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# Evolving Measurement for an Evolving Economy: Thoughts on 21st Century US Economic Statistics

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The system of federal economic statistics developed in the 20th century has served the country well, but the current methods for collecting and disseminating these data products are unsustainable. These statistics are heavily reliant on the great 20th century measurement innovation: sample surveys. Recently, however, response rates for both household and business surveys have declined, increasing costs and threatening quality. Existing statistical measures, many developed decades ago, may also miss important aspects of our rapidly evolving economy; moreover, they may not be sufficiently accurate, timely, or granular to meet the increasingly complex needs of data users. Meanwhile, the rapid proliferation of online data and more powerful computation make privacy and confidentiality protections more challenging.

There is broad agreement on the need to transform government statistical agencies from the 20th century survey-centric model to a 21st century model that blends structured survey data with administrative and unstructured alternative digital data sources. For discussions along these lines, see the deliberations of the panel chaired by former Census Bureau Director Robert Groves (National Academies of Sciences 2017), the independent review of the UK statistical system produced by Bean (2016), and the arguments in Bostic, Jarmin, and Moyer (2016). Government statistics in 21st century measurement will be based on vastly more source data, much of which is unstructured—or at least not designed for

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statistical uses. Surveys will remain critical, but they will be designed to complement available administrative and alternative data sources and to improve the measurement capabilities of the nontraditional sources. Digital information generated from transactions, online interactions, sensors, the Internet of Things, and many other sources can be used to capture various aspects of economic activity. This change is also likely to result in the decoupling of the collection of basic source data from the processing and dissemination of value-added statistical data products.

The American Economic Association's "Principles of Economic Measurement" (at https://www.aeaweb.org/content/file?id=6847) state that economic statistics need to be "Reliable," "Accurate," "Relevant," "Transparent," "Consistent in a Changing World," "Timely," and "Accessible." Traditional survey-based economic statistics are increasingly subject to concerns on all of these dimensions as users place new demands on the data. However, the explosion of digitized information and the tools of modern data science also provide an opportunity for blending traditional survey and new alternative data sources in a way that can lead to the design and delivery of new economic statistics that are more relevant, accurate, timely, and detailed.

In this essay, I describe some work underway that hints at what 21st century official economic measurement will look like and offer some preliminary comments on what is needed to get there. While my focus is on how to improve US economic measurement, there has been substantial progress in other countries that offers lessons for the United States, even in light of differing legal, political, and institutional settings. For example, the Scandinavian countries have made extensive use of linked administrative data, and the Dutch have made impressive and rapid progress moving from survey to administrative and private data sources.

I begin with a brief review of challenges faced by existing government statistical surveys. I continue by highlighting work at the agencies, by academics, and in the private sector that taps new data sources and/or uses new methods to improve economic measurement. I use a variety of examples, but I draw most heavily from activities at the Census Bureau where I have firsthand knowledge. I discuss challenges that will arise in applying new methods of generating statistical data products and sketch a path forward. For example, the use of digital data will depend on the willingness of firms, organizations, and third-party data providers to make available the source data from which more timely and granular economic statistics will be generated. Statistical agencies must maintain production of some current statistical products, but also create new ones in a way that allows longitudinal comparability for at least a select group of measures. Future users of economic statistics are increasingly likely to consume statistical information via specialized products and applications produced by downstream valued-added developers in the media, private sector, and academia who will need to work more closely with the agencies to ensure quality.

## The Survey Paradigm under Strain

The sample survey has been the workhorse of federal statistical agencies since they were pioneered at the Census Bureau in the middle of the 20th century by Morris Hansen (Hansen, Hurwitz, and Madow 1953). Well-designed and properly executed sample surveys can be an effective method of gathering scientifically robust information. But there are increasing concerns about the viability of surveys. Surveys impose a burden on households and businesses. Moreover, survey organizations in the United States and abroad face secularly declining response rates across a wide range of surveys (described in this journal by Meyer, Mok, and Sullivan 2015; see also Groves 2011; Baruch and Holtom 2008; National Research Council 2013). The downward trend is especially pronounced for the voluntary monthly or quarterly economic indicator surveys, like the Census Bureau's Monthly Retail Trade Survey or the Quarterly Services Survey. To date, the Bureau of Labor Statistics has been able to maintain relatively stable response rates for its business surveys like the Survey of Occupational Injuries and Illnesses or Current Establishment Survey, but like the Census Bureau, its mandatory annual surveys generally outperform voluntary surveys with higher collection frequencies.

These trends will almost certainly continue to be a cause of concern for survey quality and costs. While reliable methods have been developed to deal with missing data in survey estimation (Rubin 1987; Little and Rubin 2002), it is increasingly likely that reliable, unbiased estimation of many critical economic statistics will require new source data.

Limitations to the utility of surveys have been highlighted in a growing number of important contexts. As one example, consider the high-profile issue concerning the number and trends of workers in the so-called "gig economy." Abraham, Haltiwanger, Sandusky, and Spletzer (2017) and Katz and Krueger (2016) compare survey-based data on self-employment from the Current Population Survey, the Survey of Income and Program Participation, and the American Community Survey with administrative data at the aggregate and micro levels. Both sets of authors document that the surveys produce lower estimates of both the size and growth rate of gig economy employment than do the administrative data sources. Farrell and Greig (2017) carry out a big-data exercise on JPMorgan Chase account-holders to document the increase in the number of people receiving income from online platforms. The challenges noted by the Bureau of Labor Statistics in their attempt to measure a type of gig work—"electronically mediated work"—through the Contingent Worker Supplement are further evidence of the difficulty of measuring this part of the economy with survey data alone (Current Population Survey staff 2018).

## New Data for Economic Measurement

Surveys are attractive to statistical agencies because they are designed for a specific measurement task. In contrast, administrative and alternative data sources

are designed, collected, and processed for purposes other than economic measurement. Those who wish to repurpose them for statistical uses must seek to understand their measurement properties and their strengths and weaknesses. Struijs, Braaksma, and Daas (2014) discuss the opportunities and challenges of using new alternative data sources for official statistics.

Unsurprisingly, researchers have been faster than the statistical agencies to adapt alternative, and especially government administrative, data to various economic measurement tasks. There has already been a large increase in the utilization of administrative data for research (Chetty 2012) and policy evaluation (Jarmin and O'Hara 2016). Examples include analyses of trends in income equality (for example, Chetty, Hendren, Kline, and Saez 2014) and the changing nature of business dynamics (as in Decker, Haltiwanger, Jarmin, and Miranda 2016). Often, these studies turn to administrative data to study patterns that simply are not available from existing survey-based data—and moreover would be prohibitively expensive to generate in a survey context. In the examples just mentioned, longitudinally linked microdata with universe coverage permit much more precise descriptions of the underlying dynamics than would be possible with survey data.

Importantly, these research efforts can and do lead to innovation in official statistical products. For example, early work on matched employer–employee data (Abowd, Haltiwanger, and Lane 2004) led to the development of the Quarterly Workforce Indicators which integrate many sources of information, including administrative data from state unemployment insurance records and survey-based data from the American Community Survey (Abowd et al. 2009). I discuss additional examples later in the essay.

The use by government statisticians of digital data from private sector sources is also growing, but more slowly. Meanwhile, several companies have developed public-facing data products and tools that can complement official statistics. Examples include the ADP Employment Reports (job growth), Adobe Digital Insights (e-commerce), MasterCard SpendingPulse (consumer spending), and the work of the JPMorgan Chase Institute (bank account transactions). Academic economists have also been occasionally granted access to company data both to address specific research questions and to address broader economic measurement concerns (as in Antenucci, Carafella, Levenstein, Ré, and Shapiro 2014).

One major concern for government statisticians is that they do not have control over the continuity or quality of administrative or other digital data (Landefeld 2014). There is concern that data providers, be they other government agencies (in the case of administrative data) or private sector sources, could disrupt the flow of data to statistical offices or that they may lack the incentive to ensure data quality. Thus, statistical offices around the world have approached the adoption of new data sources cautiously. But large potential payoffs in improved statistical products have generated serious interest in alternative data sources. I focus on some important initial steps at US statistical agencies below.

It is tempting to view these alternative sources of data as substitutes for official statistical products. However, the developers of these alternative sources of data are

quick to note their limitations and their dependence on benchmarking to official data. Thus, it is better to view these private sector and academic products as complements to official statistics. Twenty-first century economic measurement will require that private, academic, and government data providers find new ways to collaborate to leverage their different strengths.

**Alternative Data for Measuring the Retail Sector**

Recent work at the Census Bureau has focused on augmenting the source data for its monthly and annual statistics on retail trade. The underlying Monthly Retail Trade Survey suffers from low and declining response, dropping from a response rate of 65.9 percent in 2009 to 52.4 percent by 2015. But this work is also motivated by the desire for more timely indicators with more geographical detail than the national estimates available from the survey. Two sources of alternative data are particularly useful in this context: point-of-sale or scanner data and credit/debit card transactions.

Early work on using scanner data to construct prices indices is summarized in Feenstra and Shapiro (2003). More recently, the Census Bureau has been testing the use of data on retail sales obtained from NPD Group to augment its monthly and annual estimates as well as to provide product detail for the 2017 Economic Census. NPD collects point-of-sale data directly from retailers for its market research activities and has negotiated with several large chains to share that information with the Census Bureau. These data track those collected on Census Bureau surveys very closely (Hutchinson 2017). The Census Bureau and NPD are working to expand the number of participating companies with the hope that NPD clients eventually would not need to complete the monthly survey.

One main advantage of data from point-of-sale or credit card transactions is that they may be available at high frequency. The Census Bureau has researched ways to improve its seasonal adjustment procedures using daily credit card transaction data from First Data. These data can help identify and adjust for trading day effects in the Bureau's monthly retail sales indicator releases (McElroy, Monsell, and Hutchinson 2018). These same data made available via a tool built by Palantir have been used by researchers at the Federal Reserve Board to get more precise impacts of disasters like hurricanes on consumer spending (Aladangady et al. 2016).

Neither the point-of-sale nor the credit/debit card data provide complete coverage of the retail sector. That said, their month-to-month changes track official survey data very closely. This might allow a design that employs an annual benchmarking survey coupled with monthly or higher frequency alternative data to construct high-frequency retail sales estimates at subnational levels. However, additional testing with more source data for a larger portion of the retail universe and for more years is required.

In both the NPD and First Data cases, statistical agencies have acquired access to the data for testing purposes through contractual means. It is not clear that a sustainable business arrangement can be negotiated where the agencies could use these as reliable production sources. In the case of NPD, the unit prices that the

Census Bureau is paying for research access would be unaffordable, at least with current budgetary resources, if the project were to be scaled up to cover even the portion of the retail sector captured in NPD data. One possible solution would be if the government allowed third parties like NPD to offer the provision of statistical data to government agencies as part of the service they provide their retail company customers, which would reduce the costs of the survey burden for retail companies. That is, retailers would pay NPD an extra fee to have NPD transmit their retail sales data to the Census Bureau rather than undergoing the burden associated with completing the survey. More broadly, platforms like SAP and QuickBooks could also be useful for facilitating agency access to company data for statistical uses. There are many possible ways to solve the technological, legal, and business relationship issues surrounding the efforts of statistical agencies to get better data in an automated way that minimizes burdens for businesses. Finding the right mix of incentives for all participants—firms, third party data providers, and the statistical agencies—is a challenge to be addressed going forward.

Finally, when the data product in question is a principal economic indicator—like the monthly unemployment rate or retail sales estimate, having the potential to move markets—any partnership with outside providers must take into account the challenge of limiting any reverse-engineering of the indicator. That is, the agencies must be careful that no commercial data provider supplies an identifiable component of the information contained in a principal economic indicator, which would allow that company to predict the statistic more accurately than others before its release.

**Alternative Data for Measuring the Healthcare Sector**

The Bureau of Economic Analysis has recently introduced a set of Health Care Satellite Accounts (Dunn, Rittmueller, and Whitmire 2015). These satellite accounts depart from the normal procedure of the national income and product accounts by allocating consumer healthcare spending across disease categories, so that the "good" being measured is overall treatment of a disease rather than any of the BEA's traditional goods and services categories. It allows for the development of disease-specific prices indices, so that data users can separate trends in healthcare spending by the price and quantity of treatment for specific disease categories.

Two approaches are used to construct the Health Care Satellite Accounts. The "MEPS Account" relies on data from the Medical Expenditure Panel Survey (MEPS). The MEPS is the only nationally representative survey on healthcare spending, but its limited sample size can result in noisy estimates. The "Blended Account" augments the MEPS data with billions of claims records (from MarketScan and Medicare) covering millions of individuals. The Blended Account effectively and dramatically increased the sample size for the MEPS, allowing for the smoother and more granular estimates of healthcare spending that researchers and policymakers need. Importantly, it also retains the scientific properties of the MEPS, even though the claims data are not representative of the entire population. This blended survey and alternative data approach will become increasingly important as official statistics integrate more data sources.

**Extracting More Value from Existing Data Resources**

In some cases, better utilization of the existing data assets can yield significant returns. The diffusion of computing power as early as the 1980s and 1990s allowed researchers to begin to access large micro-datasets in order to examine more fundamental economic units such as establishments, firms, households, individuals, and products. Examples of research in this area include within-industry firm heterogeneity (McGuckin 1993), new goods biases in price indices (Feenstra 1994), and the role of producer dynamics in productivity growth (Foster, Haltiwanger, and Krizan (2001).

The introduction and steady expansion of statistics on business dynamics offers an excellent example of using existing data to generate new statistical products. Following recommendations from the National Academies (Haltiwanger, Lynch, and Mackie 2007), the Census Bureau and the Bureau of Labor Statistics both introduced new statistics based on the longitudinal linkage of their respective business lists. These lists had been used for decades as sampling frames for business surveys and for generating (primarily) cross-sectional statistical products (for example, County Business Patterns). The Census Bureau now publishes the annual Business Dynamics Statistics, and the Bureau of Labor Statistics publishes the quarterly Business Employment Dynamics. While these products are similar, they do have certain key differences that originate in the underlying administrative data that provides the sources for these business lists—the Census Bureau list is based on income and payroll tax data from the IRS, and the Bureau of Labor Statistics list is based on business-level state unemployment insurance data—which in turn can determine their fitness for particular uses (Decker, Hatliwanger, Jarmin, and Miranda 2014). Synchronization of the business lists between the Census Bureau and the Bureau of Labor Statistics would improve data quality, eliminate duplication, reduce the current extraordinary efforts required by Bureau of Economic Analysis to reconcile the statistics derived from the separate business lists, and also enable enhancement and creation of new and improved longitudinal business products (Becker et al. 2005). Differential statutory access to administrative data, particularly to tax data, has hampered these efforts (Shapiro et al. 2014).

These statistical products are entering their second decade, having demonstrated the measurement importance of these universe lists beyond their use as sampling frames. Building on that success, researchers from the Census Bureau and the Federal Reserve recently released a beta product that uses modeling and high-frequency data on applications from firms to the IRS for an "employer identification number," available with a short lag, to produce more timely data on business startups than is currently available in either the Business Dynamics Statistics or the Business Employment Dynamics. Bayard et al. (2018) describe how to identify "high propensity applications" that are associated with entities that hire employees and grow. The beta version of public-use Business Formation Statistics are available at the national and state level, but the research demonstrates that statistics at the county level and the level of core-based statistical areas (multicounty areas with

an urban center) are feasible as well. Finally, a novel aspect of this work that is not typical for statistical agencies is that the Business Formation Statistics offer projections of future startup activity.

Another recent example of linking two existing data sources is the Opportunity Atlas that combined longitudinal income data from the IRS with Census Bureau data on race and ethnicity. The Opportunity Atlas (https://www.opportunityatlas.org/) is a powerful online tool that allows users to see how parental incomes and childhood neighborhood characteristics impact adult outcomes. The methodology for the underlying data is described in Chetty, Friedman, Hendren, Jones, and Porter (2018).

The work represented by the above examples is important not just in providing more timely and granular estimates of business startup activity and income mobility, but also in demonstrating how existing resources can be repurposed to build useful new products. Furthermore, the work highlights the importance of forming teams including subject matter experts who understand the measurement need, those who understand and have access to the data resources, and those with the appropriate technical expertise. The Business Formation Statistics research team is comprised of individuals who possessed decades of experience with Census Bureau surveys and administrative data and are also scholars with a keen sense of measurement needs around business formation. The Opportunity Atlas was possible through the collaboration of academic researchers, Census Bureau experts, and private sector data visualization specialists. The teams these projects rely on for their success possess more diverse skill sets and represent more organizations than is typical for federal survey operations.

## Rethinking the Role of Surveys

Given declining survey response rates and the growing availability of alternative data sources, surveys will contribute a declining share of the source data for official statistics over time. Instead of being the primary source data for key economic statistics, survey data should evolve to serve three critical functions.

First, survey data can act as benchmarks to improve the utility of administrative and alternative data. Administrative and alternative data sources often have coverage deficiencies or lack key population characteristics used to make subpopulation estimates like those related to age, race, or industry. For example, the Health Care Satellite Accounts discussed above can use the Medical Expenditure Panel Survey to extend the insights from less systematic data on claims, and the Census Bureau's Small Area Income and Poverty Estimates can use the American Community Survey (ACS) to extend the insights from unrepresentative tax data. It becomes possible to build up estimates on healthcare spending and income, respectively, that are both representative and granular, even though these alternative data on healthcare claims and taxes by themselves lack full coverage and are not representative of the entire US population.

Similarly, preliminary analyses of credit card and point-of-sale data used to generate more timely and granular retail sales estimates indicate that these sources mimic high-frequency changes quite well, but estimates of the level of retail sales can drift away from the official number. Thus, one could envision replacing monthly surveys with a combination of credit card and point-of-sale data that is benchmarked to an annual survey. This would accomplish both a reduction in survey response burden and more timely and granular retail indicators that are benchmarked to scientifically designed survey estimates.

Second, surveys will remain critical for items that are not available from administrative or alternative sources. For example, a relatively new economic collection at the Census Bureau is the Management and Organizational Practices Survey (MOPS) (Buffington, Foster, Jarmin, and Ohlmacher 2017), which, as its name suggests, asks businesses about management practices, something that's not available from company databases. Rather than introducing an entirely new survey, the MOPS is a supplement to the Annual Survey of Manufacturers and thus can use the outcome variables derived from that survey to examine whether differences in management practices translate into business outcomes such as growth, survival, and productivity.

Third, survey design at statistical agencies should over time be optimized to take advantage of the administrative data available to the agencies, as well as new alternative sources. At this point, official statistics on businesses generally make better use of available administrative data than do household surveys. This reflects better availability of administrative data on businesses through the tax and unemployment insurance systems, covering nearly the entire universe of business units. Nevertheless, as highlighted in a recent National Academies of Sciences (2018) report, there remains much scope for better integration of survey and nonsurvey data to improve estimation and to harmonize data and methods across different measurement programs. This optimized survey design involves minimizing the use of surveys to collect information for which administrative or alternative source data are available and prioritizing those items not captured in nonsurvey sources for inclusion in survey data collections.

## New Methods throughout the Value Chain of Economic Measurement

Utilizing new sources of data for economic measurement requires statistical agencies to adopt new ways to acquire, ingest, and process these data. The timely and more granular data products we hope to generate from these new sources will also require the agencies to adapt to new ways of marketing and disseminating data to users. Here, I highlight some of the challenges and issues that arise.

### Automating Acquisition of Source Data

Statistical agencies have received large amounts of nonsurvey data for decades, but typically via file transfers that require manual mediation. Agencies are looking to automate the large-scale ingestion of nonsurvey data. Passive data collection via

web-scraping is attractive for some data collection tasks. The Bureau of Labor Statistics uses limited web-scraping to supplement its Consumer Price Index program (as discussed in this journal by Groshen, Moyer, Aizcorbe, Bradley, and Friedman 2017) and continues to research ways to passively collect data similar to the Billion Prices Project (discussed in this journal by Cavallo and Rigobon 2016). The Census Bureau is beginning to use web-scraped data to replace survey collections for some state and local government units for its *Quarterly Summary of State and Local Government Tax Revenue* (Dumbacher and Hanna 2017).

Several statistical agencies including the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Census Bureau are experimenting with acquiring data directly from companies or third parties rather than from surveys. Automated feeds through company "application programming interfaces" (APIs) offer the hope of reducing the burden on survey respondents and improving the quality of source data for the statistical agencies. However, investments need to be made by both businesses and the statistical agencies to make this a reality. Survey responses are designed to meet agency requirements. For example, companies sum sales across products and establishments to report to the monthly retail trade survey. In the future, businesses could transmit more granular summaries of transactions by location and product through third parties or allow access to transactions or summaries of transactions directly via an API. Another possible way statistical agencies could perform statistical computations on company data is through Secure Multi-Party Computing (Goroff 2015). The Census Bureau is currently working with Microsoft on a proof-of-concept to learn how this could be used in the production of economic statistics. Regardless of how the statistical agencies access company data for statistical uses, one critical issue, that will probably need to be resolved on a case-by-case basis, is the degree to which company databases will be required to conform to statistical agency requirements before they are transmitted or otherwise made available to the agencies.

**Innovation Requires Putting the Data User First**

In the past, the statistical agencies relied on a handful of key (mostly federal government) stakeholders to drive the measurement agenda and to determine what products to develop and publish. The data user community is much broader today and it includes many nongovernment users. Along with traditional economic statistics, many of these users require data that is timelier and more granular. This shift requires government agencies to seek new ways to engage users to identify measurement priorities and to develop products to meet their needs.

The Census Bureau's Opportunity Project (described at https://opportunity.census.gov/) provides a structured and repeatable process to engage stakeholders, the agencies, data scientists, developers, designers, and business strategists around a given measurement problem. Partners have included companies like Cisco and Redfin, nonprofit organizations like the National Urban League, and several government agencies. Initial proofs-of-concept are developed in twelve-week sprints, dramatically faster than typical agency product development timelines. Prototype

products showing promise can be further developed either by agencies or stakeholders; as one example, see the Redfin "Opportunity Score" at https://labs.redfin.com/opportunity-score, which shows what types of jobs can be reached from a given location by walking or mass transit, along with information on housing prices in that location.

Increasingly, data users will consume official statistical data via apps that are developed through this type of process. Agencies will need to set up review and quality assurance procedures to facilitate the development of new innovative products. Data users will also consume official economic statistics on platforms over which the agencies have limited control like USAFacts (https://usafacts.org/). Ideally, the agencies will work with such platforms to help ensure official products are properly deployed and documented. Clearly, resource constraints will require agencies to prioritize the platforms with which they will choose to work.

**Expanding the Toolkit**

Continued innovation requires adding the tools of modern data science to the traditional toolkit of the official statistician (National Academies of Sciences 2017). The agencies have responded by updating training to include modern data science methods through partnerships with academia, including the Joint Program on Statistical Methodology. Pilot classes on "Big Data and Federal Statistics" led to the development of a textbook (Foster, Ghani, Jarmin, Krueter, and Lane 2017).

Agency staff are applying modern data science methods within several projects. For example, the Bureau of Labor Statistics and the Census Bureau are exploring how machine learning can be applied to a variety of classification activities (for example, industry and occupation coding). Bertke, Meyers, Wurzelbacker, Measure, Lampl, and Robins (2016) utilize machine learning to improve coding of work-related injuries for the Survey of Occupational Injuries and Illnesses. The Innovation Measurement Initiative, a partnership between the Census Bureau and the University of Michigan's Institute on Research in Innovation and Science, makes heavy use of the data science toolkit and introduces new data to address a longstanding measurement challenge of relating investments in research and innovation to economic outcomes. Early work is described in Zolas et al. (2015), and the growing data infrastructure is now available to researchers via the Federal Statistical Research Data Centers.

**Modernizing Privacy Protections for Granular Data**

Providing data users with the more timely and granular estimates while protecting the confidentiality of the underlying data is increasingly difficult for statistical agencies. The proliferation of data on the Internet, along with increased computing power and the availability of software for performing linkages, increase the risk that public statistics may permit re-identification of individuals or businesses in the data from which estimates were tabulated. Importantly, this problem exists for both public use microsamples and aggregated tabulations (Abowd et al. 2017). Academic and private sector researchers have approached this problem from both

statistical and computer science (especially cryptographic) perspectives. Heffetz and Ligett (in this journal, 2014) provide a good introduction to this topic. Fundamentally, no public release from a confidential dataset is completely safe from re-identification. However, differentially private methods provide a way to quantify the privacy risk from publishing a given set of statistics. The essential intuition here is that adding or removing an individual from a dataset should have (nearly) no effect on any publicly released outcome of the data, but accomplishing this requires adding noise to the released data (so that the gain in privacy has a tradeoff of slightly less precision). The Census Bureau's OnTheMap application was the first public data product to employ formal, quantifiable privacy protections (Machanavajjhala, Kifer, Abowd, Gehrke, and Vilhuber 2008).

An excellent example of the need for modern approaches to privacy protection is the new Post-Secondary Employment Outcomes (PSEO) product (described at https://lehd.ces.census.gov/data/pseo_beta.html), which started as a partnership between the Census Bureau and the University of Texas System to develop a tool (available at https://seekut.utsystem.edu/seekuttool) for students and their families to examine postgraduation outcomes by campus and degree field. This is accomplished by linking student data from universities and community colleges to workforce data from the Longitudinal Employer-Household Dynamics program at the Census Bureau. This permits the Census Bureau to improve measures of workforce education and within-firm human capital. The privacy protection problem for this application is complicated, because the schools both possess the original lists and in some cases publish statistics from them. The solution infuses noise into the data, in a way that provides "provable differential privacy" (US Census Bureau 2018) and allows users to generate queries that would otherwise have high risk of disclosing data for particular students. Given the initial success of the pilot PSEO, the Census Bureau is in the process of adding schools to scale up the project.

## Path Forward

It is possible to envision a future in which there is more private sector and/or academic provision of economic statistics. ADP, the JPMorgan Chase Institute, and the Billion Prices Project demonstrate that high-quality statistics based on alternative data sources can be produced outside of the statistical agencies. While these developments are welcome, there are two reasons why federal statistical agencies will still need to play a central role in the provision of economic statistics.

First, although the information underlying them may not be so, official statistics are essentially public goods. Socially efficient provision of statistical information on the structure, evolution, and performance of the economy requires the resources and the coordination function of the federal government. The federal government also has the ability to provide continuity, and it is difficult to envision the scale and scope of statistical production being fully duplicated by the private or academic sectors.

Second, private sector provision may not always enjoy the same degree of public trust as official statistics, because private actors may have incentives to use pre-release information for private gain. Thus, the official statistical agencies need to work with private sector and academic providers to identify opportunities where they can add value along some quality dimension that the agencies find difficult, which may be especially relevant for big data that is more timely or detailed but perhaps not representative of the population of interest. In this way, efficient provisioning of publicly available official statistics requires planning and coordination as well as a commitment by the statistical agencies to sound methods and transparency.

**Access and Data Governance**

Some foreign statistical offices have made substantial progress using alternate data sources and methods. For example, Statistics Netherlands created estimates of traffic intensities in Holland using GPS data and traffic sensors (Ma, van Dalen, de Blois, and Kroon 2011) and Belgian daytime population estimates have been constructed using mobile phone data (Deville et al. 2014). Of course, legal and institutional characteristics may constrain access and use differently across countries, but the US statistical agencies should pay attention to innovations in other countries.

A key question is whether some statutorily mandated US data collections, like the Economic Census, could be done through automated data access modes (like application programming interfaces), or via secure multiparty computing. If so, and if the additional reporting burden for companies was minimal, could the frequency and quantity of information delivered be increased? What sort of legal and policy structure is needed to govern how statistical agencies access private data assets for statistical uses? Another key question is whether companies would seek to charge for access to data delivered in this way. If so, would the associated fees be within the budgetary resources of the statistical agencies or other public-spirited organizations committed to high-quality economic statistics? Similarly, federal, state, and local government agencies that possess important administrative data are not always incentivized to make them available for statistical uses. The recommendations of the Commission on Evidence-Based Policymaking (2017) and the Federal Data Strategy (https://strategy.data.gov/) seek to encourage agencies to permit secure and lawful access for statistical, evaluative, and research purposes. Perhaps a bigger concern is how changes in, for instance, tax law policy could affect the content or coverage of administrative data available for statistical purposes.

**Methods and Processes**

As blended data from surveys and alternative sources become the norm for government statistics rather than the exception, the way in which such estimates are modeled will play a much larger role. The statistical agencies have some experience with blended data from programs such as the Census Bureau's Small Area Income and Poverty Estimates using methods based on Fay and Herriot (1979). Lohr and Raghunathan (2017) provide an updated review of methods for combining survey and nonsurvey data.

In addition to producing estimates from blended data, the statistical agencies must expand their general data science capabilities. Varian (in this journal, 2014) discusses modern data science tools, many of which can be applied to generating economic statistics from the types of data discussed here. An important point of focus for the statistical agencies will be data acquisition and curation as new unstructured data sources are accessed, tested, and applied to measurement problems. The ingestion, processing, and curation of large administrative and alternative sources introduces scalability concerns not present in most survey contexts. Negotiating access will require the agencies to get more staff with skills to initiate and manage business relationships with data providers.

Modernized confidentiality protection also has methodological and computational implications. The statistical agencies currently have the computer science expertise to scale "formally private" disclosure protection methods for only a small number of products. The Census Bureau is the only agency to implement these procedures in production, and its team is currently fully tasked in modernizing its confidentiality systems for the 2020 Census. Relatedly, cryptographic methods like secure multiparty computing might allow statistical agencies to perform privacy-preserving computations, but the agencies currently do not have enough expertise to move beyond small-scale testing. As yet, statistical agencies lack the technical expertise to fully test and scale solutions for these promising technologies.

Clearly, modernization requires significant investments in computer science and engineering expertise at the statistical agencies. This is a major challenge given the competition for attracting talent across other government agencies and the private sector. Collaboration with academic experts and contracting can be part of the solution, but some internal expertise is essential.

In general, agencies should seek to expand substantially the accessibility and usability of their data products. In the future, many users will access statistical information through special purpose apps (whether provisioned by the agencies themselves or by others relying on the application programming interfaces from the agencies), which requires more user-centric approaches to the design and provisioning of agency data products. This will require difficult resource allocation decisions as most statistical agencies concentrate the bulk of their resources on collection and processing, not dissemination.

**Priorities, Duplication, and Organization**

The current federal statistical system is decentralized. There are 13 principal statistical agencies, with three that are most heavily involved in economic measurement: the Bureau of Economic Analysis, Bureau of Labor Statistics, and the Census Bureau. A decentralized system does not impose high additional costs when most economic statistics are produced within vertically integrated stand-alone surveys, or where data linkage is conducted at an aggregated level. But a system that takes advantage of linking surveys, administrative, and third-party data at the micro-level, and where data are captured via application programming interfaces, scraped from the web or harvested

from sensors, could gain from leveraging scale economies in data access and processing.

Many commenters on this issue, including former Commissioner of Labor Statistics Janet Norwood (1995), have contemplated reorganizing the federal statistical system. The Confidential Information Protection and Statistical Efficiency Act of 2002 called for greater collaboration and business data sharing between the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Census Bureau, but the Census Bureau is limited in sharing data that are commingled with federal tax information (Pilot 2011). Recently, the Office of Management and Budget (2018) proposed moving the Bureau of Labor Statistics to the Commerce Department, which is already home to the Bureau of Economic Analysis and the Census Bureau. This is a positive step, but resolving all legal issues around data sharing would probably require a full merger of the three agencies. Congressional approval would be required, whether the three agencies are merged or whether BLS is moved to the Commerce Department.

Regardless of whether the federal statistical agencies are realigned or reorganized, they need to review their current structure given how the production of statistics is evolving. Current structures tend to be vertically integrated and centered on specific data collection activities. This structure results in some activities being starved for talent, while others do not fully utilize skilled staff. The Census Bureau has made partial progress on organizing more functionally with matrixed multidisciplinary teams, but more is needed to allocate staff to agency priorities most effectively.

The collective economic measurement system will need to make a number of investments. It will need to invest in building relationships across government agencies and the private sector to secure access to high-quality source data. It will need to invest in staff with the skills to acquire, process, and curate large datasets, and to build reliable and privacy-protected statistical products from blended data. Information systems need to be redesigned to accommodate both survey and alternative data processing.

**The Role of Economists and Social Scientists**

The statistical agencies will need to work with many external partners to provide high-quality 21st-century economic statistics. The need for combined expertise across subject matter areas, including economics, demography, statistics, data science, computer science, and others, suggests that interdisciplinary teams will be important to improving economic measurement. Indeed, many of the new products developed with administrative and alternative data described above were developed by economists and other social scientists pursuing measurement-focused, curiosity-driven research—some directly employed by the agencies, some from outside government in collaboration with agency staff. Academic economists have long worked with the federal statistical system to improve economic measurement, especially through the Conference on Research in Income and Wealth (http://www.nber.org/CRIW/). I encourage academic economists with interest in measurement to get more directly involved with the agencies and the CRIW.

Recent years have seen a large increase in economists working in companies, especially tech companies. Given their joint interest in using new data sources for various aspects of economic measurement, there is a natural affinity between economists in the statistical agencies and those working in the private sector. The National Association for Business Economics (NABE) has been providing important opportunities for these economists to interact and explore ways to work together. An important note regarding this for academic departments training economists is that a growing share of PhD economists are now working in multidisciplinary settings where the goal is not always publishing in the scholarly literature. How can we give those not taking academic jobs more exposure to the methods and language of diverse disciplines like computer science, product design, and so on?

Agencies must continue to improve access to confidential data for qualified researchers such as through secure systems like the Federal Statistical Research Data Centers. The issues surrounding research and program evaluation use of confidential statistical and administrative data are discussed in Foster, Jarmin, and Riggs (2009) and the Commission on Evidence-Based Policymaking (2017). Secure access systems like the Federal Statistical Research Data Centers enhance agency collaboration with academic researchers, facilitate knowledge transfer, and leverage the value of nonpublic data assets.

## Conclusion

The system of economic measurement developed in the 20th century continues to provide critical statistics on the health and performance of the economy. That said, current measurement programs are not keeping pace with the changing economy, and current methods for collecting and disseminating statistical information are not sustainable. A process is underway in which government statisticians will take greater advantage of the proliferation of new data sources that can be utilized for economic measurement, as well as new tools for processing, analyzing, and publishing improved economic statistics. My hope is this brief summary can begin a conversation both within the economics profession and across the entire set of stakeholders on how to build a 21st-century economic measurement system.

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