

The Digital Economy and Productivity: Three Measurement Challenges

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The views expressed here are not represented to be the views of the
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- 1 [Definitions of the Digital Economy](#)
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Defining the Digital Economy

Vernacular Definition

Fig. 1: Digital Economy Companies



Fig. 2: Digital Economy Concepts



Note: Word clouds created with *R* (R Core Team, 2021) supplemented with *wordcloud* (Fellows, 2018), available at <https://CRAN.R-project.org/package=wordcloud>

Source: Companies and concepts frequently mentioned in *Harvard Business Review* articles with "digital economy" in the title, 2015-2019.

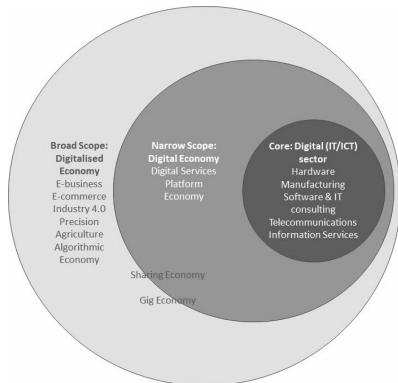
National Accounting Definition

Fig. 3: Three Alternative Definitions of the Digital Economy

The 2025 SNA revision defines **digitalization**...

- “the process of goods and services being delivered in new and innovative ways utilising digital technology”
- “the representation of information in bits”

... but leaves the boundaries of **the digital economy** uncertain.



Source: *Price and volume measurement of goods and services affected by digitalization*, 2008 SNA Update Digitalization Task Team, 2020.

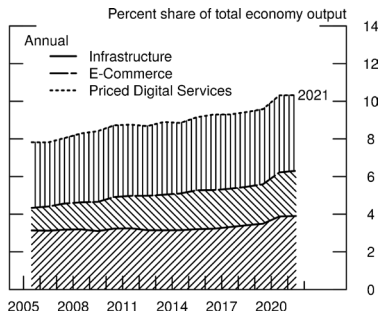
Defining the Digital Economy (continued)

U.S. National Income and Product Accounts Definition

Digital economy satellite account

- Production of infrastructure (IT hardware and software)
- E-commerce
- Priced digital services

Fig. 4: The Digital Economy (BEA)



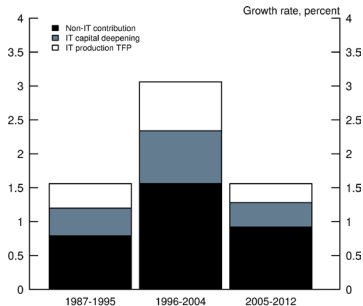
Source: U.S. Bureau of Economic Analysis.

Note: The BEA digital economy definition also includes federal non-defense digital services (very small and not shown), and structures investment and digital intermediary services (to be quantified in future updates).

Growth Accounting Definition

- Total factor productivity for industries producing IT capital (including components)
- Contribution to all industries from *use of* IT capital

Fig. 5: Digital Economy Growth Accounting



Note: Non-IT contribution is aggregate productivity unexplained by IT capital use and production.

Source: Byrne, Oliner, Sichel (2014).

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Motivation for Focus on the Digital Economy

The digital economy plays a central role in the study of...

- **Sources of economic growth.** Production and use of IT capital boosted (aggregate) productivity growth in the late 1990s and early 2000s. Now many wonder why it isn't.
- **Innovation and technical change.** Continual innovation in electronics since the 1950s (loosely, Moore's Law) has fueled technical change in every sector of the economy.
- **Globalization.** The electronics supply chain exemplifies globalization. Local ecological, epidemiological, and political disruption is magnified through the supply chain.

... and accurate measurement is essential for this work.

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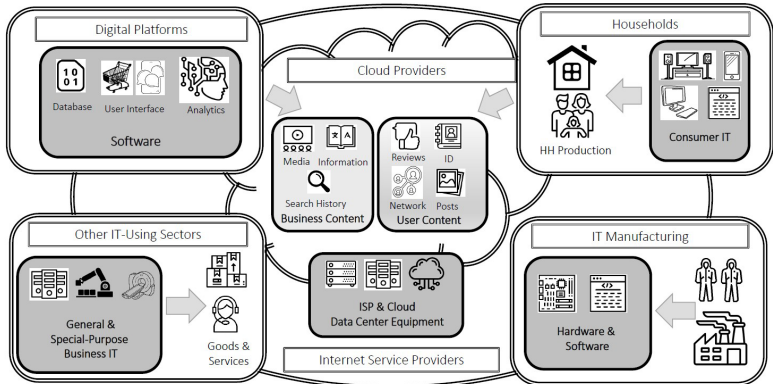
Three Measurement Challenges

Accurate and useful measures of the digital economy have three types of consistency:

- **Capital types.** Symmetric treatment for high-volume and low-volume production, and for tangible & intangible capital.
- **Time-series.** The process of leveraging innovation to raise productivity unfolds over a long period of time.
- **Geographic.** Cross-country comparisons and study of the value chain require a global measurement system.

Consistency across Capital Types

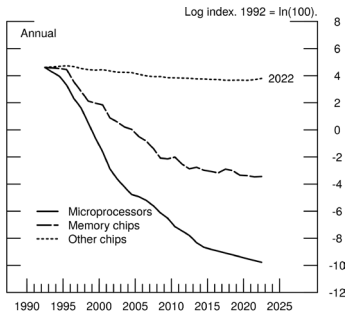
Digital Economy Schematic



Source: Author's depiction.

Consistency across Capital Types (continued)

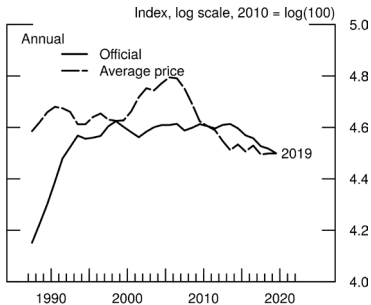
Fig. 6: Chip Prices by Type



Note: MPU and memory price indexes are used in the industrial production index as shown. Other chip price index is adjusted for bias.

Source: Federal Reserve Board.

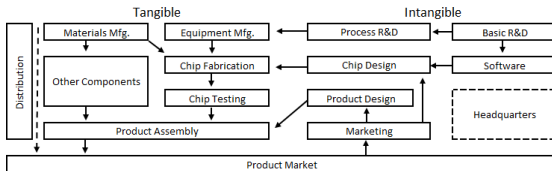
Fig. 7: Flat Digital Service Prices



Source: Bureau of Labor Statistics; Byrne and Corrado (2020).

Consistency across Economies

Electronics Sector Process Flow



Source: Byrne and Green (2023).

Note: Headquarters includes functions such as strategy, policy, marketing, back office, communications, and finance.

Checkpoint Risk by Process

Outside U.S. Sphere of Influence

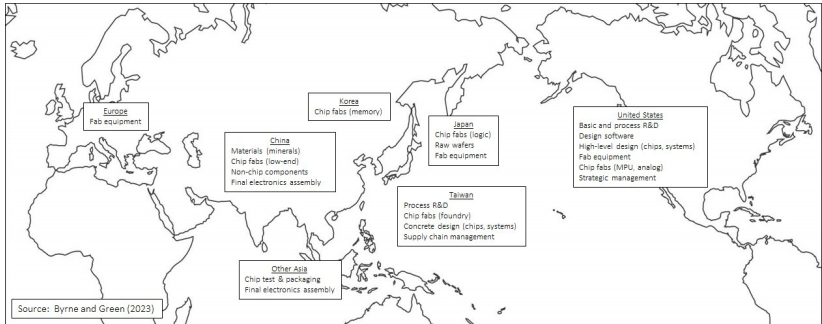
- Materials: Chinese Gallium, etc. Ukrainian Xeon.
- Chip Fabrication: China-Taiwan conflict.
- Chip testing: COVID in Malaysia.
- Distribution: Pandemic shipping delays.
- Other components: Flooding in Thailand (hard drives)
- Product assembly: COVID in Guangzhou.
- Marketing: China is biggest market for chips

Within U.S. Sphere of Influence

- Basic R&D
- Process R&D: Equip. manufacturers, plus Intel, Samsung, **and TSMC**.
- Software: EDA (electronic design automation)
- Equipment: Dutch, U.S., & Japanese companies
- Chip & product design: United States **and Taiwan**.
- Management: HQs located in the United States, Japan, Europe, S. Korea, **and Taiwan**

Consistency Across Economies (continued)

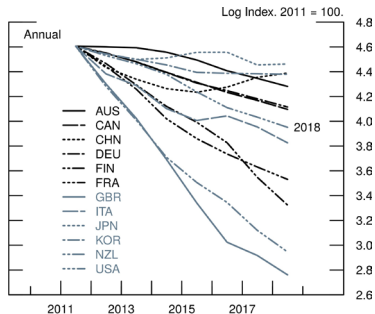
Electronics Sector Specialization by Economy



An Example of Troubling Inconsistency

- Mobile phones sold in each country are produced in the same global industry.
- Differences in market concentration, transport costs, etc. may contribute to price differences
- But not a sustained difference of this magnitude.

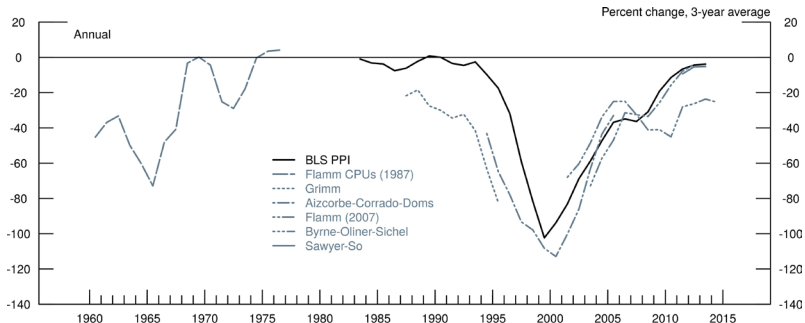
Fig. 8: Mobile Phone Price Indexes



Source: National statistical agencies.

Consistency Across Time

Fig. 9: Processor Price Index Alternatives



Note: Indexes differ with respect to price data source, methodology, and scope (see text).

Source: Bureau of Labor Statistics, Grimm (1998), Aizcorbe, Corrado, and Doms (2003), Flamm (2007), Holdway (2000), Byrne, Oliner, and Sichel (2018), Sawyer and So (2017).

How do we integrate indexes that differ in data sources, index methods, scope, and timespan?

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Three institutional barriers to better digital economy measurement merit attention.

- **Balkanization of the global measurement system.** Each economy implements a system of national accounts. Who can enforce consistency?
- **Perfectionism.** Focus on narrow projects and reluctance to take educated guesses leads to what Bertrand Russell called “islands of knowledge in a sea of nescience.”
- **Recency bias.** Tendency to believe current innovations are more remarkable than historical ones.