Measuring Business Adoption and Use of Advanced Technologies, Artificial Intelligence, and Data

Lucia Foster
Chief Center for Economic Studies
Chief Economist U.S. Census Bureau

FESAC
December 13, 2019

Disclaimer: Any opinions and conclusions expressed herein are those of the authors and not the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed.

This presentation benefited greatly from the contributions of David Beede, Cathy Buffington, Emin Dinlersoz, Nathan Goldschlag, Zachary Kroff, Scott Ohlmacher, and Nicholas Zolas.
Overview of Presentation

• Measurement Approach
• Challenges
• Examples
  • Digitization, Cloud, and Advanced Technologies (ABS)
  • Robotics (ASM, ACES)
  • Technology and Workforce (EC, ABS)
  • Technology and Business and Workforce Dynamics (BDS, QWI)
  • Productivity and Innovation (LBD)
  • Use of Data (MOPS, EC)
• Vision for the Future
Measurement Approach

- Identify Data Gap
  - Policymakers
  - Businesses and trade associations (NABE)
  - Academic and institutional researchers (FSRDC)
  - AEAStat, CRIW, FESAC, CSAC

- Research Approaches
  - Leverage Census expertise and outside experts
  - Coordinate with other Federal Statistical Agencies

- Develop New Content
  - Appropriate, Consistent, Optimal

- Testing

- Post-Collection Validation

- Dissemination
  - CES Working Paper (and peer-reviewed journals)
  - Presentations – for example AEA Stat Session
  - Experimental data products
  - Official statistics
Multi-Dimensional Measurement Approach

• Survey Data
  • Annual Business Survey (ABS)
  • Annual Survey of Manufactures (ASM)
  • Annual Capital Expenditures Survey (ACES)
  • Management and Organizational Practices Survey (MOPS)
  • Economic Census (EC)

• Administrative Data
  • Business Dynamics Statistics (BDS), Longitudinal Business Database (LBD)
  • Quarterly Workforce Indicators (QWI)

• Alternative Data Sources => not yet, but could be used for validation
  • Firm technology profiles
  • Technology shipments
Some Challenges We Face

- Deciding *which technology* matters
- Determining the *timing* of when to add a new technology
- Precisely *defining* technology of interest
- Determining *unit of interest*: establishment versus firm
- Picking relevant *frequency* for capturing adoption and diffusion (e.g., 1, 3, 5- years)
- Disclosure modernization
Digitization, Cloud, and Advanced Technologies

- **Sample:** 850,000 firms, non-ag sectors
- **Survey:** (NCSES) includes firm characteristics, innovation, R&D, and technology module
- **Research:** Brynjolfsson and McElheran
- **Questions:** digital share of business activities; cloud services purchases; business technologies for production of goods and services – including machine learning
- **Challenges:** unit of measure, frequency
- **Dissemination:** AEA Technology session will provide “first look”
Robotic Equipment

Annual Survey of Manufactures (2018)

• **Sample**: 50,000 manufacturing establishments
• **Research**: Seamans, Helper, Brynjolfsson
• **Questions**: number of robots (in operation and purchased) and capital expenditures on robotic equipment
• **Challenge**: defining technology robots => industrial robotic equipment
• **Dissemination**: Buffington et al. (2018)

Annual Capital Expenditures Survey (2018)

• **Sample**: 50,000 employer companies non-ag sectors
• **Research**: language consistent with ASM and may benchmark to published RIA data
• **Question**: capital expenditures for robotic equipment
• **Challenge**: units
• **Dissemination**: Census website
Technology and Workforce
Economic Census (2017)

• **Sample:** Establishments in eleven selected Retail and Service industries

• **Research:** Basker et al. (2017), customer-employee substitution in gas stations

• **Question:** Do you provide self-checkout (self-service)?

• **Challenge:** Timing -- difficulty of measuring adoption and diffusion in the face of disruptive technology: Amazon Go

• **Dissemination:** Basker et al. (2019)
Technology and Workforce
Annual Business Survey (2019, 2022)

• **Sample**: 300,000 firms across all non-ag sectors
• **Survey**: (NCSES) includes firm characteristics, innovation, R&D, and technology module
• **Research**: Acemoglu and Restrepo and NCSES
• **Questions**: 34 questions concern: (1) motivation, (2) challenges of adoption, (3) impact on workforce (including on skill levels) and (4) impact by worker types. Which cover use of and production of five technologies:
  • Artificial Intelligence
  • Cloud computing
  • Specialized software (excluding AI)
  • Robotics
  • Specialized equipment (excluding robotics)
• **Challenges**: Defining technology and worker types
Technology and Business and Workforce

Business Dynamics Statistics

- **Research:** Goldschlag and Miranda (2016) entry and exit of high tech businesses
- **Challenge:** Disclosure modernization
- **Dissemination:** Planned *future BDS tables*

Quarterly Workforce Indicators

- **Research:** Goldschlag (2017) employment dynamics at high tech businesses by demographics
- **Challenge:** Source data voluntarily provided by states
- **Dissemination:** QWI website
Productivity and Innovation
Longitudinal Business Database

- **Research**: Foster et al. (2018) develop a framework for identifying areas of the economy where innovation has taken place using patterns in business entry and productivity dynamics => effects more pronounced in high-tech sectors

- **Challenge**: Measuring productivity at the micro-level

- **Dissemination**: Dispersion in Statistics of Productivity (DiSP) produced and hosted with BLS
Use of Data

- **Sample:** 30,000 manufacturing establishments (ASM supplement sponsored by researchers)
- **Survey:** management practices, organization, data and decision making
- **Research:** Brynjolfsson and McElheran (2019)
- **Questions:** availability of data, use of data, who chooses data, sources of data, activities using data, reliance on predictive analytics
- **Challenge:** Defining technology (an absolute not a relative)
Use of Data
Economic Census (2017)

• **Sample:** Establishments in 14 Health Care Services Industries

• **Research:** Bloom and Sadun

• **Questions:** measures of clinical performance (who sees, who chooses, review frequency)

• **Challenges:** Unit

• **Dissemination:** Basker et al. (2019)

• **Future work:** MOPS-Hospitals
Vision for the Future

• More Coordinated and Collaborative Approach
  • Within Census Bureau (Economic and Demographic)
    • Use economy-wide survey results to drive deeper-dive by
      • sector (e.g., warehousing, finance)
      • technologies (e.g., complements to labor such as cobots in surgery)
  • Across Federal Statistical Agencies
    • Technology and innovation => testing, adoption (NCSES)
    • Technology and workforce => training of workforce (BLS, NCES, NCSES)
    • Data => valuation of data (BEA)
  • With Stakeholders
    • More focused outreach to stakeholders and experts through AEASstat, CRIW, NABE, other opportunities?

• Integration of Alternative Data Sources
  • Starting with validation and research integration

• Prioritize Importance of Repeated Views over Time
  • ABS two sets of two waves of technology questions (3-yr time frame)
  • MOPS three waves of data questions (5-yr time frame)
Background Slides
References


Links to Census Products

- ABS: https://www.census.gov/programs-surveys/abs.html
- ACES: https://www.census.gov/programs-surveys/aces.html
- ASM: https://www.census.gov/programs-surveys/asm.html
- BDS: https://www.census.gov/programs-surveys/bds.html
- Economic Census: https://www.census.gov/programs-surveys/economic-census.html
- QWI: https://www.census.gov/data/developers/data-sets/qwi.html
Discontinued Surveys

• **Technology**
  - Survey of Manufacturing Technology (SMT)  
    [https://www.census.gov/econ/overview/ma0700.html](https://www.census.gov/econ/overview/ma0700.html)
  - Information and Communication Technology Survey (ICTS)  
    [https://www.census.gov/programs-surveys/icts.html](https://www.census.gov/programs-surveys/icts.html)

• **Workforce**
  - National Employer Survey (NES)  
    [https://www.census.gov/econ/overview/mu2400.html](https://www.census.gov/econ/overview/mu2400.html)