Capturing the Annual Business Survey in Synthetic Microdata: Construction and Use Cases of a Public Use File

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Annual Business Survey

- The **Annual Business Survey** (ABS) collects data on innovation, globalization, and business owner characteristics for nonfarm, for-profit businesses in the United States and measures R&D expenditures for the subset of those businesses with one to nine employees
    - ABS is a mandatory survey conducted by NCSES in partnership with the Census Bureau

- ABS frame includes about 5 million businesses engaged in mining, utilities, construction, manufacturing, wholesale trade, retail trade, or services industries
    - ABS 2023 sample = **850,000** while other ABS years are approximately 300,000
    - Sample includes all companies classified in selected research intensive industries, such as scientific R&D services

- Currently ABS microdata is available only in **Federal Statistical Research Data Centers** (FSRDCs)

Public-Use Microdata Sample

Public-use microdata samples (PUMS) play a critical role in meeting demand for public access to government-funded data and are essential for exploratory research and decision-making

- Enable statistical organizations to **reach a wider public** and **support more use cases** in a timely manner
- Less reliance on FSRDCs for high-level analyses
- United Nations Economic Commission for Europe (UNECE) *Synthetic Data for Official Statistics (2022)*: **transparency** and **increased public access** to vital data
- Limited PUMS for business surveys
  - Survey of Business Owners (SBO) 2007 PUMS still requested: not private enough for today's standards and modern attacks
- **Challenge:** making a safer PUMS with analytically interesting data

Business **Public-Use Microdata Sample**

Challenges of developing and releasing PUMS file for business survey data

- Fewer firms than people, but differences across firms are much larger than across people (a zoo of different species versus a herd)
- Business data is **highly skewed** with a small share of firms accounting for a large share of employment, sales, etc.
- Collecting complete feature information for every firm rapidly becomes difficult to provide in a way that ensures good and equitable utility for all users
- Privacy can be breached when "secured" data can **be linked with publicly available data**
- Numerous **industry** and **geographic features** of interest

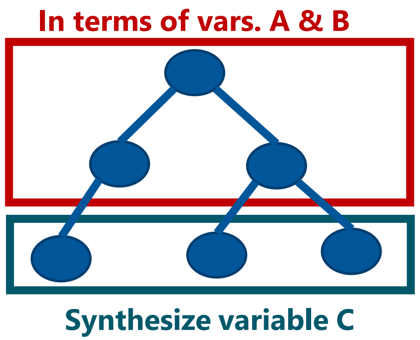
Synthetic Data

Synthetic data is artificially generated data that represents statistical properties of real data, while ensuring privacy and confidentiality of sensitive information

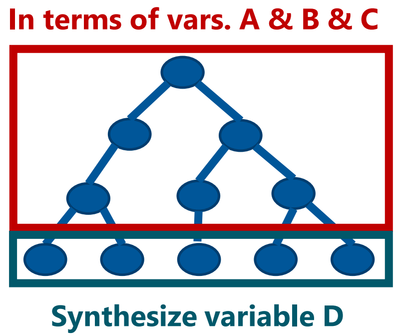
- **Preserves privacy** by releasing realistic data without exposing sensitive information, mitigating the risk of privacy breaches
- Maintains statistical relationships of original data, enabling **high utility** and meaningful analyses for preserved variables
- Privacy-preserving solution while maintaining data utility and integrity
  - US Census Bureau & IRS: Synthetic Longitudinal Business Database (2011, experimental)
- By learning and replicating patterns and structures within original data, AI-generated synthetic data ensures that key correlations and distributions are preserved

CenSyn Synthetic Data Generator

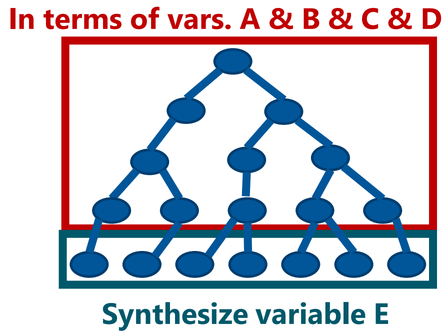
- **Classification and Regression Trees (CART)** is a straightforward data modeling method that predicts value of variable based on values of other variables using decision trees



- Different groups in data are channeled down different paths in a tree, as the **tree learns how best to partition population** into low-entropy and self-similar groups of firms with respect to target variable
  - To synthesize a single variable, we could use one decision tree



- To synthesize many variables, we use sequence of many decision trees
  - Algorithm that underlies **CenSyn Synthetic Data Generator** developed by Knexus



CenSyn Synthetic Data Generator

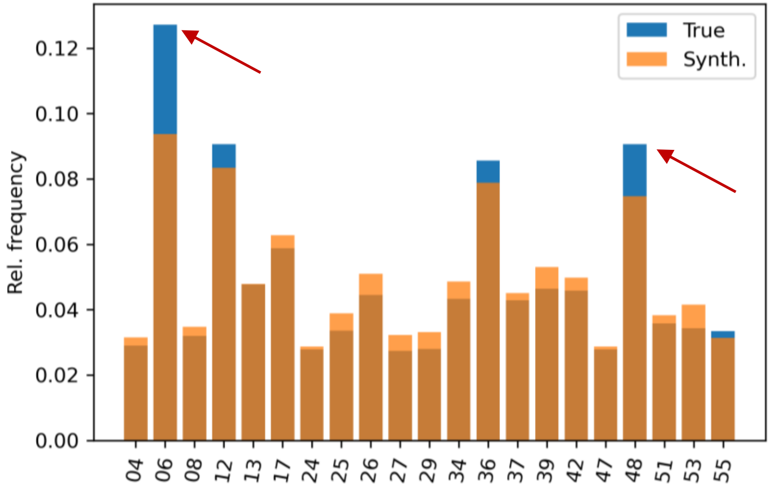
- Several other tree-based synthesizers exist, also built by or for statistical agencies:
  - **R synthpop library** for Scottish Longitudinal Survey
  - R tidysynthesis by Urban Institute for US IRS

- CenSyn was built for US Census Bureau projects
  - Configured for multiple groups and data products
  - Capabilities to deal with complexities that arise at scale of Census Bureau

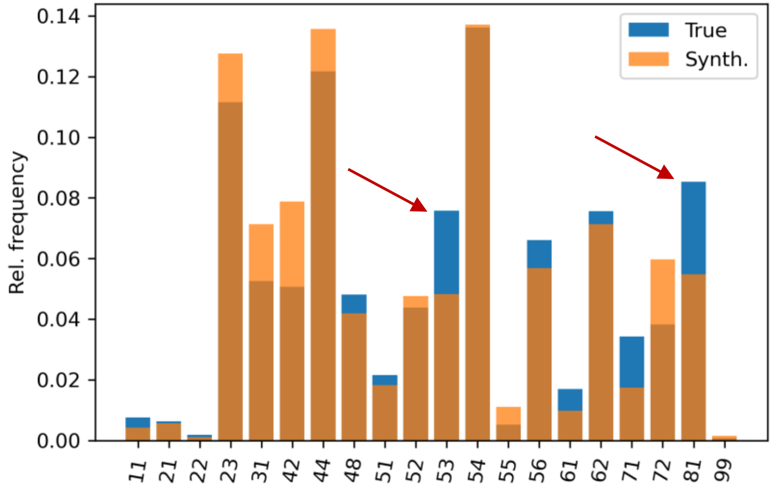
- Efficiently performs synthesis, evaluation, privacy checks, and consistency checks; handles weights, partial synthesis, etc.
  - Preserves distribution of data, in all its diversity, while also ensuring any real record is difficult to find in released product
  - Iterative nature with stakeholders and survey managers

Comparisons on SBO 2007 PUMS

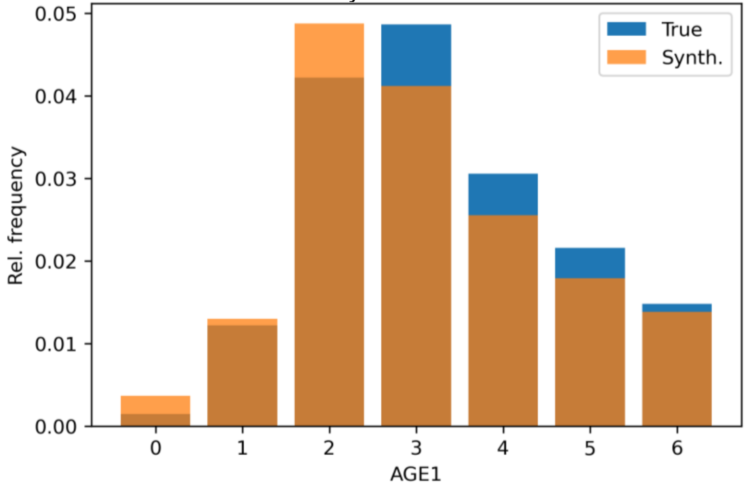
US States



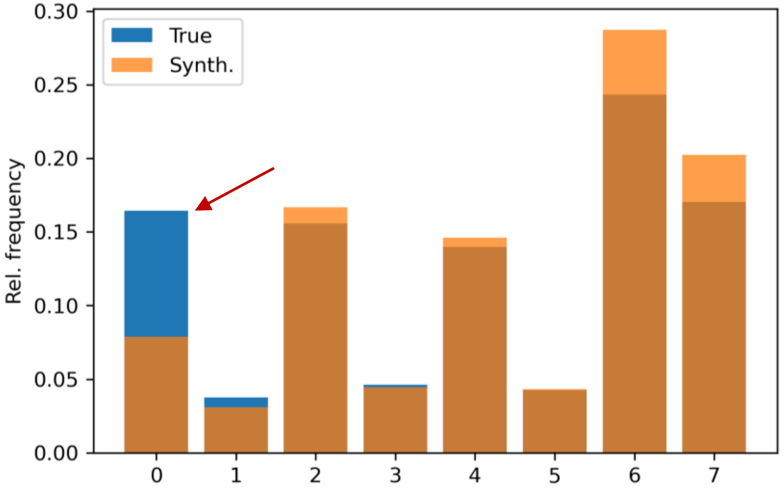
Sector (2-digit NAICS)



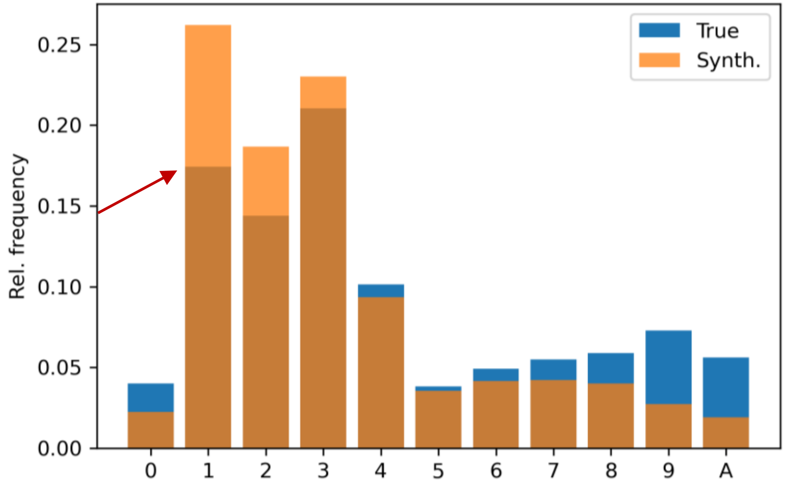
WA, 2000-05, jointly owned with spouse and primarily owned by husband



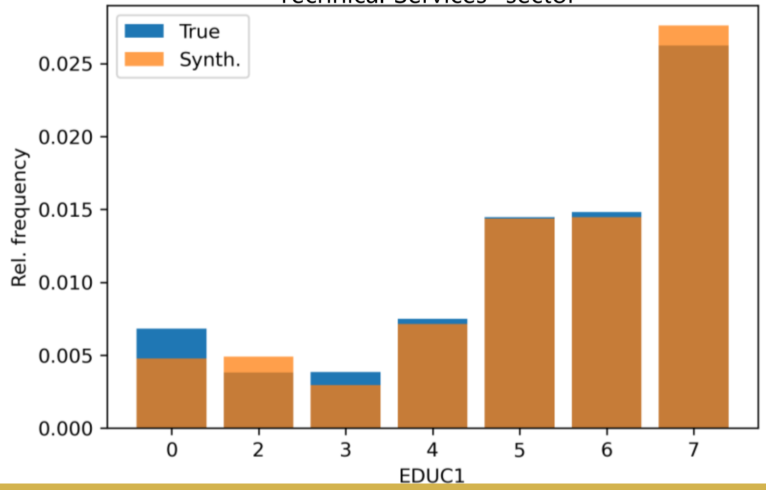
1st Owner Education



Year Business Established



OH, startup capital $5,000-10,000, “Professional, Scientific, & Technical Services" sector



ABS User Workshop

Specific objectives

- Develop a prioritized list of variables that users and potential users find important in academia, industry, government agencies, etc.
- Explore how users would use a PUMS and determine if a synthetic PUMS could meet needs

Target audiences

- Group 1 (*current* ABS users): Have completed the FSRDC process and currently have access to ABS restricted-use data
- Group 2 (*potential* ABS users): Researchers who do not have access to ABS restricted-use data but have expressed interest or who are current users of existing ABS public-use tables

Findings

- Both groups emphasized importance of preserving key features, such as business owner demographics, geographic information, and innovation activity
- Consensus on the utility of synthetic PUMS for generating descriptive statistics, conducting preliminary analyses, and assessing research feasibility

Conclusion

- Demonstrated difficulties that arise in preserving **privacy, equity, and utility** when working with complex feature sets
- Introduced idea of using models to better capture feature correlations
  - **CenSyn** operates well with large, complex national statistical data
  - Models tuned to data have potential to collect "right" information from different groups to preserve full, diverse data distribution (without releasing real establishment records)
- Having synthetic PUMS does not solve all problems
  - **Geography + industry** exposes firms: membership and attribute disclosure concerns
  - Industry + salient place characteristics (rural, affluent, disadvantaged areas) may work
- ABS User Workshop input and feedback
- **Next steps:** longitudinal data, quality metrics, clustering industry and geography variables

Thank you! Questions?

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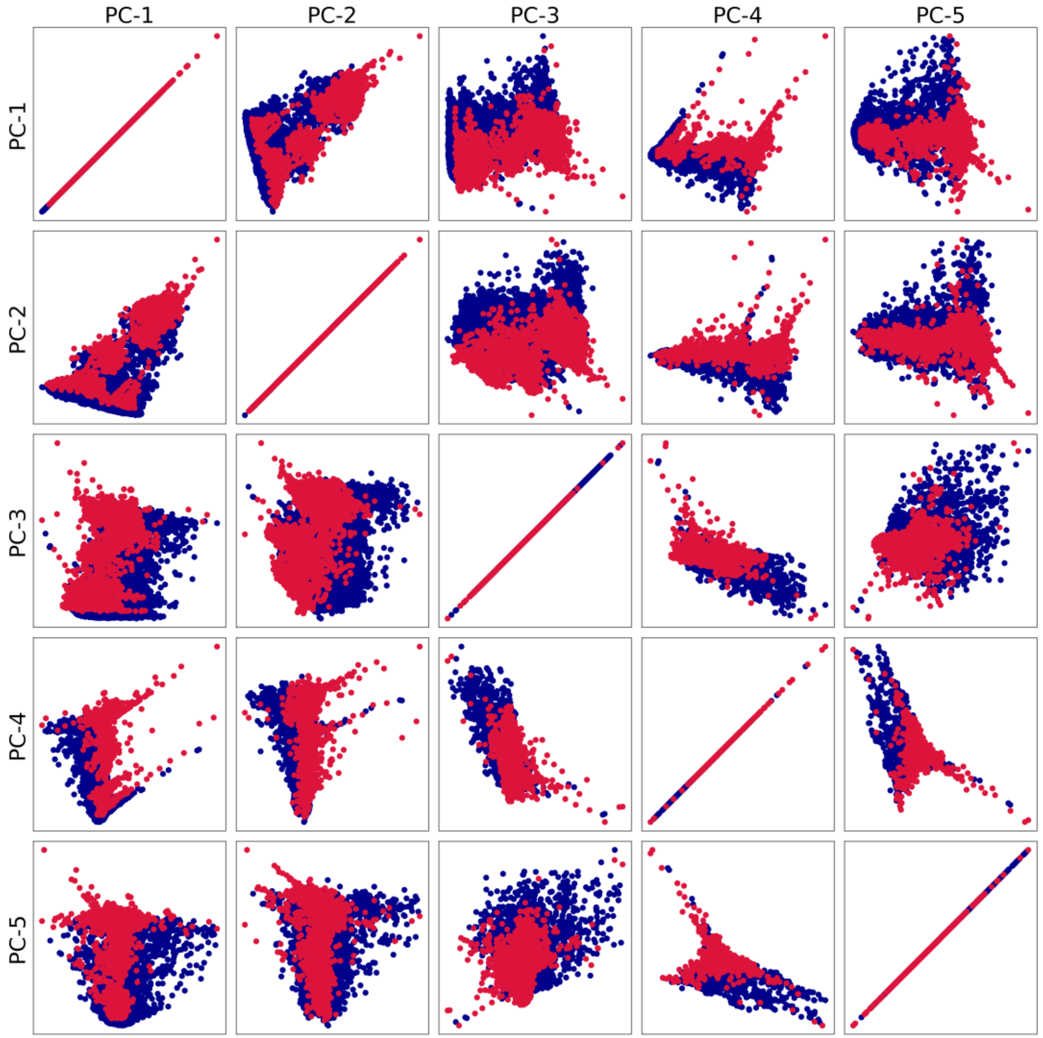
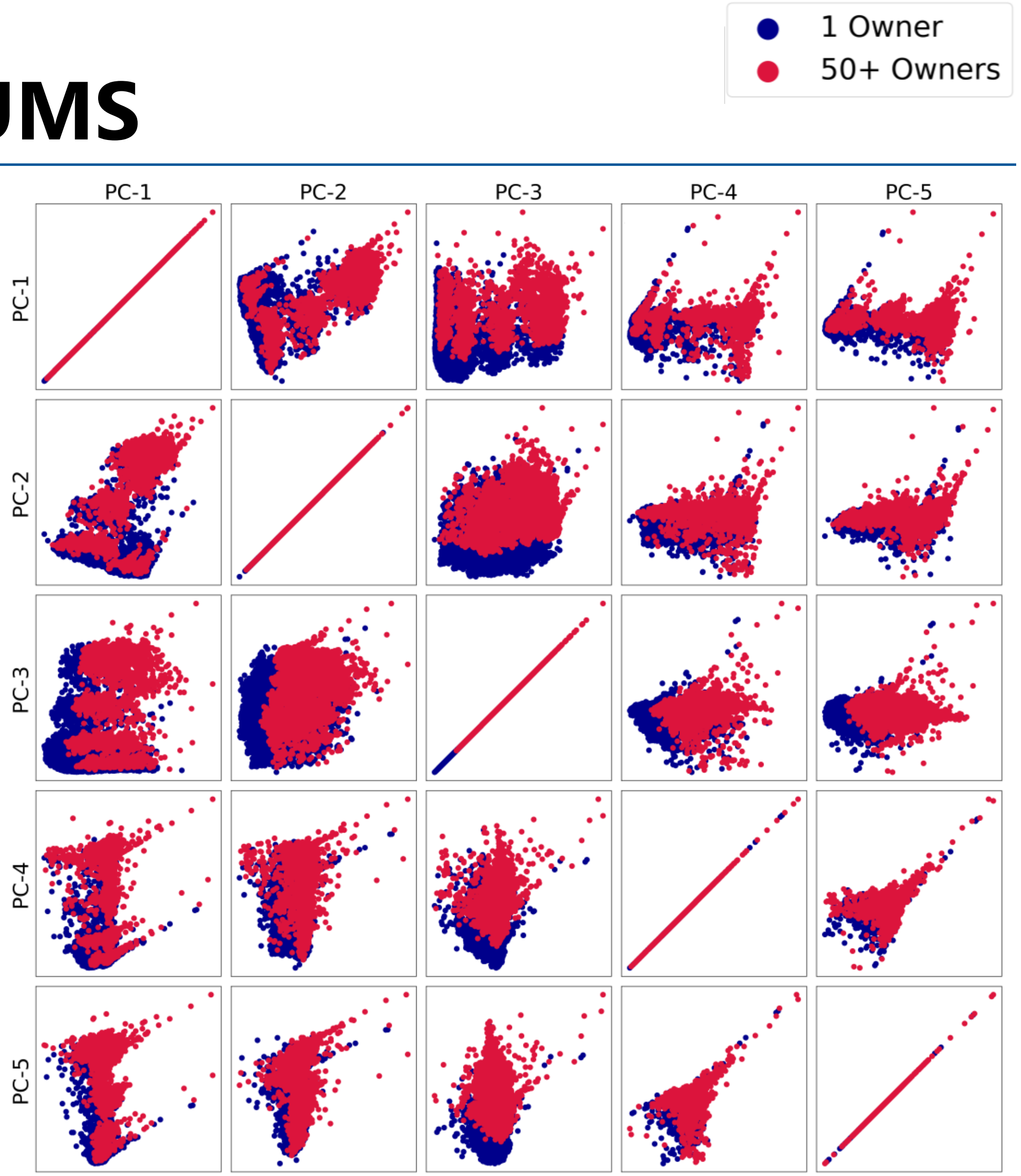
Additional Slides

Comparisons on SBO 2007 PUMS



Original data distribution shape



De-identified data distribution shape

Group 1 (Current ABS Users) Findings

- **Utility prior to FSRDC access:** Help researchers understand how the data are organized, run pilot analyses, publish more descriptive statistics; many researchers link ABS to Longitudinal Business Database, Business Enterprise Research & Development Survey, and SEC data, so synthetic data would need to include these linkages

- **Variables of interest:** All technology modules, innovation incidence, business owner demographics, startup capital

- **Concerns about using a synthetic PUMS:** Mixed; some researchers said they were wary of publishing based on synthetic data, while others did not think it would be a problem; would want to know what characteristics went into the synthetic data and validation tests

Group 2 (potential ABS users) Findings

- **Variables of interest:** Analyzing innovation outputs by geography (urban, suburban, rural), by industry, by business owner demographics

- **Use of ABS PUMS:** Make tabulations, develop descriptive statistics, and develop estimates to respond to policymaker questions, linkage with other data sets

- **Concerns about using a synthetic PUMS:** Few reports; most trust statistical methods used by NCSES and the Census Bureau