We See the Digital Revolution Everywhere But in GDP

Measuring and Accounting for Innovation in the 21st Century
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** The views expressed today are my own and not necessarily those of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.*

Disclaimer:

- These are our opinions and not those of the Federal Reserve Bank of Philadelphia or of the Federal Reserve System.
- The US statistical agencies are among the best in the world and are leading innovators in statistical methodology despite limited resources.

Economic Growth in the Age of the Internet

- The last three decades have seen tectonic changes in technology and structure of economy
  - profusions of new or improved goods -- internet , mobile communications, new ITC devices, medical breakthroughs
  - new modes of distribution – warehouse stores; Amazon
  - much more information about alternative choices
- These goods are hard to measure
  - intangible (units of measurement problems)
  - some are contingent on hard-to-observe factors (talent)
  - some distributed “free” or below cost
- Current measurement procedures may understate the true growth of real GDP, and overstate prices

Project Overview

- The objectives of our project are
  - To take a broader look at the potential for mismeasurement of real GDP, rather than an in-depth look at selected new economy goods
  - Understand the productivity slowdown beginning in 2000s (PS2)
  - Examine preparedness for innovations on horizon
- Background: First productivity slowdown (PS1) from 1970s
  - Many explanations, two foremost:
    - Baumol's cost-disease in services
    - Mismeasurement
      - Griliches and Greenspan doubted Baumol's cost-disease because ICT was being used to a growing extent in hard-to-measure service industries
      - Triplett and Bosworth took up the challenge of HTMI in Brookings project on services measurement (1998-2004)

Griliches Hard-to-Measure Industries

- Griliches in his 1994 AEA Address distinguished:
  - Readily-measurable industries (ETMI) that are quantifiable
    - Agriculture, Mining, Manufacturing, Transportation, Utilities (including information)
    - Bushels, tons, feet, ton-miles, kilowatts
    - [But digital revolution makes these harder to quantify]
  - Hard-to-measure industries (HTMI) that are not
    - Most are knowledge-intensive service industries
      - FIRE, Educ. and Health, Professional and Business Services
    - Also Trade, Construction, Arts and Rec, Hotels and Restaurants, etc.
- Griliches's challenge: Can we measure the HTMI?

GDP Shares of Hard-to-Measure vs Easier-to-Measure Industries

	1955	1985	2015
HTMI as Percent of GDP			
Financial Services and Real Estate	12.46%	17.11%	20.27%
Professional & Business Services	3.78%	7.39%	12.24%
Education & Health Care	2.21%	5.23%	8.32%
TOTAL HTMI	**55.54%**	**66.87%**	**75.94%**

ETMI As Percent of GDP	1955	1985	2015
Agriculture	4.41%	1.77%	0.97%
Manufacturing	27.57%	18.53%	12.03%
Transportation	4.93%	3.17%	3.01%
Information	3.28%	4.58%	4.66%
TOTAL ETMI	**44.46%**	**33.13%**	**24.06%**

Bosworth-Triplett Studies

- Triplett and Bosworth took up Griliches' challenge in a multiyear, 15 workshop study (1998-2004)
  - Their detailed studies showed MFP (relative growth of inputs vs. outputs) was a good diagnostic tool
    - Negative MFP growth was a sign of mismeasurement in an industry
  - For the period 1995 to 2001, they found services MFP growth was close to the goods MFP
    - This remained true until mid-2000s
  - Major contributors: trade and transportation, FIRE
  - Most of services not well-measured

Diagnostic: If we deflate all of GDP by the prices of ETMI, PS1 disappears

	ETMI prices	Official prices	Nominal GDP growth	Official real GDP growth	real GDP growth deflated by ETMI
55-85	4.04%	4.44%	8.05%	3.46%	3.85%
85-15	0.93%	2.20%	4.86%	2.60%	3.89%
55-75	3.14%	3.58%	7.13%	3.44%	3.83%
75-15	2.14%	3.18%	6.10%	2.82%	3.87%

MFP and Mismeasurement

- ETMI MFPG rates generally larger than HTMI rates, but suspicious in some cases
  - Manuf. MFPG is fairly robust until 2007 (~1.8 1995-2007)
    - Ex computers, manufacturing MFPG near zero
  - Autos and Chemicals MFPG near zero
  - Measuring the output of “Information” is problematic
- HTMI MFPG in services
  - NAICs services 54-81 (expert industries) near zero MFPG
    - Value added in this sector was 25% of GDP in 2015
    - If sector MFP were 100 bp higher, GDP increases by ~40 bp

Suspicious Signs of MFP mismeasurement

MFP Growth Rates	87 to 95	95 to 05	05 to 14	87 to 14	2005 VA weights
FIRE	-0.34%	0.38%	0.76%	0.29%	23.2%
Other Services	-0.83%	0.32%	-0.08%	-0.16%	28.0%
Education	-0.33%	-0.88%	-0.60%	-0.62%	1.1%
Doctor offices	-2.11%	0.04%	-0.16%	-0.67%	3.5%
Hospitals	-1.30%	-0.70%	-0.16%	-0.70%	3.1%

MFP Growth Rates	87 to 95	95 to 05	05 to 14	87 to 14	2005 VA weights
Manufacturing	0.76%	1.85%	-0.05%	0.89%	15.0%
Chemicals	-0.99%	-0.14%	-1.24%	-0.76%	1.7%
Transportation Equip	-0.72%	0.78%	0.48%	0.23%	2.0%
Computers	8.27%	10.96%	3.37%	7.59%	1.9%

Case Studies

- Here we focus on:
  - Smart phones and Internet access and telecommunications
  - Autos
  - Health

Smartphones

- Smartphones are only $18 billion in PCE
  - 0.15 % of PCE: electronic revolutions are cheap
- Globalization
  - Smartphones are all imported (not in GDP)
  - Intellectual property exports not reported
- When the iPhone was introduced in 2007, no apparent impact on prices
- Personal online hours were 6 hours per week in 2007, now 14 hours per week

The Smart Phone is Output-saving

- Hal Varian, 2016:
  - A **mobile phone is a substitute** for a camera, a GPS, a land line, a game machine, an ebook reader, a computer, a movie player, an audio player, a map, a password generator, a fitness monitor, an alarm clock, a web browser, a calculator, a recording device, video camera, etc.
- Smartphones use broadband and cellular network
  - Often sold as part of bundle
- Smartphones use free apps (Nakamura et al, 2016)
  - Value these at resource cost or user utility?

Internet Access and Cellular Networks

- Smartphones use broadband and cellular networks
  - Internet +cell serv = 1.8 % of PCE (12 x smartphones)
- Speed has risen 1000-50,000 x in 27 years
  - Speed rises 30 to 50 % a year; deflators -2 % a year 2005-2015
  - PPI initiated hedonic index for broadband Jan 2017; 30 % speed increase implies - 9 % in price
- Cord-cutting: wireless replaces wired phones
  - Wired phone service has fallen from 1.7 % to 0.3 % of PCE, 1988-2015

Autos

- Autos now have sensors and computer power for safety and to improve cruise control, parking, backup vision
  - Devices and software too inexpensive to make a difference
- Also hybrid and all-electric technology
  - Hybrids and all-electrics no impact on prices at introduction
- Real value per car was nearly flat 2005 to 2015
  - $14.3 K 2005, $14.5 K 2015
- Near-self-driving cars are on the road!

Challenge: Self-driving cars

- If it reduces accidents, should that be included in GDP?
- Suppose it reduces consumer work and increases leisure, should that be included in GDP?
- If the car is made self-driving by a free download, should that be included in GDP?

Health

- BEA has put substantial resources into the measurement of health care
  - Exceptionally difficult project
  - Medical deflators still grow faster than input cost
- Real health care per capita rose 2 % annually, 1985-2015
  - Real health spending rose about $3000
  - Lifespans rose 5 years in 30 years
    - If 1/3 of increased longevity due to health care, value of extra year of life $2000?
    - Note: recently life spans not increasing

Challenge: Alzheimer's Vaccine

- One downside to a long life: dementia
  - Current prevalence for 65+: 8.8 %
- What would the value of an Alzheimer's vaccine be?
  - Its resource cost?
  - 19 year life expectancy at age 65: add 1+ years of disability free life?
  - Non-disabled retired persons have highest self-reported happiness
- If Alzheimer's disappears
  - We no longer have expenses for care facilities and caregivers (paid and voluntary)

Conclusion

- The revolution in technology has produced many new goods, processes, modes of distribution. They have made it harder to estimate GDP.
- The statistical system is struggling to keep up with some of the new problems posed by the tech revolution.
  - Many advances (capitalization of intangibles, industry accounts, health care, satellite, tech goods initiative at BEA)
  - Old problems remain (service sector output, new goods and the class-imputation method). Some have gotten harder.
- The floods of virtually free and readily accessible information is a game changer (Hulten and Nakamura (2017)
- Current measurement procedures probably understate GDP, certainly understate gains in the standard of living

Suggestions for future work

- Need a national innovation account supported across statistical agencies
- Need to think more about what is a “good” and the “bundling” issue; value of information
- Need to know more about how much of a new or improved good is consumption rather than an investment
- Need to think about how consumer surplus fits into GDP framework when consumer surplus is large vis-a-vis resource costs
- Need to deal with household production *and* consumption