

# **Can Mismeasurement of the Digital Economy explain the U.S. Productivity Slowdown?**

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with major contributions from David Byrne and John Fernald

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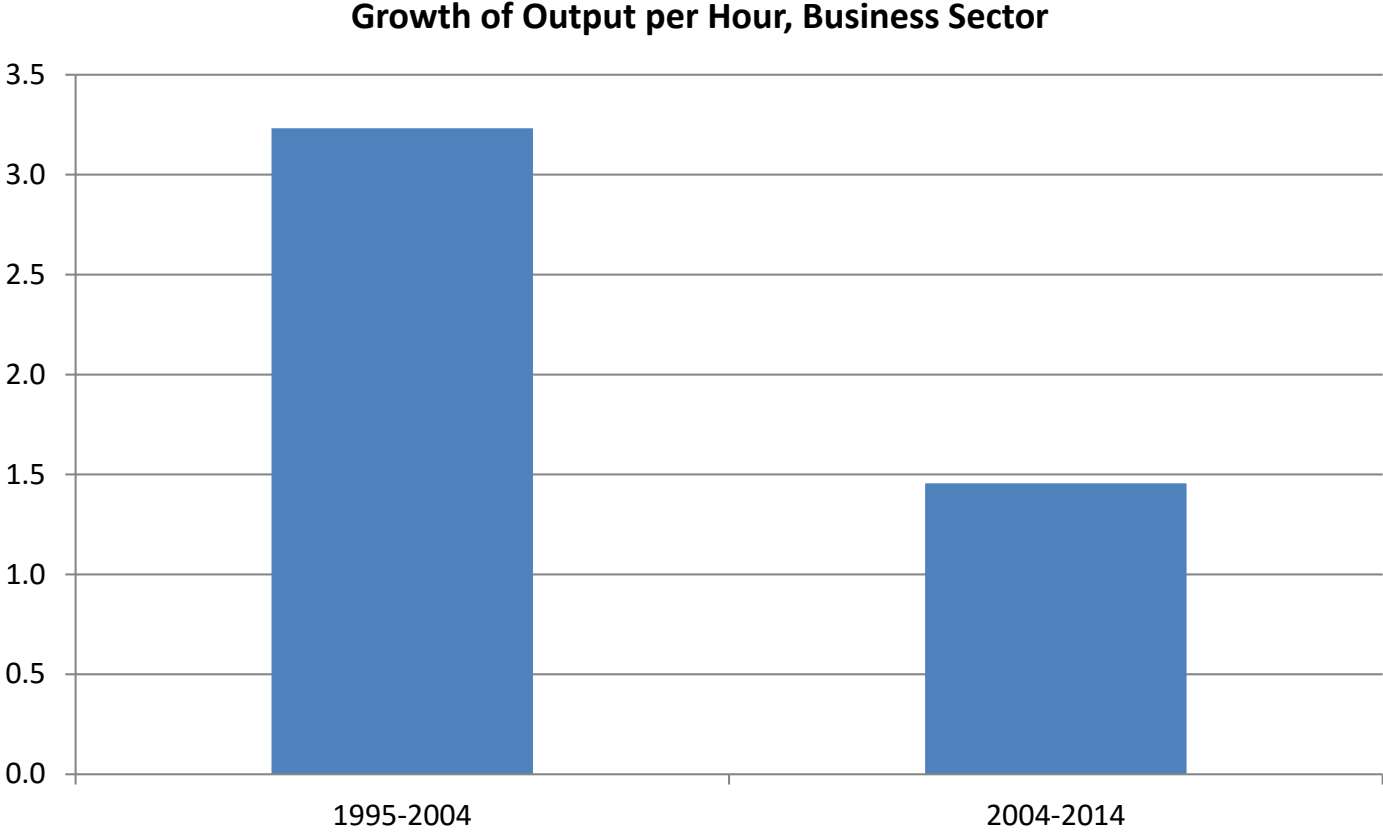
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# U.S. Productivity Slump

- U.S. productivity growth slowed 3 or 4 years before the Financial Crisis
- Normal post-recession rebound in productivity never materialized – growth rates of labor productivity and TFP still slow
- Other advanced economies experienced similar productivity slowdowns
- Had pre-2004 trend growth of labor productivity continued, U.S. GDP would have been \$3 trillion higher in 2015 (2009 dollars)

# Labor Productivity Growth Rates, U.S. Business Sector Market Producers

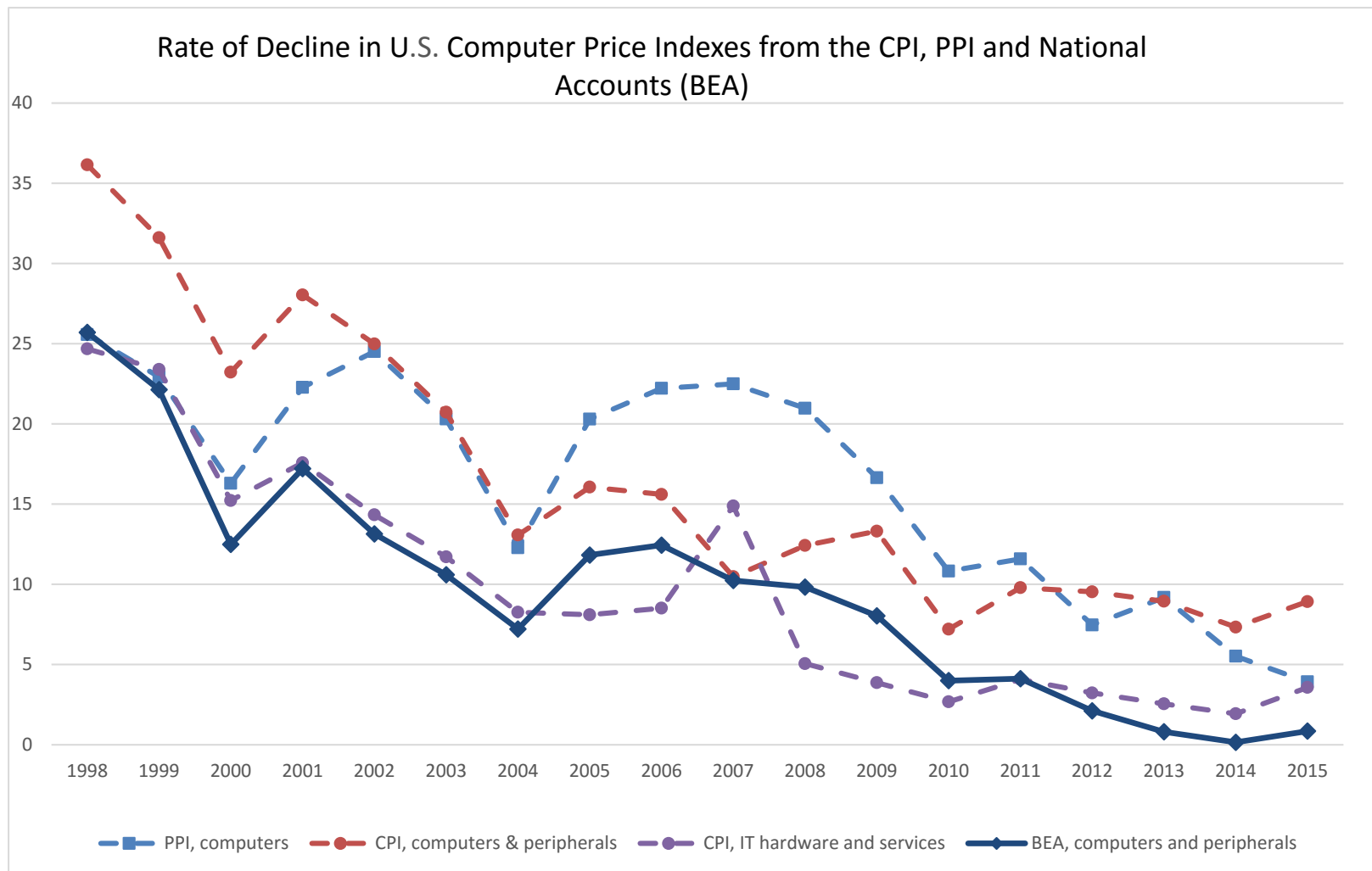


Source: Log-change in output per hour from official BLS data republished by Fernald (2014)

# Productivity Slump

- Commentators in Silicon Valley and Wall Street argue that explanation is measurement error
  - Technology seems to be progressing as fast as ever
  - New digital products have increased welfare
  - Inflation is low and corporate profits are good
  - “The numbers are too bad to be true”
- The deflators for computers and other digital products look high compared to what could be expected from strong technological progress

# US Computer Price Indexes, Rates of Decline



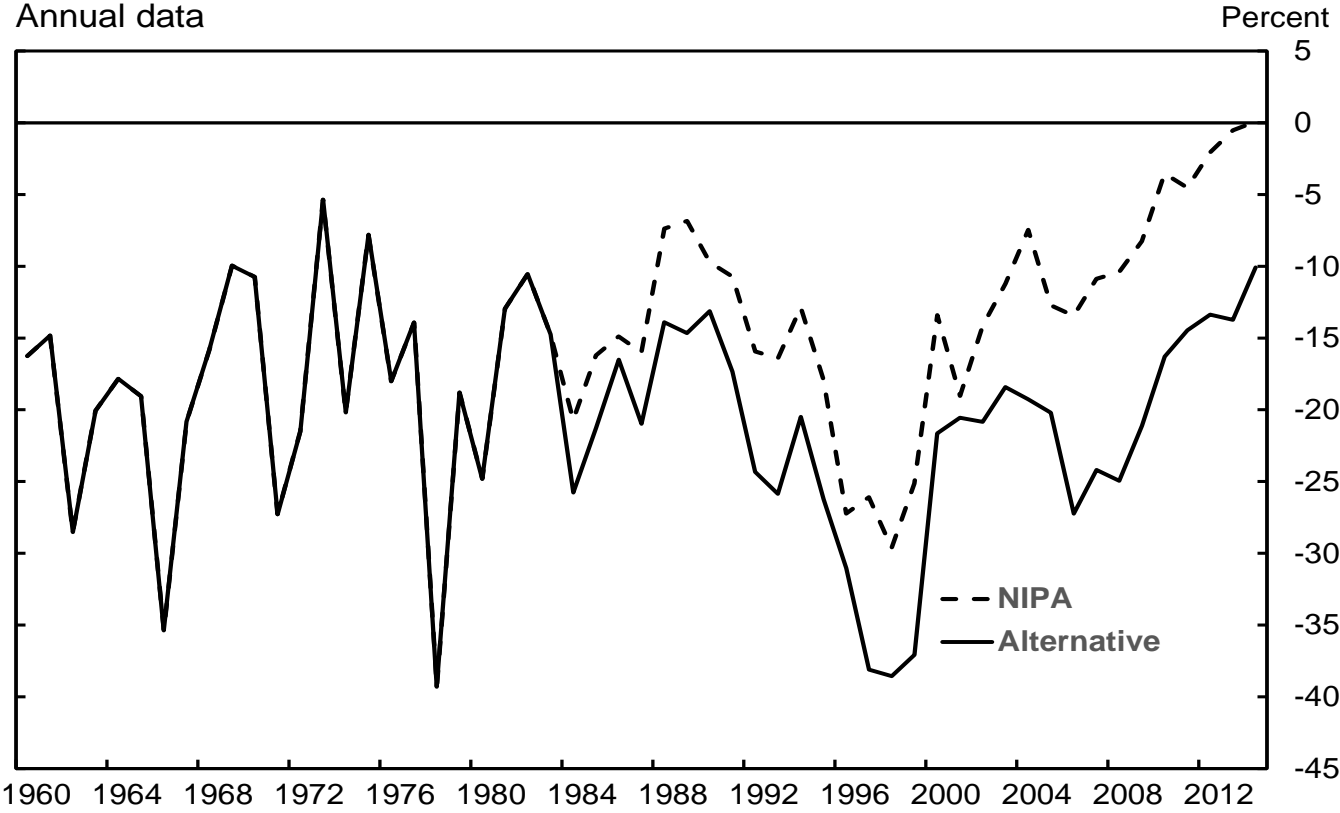
# Outline of Paper

- Byrnes, Fernald and Reinsdorf (BPEA, 2016) calculate alternative deflators for ICT products
- We used the alternative deflators for ICT products to adjust measured productivity growth
- We also adjusted for mismeasurement linked to intangibles, globalization, Internet access, and fracking
- These sources of mismeasurement don't help to explain the slowdown
- Adding unmeasured gains from the Internet and smartphones would make the total adjustment in 2004-2014 a little bit larger

# BFR (2016) do find increasing bias in computer deflators

## Computer and peripheral prices

Annual data



# Factors Contributing to Rising ICT Price Mismeasurement

- Changing pricing policies for model turnover (Byrne, Corrado and Sichel, 2015)
- Technology has changed in ways that make earlier hedonic specifications obsolete (Byrne and Pinto, 2015; Byrne and Corrado, 2016)
- Innovations in **cellular networks** missed (Byrne and Corrado, 2015, 2016)
- Specialized equipment and software overlooked or hard to measure



# But weights on IT Products decreased

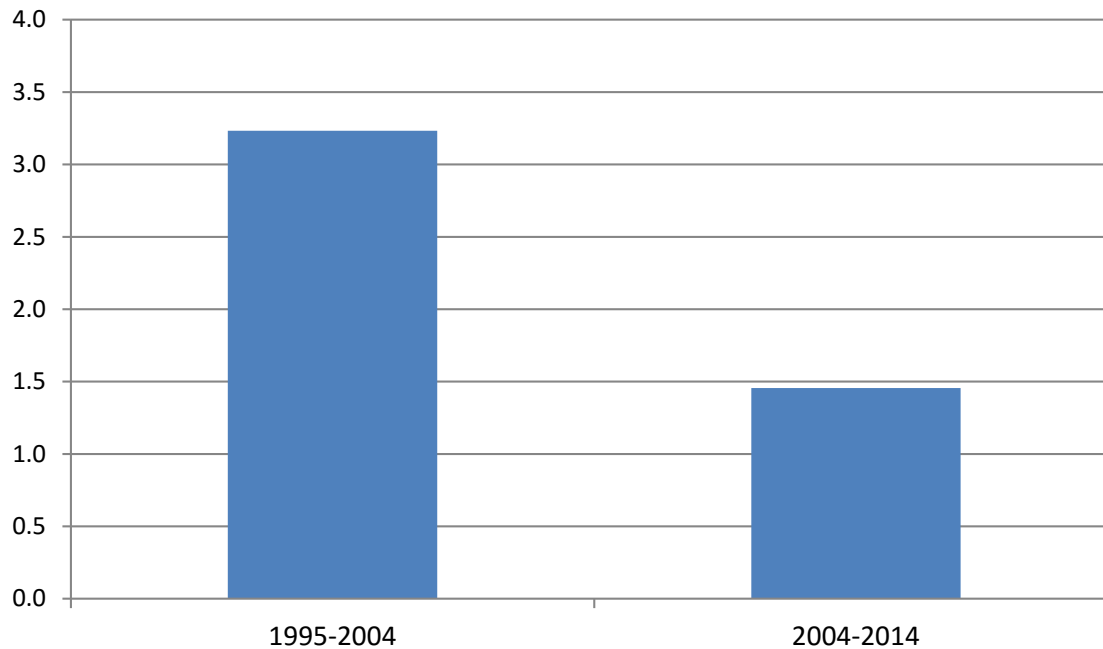
- Reason for the lack of effect on the slowdown is the decline in weights of ITC products
- Computers' weight went from 2.9% to 0.5%
- Semiconductor deflator adjustment raises productivity if semiconductors exported
- The U.S. still produces semiconductors, but imports  $\approx$  exports giving weight  $\approx 0$

# Flash Memory Plant in Utah

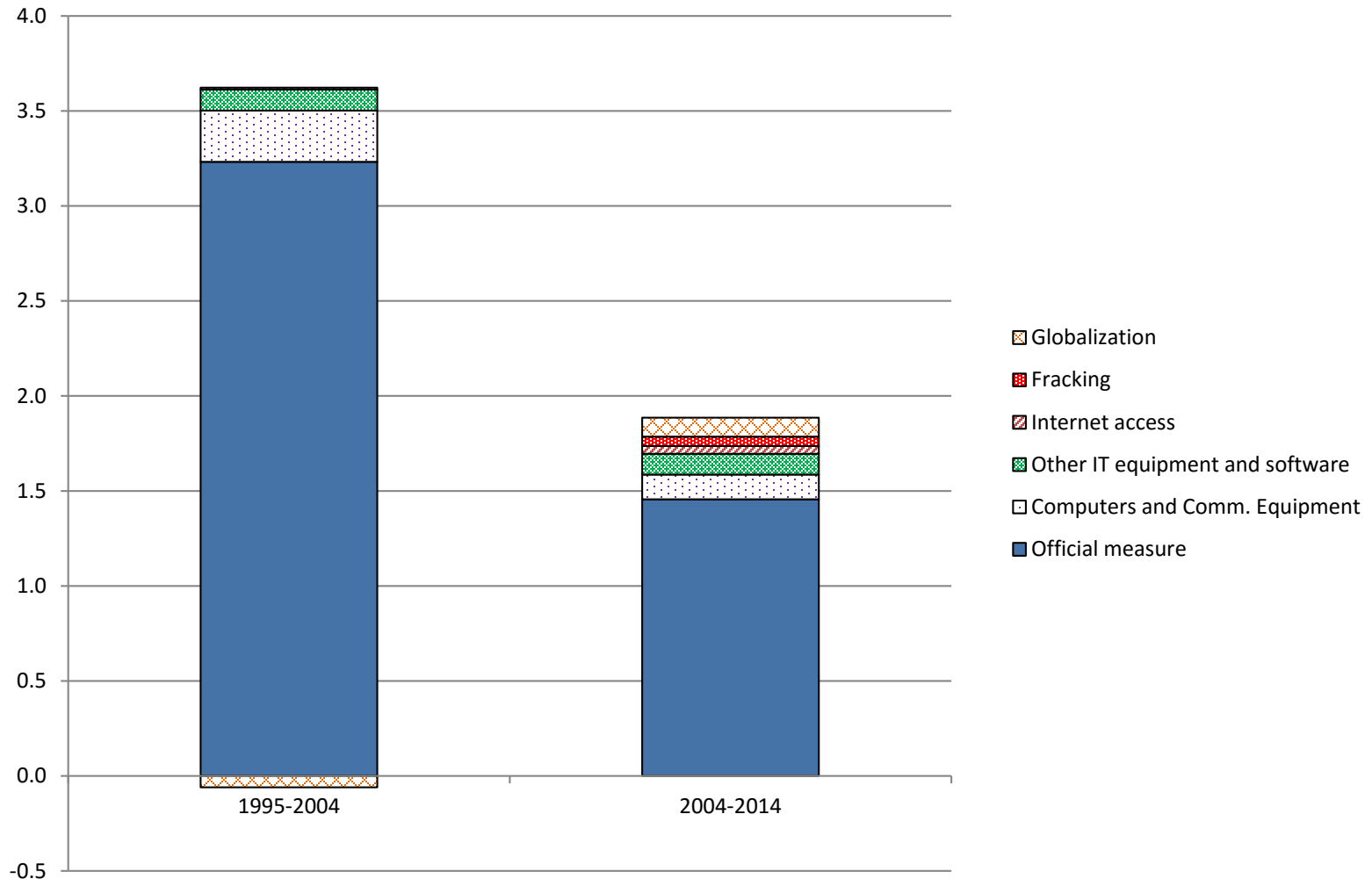


# Labor Productivity Slowdown before Adjustments

**Growth of Output per Hour, Business Sector**



# Adjustments to Labor Productivity



# Adjustments to Labor Productivity

	1995-2004	2004-2014
Computers and Comm. Equipment	0.27	0.13
Other IT equipment and software	0.11	0.11
Internet access	0.01	0.04
Fracking	0	0.05
Globalization	<u>-0.06</u>	<u>0.10</u>
TOTAL	0.33	0.43

Note: excludes adjustment for investment in intangibles of 0.1 in 1995-2004 and consumer surplus from treating web access via smartphones as a new good

# Total Adjustments

- Total of adjustments in 1995-2003 is 0.33 percent per year, but BFR also find that investment in intangibles identified by Corrado, Hulten and Sichel (2009) adds 0.1 percentage point
- Total adjustments in 2004-2014 = 0.43%/year
- Measurement effects looked at so far imply the same upward adjustment in both time periods, so don't help to explain the productivity slowdown

# Internet-based Digital Products

- Free digital products, delivered over the Internet or from smartphone apps have improved consumers' welfare
- Proposals to add these welfare gains to GDP would raise productivity, but often ignore the conceptual framework and purpose of GDP
- Ahmad and Schreyer (2016) find that GDP conceptual framework remains valid; practical estimation challenges are the real concern

# Free digital services

- Brynjolfsson and Oh (2012) infer from the value of time spent consuming free services from Facebook, Google, Wikipedia, and YouTube they generated consumer surplus that would add 0.74 percentage points to growth in 2007-2011
- But raising households' productivity in home production of non-market services for own consumption does belong in a measure of market sector productivity growth
- Welfare gains from raising households' productivity in home production would be worth measuring, just not as part of GDP



# Free digital services

- Advertising-supported media businesses attract an audience or user base by offering entertainment and information that households consume
- National account treat advertising-supported media as providers of intermediate inputs
- Several proposals to include household consumption of media service in GDP

# Free digital services

- Nakamura & Soloveichik (2015) propose to include a barter transaction national accounts where households sell ad-watching services
- Value of newly recorded household consumption equals the cost of producing the entertainment and information services
- Ravets (2016) discusses recording a transfer to households rather than a barter transaction

# Free digital services

- Digital platforms have network effects that make user base “sticky” (loyal)
- Free digital services aimed at attracting a sticky user base can be viewed as investment in an intangible asset
- This would raise productivity in 2004-2014 more than in 1995-2004, offsetting some of the earlier intangible adjustment

# Free digital services

- Would be useful to estimate how much money consumers have saved by replacing things they used to buy with free or low-cost smartphone apps as a kind of Paasche lower bound on cost of living index
- Could also use access to wider variety of Internet services as a quality adjustment factor for Internet access

# Other digital services

- Peer-to-peer services such as Uber and Airbnb are already included in U.S. nominal GDP
- For peer-to-peer services similar to an existing service (e.g. Uber and taxis) should measure the decline the cost of living and the implied volume increase in household consumption
- Consumer surplus from non-comparable peer-to-peer services will be missed, as is the standard practice for new goods with no counterpart

# E-commerce

- e-commerce saves time, relieves consumers of task of finding things on shelves and packing them, increases access to variety, and may offer lower prices
- Byrne, Fernald & Reinsdorf calibrate the Feenstra model of gains from new varieties using U.S. Census Bureau data on the share of e-commerce
- Adds 0.04 percent per year to growth rate of productivity in 2004-2014
- Other approaches might yield bigger estimates

# Conclusion

- Mismeasurement is not a significant contributor to the productivity slowdown seen in the official statistics
- But it would be useful to develop new measures of the growth and welfare implications of new digital products delivered over the Internet or smartphones