The State of Data for Services Productivity Measurement in the United States

Jack E. Triplett and Barry P. Bosworth[1]
Brookings Institution

ABSTRACT

In this article, we present a brief history of the development of services industry data in the United States, review the substantial progress that has been made over the past decade and a half, and present recommendations for needed additional improvements. We conclude that the state of U.S. data for services industry productivity measurement is far better than it was even around 1990. However, our list of more than 40 suggested improvements indicates that, despite the substantial progress the U.S. statistical agencies have made in a relatively brief time, much more work needs to be done. The size of the services sector in GDP and its importance as a contributor to recent productivity advance justifies a further expansion of resources to bring the measurement of services industries fully up to the standard met by the goods-producing industries.

LABOUR PRODUCTIVITY (LP) IN THE United States grew much faster after 1995 than earlier, and continued to advance after 2000 at roughly the same rate (Table 1). In Bosworth and Triplett (2007), Triplett and Bosworth (2004), and Triplett and Bosworth (2007), we showed, using data from the Bureau of Economic Analysis (BEA) industry accounts, that two major sources accounted for accelerating LP growth after 1995:

- Increased capital per worker. From 1995 to 2000, capital deepening was mainly in information technology equipment (IT), a finding present in the work of many others. But after the dot com collapse, increases in non-IT capital per worker contributed to U.S. LP growth, offsetting a reduced contribution made by IT investment.
- An unprecedented acceleration in multifactor productivity (MFP) growth in the services industries.

The period around 1995 marked a great transformation in the performance of U.S. services industries. Over much of the postwar period, services industries experienced stagnation in productivity growth: Services MFP grew only 0.5 per cent per year for 1987-1995, in the Bureau of Economic Analysis data currently available (Table 1). However, services MFP growth post-1995 was more than twice as high as between 1987 and 1995, and post-2000 it grew at three times its pre-1995 rate. Indeed, services MFP is the only major contributor to LP growth whose contribution increased after 2000. In our view, the post-1995 and post-2000 U.S. productivity expansions were similar, not dissimilar (as has sometimes been written else-

1 The authors are Nonresident Senior Fellow and Senior Fellow, respectively, at the Brookings Institution, Washington, D.C. Email: jtriplett@brookings.edu, bbosworth@brookings.edu.

Table 1
Sources of Labour Productivity Growth, U.S. Nonfarm Business Sector, 1987-2005
(average annual rate of growth)

	1987-1995	1995-2000	2000-2005
Labour productivity	1.4	2.5	2.5
Capital contribution	0.5	0.9	0.8
Of which: IT	0.4	0.8	0.5
Multifactor productivity	0.9	1.6	1.7
Of which: Computers	0.3	0.7	0.3
Services	0.3	0.9	1.1

Source: Triplett and Bosworth (2007).

where), in that in both periods the contributors were increased capital per worker and advancing MFP in services industries.

The European Union, taken as a group, did not experience similar services industries productivity growth, though some individual countries did.[2] Canada also lagged in services MFP growth.

Analysis of productivity growth is very demanding of high-quality data, particularly at the industry level. It is natural to ask whether differential U.S.-E.U. services productivity growth comparisons are biased or illusionary because of data differences across countries. The best answer at the moment seems to be "no" (Inklaar and Timmer, 2006). However, the stage of data development for industry productivity analysis differs greatly among OECD countries, and the effect of data comparability on international comparisons deserves much more attention. In this article, we review and assess the U.S. data on services industries from the viewpoint of productivity research. In the first section we provide a brief history of data development in services industries in the United States. The second section presents a recent assessment of U.S. services data. In the third section we review other measurement issues of relevance to services industries. The fourth section concludes.

A Brief History on Services Data Development in the United States

Collection of industry data in the United States began in 1810. They were originally collected as a by-product of the decennial population census, but the usefulness of industry data before 1860 was greatly diminished by various under-reporting and tabulating problems (most of the early history in the following was drawn from Micarelli, 1998). Not surprisingly, these early collections emphasized goods-producing industries. However, foreign trade establishments, lumber yards and grocery stores were surveyed in the 1840 census, and the 1860 census covered new technologies in transportation and communications (railroads and steamboats, telegraph and telephone). An attempt to collect data on the insurance industry failed in 1860, in part for conceptual reasons (150 years later there is still conceptual controversy over the appropriate measure of insurance output--Triplett and Bosworth, 2004, chapters 5 and 6). Most of the 19th century collections gathered information on labour, capital (usually machinery in place) and purchased inputs, as well as output.

In the twentieth century, collection of industry data became a Census Bureau program separate from the population census, and industry censuses were carried out with greater frequency. Again, data for goods-producing industries were primary, but scattered services industry data were collected, as for example electric power generation in 1900, steam laundries and butchers in 1910, wholesale and retail trade (the latter defined to include restaurants and car repair shops) and hotels in 1930, followed by "services, amusements, and hotels" in 1933. A major increase in funding for the 1935 Business Census (as it was then called) permitted a great expansion intended to cover the entire

2 On this point, see O'Mahoney and Van Ark (2003), Inklaar and Timmer (2008), and especially Inklaar, Timmer, and Van Ark (2008).

economy, including all services industries. The 1935 census was not entirely successful, probably in part owing to the difficulties of designing and managing such a large increase in scale in a short planning interval. For 1937 (the Business Census having become a biennial effort) the whole effort was cut back to manufacturing (351 industries), though wholesale and retail trade and "selected" services industries were restored in the 1940 census. Up to 1940, then, services statistics were collected periodically and sporadically, but neither systematically nor in a manner that yielded linked time series.

The first postwar economic census, the one for 1947, was purely a Census of Manufactures. It is not entirely clear (to us at least) whether this reduced focus was induced solely by resource limitations or because the value of data on non-goods producing industries was under appreciated.[3] As part of a 1948 proposal to reduce the periodicity of the Business Census to five years (from its pre-war biennial cycle), an annual survey was introduced, but this was also restricted to manufacturing (it became the Annual Survey of Manufactures, or ASM).

Thereafter, through the 1950s and 1960s, Economic Censuses contained data for "selected services industries," and for retail and wholesale trade, but annual data were collected only for manufacturing and mining. At several points, Congress refused to fund data collection outside manufacturing and only in 1963 was the first Census of Transportation conducted (by then the railroads, a new technology when data were initially collected 100 years before, held a declining share of transportation, and steamships were essentially gone). For the 1967 Census, coverage outside the good-producing industries supposedly expanded but still included only "selected services industries" plus wholesale-retail and transportation.[4] The list of industries had huge gaps — for example, the Business Census covered no part of medical care. The Census Bureau collected a fair amount of product detail in its receipts data (for example, auto repair shops receipts distinguished body repair, brake repair and so forth and law firms reported receipts from domestic relations, real estate, corporate, and so forth). However, the data for only a few service industries included information on purchased inputs and for most of them, even labour data were missing (for example, the lawyers reported employment, compensation, and nonlabor expenses, but the car repair shops reported only receipts).

On the other hand, throughout all this period data on employment, hours and average hourly earnings were available by industry from the Bureau of Labor Statistics. Joe Stone and Ollie Ballard (1983) showed that quarterly earnings time series for nearly all services industries — including services narrowly defined, plus transportation, wholesale and retail trade, and finance — extended back to 1947. The same data set included employment. Stone and Ballard also documented that, with the exception of a few transportation industries, BLS had no price indexes for services industries (and even as late as the 1980s, when they were writing, no plans to do any).

Thus, by the end of the 1960s U.S. services industry data consisted of Economic Censuses every five years for a small number of industries, with no annual surveys, plus employment and

3 For the latter perception, Fuchs (1969:1-2) blames, in part, economists from Adam Smith on.

4 By 1967, the list of "selected service industries" yielded reports on the following (U.S. Census Bureau, 1969): advertising agencies, architectural and engineering firms, automobile and truck leasing, automobile parking, automotive repair and service, bowling alleys, commercial research and testing labs, credit reporting and collection agencies, dental labs (but not dentists!), hotels and motels, laundries and dry cleaners, motion pictures, law firms, photographic studios, spectator sports, travel agencies, and truck and bus carriers (but only the non-regulated ones).

earnings on a quarterly basis for nearly all services industries. Even where current-price output measures could be constructed (over five year intervals) by interpolating from Economic Census data, no services industry deflators existed and constant price measures were usually estimated with proxy measures of various kinds, as explained by Marimont (1969), or by deflation by components of the Consumer Price Index.

The situation was a bit better than it seems from this summary because for services industries that were regulated (transportation, utilities, banks, and to an extent insurance), the regulatory agencies collected a great amount of data, which was used for estimating output. Such secondary data, however, have major disadvantages because they often do not correspond to what is needed for economic analysis, particularly for computing productivity. Fuchs and Wilburn (1967) provides probably the best assessment. He determined that because of data limitations he could estimate LP growth only for ten retail industries and eight services industries.[5]

It is sometimes said that no services data exist for this period. This statement is not strictly correct, but it is not far wrong, either.

The non-goods producing industries first surpassed fifty percent of U.S. employment in the 1940 Census. Whatever their share of output thirty years later, the absence of data on them did not mean that services production could be ignored in the preparation of national accounts. Marimont (1969) summarized the methods then used by BEA's predecessor organization for estimating services industry output — actually, industry estimates at that time only included value added, often called "net output" in the language of the day. A number of them were unpublished, existing only in staff worksheets.

Marimont (1969:25) listed 19 services industries for which he presented methodologies. He reported that for 12 of them, real output (that is, real value added) was produced by deflation, and for the other seven, real output growth was obtained by extrapolation. Of the latter group, four were extrapolated by employment (brokerage, insurance agents, miscellaneous business services, and miscellaneous repairs), one by output (hotels, by room rentals) and two by value added (this method is not explained). Employment extrapolation means that labour productivity is unchanged, tautologically, unless some judgmental productivity estimate is applied to employment growth to obtain output growth, which was apparently done. "In some cases, the lack of suitable data has been dealt with by making assumptions for output per labor input, price relationships, etc." (Marimont, 1969:18). Presumably, an LP adjustment for a services industry would be based on LP growth in manufacturing, since that was the only sector for which LP estimates were prepared at that time.

It turns out that the 12 "deflation" cases were not on much better footing, conceptually. All or part of seven of these industries were deflated by an earnings index — deflation by labour earnings, as extrapolation by labor quantity, yields unchanged LP, unless adjusted judgmentally. And even in the other cases, the story is mixed at best. For banks, Marimont reported that the implicit deflator was the ratio of current dollar interest to constant dollar interest--but constant-dollar interest was not produced by a price index for interest, but rather by the overall CPI (Marimont, 1969:27). The same aggregate CPI deflator produced the constant price output series for credit agencies and investment companies (old SIC 61 and 67), and formed part of the

5 Fuchs' list of services industries included: auto repair, barber shops, beauty shops, dry cleaning, hotels and motels, laundries, motion picture theaters, and shoe repair. It is curious that Dean and Kunze (1992, table 2.4) list BLS LP measures extending to 1967 for only three of these — hotels and combined laundry/dry cleaning, though by 1973 three more existed.

deflators for several other industries. Using the overall CPI or the overall GDP deflator for the output of an industry biases the industry's productivity rate toward the aggregate rate (since any industry relative price change caused by its own productivity growth is lost).

Only a small number of industries were deflated by price indexes that pertained to their own output. For these, a component of the CPI was used or a price index from a component of Personal Consumption Expenditures (which mostly used CPI components in whole or in part); such CPI deflated industries included all or part (mostly part) of personal services, auto repair, motion pictures, real estate, and medical care. The CPI price indexes were employed because at that time, the old Wholesale Price Index (now the Producer Price Index) covered only goods-producing and some transportation industries.

Of the 19 industries, then, only the latter group properly qualify as deflated output, and then some of them only in part. Moreover, even for these industries value added was deflated by an output deflator, rather than produced by double deflation of outputs and inputs, and the deflators were mostly CPI components, which do not necessarily measure industry output prices. A formidable list of reservations indeed.

Griliches (1992a:3 and 5) pointed out that services LP growth implied by national accounts data did not trail goods sector LP growth in the early postwar period (up to 1969). This result appears a consequence of the data construction, if not merely a coincidence. No confidence can be placed on these early services sector productivity numbers, and no better ones can be produced short of innovative data developments by economic historians.

Mohr (1992) updated Marimont's study from the vantage point of twenty years on. He presented the first stage of a BEA project to improve its industry accounts, and in the process critiqued shortcomings in BEA's former methods. His critique goes far beyond that of Marimont and in itself shows that a great amount of improvement had taken place. Where none of Marimont's 19 services industries were estimated with double deflation, Mohr reported that his "first stage" of improvements had raised that to 23 of 33 services industries, accounting for 80 percent of GNP generated by those industries. He specifies that improvements in the Census Bureau's coverage of services contributed greatly to the feasibility of BEA's project.[6]

Yet, the refrain was similar: Too little data were being produced by the primary statistics gathering agencies, mainly the Census Bureau and the BLS PPI. Mohr's data improvement agenda (Mohr, 1992:66) included: expand the Economic Census coverage of services industries, expand collection of data on inputs, especially purchases by services-producing industries and of purchased services inputs by other industries, increase the amount of detail on services industry outputs, and augment the BLS PPI program to cover more services industries.

Among several "outside" evaluations of the BEA industry program around that time, Baily and Gordon (1988) reviewed the consistency of industry data for productivity analysis. Though they were writing before completion of Mohr's first-stage improvement project, they were not positive, and pointed to many inconsistencies. Griliches (1992b, 1994), also reviewed the state of the data on output and productivity measurement in the services industries and found many problems. There is no reason to quarrel with either of these assessments. Improved they might be, but the U.S. data available for analysis of services productivity remained in doleful condition.

6 Obtaining Congressional funding for Census collection of services statistics was largely the work of Harry Freeman and the Coalition of Services Industries.

Recent Assessments of U.S. Services Data

Had U.S. services data remained in the state it were in when Mohr, or Baily-Gordon or Griliches were writing, we might not have learned about the remarkable post-1995 turnabout in services industry productivity growth, or we would have learned about it only long after.[7] The statistical agencies have accomplished a tremendous amount over the past decade and a half, beginning roughly with the "Boskin Initiative," former Council of Economic Advisor (CEA) chairman Michael Boskin's effort to improve services sector data.[8]

The major improvements include the following:

- The Bureau of Economic Analysis has made vast improvements in the industry accounts, which now include (for more than 60 industries) measures of output and intermediate inputs (not just value added, as in the old days). The BEA industry accounts can be linked to BEA capital stock and (with some difficulty) to capital and labour services estimated by the Bureau of Labor Statistics.
- The BLS Producer Price Index (PPI) program has extended its price measures to cover an ever-growing number of services industries. The PPI has not only moved into an area that needed attention, it has done so with noteworthy innovation and commendable professional analysis.
- The Census Bureau enlarged the coverage of the periodic Economic Censuses in 1992, and expanded its annual services surveys. These expansions generated additional information on the outputs of services industries and on purchased services inputs.
- Continuing work on deflators for high-tech capital goods has been carried out by BEA, BLS and the Federal Reserve Board. Services industries purchase the major share of IT and other high-tech capital, and the improvements in the deflators have made it possible to estimate the impact of IT investment on labour productivity in services (and in goods-producing) industries.
- BEA greatly improved its measures of capital stock, especially by modernizing its measures of depreciation, and BLS has used those improved capital stock measures to estimate capital services. Thus, we now have capital services measures for all using industries, and the capital services measures distinguish between different types of capital, such as IT.
- Underlying some of these data developments is the new North American Industry Classification System (NAICS), which created a rationalized industry classification with an enlarged list of services industries, and the subsequent North American Product Classification System, which initially focussed on creating meaningful services product detail (which did not exist before NAICS).

However, major lacunae remain in services measurement. Our finding of an unparalleled expansion of services industry MFP growth in the United States is really a call for improving the services data: It is well known, at least since the pioneering work of Jorgenson and Griliches (1967), that errors of measurement, particularly imperfectly measured inputs, pour inappropriately into measured MFP growth. We need improved services data to understand services productivity growth.

With the background of the substantial improvements that have been made, and continue to be made, it is appropriate to assess

7 The post-1995 services productivity acceleration was not a spurious product of data improvement because the major improvements have been pushed back to at least 1987. However, comparison of recent U.S. services productivity growth with the more distant past is confounded by differences in data regimes, which is why we have not tried to extend our own analysis before 1987.

8 See Leeuw, Mohr and Parker (1991) for a description of this initiative.

where data development should be heading for continued improvement in services productivity measurement. A substantial amount of material developed in the Brookings Institution Program on Economic Measurement (which we summarized in Triplett and Bosworth, 2004) permits us to assess the state of data in services industries as of the ending of that program. More recently, Atrostic (2008) has evaluated data needs for innovation studies, including but not restricted to, data on services industries. We make use of these two reviews in this section. Later in this article we discuss recent issues that do not fit readily into the same contexts.

The Brookings Project on Economic Measurement

Triplett and Bosworth (2004) capped the five-year Brookings Institution Program on Economic Measurement. The program hosted 15 workshops, each one devoted to a services sector measurement topic—measurement problems in specific industries, such as the output of retail trade or of transportation, or discussion of some issue that affects services industries broadly, such as the workshop on deflators for high tech equipment. Each workshop contained presentations from academic and research institution economists and also presentations from the statistical agencies.[9]

Triplett-Bosworth Detailed Data Recommendations Table

Chapter 11 ("Data Needs") of Triplett and Bosworth (2004) lists major data recommendations, for the most part ones that cut across services industries. Other, more specific, recommendations occur in the other chapters. Table 2 provides a summary. When read in conjunction with the list of agency accomplishments, the table provides our assessment of the state of measurement in services industries at the time that the Brookings Program on Economic Measurement ended. Notes in the right-hand column of Table 2 record where the agencies have made additional improvements in the interim. No doubt some relevant work in statistical agencies has escaped our attentions.[10]

Although the first 18 items in the table have some priority because they are, for the most part, cross-cutting matters that affect a large number of services industries, we do not rank our recommendations. We did not try to set priorities for the agencies, but rather gave them a wish list that arises out of the needs for productivity research.

The list is obviously a list of data needs for productivity measurement and analysis and takes no account of priorities for other purposes. For example, Census and BEA put quarterly measures of services output, needed for quarterly GDP estimates, ahead of expansion of detail (particularly, of purchased inputs by services industries) in the annual services industries surveys. The latter would have ranked higher for productivity analysis. We do not necessarily contend that the BEA and Census decision was the wrong one (though we wish that it had been more widely discussed). Rather, we are pointing out that data needs and priorities may conflict among important uses of services data. Productivity analysis, though an important topic and one that provides

9 The full list of workshops, with the names of participants, appears in Appendix B of Triplett and Bosworth (2004). Many of the papers are posted on the Brookings Institution website: http://www.brookings.edu/es/research/projects/productivity/workshops.htm. Because the comments, general discussion, and exchange of views at the workshops became so valuable a part of their output, Triplett and Bosworth prepared summaries of most of them; the summaries are also posted on the Brookings website. The content of these summaries, in turn, combined with conclusions from our own research, informed the data critiques and needs discussions in the individual chapters of our book.

10 We appreciate reviews of the information in this table by Roslyn Swick and Michael Holdway of BLS, Ruth Bramblett of BEA, and Mark Wallace of the Census Bureau, who have updated the agency plans in the "work underway" column.

Table 2

Summary of Data Recommendations

(from Triplett and Bosworth (2004), Chapter 11 and Individual Industry Chapters, Updated in February 2008)

Change	Agency	Impact	Status or work underway
1. Continue and accelerate PPI indexes for services	BLS	A major source of improvements so far, much left to be done	In progress
2. Continue and accelerate Census collection of inputs for services industries and of purchased services for all industries	Census	A major source of improvements for MFP and for GDP, much to be done	Census-BEA agreed input list added to Annual Survey, but funding grossly inadequate
3. Integrate I-O and GDP accounts	BEA	Remove inconsistency in estimates of VA and intermediate inputs	Partial in 2004, further work underway
4. Integrate BLS and BEA output measures	BEA/BLS	Remove inconsistencies, rationalize and improve output measures	Partial; report forthcoming
5. Allocate resources to negative productivity growth industries	All	By resolving puzzles, improve output and input measures	Some work done in BEA
6. Change hours measures to all employees, rather than (as in the past), production and nonsupervisory wkrs	BLS	More meaningful measure, better hours by industry	Done, data forthcoming
7. More detail, better classifications for IT products	Census/BEA/ BLS	Improve high tech deflation; independent of improving deflators	NAPCS detail in 2007 Census
8. Research on capital flow table methods	BEA	Allocation of capital services by industry is inexact, needs improvement	Review of Statistics Canada method by BEA
9. Implement NAICS in industry tables	BLS/BEA	Will (finally) create industry file by new (1997!) classification system	Done
10. Create additional SIC-NAICS bridge tables	Census/BLS	Permit consistent backward extrapolation of NAICS industry series	Partial, by FRB
11. Bring medical equipment into investment component of NHE	CMS	Close gap, equipment not in NHA definition of investment	Done by BEA, adopted by CMS
12. Improve medical price and output measures	BLS/BEA/ CMS	"Quality adjustments" for improvements in medical treatments	Much work remains; PPI work underway
13. Combine cost of disease and NHA accounts	CMS	Closes missing dimension in NHA, shows what money is spent on, links expenditures with economic and medical research	Rejected by CMS (but being addressed by BEA); 2007 Census collected ICD detail
14. Research on output concepts for business services	BEA/BLS	Improve output measures	Some by BLS PPI, much work remains
15. Integrate business services inputs forward to using industries	BEA	Insight into output measurement problems; for intermediate purchases, "evades" output measurement problem	None
16. Change SNA concepts for finance and insurance	BEA	More realistic output concepts will improve output measures; in particular, risk is central to finance and insurance, concept should focus on how to measure it and incorporate risk into output, not (as in present SNA and NIPA) how to exclude it from output	None, BEA does not agree
17. Research on output concept for SNA 'margin industries' (trade, finance and insurance)	BEA	Determine if gross margin (and analogs) provides advantages for measuring output, compared with usual gross output concept	BEA paper presented at 2006 NBER workshop
18. Develop better self-employment income methods	BEA/BLS	Split into labour and property income problematic, affects K and L shares	None
Some of the following, from the individual industry chapters (chapters 3-10), are implicit in the analysis and criticism in those chapters; here rendered as explicit recommendations.			
Chapters 3 and 4: Transportation and Communication			
19. Evaluate PPI indexes for rail and trucking for compositional changes in industry outputs	BLS	Improved deflators and output (NB: PPI indexes are Laspeyres formula)	PPI 'directed substitution' project
20. Add passenger-based quality changes to air transport indexes	BLS/BTS	Improved deflators and output (many quality changes in air transport)	None, except BLS-BTS paper
21. Research on adding highway inputs into trucking productivity measures	BLS/BTS	Overcome bias to MFP for trucking because of omitted government infrastructure contributions	None

22. Integrate BLS and BEA approaches to airline output and inputs	BLS/BEA	Coverage, capital measures, purchased inputs cloud productivity comparisons	BEA-BLS project underway
23. Develop better deflators for transport equipment	BLS/BEA	Better capital and MFP measures (usual quality change issues)	None
24. Research on communications services prices	BLS/BEA	CPI and PPI telephone indexes problematic (discounts, change in mix, fixed weights)	CPI change recently; PPI changed to unit value to capture discounts
25. Research on communications equipment prices	BLS/BEA/ FRB	Better deflators for capital input	Some research incorporated into GDP
Chapters 5-7: Banking, Finance, and Insurance			
26. Review flows between insurance carriers and agents	BEA	Inaccurate flows of intermediates perhaps causing negative productivity	None
27. Collect insurance data in Census and annual surveys	Census	AM Best data, used in absence of gov. data, appear faulty	2007 Economic Census covered insurance
28. Conduct research on new financial products	BLS/BEA	Current SNA definitions (see number 16, above), impedes progress	Some OECD studies
29. Improve allocation of self-employment income	BLS/BEA	Allocation method leads to wide fluctuations in capital share and MFP in finance and insurance (see also number 18, above)	None
30. Research on allocation of indirect business taxes	BLS/BEA	Remove inconsistency in present treatments	In progress
NB: Many other detailed recommendations in chapters 6 and 7, but subordinate to the SNA-NIPA output concepts matter (see number 16, above)			
Chapter 8: Retail trade			
31. Review BEA use of gross output price to deflate	BEA	Part of gross output vs gross margin question (number 17, above)	BLS now produces gross margin PPI index; BEA
gross margin			2006 paper on trade
32. Develop explicit measures of retailing services bundled into gross margin	BEA/BLS	Improve output, whether gross margin or gross output	Underway in PPI, needs evaluation
33. Research on capturing changes in store format in price indexes	BLS	Reduce "outlet substitution bias	Some CPI changes
Chapter 9: Other Services (see also number 14 and 15 for business services and number 11-13 for medical services, above)			
34. Review "model pricing" for business services	BLS	Innovative method, but needs testing or outside evaluation for validity	None
35. For education, research on output concept, price and quality indicators, inputs, and implications of educational institution as a multi-product firm	All	Little agreement on any of these issues; education productivity measures most unsatisfactory	Recent BEA paper, many problems remain
Chapter 10: High-tech Capital Inputs for Services (see also number 7, 8, and 11, above)			
36. More aggressive incorporation of weight shifts for new ITC products in PPI and of improved deflators for Communications equipment in investment measures	BEA/BLS	Improved capital measures and improved MFP	Partially done
37. Research on accounting for fibre optics	BEA/BLS	Little is known, many problems exist, though shares are small	None
38. Research on classification of software	BEA	Current 3-way (packaged, custom, own account) may distort	None
39. Better data on software expenditures	BEA/Census	Shares of software not firmly known, and therefore bias MFP	Census surveys collect software, but too little industry detail
40 Better deflators for software	BEA/BLS	PPI has indexes for packaged software; much less is known for custom and own-account	Some research, BEA 2006 paper, but Brookings and NAS workshops unsuccessful at pointing to research directions; quality change problems remain even with packaged software
41. Improved deflators for high-tech medical equipment	BLS/BEA/ CMS	Little is known, still only a single study (Trajtenberg, 1990)	None

Note: Output and non-labour inputs use Census NAICS-SIC bridge for the year 1997, plus additional bridges for earlier Economic Census years constructed by FRB. Labor inputs uses BLS QCEW. Substantial inconsistency discussed in text.

Source: Drawn from Jack E. Triplett and Barry P. Bosworth, *Productivity in the U.S. Services Sector: New Sources of Economic Growth*, Brookings Institution (2004), supplemented in December 2006 with information from BLS and BEA on their new statistical initiatives.

BEA = Bureau of Economic Analysis, BLS = Bureau of Labor Statistics, BTS = Bureau of Transportation Statistics, Census = Census Bureau, CMS = Centres for Medicare and Medicaid Services, FRB = Federal Reserve Board.

an integrating framework for assessing data adequacy and consistency, is not the only statistical priority.

Finally, our list represents only our own views, though they have been informed by the participation of a large number of economists in the Brookings workshops. Others might devise a somewhat different list.

As the right-hand column of Table 2 might suggest, we are gratified at the number of our recommendations that the statistical agencies have accepted and for which they have carried out at least some preliminary work. Undoubtedly, some of them would have been undertaken in any event, but nonetheless continued progress is being made on services data.

It is noteworthy that some of the topics where we cited the agencies for excellent work (above) also appear in the data recommendations for further work in Table 2—PPI indexes for services, Census collection of purchased inputs, improved deflators for high tech goods (numbers 1, 2, and 36-40 in the table) are examples. Much has been done recently in a relatively short time, but the goal of a comprehensive dataset for services industries that matches the information available for the goods producing sectors is an ambitious one that requires a huge effort to overcome its late start. Much difficult work remains.

Only two of our recommendations have been rejected by the agencies to date (though others have not been acted upon).

Our number 13, to add cost of disease accounting to the National Health Expenditure (NHE), has been rejected by the compilers of these accounts, even though their own advisory committee endorsed our recommendation in 2006. The importance of the cost of disease dimension is great: at present, the NHE tells us who provides the money for medical care and who gets the money, but not what is purchased with medical care expenditures. We literally do not know, from the NHE, whether medical costs are increasing because of cancer treatments or because of setting broken bones. Any sensible debate about medical care costs cannot proceed without information about what we are spending the money for and where the costs have been rising.

Additionally, all the relevant economic research on medical deflators, and all the scientific research on which the economic research relies, occurs at the disease level. Improved deflators for, e.g. heart attacks and mental health (Cutler *et al.*, 1998; Berndt, Busch and Frank, 2001) have lesser value without matching expenditure categories to deflate, which the national health accounts compilers have refused to provide.

We hope for progress, however. Conferences and workshops sponsored by the OECD have led to increased international consensus that cost of disease classification of medical care expenditures is the wave of the future (the international classification of diseases (ICD-10) is available for this purpose). The NIESR-York report for the National Health Service in the United Kingdom (Dawson *et al.*, 2005) contains a recommendation for arraying NHS expenditure data by disease, which seems likely to be adopted. In the United States, BEA has taken up our recommendation and has proposed producing cost of disease accounting in a projected health care "satellite account" and the 2007 Economic Census obtained data from hospitals classified by the ICD.

Our recommendation number 16, to change the national accounts concepts for the output of banking and of insurance, has been rejected rather emphatically by BEA. In this case, BEA follows the System of National Accounts (SNA), the international guidelines for national accounts. BEA shows no inclination to push for change; rather it has vigorously defended the SNA approach in professional presentations. We remain hopeful that BEA will reconsider.

We have shown that the BEA-SNA output concept for insurance causes understatement of insurance industry productivity growth, which is very low in the presently published data (Triplett and Bosworth, 2004, chapter 6), so empirically the insurance output concept matters. We cannot address the substance of the complex issues in finance output here.[11]

Commerce Department Reviews of Data for Innovation Studies

In a paper prepared within the Census Bureau as background for the Advisory Committee on Measuring Innovation in the 21st Century, Atrostic (2008) evaluated data for studying innovation that are available in the U.S. and other countries.[12] She concludes that among "critical data gaps" for studying innovation, the highest priority should go toward comprehensive coverage of services industries in the Census Bureau's programs. Major needs are expansion of product coverage in services industries to achieve parity with the information collected for manufacturing, more comprehensive coverage of input data for services industries (where again the data are less complete than for the goods-producing sectors), and more integral collection of data from services-producing establishments, again on lines that are closer to the standard for manufacturing. On the latter point, she observes that there is a basic inconsistency in services data collection. For manufacturing, data on inputs and outputs are collected from the establishment; but for services, data on outputs and some inputs are collected in different surveys, so that they cannot be linked together in a reliable way. For example, data on purchased inputs from the Business Expenditure Survey contain too little industrial detail to permit linking it to detailed services industries. Some of these shortcomings are being corrected in future Census Bureau surveys.

Atrostic's recommendations are paralleled in the report of the Advisory Committee on Measuring Innovation in the 21st Century (2008). In its first and most important recommendation, the Committee urged the Commerce Department to develop annual, industry-level measures for estimating MFP. To implement this proposal, the Committee called for improvements in the Census Bureau's services industry data collections, including extending its annual surveys of services industries (which now cover only about half of services, by share of GDP), and also extension of the BLS industry PPI indexes to cover more services industries.

Other Measurement Issues

Inconsistent Labour Input: The U.S. Statistical System's Implementation of NAICS[13]

Data improvements often bring to the fore data problems that, though possibly existing before, were either hidden or less consequential. One major example occurred when the BEA industry accounts were initially improved several years ago: Discrepancies between alternative approaches to value added (Triplett and Bosworth, 2004:9-11 and 323-327) had not previ-

11 See Triplett and Bosworth (2004, chapter 7) and Basu, Inklaar and Wang (2006), both of which also cite additional (and extensive) literature on these topics.

12 The working paper (but not the published) version contains an Appendix that presents valuable survey-by-survey reviews of Census Bureau special surveys on innovation topics (for example, the Information and Communication Technology Survey). Each review describes the data in a particular survey, gives references and a brief summary of findings from research studies that are based on it, and concludes with a "lessons learned" appraisal that suggests future directions or limitations of the survey approaches followed. The working paper is available from: http://www.bls.gov/ces/.

13 A personal disclaimer: Triplett was chair of the U.S. committee that designed and negotiated NAICS 1997 with the statistical agencies of Canada and Mexico. The new industry system was implemented in the other two countries without the substantial deficiencies in the U.S. implementation that are discussed in this section.

ously been transparent to users and were only revealed when BEA revised and improved the industry accounts to construct them on the basis of gross output.[14] The problem has received attention of late (Moyer, Reinsdorf and Yuskavage, 2006), and is one of the major improvements described in the previous section.

A second example has arisen more recently, and affects our own productivity analysis, as well as the productivity estimates of others. The Bureaus of Labor Statistics (BLS) and Census have always assigned industry classifications independently, based on different data, and it has always been known in the statistical literature that industry classifications carried out by the two agencies differ, in some cases by substantial amounts. In the past, economists lived with these differences and hoped they did not bias their results.

In the changeover from the old U.S. SIC system to the North American Industry Classification System (NAICS), however, the old dual BLS-Census classification problem has become worse. The following summary represents our understanding at the time of writing.

Following past practices for industry classification revisions, Census prepared a NAICS-SIC bridge table from data collected for the 1997 Economic Census—that is, for a single year, but on an annual basis. The alternative classifications were based on commodity detail that is collected routinely in the Economic Census.

Subsequently, a Federal Reserve Board (FRB) project (Bayard and Klimek, 2003) used Census establishment microdata to reclassify manufacturing establishments in previous Economic Censuses to NAICS. By providing a series of SIC to NAICS bridges, rather than just one, it created a more nearly consistent NAICS industry time series than was ever the case for earlier SIC classification system changes (which were always limited by a single bridge period). BEA adopted at least part of the Bayard-Klimek reclassifications in its industry accounts, so that BEA's NAICS time series for industry outputs, intermediate inputs and capital services has much more time series consistency in it than has ever been true in the past.[15]

Improvement in the consistency of the non-labour variables, however, heightens the long-standing Census-BLS coding inconsistency, for the BEA industry file gets its labour data from BLS. For its establishment employment and earnings series (often called the "790"), BLS carried out its NAICS-SIC bridge with data for the first quarter of 2001. Not only is the BLS employment bridge a bridge for a single quarter, it does not even fall into the same year as the Census bridge. The BLS time series of NAICS employment by industry was then "ratioed" backward to 1990 by the bridge for this single quarter.[16]

BLS used its first quarter 2001 information in a second way. It reclassified the establishments in its universe file (which is constructed from employer Unemployment Insurance reports filed with the states). It then followed these reclassified establishments back to 1990, with imputations for

14 This inconsistency problem was known before, but not widely appreciated. It was described, for example, by Mohr (1992).

15 The 1987 SIC revision restricted changes in classifications that crossed the old 2-digit boundaries, roughly the level of detail in BEA industry accounts. Accordingly, earlier industry classification changes created fewer reclassification problems than did NAICS, where classification changes were not so restricted. Offsetting this, however, industries in the old BEA input-output accounts did not match SIC industries, so much reallocation was required, for which data were frequently sketchy. Such reallocations have been reduced under NAICS because NAICS classifications match I-O principles. On balance, the new NAICS industry accounts series is more consistent than any past BEA industry series.

16 Ratios established for March 2001 were used to map employment from SIC to NAICS in order to form the NAICS-based history for each series.... These ratios were used to reconstruct the series back to its stating date of 1990" (Morisi, 2003:4). The article suggests that establishments were contacted over a number of years to obtain their NAICS codes. See also Strifas (2003), who provides a similar description of the BLS bridge.

establishments that were not in the 2001 database (information obtained from BLS). These reclassified establishments created another NAICS employment series, published in the BLS Quarterly Census of Employment and Wages (QCEW, formerly called the "202"). The reclassified QCEW employment series, with some additional information from the Census Bureau's County Business Patterns, forms the basis for the employment data in the BEA industry file.

The two methods used by BLS (ratioing by the proportions observed in 2001 and reclassifying establishments by their activities in 2001) will not yield the same NAICS industry time series. BLS has informed us that they gave surprisingly close results in most industries and that in industries where the two methods differed, they considered the QCEW results in constructing NAICS series for the 790.

Nevertheless, we compared annual employment estimates in the BEA industry file (which are based on QCEW data) with employment data maintained by the BLS Office of Employment Projection (OEP) which come from the 790 series. We compared these two BLS sets of employment data because productivity researchers use them. In our studies, we employ BEA data (based on the QCEW file). Stiroh (2006) and Jorgenson, Ho and Stiroh (2005) have used OEP employment data (which is 790 data).

Results of our analysis are summarized in Table 3.[17] Using annual data for 1990-2004, we first computed for each industry annual ratios of the two employment series. We then computed the mean value of the ratio for each industry:[18] For example, the mean value of the ratio of 790 to QCEW employment in the wood products industry is 97.8 (the 790 is on average 2.2 percent lower) and for rail transport is 106.5 (the 790 is 6.5 percent higher). We also computed the standard deviation of the ratio and its range: Referring again to rail transport, the range is 16.9. Finally, we computed least square trends for each ratio. The coefficient on the trend measure indicates the average annual drift in one employment series relative to the other.

As Table 3 indicates, a large number of these trend coefficients are statistically significant (highly so), and some of them are quite large. For example, rail transport has an average drift of 1.0 points per year, motion pictures and brokerage 1.3 points, and so on. To put these figures in context, the average drift in the motion picture and sound recording industry (1.3 points per year) cumulates over the 15 years of our study to a 21 percent difference in the alternative estimates of the labour input. We estimated LP growth in this industry (using BEA data), at only 1.2 percent per year from 1995-2004—though 3.2 percent per year for 2000-2004. Thus, the mean deviation in alternative employment growth estimates in this industry is larger than our estimated annual LP growth for it. We have not computed alternative LP estimates using the two employment series, but the variability and trend differences in some of these industries are a cause for concern.

Our analysis suggests serious inconsistencies between the employment data that we use for our industry LP and MFP measures (the BEA file) and the employment data used by Stiroh (2006) and Jorgenson, Ho and Stiroh (2005), the OEP file. This is true even though both datasets were obtained ultimately from BLS.

An additional question is whether BEA's Census-derived output, intermediate input and capital services measures are consistent with the BLS-based employment data in its industry file. The Census Bureau classified establishments to NAICS (annual surveys and 5-year Economic Censuses) using dif-

17 One should not make too much of the entries for the Agriculture group, since BLS does not actually survey most of these industries for its employment programs. They are in the OEP file, and hence would be used by any researcher who used the complete file. Presumably, OEP supplements BLS data with data for other sources.

18 These data are available from the authors on request.

Table 3

Comparison of Wage and Salary Employees by Industry,BLS, BEA, and FRB, Summary Statistics[a]

	Annual data covering 1990-2004	
	Ratio of BLS to BEA	Ratio of FRB to BEA
Industry	OLS Trend Line	OLS Trend Line
Private industries	0.0**	-0.0***
Non-farm goods	-0.2***	-0.1***
Services less real estate	0.1***	0.0
Agriculture, forestry, fishing, and hunting	-1.4**	0.4***
Mining	-0.2***	-0.1*
Utilities	0.0	0.8***
Construction	-0.1*	-0.2***
Manufacturing	-0.1***	-0.1***
Durable goods	-0.1***	-0.1***
Wood products	-0.1***	-0.1***
Nonmetallic mineral products	-0.1*	0.0
Primary metals	-0.2***	0.1**
Fabricated metal products	-0.2***	-0.3***
Machinery	0.1**	0.0
Computer and electronic products	-0.1***	0.1
Electrical equipment, appliances, and components	-0.3***	0.5***
Motor vehicles, bodies and trailers, and parts	0.3**	0.1*
Other transportation equipment	-0.5***	-0.2**
Furniture and related products	0.3***	0.3***
Miscellaneous manufacturing	-0.3**	-1.0***
Nondurable goods	-0.1**	-0.1**
Food and beverage and tobacco products	-0.2***	0.0
Textile mills and textile product mills	0.0	-0.7***
Apparel and leather and allied products	-0.2*	0.9***
Paper products	0.0	0.1*
Printing and related support activities	0.1**	-0.1**
Petroleum and coal products	0.2	0.2
Chemical products	-0.3***	-0.2***
Plastics and rubber products	-0.4***	-0.5***
Wholesale trade	0.2*	0.2***
Retail trade	-0.1**	0.0
Transportation and warehousing	-0.1**	-0.1
Air transportation	-0.5***	0.8***
Rail transportation	1.0***	0.0
Water transportation	0.4***	1.9***
Truck transportation	-0.1**	0.3***
Transit and ground passenger transportation	0.3*	0.9***
Pipeline transportation	0.3*	0.7***
Other transportation and support activities	0.1	-0.8***
Warehousing and storage	-0.9**	-1.9**
Information	0.1**	0.3***
Publishing industries (includes software)		0.1*
Motion picture and sound recording industries	1.3***	0.7***
Broadcasting and telecommunications	-0.1**	-0.1***
Information and data processing services		2.2***
Finance, insurance, real estate, rental, and leasing	0.2***	0.1***
Finance and insurance	0.2***	0.0
Federal Reserve banks, credit intermediation, and related activities	0.0	0.1
Securities, commodity contracts, and investments	1.3***	0.1**
Insurance carriers and related activities	0.0	0.0
Funds, trusts, and other financial vehicles	1.3***	-0.6**
Real estate and rental and leasing	0.3***	0.5***
Real estate	0.3***	0.3***
Rental and leasing services and lessors of intangible assets	0.2**	1.0***
Professional and business services	0.6***	-0.2***
Professional, scientific, and technical services	0.9***	0.6***
Legal services	0.9***	0.5*
Computer systems design and related services	1.2***	0.5***
Miscellaneous professional, scientific, and technical services	0.8***	0.7***
Management of companies and enterprises	-1.5***	-1.5***
Administrative and waste management services	0.8***	-0.5***
Administrative and support services	0.8***	-0.5***
Waste management and remediation services	1.2***	-0.2**
Educational services, health care, and social assistance	0.2*	0.2***
Educational services	0.6***	0.0
Health care and social assistance	0.1	0.2***
Ambulatory health care services	0.4***	0.3***
Hospitals and nursing and residential care facilities	0.1**	0.3***
Social assistance	-0.1	0.2***
Arts, entertainment, recreation, accommodation, and food services	-0.3***	-0.2***
Arts, entertainment, and recreation	0.1	0.4***
Performing arts, spectator sports, museums, and related activities	1.1***	1.2***
Amusements, gambling, and recreation industries	-0.2	0.0
Accommodation and food services	-0.3***	-0.3***
Accommodation	-0.2***	-0.2***
Food services and drinking places	-0.4***	-0.3***
Other services, except government	0.2***	-0.3***

a/ For FRB and BEA, series is entitled "full-time and part-time workers" (ftpt).

Significance levels: *, **, *** indicate significance at the .05, .01, .001 levels, respectively.

Sources: BLS, Employment Projections; BEA, GDP by industry accounts; FRB, Corrado *et al.*(2006).

ferent information from that used by BLS, and for different time periods. The Census and BLS data may differ, as well, for other reasons—differences in their sampling frames, for example, but we do not explore that directly here.[19]

Bayard and Klimek (2003) produced bridges for Census data on employment (also production worker employment) in manufacturing industries, using reclassified establishments for Economic Censuses back to 1982. We understand that additional bridges for wholesale and retail trade and for some services have been created. Corrado *et al.* (2006) used the Bayard-Klimek employment time series in their industry productivity study.

We obtained the Corrado *et al.* data (many thanks to the authors). We carried out an identical comparison to the one we carried out for the BEA and OEP employment estimates, that is, we compared the Bayard-Klimek employment series (which is consistent with other Census data) with the BLS-based (QCEW) employment series in the BEA industry file. Results are in the right-hand columns of Table 3.

Again, trends differ across the two employment series, and for a large number of industries, they are highly significant. The left-hand and right-hand panels of Table 3 look very similar, suggesting substantial inconsistency among all three alternative industry employment series.

Corrado *et al.* (2006) point especially to the management of companies and enterprises industry (a new industry under NAICS). The level difference is particularly great for the Census-BEA comparison. However, the variability and trend difference for the BEA-Census comparison are matched by equally large values for the two BLS series. This industry appears problematic even within the BLS tabulations, as well as across agencies.[20]

The Economic Census contains the production and output data necessary for industry classification of establishments. BLS data do not (a special survey is required). Accordingly, we think that the Census Bureau assignments of industry codes are more accurate, regardless of the merits of the long-standing inter-agency dispute over which establishment frame is better. Set against this, the accuracy of the codes may decline as the Economic Census recedes into the past, and establishments shift their productions to new products. Additionally, Census obtains some codes from other data, such as Social Security filings, particularly for smaller establishments, and these may pose accuracy problems. We understand that Census is addressing both these problems.

The incompatibility of employment series is a major problem that, we suspect, affects results obtained by different productivity researchers. It deserves prompt attention from the statistical agencies.

In light of this inconsistency, and for reasons of efficiency, we recommend that BEA, the BLS Office of Productivity and Technology and the BLS Office of Economic Growth and Projections cooperate in producing a single U.S. industry database that would be "owned" and

19 In a comment on an earlier draft of this paper, Associate BLS Commission Jack Galvin told us that in his view the sampling frame source was the most important contributor to Census-BLS data differences. A joint project is underway to resolve these differences (the Business Register project), or at least to understand them.

20 Though this is a new industry in NAICS, the inconsistency in its coding is not a new statistical result, but rather one that has only become apparent with the new industry classification system. Many of the establishments in the management of companies and enterprises industry would have been classified as "auxiliaries" in the old SIC system and placed in the industries they supposedly served (e.g., the management office of some conglomerate enterprise would have been put into the industry where its largest sales occur). But abundant evidence existed that BLS and Census were not classifying auxiliaries in the same industries in the past; these classification differences were generally hidden in the detailed industry data produced under the old SIC system. The change to NAICS has not made the data worse. Rather, it has highlighted a problem that existed before but did not receive sufficient attention because it was not generally known among users of industry data.

maintained jointly by the two agencies. This implies that insights that any one group has developed in its separate pursuit of building an industry database should be utilized in the joint dataset. We know of no conceptual reason why the three uses (national accounts, productivity analysis, and employment projections) could not share the same industry database. Having three different industry databases, as the United States now does, is wasteful of statistical agency resources. None of the existing three is as good as what a combined effort would produce, and having three different industry data sets is also confusing to data users.

Intangible Investment

The U.S. services industry database contains measures of capital services flows, by industry and by type of capital, for tangible capital (equipment and structures). In recent years, economists have widened their attentions to include intangible capital assets. A long literature exists analyzing research and development (R&D) and patents, data are available for both, and for the former experimental accounts have been computed. But quantitative information for other types of intangibles — brand names and company reputations, business models, organizational innovations and so forth are among the assets usually mentioned — has not been developed. Corrado, Sichel and Hulten (2005) present estimates of the size of the U.S. intangibles stocks that amount to a third or more of the stock of tangible capital.

It seems likely that some intangibles are relatively more important in services industries, in the sense that starting a successful services firm requires much more investment than just its physical plant and equipment. A firm that undertakes intangible investment will have output that is understated during the investment period (because its investment in intangibles it produces for itself is omitted from output), but its capital input will be understated when the flow of services from its intangibles begins to be used. In the latter case, the omitted capital service flows means that the firm's MFP is overstated (because its total input usage is understated). Such understatement of inputs from intangibles might explain, in part, our finding of accelerating MFP in services industries after 1995, though no estimates exist.

A research and data development agenda of great importance is developing measures of intangible investments, estimating their depreciation rates, and converting intangible stocks into capital services flows to match the capital services flows for tangible investments.

Conclusion

Current recommendations for improving U.S. services statistics have the flavor of deja vu. The words and in part the content of some of our recommendations and those of Atrostic and the Commerce Advisory Committee seem similar to the data needs specifications of Fuchs and Marimont in 1969 and Griliches and Mohr in 1992. Seemingly forever, economists have pointed to the inadequacy of data on services industries, and their lists of needed improvements through many years repeat common themes.

The language is deceptive. Though it might seem that little progress has been made, quite the contrary is the case.

As the historical section of this article indicates, the U.S. statistical system was a very late starter in measuring the services economy. Serious services data collection only began in the 1980s and 1990s. Most services industries are now included in the Economic Census, not just the small number of "selected services" in the days when Fuchs and Marimont were writing. Moreover, looking beneath the three-digit level of NAICS (2-digit of the old SIC), data for many more detailed services industries are now available, compared to the small number in 1969, or even in 1990.

And even though no annual surveys are conducted for half of services industries, this is up from none not so long ago. A similar statement applies to the PPI services industries price indexes, which basically did not exist in 1990. Services industries are still not covered in statistical programs to the degree that they should be, given the size of the services sector and the role of the sector in recent productivity advance, and in that sense, much remains to be done. But our own work would not have been possible without the substantial progress that the statistical agencies have made.

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