How Govt. Stats Adjust for Potential Biases in an Age of Digital Technologies: A View from the Trenches

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Erica L. Groshen, Cornell University—ILR School
Brian C. Moyer, BEA
Ana M. Aizcorbe, BEA
Ralph Bradley, BLS (ret.)
David Friedman, BLS
Agenda

• Background
• Challenges in measuring price indexes
  • Adjustment methods
• Estimated quality-adjustment and new-goods biases in measuring real GDP
• Challenges in measuring nominal GDP
• Improving price and output measures
BLS mission

• ... principal Federal agency responsible for measuring
  • labor market activity
  • working conditions
  • price changes in the economy

• ... collect, analyze, and disseminate essential economic information

• ... support public and private decision making.

Underestimating the Real Growth of GDP, Personal Income, and Productivity - Martin Feldstein
  • Asserts there’s a huge measurement problem

Challenges to Mismeasurement Explanations for the US Productivity Slowdown - Chad Syverson
  • Refutes many mismeasurement explanations

  • Current processes, issues, adjustment strategies, bias estimates, measurement strengths
BLS price indexes

Most of the price indexes used for real GDP

- **Consumer Price Index** (CPI)—prices paid by urban consumers

- **Producer Price Index** (PPI)—prices received by domestic producers

- **Import and Export Prices** (MXP)—prices related to trade between US & rest of world
Price indexes in the trenches

• Goal
  ➢ Best possible monthly indexes of price changes

• Constraints on methodology
  ➢ Compatible with resources
  ➢ Computable and reviewable in 20 days
  ➢ Preserve respondent confidentiality
  ➢ Avoid undue burden on respondents
  ➢ Make changes only if reduce bias certainly & significantly
How BLS accounts for innovation in price indexes

• Issue as old as price indexes; innovation is old
  • Note: Not same as substitution bias

• **Matched model** = cornerstone of price measurement
  • Compare prices for identical products over time
  • Attribute any price change to inflation
  • In CPI, from 12/2013 to 11/2014
How BLS accounts for innovation in price indexes, contd.

- As items disappear (5% of items), “replacement” identified
  - If very similar (3% of items), new item replaces older
  - For remaining 2% of items, quality adjustment procedure invoked—see Table
# Methods to account for new and improved goods and services

<table>
<thead>
<tr>
<th>Method</th>
<th>Requires demand estimation</th>
<th>Based on characteristics, product or other</th>
<th>Studies</th>
<th>In production</th>
<th>Reason not in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality adjustment from producer</td>
<td>No</td>
<td>Characteristics</td>
<td>Yes; PPI, MXP, CPI***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input from other surveys</td>
<td>No</td>
<td>Characteristics</td>
<td>Yes; primarily PPI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explicit hedonic quality adjustment</td>
<td>No</td>
<td>Characteristics</td>
<td>Yes; CPI*, PPI**, MXP**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time dummy hedonic index</td>
<td>No**</td>
<td>Characteristics</td>
<td>No</td>
<td></td>
<td>Restrictive assumptions</td>
</tr>
<tr>
<td>Imputed hedonic index</td>
<td>No</td>
<td>Characteristics</td>
<td>No</td>
<td></td>
<td>Requires larger sample sizes</td>
</tr>
<tr>
<td>Discrete choice</td>
<td>Yes</td>
<td>Characteristics</td>
<td>No</td>
<td></td>
<td>High computational intensity and cost; poor timeliness</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>Yes</td>
<td>Product</td>
<td>No</td>
<td></td>
<td>Endogeneity problems (under investigation); high cost</td>
</tr>
<tr>
<td>Disease-based price indexes</td>
<td>No</td>
<td>Treated disease</td>
<td>Partial; BEA and BLS experimental indexes</td>
<td></td>
<td>Do not yet adjust for differences in outcomes</td>
</tr>
</tbody>
</table>

* See [http://www.bls.gov/cpi/cpihqablsbib.pdf](http://www.bls.gov/cpi/cpihqablsbib.pdf) for CPI items that are quality adjusted.

** PPI and MXP do explicit hedonic quality adjustment for computers.

*** For example, this is done for new vehicles in the CPI and PPI.

**** PPI is experimenting with this method for microprocessors.
Three BLS quality adjustment approaches for price indexes

1. Producer-provided quality adjustment
   - Producers supply monetary value (generally cost-based) for quality change or info about replacement model
     - E.g., autos, machinery, goods with model changes
   - Most prevalent for PPI and MXP
   - Appropriate for adjusting output (not welfare) price indexes
     - See Triplett [1982] and IMF [2004]

2. Input from other surveys, e.g.
   - DHHS Hospital Compare and Nursing Home Compare database
   - Insurance Services Office
Three BLS quality adjustment approaches, contd.

3. Hedonic adjustments
   • Estimates what each product characteristic adds to value
   • CPI goods eligible for hedonics account for 33% of market basket (includes housing)
   • PPI and MXP use hedonics for computers
   • Requires
     • Adequate sample size
     • Data on characteristics, all observable
     • Stable characteristics
     • Competitive market
Key approach not in production, sort of...

- Disease-based price indexes
  - Healthcare spending **17.5% of GDP**
  - Medical price indexes (service-based) upwardly biased when many new treatments replace costlier services
  - Disease-based indexes account for price impact of substituting or dropping services
  - BLS and BEA both developed new disease-based indexes (6/2017 BLS “Beyond the Numbers”)
    - Still experimental
    - Outcomes not accounted for
How large might be bias in measured real GDP growth?

- Goal: Judge degree of quality-adjustment and new goods bias remaining
- Apply and add up best external empirical estimates
  - Lebow & Rudd (2003); Byrne, Fernald & Reinsdorf (2016); Cutler, Rosen & Vijan (2006); Greenstein & McDevitt (2011)
- Value (despite subjectivity and uncertainty)
  - Direct improvement efforts
  - Inform users of data limitations
  - Potentially rule out hypotheses
Impact of possible biases to Personal Consumption Expenditures deflators on measured real GDP growth, 2000-2015

<table>
<thead>
<tr>
<th>Expenditure Category</th>
<th>Contributions to real GDP growth (percentage points per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected PCE categories</td>
<td></td>
</tr>
<tr>
<td>Medical care:</td>
<td></td>
</tr>
<tr>
<td>Prescription drugs</td>
<td>-0.02</td>
</tr>
<tr>
<td>Nonprescription drugs</td>
<td>0.00</td>
</tr>
<tr>
<td>Medical care services</td>
<td>-0.07</td>
</tr>
<tr>
<td>PC services (incl. internet)</td>
<td>-0.01</td>
</tr>
<tr>
<td>All other PCE categories</td>
<td>-0.10</td>
</tr>
<tr>
<td>All PCE categories</td>
<td>-0.20</td>
</tr>
</tbody>
</table>

NOTE: Total for All PCE categories may not add exactly due to rounding.
**Impact of possible biases to Private Fixed Investment deflators on measured real GDP growth, 2000-2015**

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>Contributions to real GDP growth (percentage points per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication equipment</td>
<td>-0.07</td>
</tr>
<tr>
<td>Computers and peripherals</td>
<td>-0.08</td>
</tr>
<tr>
<td>Other info. systems equipment</td>
<td>-0.05</td>
</tr>
<tr>
<td>Software</td>
<td>-0.03</td>
</tr>
<tr>
<td><strong>All PFI categories</strong></td>
<td><strong>-0.23</strong></td>
</tr>
</tbody>
</table>

Note: Total for All PFI categories may not add exactly due to rounding.
Bottom line on biases

GDP impact on PCE + PFI: -0.4 percentage point

- Reduction in measured real GDP growth from biases (2015)
  - PCE: -0.26 percentage point
  - PFI: -0.15 percentage point
- Little change over time
- Looms larger when growth is slow

- BLS & BEA perspective
  - Not alarmed, nor satisfied
  - Helps focus improvement efforts
  - Next, explore potential biases in trade and government spending
Challenges for BEA in measuring nominal GDP in the digital age

- GDP may omit valuable new goods and services that are not sold (e.g., searches, Wikipedia)
- GDP tracks market activity, not welfare
  - BEA’s satellite accounts track some non-market activity, like household work
- “Free” digital services supported by ads appear in GDP (Google and many more)
  - Wikipedia, many blogs & photo archives are nonmarket
Challenges in measuring nominal GDP in the digital age, contd.

- Movement between market and household production (e.g., travel arrangements)
  - Appropriately tracked, but may be of interest
- Business investments in intellectual property—likely undercounted
- Purchased cloud services—not directly problematic

**Bottom line:**
- Most marketed digital products appear in GDP
- Misallocations across GDP categories (Uber, Airbnb)
- Distortions likely small now, but growing rapidly
- Traded intellectual property needs further attention
Improving quality adjustments in prices and output—BLS & BEA together

- **Cell phones, CPI**
  - Using datasets from BEA, BLS built a new QA hedonic model—in production starting in January
  - Directed substitutions 2x/year, as major new models are released
  - QA models will be updated twice yearly to correspond with release dates

- **Wireless telephone services, CPI**
  - BLS refined QA practices last spring
  - Exploring JD Household data for item selections and substitution frequency next year
  - Exploring another source from BEA to replace surveys
  - BEA using source to estimate historical biases
Improving measurement—BLS

• Scanner data
• Outcome measures for medical services
• Hedonics
  • Scrape prices and characteristics
  • Corporate transactions data
  • Add/improve models and products (next slide)
Quality adjustment improvements—BLS

• **Microprocessors, PPI**
  - New hedonic methods deal with changed pricing practices
    - Responds to and expands on Byrne, Oliner & Sichel framework
    - Looks at all products (new and old), updates models frequently, etc.
  - Template for quality adjustment in other industries with rapid technological change, using
    - Statistical learning methods for model specification
    - Time dummy variables approach

• **Broadband services, PPI**
  - Hedonic regression model in production
  - First QA model for a service
Improving measurement of prices and output—BEA

- Tracking ad-supported media
- Coverage of intellectual property transactions, here and abroad
- Value created in production chains
Tapping external data sources—BEA

- Constructing historical price indexes from new sources
  - Goal: Assess any potential biases in rapidly innovating sectors with substantial GDP shares
  - Sectors
    - Custom & own-account software
    - Electro-medical equipment
    - Residential Communication Services:
      - Wireless services, including devices
      - Wireline services (broadband, cable, telephone)
Conclusion

• **Price index measurement** → **understated real output growth**
  • From rapid innovation and globalization
  • Affects healthcare, possibly areas using IT/comms technology
  • Stable over time

• **Producing official stats**: **not for the rigid or fainthearted**
  • Put out timely monthly data, within budget
  • Biases will be addressed over time

• **Official statistics**
  • Imperfect, like all statistics
  • Uniquely accurate, objective, relevant, timely and accessible
  • Infrastructure supporting efficient markets, helping policymakers and citizens make decisions
  • Need active support in today’s environment
You can help the work in the trenches.
Approaches not in production

- Discrete choice
  - More general than traditional hedonics
  - Currently logistically impossible (needs more data, computational power, monthly item-area estimates)

- Consumer surplus
  - Estimated demand functions solved for virtual prices
  - Original versions subject to large biases
  - Newer versions may hold promise
**Impact of estimated biases to Private Fixed Investment deflators on measured real GDP growth, 2000-2015**

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>Share of GDP</th>
<th>Byrne, Fernald, and Reinsdorf estimated bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication equipment</td>
<td>1.2%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Computers and peripherals</td>
<td>1.0%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Other info. systems equipment</td>
<td>0.7%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Software</td>
<td>1.8%</td>
<td>1.7%</td>
</tr>
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**Contributions to real GDP growth (percentage points/year)**

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>-0.07</th>
<th>-0.04</th>
<th>-0.03</th>
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<tbody>
<tr>
<td>Communication equipment</td>
<td>-0.08</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.03</td>
</tr>
<tr>
<td>Computers and peripherals</td>
<td>-0.05</td>
<td>-0.06</td>
<td>-0.06</td>
<td>-0.06</td>
</tr>
<tr>
<td>Other info. systems equipment</td>
<td>-0.03</td>
<td>-0.02</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td>Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>All PFI categories</strong></td>
<td>-0.23</td>
<td>-0.17</td>
<td>-0.16</td>
<td>-0.15</td>
</tr>
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Note: The contributions to GDP growth for 2000 and 2005 are calculated using the bias estimates for 1995–2004; the contributions for 2010 and 2015 use the bias estimates for 2004–2014. Total for All PFI categories may not add exactly to sub-components shown in columns due to rounding.
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescription drugs</td>
<td>1.3%</td>
<td>1.6%</td>
<td>1.9%</td>
<td>2.3%</td>
<td>1.20%</td>
</tr>
<tr>
<td>Nonprescription drugs</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.50%</td>
</tr>
<tr>
<td>Medical care services*</td>
<td>9.8%</td>
<td>10.9%</td>
<td>12.2%</td>
<td>12.5%</td>
<td>0.76%</td>
</tr>
<tr>
<td>PC services (incl. internet)**</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.4%</td>
<td>0.6%</td>
<td>6.50%</td>
</tr>
</tbody>
</table>

#### Contributions to real GDP growth (percentage points per year)

<table>
<thead>
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<th>Expenditure Category</th>
<th>Contributions</th>
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<td><strong>All PCE categories</strong></td>
<td><strong>-0.20</strong></td>
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</tbody>
</table>

* Bias estimate for medical care services has been adjusted based on data from AHRQ (2017).
** Bias estimate for PC services (including internet) is based on Greenstein and McDevitt (2011).
NOTE: Total for All PCE categories may not add exactly to the sub-components shown in the columns due to rounding.