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RETURN OF THE SOLOW PARADOX?

SUMMARY

- ▶ The authors tried to illustrate that Solow Paradox may not be resolved yet by using detailed data from the US manufacturing sector.
- ▶ They found productivity growth in IT-intensive manufacturing industries depends on the measure of IT intensity and is never visible after the late 1990s.
- ▶ More importantly, when present, productivity growth is driven by declining relative output accompanied by even more rapid declines in employment.

- ▶ What is Solow Paradox?
- ▶ Why did the author perform analysis on such a topic?
- ▶ What are the methods used and how did the authors interpret the results?
- ▶ Critical thinking: counterpoints from the authors themselves.
- ▶ Plausible results and further tests

WHAT EVERYONE FEELS TO HAVE BEEN A TECHNOLOGICAL REVOLUTION, A DRASTIC CHANGE IN OUR PRODUCTIVE LIVES HAS BEEN ACCOMPANIED EVERYWHERE BY A SLOWING-DOWN OF PRODUCTIVITY GROWTH, NOT BY A STEP UP.

Robert Solow on computers, 1987

US WORKPLACES HAVE BEEN, AND WILL CONTINUE TO BE, AUTOMATED AND TRANSFORMED BY INFORMATION TECHNOLOGY CAPITAL.

Brynjolfsson and McAfee, 2011

WHY DID THE AUTHOR PERFORM ANALYSIS ON SUCH A TOPIC?

- ▶ All sectors – particularly IT-intensive sectors – are experiencing major increases in productivity.
- ▶ IT-powered machines will increasingly replace workers, ultimately leading to a substantially smaller role for labor in the workplace of the future.

EVEN MORE URGENT FACT

- ▶ “race against the machine” has already been run and workers have lost
- ▶ evidence: robust US productivity growth and negligible growth rates of median US worker compensation

INFORMATION TECHNOLOGY AND LABOR PRODUCTIVITY

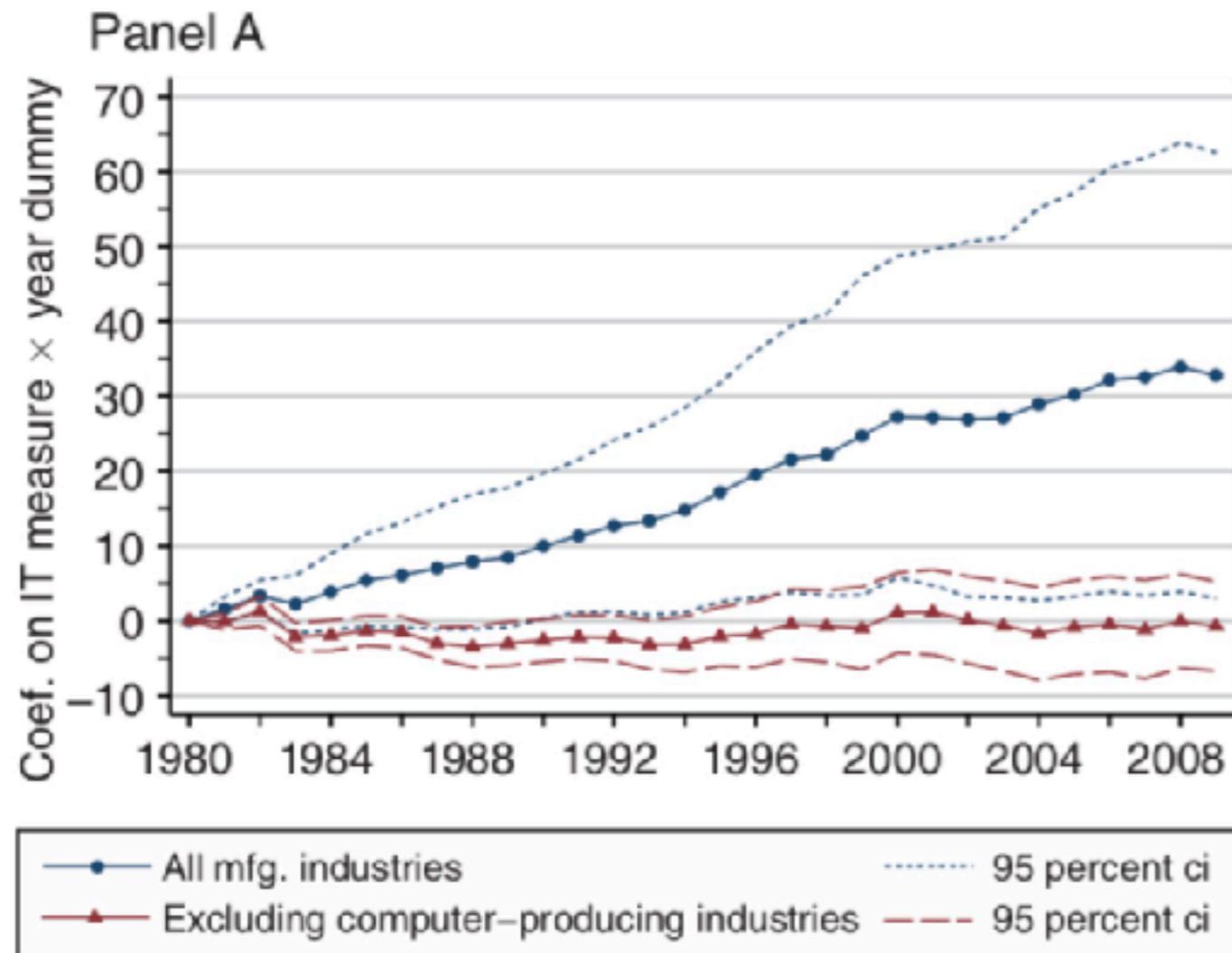
- ▶ Regression analysis

- ▶ relationship between IT investment and industry-level outcomes 1980-2009.

$$\log Y_{jt} = \gamma_j + \delta_t + \sum_{t=81}^{09} \beta_t \times IT_j + e_{jt}$$

- ▶ IT is the fixed IT intensity (average across the time period)
, ratio of industry computer expenditure to total capital expenditure.

TESTING PROCESS (1) PLOTS



- ▶ Over-time relationship between IT-intensity and the log of real shipments per worker (preferred productivity measure, unaffected by the choice of deflators for IT intermediate inputs).
- ▶ Blue line: dramatic differential rise in output per worker throughout the entire period.
- ▶ Red line: murky. By 2009, there is no net relative productivity gain in IT-intensive industries over the full sample period.

OUR FOCUS ON MANUFACTURING IS MISPLACED — PRODUCTIVITY GAINS FROM IT INVESTMENT ARE TAKING PLACE ELSEWHERE

- ▶ Evidence from Stiroh (2002) suggests that the IT-driven productivity growth in the 1990s was not specific to non-manufacturing and may in fact have been more pronounced in manufacturing.
- ▶ Productivity growth in US manufacturing has generally exceeded that outside of manufacturing for many decades.

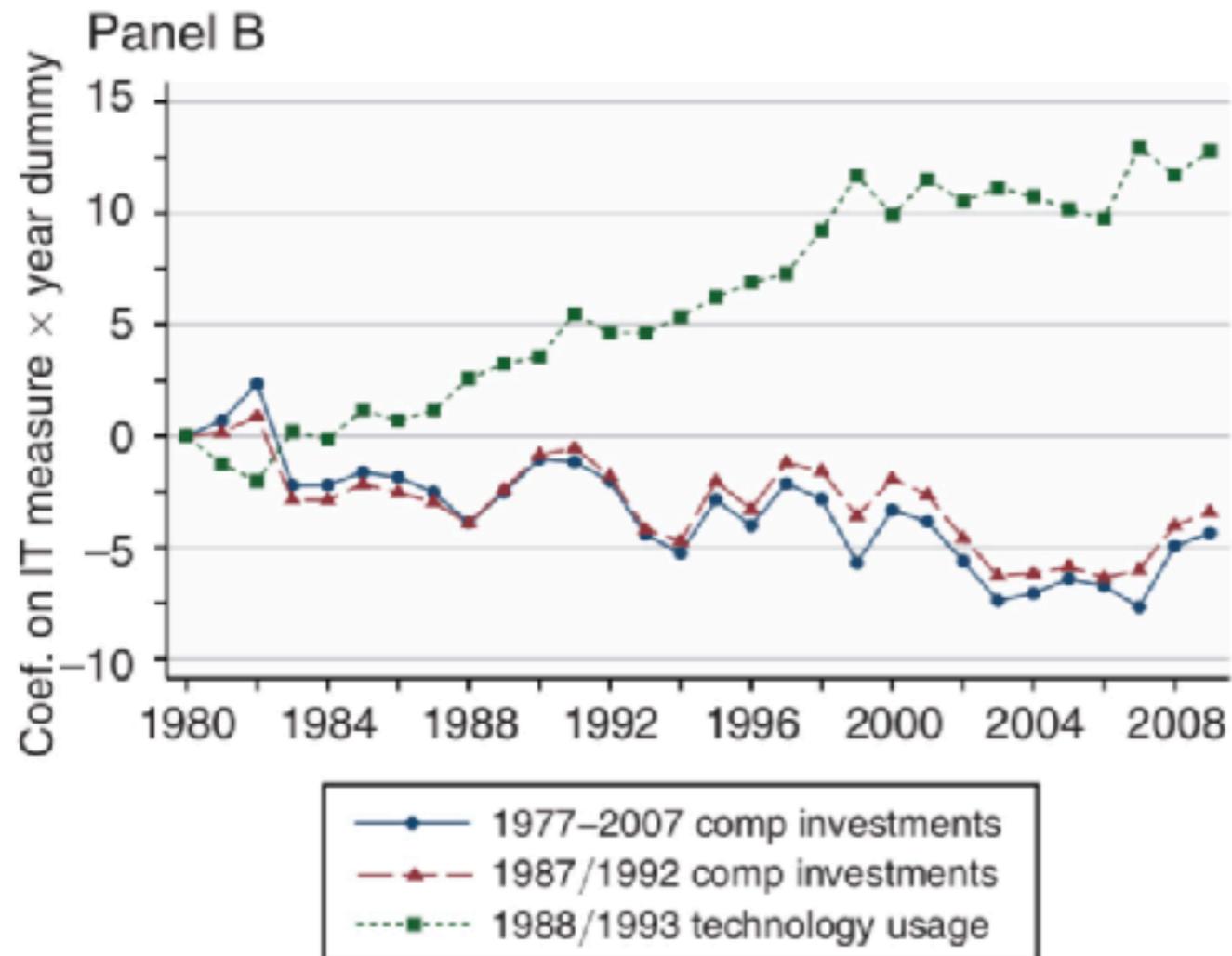
OUR MEASURE OF IT INVESTMENT, CONSTRUCTED BY AVERAGING COMPUTER INVESTMENT DATA FROM 1977–2007 MISSES THE MARK.

- ▶ People may argue most recent investment data can be more predictive of recent productivity growth.
- ▶ The authors used 3 different period of data, averages of 1977 and 1982, 1987 and 1992, and 2002 and 2007
- ▶ Results: strongest predictor of industry relative productivity growth during the 1990s is the 1977/1982 investment measure, whereas the most recent measure (from 2002/2007) is the weakest predictor.

IT INVESTMENT MEASURES MAY FAIL TO CAPTURE RECENT INNOVATIONS THAT ARE EMBODIED IN NEWER MANUFACTURING TECHNOLOGIES, SUCH AS AUTOMATED GUIDED VEHICLE SYSTEMS

- ▶ The authors did more research on this issue by exploiting data from the Census Bureau's Survey of Manufacturing Technology (SMT), which surveyed plants about their use of 17 advanced manufacturing tech.
- ▶ Changes made for this analysis:
 - ▶ Computer investment measure -> SMT based measure
 - ▶ Excluding computer-producing industries, focusing on induced productivity gains in IT-using industries.

TESTING PROCESS (2) PLOTS



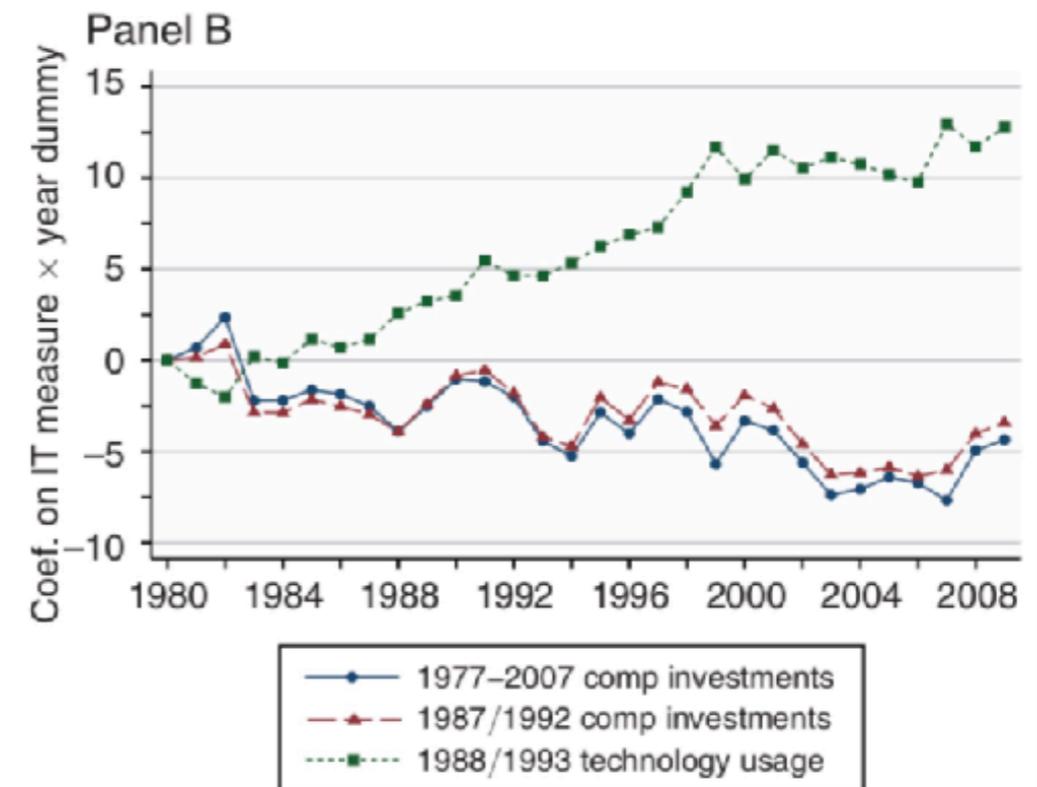
- ▶ The technology usage series defines SMT based measure of IT intensity. It documents labor productivity rose relatively rapidly in SMT-intensive manufacturing industries during the 1980s and 1990s.
- ▶ Neither the SMT nor the computer investment measure predicts a differential rise in productivity in IT-intensive industries after the late 1990s.

- ▶ Different measures of IT intensity thus appear to give different results
 - ▶ very limited IT-driven productivity growth in computer-intensive manufacturing industries
 - ▶ more rapid productivity growth in industries using advanced manufacturing technologies more intensively
- ▶ Adoption of high-tech, IT-related capital has contributed to rapid productivity growth in manufacturing. But...

WHAT DRIVES RISING Y/L: THE NUMERATOR OR THE DENOMINATOR?

$$\log Y_{jt} = \gamma_j + \delta_t + \sum_{t=81}^{09} \beta_t \times IT_j + e_{jt}$$

- ▶ What is Y ?
 - ▶ Log ratio of gross output to payroll employment.
 - ▶ Positive relationship
 - ▶ industry output is rising proportionately faster than employment in IT-intensive industries



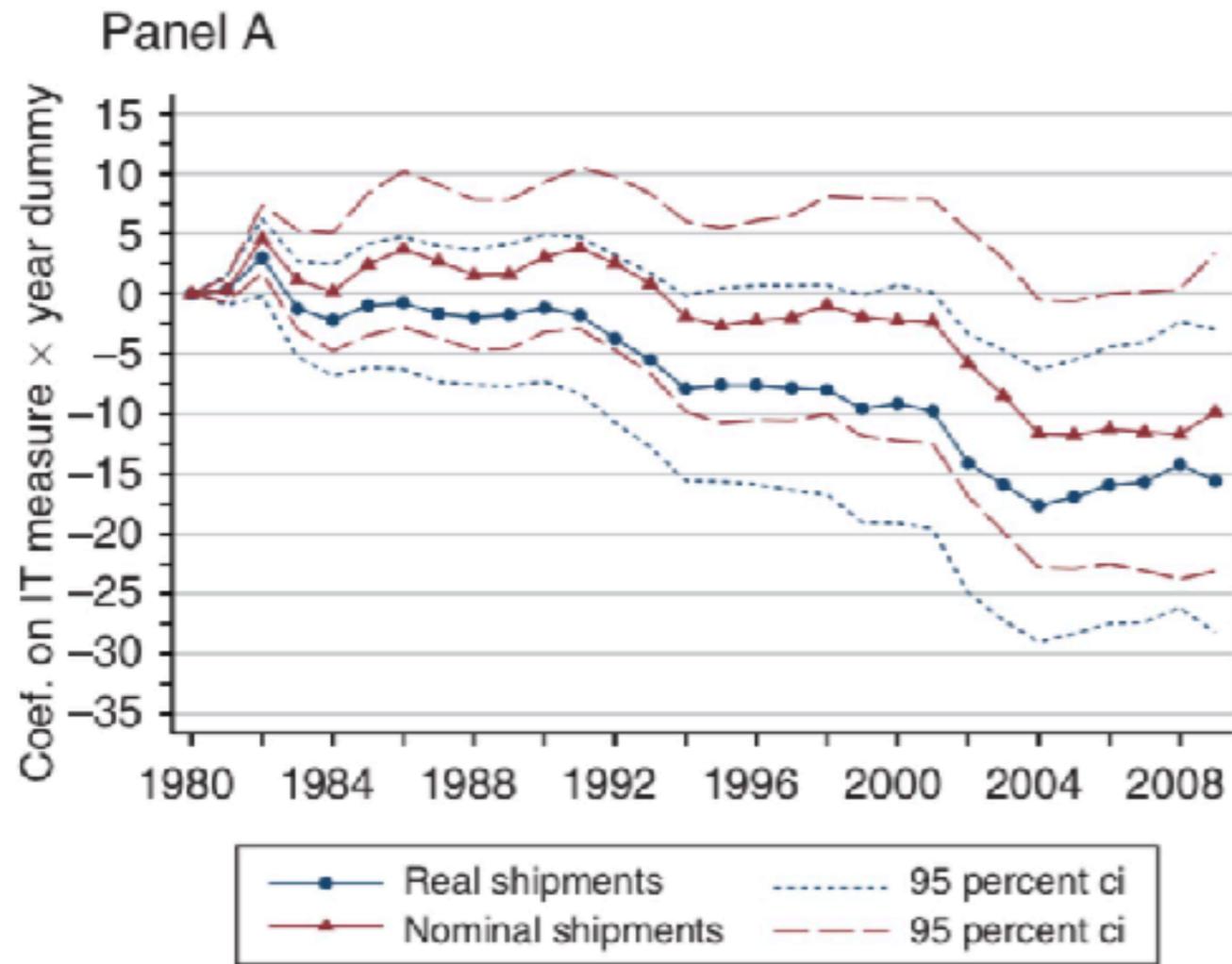


HOWEVER !

IT IS BECAUSE

- **Output is rising faster?**
- **Employment is falling faster?**

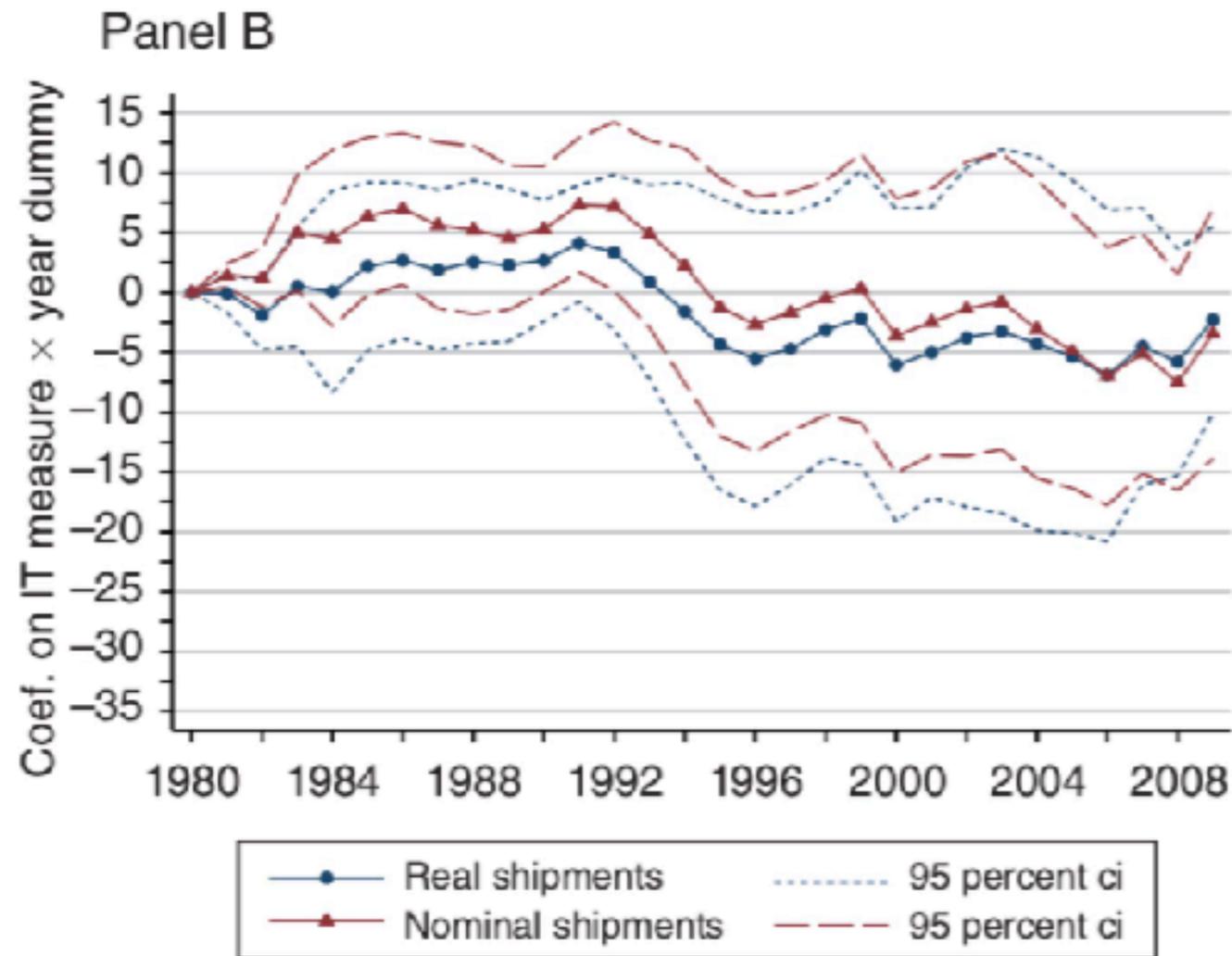
TESTING PROCESS (3) PLOTS



● Nominal / real = deflator

- ▶ Examine the numerator (gross output) first. Using computer investment
- ▶ If IT-intensive industries have upgraded their quality relative to other industries and this is not fully captured by the industry price deflators, this mismeasurement could explain the decline in real shipments but not the decline in nominal shipments.
- ▶ If it did capture the quality improvements, real shipments should not be declining.

TESTING PROCESS (4) PLOTS

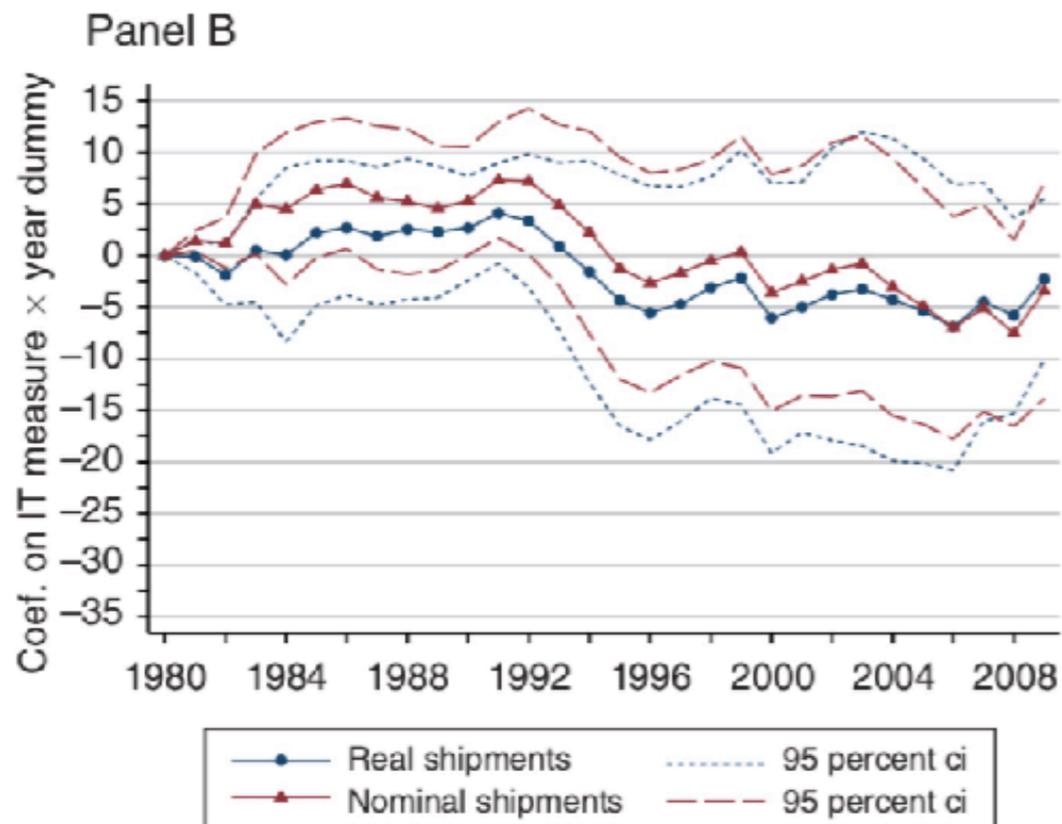
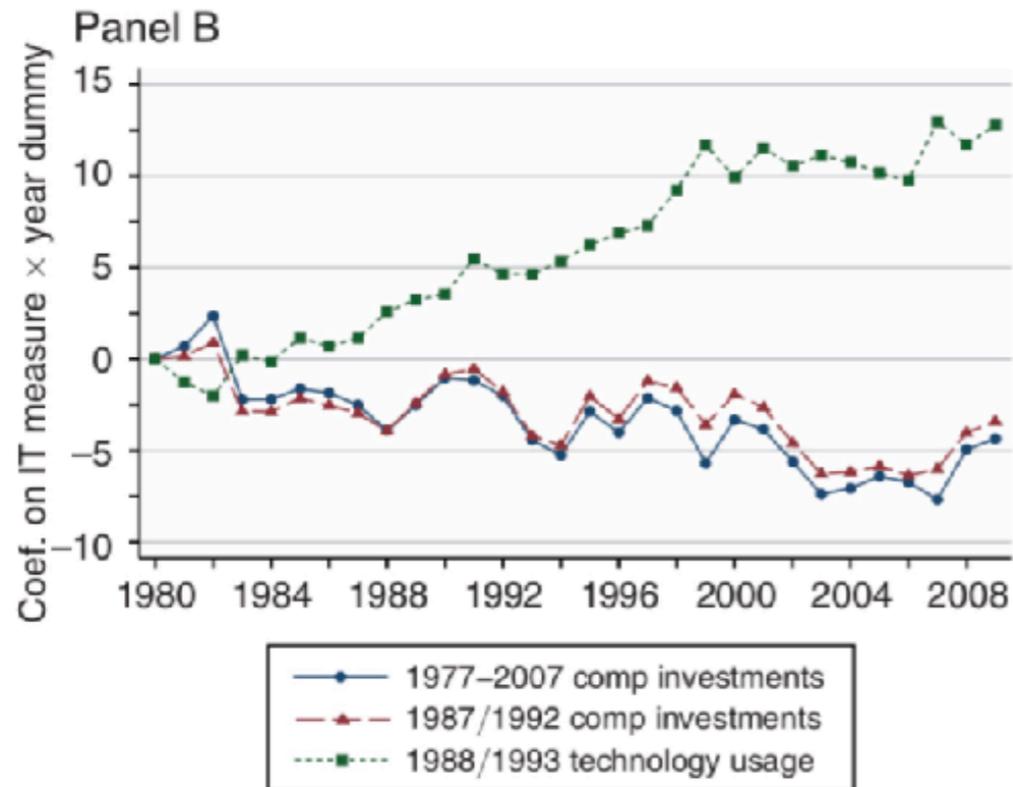


- Nominal / real = deflator

- ▶ Examine the numerator (gross output) first. Using SMT database
- ▶ we have detected previously a more robustly positive relationship between use of advanced manufacturing technologies and growth in output per worker
- ▶ however, both real and nominal shipments in industries that heavily adopted these technologies also exhibit a sharp relative decline between 1992 and 1996, with no rebound thereafter

CONCLUSIONS SO FAR...

- ▶ Rising log output per worker and falling log output in IT-intensive industries implies that log employment must have fallen even more rapidly than output in these industries



TESTING PROCESS (5) PLOTS

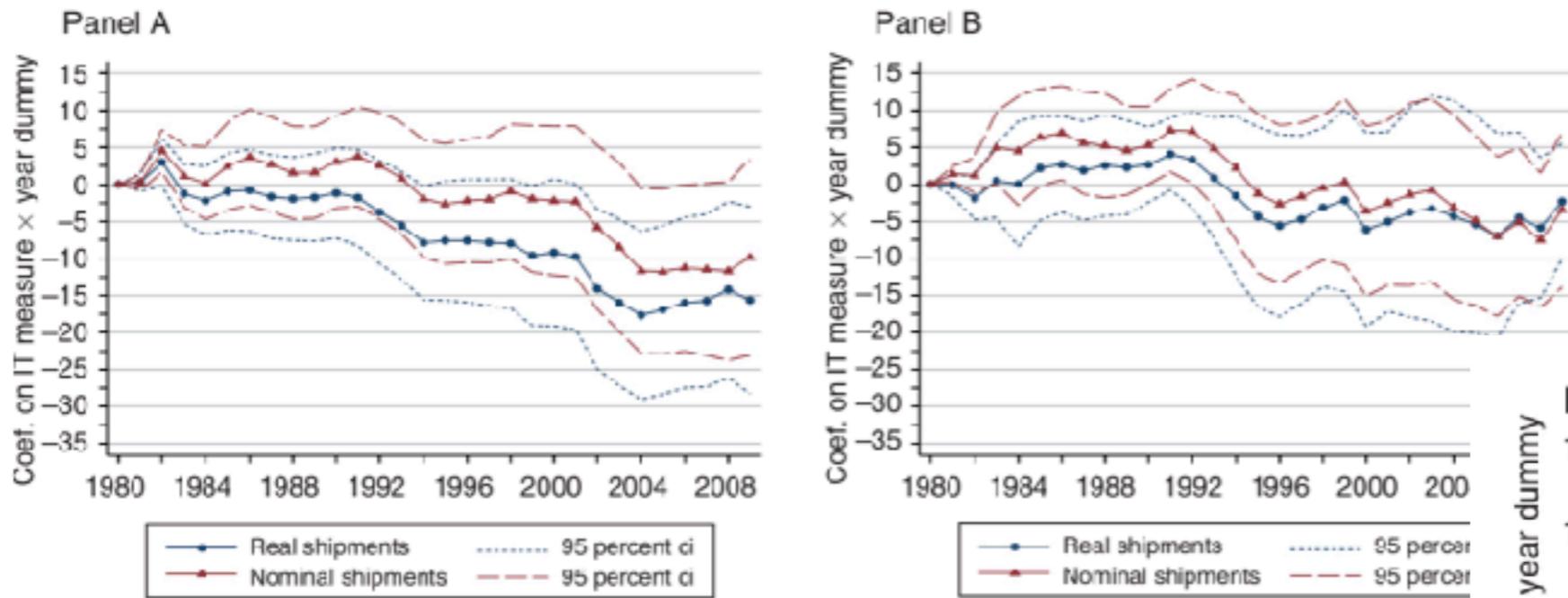


FIGURE 2. IT INTENSITY AND LOG REAL AND NOMINAL SHIPMENTS, 1980-2009

Notes: Panel A: $n = 359$ non-computer-producing manufacturing industries, and IT intensity is based on 1977-2007 c investments. Panel B: $n = 120$ non-computer-producing industries in SIC 34-38, and IT intensity is based on 1988/1993 technology usage. Real shipments are computed using industry-specific price deflators.

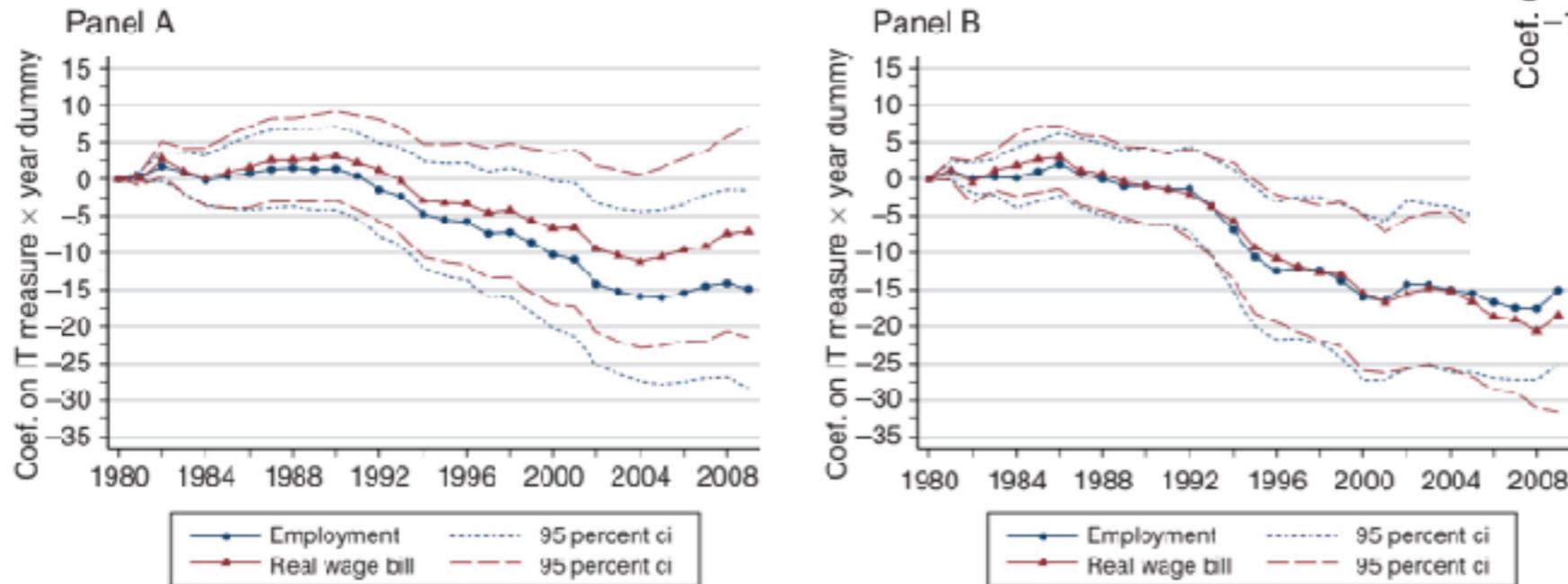
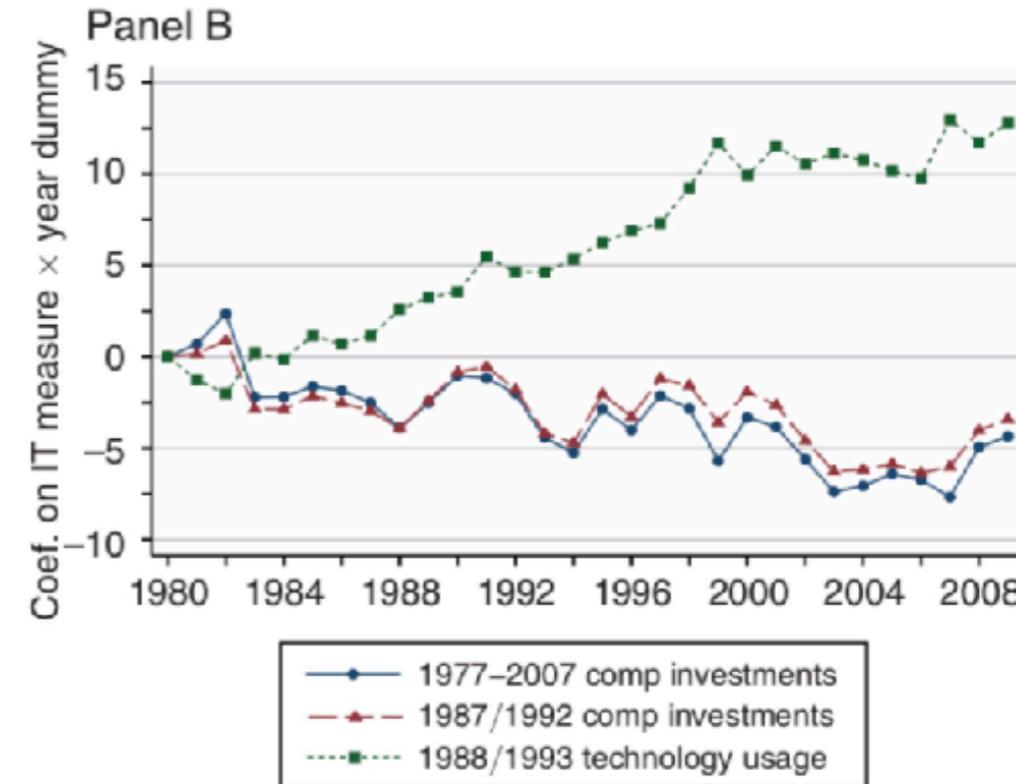


FIGURE 3. IT INTENSITY AND LOG EMPLOYMENT AND REAL WAGE BILL, 1980-2009



CONCLUSION

- ▶ The authors find some evidence of differential productivity growth in IT-intensive manufacturing industries, this depends on the measure of IT intensity and is never visible after the late 1990s.
- ▶ More importantly, when present, it is driven by declining relative output accompanied by even more rapid declines in employment.

THOUGHTS

- ▶ Throughout the paper, the authors utilized data from the Bureau and tried to only taking into accounts those IT-using or computer investing industries, which is questionable.
- ▶ investing/buying computers != actually using computers
 - ▶ What is the percentage of high level computer usage among those industries the authors chose?
 - ▶ how do we define "high level" computer usage?