Some Thoughts on Digital Products, Consumer Prices and GDP

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Overview

1. A longstanding debate: measuring productivity and welfare
2. Which welfare effects may go amiss?
3. Capturing welfare effects
   3a. Inside price indices & inside GDP
   3b. Outside price indices & inside GDP
   3c. Outside GDP
4. Conclusions
1. A longstanding debate: productivity and welfare
A longstanding debate

- Weak productivity growth
- Shortage of ideas, innovation slowdown
- Break-down of the diffusion machine
- The Mismeasurement Hypothesis: inflation is overstated
- Although, other issues around inflation have recently moved centre-stage
Presence in the public debate

"Silicon Valley Doesn’t Believe U.S. Productivity"

Why we’re measuring the digital economy in the wrong way

Charlie Bean: “statistics have failed to keep pace with the impact of digital technology”

Diane Coyle: The pace of change in OECD countries is making the existing statistical framework increasingly inappropriate for measuring the economy

Some optimists argue instead that the problem is one of measurement. Technological progress often raises productivity in ways that statistical agencies struggle to detect.
2. Which productivity/welfare effects may go amiss?
Possible welfare effects

<table>
<thead>
<tr>
<th>1. Quality change in existing product types</th>
<th>2. Appearance of truly novel products</th>
<th>3. Appearance and use of free products</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Quality change in existing digital products through evolving characteristics embodied in new varieties of digital products (e.g. computers)</td>
<td>e.g., smartphones</td>
<td>e.g., free communication services through apps</td>
</tr>
<tr>
<td>(b) Digital replacement of non-digital products (e.g., streaming services replacing CDs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Improved variety selection among products, digital and other (e.g., clothing, books)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Reinsdorf and Schreyer (2019)
Quality change in existing product types

- Appearance of new models/varieties of existing products and new products
- Digital replacements
- Improved variety selection
Truly novel products

- Smartphone, DVD players, streaming services,…

- Captured once they are on the market, but introductory welfare gain (or loss) is lost
Free products

• Transaction price = 0
• Excluded from price index
• Shadow price:
• Marginal consumer surplus > 0, valuation:
  • Implicit transaction (advertising, user data)
  • Value of time (opportunity cost)
  • Willingness to pay/accept can be observed
  • Almost certainly, different results
3. Capturing welfare effects
3a. Inside the price index & inside GDP
Established approaches to deal with quality change for existing products include:

- **Direct price comparison** (price difference = pure price change, no quality change)

- **Link-to-show-no-price change** (price difference = quality difference)

- **Linking with aggregate price change**

- **Hedonics** (well developed area, also with new sources - see eg Nyborg Hov & Nygaard on consumer electronics, this meeting)

- **Proxies**
A few issues with established approaches to quality-adjust (1)...

• Outlet effects for digital products – online versus physical stores – unclear

• Much less investigated: quality decline:
  Programmed obsolescence
  Purely machine based after sales services
  No backward compatibility of new software
  Digitally-enabled products with reduced convenience (e.g. self-checkout)

• Proxies
  E.g., Byrne and Corrado (2020): direct measures of volume (data transmitted, talk time, and hours of programming) for quality adjustment of consumer digital access services
  U.S. (1988-2018): -12% adjusted vs +1.2% official for digital access services -> 0.5 pp overestimation of PCE prices

• General: knowledge gap on effects of quality adjustment on price indices (ECB 2021)
...also international comparability...

Price indices across countries, adjusted for overall inflation

Difference in average annual % rate of change, 2010-15

Source: Ahmad, Reinsdorf, Ribarsky (2017)

- Menz, Wieland and Merhoff (this meeting) estimate effects of differences in quality adjustment methods more generally and find non-negligible effects on HICP
...although, GDP effects depend on imports and intermediate inputs...

GDP growth, aggregate impact of ICT assets and communication services using lower bound price indices

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP growth, unadjusted</th>
<th>Adjusted GDP growth minus Unadjusted GDP growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scenario I: M=0</td>
</tr>
<tr>
<td>Australia</td>
<td>2.761%</td>
<td>0.023%</td>
</tr>
<tr>
<td>Austria</td>
<td>1.047%</td>
<td>0.294%</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.996%</td>
<td>0.400%</td>
</tr>
<tr>
<td>Canada</td>
<td>2.148%</td>
<td>0.286%</td>
</tr>
<tr>
<td>France</td>
<td>0.943%</td>
<td>0.157%</td>
</tr>
<tr>
<td>Germany</td>
<td>1.572%</td>
<td>0.122%</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.641%</td>
<td>0.200%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.748%</td>
<td>0.367%</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.235%</td>
<td>0.176%</td>
</tr>
<tr>
<td>UK</td>
<td>1.978%</td>
<td>0.365%</td>
</tr>
<tr>
<td>US</td>
<td>2.072%</td>
<td>0.208%</td>
</tr>
</tbody>
</table>

Notes: Data reported for Austria (communications) correspond to 2011-2015 and Spain (ICT goods and software) correspond to 2010-2014.


Source: Ahmad, Reinsdorf, Ribarsky (2017)
...and expenditure weights in PCE of digital products are declining

<table>
<thead>
<tr>
<th>Description</th>
<th>2005 Weight (average across 34 OECD countries) (%)</th>
<th>2015 Weight (average across 34 OECD countries) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant potential for under adjustment for quality change ('affected products') except communication services</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Communication services</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Some potential for under adjustment for quality change ('potentially affected prods.')</td>
<td>7.4</td>
<td>6.2</td>
</tr>
<tr>
<td>Significant replacement by digital products ('affected products')</td>
<td>2.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Some replacement by digital products ('potentially affected products')</td>
<td>5.8</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>19.1</td>
<td>15.4</td>
</tr>
</tbody>
</table>

Source: Reinsdorf and Schreyer (2019)
Turning to novel and free products – insider the price index

• Reservation price (Hicks 1940)
  • Pre-entry price that drives demand to zero (Hicks 1940)
  • How to get it?
  • Econometrics (e.g., Diewert & Feenstra, 2019)
  • Experimental economics (Brynjolfsson, Collis, Diewert, Eggers and Fox 2018)

• Issues
  • Estimation costs, data availability
  • No reservation price if product hasn’t been invented yet
  • COLI perspective required and economic approach to indices
  • Acceptance as tool in official statistics

• Capturing welfare effects of novel/disappearing and free products - a lost cause?

• Not quite: outside the price index may be a better space to capture welfare effects
3b. Outside the price index & inside GDP
Outside the price index & inside GDP

• Capturing welfare effects of free products through nominal income effects
• Use of results on willingness to pay/forego through choice experiments (Brynjolfsson, Collis, Diewert, Eggers and Fox 2018)
• Facebook: around 500$/year: shadow price (marginal consumer surplus)
• Added on to nominal GDP
• BCDEF: U.S. GDP ‘B’ growth
Still some problems

- Who produces?
- Who gets attribution of productivity gain/loss?
- Possibly conflicting valuation – case of Facebook
  - Financing via advertisements or data sales
  - Facebook’s measured value-added = income generated in the advertising or data sales business
  - Problem: measured value-added ≠ shadow price*#of users
  - $25/user/year (approximative advertising revenues) < $500/user/year (willingness to forego)
The broader issue

• How far do we want to go with imputations to GDP or household income/consumption to reflect welfare gains or losses?

• A possible way forward – quantification outside GDP, as own account household production
3c. Outside GDP
Free digital products as inputs to own-account HH production

- Production process by households who use:
  - time
  - capital services (hardware, software) including freely provided
  - to produce (typically, leisure) services

- Unit values and quantities need not coincide with advertising or data sales revenues of digital service provider

- Choice experiments inform about the value of own account production to HHs
### Computations for the Facebook case (1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Acronym</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent on Facebook</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hours/year</td>
<td>$t_F$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2004: 20</td>
<td>2017: 40</td>
</tr>
<tr>
<td>WTA (BCDEF[8])</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>— all ICT capital services</td>
<td>4</td>
<td>$u_FK_F$</td>
<td>2004: 0.01</td>
</tr>
<tr>
<td>— Facebook ICT capital services</td>
<td>5=4*2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implied wage rate</td>
<td>6</td>
<td>$w_F$</td>
<td>2004: 1.46</td>
</tr>
<tr>
<td>Value of leisure time per person</td>
<td>7=6*2</td>
<td>$w_Ft_F$</td>
<td>2004: 192</td>
</tr>
<tr>
<td>Value of leisure services per person</td>
<td>8=7+5</td>
<td>$p_{Fq_F}$</td>
<td>2004: 194</td>
</tr>
</tbody>
</table>

Source: Schreyer (2022)
### Computations for the Facebook case (2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Acronym</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change of wage rate for leisure services</td>
<td>Index</td>
<td>$w_F^1/w_F^0$</td>
<td>1.00</td>
</tr>
<tr>
<td>Price change of ICT capital services</td>
<td>Index</td>
<td>$u_K^1/u_K^0$</td>
<td>1.00/0.3604</td>
</tr>
<tr>
<td>U.S. Facebook users</td>
<td>Million persons</td>
<td>$Z$</td>
<td>0.10/200</td>
</tr>
<tr>
<td>Törnvist unit cost index of leisure services</td>
<td>Index</td>
<td>$p_F^1/p_F^0$</td>
<td>1.00/1.2493364</td>
</tr>
<tr>
<td>—no quality adjustment</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>—quality adjustment</td>
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<td></td>
<td></td>
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<tr>
<td>—quality adjustment</td>
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<tr>
<td>—quality adjustment</td>
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<td></td>
</tr>
<tr>
<td>—quality adjustment</td>
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</tbody>
</table>

- Extended measure of activity (EMA) would rise between 0.04 and 0.3 ppt/year faster than U.S. GDP
- EMA-based labour productivity would always be less than official number

Source: Schreyer (2022)
Outside **GDP**, yes, but not in isolation

- **Big tickets** in home production (25%-60% of GDP)
  - Childcare, care for infirm and elderly, cooking, cleaning,…
- **Important gender issues**
- Digitally-enabled leisure services best considered in conjunction with other forms of household production
Conclusions

• Digital economy makes price measurement harder and raises questions about possibly neglected welfare effects (positive and negative)

• No silver bullet – case by case approach

• Consider methods both within and outside price index and within and outside GDP boundaries

• No clear conclusion how far welfare effects should be imputed into GDP – theoretical and practical issues

• No progress without research, though, and much is to be done to better understand the digital transformation
References


• Aeberhardt, L, F. Hatier, M.Leclair, B. Pentinat and J-D. Zafar,


References


