Perspectives on Measuring the Digital Economy

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Brief Overview of Talk


- The Policy Paper considers a broad range of statistics: prices, GDP/productivity, balance of payments, monetary-financial

Brief Overview of Talk

IMF Policy Paper

- Motivation
- Definition of Digital Sector and Digital Transactions
- GDP Conceptual Framework
  - Nonmarket production enabled by digital platforms/products
  - GDP and Welfare
- Deflators
- Productivity
- Compilation Challenges and New Data Needs
- Summing up: Main findings and recommendations

Employment Statistics and Future of Work
Motivation

- Debate over measuring the digital economy in GDP/productivity statistics, fueled by ...
  - Puzzling slowdown in productivity beginning in mid-2000s
    - IMF SDN on *Gone with the Headwinds: Global Productivity*
  - Perception that the conceptual framework of GDP might not be suitable for measuring the digital economy
    - Many digital products are free once you’ve already bought a computer or smartphone and paid for access to the web
    - Growth statistics may not reflect welfare from Internet, smartphones, ...

- Importance of considering new data needs for understanding the digital economy, and implications for Balance of Payments and Monetary & Financial Statistics
Definition of the Digital Sector

- The Policy Paper defines a *digital sector*
- A less ambiguous term than “the digital economy”
  - Some use “digital economy” to mean the Internet, new activities enabled by the Internet, and production of ICT goods and services
  - Others include all processes, products and transactions embodying digital technology
- Digital sector definition is broader than the ICT sector of ISIC 4
  - More complete/clearer coverage of online platforms
  - Includes platform-enabled services
Definition of the Digital Sector

- Definition of “digital sector” comprises areas of main measurement concern:
  - Producers of ICT equipment, software, and ICT services
  - Online platforms
  - Platform-enabled activities (the Sharing Economy, gig economy, ...)

- Online platforms include e-commerce, (social) media, search, sharing/gig/collaborative economy, on-demand property rental, crowdsourcing, fintech, ...

- Definition of Digital transactions also needed for analytical purposes
  - “digital ordering” is criterion for defining e-commerce
  - “digital delivery” of services (e.g. in foreign trade)
  - “platform-enabled” services
Dimensions of digital transactions

Nature (‘how’)
- Digitally ordered
  and/or
- Platform enabled
  and/or
- Digitally delivered

Product (‘what’)
- Goods
- Services
- Information/data

Actors (‘who’)
- Corporations
- Households
- Government
- Non-profit Institutions Serving Households

Size of the digital sector: VA of ICT sector

Source: García Herrero and Xu, presentation at 2017 IMF Statistical Forum
### Example of Plausible Size of the Digital Sector

#### Possible Size of the Digital Sector in the United States, 2015

<table>
<thead>
<tr>
<th>Product group</th>
<th>Percent of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Included in GDP (on a value-added basis):</strong></td>
<td></td>
</tr>
<tr>
<td>ICT equipment, semiconductors and software</td>
<td>2.8</td>
</tr>
<tr>
<td>Telecommunication and Internet access services</td>
<td>3.3</td>
</tr>
<tr>
<td>Data processing, and other information services</td>
<td>0.7</td>
</tr>
<tr>
<td>Online platforms, including e-commerce platforms</td>
<td>1.3</td>
</tr>
<tr>
<td>Platform-enabled services, (e.g., the “sharing economy”)</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8.3</td>
</tr>
<tr>
<td><strong>Conceptually not included in GDP, or missed for procedural reasons:</strong></td>
<td></td>
</tr>
<tr>
<td>Volunteer-produced content and open source software</td>
<td>0.5</td>
</tr>
<tr>
<td>Free digital media funded by advertising</td>
<td>0.2</td>
</tr>
<tr>
<td>“Do-it-yourself” fixed capital formation of online platforms</td>
<td>0.3</td>
</tr>
<tr>
<td>Output of digital MNEs mis-attributed to tax havens</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.4</td>
</tr>
</tbody>
</table>

Source: Staff estimates based on official U.S. data, Nakamura, Samuels and Soloveichik (2017), Byrne, Corrado and Sichel (2017), and Guvenen et al. (2017).
GDP Conceptual Framework

- Debate over whether growth is well-measured involves 2 issues:
  - Adequacy of GDP concepts/definitions
  - Compilation procedures used to estimate those concepts
- Welfare from free services enabled by, or supplied by, digital products/platforms not captured in growth statistics is the main conceptual issue
- Estimation problems include the deflators and gaps in the source data on new digital products/suppliers
GDP Conceptual Framework

- *System of National Accounts 2008 (SNA)* provides conceptual framework and definition of GDP and other NA aggregates

- A unifying conceptual framework needed to ensure coherence of inter-dependent, balanced system
  - Changing the system is not as simple as is sometimes presumed: any change will have ramifications for the other parts of the system
GDP Conceptual Framework

- GDP is a measure of market and near-market goods and services produced in the national economic territory
  - The last letter in GDP reminds us that it measures production

- Market output means output sold for a price that at least comes close to covering the costs

- For market output, value is measured by price*

* Output that governments and nonprofits serving households provide for free, or at a price far below cost, is valued at the cost of production
3 approaches to calculating GDP

1) GDP = \( C + I + G + X-M \) ("expenditure approach")
   - Inventory changes in \( I \), and \( X-M \), convert consumption to production
   - Items in \( M \) are also in \( C + I + G \); uses of this equation to justify protectionism on grounds that imports subtract from GDP ignore this

2) GDP = sum of Value Added of every industry + adjustment for taxes less subsidies on products ("production approach")

3) GDP = income from production distributed to the suppliers of labor and capital, or paid in taxes ("income approach")
GDP Conceptual Framework

- Proposed changes to address concerns about unmeasured welfare growth from free services enabled/supplied by digital platforms must maintain the conceptual identity between the three approaches.

- Any imputation of extra consumption requires parallel imputations of extra production and extra income.
  
  - *Imputed income* is not really equivalent to money income—it can’t be saved, spent on other items, or taxed.

- The imputations reduce suitability of GDP for questions about employment, government revenue and financial stability.

*No single statistic can provide the answer to every question.*
Households’ nonmarket production of services for own consumption and Volunteers’ services are outside the GDP production boundary.

Need to measure as a complement to GDP long recognized (e.g., “Measure of Economic Welfare” of Nordhaus and Tobin, 1972).

Several countries began to produce estimates after the Stiglitz-Sen-Fitoussi (2009) commission report.

Some have argued that in the digital age, nonmarket production is growing faster than market production.
Production boundary issues redux

Core SNA

<table>
<thead>
<tr>
<th>Market production</th>
<th>Volunteer production (goods)</th>
<th>Household production for own use</th>
<th>Non-SNA production (£1018.9bn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNA production (£1817.3bn)</td>
<td>Owner occupiers’ Own production of goods (esp. imputed rent) of dwellings)</td>
<td>Other services produced for own use</td>
<td>Volunteer production (services)</td>
</tr>
</tbody>
</table>

Substitutions out of market production (digital intermediation services; business model changes)

Voluntary production of digital intangibles

Other types of household capital services (Car clubs)

Housing maintenance

Nutrition

Transport

Childcare

Laundry

Adult care

Source: Sir Charles Bean, STA-ICD Invited Speaker Program lecture, April 2017, based on 2014 data from the UK ONS
Classifying Nonmarket Digital Production

- Digital products/platforms have fostered growth of services outside the GDP production boundary
  1) *Self-produced*: Digitally-enabled household nonmarket production replaces market services ("digital replacements")
     - Households serving as their own travel agent
     - Skype, WhatsApp, digital camera, smartphone capabilities
  2) *Volunteer-produced*: Wikipedia articles, user-generated media and content, open source software
  3) *Platform-produced*: Free media and search services supplied by online platforms funded by advertising and collection of data
     - Fits into a measurement literature that begins with broadcast TV
     - Whether this production is currently missed by GDP is being debated
1. Replacement by Household nonmarket production
1. Replacement by Household nonmarket production

- It is often said that digital replacements “make GDP go down”
- But the money saved will be spent on other things
  - Analogous to the “lump of labor” fallacy that productivity gains automatically cause unemployment
- More accurate to say that the *composition* of GDP changes
- If properly measured, the downward impact on the cost of living would add to growth of real GDP (and reduce inflation)
- Measure of real GDP is likely to be flat, understating the welfare growth
- Digital replacements may be features of new or improved goods—part of the longstanding problem of unmeasured welfare gains from truly novel new goods and quality improvements in existing products
Replacement of household nonmarket production

- Research on how digitalization has changed households’ time use in non-market production could illuminate the “productivity”/welfare gains from digitalization.

- Alternative or improved measures of HH consumption deflator would also help us to understand/capture the welfare growth.

- Some of the gains come from shifts of tasks to the market side of the production boundary:
  - Online shopping means tasks of finding things on shelf and transporting them home become market services.
  - Uber may substitute for driving your own car.
2. Volunteer nonmarket production

**Digitally-enabled volunteer-produced services**

- Most kinds not big enough to materially affect GDP
  - Even though Wikipedia has 15 billion page views/month, if it sold advertising its revenue would be a microscopic share of world GDP

- Open source is significant share of software investment
  - Greenstein-Nagle (2014) found that 23% of outward-facing servers were running Apache
  - Microsoft just announced $7.5 billion acquisition of Github

- Partly included in GDP already—production of software is partly estimated from earnings of coders, some of whom write open source software used for advertising or in a “freemium” business model
3. Free services of digital platforms

- Free online platforms funded by advertising and collection of user data provide search, information and entertainment media, social media, product/business reviews, e-mail, etc.

- Brynjolffson, et al. (2017) survey of willingness-to-accept to forego access finds large consumer surplus for users.

- SNA views platforms as suppliers of advertising services used by other businesses.
  - Ad revenue covers the platform’s costs.
  - Output of platforms is included in GDP as part of the output of the businesses that buy the advertising services.

- Some propose to add the free media to the consumption of the viewers, with a value based on costs of production.
  - Analogous to use of production cost to value NPISH output.
3. Free services of digital platforms

- Nakamura, Samuels and Soloveichik (2017) treat ad-funded platforms as bartering access to free media for viewers’ ad viewing services; their estimate of HH consumption of free digital media is around 0.2% of US GDP in 2015
- Effect on U.S. real GDP growth is negligible
- Adding self-promotion and products distributed as part of a “freemium” business model makes the effects a bit larger
- OECD Working Paper (Ahmad, Ribarsky and Reinsdorf, 2017) found tiny effects in OECD countries, and effects on growth were occasionally negative
3. Free services of digital platforms

- Options discussed so far for imputing extra production implied by a new imputation of HH consumption of free media funded by advertising have drawbacks
  - But platform users could be seen as consuming capital services

- Failure to capture welfare is not in itself a reason to change nominal GDP, as it measures *production of market output*

- Scope to improve SNA treatment of data/data-driven businesses
  - Data acquisition, and free services to attract “sticky” users to platform with network effects, have characteristics of investment
  - More thinking needed on how to measure the extra real output generated by using data to deliver the right thing at the right time

- Scope to clarify framework for free services of 2-sided platforms
  - In SNA, free services are only supplied by governments and NPISHs
GDP and Welfare

- GDP is not a welfare measure, even if it’s used as a proxy for one
- GDP uses prices that reflect scarcity/abundance to gauge value
  - Welfare from water is large as it’s essential for life, but price is low
- Production, measured by GDP, is only loosely related to welfare*
- But real HH consumption and real income are welfare indicators
- Real GDP/consumption/… calculated by deflating by price index
- Deflators are main issue for measuring welfare growth

* SNA concepts intended for gauging welfare include Adjusted Individual Consumption and Real Net Domestic Income. Also, Weitzman (1976) interprets real Net Domestic Product (NDP) as a dynamic welfare measure reflecting sustainable consumption
GDP and Welfare

- Although level of nominal GDP is not a measure of welfare level, growth of real consumption measures welfare growth.
  - In figure below, nominal consumption $c = p \times q$ omits the consumer surplus $s$, given by the area under the demand curve above $p$.
  - Suppose real income grows, causing $c$ to rise. Relative change in $c$ may equal relative change in $c+s$. 
GDP and Welfare

$c \neq \text{welfare because surplus } s \text{ is omitted}

\text{Increase in income raises } c \text{ by } \Delta c

\% \text{change in welfare } (c + s) = \% \text{change in consumption } (c)$
GDP and Welfare

- **Price as measure of value gives the right weights** for real consumption to be (approximate) measure of welfare growth
  - Low price of water gives correct weight to welfare impact of marginal changes in water consumption (assuming no rationing)
  - Relative prices give the slope of the indifference curve

- Theoretical framework for productivity measurement also assumes that slopes of isoquants and production possibility frontier are given by relative prices

*Proposals to capture the welfare or productivity growth from free digital products by imputing a shadow price may be inconsistent with the conceptual framework for welfare and productivity measurement*
Measuring Welfare Growth: Technical Detail

- **Laspeyres volume index** values current q’s at previous prices; **Paasche index** values previous q’s at current prices.

- Utility maximization is observationally equivalent to consistency of the Laspeyres and Paasche volume indexes with the **weak axiom of revealed preference (WARP) and ordinal transitivity**:
  - If change in Laspeyres (Paasche) volume index is 0 or negative (positive), WARP implies that welfare growth is 0 or negative (positive).
  - Utility maximization $\Leftrightarrow$ rankings implied by Laspeyres and Paasche indexes obey WARP and transitive consistency; impossible to find a cycle implying that a point is inferior, or superior, to itself.
  - Shows the close link between real consumption and welfare.

- Laspeyres (Paasche) is an upper (lower) bound approximation to welfare change.
The “new goods” problem

- Quality adjustment to compare the price of a truly novel new product to one it replaced is often impossible
  - Keynes (1931) gave example of impossibility of a quality adjustment to compare the modern cinema to the gladiators

- Growth and inflation statistics mostly don’t capture level shift in living standards from appearance of truly novel new goods
  - NAS-CNSTAT panel on CPI split on whether would even be desirable

- Welfare from smartphone and Internet is the current concern

- Large impact is limited to the period of rapid diffusion—cannot explain the long persistence of the productivity slowdown
GDP and Welfare

The “new goods” problem

- Hicksian reservation prices provide a theoretical solution, or perhaps we could cost the function that the good accomplishes.

The Price of Light: Cost per Lumen falls but CPI doesn’t

Deflators

Source: Meany-Thomas Report on CPI
Questions about whether real consumption/welfare is correctly measured usually revolve around the deflators.

Quality improvements represent volume growth, not inflation.

Implies need to use quality-adjusted prices to compile price indexes for products whose quality changes.

“Matched models” indexes link in replacement models, with an observed or imputed overlap price.

- Technique works well if price differentials fully reflect quality differences.
- Under-adjusts for quality in cases when advances in technology allow new model to offer better quality at the same price.
- Over-adjusts if sellers are masking price increases.
Deflators

- Alternatives to “matched models” include hedonic regressions, manufacturers’ estimates of the price/cost impact of new features, and other direct quality adjustment methods.

- Improved quality adjustment techniques helped to enable us to measure the productivity speed-up of 1995-2005.

- Byrne (et al.) quality adjusted indexes for ICT equipment and software in the US add 0.25 percent per year to labor productivity growth in 2004-14.

- Additional adjustments for quality improvements in telecom services and for savings to households from buying from online sellers with lower prices could add to this figure.
Deflators

Factors often impeding accurate, quality-adjusted indexes

- Over-reliance on “matched models” procedures rather than attempting an explicit quality adjustment
- New models mostly enter index during sample rotations (which are typically handled by linking in the new sample)
- Unrepresentative older models in index sample/basket
- Lags in bringing in new products/models cause early price declines to be missed
- Hedonic model not updated, or specification omits currently important characteristics
- Manufacturer price list overprices old model
In 2017, the iPhone 7 replaces the iPhone 6s in the Price Index for iPhones

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPhone 6s 32GB, Transactions price (US dollars)</td>
<td>550</td>
<td>450</td>
</tr>
<tr>
<td>iPhone 7 32GB, Transactions price</td>
<td>N.A.</td>
<td>650</td>
</tr>
<tr>
<td>Quality adjustment, iPhone 7 vs iPhone 6s</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>Quality-adjusted iPhone 7 price</td>
<td>100</td>
<td>450</td>
</tr>
<tr>
<td>Price index for iPhones</td>
<td>100</td>
<td>81.8</td>
</tr>
<tr>
<td>iPhone sales, Western hemisphere ($ US billions)</td>
<td>54.9</td>
<td>60.5</td>
</tr>
<tr>
<td>Value index</td>
<td></td>
<td>110.2 (60.5/54.9)</td>
</tr>
<tr>
<td>iPhone Sales, in constant prices of 2016</td>
<td>54.9</td>
<td>73.9 (60.5/81.8)</td>
</tr>
<tr>
<td>Volume index</td>
<td>100</td>
<td>134.7 (73.9/54.9)</td>
</tr>
<tr>
<td>Memo: Index of number of phones sold (90.6 million in 2017/ 85.1 million in 2016)</td>
<td>100</td>
<td>106.4</td>
</tr>
</tbody>
</table>
Deflators

- Large differences between countries in growth rates of official deflators for ICT products seem to partly derive from differences in quality adjustment procedures
  - At least in the case of internationally sourced ICT equipment, the indexes can be expected to behave similarly after controlling for differences in general inflation

- Measurement error in growth and productivity from overstated deflators for digital products depends both on the size of the overstatement and on the importance of digital products in domestic production
Real growth rates of ICT prices, official measures, 2010-2014*

*Data from Spain for ICT equipment and Software cover 2010-2014, and data from Austria for Communication services cover 2011-2015.
Deflators


Source: Ahmad, Ribarsky and Reinsdorf (2017) based on OECD Data
Deflators

Price Indexes for
Software and
Databases, 1994-2015

Price Indexes for
Communication
Services, 2002-2015

Source: Ahmad, Ribarsky and Reinsdorf, 2017
Productivity

- Productivity statistics measure performance of producers in transforming inputs into *market output*
- *Overstated* ICT deflators cause *understated* output growth
- Byrne and Corrado find 6-7 % pts in U.S. deflators for ICT equipment, 2-3 % pts for software; conservative index of Abdiraham et al. implies 7 % pts for telecom services in U.K.
- ICT goods and services appear to be under 7% of *market output* for final uses in most OECD economies

Plausible understatement of productivity growth in range of 0.3 % pts much smaller than amount of missing growth from the productivity slowdown (1.5-2 % pts)

- Similar effect of overstated ICT deflators before the slowdown
Compilation Challenges and New Data Needs

- Digitalization affects *adequacy* of existing statistics on prices, GDP, external sector and monetary and financial instruments
  - Granular data needed on the digital sector and digital transactions
- OECD and IMF surveyed compilers on the state of play in their country
- Updated classification systems with better coverage of online platforms, platform-enabled services and new digital products would help
Compilation Challenges – Price statistics

- Need for more quality adjustment of high tech products
- Shorten time to bring new products and suppliers into index samples and basket
- Updating of higher level weight and basket structure at intervals of 5 or more years in CPIs of EM and developing economies and in PPIs everywhere creates potential for important omissions or under-weighting of digital products/transactions
Compilation Challenges – Price statistics

- Need for more quality adjustment of high tech products
- Shorten time to bring in new products and suppliers
- IMF-OECD survey of compilers showed under-representation of e-commerce prices in CPIs to some extent, and in PPIs
- 70% of respondents include some e-commerce prices in CPI, but important items like clothing and footwear often omitted
  - e-commerce prices may behave differently: “Adobe DPI” implies that in the U.S. they rose 1 percentage point more slowly
- Just 3 countries include sharing economy prices in their CPI
- Savings from substitution to lower-priced online or sharing economy suppliers tends to be missed
Compilation Challenges – National Accounts

- Improved deflators, and better match between deflators and aggregates that they deflate
- Including new digital products and suppliers promptly
- Granular statistics on the digital sector
- In OECD-IMF survey of compilers, measuring the digital sector was often not a priority, in part because resources lacking
  - Sharing economy labor services (e.g., Uber) included about half the time; but Airbnb is usually not covered
  - Estimating platforms’ intermediation services a challenge
  - About a third of respondents collect data on online purchases
Compilation Challenges – National Accounts

- Digital sector transactions may be included in GDP, but not identified in a way that permits separate identification
- Need for updated classifications covering new digital products/industries
  - An accelerated updating process is needed (or a work-around if this is impossible)
Compilation Challenges – External Sector Statistics

- Cross-border e-commerce (digital ordering, delivery) and digital payments have fostered growth of small transactions
  - Reporting thresholds and estimation practices vary
- Outsourcing platforms (e.g., Upwork) accelerate developing country exports of digitally-delivered “gig economy” services
- Platforms for cross-border payments net outflows and inflows
- Some cross-border mobile money remittances missed
- Residence of crypto currency holders/traders is unknown
- Disseminating granular data on ICT and ICT-enabled trade
- Unpriced data flows that contribute to production
- Globalization-related distortions (also applies to nat. accounts)
Compilation Challenges – ESS

Percentage of Respondents to IMF-OECD BOP Survey who …

- use a threshold in customs declarations
- adjust BOP for below-threshold values
- adjust IMTS for below-threshold values
- have conducted a study on transactions facilitated by e-commerce
- can identify the share of merchandise ordered digitally
- can distinguish merchandise trade by households from other transactions

OECD countries (n=35) vs non-OECD countries (n=39)

Source: OECD and IMF surveys of BOP compilers.
MFS guidelines treat peer-to-peer/marketplace lending platforms as financial auxiliaries unless loans kept on platform’s own balance sheet.

- P2P lending between households is out of scope for MFS
  - But should be reported as supplementary information if large

- Loans that banks or asset securitizers buy from P2P platforms should already be captured in data reported by buyers, but loans held on platform’s own balance sheet may be missed
  - If P2P lenders assist with origination of a large amount of loans, statistics on holders could be relevant for risk analysis
Compilation Challenges in Monetary and Financial Statistics (MFS)

- E-money is stored on a card or device (such as a mobile phone) and generally mirrored by an escrow account at a financial institution, implying no undercount of money supply.

- Supplementary data needed to understand improvements in financial inclusion from e-money:
  - HH mobile money accounts outnumber HH bank accounts in 21 African countries.
Digital Currencies

- Crypto currencies are the main kind of digital currency
  - Implement “distributed ledger technology”
- Residence of holder/trader hard to determine
- Several central banks are investigating issuance of digital currency, and they may have statistics by residency
- Don’t qualify as money as the term is defined in the SNA
- But are a source of liquidity
- Other questions: Has mining bitcoins contributed to the productivity slowdown? Are transactions paid for with digital currency missing from GDP and trade statistics?
Summing up: Main Findings in *Policy Paper*

**GDP, welfare, and the GDP production boundary**

- GDP level should not be confused with a welfare measure
- Imputing consumption of free products requires also imputing income
- Deflators are key to measuring real consumption growth
- Production outside the GDP production boundary is relevant for welfare
- Possible changes in boundary definition include data as a product
- Complementary measures of welfare and *open source software* are needed

**Productivity** understatement in range of 0.3 percentage points — smaller than 1-2 percentage points of “missing growth”
Main Findings

Compilation challenges/gaps

• Quality adjustment in price indexes
• Bringing in new digital products/suppliers without delay
  ❖ E-commerce tends to be under-represented in price samples
  ❖ Gaps in coverage of sharing economy/gig economy
  ❖ Services of online platforms not fully captured
• Trade statistics may not capture all e-commerce and digital services
• Gap in measuring mobile money remittances not assisted by a bank
• Needs to disseminate granular data on digital transactions
Recommendations for Compilers

- Focus on quality-adjusting prices of key products
- Consider innovations in data collection and processing to accelerate inclusion of new digital products in indexes/GDP
- Important to align deflators and aggregates being deflated
- In external sector statistics, update assumptions/methods for small transactions, and digitally delivered services and make payments via digital platforms are captured
- For financial statistics, incorporate *marketplace lending platforms that lend own funds*, and report supplementary information on peer-to-peer lending
Independent work on digital platforms growing rapidly

• Micro-enterprises sell goods and services on digital marketplaces (the U.S., a 2016 survey by the Pew Research Center found that 4 percent of adults produced items to sell online in the past year, compared to 8 percent of adults who worked in the gig economy)

• Two kinds of gig economy work: (1) digitally delivered freelancing and crowdsourcing services (e.g., Upwork and Mechanical Turk), and (2) on-demand services (e.g., Uber)*

Growth of contingent/on-demand work in general seems to have been fostered by digitalization

Abraham et al. (2017) find that contingent/temp work is flat in US HH labor surveys

Comparing tax micro-data to HH survey responses shows that survey respondents under-report their gig economy work

Employment estimates based on HH surveys potentially low if surveys are not redesigned to probe for gig economy activity

Need for granular data on gig economy employment/earnings and on participants’ characteristics and economic security

Data on cross-border work on outsourcing platforms may also be relevant
Employment Statistics & Future of Work

- Implications for statistics if robots and artificial intelligence destroy/transform 15-35% of jobs, as has been predicted
- Gap between skills/competencies required by employers and those possessed by the workforce likely to widen
- “Big Data” techniques may allow monitoring of in-demand competencies to better guide training/retraining
- *Index of Technology* covering the diffusion of robots and AI needed to understand the pressures on the job market (and productivity developments)
- Occupational classifications and descriptions of skill requirements will need frequent updates (and more detail)
Comments on Marshall Reinsdorf presentation

Diane Coyle
“The digital sector”

• Isn’t (almost) everything digital?
  • Books
  • Tunnels
  • Dogwalking

• Many boundary problems

• Diffusion/usage in production/consumption best indicator of how ‘digital’ economy is
Production boundary questions

• GDP not really a measure of (near-) market goods
• Nominal GDP not affected by shifts but ‘true’ ‘real’ GDP will be
  • (‘real’ GDP inevitably a welfare measure, albeit flawed)
• Measured real GDP/TFP lower than in counterfactual world
• Back to Becker
  • Household production & market production
  • Time to produce & time to consume

Coyle, forthcoming, *Economica*
What is ‘productivity’ in the digital economy?

Coyle & Nakamura, in progress
What about deflators?

or?