

MEASURING THE ELECTRONIC ECONOMY AT THE U.S. CENSUS BUREAU

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ABSTRACT

The demand for information about the electronic economy requires statistical agencies to assess the relevancy and improve the quality of their existing measurement programs. Innovations at the U.S. Census Bureau begin meeting the most urgent user needs for information about the electronic economy and improving data quality. Research tapping the expertise of academia, the private sector, and other government agencies underpins its new data on electronic commerce and electronic business processes. Research conducted at the U.S. Census Bureau, using both existing and new data, provides key new estimates of the size, scope, and impact of the new economy.

KEY WORDS: Electronic Economy; Economic Measurement; Quality Improvement

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1. INTRODUCTION

The recent phenomenal growth and collapse of the “dot.com” sector focused attention on the increased use of computers and computer networks in business. However, businesses were conducting numerous processes over computer networks long before the advent of dot.coms and e-commerce. Some of the impacts of networked computer use by businesses are easy to see, such as new industries, products, business models and processes. Some impacts are subtle and difficult to convincingly quantify, such as attributing productivity growth to computer and computer network use. Most expect increased computer network use to continue to lead to new products and services, new delivery methods, streamlined or re-engineered business processes, new business structures, and enhanced business performance. These changes, in turn, potentially affect the performance of the economy as a whole, including economic growth, productivity, prices, employment, trade, and the structures of businesses, regions, and markets.

Evaluating these expectations requires solid statistical information. However, official statistical series contain little identifiable information about the electronic economy. What information there is comes from several sources and is difficult to link and compare. Statistical agencies around the world have been assessing how well information in their existing measurement programs provides the data users need to evaluate these expectations, and setting priorities to begin improving the quality of their data on the electronic economy. In 1999, the U.S. Census Bureau implemented a measurement initiative to begin improving the quality of information on the electronic economy. The initiative leverages existing measurement programs by adding questions to existing surveys. The Census Bureau is also fielding a new survey, and undertaking research using both new and existing data to generate estimates of key aspects of the electronic economy.

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Even with these efforts, there is still much to do before many of the key questions surrounding the electronic economy can be adequately addressed. Some of the information needed can be obtained by adding more new items to existing surveys, making the scope of existing surveys consistent, and developing additional new surveys. Addressing other key questions, however, poses significant measurement challenges. While some of those challenges are specific to the electronic economy, many are difficult and long-standing ones. Interest in the electronic economy highlights the importance of addressing them. Many of these improvements would also substantially improve the information available to evaluate the performance of the entire economy. The discussion highlights these additional enhancements and expansions of the U.S. Census Bureau's existing measurement program.

2. QUESTIONS ABOUT THE ELECTRONIC ECONOMY

The questions key groups of data users ask about society and the economy drive the U.S. Census Bureau's data collection, processing, reporting, and analysis. Data users are diverse, and satisfying all their needs is difficult, given fixed resources and limits on the ability of respondents to U.S. Census Bureau surveys to accurately provide the necessary information. The same challenges hold for their questions about the electronic economy.

Data users in government, academia, and the business community all voiced a need for information about the electronic economy. The Census Bureau, recognizing the growing importance of the electronic economy, set up an interagency E-Business Steering Committee² in 1999 to review data needs and begin planning a strategy to meet them. The steering committee's first step was researching the types of information data users needed, both to understand the changes to society and the economy that are due to the electronic economy, and to assess their implications. The committee contributed to and reviewed a series of papers examining the role of the U.S. Census Bureau, and other federal and national statistical organizations, in providing information about the electronic economy (for example, Atrostic, Gates and Jarmin, 2000; Haltiwanger and Jarmin 2000; U.S. Department of Commerce 1998 and 1999; Atrostic, Colecchia, and Pattinson 2000; Fraumeni, Manser and Mesenbourg, 2000; Statistics Canada 1999).

These papers discuss three broad classes of questions about the electronic economy. First are questions about the size and dimensions of the electronic economy, such as: How many books were sold over the Internet? How many establishments use certain e-business process? What is the investment in information technology equipment in a given industry?

The second broad class of questions concerns the impacts of the electronic economy on business and economic performance. These are questions such as: How do investments in information technology impact productivity? What new goods and services are available from the electronic economy? Has the pace of innovation increased? Such questions cannot be answered by asking data providers directly. Rather, the answers are inferred by analyzing both existing and new data on economic growth and productivity in new ways (Haltiwanger and Jarmin, 2000; Atrostic, Gates and Jarmin, 2000).

The third class of questions concerns how the electronic economy affects existing data series (see Haltiwanger and Jarmin, 2000; Fraumeni, Manser and Mesenbourg, 2000). Does the use of information technology and e-business processes change economic activities in ways that affect the completeness, relevance, and accuracy of official statistical series on output, prices, productivity, etc? For example, changing roles within supply chains mean that activities classified in one subsector, such as wholesaling, may shift to another, such as manufacturing or logistics. The U.S. Bureau of Economic Analysis relies on the subsector classifications in developing key statistics such as the input-output accounts. Changes in the sectors where these activities occur can affect the accuracy of those statistics.

² The U.S. Census Bureau's E-Business Steering Committee is headed by Thomas Mesenbourg, Assistant Director of Economic Programs, and includes members from all the subject matter divisions (including the authors), the Census Bureau's Center for Economic Studies, the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, and the U.S. Department of Commerce.

Do e-commerce and e-business make it harder to attribute economic activity to the appropriate sector? One example is direct sales to consumers by manufacturers out of manufacturing plants or headquarters facilities. Current national income accounting practice would count these as intermediate, rather than final, demand. Such misclassification affects estimates of gross domestic product. If these direct sales are growing because of the electronic economy, their effect on the accuracy of statistics also increases. Do e-commerce sales reduce the accuracy of customs data on international trade? Small shipments overseas need not be declared to U.S. Customs, and, thus, will not be captured as exports. If e-commerce increases the volume of small shipments, such as books purchased by individuals, official statistics will capture a smaller share of economic activity. Finally, does the electronic economy exacerbate known measurement problems, such as the use of temporary workers, or alternative compensation schemes like stock options, or output measurement in difficult sectors like financial services (Triplett and Bosworth 2000)?

3. DEFINING E-BUSINESS FOR STATISTICAL PURPOSES

Improving measurement of the electronic economy requires defining it. The Census Bureau has been a leader in an international effort to arrive at useful and workable definitions (Atrostic, Colecchia and Pattinson, 2000; Mesenbourg, 1999 and 2001; Fraumeni, Manser and Mesenbourg 2000). An important next step in the E-business Steering Committee's strategy was defining three primary components of the electronic economy (more detailed definitions are given in Mesenbourg, 2001):

- **E-business infrastructure:** This is the share of total economic infrastructure used to support electronic business processes and conduct electronic commerce. It includes hardware, software, telecommunication networks, support services, and human capital used in electronic business and commerce.
- **Electronic business (e-business):** This is any process that a business organization conducts on-line. Examples of major electronic business process categories include online purchasing, selling, production management, logistics, as well as internal communication and support services.
- **Electronic commerce (e-commerce):** This is the value of goods and services sold on-line.

“On-line” is key to the definitions of e-business processes and e-commerce (which is just a special e-business process). On-line means using electronically linked devices (e.g., computers, Internet-enabled cellular phones, personal digital assistants and so on) that communicate interactively over networks. The U.S. definition of on-line includes both open networks such as the Internet, and proprietary networks running systems such as Electronic Data Interchange (EDI). Manufacturing and wholesale trade industries had used EDI systems for online selling for years, while service industries adopted Internet systems much more recently. We decided to use a broader definition and to ask separate questions about the use of the Internet and EDI. We were concerned that measuring only Internet use would understate the economic activity of interest while attributing all effects of the electronic economy to Internet use could overstate the Internet's impact.

The new data show the importance of distinguishing between these networks in the U.S. E-commerce shipments in manufacturing accounted for 12 percent of the total value of manufacturing shipments, or US\$485 billion. Responding plants that reported on-line purchasing (e-purchases) or accepting orders on-line (e-shipments) were asked their primary network for making each type of transaction. One-third of responding plants used the Internet as their primary network for accepting online orders. These plants accounted for only 5 percent of e-shipments at responding plants, while plants primarily using EDI networks accounted for two-thirds of e-shipments.

4. INITIATIVES TO IMPROVE THE QUALITY OF INFORMATION

The U.S. Census Bureau took the lead in improving measurement of the U.S. electronic economy. Its E-business Steering Committee assessed the fit between the most urgent data needs and those that the U.S. Census Bureau was in the best position to meet. The committee recognized early on that providing data

describing the dimensions of the electronic economy and allowing analysts to infer its impact on the performance of the broader economy requires both collecting new types of data and improving and enhancing existing data.

In responding to that complex set of data needs, the U.S. Census Bureau undertook three major innovations in its measurement programs. Baseline improvements include straightforward changes to current data collection programs. For example, to describe the size and reach of the electronic economy, we need to ask respondents to break out activities, such as sales, by the electronic and non-electronic components.

The second group of improvements requires substantial effort, such as initiating new measurement programs, or an initial round of research to identify proposals for specific improvements. For example, estimating the impact of IT investment on the productivity of banks requires not only collecting new data on IT investment at banks, but also improving our measures of banking productivity. This in turn requires collecting better data on inputs and outputs in banking (many of which are poorly defined), improving banking price deflators, and other improvements.

The third group of improvements includes innovations in how the U.S. Census Bureau collects, processes, reports, and analyzes the existing and new data collections. These innovations provide additional information in novel ways without increasing respondent burden. They also provide the kind of feedback about the quality of the data, including its ability to meet rapidly changing user needs, that comes only from direct and continuing use of the underlying micro data to address user questions about the effect of the electronic economy.

Improving the quality of information about the electronic economy is clearly a huge undertaking. While many of the required improvements in data collection and measurement fall under the purview of the Census Bureau, many are the responsibility of other federal statistical agencies. In addition, the Census Bureau and other federal statistical agencies must weigh steps to improve measurement of the electronic economy against available resources and competing measurement needs.

4.1 Improving Baseline Data Collections.

The U.S. Census Bureau took a crosscutting approach to improving its baseline data collections from businesses. These extensions address what the steering committee determined was the most urgent data need: describing the size and scope of the electronic economy. New data from several such extensions are now available. Beginning with reference year 1998, E-commerce sales data have been collected on the Annual Retail Trade (ARTS), Annual Trade (ATS - Wholesale) and Services Annual (SAS) Surveys. E-commerce sales and on-line purchases data have been collected on the Annual Survey of Manufactures (ASM) since reference year 1999. The U.S. Census Bureau also collected data on the use of selected e-business processes in manufacturing for reference year 1999. A summary of the findings is available at www.census.gov.estats. E-Commerce sales questions will also be added to the 2002 Economic Census.

While retail e-commerce activities attracted considerable attention, the new data show that they remain a small fraction of overall retail sales, accounting for as much as 1 percent of retail sales only in the fourth quarter of 2000. Our new data show that e-commerce is much more important in other sectors. For example, e-commerce shipments in U.S. manufacturing accounted for 12 percent of the total value of manufacturing shipments. We can make some simplifying assumptions to estimate the shares of e-commerce in these sectors that are business-to-business (B-to-B) and business-to-consumer (B-to-C). Assuming all manufacturing and wholesale e-commerce was entirely B-to-B and all retail and service e-commerce activity was entirely B-to-C, and ignoring the definitional differences among shipments, sales, and revenue, B-to-B accounted for more than 90 percent of total U.S. e-commerce. This finding highlights the importance of collecting information about the electronic economy in many sectors, not just retail trade.

A related improvement is the new North American Product Classification System (NAPCS) that is being developed. NAPCS initially is developing classifications for products sold in four selected service sectors (information; finance and insurance; professional, scientific, and technical services; and administrative and

support, waste management and remediation) in the North American Industry Classification System (NAICS). NAPCS, as was NAICS itself, is being developed jointly with the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the statistical agencies of our North American trading partners. Several of these sectors, such as information and finance and insurance, are ones the electronic economy is expected to affect. Once the new product classifications are in place, they will provide the first product information available for these sectors.

Baseline improvements will include enhancements to the 2002 Economic Census. These improvements will increase the basic information the Census Bureau collects on core components of GDP and productivity estimates. That information includes the goods and services businesses use, and what they produce. The improvements should focus on sectors where measurement is currently weak (either because relatively little information is collected, or because of the presence of measurement challenges) and the electronic economy is thought to have a large impact (such as services; finance, insurance, and real estate; and retail and wholesale trade).

4.2 Research and Development

The Census Bureau has undertaken a number of research projects to find ways to improve the quality of its measurement program on the electronic economy. These projects draw on expertise from academia, the private sector, and other government agencies. Projects include research on the electronic economy's infrastructure, the usefulness of a supply chain survey, and the coverage of the electronic economy by the North American Industrial Classification System (NAICS).

The Census Bureau's E-business Steering Committee assigned a sub-group to examine the best way to collect information on the E-business Infrastructure. While most of the E-business Infrastructure consists of various types of capital equipment (e.g., computers, routers, fiber optic lines and so on), it also includes data about the human capital (skills) used in the electronic economy. One way to collect detailed information on these kinds of capital equipment would be through a supplement using the same frame and sampling methodology as the Annual Capital Expenditures Survey (ACES). This strategy has the advantage that the E-business Infrastructure data would be comparable to ACES capital data. The sub-group will involve key data users in further planning.

There is a perception that e-business is changing the nature of the supply chain for many goods and services. This is both of generic interest and a concern for data collection and interpretation. Fein, Solodar and Ruppertsberger (2001) recommend collecting additional data on supply chain activities and considering some classification changes. As a first step in implementing this recommendation, the U.S. Census Bureau plans to add several questions on supply chain activities to the 2002 Economic Census. It also is researching the concept, and potential data improvements, of a separate supply chain survey.

A key concern with the electronic economy, as well as other areas of the economy experiencing rapid change (e.g., biotech), is that current statistical methodologies, such as industry classification, are no longer appropriate. Research commissioned by the U.S. Census Bureau and conducted by Tarragon Consulting (2000) examined how well NAICS classifications work for the electronic economy. The conclusions were that NAICS did quite well. However, classification is difficult for some "networked" firms.

The establishment is the reporting unit in the Economic Census. A current initiative re-examines this practice for establishments owned by large companies operating in so-called "networked industries" such as telecommunications (Trimble 2000). In these instances, reporting practices make it difficult for these companies to supply establishment-level information. As a result, changes are being made to allow alternative reporting units for selected networked industries in the 2002 Economic Census. This is part of a larger ongoing program of cognitive research at the Census Bureau that seeks to assure that respondents know what is asked of them, and that they can provide the information (for example see Nichols, Willimack and Sudman 2000).

Increased detail on inputs and outputs is needed in baseline collections for sectors outside of manufacturing. The additional detail is needed to allow assessments of whether, for example, businesses conducting electronic commerce transactions or using electronic business processes use different mixes of capital, labor, and materials. While substantial progress is being made, developing good baseline measures of inputs and outputs in non-manufacturing sectors presents major challenges for statistical agencies (see, for example, Triplett and Bosworth 2000) that can benefit from additional research.

Finally, research projects at the U.S. Census Bureau's Center for Economic Studies (CES) and its Research Data Centers (RDCs) are examining the impact of the electronic economy with existing Census Bureau data (e.g., Dunne, Foster, Haltiwanger and Troske, 1999; Stolarick 1999, Doms, Jarmin and Klimek, 2001). These studies add to the literature on the impacts of the electronic economy, and these studies are important for two additional reasons. First, current efforts to improve measurement of the electronic economy cannot improve the data available to study prior years; existing data are all that are available. Second, it is important to know what current data collections can say about the electronic economy so that resources can be allocated more efficiently to any new measurement initiatives.

4.3 New Processes for Collection, Dissemination, and Quality Assessment

The U.S. Census Bureau also is innovating in how it collects, processes, and reports information about the electronic economy. On-line collection was introduced for a portion of the sample for the 1999 ASM Computer Use Supplement. Through its E-Stats program, the U.S. Census Bureau is experimenting with new approaches to integrating the data it reports from related surveys. Standard practice is for the responsible subject matter division to release reports on its own survey data. The new E-Stats paradigm, however, integrates the analysis and reporting of data from different subject matter areas to focus on their implications for measuring the electronic economy, and releases them jointly.

Many observers expect the major changes due to the electronic economy to result from new electronic business processes rather than from electronic commerce alone. Improved measurement of e-business processes will permit data users and researchers to quantify the importance of electronic business processes for productivity and economic growth. These measures can also be related to measures of electronic commerce and other important economic statistics to examine the impact of the electronic economy on the broader economy. Collecting information on business processes is a relatively new activity for statistical agencies, particularly outside the manufacturing sector, and presents many challenges (Fein *et al.* 2000).

New information about more than 25 electronic business processes was collected in the Computer Network Use Supplement to the 1999 Annual Survey of Manufacturers (ASM). Respondents' answers to questions about processes can be linked to the information the same respondents reported on regular ASM survey forms, such as the value of shipments, employment, and product class shipments.

The U. S. Census Bureau's E-business Steering Committee recognized that access to respondent-level data at CES and the RDCs will be an important method of generating new statistics and other estimates about the electronic economy³. This recognition places increased emphasis on the goal of ensuring that the underlying micro data about the electronic economy, as well as published statistics, are of high quality. It also leads to the development of an electronic economy research agenda, beginning with data from the Computer Network Use Supplement to the 1999 Annual Survey of Manufactures. The first products from this agenda are selected special tabulations and studies sponsored by the Manufacturing, Construction Division (MCD), often conducted jointly with CES. The first product was a preliminary internal analysis of some of the economic characteristics of plants that use a small number of these processes. A second product will be a series of detailed tabulations of responses to the supplement that will be available on the

³ CES and its RDCs will provide controlled access to qualified researchers to these new data on the electronic economy. CES maintains archived research versions of many U.S. Census Bureau survey and census micro data. These confidential data are available to U.S. Census Bureau researchers and to qualified external researchers. Access to qualified external researchers is granted for projects whose predominant purpose is to benefit the Census Bureau.

Internet. The first published product of this agenda (Atrostic and Gates 2001), models preliminary estimates of the use of selected computer networks in U.S. manufacturing. It finds that complex networks are used nearly as much in a few “old-tech” subsectors, such as chemicals and transportation equipment, as they are in the “high-tech” computer and electrical equipment subsectors that have experienced relatively high productivity growth. This finding, while contrary to conventional wisdom about the electronic economy, is consistent with two previous U.S. Census Bureau surveys of technology use in manufacturing that were limited to only five detailed industries.

Proposed research projects include additional analyses of the economic characteristics of plants using specific e-business processes and combinations of processes, and conducting such analyses separately for plants in more detailed subsectors, such as motor vehicles and aerospace product and parts within the transportation equipment subsector. A second group of proposed projects use the new e-business process data to extend existing analyses of plant and corporate behavior, such as whether these processes affect regional location decisions, ownership structure, worker skills, or the use of new workplace practices.

5. SUMMARY

The U.S. Census Bureau began its assessment and strategic planning for improving data on the electronic economy early in 1999. Those plans drew extensively on parallel assessments undertaken by other national and international statistical organizations. The U.S. Census Bureau led national and international efforts that developed comparable and workable definitions of the electronic economy. It identified key data gaps and implemented a number of innovations to meet the most urgent user needs for information on the size and scope of the electronic economy. Adding questions on electronic commerce (goods and services sold over computer networks) to existing data collections in several broad economic sectors integrates those measurement programs more closely, and leverages data the U.S. Census Bureau already collects. These extensions and enhancements also improve the quality of its data.

In determining the next steps in this information improvement initiative, the U.S. Census Bureau sponsored or collaborated in research projects taking advantage of expertise from academia, the private sector, and other government agencies. These projects assessed important facets of the current system, including the fit between the rapid change characterizing the electronic economy and classification systems such as NAICS, the ability of existing surveys to capture changes in the supply chain, and the best way to collect information on the e-business infrastructure. Research conducted at the U.S. Census Bureau, using both existing and newly collected data, provides new estimates of key aspects of the size, scope, and impact of the new economy. That research also contributes vital critical assessments of the quality of new data, and identifies new and continuing measurement needs. The U.S. Census Bureau continues to work with data users and with U.S., national, and international statistical organizations, to define user needs and priorities in this rapidly changing area. Its strategy is to keep its measurement program flexible enough to continue improving the quality of information available about the electronic economy.

Measuring the electronic economy touches on almost every aspect of the economy. No single statistical agency has the resources and technical expertise to independently resolve all the measurement issues and fill all the information gaps associated with measuring the electronic economy. Cooperation across statistical agencies is required. We invite our colleagues at the U.S. Census Bureau and at other statistical agencies, as well as data users and data providers, to provide feedback, corrections, and suggestions to help us continue to improve the quality of the information available about the electronic economy. Please direct your comments and suggestions to the authors.

REFERENCES

Atrostic, B.K. and J. Gates (2001), “U.S Productivity and Electronic Business Processes in Manufacturing,” IAOS Satellite Meeting on Statistics for the Information Society, August 30 and 31, 2001, Tokyo, Japan.

- Atrostic, B.K., J. Gates and R. Jarmin, (2000) "Measuring the Electronic Economy: Current Status and Next Steps," Center for Economic Studies Discussion Paper, CES-WP-00-10.
- Atrostic, B.K., A. Colecchia, and B. Pattinson (2000), "Defining and Measuring *Electronic Commerce*: A Discussion Paper," presented to the Working Group on Statistics on the Information Society, Eurostat, January.
- Doms, M., R. Jarmin and S. Klimek (2001), "IT Investment and Firm Performance in U.S. Retail Trade," mimeo, Center for Economic Studies, U.S. Census Bureau.
- Dunne, T., L. Foster, J. Haltiwanger, and K. Troske (1999), "Wage and Productivity Dispersion in U.S. Manufacturing: The Role of Computer Investment," mimeo, Center for Economic Studies, U.S. Bureau of the Census, Washington, DC.
- Fein, A., J. Solodar, and G. Ruppertsberger (2001) "The Changing Supply Chain: Challenges and Implications for Economic Data Collection," Pembroke Consulting, Inc., Philadelphia, PA. May.
- Fraumeni, B., A.M. Lawson, and G.C. Ehemann (1999), "The National Accounts in a Changing Economy: How BEA Measures E-Commerce," Paper presented at the Brookings Program on Output and Productivity Measurement in the Service Sector, Workshop on Measuring E-Commerce, September 24.
- Fraumeni, B., M. Manser and T. Mesenbourg (2000), "Government Statistics: E-Commerce and Electronic Business,"
- Haltiwanger, J., and R. Jarmin (2000), "Measuring the Digital Economy," in E. Byrnjolfsson and B. Kahin (eds.) *Understanding the Digital Economy*, MIT Press, pp.13-33.
- Mesenbourg, T.L. (1999), "Measuring Electronic Business, Definitions and Underlying Concepts," United States Census Bureau, September, <http://www.census.gov/econ/www/index.html>.
- Mesenbourg, T.L. (2000), "Measuring Electronic Business," presentation to COPAFS, March 10, <http://www.census.gov/econ/www/index.html>.
- Nichols, E., D. Willimack, and S. Sudman (1999), "Who Are The Reporters: A Study Of Government Data Providers In Large, Multi-Unit Companies," American Statistical Association Proceedings.
- Statistics Canada (1999), "A Reality Check to Defining eCommerce" report prepared by CGI for Statistics Canada.
- Stolarick, K.M. (1999), "IT spending and Firm Productivity: Additional Evidence from the Manufacturing Sector," U.S. Census Bureau, CES Working paper 99-10, October.
- Trimble, J. (1999), "Redesigning the Service Sector Statistics Program," presentation to the Census Advisory Committee of Professional Associations Meeting, October 21-22.
- Triplett, J.E., and B. Bosworth (2000), "Productivity in the Services Sector," presented at The American Economic Association meetings (January).
- U. S. Department of Commerce (1998), *The Emerging Digital Economy*, Washington, DC: G.P.O.
- U. S. Department of Commerce (1999), *The Emerging Digital Economy II*, Washington, DC: G.P.O.