Measuring the Digital Economy

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A. Introduction:

Many observers have noted the rapid growth of the broadly defined digital economy. Our focus here is to consider the data needs and measurement challenges associated with the emerging digital economy. One immediate measurement challenge is to define what one means by the digital economy for data collection and measurement purposes. Much attention is being paid to the ongoing and dramatic growth in electronic or e-commerce. This growth is, no doubt, facilitated by widespread access to computers and the Internet. At our jobs, home, and school, we work, communicate, study and play on PCs and the Internet. In addition, there is a growing sense that the nature of how goods and services are produced, the nature of goods and services themselves, and means by which goods and services are brought to market are changing at a rapid rate.

In spite of its rapid growth in recent years, we view the emergence of e-commerce as an important trend that is only part of the more general changing structure of the economy brought on by the dramatic changes in information technology (IT). The changes in the latter have been occurring over last several decades. Moreover, the U.S. statistical agencies are still addressing the challenges of adequately measuring the changes brought on by the IT revolution. Thus, for measurement purposes the challenges induced by the recent growth of e-commerce are closely linked to the ongoing challenges of measuring economic activity with changes due to advances in IT.

The banking sector offers an excellent example of some of the problems confronting the statistical agencies due to the IT revolution. The IT revolution has dramatically changed the nature of banking services with the introduction of electronic banking, ATMs and so on. Statistical agencies have grappled with how to define and measure output in banking for years and the IT revolution has simply made this problem worse. For example, it is clear that ATMs have increased the level of service offered by banks to their customers by allowing them to access their accounts 24 hours a day and 7 days and week, and by reducing the time they spend in teller lines. However, the value of these services is not directly measured in any official statistics, but the cost of installing the ATM networks is. Thus, we see that government statistics will understate the productivity increases in banking arising from investments in IT due to measurement problems.

There is widespread belief that significant changes to the U.S. statistical system are needed if we are to track the growth and impact of the digital economy. Good examples of the aspects of the digital economy that need measurement are provided in Department of Commerce (1997) report titled *The Emerging Digital Economy.* Some of these issues have been around for years, but the urgency surrounding them has increased due to the IT revolution and e-commerce. Examples include:

1. *The shape and size of the key components of the evolving digital economy such as e-commerce, specifically, and, more generally, the introduction of computers and related technology in the workplace.* [1]

[1] The latter objective is well-established in the measurement community. Unfortunately, our understanding of the impact of IT and computers on a variety of economic outcomes is still very incomplete.

2. *The process through which firms develop and apply advances in IT and the use of e-commerce.*
3. *The change in the structure and functioning of markets including changes in the distribution of goods and services and changes in the nature of international and domestic competition.*
4. *The social and economic implications of the IT revolution and e-commerce such as the effects of investments in IT on productivity.*
5. *Demographic characteristics of user populations*.

In the next section, we present in more detail what we believe are the data needs for the evolving digital economy. We then summarize the activities of federal statistical agencies and assess how well we are currently measuring the digital economy. We find that current data collection activities are inadequate and that a number of very difficult measurement issues exist.

Nevertheless, we think there are some practical and feasible things that statistical agencies can do to improve measurement of the digital economy and we offer several examples. However, we stop short of providing specific suggestions and instead provide a framework in which discussions about changes to the measurement system can take place. This process should begin soon, as there can be considerable lags between stating a data need, finding a way to address it, implementing a collection program and the time when users get the data.

B. Data needs for the information economy

In this section we outline what we believe are the important measurement issues surrounding the digital economy. We restrict our attention to the types of data required for public policy and general economic research and which are typically collected by government statistical agencies via nationally representative surveys of individual, household and business units. We recognize that there is a large data using constituency that requires different types of data than those collected by the statistical agencies. However, this constituency has traditionally been served by private sector sources and we believe this will continue to be the case.

Given the pace of technological change in IT and the myriad new ways (e.g., e-commerce) that businesses, households and others exploit this technology, it is understandable that the institutions which collect economic and demographic data are behind in measuring the magnitude and scope of IT's impact on the economy. But before discussing measurement issues directly related to IT and the digital economy, we would like to stress that continued and improved measurement of many "traditional" items is crucial for understanding the impact of IT on the economy. It is by relating measures of the changes in the quality and use of IT to changes these "traditional" statistics (e.g., productivity and wages) that we will be able to assess the impact of IT on the economy. For example, if we can not measure and value output in many of the service sector industries where IT is important, it will likely be difficult to show the impacts of IT. Therefore, a large part of any attempt to better measure the digital economy should include finding better ways to measure the activities of firms in the so called unmeasured sectors of the economy and improving the quality of our statistics for the measured (i.e., the goods producing) sectors.

There are three broad areas of research and policy interest concerning the emerging digital economy that require high quality data. First, is the question of the impact of IT on key indicators of aggregate activity such as productivity and living standards. Aggregate productivity growth slowed over much of the period where large investments in IT occurred, especially in a number of service industries, such as banking, that have had particularly large IT investments. A number of studies, at various levels of aggregation, failed to find a link between IT investments and productivity leading to the so called productivity paradox[2].

Several explanations have been offered to explain this paradox. One is that official statistics do not capture all the changes in output, quality and cost savings associated with IT and, thus, understate its impact (see Siegel and Griliches, 1994). Another, compares IT to other important innovations in the economy, such as electrification (see David 1990 and Greenwood and Yoruglu 1997), and notes that there can be considerable lags between investments and eventual productivity increases.

Recent studies using data from a variety sources have reported a link between IT and productivity[3]. These, combined with improved aggregate productivity performance of late, have lead some to speculate that the productivity paradox has been resolved[4]. While it is undoubtedly that case that several firms and industries have seen large returns on investments in IT, empirical evidence of the economy-wide impact so often hyped in the popular media is limited. A large part of this problem may be due to the inadequacy of the available data.

Box 1
Data Needs for the Digital Economy: Information Technology Infrastructure

We should measure the physical and software infrastructure of the information economy.

a. Measure investments in the physical infrastructure (e.g., IT equipment including computers, phone lines, switches, fiber optic and cable lines, satellites, wireless networks, LAN equipment and the like).
b. Measure investment in the software infrastructure.
c. Measure the capacity of the Internet of other communications networks.
d. Measure the actual traffic on these systems.
e. Measure depreciation in the infrastructure (both equipment and software) and how investments and depreciation act to change the capacity of the system.
f. We also need to have some idea of the IT and software components of "non IT" equipment such as computer numerically controlled machines.

[2] See, e.g., Solow (1987) and Berndt and Morrison (1995). Brynolfsson and Yang (1996) review the literature that examines the link between IT investments and productivity.

[3] See, e.g., Jorgenson and Stiroh (1995), Greenan and Mairesse (1996), Brynjolfsson and Hitt (1996), and Dunne, Foster, Haltiwanger and Troske (1999).

[4] An example of this can be found in a recent New York Times article entitled "Computer Age Gains Respect of Economists," New York Times, 4/19/99.

Box 2
Data Needs for the Digital Economy: E-Commerce

We should measure e-commerce by measuring

A. Business to business vs. business to consumer.
B. Digital vs. non-digital goods and services. Non digital products must be physically delivered to consumers. Digital products can bypass the wholesale, retail and transport network. Also, digital products may have very different (non-linear) pricing structures due to their high fixed cost - low marginal cost nature (see Shapiro and Varian, 1999). This may be important for computing valid price deflators and may make it difficult to use revenue based measures of activity levels).
C. Transactions vs. non-transactions (e.g., customer service, general info, bid posting and so on).

With the growth of e-commerce, particularly in business to business transactions, we are no longer just interested in measuring the impact of computers and IT on productivity within organizations. We now want to assess whether there have been measurable improvements in productivity from hypothesized improvements in information flows and reduced transactions costs across organizations conducting business via e-commerce. It will be interesting to see whether e-commerce is associated with measurable productivity gains in sectors/firms that rely heavily on e-commerce vis à vis those that employ e-commerce less extensively.

Of related interest are the implications of IT and e-commerce for the measurement of the capital stock -- particularly of equipment. Accurate measurement of the equipment capital stock is essential for understanding the impact of IT. Accurate statistics require measurement of equipment investment expenditures by detailed asset category, quality-adjusted deflators of equipment investment taking into account the advances in technology, *and* appropriate measures of the depreciation rates of the assets in question. In the case of IT, the measurement of the latter has become much more difficult due to rapid technological change (e.g., the pace at which the speed of successive generations of processors increase) and the associated rapid turnover of computer hardware and software (storage closets, attics and junkyards are increasingly full of surplus PCs that were on the cutting edge just a few years ago!). In addition to measuring the national capital stock, we are also very interested in understanding where (e.g., in what industries, geographic locations and types of firms) IT is being applied. This, in turn, provides a basis for evaluating the impact of IT on productivity as, in principle, it should be those sectors with the greatest advances in IT that we observe the greatest gains in productivity. An implication of this is that using accounting methods to estimate IT (or other types of) investment is insufficient since we need micro level data to perform these types of analyses. Therefore, data on IT investment must be collected from businesses and other organizations in every major sector of the economy.

Second, policymakers and researchers want to understand the impact of IT on labor markets and the income distribution[5]. Of particular interest here, is the issue of whether IT is increasing wage and income dispersion by creating groups of haves and have nots based

[5] Broader discussions of the issues here are contained OECD (1999) and DOC (1999).

upon whether they have the skills (and/or are employed in the appropriate sectors) that can take advantage of the advances in IT (see Autor, Katz and Krueger, 1997 and Dunne, Foster, Haltiwanger and Troske, 1999). Understanding this requires measuring the use of computers and other IT equipment in the workplace and relating it to wages. Also, we need to assess how the educational system is providing the next generation of workers with the skills needed to succeed in the digital economy.

Finally, policymakers and researchers want to assess the impact of IT on the way production is organized. Namely, they want to see how firm and industry structures have changed as IT has become a more important input to production in every sector of the economy (see Hitt and Byrnolfsson, 1997).

Box 3
Data Needs for the Digital Economy: Firm and Industry Structure

We should measure the impact of improvements in IT, software and the Internet on firm and market structures. More generally, we should quantify the changes in the location, industry, size and organizational structure of businesses, as well as the change of their input mix (e.g., capital, labor, inventories) and their relationships with other businesses (e.g., outsourcing).

Importantly, they want to understand the impact of the digital economy on market structure. The sense is that E-commerce, facilitated by the Internet, is dramatically changing the manner in which buyers and sellers find and interact with each other. Electronic networks (namely, Electronic Data Interchanges or EDIs) have existed for some time allowing many large companies to communicate with other large suppliers and/or customers. However, these networks were limited primarily to large firms with mainframe computers that communicated across expensive proprietary lines. The Internet allows anyone with a PC and modem to communicate with millions of computers all over the globe. This has potentially important implications for the nature and location of businesses – particularly those involved in the distribution of goods and services – and important implications for how markets work.

The ubiquitous availability of inexpensive and powerful computer hardware and software greatly reduces the costs setting up an "e"-business regardless of location. The open structure of the Internet now allows small firms to download specifications and bid on jobs previously available only to a select few via EDIs. This is likely to have significant market structure implications for a wide range of goods and services.

Box 4
Data Needs for the Digital Economy: Demographic and Worker Characteristics

We should measure the demographic and labor marker characteristics of individuals and workers and compare those participating in the digital economy vs. those not participating fully.

The Internet is also giving consumers more power in the marketplace by making information on the prices and qualities of a wide range of goods and services more accessible. Thus, price competition may be substantially enhanced by the ability of buyers to search for alternative suppliers of goods and services on the Internet.

Also, it is important to get a handle on the degree of substitution occurring

between goods and services purchased via e-commerce (e.g., over the Internet from Amazon.com) and similar goods purchased through traditional channels (e.g., from a Barnes and Nobles store). This substitution may be particularly important for "digital" goods and services. Digital goods, such as books, movies and music, are goods that can be delivered to customers in digital form over the Internet. Thus, its possible for these goods to completely bypass traditional distribution channels. This obviously has major implications for wholesalers, retailers and transporters of this class of products. It would be interesting then to examine the changes in how these products are delivered as the bandwidth of the Internet expands.

Box 5
Data Needs for the Digital Economy: Price Behavior

Price deflators for goods and services must be adjusted to reflect changes in quality induced by IT in order to measure changes in key aggregate statistics like productivity accurately. Measures of price differentials across goods and services sold by different methods (e.g., e-commerce vs. traditional methods) as well as measures of price dispersion across producers using the same method are of critical importance to understand the changing nature of competition from the digital economy.

Let us summarize the general data requirements for the digital economy. We must be able to produce the statistics on inputs and outputs required to construct measures of productivity at several levels of aggregation, to maintain the National Income and Product Accounts, conduct cross region and industry studies and perform micro data analyses. This would include constructing appropriate quality adjusted price deflators. Importantly, we are interested not only in understanding the implications for consumer and producer prices but to understand whether market competition has changed (e.g. have price-cost markups changed) as a result of e-commerce. We also need to understand the organization and location of production and where workers of different types work. This requires collecting, at least some, data at the sub-firm, or establishment level. We also need data on the human capital embodied in workers and on the occupations and industries they work in and the wages they receive. Finally, we need detailed demographic data on the US population and in particular of individuals and households that participate in the digital economy.

Taking for granted that we will continue to collect and improve our traditional menu of economic and demographic data and given the three broad research areas where we would like to assess the impact of IT, what are some of the specific data items we should be measuring in order to understand the emerging digital economy? We believe there are five areas where good data are needed. These are: 1) measures of the IT infrastructure, 2) measures of electronic or e-commerce, 3) measures of firm and industry organization, 4) demographic and labor market characteristics of individuals using IT and 5) price behavior. Boxes one through five give important examples of specific data items that policy makers and researchers might be interested in each of these five areas. We now move on to assess how well federal statistical agencies are meeting these data needs.

C. How well are we measuring the digital economy?

In this section we briefly review some of the data available to help researchers and policymakers understand the digital economy. We can not hope to survey all data sources.

Therefore, this summary pertains mostly to data collected by the Census Bureau and other federal statistical agencies[6]. Even though our survey of the available data is incomplete, there can be no argument that current data collection for the items outlined in the last section is spotty and inconsistent. The following is a summary of where data collection efforts stand in relation to the five data needs areas discussed in the last section.

Infrastructure: Our estimates of the impact of computers and related information technologies are based upon relatively limited data collections. As with most equipment investment, we measure the magnitude of aggregate investment in computers by examining the output of sectors producing such equipment and adjust for exports and imports (e.g., these statistics are generated from current industrial reports and export and import statistics as well as annual surveys of businesses). This methodology provides reasonable national totals of investment in computers and related technologies on a nominal basis. Further, much work has been done to generate quality-adjusted deflators for computers and to the extent that these deflators are reliable, a reasonable estimate of the national real investment in computers emerges. However, we know very little about what types of firms and industries are implementing these computers and other advanced technologies. In the past, the Annual Survey of Manufactures (ASM) asked about computer investment in economic census years (in 1977, 1982, 1987 and 1992). This question was not asked in 1997 but supposedly will be asked again in the future. The ASM also asks about purchased communication services and software purchases. Every five years as part of the economic census the Census Bureau conducts the Business Expenditure Survey (formerly known as the Assets and Expenditures Survey) for businesses in Retail, Services and Wholesale. The survey contains a question about spending on computer, peripherals and software. This survey is conducted at the Employer Identification Number (or EIN level which is a legal entity and in the case of many multi establishment firms corresponds neither to the establishment or to the company) level from a sample drawn from the Bureau's monthly survey programs.

The relatively new Annual Capital Expenditure Survey does not currently break out equipment investment by type of capital, but will soon begin to do so. This survey, however, is at the firm level. Therefore, it will be difficult to construct accurate statistics for investments in IT and other types of capital by industry and geographic region since many large multi-unit firms span several industries and regions.[7] The Bureau of Economic Analysis (BEA) produces capital expenditures and stocks by asset type by industry. However, the allocation of assets by industry are derived from Capital Flow allocation tables that are based upon strong assumptions and with limited data (e.g., the asset allocations by industry are based in part on the occupational mix by industry). In short, while we may have a reasonable national estimate of investment in computers, we know very little about investment in computers by industry or geographic area or firm type.

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[6] In several cases, data of relevance to the digital economy are available from sources outside the federal statistical system. These data sets tend to be rather specialized, however. Often they are based on non-representative surveys and rarely are they available to the wider research and policy communities.

[7] The 1998 survey does ask companies to break out equipment by both type of equipment an by industry – roughly at a 2-digit level.

There is little official data on investments in and the capacity of the telecommunications networks that support the Internet. There is also, little information outside of the ASM about investments in software. It is especially important to get a handle on the differential pricing and depreciation of software.

E-Commerce: There is even less information collected on the magnitude of e-commerce. It is important to emphasize in this regard that sales by e-commerce should be covered by economic censuses and surveys as the Census Bureau is able to maintain representative samples of all businesses including those engaged in e-commerce. However, in the past there has been no attempt to break out sales by method of selling in a systematic manner.

There are future plans to ask questions on annual retail surveys to collect this information so that e-commerce retail sales can be measured. While there is considerable interest in beginning to also measure business-to-business transactions, currently there are no questions on economic census and survey questions that could be used to break out e-commerce transactions between businesses. In the case of digital goods and services, there is currently no way to estimate sales delivered to consumers electronically versus those delivered using traditional methods (e.g., in store purchases or through the mail).

Firm and Industry Structure: The ingredients for characterizing the changing structure of markets in terms of the location of businesses, the industries in which businesses operate, and the size distribution of businesses are available in business lists maintained by federal statistical agencies. For example, the Census Bureau maintains the Standard Statistical Establishment List (SSEL) which is constructed from administrative data, economic censuses and surveys. The SSEL follows the universe of all establishments in the U.S. and is a very useful resource for keeping track of the changing demography (in terms of size, location and industry) of U.S. businesses. However, it is an underutilized resource for this type of analysis and can be used to quantify and assess the magnitude of such changes. For example, there is some sense that e-commerce has reduced entry barriers substantially allowing small businesses to compete in an unprecedented manner. The SSEL offers a comprehensive dynamic picture of all businesses (large and small) and thus is a superb resource for tracking the impact of the digital economy on small businesses.[8]

There are some challenges in the use of the SSEL for these types of analyses. First, the quality of such analysis depends critically on the quality of the industry and location codes in the SSEL. While the quality of such codes is relatively high for most businesses, the quality for new businesses and small businesses is lower. This could prove to be problematic for tracking the impact of the digital economy with its highly dynamic nature and purportedly large number of small start-ups. In addition, while the new North American Industrial Classification System (NAICS) offers much greater detail in terms of industries in the information and service sectors, it is unclear how easy it will be to track key aspects of the digital economy without additional modifications to our industry codes. For example, there are no current plans to classify businesses that primarily sell by e-commerce in a separate category. Instead they are grouped with mail order houses.

[8] There is an ongoing collaborative project between the Small Business Administration and Census to develop and use a longitudinal version of the SSEL to track the dynamics of small vs. large businesses.

Demographic and Worker Characteristics: The CPS (October supplement every 3 years) looks at household computer use. This information has enabled analysis of the impact of computer use on labor market outcomes, such as wages, and to better understand the connection between computer use and worker characteristics such as age, gender and education. The most recent supplement provides a substantial set of questions about the use of computers and the Internet at home, work and school. The CPS as well as the BLS Occupational Establishment Survey offers the potential to assess how the mix of occupations and, thus, skill types are changing in response to the emerging digital economy. An open question is whether the occupation codes need to be revised to reflecting the changing nature of skills and tasks due to the impact of the digital economy.

Price Behavior: Quality-adjusted deflators for computers have been in use for a number of years which has greatly helped in quantifying and understanding the impact of the IT revolution. In terms of the impact of e-commerce on output price behavior, little thought or effort has been devoted to this issue.

D. What can the Census Bureau and other statistical agencies do to improve our understanding of the digital economy?

It is clear from the discussion so far that there are many holes in the data collection efforts of the federal statistical system that need filling before a clear understanding of the digital economy can emerge. There are many difficult and long standing measurement and data collection issues that arise again in the context of measuring the digital economy. Important examples include defining and measuring output in the non-goods producing sectors, collecting establishment level data from multi-establishment companies and issues surrounding industry and commodity classification. Indeed, the digital economy has exacerbated many of these problems by spawning new products and services, new delivery methods and forms of communication, and improved data processing capabilities. The result is a rapidly changing business environment that poses many challenges to agencies not known for rapid change. We are optimistic, however, that there are several practical and feasible steps that agencies can take to fill some of these data holes. Below are some examples.

Infrastructure: We should consider improving how we measure investment and depreciation of IT and software. This would go beyond current efforts with the ACES to break out equipment investment by type of equipment. In particular, plant (or some other sub-firm) level measures are preferable in order assess the effects of these investments on productivity, employment, firm and industry structure[9]. Some of this could be accomplished by augmenting current data collection efforts. For example questions on IT investment could be added to the Economic Censuses. Annual plant level data could be collected for manufacturing via the Annual Survey of Manufactures. Outside of manufacturing other annual

[9] This is because many large firms span several industries (and sectors) and geographic regions. In addition, these firms account for a large share of investment in IT. Thus, it is not possible to get accurate measures of IT investment by industry or by geographic area. Clearly, we would like to have this ability.

business surveys[10] could be used to collect IT investment data. While we should try to improve measures of the IT infrastructure for all sectors of the economy, the manufacturing, services, wholesale and retail sectors should get the highest priority.

Unfortunately, many large multi-establishment firms find it difficult to report investment and other items at the establishment level. This is especially true outside of manufacturing. The Census Bureau and other statistical agencies need to work with businesses to get data at the lowest level of aggregation that firms can provide, and that allows that agencies to provide the richest possible data for research and policy analysis at a reasonable cost to the taxpayer.

E-Commerce: To get a handle on the prevalence and magnitude of e-commerce, we suggest that the Census Bureau include class of customer and method of selling questions on all Economic Censuses and Annual Surveys. These questions would break revenue out by the class of customer and the method of selling. Simple cross tabs could then provide estimates of business to business and business to consumer e-commerce, as well as traditional commerce. Questions of this type are typically only asked in the retail, wholesale and service sectors and are used primarily for classification purposes. But the Internet, catalogs and other direct marketing channels have increased the need for questions such as these in the goods producing sectors as well.

Classification efforts are particularly important for examining e-commerce. Under NAICS, businesses engaged primarily in Internet commerce are classified separately from traditional retailers. This is consistent with maintaining a "production" oriented classification system. However, we still want to know how many books are sold. Thus, survey forms for Internet retailers should break out revenues by product types.

The sense is that the impact of e-commerce on the markets for digital goods and services will be much larger than for goods and services that must be physically delivered (e.g., furniture, haircuts and pizza). Digital product products are characterized by high fixed costs (e.g., writing a "book") and low marginal costs (e.g., emailing a PDF file, see Shapiro and Varian, 1999). This has important implications for the operation and structure of the markets for these goods and services, for intellectual property rights, for local tax authorities and for international trade (the Internet has no customs posts). Thus, its important that we try to track the sales of digital goods and services by the method they are delivered. Currently, the limited bandwidth of the Internet limits this area of e-commerce. But improved technology will allow for more electronic delivery of these goods.

Finally, we might consider undertaking an occasional survey that examines e-commerce practices in the economy. This would include asking firms about how they use IT to communicate with suppliers and customers, whether they purchase and/or sell goods and services electronically and whether they use the Internet or other telecommunication networks for customer service and related tasks. This would also include surveying consumers on their electronic buying habits, perhaps via the Consumer Expenditure Survey. An important thing to accomplish with a consumer survey would be to compare prices paid for similar goods and services purchased electronically versus through traditional retail outlets.

Firm and Industry Structure: The Census Bureau and the Bureau of Labor Statistics already has much of what is required to examine the impact of investments in IT and the

[10] The ASM is a plant level survey. The annual surveys outside of manufacturing typically use an Employer Identification Number based unit of observation and, therefore, are not exactly plant or firm level surveys.

growth of e-commerce on the structure of firms and industries. In particular, the Bureau's Standard Statistical Establishment List has basic data on employment, payroll, industry and location for the universe of employer business establishments in the U.S. The data can be linked to other Census Bureau establishment and firm level surveys. Thus, one could compare how the structure of IT intensive firms changes over time relative to less IT intensive firms. An important question in this area is whether lower transactions costs associated with business to business e-commerce are leading to flatter firm organizational structures. Thus, by combining data collected following our suggestions above with the SSEL, we would expect to see firms that use e-commerce extensively shedding establishments that are outside the firm's main line of business, but support those that are. Instead of relying of internal sources of supply and support, firms that exploit e-commerce, with its associated lower transactions costs, now out-source these functions to other firms.

Another important issue is to see how the different marketing channels made available by electronic networks, such as the Internet, are changing the structure of markets. Not only can firms set up an electronic store front on the Internet and serve customers all over the world, but goods producers can market directly to consumers and avoid the traditional distribution channels. Thus, traditional boundaries defined by geography and industry are being blurred. The SSEL linked to surveys asking about class of customer and method of selling is the best way to see how the structure of the economy is shifting from the traditional model to the digital model.

Demographic and worker characteristics: We need to understand how both consumers and workers in the digital economy differ from those in the traditional economy. The Consumer Expenditure Survey should be modified to better describe the digital consumer. First, household spending on computers and IT equipment and related expenditures (e.g., fees for Internet access) should be broken out separately in the CES. Next, the CES should ask about the magnitude and nature of household electronic purchases (e.g., how much was spent and on what goods and services). In a similar vein, special supplements to the Current Population Survey should continue to ask questions about computer and Internet use at home, school and work. The precise nature of these questions should evolve to help characterize the evolving role of computers and the Internet in the work activities of the worker.

Also, just as the industry coding requires further consideration, occupation codes should be examined to determine whether they need to be modified to reflect the changing structure and tasks of the workforce in response to the emerging digital economy. Such modified occupation coding and related workforce composition change questions is relevant not only for household surveys but also for business surveys (e.g., the BLS Occupation Establishment Survey) that seek to measure and characterize changes in the structure of the workforce.

Price Behavior: The IT revolution has changed the way businesses operate and altered the nature of the goods and services produced. There is a need to quantify the quality changes in goods and services introduced with the emerging digital economy. In addition, quantifying the changes in the nature of competition that are likely with the emerging digital economy is important. For capturing quality change, information about the characteristics of goods and services sold must be collected. Understanding changes in the nature of competition requires collection of information about pricing of goods sold via the Internet and the same goods sold via more traditional methods. In this regard, it would be useful to quantify how price-cost markups have changed and how price dispersion across sellers of the same product varies by method of selling and/or delivery, in the case of digital products. Since

prices are traditionally collected by the BLS for the CPI and PPI programs, coordination between BLS and Census about method of selling and pricing behavior seems essential.

Other Areas; Finally, we would like to point out some more general ways that the federal statistical system could improve measurement of the digital economy. First, we should improve our ability to measure output and productivity in the non-goods producing sectors. Second we should continue to refine our industry, product and input classification systems and increase the resources devoted to assigning establishments and businesses to the appropriate category. Third, increases in the resources devoted to developing and maintaining a master list of business establishments, such as the SSEL, with high quality industry, location, business age and size information is required. A high quality and appropriately detailed business list is an invaluable tool for providing a comprehensive perspective on the changing landscape of business activity brought by the emerging digital economy. Fourth, many questions about the impact of the digital economy can only be addressed using micro data on businesses and households. This is because using the micro data permits controlling for relevant worker and business characteristics and because a useful means of assessing the impact of IT is to look across businesses and workers that have differentially adopted new processes and differentially produced new products and services. Moreover, as discussed above, linking comprehensive files, such as the SSEL, to micro data from specific targeted surveys offers the ability to shed light on how changing business practices have influenced firm and industry structure. In a related manner, since the digital economy is having a profound impact on both businesses and the workers within those businesses, this is an area for which the newly developed (and proposed) databases that link employer-employee data are especially valuable.

E. Discussion and Conclusions

The ubiquity of computers and the Internet at home, school and work is creating a sense that the economy is changing in fundamental ways: in the way that goods and services are produced, distributed and sold, and in the training and skill requirements of the work force. While the ubiquity of IT is self-evident, our ability to quantify its impact on the economy is limited by the nature and types of data currently being collected by federal statistical agencies and other sources. There are a number of unresolved conceptual questions that exacerbate the measurement difficulties. For instance, the IT revolution is closely connected to growth of sectors of the economy (e.g., services) which we have traditionally struggled to measure.

The emerging digital economy is forcing the statistical agencies to rethink how they measure the basic building blocks of our national accounts: outputs, inputs and prices. Some progress has been and is being made on refining the measurement of individual components (e.g., the national investment in computers taking into account changes in computer quality and the fraction of retail sales accounted for by e-commerce). Clearly, policy and research needs should direct further efforts by statistical agencies to improve data collection and measurement of the emerging digital economy. In this paper, we have outlined many of the issues involved in improving our measurement of the digital economy. However, while policymakers and researchers have an insatiable appetite for data, concerns about respondent burden and the resource costs of collecting data cannot be ignored.

It is not likely that all the suggestions that we, or other observers, offer can be implemented. Therefore, realistic priorities must be set by the data using community. We

suggest that actual suggestions for changes to the data collection programs at U.S. federal statistical agencies be made within the following framework:

- Plans to measure the digital economy should complement the basic and long-standing measurement programs of the U.S. statistical system that measure the characteristics, inputs, outputs and prices of businesses, and the characteristics and activities of individuals and households. The focus should on measuring changes in the quality, and use in IT and its impact on all sectors of the economy. Special focus to be to improve measurement in those sectors where measurement has traditionally been difficult and that have witnessed large investments in IT.

- Plans to measure the digital economy should leverage existing data resources in a variety of ways including the: (i) Development and use of underutilized administrative data sources, such as the SSEL; (ii) Addition of supplementary questions to existing survey and census forms; (iii) Encouragement of micro data development including linking data from different sources and sharing data across different U.S. federal statistical agencies.

That is, we suggest an incremental approach that modifies and keeps intact our basic system for economic and demographic measurement.

In spite of this apparent caution, it is also important to recognize that making changes in the basic data collection plans by the U.S. statistical agencies is a very slow process. For example, the new industrial classification system, NAICS, is being implemented by the statistical agencies over a 7-year horizon and, even though it is a great advance over the prior system, it does not adequately capture the changes emerging from the growth of e-commerce. Moreover, plans are being made now for the next Economic Census in 2002. The inherently slow process of altering the course of U.S. data collection implies that, unless we make progress in our thinking and plans now, we may find ourselves with relatively little information about the magnitude, scope and impact of e-commerce for a decade or more.

Put differently, U.S. statistical agencies need to set priorities now in order to implement specific data collection plans. This paper intentionally falls short of setting these priorities and offering detailed recommendations. Instead, we have sought to provide a menu of the measurement concerns and stressed some general considerations that should be taken into account in planning how to improve measurement of the digital economy.

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