Why Is Manufacturing Productivity Growth So Low?

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Motivation

- Traditional view: Manufacturing is a locus of innovation. In the U.S.:
    - Productivity growth in manufacturing is higher than elsewhere.
    - Manufacturing is 10 percent of employment, but generates ⅔ of patents and R&D spending. (Autor, Dorn, Hanson, Pisano, Shu, 2020)

Motivation and Questions

- Traditional view: Manufacturing is a locus of innovation. In the U.S.:
  - Productivity growth in manufacturing is higher than elsewhere.
  - Manufacturing is 10 percent of employment, but generates ⅔ of patents and R&D spending. (Autor, Dorn, Hanson, Pisano, Shu, 2020)
- Since the late 2000s: Manufacturing productivity growth is 0.

- Why has manufacturing productivity growth been so low?
  - To what extent is TFP growth mismeasured specifically in manufacturing?

This Paper

- BLS applies different sets of techniques to account for quality improvements when constructing the CPI, PPI, and Import Price Indices.
  - Posit CPI (and PCE) more comprehensively account for quality improvements
- BEA (Gross Output) Price Deflators rely primarily on PPI, especially in manufacturing.
- For goods (especially ICT goods): Gross Output Deflator Growth $\ll$ PCE Inflation.

$\Rightarrow$ BEA real output growth is understated.

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- For goods (especially ICT goods): Gross Output Deflator Growth $\ll$ PCE Inflation.

$\Rightarrow$ BEA real output growth is understated. But so, too, is real input growth for ICT goods.

- Use Input-Output Framework to estimate how much TFP is understated:
    - 0.8% (per year, '97-'23) in manufacturing; 1.7% in durables; 0.4% in nondurables; essentially 0 outside of manufacturing.
- Manufacturing TFP growth *has* slowed down, but is still growing (by 0.6%, annually, since 2009):
    - Corrected for mismeasurement, TFP growth is no longer concentrated in Computers and Electronics.

Related Literature

- To what extent do official price indices account for quality improvements?
  - Consumer price indices may miss key quality improvements (or more generally welfare gains): Byrne, Fernald, Reinsdorf (2016); Brynjolfsson, Collis, Diewert, Fox (2025)
  - Components of PPI may understate quality growth: Byrne (2015; IT Storage Equipment); Byrne and Corrado (2015; Communications Equipment); Byrne, Oliner, Sichel (2018; Semiconductors).
- Why has manufacturing productivity slowed down?
  - Computers play an important role in manufacturing sector’s recent trajectory: Syverson (2016), Houseman (2012, 2018), Sprague (2021).
    - Lashkari and Pearce (2024, 2025) argue that the decline in manufacturing TFP growth is more broad-based.

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To what extent is TFP growth mismeasured specifically in manufacturing?

We Compare Components of PCE to BEA Industry Gross Output Deflators to Infer Missing Quality Growth in Real Output Measures

- For output deflators (e.g., PPI→BEA Gross Output Deflators) and consumer price indices (e.g., CPI→PCE) statistical agencies need to control for quality improvements.
- But extent of these adjustments differ across series.
  - PPI applies hedonic quality adjustment only for computers, microprocessors (beginning in 2016), and broadband internet access (beginning in 2018).
  - Hedonic quality adjustment in PPI is “solely to capture changes in production costs directly connected to specific inputs” not those that raise the user value of the good. (Byrne, Fernald, Reinsdorf, 2016)
  - Output deflators may be understating quality improvements of high-tech products.
- If output deflators miss quality growth for a set of industries, TFP growth will be understated.
  - Need Input-Output Tables to account for the possibility that similar quality mismeasurement would apply to intermediate input prices.

Gross Output Deflators and the PCE Price Index Attempt to Measure Different Things.

- Gross Output Deflator (from BEA GDP by Industry data):
  - Prices paid to producing industries.
  - Excludes costs of distribution.
  - Includes commodities that are produced domestically.
  - Relies primarily on PPI, especially in manufacturing industries.
- PCE Price Index:
  - Prices paid by consumers.
  - Includes wholesale, retail, and transport margins.
  - Includes domestically sourced and imported commodities.
  - Relies primarily on CPI, especially in goods categories.

We Use the PCE Bridge to Compare Gross Output Deflators and Import Prices to PCE Inflation

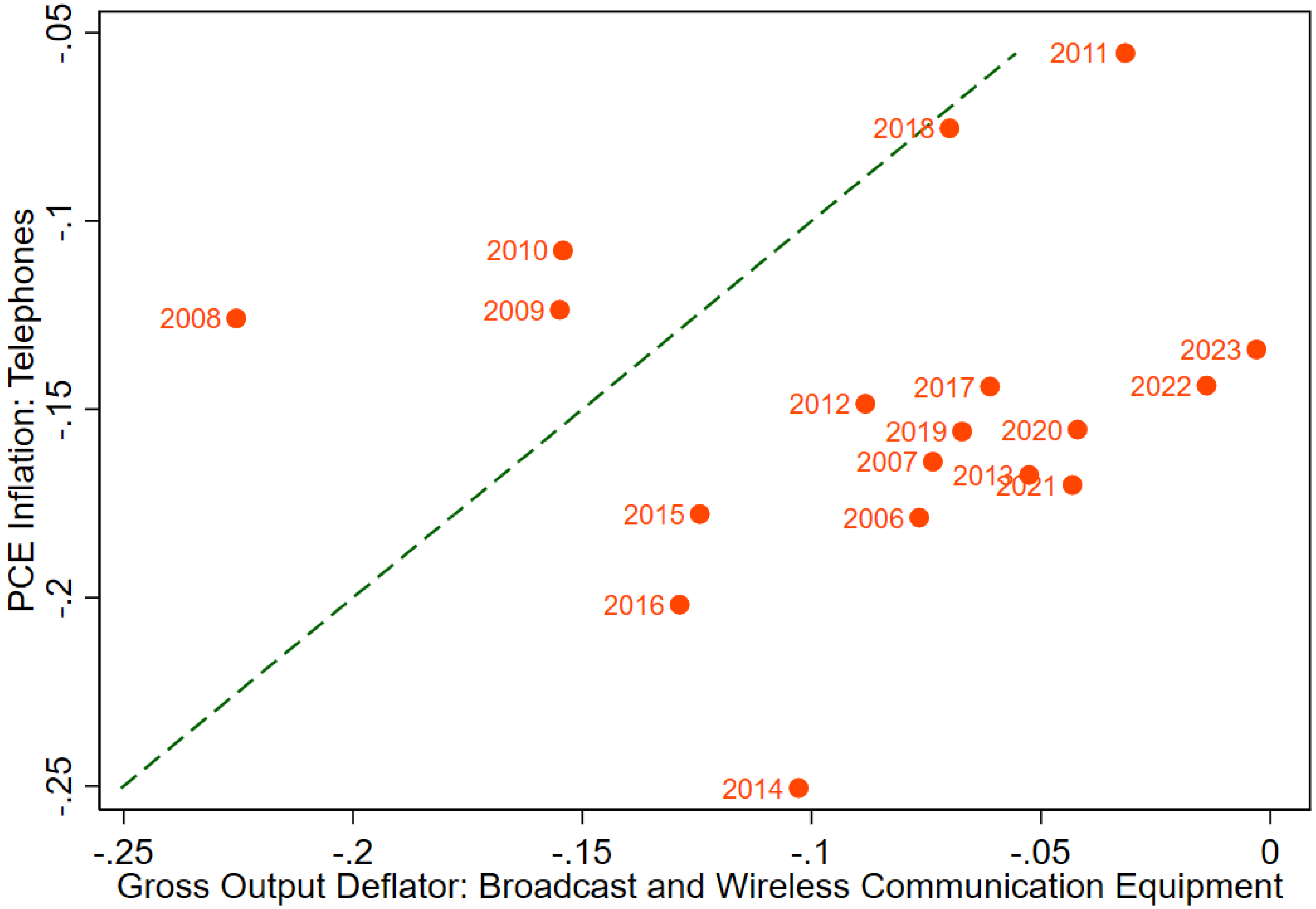
Compute an analogue of PCE inflation in a category, *c*, but using gross output deflators and import price indices:

$$\Delta \log \hat{P}_{t,c} = \sum_j s_{t,j \to c} \left[\left(1 - m_{t,j}\right) \Delta \log P_{t,j}^{GO} + m_{t,j} \Delta \log P_{t,j}^{\mathrm{Import}} \right]$$

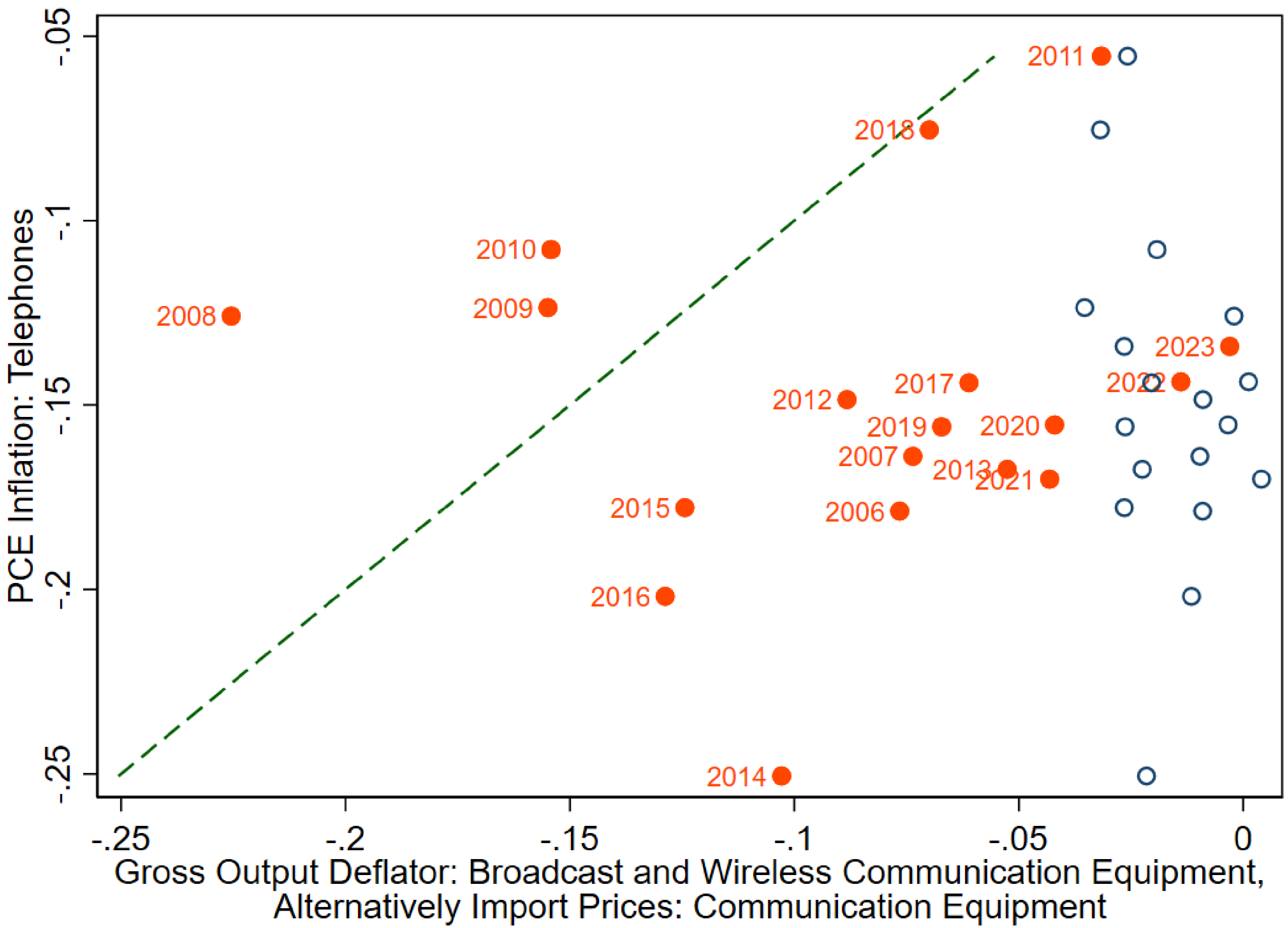
- $s_{t,j \to c}$: Share of PCE category *c* that comes from commodity *j.*
  - Measured using "PCE Bridge Table"
- $m_{t,j}$: Share of consumption of commodity *j* that is imported.
- $\Delta \log P_{t,j}^{\mathrm{Import}}$: Price growth of imports of *j.*
- $\Delta \log P_{t,j}^{\mathrm{GO}}$: Price growth of output of *j.*

Next few slides: $\Delta \log \hat{P}_{t,c}$ (and $\Delta \log P_{t,j}^{GO}$) >$\Delta \log P_{t,c}^{\mathrm{PCE}}$

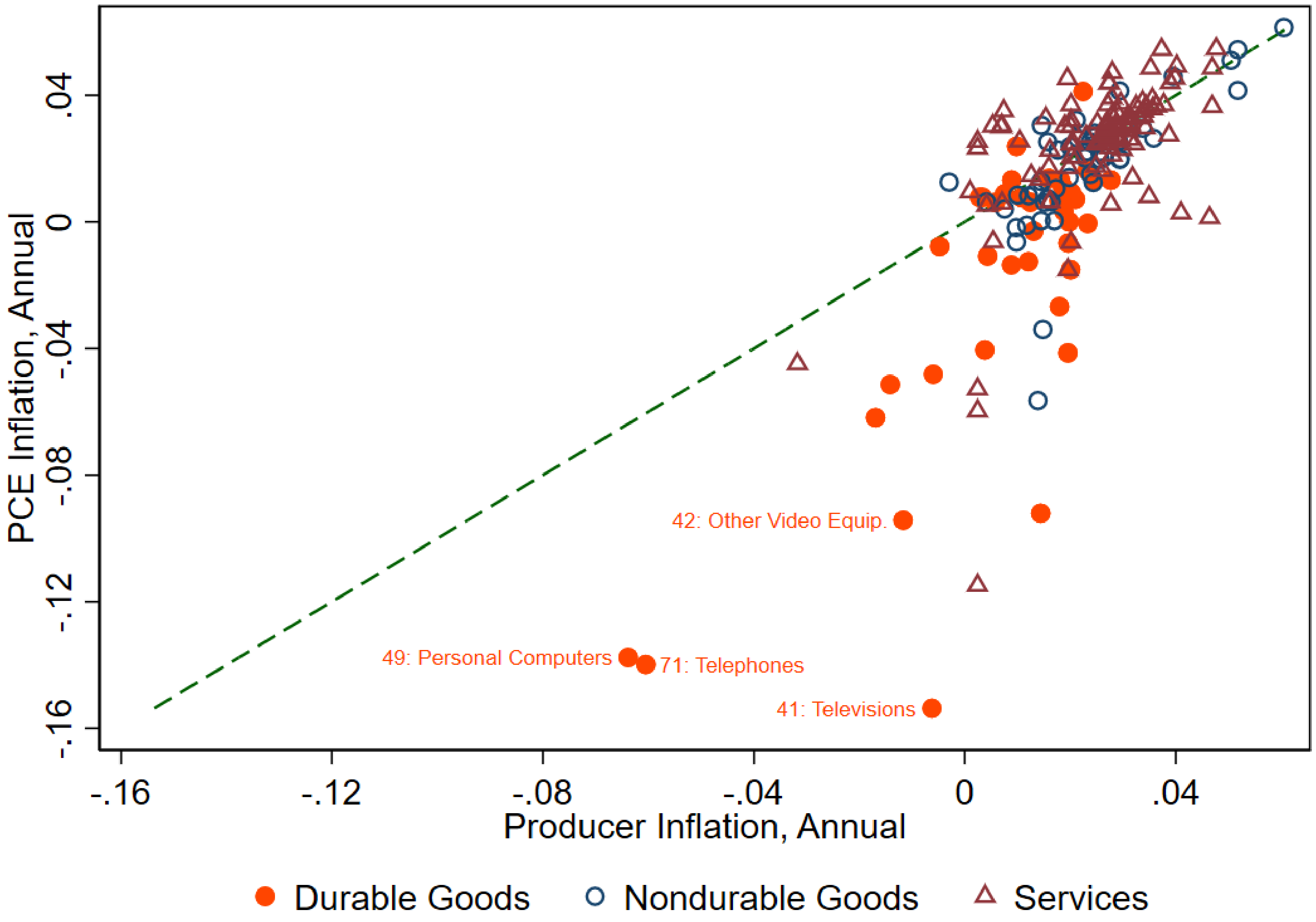
For Telephones: PCE Inflation ≪ Output Price Inflation



For Telephones: PCE Inflation ≪ Output Price / Import Inflation



For Many Durable Goods: PCE Inflation≪ Output Price / Import Inflation



Gap: 2.6 p.p. for durable goods; 1.1 p.p. for nondurable goods; -0.1 p.p. for services

To Compute Industries' TFP Mismeasurement, we Compare Output Price and Input Price Mismeasurement

- Output price is a function of TFP and Input Prices:

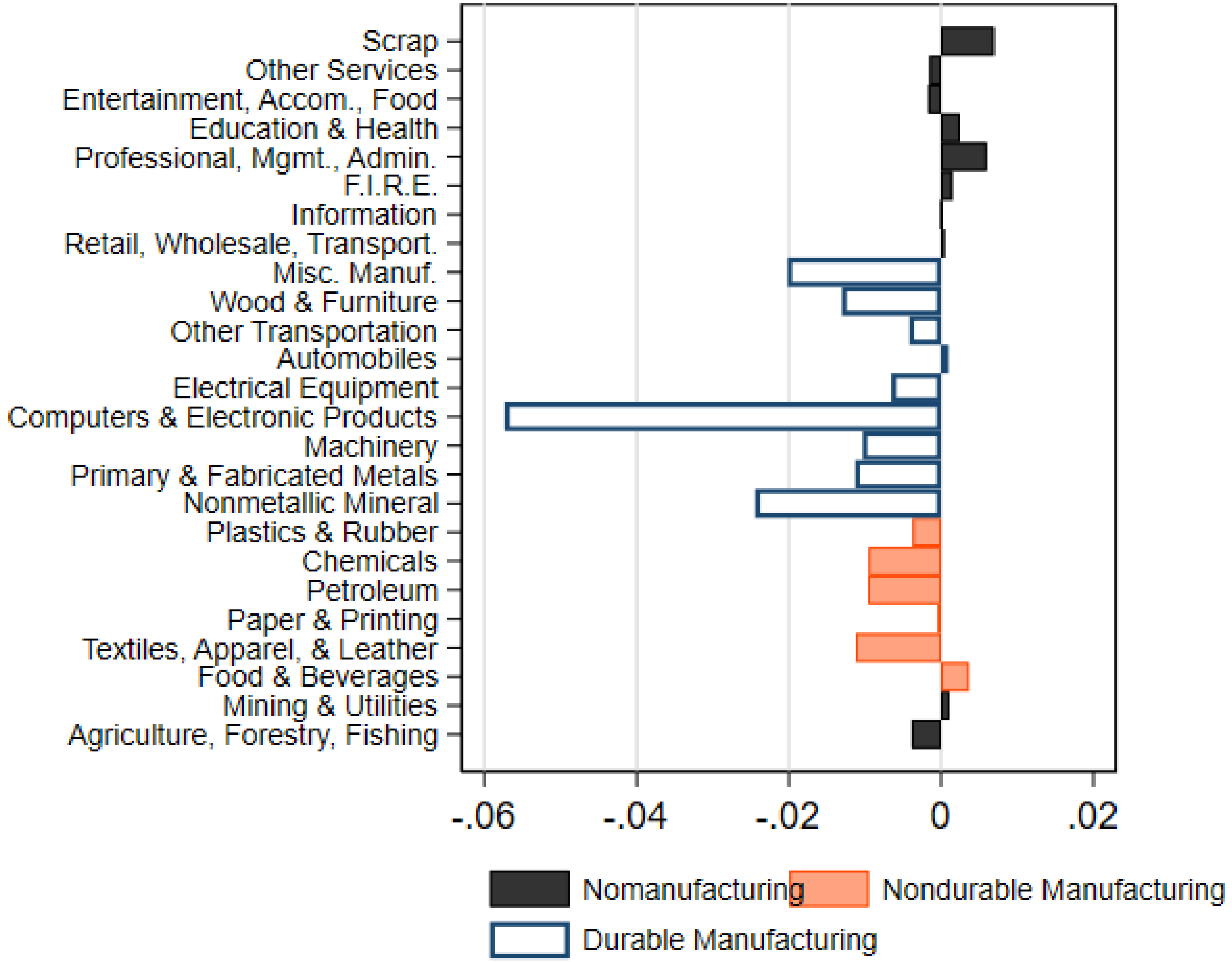
$$\Delta \log P_{tj}^{\mathrm{GO}} = \Delta \log A_{tj} + \Delta \log P_{tj}^{\mathrm{Input}}$$

- Mismeasurement in TFP is a function of mismeasurement in output and input prices.

$$\Delta \log \tilde{A}_{tj} = - \underbrace{\Delta \log \tilde{P}_{tj}^{\mathrm{GO}}}_{\substack{\text{output price} \\ \text{mismeasurement}}} + \underbrace{\sum_i \gamma_{t,i \to j} \left[(1 - m_{ti}) \Delta \log \tilde{P}_{ti}^{\mathrm{GO}} + m_{ti} \Delta \log \tilde{P}_{ti}^{\mathrm{Import}} \right]}_{\text{mismeasurement of intermeidate input prices}}$$

- Use the gaps from the previous slide to infer $\Delta \log \tilde{P}_{ti}^{\mathrm{GO}}$ and $\Delta \log \tilde{P}_{ti}^{\mathrm{Import}}$

From 1997 to 2023: Manufacturing TFP Growth Is Understated by 0.8 p.p.: 1.7 p.p. in Durables, 0.4 p.p. in Nondurables



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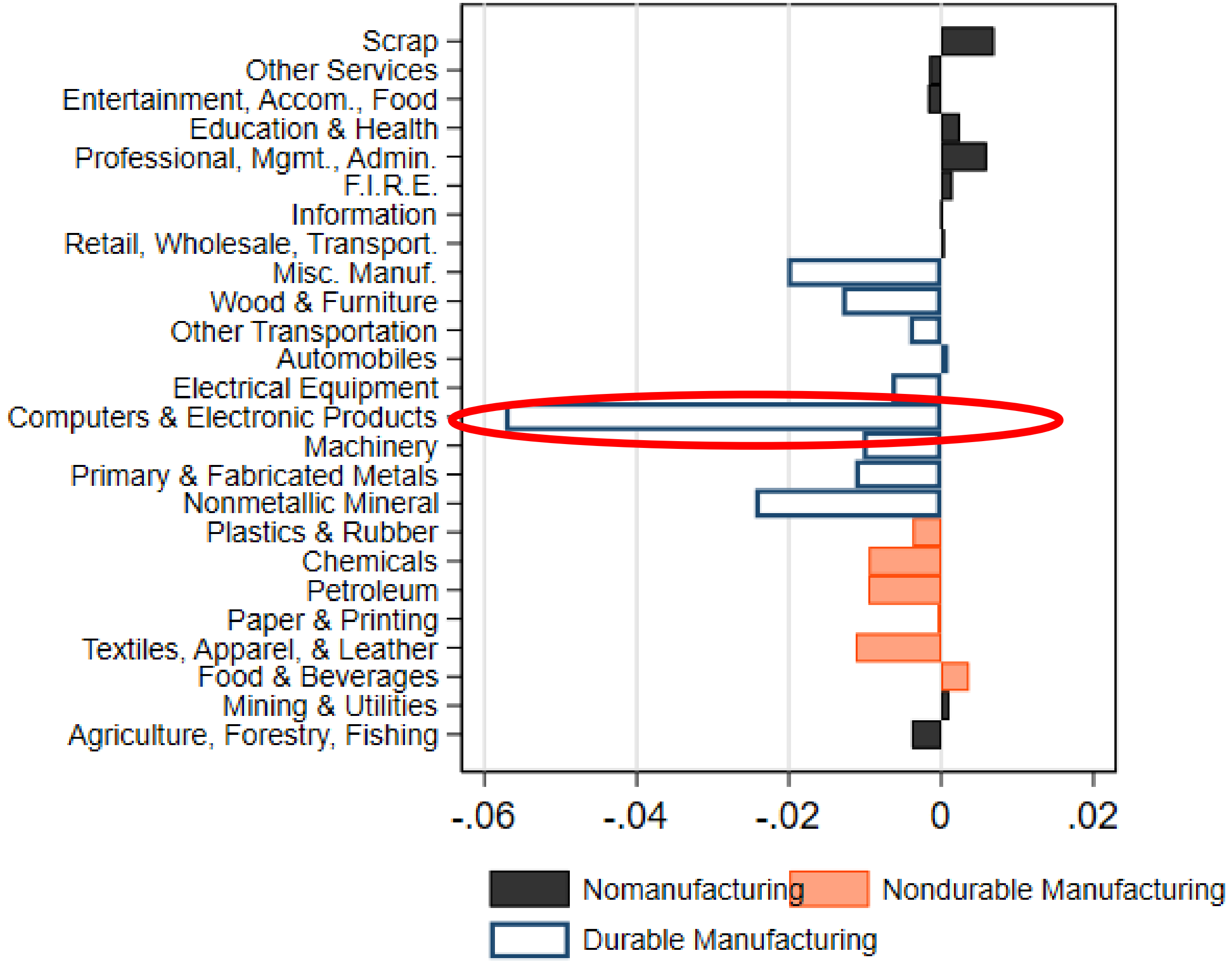
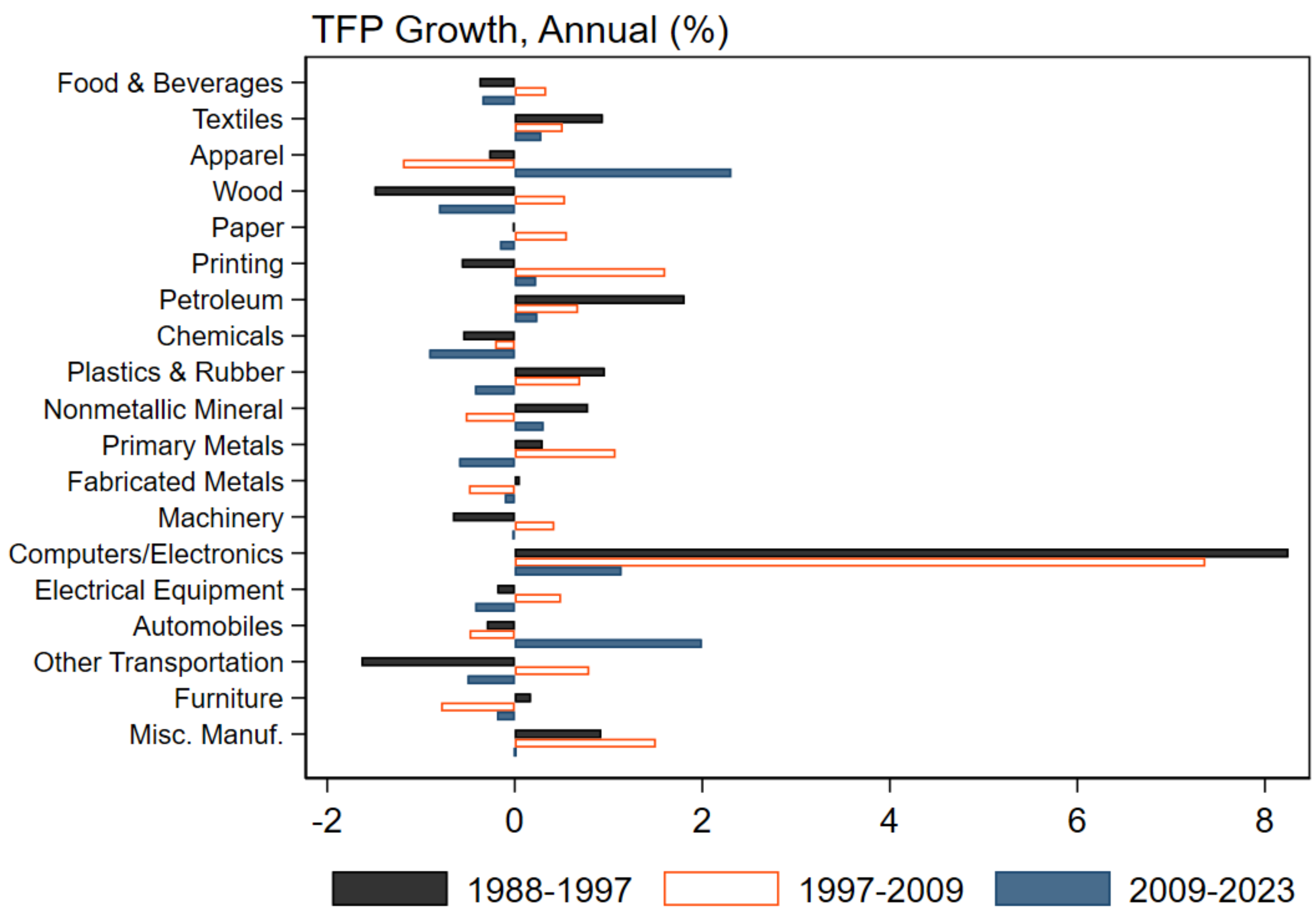


How do these findings reshape our understanding of manufacturing TFP growth?

Computer and Electronic Products Manufacturing TFP Slows Dramatically in 2010s



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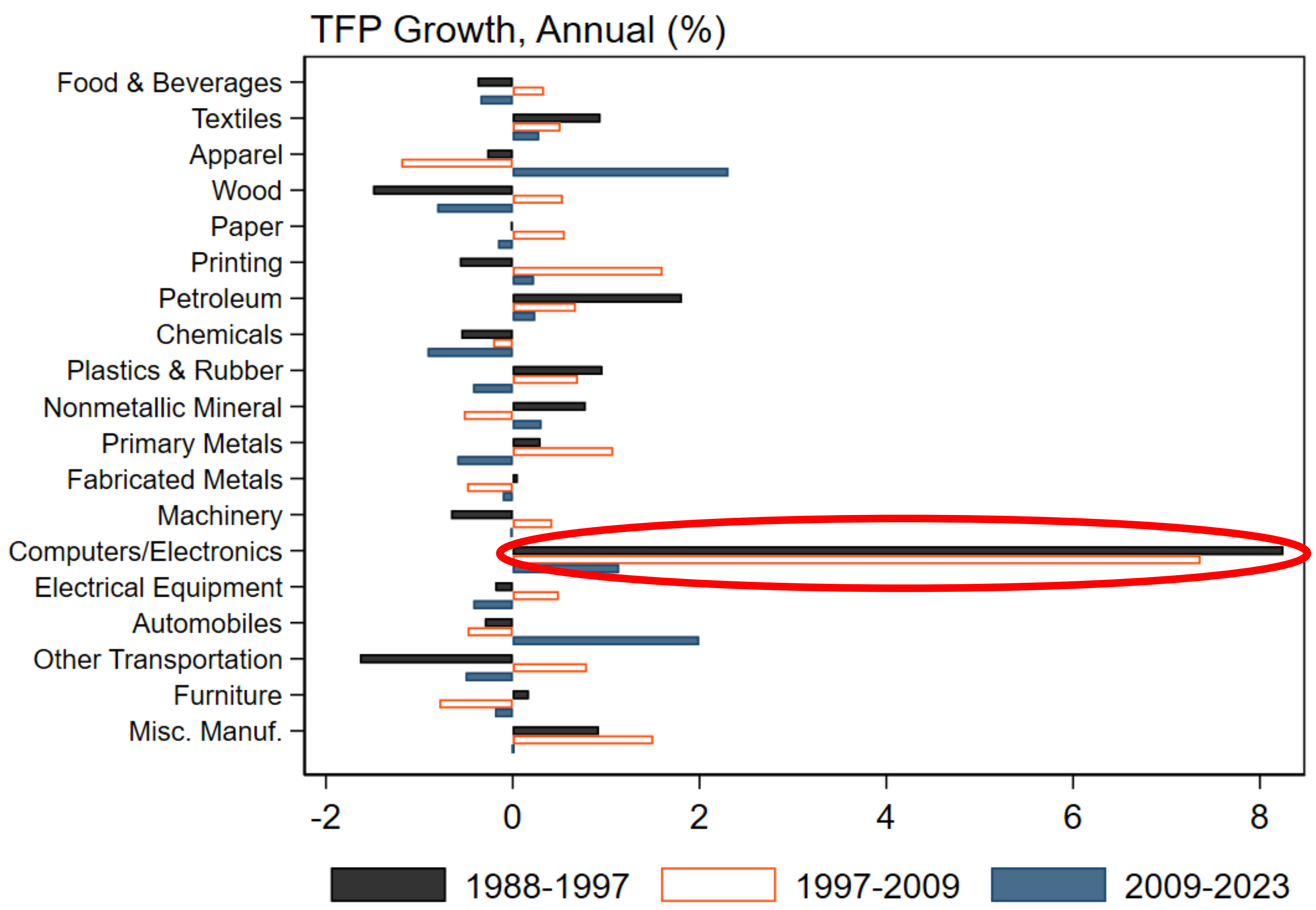
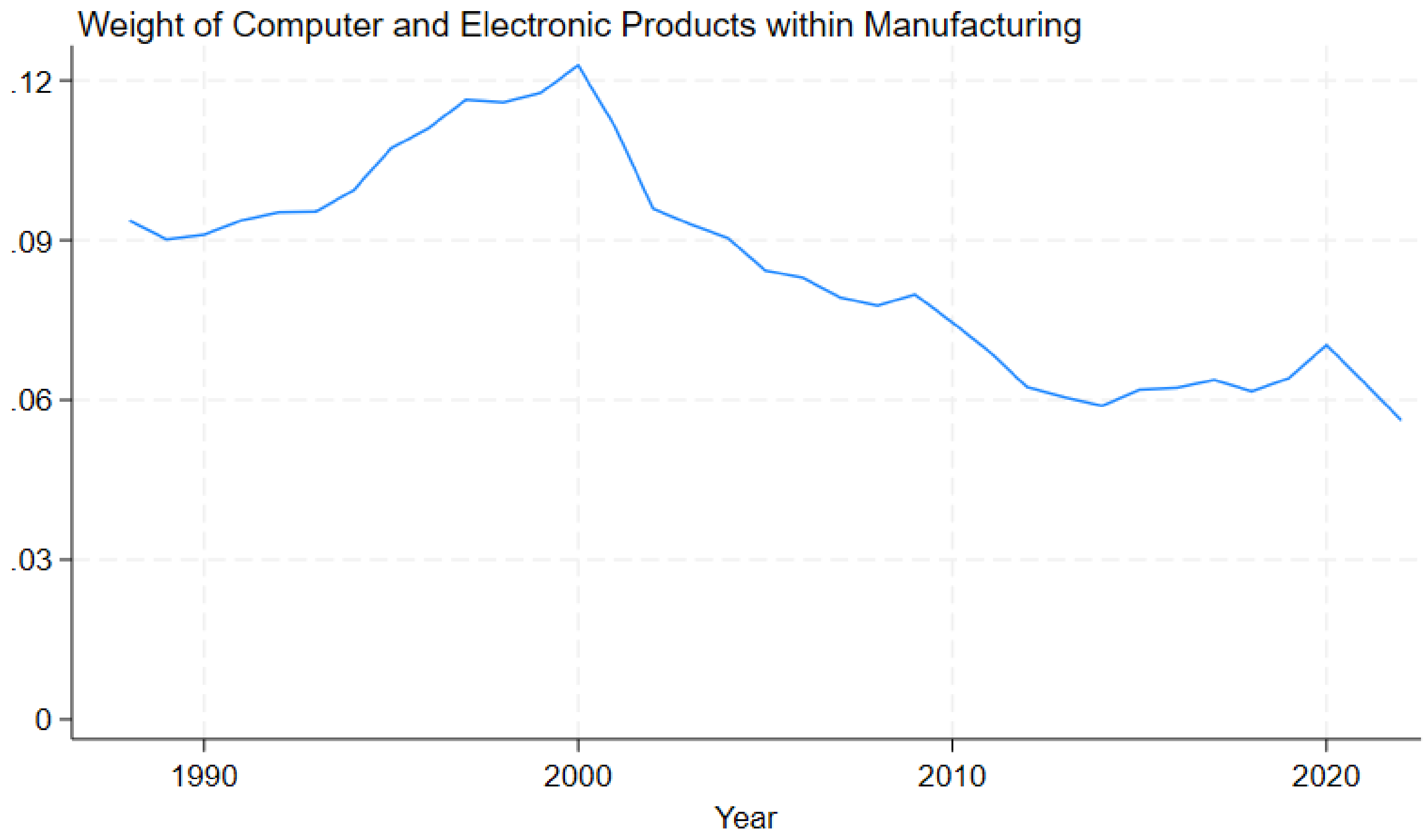


Computer and Electronic Products Manufacturing Comprises a Smaller Share of Manufacturing Output



How to Compute the Contribution of Computer and Electronic Products Industry to Manufacturing TFP?

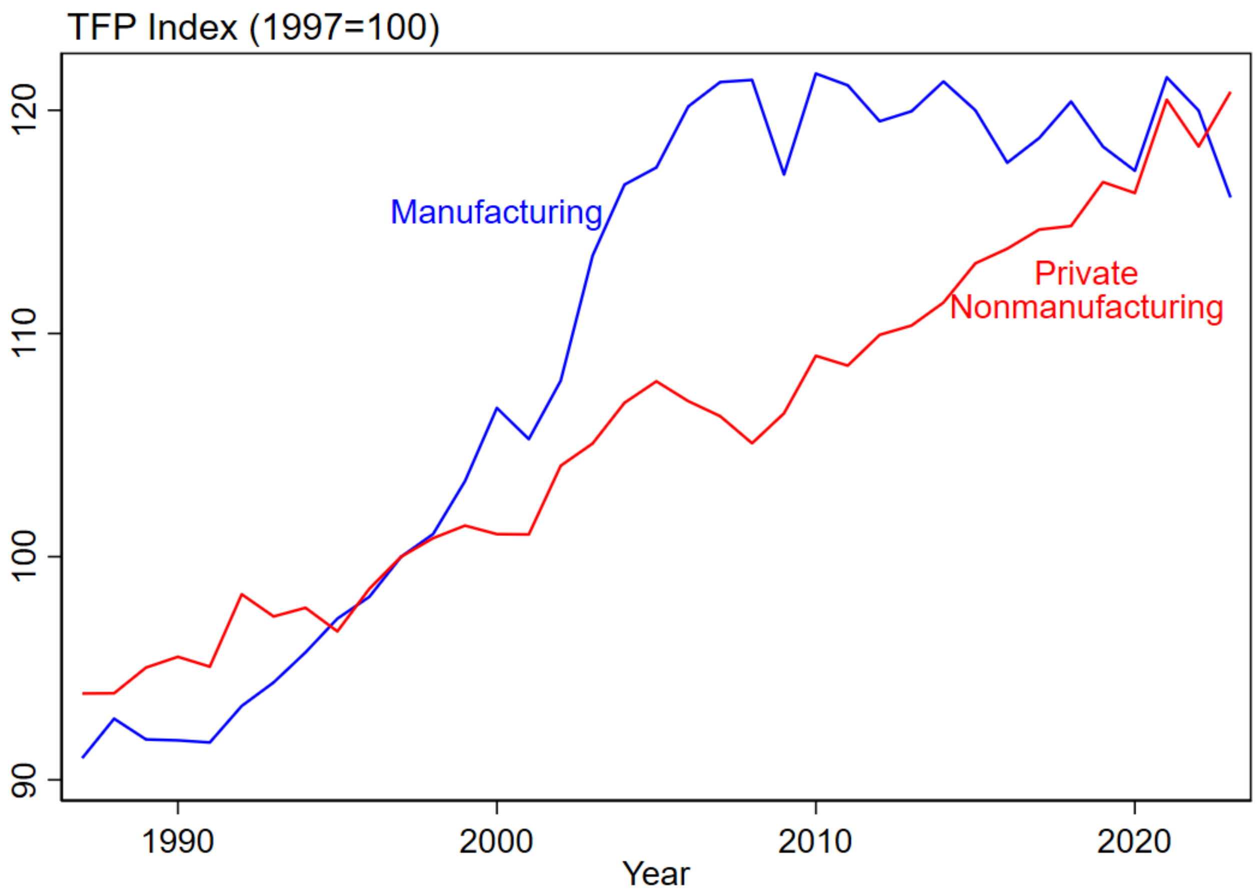
- Manufacturing TFP growth is a weighted average TFP growth rates of its constituent industries:

$$\Delta \log A_{t,M} = \sum_{j \in \text{Manufacturing}} \omega_{tj} \, \Delta \log A_{t,j}$$

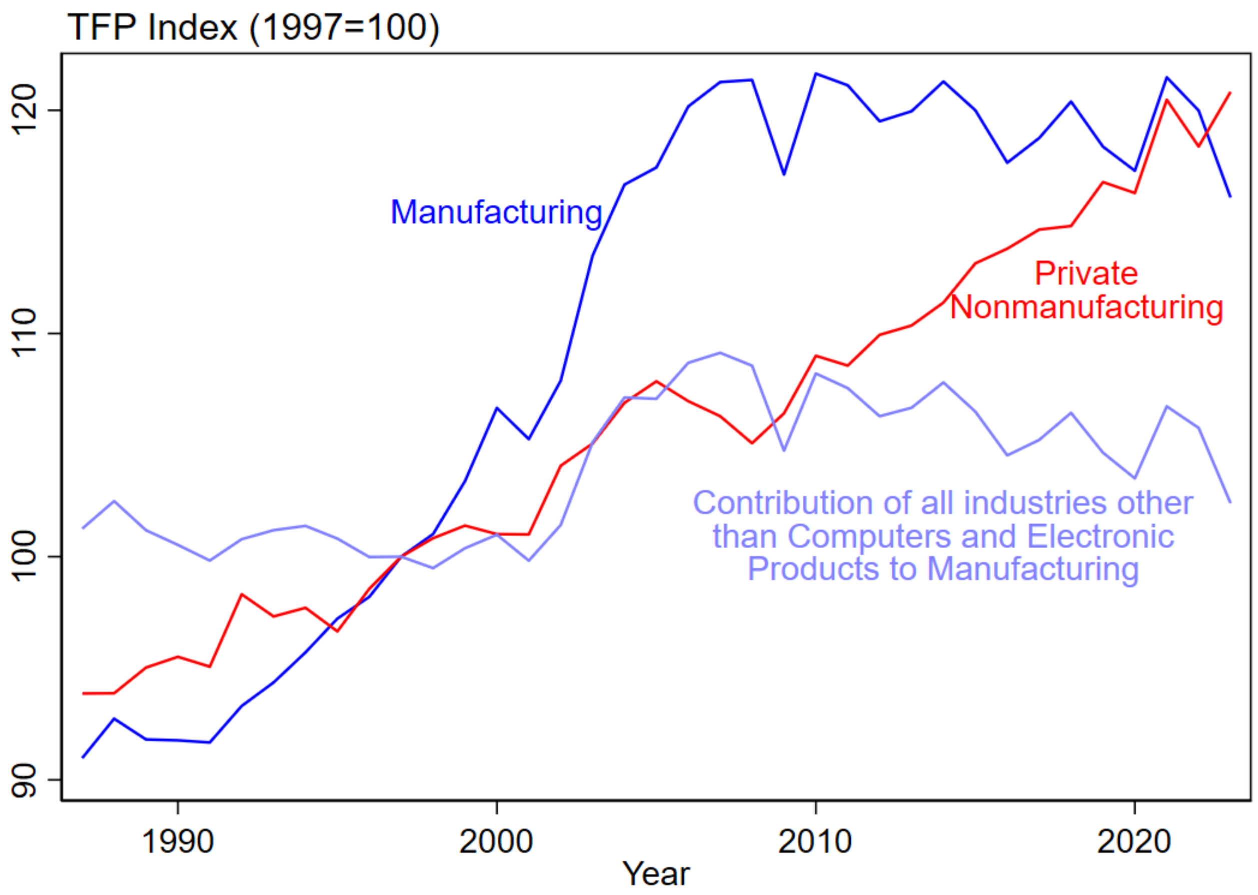
- In the next slide, we compute:

$$\Delta \log A^{C}_{t,M} = \sum_{\substack{j \in \text{Manufacturing} \setminus \\ \text{Computers} \\ \text{and Electronics}}} \omega_{tj} \, \Delta \log A_{t,j}$$

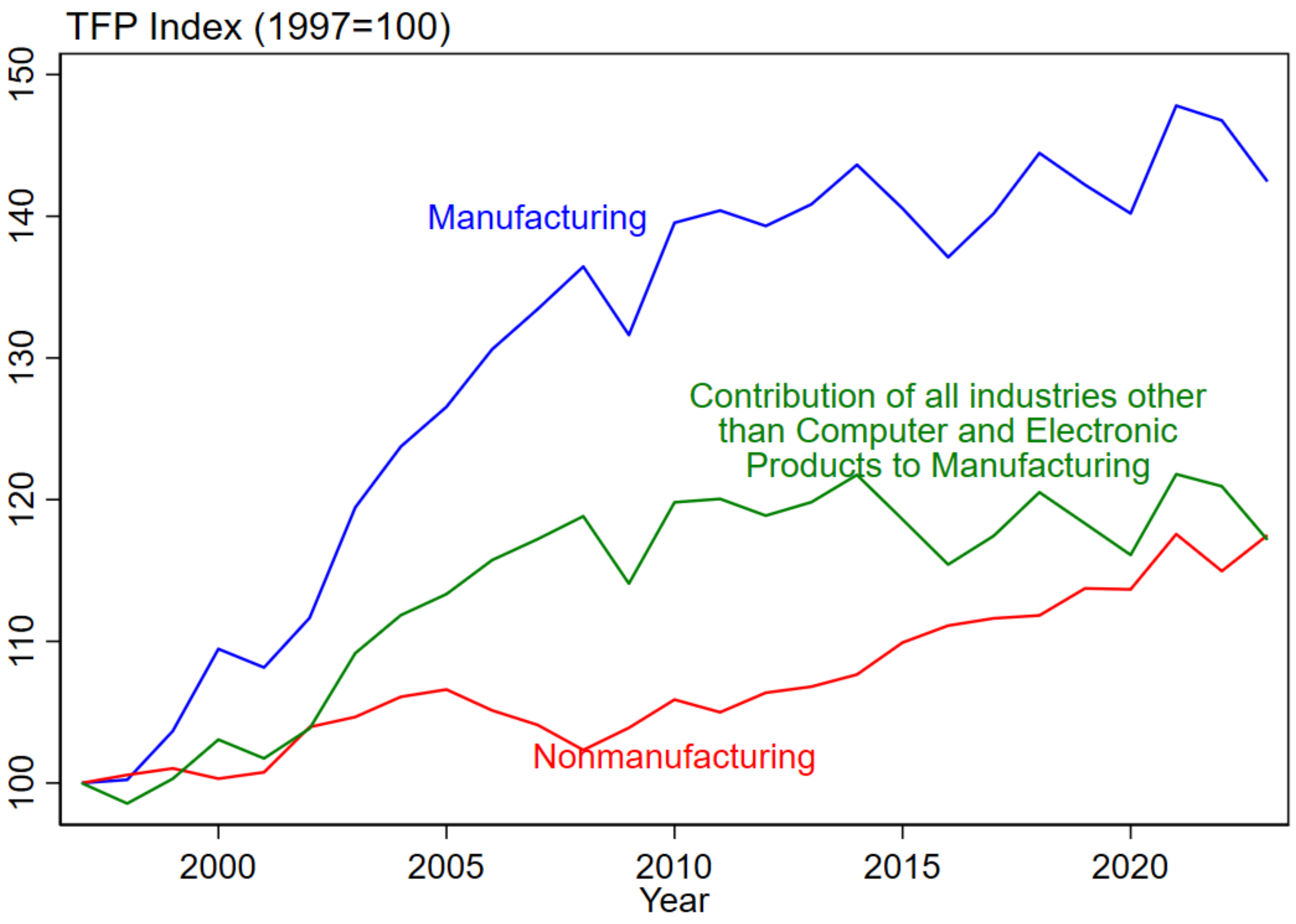
Manufacturing Measured TFP Growth: 1.2% ('87-'09) → -0.0% ('09-'23)
Private Nonmanufacturing TFP Growth: 0.6% → 0.9%



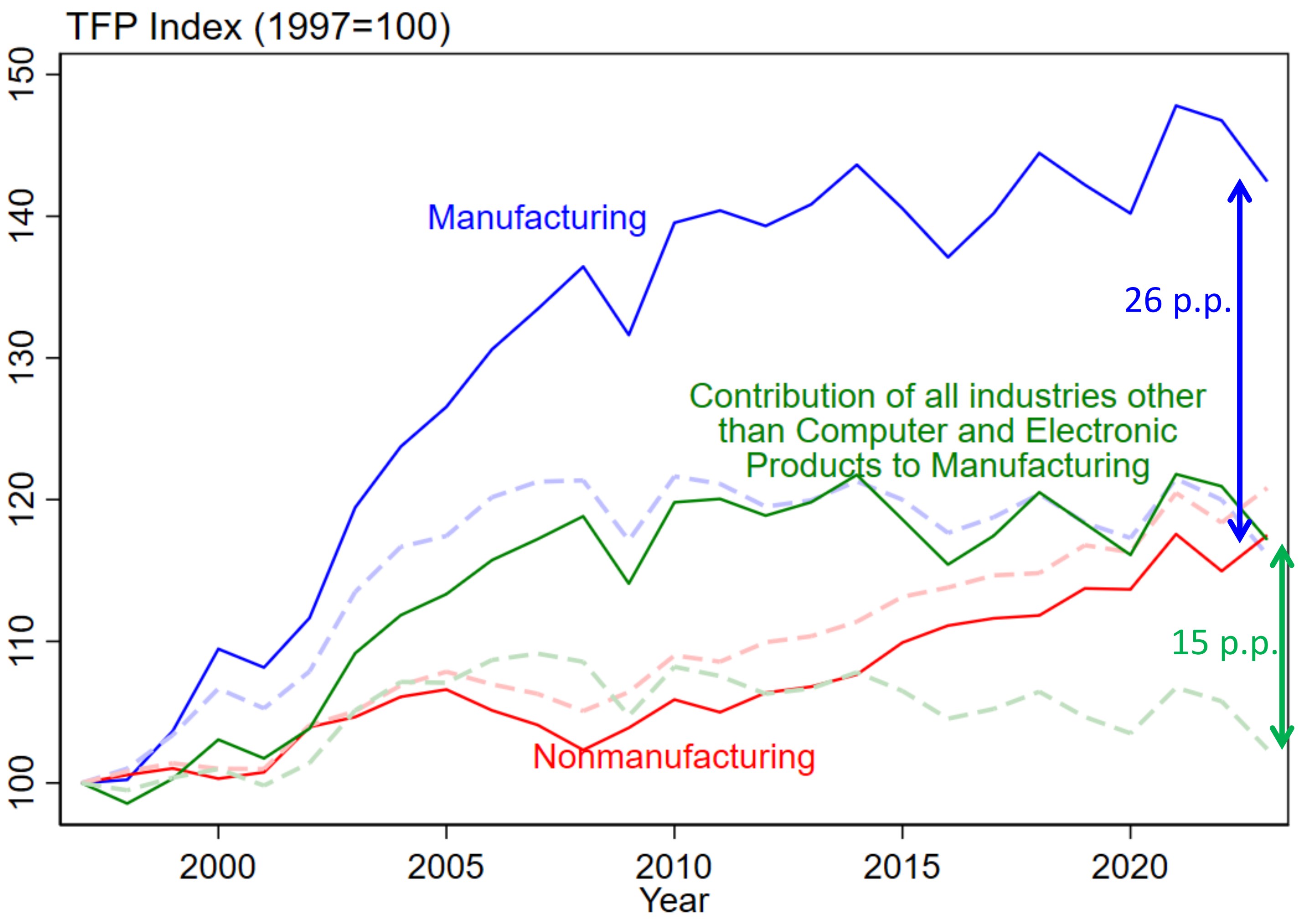
Computer and Electronic Products Manufacturing Accounts for Nearly All of (Measured) Manufacturing TFP Growth



Corrected TFP Growth in Manufacturing is Stronger, Less Concentrated in Computers and Electronics.



1997 to 2023 TFP Growth is Faster in Manufacturing: 26 p.p.; Slower in Nonmanufacturing by 3 p.p.



Conclusion

- Background
  - Manufacturing sector's measured TFP growth has collapsed, fallen behind that in the rest of the economy.
- Results
  - Manufacturing measured TFP growth since the late 1980s has been driven by a single industry: Computer & Electronic Products.
  - Correcting for mis-measurement:
    - Implies manufacturing TFP growth is still growing (at about 0.6 p.p. since 2009);
    - But has slowed down relative to before 2009; and
    - Is not so concentrated in Computer and Electronic Products manufacturing.