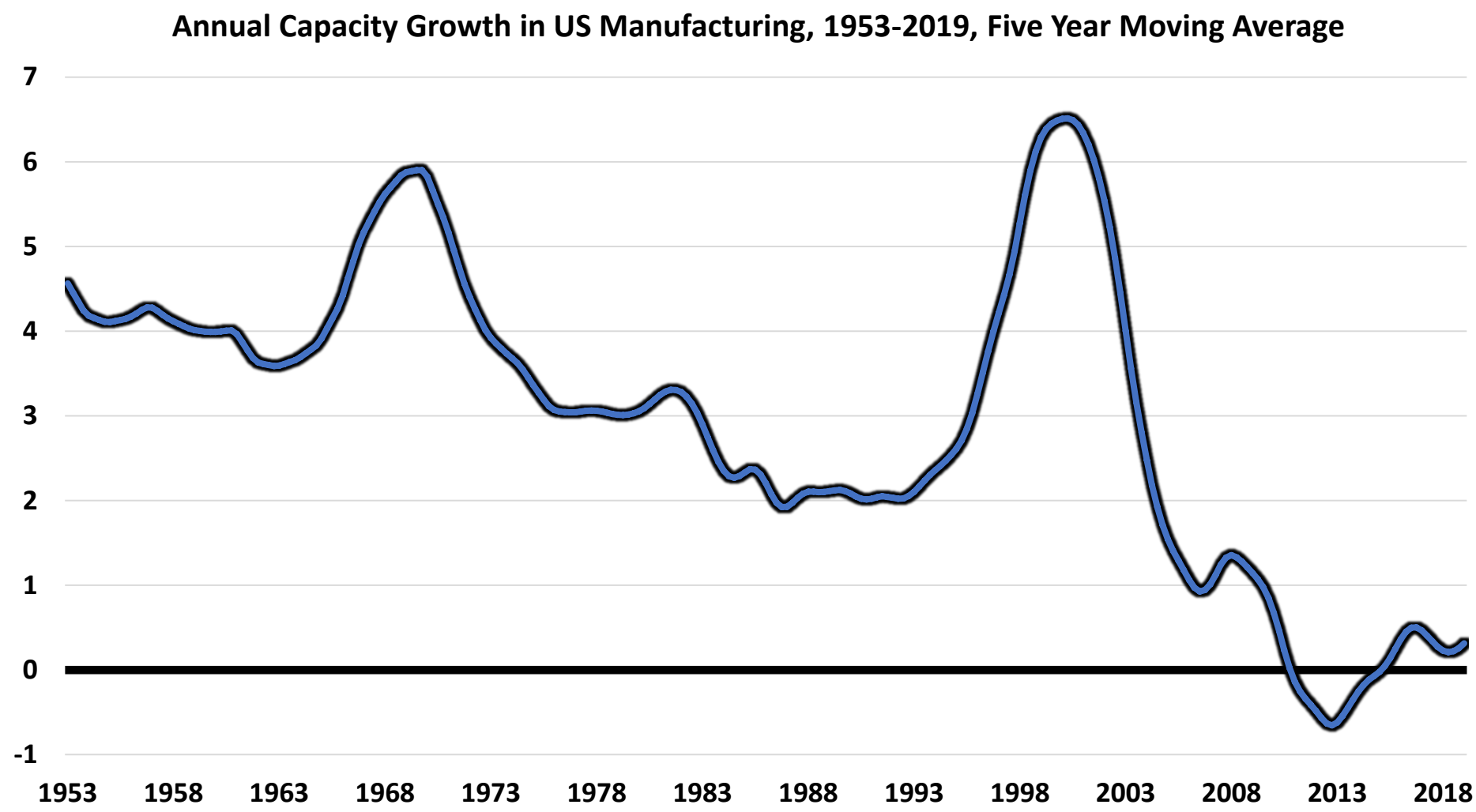
- We can indirectly examine the topic of today's papers by looking at trends in productivity growth
- We'll look at productivity growth in
  - Total U.S. economy
  - U.S. manufacturing
- Then robot penetration by country, contrast between South Korea and U.S.
  - South Korea should have accelerating manufacturing productivity growth, esp. relative to U.S.
- Japan: manufacturing productivity growth compared to U.S.

U.S. Total Economy Productivity Growth, Kalman Trend, 1950-2018

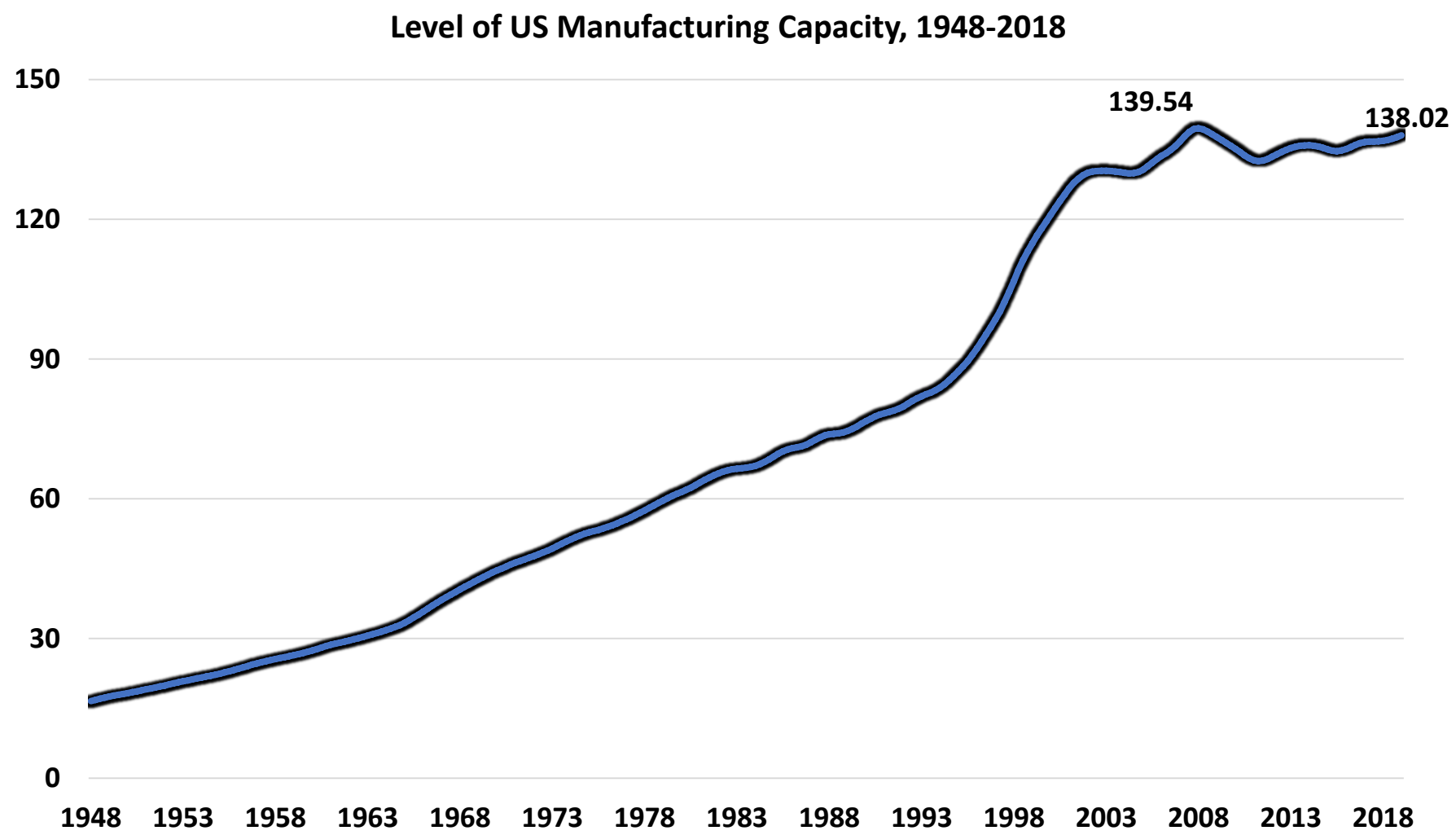
Contrast Total Economy with Manufacturing, 1950-2018



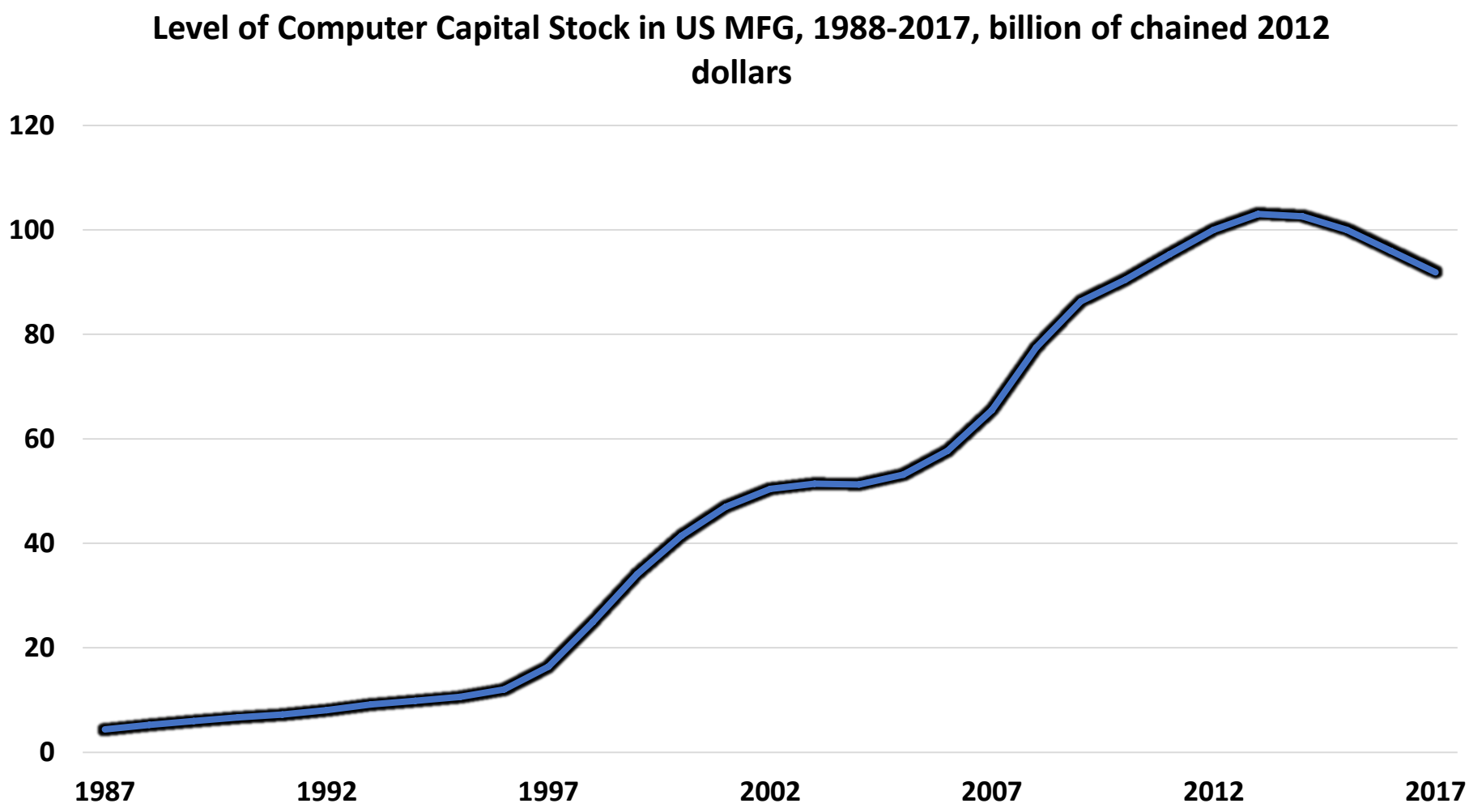
Growth in U.S. Manufacturing Capacity, 1953-2019



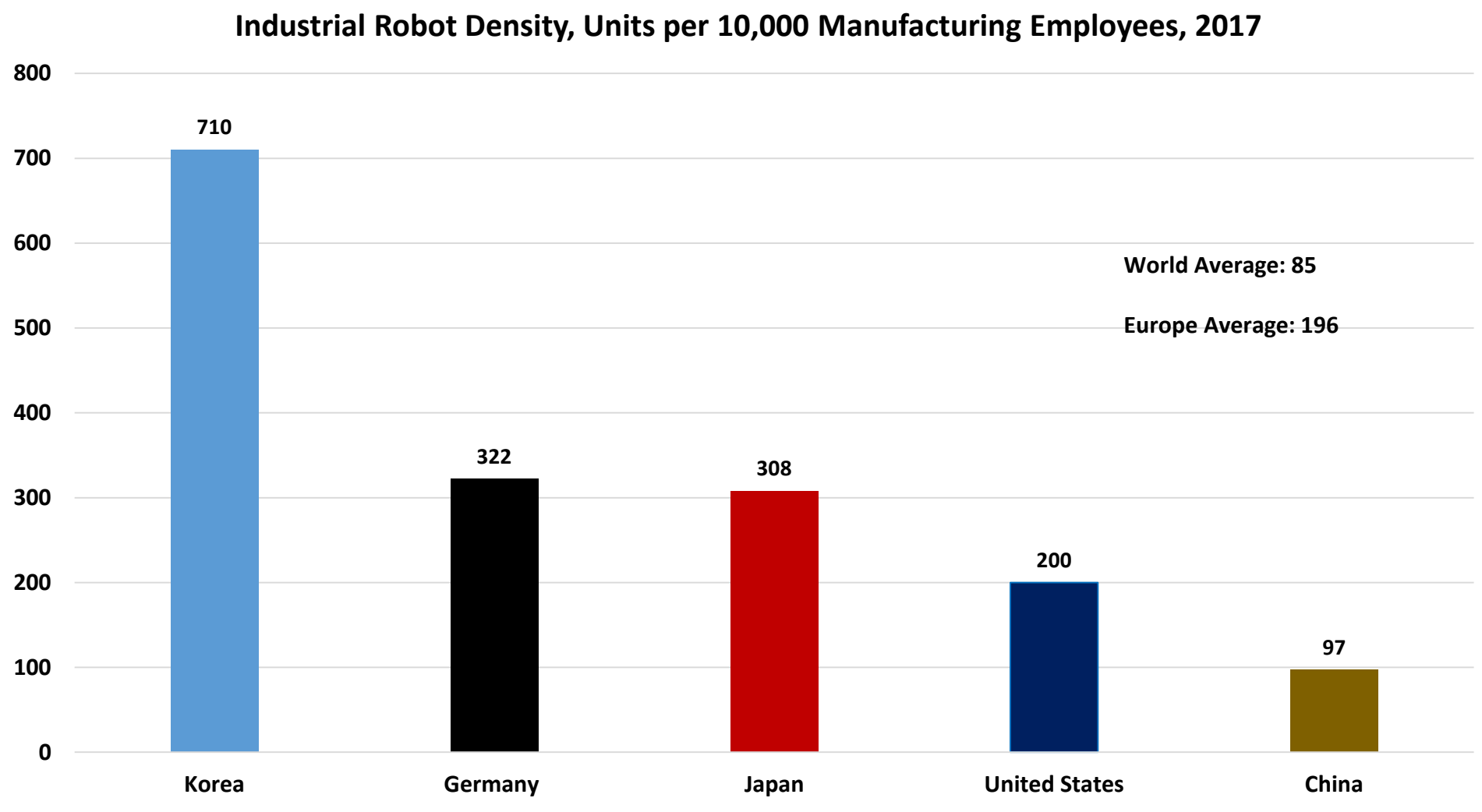
Level of U.S. Manufacturing Capacity, 1948-2019



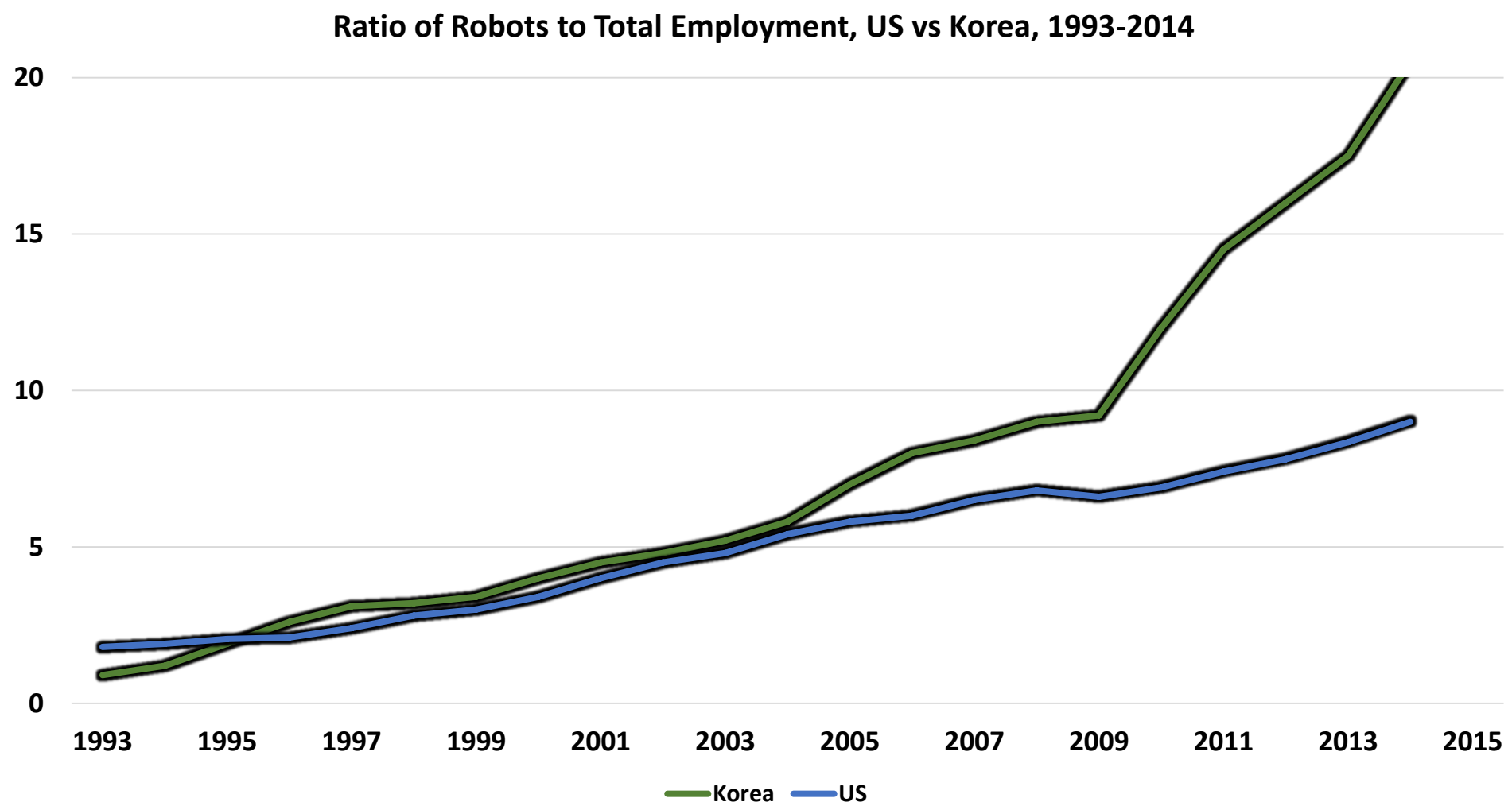
Level of Computer Capital Stock in US Manufacturing, 1987-2017



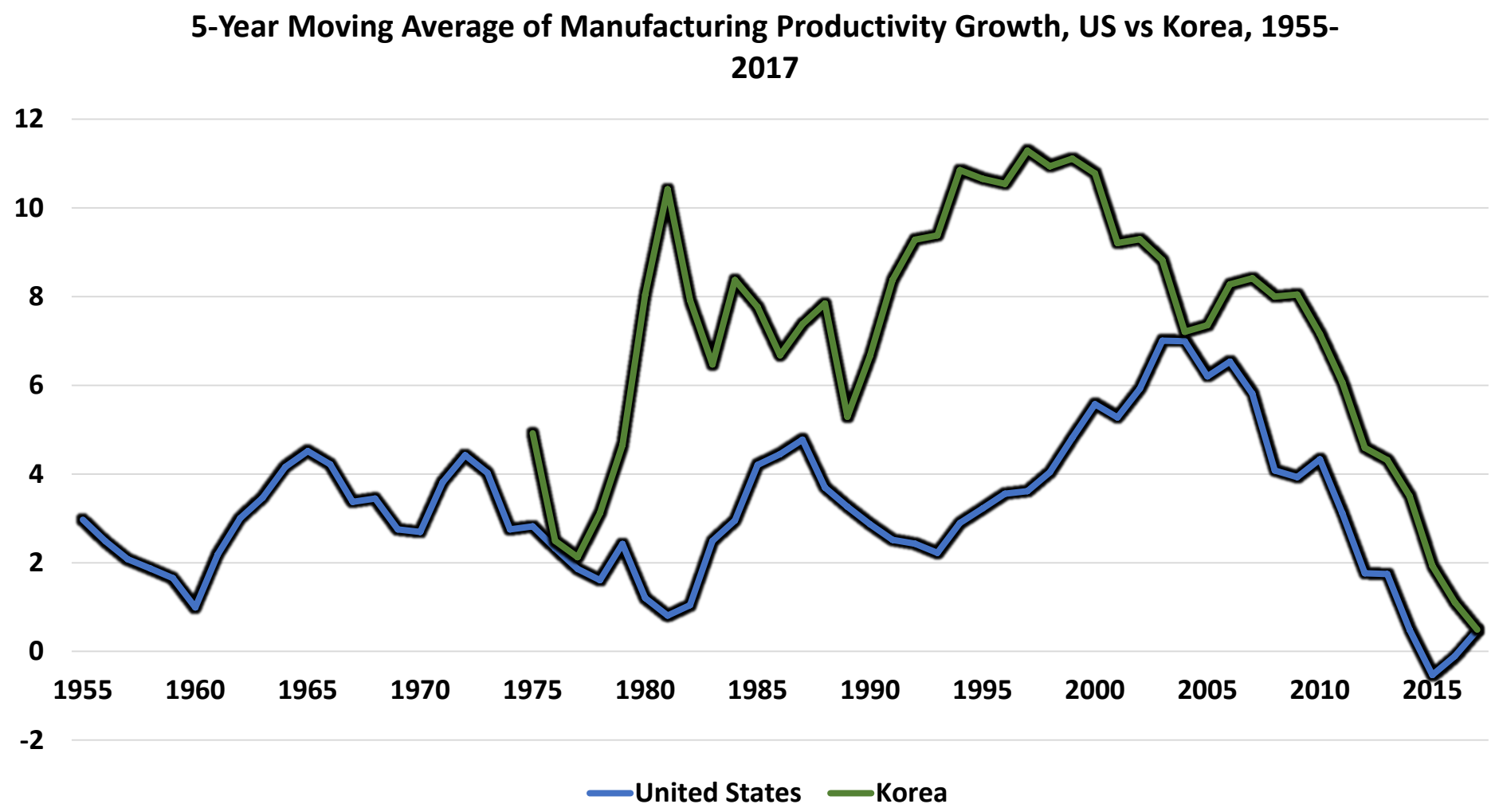
Robots per 10,000 Employees, Five Countries



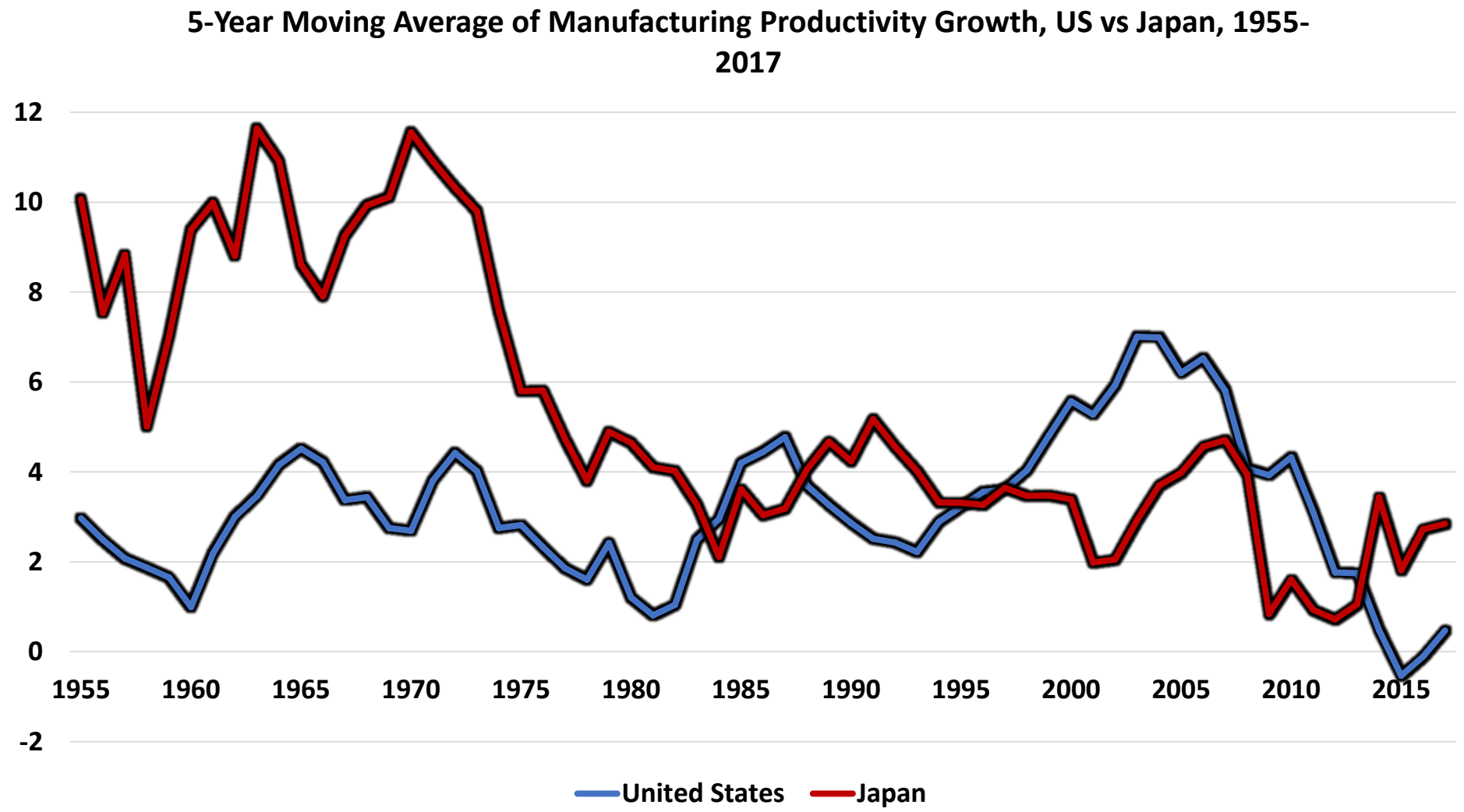
Robot Ratio, U.S. vs. South Korea, 1993-2014



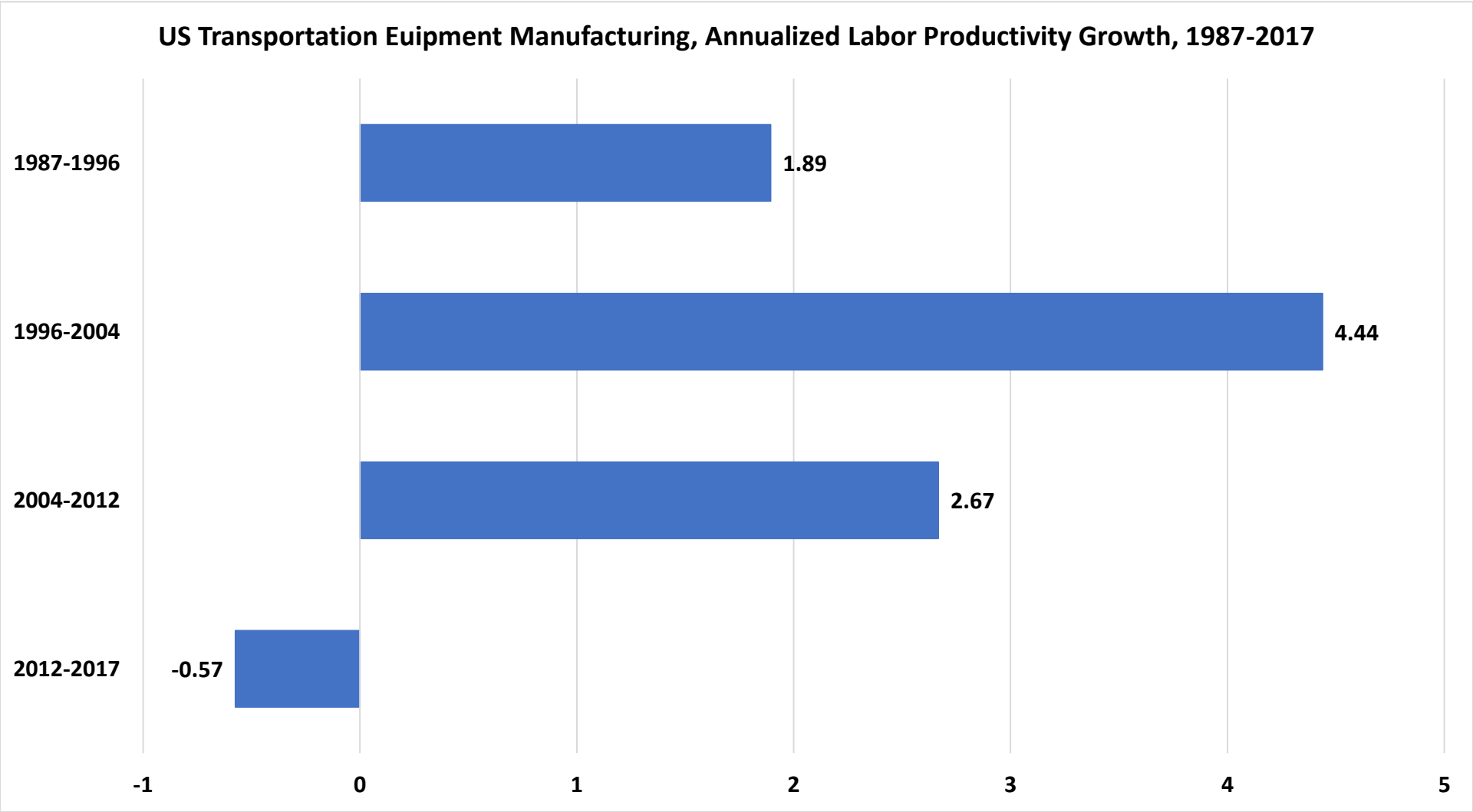
Manufacturing Productivity Growth, U.S. vs. S.K., 1955-2017



U.S. vs. Japan, 1955-2017 Average Growth Rate Identical, 1978-2017!



Do Robots Boost Productivity? Transport Equipment 1987-2017



The Kawaguchi Paper on Robots

- Important contribution to make CZ the unit of observation
- Detailed data on 300+ CZ's – employment, population, age, sex, education, industry
  - A major achievement creating the data
- The question is the effect of robots on these variables by CZ, but no data on robots in each CZ

Projecting CZ Robot Data from Industry Robot Data

- 2002-17 robot growth in a CZ is set equal to the industry share in that CZ times aggregate robot growth in that industry
  - Transport equipment has far more robot growth than any other industry
- Endogeneity problem
  - Demand shock for an industry raises employment and robot growth
  - Solution: substitute German robot growth by industry as an IV

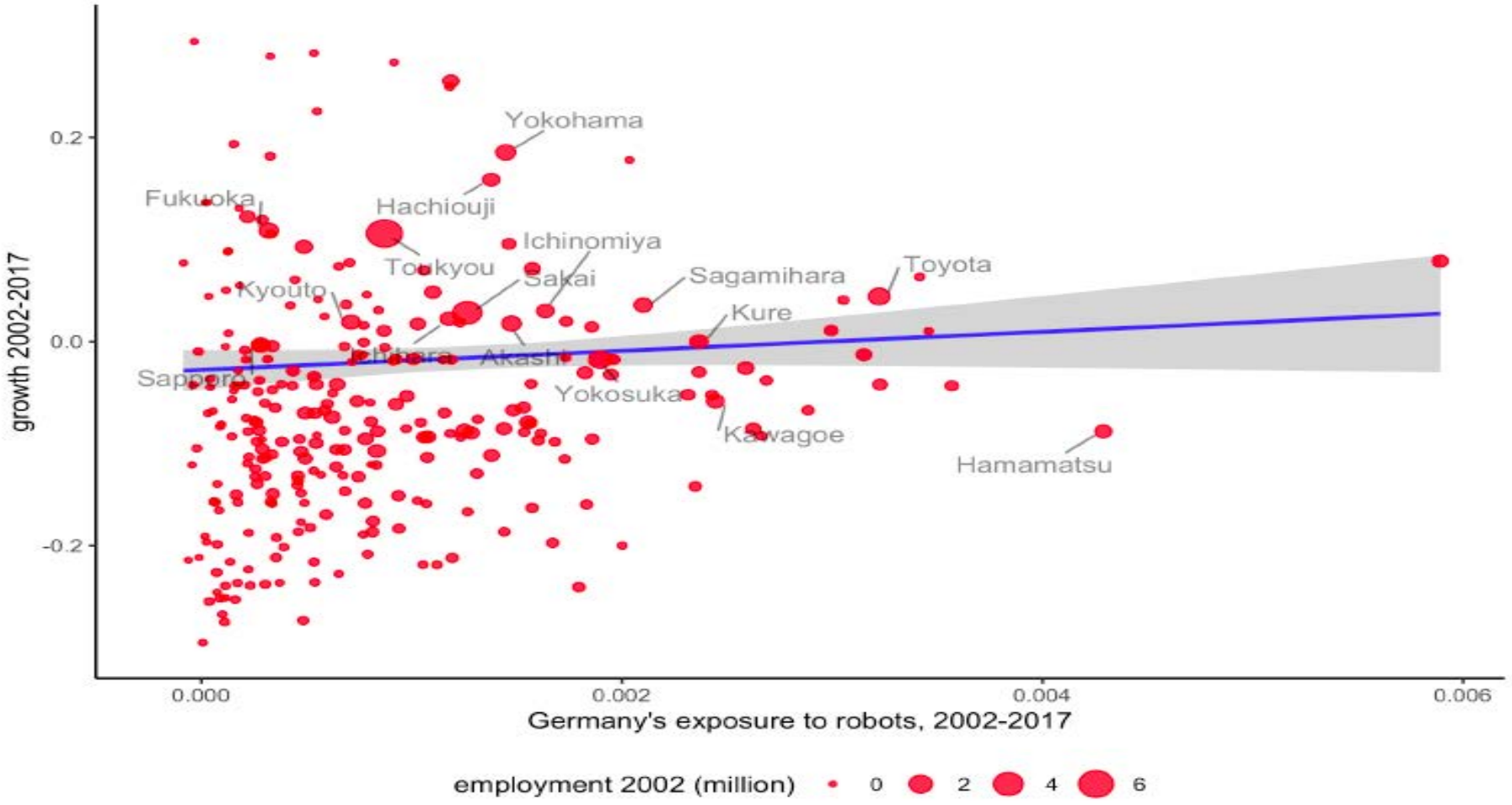
Surprising Results

- Faster robot growth in a CZ raises employment, boosts population even more, thus reduces empl/pop ratio
- Results overturn previous research
  - Frey-Osborne on job losses from automation
  - Acemoglu-Restrepo on 6 jobs lost per robot
- Explanation for greater rise in population?
  - "Local multiplier effect"
  - "Gain in jobs in service sector"

Comments on Results

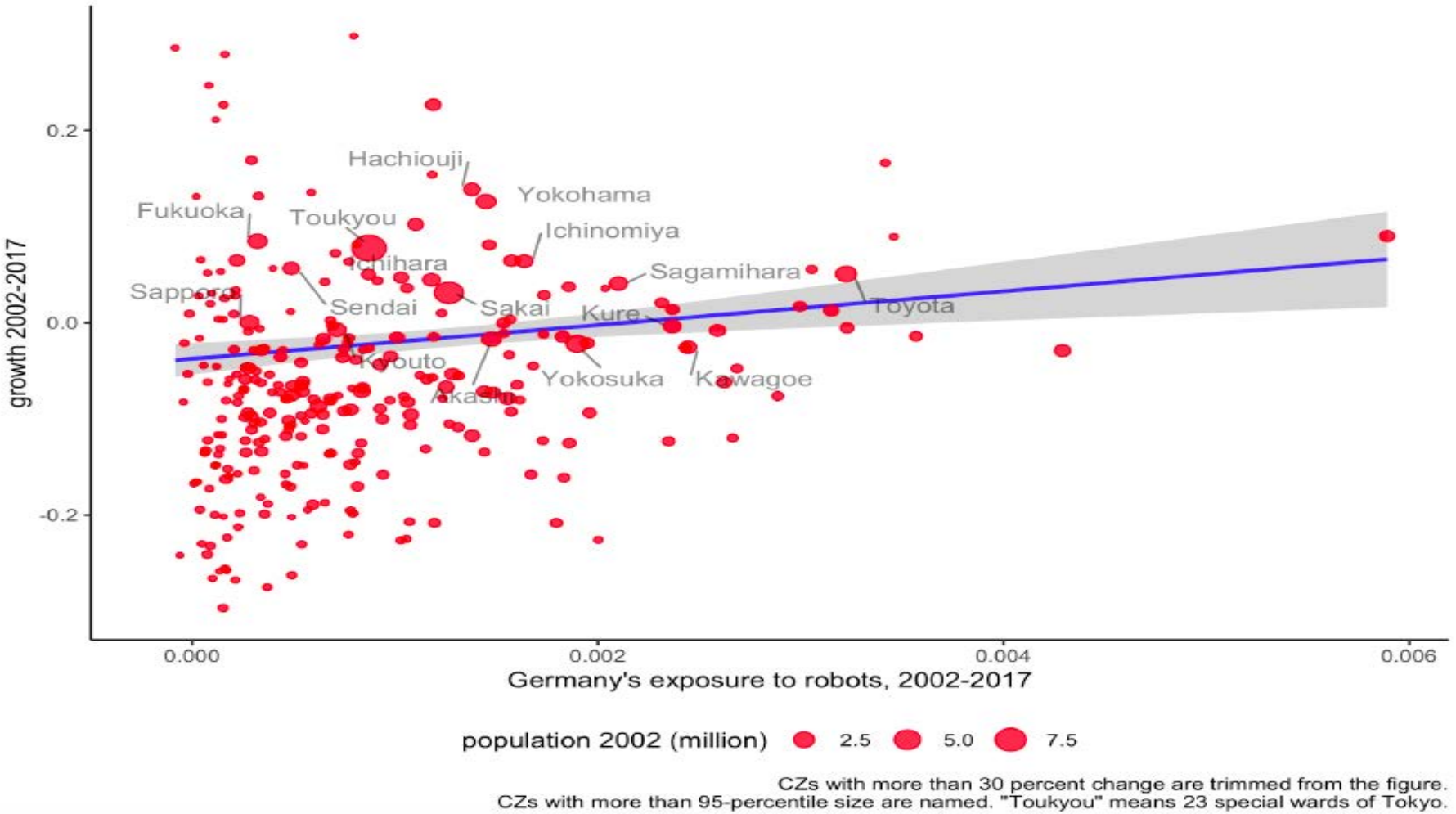
- Very high correlation between Japan and Germany in industrial distribution of robots
  - Thus IV solution to endogeneity problem is unconvincing
- Figure 6, empl/pop is almost uncorrelated with robots, regression line almost flat
  - Results depend on a few observations of CZ's with high share of transport equipment
- Figures 7 and 8, both empl and pop are positively correlated with robots. Why?

Reduced Form, Employment Rate



CZs with more than 30 percent change are trimmed from the figure.
CZs with more than 95-percentile size are named. "Toukyou" means 23 special wards of Tokyo.

Reduced Form, Population Growth



Alternative Explanation

- Robot variable (change per 1000 employees 2002-2017) very skewed.
  - Transport equipment +19
  - 13 industries -3 to +0.3
  - Remaining 6 industries -12 to -4
- So result that high robot change raises empl and pop amounts to saying
  - "CZ's intensive in motor transport had above-average growth in empl and pop"
  - Many CZ's dominated by other industries had population decline. The "Japan Rust Belt"

Shinozaki Paper on AI

- **Paper studies effects of AI on hours, employment, and three components of NRTI *(reminds me of airport code NRT)***
- **Results show very slight (4%) reduction in hours/employee in group "with AI" relative to group "without AI"**
- **Surprisingly, AI – which would be expected to replace routine tasks – raised "repetition" task NRTI1**

Measurement Issues

- Unlike the robot paper, this paper does not use government or industry data
- It is based on their survey of employees and managers
- But results on hours/employee and task intensity are reported only for the employee survey
- Primary emphasis on change in hours per employee reported by employees.

Measurement of AI, "Treatment" vs. "Control" Groups

- The Kawaguchi robot paper found a spectrum of robot change intensity
- This paper has no spectrum, either "AI Added Last 5 Years" or "No AI"
- No consideration of a third category, "AI already present 5 years ago so no change"
- No discussion of what qualifies as AI
- Minority AI, 212 / 2266 observations

Difference-in-Difference Methodology

- Treatment group is compared to control group
- In robot paper we learned that firms with large robot change were different also because they made motor vehicles
- Here there is no information on what kinds of firms are in AI group compared to no-AI group
- They may be different in important ways related to employment growth

The Measurement of Hours

- Employees are asked for change in hours compared to 5 years ago
  - This concept is hours/employee not aggregate hours. Do salaried employees work fixed hours
  - How can an employee remember how many hours worked 5 years ago?
  - Substitution from AI we're concerned with total hours and employment, not hours/employee
- Survey: only employees who remained.
  - Departing employees excluded, minimizes loss
  - New employees have no recall of past hours

Employee Survey vs. Manager Survey

- Preferable to use manager survey
- Can distinguish change in aggregate employment, hours/employee, and aggregate hours
- Managers may have records of employee hours that employees cannot recall
- Managers know how many employees have departed, total count of employees compared to five years ago
- Note conflicting results, AI reduces hours/employee but increases employment

Task Intensity Measures

- **NRTI1 = repetition**
- **NRTI2 = decision making**
- **NRTI3 = communication**
- **Can all tasks be accurately characterized by these three categories? What about other tasks?**
- **Major part of paper is devoted to estimating AI effects on changes in hours by task.**
  - **Same question: Can employees remember 5 years ago?**
- **Surprise! "repetition" task hours increased by AI, no significant AI effect on other tasks**

Detailed Results by Five Occupational Categories

- Significant reduction in hours/employee only for two of five occupations included
- No results reported for employment
- Significant increase in repetition NRTI1 for only two of five occupations included
- Significant increase in decision making NRTI2 for only one of five occupations included
- No significant effect for communication NRTI3 in any occupation

Authors' Conclusions

- Reduction in hours/employee and increase in employment reveals presence of both substitution and complementarity
  - This set of conflicting results can be questioned because of the defects in measuring hours/employee from an employee survey
- Increase in "repetition" task
  - True for only 2/5 occupations
  - Even more severe memory problems of what tasks were performed 5 years ago
- Future Research: survey managers not employees