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**INFORMATION AND COMMUNICATION TECHNOLOGY INVESTMENT:
NEW AND FUTURE IMPROVEMENTS**

Invited paper submitted by the Bureau of Economic Analysis, United States of America*

I. INTRODUCTION

1. Information and communication technology (ICT) capital goods encompass computers and peripheral equipment, computer software, and communications equipment. These goods have been characterized by rapidly changing technology, by decreasing prices, and by substantial growth in fixed investment (fixed capital formation). Table 1 shows the shares of the private components (government is excluded) in the category for 1996, the reference year for the NIPA's. Expenditures on ICT goods by U.S. businesses are cited as playing a significant role in the growth for the U.S. economy in the second half of the 1990's. Chart 1 shows historical relative growth rates of real GDP, real nonresidential fixed investment, and real private fixed investment in ICT. As shown in table 2, the average rate of growth of real GDP increased from an average rate of

* Prepared by Ms. Carol Moylan, Bureau of Economic analysis.

2.4 percent in the first half of the 1990s to an average rate of 4.1 percent in the second half. Nearly half of this increase was accounted for by private fixed investment, and half of this, in turn, was due to ICT. Thus investment in ITC contributed about three-quarters of a percentage point to the average growth rate of real GDP in the second half of the 1990s. It also contributed to the slowdown in GDP growth during 2000 and 2001.

2. The United States, and other countries that follow the SNA, recognize business and government expenditures for computer software as fixed investment. Three types of software are included: Prepackaged software, custom software, and own-account software. Software purchases that are bundled or embedded in other equipment or software products are classified as inputs to production and are excluded. Expenditures on software are large, and like other assets currently included in fixed investment, software provides services in production and it has a service life of more than one year; BEA estimates the average service life is 3-5 years, depending on the type of software. Thus, software expenditures meet all of the classic criteria for capital formation.

3. Because investment in ICT goods plays such a significant role in GDP growth, much attention has been given to improve these estimates. This paper focuses on recent improvements made to U.S. private investment in ICT, on improvements underway, and on new budget initiatives that could greatly improve this measure of information technology. Recent improvements include:

- An improved methodology for estimating quarterly fixed investment in purchased software;
- Improved quarterly source data for computers and peripheral equipment;
- Improved prices for LAN equipment.

4. Improvements underway include:

- Improved estimates of intermediate consumption and an expanded definition of exports and imports for purchased software;
- Improved estimates of own account software;
- Improved prices for ICT.

5. In addition, some significant long-term improvements may come from the funding of the Bureau of the Census' fiscal year (FY) 2003 Improved Services Measurement initiative and FY2003 E-business Initiative, which are focused in large part on ICT related improvements. Possible improvements include:

- More comprehensive "demand-side" data for ICT (E-business initiative), including:

- Separately collecting both capitalized and expensed business spending on each of the three major components of ICT by industry;
- Separately collecting business spending on each of the three major components of software at an all-industry level;

- Improved data on quarterly receipts of prepackaged and custom software (Services initiative);
- New annual product detail for prepackaged and custom software (Services initiative).

II. Current-dollar estimation

6. The U.S. follows a commodity-flow procedure (or supply approach) to estimate private fixed investment for ICT, excluding own-account software, in current prices. This approach follows the estimation methodology used for most components of private fixed investment in equipment and software. The strength of the commodity-flow method is that it draws on the very detailed commodity classification and comprehensive coverage of the economic censuses, as well as on the conceptual rigor of an I-O table in which production and uses of commodities are reconciled for benchmark years. The commodity-flow estimates are based on commodities produced rather than on the total output of the industry, which may include receipts for secondary products. It provides detailed information on the commodity composition of investment, but it does not yield information on investment by industry or by class of purchaser.

7. The commodity-flow method is a “supply-side” approach, which traces commodities from their domestic production or importation to their final purchase. An alternative estimation method that is used by many other countries is a “demand-side” approach, which would base estimates on capital expenditure data collected from purchasers, such as the Bureau of the Census’ U.S. Annual Capital Expenditures Survey (ACES).

8. A supply-side approach is preferable to a demand-side approach for three reasons. First, capital expenditure surveys reflect business accounting practices, which tend to reflect tax and regulatory requirements rather than economics. Firms have a clear tax incentive to expense items—such as software—and they will do so whenever possible. The expensing of most software on tax returns is analogous to their treatment of another fixed asset—oil and gas well drilling, which U.S. tax law allows to be expensed in most cases. Because business accounts do not consistently treat expenditures of software and other tangible and intangible assets as fixed investment, BEA implements the national accounts concept of investment and depreciation using the supply-side approach. Second, the estimate begins with the most reliable available information—domestic and import supply which is then assigned to specific types of expenditures (i.e., intermediate expenditures, private investment expenditures, consumer expenditures, exports, and government expenditures). In contrast, source data for demand-side measures are generally

less comprehensive, especially for ICT components such as computer and peripheral equipment and software. Third, the supply-side approach yields additional detail on type of asset that is generally not available from capital expenditure surveys. Typically, the ACES provides annual estimates for capital expenditures by industry, but not by type. Capital expenditures by type are published every five years - the latest year available is 1998 - and provide only a limited amount of information on type of asset. In BEA's accounts, the supply-side approach is used to estimate total investment and investment by type of asset, and then industry data from the ACES is used along with other information to allocate investment by industry.

9. For many products, the two approaches yield similar results, however, there can be considerable differences. For example, in the 1998 ACES, U.S. companies reported expenditures of \$11.8 billion on capitalized software purchased separately. In contrast, the 1999 Census Bureau's Service Annual Survey (SAS) reported sales for 1998 of the prepackaged software industry -that is software publishing- of more than \$70 billion, and sales of the custom software industry -that is computer programming services- of more than \$50 billion. BEA's commodity-flow methodology produced an estimate of business investment in these two types of software totaling somewhat more than \$90 billion, more than seven times as much as reported by businesses in the ACES. The ACES understates software investment because many firms do not capitalize software for their accounting records and the 1998 instructions asked firms to include only capitalized software and to exclude software considered intangible. The Census Bureau has revised its software instructions for the 2000 ACES, but anecdotal evidence suggests that businesses fail to report many purchases of software as investment. While this comparison of software estimates is not typical of most products, it does demonstrate the potential differences between the two approaches.

10. U.S. tax records and company financial data do not provide an adequate measure of capital formation, particularly for software. Under tax law, some software expenditures must be expensed, some must be capitalized, and some are subject to interpretation. For software expenditures to be capitalized firms must view these expenditures as significant and they must have a useful life of more than one year. Annual site licenses are expensed, but multi-year licenses should be capitalized.¹ Firms decide for themselves what is maintenance and what is a major improvement that requires capitalization. All research and development (R&D) expenditures are generally recorded as expenses until such time that it is determined that a commercially viable product is being developed; at that time, and continuing until the product is developed, the expenditures are accumulated in an asset account. The capitalized expenditures are then usually depreciated over a period of 5 years or less. For tax reporting purposes, firms must consistently treat these costs over time; any change in treatment is considered a change in accounting methods.

11. Under tax accounting, almost no own-account software is capitalized, while some prepackaged and custom software are capitalized. Firms not in the business of producing software for commercial sale view own-account expenditures as an expense. Stockholder and tax

return disclosures indicate that the amount and proportion of capitalized R&D costs is quite low for firms that develop software for commercial sale to others. Although in theory, prepackaged software purchases with a useful life of at least one year should be capitalized, most are treated as an expense. For example, a Fortune 500 firm said that its policy was to expense all single software purchases of \$250 or less, as well as all site licenses or combined purchases that are less than \$10,000.

12. The commodity-flow method of estimating equipment is implemented in its most complete form for estimates in the I-O tables for the benchmark-year. For non-benchmark years, the commodity-flow method is abbreviated to utilize the product-level data that are available for the annual NIPA estimates. A further abbreviation of the commodity-flow method is used for current-quarterly estimates that relies on industry-level data for the shipments component.

13. The commodity-flow method is not used for the measurement of own-account software investment. Own-account software expenditures are measured as the sum of production costs, which are limited to compensation (wage and nonwage) of employees and to the costs of intermediate inputs. For years when occupational employment/compensation data are available, total output of own-account software is calculated by multiplying the number of programmers and systems analysts in selected industries times a factor to account for the share of time they spend doing tasks associated with non-embedded software development, times a national median wage rate for programmers and systems analysts, times various factors that cover nonwage compensation costs and intermediate inputs. These estimates are derived separately for private capital formation and for government capital formation using Bureau of Labor Statistics (BLS) employment-by-industry data. For years when these data are not yet available, business own-account software expenditures are extrapolated using NIPA estimates of private fixed investment in computers and peripheral equipment.

III. Price and volume estimates

14. Detailed volume estimates for private fixed investment in ICT are derived by deflation. That is, detailed current-dollar values are divided by detailed matching price indexes. For the majority of ICT, the producer price indexes (PPI's) and international price indexes (IPI's) are the foundation for the price deflator. There are some exceptions. Two of the detailed price indexes used in the deflation of communication equipment reflect hedonic methods for quality adjustment: telephone switching equipment and local area network (LAN) equipment. The price index for prepackaged software reflects hedonic methods for quality adjustment for the period 1985-93. For periods other than 1985-93, source data are not adequate to prepare hedonic indexes, but a bias adjustment is applied to the matched model indexes reflecting part of the difference between the hedonic index and the matched model index for 1985-93. The price indexes for capitalized own-account software are input-cost indexes consisting of compensation cost indexes for computer programmers and systems analysts and intermediate input cost

indexes, which assumes no changes in productivity of computer programmers and systems analysts.

IV. Recent progress

15. Several methodological changes were introduced as part of the 2001 annual revision of the NIPA's that led to improved estimates for private fixed investment in ICT.

Improved methodology for estimating quarterly fixed investment in purchased software

16. The quarterly estimates of fixed investment in prepackaged and in custom software were improved. The estimates of prepackaged software are now interpolated and extrapolated using data on receipts from company reports to the Securities and Exchange Commission (SEC) and data on monthly retail sales of business software from a trade source. In addition, the estimates of custom software are now interpolated and extrapolated using the SEC data. Previously, the quarterly estimates of prepackaged software and of custom software were interpolated and extrapolated using BLS tabulations of State unemployment insurance data on wages and salaries of the prepackaged software and computer programming services industries. However, the Census Bureau SAS continues as the primary data source for the annual estimates of prepackaged and custom software. The improved quarterly extrapolators are conceptually more consistent with the SAS receipts data than the previously used quarterly extrapolators.

New shipments detail for estimating quarterly fixed investment in computers and peripheral equipment

17. The June 2001 Bureau of the Census conversion of its monthly industry shipments data to the North American Industry Classification (NAICS) provided new quarterly source data not previously available for computers and computer peripheral equipment. Previously, within the abbreviated commodity-flow procedure, shipments of "office and accounting equipment," which includes computers and peripheral equipment, were used to extrapolate shipments of computers and peripheral equipment. The use of new shipments categories "computers", "storage devices", and "other peripheral equipment" provide a more accurate measure of these components.

Incorporation of newly available price index from the Federal Reserve Board (FRB) that reflects quality improvements to LAN equipment

18. A newly available price index from the FRB that reflects quality improvement to LAN equipment -routers, switches and hubs- is now used in the deflation of private fixed investment in communication equipment. The improved deflator, which is a weighted geometric mean of the FRB LAN equipment price index and the PPI for telephone and telegraph apparatus, is now used to deflate the component of communication equipment that reflects LAN equipment; previously, the PPI for telephone and telegraph apparatus was used to deflate this component.

V. Plans underway

19. For the next comprehensive revision of the NIPA's (tentatively scheduled to be released in late 2003), BEA plans to incorporate information from the 1997 benchmark I-O table and hopes to make additional improvements to the price estimates of custom and own-account software and communications equipment.

20. Improvements in the estimates of purchased software will include the incorporation of greater detail and more complete information from the 1997 economic censuses as incorporated in the forthcoming 1997 benchmark I-O table. With regard to own-account software, this will include both finer levels of detail in calculations and the incorporation of newly available data from BLS and Census that support both the finer-level calculations and allow more direct estimation of the costs of production based on wage costs.²

Improved estimates of intermediate consumption of purchased software

21. A weakness in the estimation of fixed investment in software has been the measurement of intermediate consumption. Recent economic censuses, which are the source of the intermediate consumption estimate, did not collect adequate information on purchases of software by manufacturers. In addition, when the 1992 benchmark I-O table was completed in 1995, software was treated as intermediate consumption, not as investment. BEA did not make any supplementary adjustments to the 1992 Census to account for these software purchases by manufacturers; the reported Census data were used. Consequently, BEA underestimated software intermediate consumption.

22. For the 1997 I-O estimates, software will be treated as investment and adjustments will be made to supplement economic census data on intermediate software purchases by computer (and possibly other) manufacturers. New sources will be used to derive estimates of software embedded in or bundled with other equipment. For example, one source is annual detailed company revenue reports. At least one large software manufacturer reports receipts of original equipment manufacturer (OEM) software in its annual report. These receipts would provide

information on software embedded in other equipment. These OEM receipts will be used along with industry experts' estimates to calculate intermediate purchases.

Expanded definition of exports and imports of purchased software

23. The definition of exports and imports of software will be expanded to more accurately reflect the international trade of software. The present methodology includes only those exports and imports captured in the data on trade in goods from the Census Bureau. Estimates of royalties and license fees for electronically transmitted purchased software are included in the exports and imports of services estimates and should be included in the commodity flow for estimating fixed investment in software. Until 1997, these royalties and license fees were not separately identifiable in the foreign trade data.

Improved estimates of own-account software

24. The 1997 I-O account will separately identify own-account software expenditures, and treat them as capital formation. Own-account software estimates will include the incorporation of both finer levels of detail, and more complete information from the 1997 economic censuses than was available from the annual surveys for 1997, as well as additional and more detailed employment data available from BLS on an annual basis, beginning with 1997.

25. Additional improvements in the I-O estimates will be in three areas. First, BLS now estimates numbers of computer systems analysts excluding the computer engineers and computer scientists that had previously been lumped together with computer systems analysts. Removing computer engineers and computer scientists results in a more accurate measure of the number of computer programmers and systems analysts that the definition of "who creates own-account software" was intended to cover. Second, newly-available BLS data show the numbers of computer programmers and systems analysts at the three-digit SIC level of detail. This permits the use of a more finely-tuned set of limits on how many computer programmers or computer systems analysts are creating investment in own-account software rather than software to be embedded in, or bundled with, sales of other goods. Third, BLS now publishes estimates of mean -rather than median- wages of computer programmers and computer systems analysts by industry.

26. Further, the BLS now publishes estimates of both total costs and wage costs for the custom and prepackaged software industries. These new and improved data will allow a more accurate and more direct calculation of the costs of producing own-account software investment. In particular, the multi-step process currently used to move from wages to compensation to total costs will be replaced by a one-step process that uses this information about total costs versus wage costs in the programming industries. The present methodology uses a blow-up factor to move from compensation to costs that is based on a national average that includes manufacturing firms as well as software firms, and thus includes industries with widely differing proportions of

indirect costs to compensation costs. On net, the 1997 benchmark I-O table is likely to show less own-account software investment than the present NIPA estimate.

Improved own-account and custom software prices

27. The price index for own-account software is a BEA input cost index consisting of compensation cost indexes and an intermediate inputs cost index. The use of input costs assumes that there are no changes in productivity of computer programmers and systems analysts. Because custom software consists of a mixture of both new and existing programs or program modules, including prepackaged software that are incorporated into new systems, the price index for custom software is a weighted average of the price indexes for business own-account software and for prepackaged software. BEA is investigating an alternative approach for estimating price indexes for own-account and for custom software that uses a metric referred to as “function points”. This approach could take into account changes in productivity of computer programmers and systems analysts.

28. Function points (FP’s) measure software by quantifying its functionality provided to the user based primarily on the logical design.³ Data on average cost per function point are available from trade sources and may prove to be useful in preparing a price index for own-account and custom software. McKinsey Global Institute prepared an alternative software price index using FP’s and BEA will continue to evaluate their research.⁴

Improved communications equipment prices

29. BEA plans to conduct research on explicit quality adjustment for components of communications equipment. In addition to what BEA is doing, BLS has been studying switches and routers and exploring the possible hedonic methods for quality adjusting prices for these goods. The Federal Reserve Board’s staff has begun work on some other communications equipment prices, concentrating on fiber optics. If successful, these studies may lead to additional quality-adjusted price indexes. In particular, the very rapid rate of increase of maximum telephone transmission rates suggests that substantial quality improvements have taken place.⁵

VI. Budget initiatives

30. The Administration’s budget for FY2003 contains two initiatives for the Bureau of the Census, which if funded by Congress, could significantly improve the measurement of fixed investment in ICT. These initiatives are for improved measurement of services and for measuring e-business. The initiatives’ focus are in large part on information and technology related services improvements, including adding new industries and information to existing annual surveys and introducing a quarterly services survey. The first data collection year would

be 2003. If these initiatives are appropriated by the U.S. Congress, they should provide annual comprehensive “demand-side” data for U.S. private fixed investment in ICT. They would also provide a more accurate indicator for quarterly private fixed investment in prepackaged and custom software.

Annual coverage of E-business infrastructure

31. This program component would collect all business spending, whether capitalized or expensed, associated with creating, maintaining, and utilizing the ICT infrastructure, including expenditures on equipment, buildings and structures and their maintenance, software, and related services (such as programming and network support staff supporting ICT equipment and structures). Under this initiative, beginning with data year 2003, the Annual Capital Expenditure Survey would collect annually industry level data (for 132 NAICS industries) of new ICT infrastructure spending for the following categories:

- Computers and peripheral equipment;
- ICT equipment except computers and peripheral equipment;
- Electromedical and electrotherapeutic apparatus;
- Software;
- Services.

32. In addition, the Bureau of the Census plans to collect business spending of software broken down into prepackaged software, custom software, and own-account software at an all-industry level. The Bureau proposes to release results of the 2003 ICT survey in 2005.

33. By separately collecting both capitalized and expensed business spending on each of the three major components of ICT, this new survey should provide the information now missing to prepare accurate “demand-side” estimates for ICT. As mentioned above, many businesses fail to report ICT expenditures as capitalized expenditures. While there are no plans to replace "supply-side" (commodity-flow based) asset-level estimates with "demand-side" estimates, the detailed annual ACES estimates for capitalized and expensed ICT equipment and software would serve as an excellent check and could provide a basis for adjustments as needed. Estimates of fixed assets by industry also would be greatly improved by the collection of these data by industry.

Annual data on purchased services and materials for the services industries

34. This program component would entail collecting new information on the cost of purchased services and materials for the service industries. Annual information on purchased software and data processing services would provide better understanding of intermediate purchases of computer software.

New survey of quarterly services

35. In large part, the initial focus of this new survey would be on ICT related industries, reflecting their importance in the economy. This new quarterly indicator would provide industry receipts, value of contracts awarded and value of contracts cancelled for selected industries that would include software publishing, telecommunications, data processing, and computer systems design and related services. These receipts would be available each quarter in time for BEA to use in its final estimate of GDP for the quarter. They would replace the use of receipts from company reports to the Securities and Exchange Commission (SEC) and data on monthly retail sales of business software from a trade source for the quarterly estimates of prepackaged and custom software.

Development and implementation of North American Product Classification System (NAPCS) services products and their implementation incrementally in the Services Annual Survey

36. Implementation of this program component would provide product-level receipts for the prepackaged and custom software industries, providing a better commodity-flow extrapolator for prepackaged and for custom software shipments than industry receipts for non economic census years for these two software components.

NOTES

¹ Although annual site licenses should be treated as an expense, they are not separately identified in purchased software receipts. The NIPA's treat purchases of software licenses as capital expenditures by the firm purchasing the license, but do not treat the development of the software for commercial license to others as own-account capital formation.

² For more information on BEA plans to improve software, see Moylan (2001).

³ For more information on function points, see Longstreet (2001).

⁴ For more information, see McKinsey Global Institute (2001).

⁵ See Aron, Dunmore, and Pampush (1997) and Banks (1997).

Table 1. Components of Investment in ICT Equipment and Software in 1996

	Billions of dollars	Percent of total
ICT equipment and software	231.6	100.0
Computers and peripheral equipment	70.9	30.6
Software	95.1	41.1
Communications equipment	65.6	28.3

Source: NIPA table 5.9.

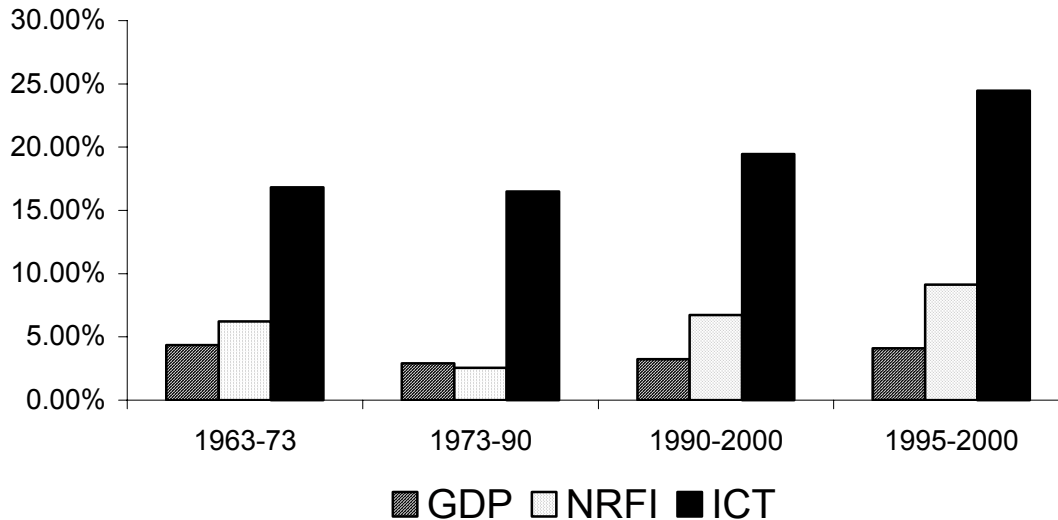
Table 2. Contributions to Average Percent Changes

	1991-95	1996-2000	Change
In Real Gross Domestic Product...			
Percent change at annual rate:			
Gross domestic product	2.4	4.1	1.7
Percentage points at annual rates:			
Private fixed investment	0.62	1.45	0.83
ICT	0.35	0.76	0.41
Other private fixed investment	0.27	0.69	0.42
Other GDP components, net	1.76	2.65	0.89
In Gross Domestic Purchases Prices...*			
Percent change at annual rate:			
Gross domestic purchases prices	2.49	1.67	-0.82
Percentage points at annual rates:			
Private fixed investment	0.16	0.00	-0.16
ICT	-0.13	-0.28	-0.15
Computers and peripheral equipment	-0.11	-0.24	-0.13
Software	-0.01	-0.01	0.00
Communications equipment	-0.01	-0.03	-0.02
Other private fixed investment	0.29	0.28	-0.01
Other GDP components, net	2.33	1.67	-0.66

Source: Derived from NIPA table 8.2 and NIPA table 8.30.

* That is gross domestic final expenditures.

Chart 1.-- Growth Rates in real GDP, in real nonresidential fixed investment, and in real ICT



REFERENCES

Aron, Debra, Ken Dunmore, and Frank Pampush, 1997. "The Impact of Unbundled Network Elements and the Internet on Telecommunications Access Infrastructure". Paper submitted to the Harvard Information Infrastructure Project. Manuscript, December 4, 1997.

Banks, Howard, 1997. "The Law of the Photon". *Forbes*. October 6, 1997: 66-69.

Longstreet, David, 2001. *Function Point Training and Analysis Manual*. Longstreet Consulting Inc, Aug. 2001 <<http://www.SoftwareMetrics.Com/freemanual.htm>>.

McKinsey Global Institute, 2001. "US Productivity Growth 1995-2000: Understanding the contribution of Information Technology relative to other factors", October 2001, Measurement appendix.

Moylan, Carol, 2001. "Estimation of Software in the U.S. National Income and Product Accounts: New Developments." OECD Paper, September 2001. <<http://webnet1.oecd.org/doc/M00017000/M00017821.doc>>

U.S. Department of Commerce, Bureau of Economic Analysis, *Benchmark Input-Output Tables of the United States, 1992* (Washington, DC: U.S. Government Printing Office, 1998).