

# **Bundled Investment and Intermediates: “Free” Smartphone Investment as a Limiting Case**

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- Capital is often bundled with intermediate inputs
  - Our project: trace through impact of bundling on measured investment, measured GDP, and industry accounts
- The paper then presents case studies of bundles
  - Vehicle warranties are used to illustrate the general framework
  - The framework is then applied to smartphone hardware and software
- Empirical impact of unbundling smartphones:
  - Nominal GDP in 2019: increases by \$6 billion of hardware investment and \$5 billion of software investment
  - Real GDP growth from 2010 to 2019:  
decreases by 0.012 percentage points per year from hardware and  
increases by 0.002 percentage points per year from software

# Case Study 1: Vehicle Warranties

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- Vehicles are often bundled with repair services
  - New vehicles purchased by businesses are investment
  - Repair services purchased by businesses are intermediate
  - Measured GDP increases when “free” warranty repairs are bundled with new vehicles
- In the United States, vehicle manufacturers pay independent dealers to carry out warranty repairs
  - Since 2004, public companies have been required to report their best estimate of warranty accruals, liabilities, and claims to investors
  - The 2012 Economic Census also reports warranty claims

# Hypothetical Accounts for Vehicle User:

1-year warranty covers repairs (parts, labor, and profit)



New Vehicle Parts \$15,000	Assembly Labor \$2,500	Assembly Profit \$2,500
Repair Parts \$200 per year	Repair Labor \$200 per year	Repair Profit \$100 per year

Measured Capital Investment: \$20,500

Measured Vehicle Repair: \$0

'True' Capital Investment: \$20,000

'True' Vehicle Repair: \$500

# Bundles Are Sometimes Hard to Value

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- Establishments often produce capital assets and intermediate inputs jointly.
  - For example, programmers are used both to develop new phone software and also patch existing phone software
- It is often impossible to observe the ‘true’ production cost for capital assets.
  - The Economic Census and other government surveys provide very little data on within-company transactions.
  - Many companies genuinely don’t measure production costs for individual components of a bundle
  - Even when companies do measure production costs for individual components, they often view that data as a business secret.

## Case Study 2: “Free” Smartphone Hardware



Wireless carriers use the same call center workers to sell new phones and support existing phones

- Determining true costs for new smartphones is difficult
- Investment is at least the wholesale cost of smartphones, and at most the total cost of wireless service over a phone’s lifespan

“Getting Smart About Phones” (Aizcorbe, Byrne, and Sichel 2019) explored the implications of consumer bundles on measured PCE

- Investment = Imputed value of smartphones sold – imputed value of smartphones add to PCE

Smartphone prices = BEA’s consumer phone prices

# Hypothetical Accounts for Phone User:

Smartphone is offered 'free' with 2-year contract

Wholesale phone \$300	Phone sales labor \$90	Phone sales profit \$90
Cell spectrum \$20 per month	Cell service labor \$10 per month	Cell service profit \$10 per month

Measured capital investment: \$0  
Measured cellular services: \$60 per month  
‘True’ capital investment: \$480  
‘True’ cellular services: \$40 per month

## Case Study 3: Open-Source Operating System

Operating systems are provided ‘free’ to any hardware owner who wants it

- Smartphone owners are not legally required to buy apps from the operating system’s store – but it’s difficult to install apps bought elsewhere
- Operating systems may also collect personal data or show ads

**Assumption: operating system cost = revenue**

- Company financial reports provide our app store revenue numbers
- US investment = (Estimated future revenue from app sales)\*(estimated share of apps sold in U.S.)\*(estimated share of apps sold to businesses)

Operating system prices = BEA’s pre-existing price index for prepackaged software



# Hypothetical Accounts for Phone User:

Operating system software is 'free' to download

Operating system development costs (programmer labor,  
intellectual property licensing fees, and profits)

**\$48**

Developer fees  
**\$2 per month**

Appstore costs  
**\$1 per month**

Appstore profit  
**\$2 per month**

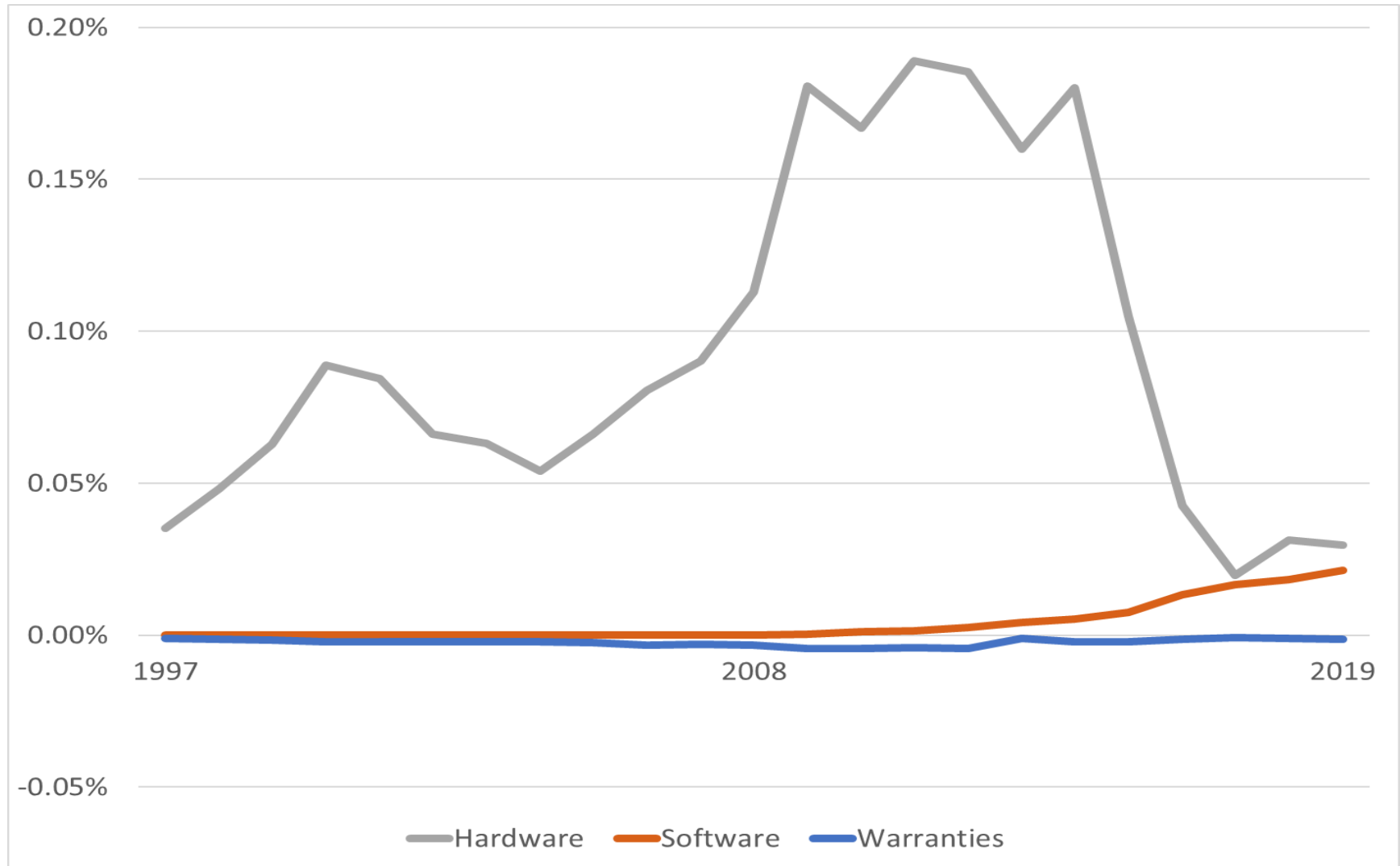
Measured software investment: \$0

Measured app purchases: \$5 per month

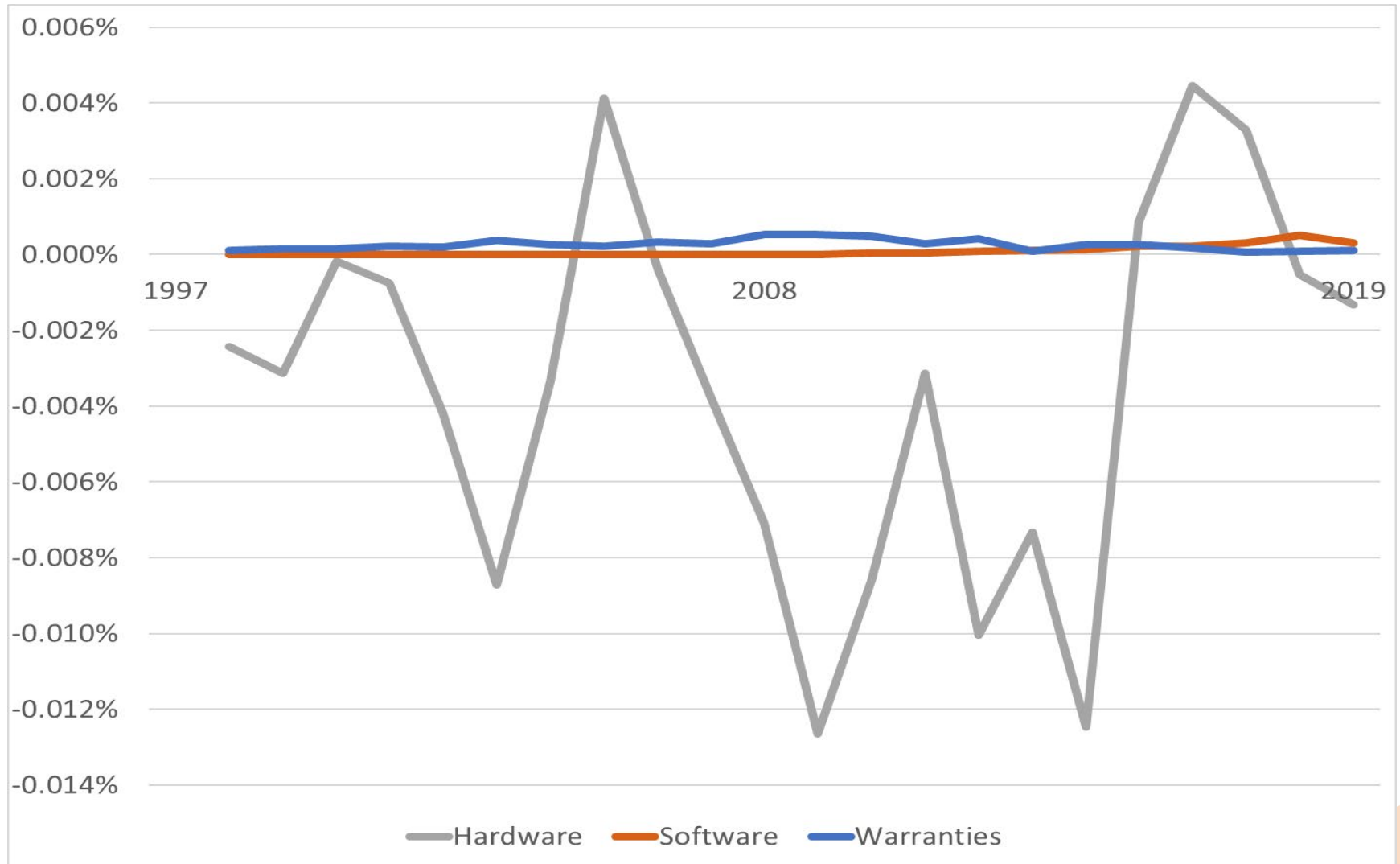
'True' software investment: \$48

'True' app purchases: \$3 per month

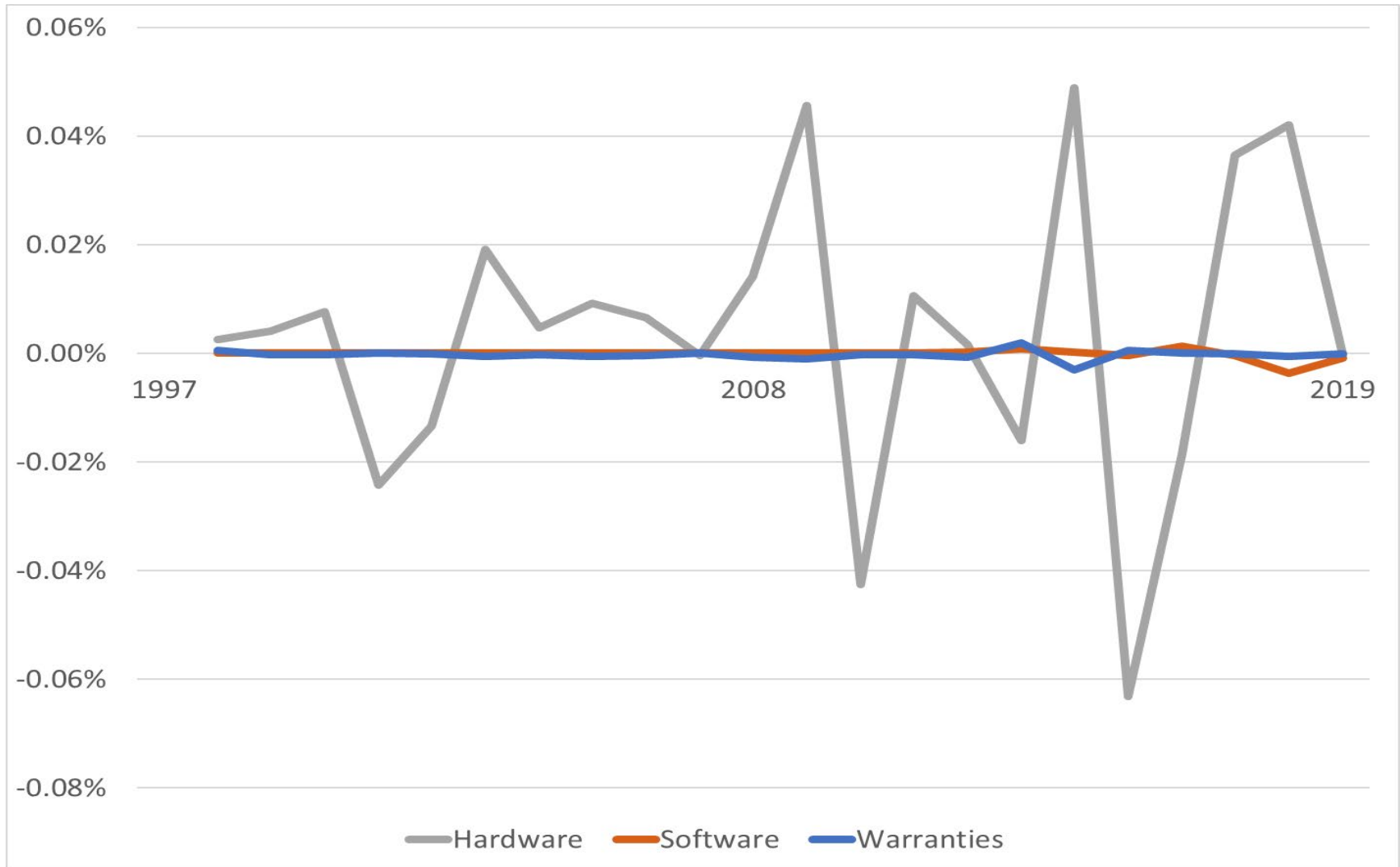
# Revision to GDP from Unbundling, as a Share of Nominal GDP



# Revision to Annual GDP Price Growth



# Revision from Annual TFP Growth



# Conclusion

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- Problem: measured value-added depends on whether bundles are classified as investment or intermediate inputs
- Case studies of smartphones:
  - Nominal GDP in 2019: increases by \$6 billion of hardware investment and \$5 billion of software investment
  - Real GDP growth from 2010 to 2019:  
decreases by 0.012 percentage points per year from hardware and increases by 0.002 percentage points per year from software
  - Measured productivity is not significantly affected by bundling
- Question to audience: search for grand holistic treatment or piecemeal approach?