Cornell University

Alfred P. Sloan
FOUNDATION

**Final and Cumulative Annual Report for Alfred P. Sloan Foundation Grant G-2015-13903
"The Economics of Socially-Efficient Privacy and Confidentiality Management for
Statistical Agencies"**

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1 Key Metrics

Goal: To study the economics of socially efficient protocols for managing research databases containing private information.

Metrics

1. **At least four peer-reviewed articles that are published in journals read by economists, statisticians, and other social scientists.**

   - The following manuscripts have been published or are forthcoming:

     1) J. M. Abowd and I. M. Schmutte. 2015a. "Economic analysis and statistical disclosure limitation". *Brookings Papers on Economic Activity*: 221–267. doi:10.1353/eca.2016.0004

     2) J. Miranda and L. Vilhuber. 2016b. "Using partially synthetic microdata to protect sensitive cells in business statistics". *Statistical Journal of the International Association for Official Statistics* 32 (1): 69–80. doi:10.3233/SJI-160963

     3) I. M. Schmutte. 2016. "Differentially Private Release of Data on Wage and Job Mobility". *Statistical Journal of the IAOS* 32 (1): 81–92. doi:10.3233/SJI-160962

     4) L. Vilhuber, J. M. Abowd, and J. P. Reiter. 2016a. "Synthetic establishment microdata around the world". *Statistical Journal of the International Association for Official Statistics* 32 (1): 65–68. doi:10.3233/SJI-160964

     5) J. M. Abowd. 2017. "How Will Statistical Agencies Operate When All Data Are Private?" *Journal of Privacy and Confidentiality* 7 (3). http://repository.cmu.edu/jpc/vol7/iss3/1/

     6) S. Haney, A. Machanavajjhala, J. M. Abowd, M. Graham, M. Kutzbach, and L. Vilhuber. 2017b. "Utility Cost of Formal Privacy for Releasing National Employer-Employee Statistics". In *Proceedings of the 2017 International Conference on Management of Data*, 1339–1354. SIGMOD '17. ACM. doi:10.1145/3035918.3035940

     7) L. Vilhuber and C. Lagoze. 2017a. "Making Confidential Data Part of Reproducible Research". *Chance* (). http://chance.amstat.org/2017/09/reproducible-research/

     8) J. M. Abowd and I. M. Schmutte. 2019. "An Economic Analysis of Privacy Protection and Statistical Accuracy as Social Choices". *American Economic Review* 109 (1): 171–202. doi:10.1257/aer.20170627

     9) J. M. Abowd, I. M. Schmutte, W. N. Sexton, and L. Vilhuber. 2019c. "Why the Economics Profession Must Actively Participate in the Privacy Protection Debate". *AEA Papers and Proceedings* 109 (): 397–402. doi:10.1257/pandp.20191106

   - The following working papers have been posted, in anticipation of later publication and for open access:

- L. Vilhuber and C. Lagoze. 2017b. *Making Confidential Data Part of Reproducible Research*. Document 41. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/41/
- J. M. Abowd and I. M. Schmutte. 2017b. *Revisiting the economics of privacy: Population statistics and confidentiality protection as public goods*. Document 37. Labor Dynamics Institute, Cornell University. doi:N/A
- L. Vilhuber and I. Schmutte. 2017b. *Proceedings from the 2017 Cornell-Census-NSF-Sloan Workshop on Practical Privacy*. Document 43. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/43/
- L. Vilhuber, S. Kinney, and I. Schmutte. 2017. *Proceedings from the Synthetic LBD International Seminar*. Document 44. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/44/
- S. Haney, A. Machanavajjhala, J. M. Abowd, M. Graham, M. Kutzbach, and L. Vilhuber. 2017a. *Utility Cost of Formal Privacy for Releasing National Employer-Employee Statistics*. Document 36. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/36/
- J. M. Abowd, I. M. Schmutte, and L. Vilhuber. 2018b. *Disclosure Limitation and Confidentiality Protection in Linked Data*. Document 47. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/47/
- J. M. Abowd and I. M. Schmutte. 2018a. *An Economic Analysis of Privacy Protection and Statistical Accuracy as Social Choices*. Document 48. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/48/
- J. M. Abowd, I. M. Schmutte, W. N. Sexton, and L. Vilhuber. 2019b. *Why the Economics Profession Must Actively Participate in the Privacy Protection Debate*. Document 51. Labor Dynamics Institute, Cornell University. https://digitalcommons.ilr.cornell.edu/ldi/51/

- The following document has been posted, without anticipation of future publication, though with intent to be updated continuously:

  - J. Abowd, I. Schmutte, W. Sexton, and L. Vilhuber. 2019d. *Introductory Readings in Formal Privacy for Economists*. Preprint. doi:10.5281/zenodo.2621344

  An online version is available at https://labordynamicsinstitute.github.io/privacy-bibliography/.

2. **A library of socially efficient algorithms that other researchers can readily implement**
   We initially developed python scripts for running the Multiplicative Weights Exponential Mechanism (MWEM), Dual Query, and Private Multiplicative Weights (PMW) privacy algorithms. Each algorithm has essentially three structured components: data preprocessing, a query generator, and the privacy algorithm. We prepared a variety of different query generators to suit specific private data publication tasks. Implementation of differentially private data publication using MWEM is proved to be the most successful of the three algorithms.

However, we then shifted our focus to supporting the DPComp project. In particular, we contributed realistic large-scale synthetic data, in particular data from the American Community Survey (United States Department of Commerce. Bureau of the Census., 2017) (a copy of which we archived for reference at openICPSR). Most other test data provided at DPComp are small-scale. The ACS data, on the other hand, are scaled up to simulate the entire US population. Data generated were deposited at openICPSR (Sexton, Abowd, Schmutte, and Vilhuber, 2017).

Furthermore, we supported Ashwin Machanavajjhala, Duke University in developing applied algorithms to protect future ACS releases by the Census Bureau, and to use current ACS releases as input to that undertaking. He also initiated work on a new system for authoring differentially private algorithms. The goal is to deploy this system for authoring differentially private algorithms within the US Census Bureau for releasing Census Bureau data with provable guarantees. Intermediate progress from this work led to the release of the Post Secondary Employment Outcomes (PSEO) using differential privacy (Foote, Machanavajjhala, and McKinney, 2019b).

3. **A policy handbook or brief to inform key statistical agencies on managing the tradeoffs between enabling data access and maintaining privacy**

   - As guidance to statistical agencies, we published

     L. Vilhuber, S. Kinney, and I. Schmutte. 2017. *Proceedings from the Synthetic LBD International Seminar*. Document 44. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/44/

     and

     L. Vilhuber and I. Schmutte. 2017b. *Proceedings from the 2017 Cornell-Census-NSF-Sloan Workshop on Practical Privacy*. Document 43. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/43/

     based on workshops we organized in May 2017 with participants from various agencies (see below). They complement Vilhuber and Schmutte (2017a).

   - A book chapter on "Disclosure Limitation and Confidentiality Protection in Linked Data" is under review by the publisher (Elsevier). Final publication is slated for May 2019. Working paper versions have been made available as

     – J. M. Abowd, I. M. Schmutte, and L. Vilhuber. 2018b. *Disclosure Limitation and Confidentiality Protection in Linked Data*. Document 47. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/47/

     – J. M. Abowd, I. M. Schmutte, and L. Vilhuber. 2018a. *Disclosure Limitation and Confidentiality Protection in Linked Data*. Working Papers 18-07. Center for Economic Studies, U.S. Census Bureau. https://ideas.repec.org/p/cen/wpaper/18-07.html

- Each of the PIs has actively engaged with key statistical agencies on matters related to the grant research. Evidence of their engagement is illustrated in the list of seminar and conference presentations and other activities described below.

4. **At least one graduate equipped with unique research and computational skills.**

   - William Sexton, whom we originally hired in January 2016, has been recruited to continue his work on confidentiality as an intern at the Census Bureau,
   - João Vítor Costa, PhD student in Economics at Cornell University, assisted with the Brazilian linked employer-employee data.
   - Daniel Lin, PhD student in Economics at Cornell University, helped validate the ACS-related synthesis, and also worked on synthesizing the Brazilian linked employer-employee data.

2   Associated Activities

All PIs gave presentations at various universities, conferences, governmental, and sundry public venues, in Argentina, Canada, Finland, Morocco, the United Kingdom, and of course the United States. All authors regularly presented at conferences and meetings in economics, statistics, and computer science, as well at regular seminars. Most presentation materials (slide decks) are archived at the Cornell eCommons at https://ecommons.cornell.edu/handle/1813/43874 https://ecommons.cornell.edu/handle/1813/43872. PIs Abowd and Schmutte presented multiple times at the Isaac Newton Institute (UK) in 2016, and at the Simons Institute (UC-Berkeley) in 2017 and 2019. PI Vilhuber spoke to the CNSTAT panel on "Transparency and Reproducibility in Federal Statistics", based on the work published in Vilhuber and Lagoze (2017a). Vilhuber (2019) is a published transcript of that presentation. PI Abowd participated in the panel in his Census Bureau capacity. PI Abowd gave widely disseminated lectures on "How Will Statistical Agencies Operate When All Data are Private?" (Julius Shiskin Memorial Award Seminar, when PI Abowd received the award in 2016 - see also Abowd (2017)), on "Data Linking Methods and Research Challenges" (NBER Methodology Lecture), on "What is a Privacy Loss Budget and How Is It used to Design Privacy Protection for a Confidential Database?" (American Statistical Association's Data Privacy Day Webinar 2018), and a Webinar with the Future of Privacy Forum.

As part of his official duties at the Census Bureau, PI Abowd reported on managing the economic trade-off between privacy loss and accuracy to the Census Scientific Advisory Committee (2016, 2017, and 2018), to the Federal Economic Statistics Advisory Committee (2018), and to the 2020 Census Program Management Review (2018). He also testified extensively on this trade-off in three separate U.S. District Court trials seeking to enjoin the Census Bureau from asking about citizenship on the 2020 Census. No District Court allowed the plaintiffs privacy claim, and briefs before the Supreme Court from both the appellants (Commerce) and respondents (all original plaintiff groups) acknowledge that the proposed statistical disclosure limitation on the 2020 Census (differential privacy) does not pose a privacy harm.

2.1 Workshops organized by the PIs

Multiple sessions at the World Statistics Congress in 2015, 2017, and forthcoming in 2019, as well as at various Joint Statistical Meetings were organized around the topic of practical privacy. We also organized three key workshops in 2016 and 2017. In each case, proceedings were made public.

- We organized the "NSF-Sloan Workshop on Practical Privacy" in October 2016 at the U.S. Census Bureau (with travel funding through NSF grant CNS-1012593, and organizational support provided by this grant). The goal of the workshop was to contemplate practical implementations of privacy preserving statistical methods by drawing together expertise of academic and governmental researchers, and to produce short written memos that summarize concrete suggestions for practical applications to specific Census Bureau priority areas. About 30 researchers from academia (including several Sloan grantees) and the Census Bureau participated. The proceedings were published as

  > L. Vilhuber and I. Schmutte. 2017a. *Proceedings from the 2016 NSF-Sloan Workshop on Practical Privacy*. Document 33. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/33/.

- We organized a second "Cornell-Census-NSFSloan Workshop On Practical Privacy 2017" in May 2017 at the U.S. Census Bureau (with travel funding through NSF grant CNS-1012593, and organizational support provided by this grant), as a follow-up to the October 2016 workshop. The proceedings were published as

  > L. Vilhuber and I. Schmutte. 2017b. *Proceedings from the 2017 Cornell-Census-NSF-Sloan Workshop on Practical Privacy*. Document 43. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/43/.

  Several other Sloan grantees participated, as did representatives of statistical agencies.

- We organized a "Synthetic Longitudinal Business Data International User Seminar" in May 2017 at the National Academy of Sciences (with travel funding through NSF grant CNS-1012593, local support by the National Academies, and organizational support provided by this grant), to discuss with interested parties the conditions necessary to implement the SynLBD approach, with the goal of providing other statistical agencies a straightforward toolkit to implement the same procedure on their own data. The proceedings were published as

  > L. Vilhuber, S. Kinney, and I. Schmutte. 2017. *Proceedings from the Synthetic LBD International Seminar*. Document 44. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/44/.

  The seminar has informed efforts to use the methodology for applications at Statistics Canada and the Urban Institute (applying it to IRS data).

2.2 Other activities

Funding, advisory boards

- PI Vilhuber : Chair of the Scientific Advisory Board (*président du conseil scientifique*) of the Centre d'accès sécurisé aux donnés (CASD) in France, since January 1, 2016 (`casd.eu`), Member of the ASA's Committee on Privacy and Confidentiality, Member of the Quebec Inter-University Center for Social Statistics's Scientific Advisory Board, Member of the Canadian Research Data Center Network's Executive Board (since Dec 2018)

- PI Abowd : Member of the Canadian Research Data Center Network's Inaugural Executive Board (until Jan 2019)

- PI Vilhuber With support from a grant from the Social Sciences and Humanities Research Council Canada (SSHRC) ("Productivity, firms, and incomes") and the assistance of a post-doc (Jahangir Alam), Statistics Canada has announced the release of synthetic establishment data produced using the SynLBD methodology. The data is available through the Canadian RDC network. These activities are a direct outcome of discussions and the visibility of this project.

- PI Vilhuber is PI of the NSF-Census Research Network Coordinating Office, and planned the final (May 2017) Workshop of the NCRN nodes at the Census Bureau. At this workshop, work on privacy and confidentiality by non-NCRN entities (Purdue University: Chris Clifton, Georgetown University: Kobbi Nissim) under cooperative agreements with the Census Bureau was presented. A final report, highlighting much work on privacy done under the NSF grants, was produced and published (Weinberg et al., 2018).

Journals

Although not funded by this grant, the work on this grant also led to PI Abowd and PI Vilhuber (together with Cynthia Dwork, Alan Karr, and Kobbi Nissim) relaunching the Journal of Privacy and Confidentiality (https://journalprivacyconfidentiality.org/) (see Vilhuber, 2018; Slavković and Vilhuber, 2018).

Replication archives and data

In support of our own papers, we created replication archives. We also collected and preserved data that might not be accessible in the original location in the future. The following is the list of such archives:

Abowd, J. M., and I. M. Schmutte. 2015b. *Replication Archive for: Economic Analysis and Statistical Disclosure Limitation by Abowd and Schmutte (2015)*. doi:10.5281/zenodo.377008.

— . 2018b. *Replication archive for: An Economic Analysis of Privacy Protection and Statistical Accuracy as Social Choices*. doi:10.5281/zenodo.1208758.

Abowd, J. M., and I. M. Schmutte. 2018c. *Replication archive for: Revisiting the economics of privacy: Population statistics and confidentiality protection as public goods*. doi:10.5281/zenodo.345385.

Schmutte, I. M. 2017a. *Economics of Privacy – Raw Cornell National Social Survey Data*. [Data set]. Inter-university Consortium of Political and Social Research [distributor]. doi:`10.3886/E100424V2`.

— . 2017b. *Economics of Privacy – Raw National Health Interview Survey Data*. [Data set]. Inter-university Consortium of Political and Social Research [distributor]. doi:`10.3886/E100424V2`.

Sexton, W., J. M. Abowd, I. M. Schmutte, and L. Vilhuber. 2017. *Synthetic population housing and person records for the United States*. [Data set]. ICPSR - Interuniversity Consortium for Political and Social Research. doi:`10.3886/e100274v1`.

United States Department of Commerce. Bureau of the Census. 2017. *American Community Survey 2010-2014 ACS 5-Year PUMS File [Data set]*. Inter-university Consortium of Political and Social Research [distributor]. doi:`10.3886/E100486V1`.

We also used funding to support the Synthetic Data Server, thus enabling the continued use of two U.S. Census Bureau synthetic data products. The Synthetic Data Server is housed at Cornell University, and researchers conduct an initial analysis on the server over the open internet. Researchers can use the results without restrictions. Their program code is then sent to the U.S. Census Bureau, where the code is replicated against confidential data. Results from the second run are subject to standard U.S. Census Bureau disclosure avoidance rules, and if conform, are provided to researchers. Typically, researchers will use the results from the second run in their published papers. Access protocols and some outcomes were presented in Abowd and Vilhuber (2013) at the Society of Labor Economists' annual meeting.

Over 150 users have used the server. Many research projects never result in published outcomes, much like when researchers use public-use data. However, several researchers have been published in top economics journals:

- Papers and theses using the SIPP Synthetic Beta:

  - P. Armour. 2014a. "Essays In United States Social Security Policy". PhD thesis, Cornell University. `http://hdl.handle.net/1813/38903`
  - A. M. Henriques. 2018. "How Does Social Security Claiming Respond to Incentives?" *Journal of Human Resources* 53, no. 2 (): 382–413. doi:`10.3368/jhr.53.2.1212-5371r2`
  - C. Neumeier, T. A. Sorensen, and D. A. Webber. 2018. "The Implicit Costs of Motherhood over the Lifecycle: Cross-Cohort Evidence from Administrative Longitudinal Data". *Southern Economic Journal* 84 (3): 716–733. doi:`10.1002/soej.12239`

- Papers using the Synthetic Longitudinal Business Database:

  - P. Sedláček and V. Sterk. 2017. "The Growth Potential of Startups over the Business Cycle". *American Economic Review* 107, no. 10 (): 3182–3210. doi:`10.1257/aer.20141280`
  - M. Greenstone, A. Mas, and H.-L. Nguyen. 2019. "Do Credit Market Shocks affect the Real Economy? Quasi-Experimental Evidence from the Great Recession and Normal Economic Times". *American Economic Journal: Economic Policy* forthcoming

– T. Mukoyama and S. Osotimehin. 2019. "Barriers to reallocation and economic growth: the effects of firing costs". *American Economic Journal: Macroeconomics* forthcoming

3 Complete List of Publications

Referreed Publications :

Abowd, J. M. 2017. "How Will Statistical Agencies Operate When All Data Are Private?" *Journal of Privacy and Confidentiality* 7 (3). http://repository.cmu.edu/jpc/vol7/iss3/1/.

Abowd, J. M., F. Kramarz, S. Perez-Duarte, and I. M. Schmutte. 2018. "Sorting Between and Within Industries: A Testable Model of Assortative Matching". *Annals of Economics and Statistics*.

Abowd, J. M., and I. M. Schmutte. 2015a. "Economic analysis and statistical disclosure limitation". *Brookings Papers on Economic Activity*: 221–267. doi:10.1353/eca.2016.0004.

— . 2019. "An Economic Analysis of Privacy Protection and Statistical Accuracy as Social Choices". *American Economic Review* 109 (1): 171–202. doi:10.1257/aer.20170627.

Abowd, J. M., I. M. Schmutte, W. N. Sexton, and L. Vilhuber. 2019a. "Suboptimal Provision of Statistical Accuracy when it is a Public Good". *submitted*.

— . 2019c. "Why the Economics Profession Must Actively Participate in the Privacy Protection Debate". *AEA Papers and Proceedings* 109:397–402. doi:10.1257/pandp.20191106.

Abowd, J. M., and M. H. Stinson. 2013. "Estimating Measurement Error in Annual Job Earnings: A Comparison of Survey and Administrative Data". *Review of Economics and Statistics*: doi:10.1162/REST_a_00352.

Bertrand, M., E. Kamenica, and J. Pan. 2015. "Gender Identity and Relative Income within Households". *The Quarterly Journal of Economics* 130 (2). doi:10.1093/qje/qjv001.

Carr, M. D., and E. E. Wiemers. 2018. "New Evidence on Earnings Volatility in Survey and Administrative Data". *AEA Papers and Proceedings* 108:287–91. doi:10.1257/pandp.20181050.

Foote, A., A. Machanavajjhala, and K. McKinney. 2019b. "Releasing Earnings Distributions using Differential Privacy: Disclosure Avoidance System For Post Secondary Employment Outcomes (PSEO)". *Journal of Privacy and Confidentiality* submitted.

Greenstone, M., A. Mas, and H.-L. Nguyen. 2019. "Do Credit Market Shocks affect the Real Economy? Quasi-Experimental Evidence from the Great Recession and Normal Economic Times". *American Economic Journal: Economic Policy* forthcoming.

Henriques, A. M. 2018. "How Does Social Security Claiming Respond to Incentives?" *Journal of Human Resources* 53 (2): 382–413. doi:10.3368/jhr.53.2.1212-5371r2.

Kinney, S. K., J. P. Reiter, A. P. Reznek, J. Miranda, R. S. Jarmin, and J. M. Abowd. 2011b. "Towards Unrestricted Public Use Business Microdata: The Synthetic Longitudinal Business Database". *International Statistical Review* 79 (3): 362–384. doi:10.1111/j.1751-5823.2011.00153.x.

Kohnen, C. N., and J. P. Reiter. 2009. "Multiple imputation for combining confidential data owned by two agencies". *Journal of the Royal Statistical Society* 172 (2): 511–528. doi:10.1111/j.1467-985X.2008.00574.x.

Miranda, J., and L. Vilhuber. 2016b. "Using partially synthetic microdata to protect sensitive cells in business statistics". *Statistical Journal of the International Association for Official Statistics* 32 (1): 69–80. doi:10.3233/SJI-160963.

— . 2016c. "Using partially synthetic microdata to protect sensitive cells in business statistics". *Statistical Journal of the IAOS* 32 (1): 69–80. doi:10.3233/SJI-160963.

Mukoyama, T., and S. Osotimehin. 2019. "Barriers to reallocation and economic growth: the effects of firing costs". *American Economic Journal: Macroeconomics* forthcoming.

Neumeier, C., T. A. Sorensen, and D. A. Webber. 2018. "The Implicit Costs of Motherhood over the Lifecycle: Cross-Cohort Evidence from Administrative Longitudinal Data". *Southern Economic Journal* 84 (3): 716–733. doi:10.1002/soej.12239.

Schmutte, I. M. 2016. "Differentially Private Release of Data on Wage and Job Mobility". *Statistical Journal of the IAOS* 32 (1): 81–92. doi:10.3233/SJI-160962.

Sedláček, P., and V. Sterk. 2017. "The Growth Potential of Startups over the Business Cycle". *American Economic Review* 107 (10): 3182–3210. doi:10.1257/aer.20141280.

Slavković, A., and L. Vilhuber. 2018. "Remembering Stephen Fienberg". *Journal of Privacy and Confidentiality* 8 (1). doi:10.29012/jpc.685.

Vilhuber, L. 2018. "Relaunching the Journal of Privacy and Confidentiality". *Journal of Privacy and Confidentiality* 8 (1). doi:10.29012/jpc.706.

Vilhuber, L., J. M. Abowd, and J. P. Reiter. 2016a. "Synthetic establishment microdata around the world". *Statistical Journal of the International Association for Official Statistics* 32 (1): 65–68. doi:10.3233/SJI-160964.

— . 2016b. "Synthetic establishment microdata around the world". *Statistical Journal of the IAOS* 32 (1): 65–68. doi:10.3233/SJI-160964.

Vilhuber, L., and C. Lagoze. 2017a. "Making Confidential Data Part of Reproducible Research". *Chance*. http://chance.amstat.org/2017/09/reproducible-research/.

Weinberg, D. H., et al. 2018. "Effects of a Government-Academic Partnership: Has the NSF-Census Bureau Research Network Helped Improve the U.S. Statistical System?" *Journal of Survey Statistics and Methodology*. doi:10.1093/jssam/smy023.

Proceedings :

Abowd, J. M., and L. Vilhuber. 2013. "Improved Research Access to Census Bureau Linked Administrative Data via Public-use Products". In *Eighteenth Annual Meetings of the Society of Labor Economists*. http://www.sole-jole.org/Abowd-Data.pdf.

Drechsler, J., and L. Vilhuber. 2014. "Synthetic Longitudinal Business Databases for International Comparisons". In *Privacy in Statistical Databases*, ed. by J. Domingo-Ferrer, 8744:243–252. Lecture Notes in Computer Science. Springer International Publishing. ISBN: 978-3-319-11256-5. doi:10.1007/978-3-319-11257-2_19.

Haney, S., A. Machanavajjhala, J. M. Abowd, M. Graham, M. Kutzbach, and L. Vilhuber. 2017b. "Utility Cost of Formal Privacy for Releasing National Employer-Employee Statistics". In *Proceedings of the 2017 International Conference on Management of Data*, 1339–1354. SIGMOD '17. ACM. doi:10.1145/3035918.3035940.

Miranda, J., and L. Vilhuber. 2014. "Using Partially Synthetic Data to Replace Suppression in the Business Dynamics Statistics: Early Results". In *Privacy in Statistical Databases*, ed. by J. Domingo-Ferrer, 8744:232–242. Lecture Notes in Computer Science. Springer International Publishing. ISBN: 978-3-319-11256-5. doi:10.1007/978-3-319-11257-2_18.

Vilhuber, L. 2019. "Making Confidential Data Part of Reproducible Research". In *Methods to Foster Transparency and Reproducibility of Federal Statistics: Proceedings of a Workshop*, ed. by National Academies of Sciences, Engineering, and Medicine, 63–66. Washington, DC: The National Academies Press. ISBN: 978-0-309-48629-3. doi:10.17226/25305.

Working papers and other documents:

Abowd, J. M. 2018. *What Is a Privacy-Loss Budget and How Is It Used to Design Privacy Protection for a Confidential Database?* Presentation 1813:55761. Presentations by the Labor Dynamics Institute. http://hdl.handle.net/1813/55761.

Abowd, J. M., G. Benedetto, and M. H. Stinson. 2007. *The covariance of earnings and hours revisited*. Working Paper. AEA Annual Meetings. https://www.aeaweb.org/annual%5C_mtg%5C_papers/2008/2008%5C_254.pdf.

Abowd, J. M., and I. Schmutte. 2016. *Revisiting the Economics of Privacy: Population Statistics and Confidentiality Protection as Public Goods*. Document 22. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/22/.

Abowd, J. M., and I. M. Schmutte. 2017a. *Revisiting the Economics of Privacy: Population Statistics and Confidentiality Protection as Public Goods*. Document 37. Labor Dynamics Institute. http://digitalcommons.ilr.cornell.edu/ldi/37/.

— . 2017b. *Revisiting the economics of privacy: Population statistics and confidentiality protection as public goods*. Document 37. Labor Dynamics Institute, Cornell University. doi:N/A.

— . 2018a. *An Economic Analysis of Privacy Protection and Statistical Accuracy as Social Choices*. Document 48. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/48/.

Abowd, J. M., I. M. Schmutte, W. N. Sexton, and L. Vilhuber. 2019b. *Why the Economics Profession Must Actively Participate in the Privacy Protection Debate*. Document 51. Labor Dynamics Institute, Cornell University. https://digitalcommons.ilr.cornell.edu/ldi/51/.

Abowd, J. M., I. M. Schmutte, and L. Vilhuber. 2018a. *Disclosure Limitation and Confidentiality Protection in Linked Data*. Working Papers 18-07. Center for Economic Studies, U.S. Census Bureau. https://ideas.repec.org/p/cen/wpaper/18-07.html.

— . 2018b. *Disclosure Limitation and Confidentiality Protection in Linked Data*. Document 47. Labor Dynamics Institute, Cornell University. http://digitalcommons.ilr.cornell.edu/ldi/47/.

Abowd, J. M., and M. H. Stinson. 2011. *Estimating Measurement Error in SIPP Annual Job Earnings: A Comparison of Census Survey and SSA Administrative Data*. SEHSD Working Paper 2011-19. US Census Bureau. http://www.census.gov/sipp/workpapr/abowd-stinson-ME-ss-20110707-sehsdworking.pdf.

Abowd, J., I. Schmutte, W. Sexton, and L. Vilhuber. 2019d. *Introductory Readings in Formal Privacy for Economists*. Preprint. doi:10.5281/zenodo.2621344.

Armour, P. 2014b. *How much work would a 50% disability insurance benefit offset encourage? An analysis using SSI and SSDI incentives*. Presentation at the 2nd Disability Research Consortium. NBER Disability Research Center. http://www.nber.org/aging/drc/10312014drcmeeting/5.1Summary.pdf.

Benedetto, G., G. Gathright, and M. Stinson. 2010. *The Earnings Impact of Graduating from College during a Recession*. Tech. rep. US Census Bureau.

Benedetto, G., M. Stinson, and J. M. Abowd. 2013. *The creation and use of the SIPP Synthetic Beta*. Tech. rep. US Census Bureau. http://www.census.gov/content/dam/Census/programs-surveys/sipp/methodology/SSBdescribe_nontechnical.pdf.

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