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Estimation of Software in the U.S. National Accounts: New Developments
by Carol Moylan
Bureau of Economic Analysis
U. S. Department of Commerce
Washington, DC 20230, USA

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Introduction

In 1999, as part of a comprehensive benchmark revision of the national income and product accounts (NIPA's), the United States recognized business and government expenditures for computer software as capital formation. Three types of software─prepackaged software, custom software, and own-account software─are now treated as capital formation. Previously, only software that was bundled with or embedded in equipment by the producer of that equipment was included in capital formation.

This paper summarizes the current methodologies used for the estimation of software and discusses recent improvements and new developments for U.S. estimates of capitalized software.

Current methodology

This section describes the methodologies used to prepare (1) annual estimates of business and government purchases of software (prepackaged and custom), (2) annual estimates of own-account production of software, and (3) price indexes that are needed to prepare the real estimates of capitalized software. The description is limited to the period beginning with 1992.[1]

<u>Business and government software purchases</u>

The U.S. follows a commodity-flow procedure (or supply approach) to estimate business and government purchases of prepackaged and custom software. This approach follows the estimation methodology used for most components of private fixed capital formation in equipment. In principle, the commodity-flow estimates are based on software produced rather than on the total output of the software industry, which may include receipts for secondary products.   For 1992, capital formation in prepackaged software and in custom software is based on estimates from the benchmark input-

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[1] For a description of the methodologies used for prior years, see "Recognition of Business and Government Expenditures for Software as Investment: Methodology and Quantitative Impacts, 1959-98" by Robert Parker and Bruce Grimm, available on BEA's Web site at <www.bea.doc.gov/bea/papers.htm>.

output (I-O) accounts that, in turn, are based on receipts for software products. For later years, industry outputs are used as extrapolators. For the commodity-flow method, directly measured output is allocated among the various expenditure components, primarily using relationships from the 1992 benchmark I-O accounts.[2] Upon completion of the 1997 I-O table, these estimates will be revised to incorporate benchmarked 1997 product-based estimates.

BEA cannot use a demand approach to estimating software, primarily due to a lack of consistent source data. The Annual Capital Expenditure Survey (ACES) provides capital spending by industry. Approximately every five years, estimates of capital spending by type are also published. Unfortunately, this survey does not adequately measure software spending, primarily because many firms do not capitalize software for their accounting records. The 1998 ACES, which provided capital expenditures both by type and by industry, included for the first time an estimate for "capitalized software purchased separately." Because the 1998 ACES instructions asked firms to include only capitalized computer software and to exclude computer software if considered intangible, the ACES estimate of computer software for 1998 is very low, only $11.7 billion, compared with the BEA published estimate for private custom and own-account software investment of $92.2 billion.   For 1999, the instructions were changed to ask for all capitalized computer software, but these estimates are not separately identifiable in the industry estimates and the capitalization treatment varies by firm.

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[2]For a description of the I-O accounts, see U.S. Department of Commerce, Bureau of Economic Analysis, <u>Benchmark Input-Output Tables of the United States, 1992</u> (Washington, DC: U.S. Government Printing Office, 1998). For a description of the commodity-flow method, see <u>Benchmark Input-Output Tables</u>, M-5.

U.S. tax records do not provide an adequate measure of software capital formation. Under tax law, some 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.[3] 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.

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.

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[3]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 licence to others as own-account capital formation.

Table 1 contains details of the commodity-flow procedure and estimating methodologies for the years 1992 and 1999. First, estimates of the total output of computer programming services (custom software) and of prepackaged software are derived based on receipts for particular software products and for software services from the Census Bureau's 1992 economic census of service industries. In 1992, the vast majority of custom and prepackaged software products were produced by the custom software and by the prepackaged software producing industries. Beginning with 1993, total output is extrapolated using industry data from the Census Bureau's service annual survey. Transportation costs and wholesale margins are added to the output in producers' prices to obtain valuations in purchasers' prices. Next, estimates of business purchases of software that are bundled with or embedded in other equipment and of the change in wholesale and retail inventories of software are prepared using benchmark I-O relationships of these transactions to total output.[4] These intermediate consumption and inventory changes are subtracted from the total output estimates to obtain domestic supply to final uses. Next, net exports of software, which are derived from data on trade in goods from the Census Bureau, are subtracted to obtain supply to domestic final uses.[5] Finally, personal consumption expenditures are subtracted to obtain total software capital formation. For 1992, consumer purchases are based on Census Bureau retail sales and services receipts from the 1992 Economic Censuses; beginning with 1993, these purchases are based on data from the Census Bureau's retail trade surveys. Finally, the estimates of total capital formation are divided between business purchases and government purchases, using benchmark I-O relationships of private purchases and of government purchases to total capitalized software, and further detail is calculated within government capital formation using information from the I-O accounts and other information.

Own-account software

The commodity-flow method is not used for the measurement of own-account software expenditures. 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 1992-98, 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 1999-2000, business own-account software expenditures are extrapolated using NIPA estimates of private fixed capital formation in computers and peripheral equipment; government own-account software is extrapolated using NIPA Federal government gross capital formation in computers and peripheral equipment.

Data on the number of programmers and system analysts are available from the BLS by occupation and by industry. In order to avoid double-counting the work performed by some of these employees

[4]Annual estimates of software inventories are available only from the benchmark I-O tables. For the calculation of capital formation in prepackaged software, it is assumed that the inventory changes for all years except 1992 are zero.

[5]When software was recognized as capital formation in the NIPA's in October 1999, the estimates of royalties and license fees for electronically transmitted custom software and prepackaged software were in the exports and imports of services estimates, but were not separately identifiable for the benchmark year (1992) or surrounding years.

to produce embedded software or to produce software for sale, an adjustment is made to the total number of programmers and systems analysts to reduce the number of employees from the mining, manufacturing, and business services industries. This adjustment is made judgmentally on the basis of unpublished BLS data on the employment of computer programmers and systems analysts as shares of detailed industries' employment. BEA assumes that industries with higher concentrations of programmers and systems analysts, such as business services, are more likely to produce software that is embedded or sold separately as purchased software than own-account software.

It is assumed that 50 percent of the time spent by programmers and systems analysts is spent on the development of new software. Because no recent studies of programmer time spent on various tasks have been identified, the proportion of time spent on the development of new software is based on a 20-year old study on the share of software development and maintenance costs in 487 business organizations.[6] Although the best point estimate of the share of time spent on development was 62 percent, a 50-percent share was chosen to emphasize the approximate nature of the estimate and on anecdotal evidence that the share of programmers' time spent doing tasks associated with new software development has diminished with the growing importance of personal computers and prepackaged software.

BLS data on national median weekly earnings for computer programmers and for systems analysts are used to derive a single wage rate for the relevant industries. The other production costs are derived as follows: Nonwage compensation, on the basis of the relationship between compensation and wages derived from published NIPA data by industry; and intermediate inputs, on the basis of the relationship between intermediate inputs and compensation derived primarily from the Census Bureau's economic census of service industries.

Prices

For capitalized prepackaged software, different methods are used to estimate the corresponding price index, depending on the year. For 1992-93, the index is an unweighted average of a BEA hedonic price index for business applications software and a BEA matched-model price index for selected types of prepackaged software, including spreadsheets, databases, and word processors. For 1994-97, the index is based on matched-model indexes for spreadsheet and word processing programs. Beginning with 1998, the index is based on a BLS matched-model producer price index (PPI) for all prepackaged applications software. To these matched-model indexes, BEA makes a negative bias adjustment because the matched-model indexes tend to understate quality-adjusted price declines for prepackaged software. For 1994-97, the bias adjustment of -6.2 percent is equal to one-half of the difference between the matched-model index and the hedonic index for 1985-93. Beginning with the use of the PPI , the bias has been halved to 3.1 percent[7]

The price indexes for capitalized own-account software are input-cost indexes that are calculated from a weighted average of the percentage changes in the compensation rates for computer programmers and systems analysts and in the intermediate inputs associated with their work. Intermediate input costs have averaged slightly more than half of total costs. The use of input costs assumes that there are no changes in the productivity of computer programmers and system analysts.

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[6]See Barry W. Boehm, Software Engineering Economics (Englewood Cliffs, NJ: Prentice-Hall, 1981): 522-35, 548-50.

[7]For a more complete description of these methodologies, see Parker and Grimm op cit.

Because of different compensation movements of private and of government employees over time, compensation cost indexes are estimated separately for government and for business own-account software capital formation.

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. Business own-account software is weighted 75 percent and prepackaged software is weighted 25 percent.

Recent improvements

The Bureau of Economic Analysis continues to refine and improve the measurement of computer software capital formation. Although most improvements will not be incorporated until the next comprehensive revision of the NIPA's, which is scheduled for late 2003, a new quarterly methodology was introduced as part of the 2001 annual revision of the NIPA's that should significantly reduce future revisions to the estimates of capitalized software for the most recent 1 or 2 years.

Although annual industry receipts of prepackaged and custom software are available from the Census Bureau, there is a lack of comprehensive monthly or quarterly indicators. Starting with the July 2001 annual revision, quarterly estimates of prepackaged software capital formation were improved by extrapolating using an indicator that is a combination of 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. The quarterly estimates of custom software capital formation are extrapolated using the SEC receipts. The Census Bureau's service annual survey continues to be used as the primary data source for the annual estimates.

The previous quarterly methodology, which was based on lagged percentage changes in BLS tabulations of wages and salaries of workers in the prepackaged software and computer programming services industries, overstated the growth rate of the output of the prepackaged and of the custom software industries and had resulted in large annual revisions to the estimates of software capital formation. For example, revised estimates of computer software capital formation accounted for about one-half of the downward revision to the growth rate of GDP from 1997 to 2000 in the August 2001 annual revision of the NIPA's.   Use of the new quarterly methodology would have resulted in much smaller revisions to software capital formation for 1999 and 2000 when the annual source data became available.

Developments underway

For the 2003 comprehensive revision of the NIPA's, BEA plans to incorporate an improved benchmark I-O estimate for the year 1997 and hopes to make improvements to the price measures for both own-account and custom software that account for increases in labor productivity of computer programmers and system analysts.

The 1997 benchmark I-O estimates of software capital formation will include several significant improvements:
- For purchased software--improved estimates of intermediate consumption and an expanded definition of exports and imports of software.

- For own account software--improved employment and wage data, including estimates of the number of system analysts, improved industry detail, and the replacement of mean wages for median wages, and improved ratios to convert directly from wages to total costs, in place of the current two-step process.

Intermediate consumption

A weakness in the estimation of software capital formation has been the measurement of intermediate consumption. The 1992 and 1997 economic censuses did not collect information on purchases of services by manufacturers. Thus, census data on purchases of computer software, classified as a service, were not available. In addition, when the 1992 I-O table was completed about four years ago, software was treated as intermediate consumption, not as capital formation. As such, 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.

For the 1997 I-O estimates, software will be treated as capital formation and adjustments will be made to add these missing receipts in deriving capital formation. New sources are being investigated to derive estimates of software embedded in or bundled with other equipment. For example, one possible source is annual detailed company revenue reports. At least one large software manufacturer reports receipts of original equipment manufacturer (OEM) software on its annual report. These receipts would provide information on software embedded in other equipment. At a minimum, these OEM receipts would provide a lower boundary for intermediate consumption. In addition, an estimate for the intermediate purchase of custom software is available from a Census Bureau current industrial report on systems integration revenue.

Expansion of exports and imports

The definition of exports and imports of software will be expanded to more accurately reflect the international trade of software. The present methodology only includes 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 custom software and prepackaged software are included in the exports and imports of services estimates and should be included in the commodity flow for estimating software capital formation. Until 1997, these royalties and license fees were not separately identifiable in the foreign trade data. For the 1992 I-O table, these royalties and license fees were not included in the commodity-flow estimation for software capital formation, although they were included elsewhere in the commodity-flow calculation.

Own-account software

The 1997 I-O account will separately identify own-account software expenditures and treat them as capital formation. Two major improvements will be introduced. Newly available data on the number of programmers and system analysts and their mean wage from the Bureau of Labor Statistics (BLS) by three-digit standard industrial classification system (SIC) industry will be used. BEA previously used employment data at the two-digit SIC level and a national median wage by occupation. A better estimate of system analysts will also be prepared. When own-account software was recognized as capital formation in the NIPA's, the occupation "systems analysts" could not be separately identified from a larger occupational group "computer engineers, scientists, and systems analysts." Thus, the estimates of computer programmers and systems analysts actually included computer engineers and scientists. BLS now separately identifies systems analysts in their occupational data. Removing computer engineers and scientists in the 1997 I-O estimate will result in a more accurate measure of the number of "computer programmers and systems analysts" lowering it by approximately 15 percent from the previously-used measure.

Table 1.–Principal Source Data and Estimating Methods Used in Preparing Estimates
of Annual Current-Dollar Prepackaged and Custom Software Capital formation

Component	1992 Value (billions of dollars)	1999 Value (billions of dollars)	Benchmark year estimates	Other years
Total shipments of domestic producers Prepackaged Custom	48.7 22.6 26.1	150.9 70.7 80.2	Census Bureau's quinquennial census of service industries and census of manufactures.	Receipts of prepackaged and custom programming industries from the Census Bureau's service annual survey.
Less: Intermediate consumption Prepackaged Custom	0.3 0.3 0.0	1.0 1.0 0.0	Detail from the input-output estimates for computer manufacturing industry from census of manufacturers.	Ratio of intermediate consumption to total receipts in benchmark year times total receipts.
Less: Inventory change Prepackaged Custom	0.0 -0.0 0.0	0.0 0.0 0.0	Detail from the input-output estimates.	Assumed to be zero (lack of source data).
Equals: Domestic supply to final uses Prepackaged Custom	48.4 22.3 26.1	149.8 69.7 80.2	Calculated as a residual.	Calculated as a residual.
Less: Exports Prepackaged Custom	2.0 1.3 0.7	3.3 2.1 1.2	Balance of payments amounts: Exports documents compiled monthly by the Census Bureau.	Balance of payments amounts: Exports and imports documents compiled monthly by the Census Bureau.
Plus: Imports Prepackaged	0.4 0.2	0.5 0.3	Balance of payments amounts: Imports documents compiled monthly by the Census Bureau,	Balance of payments amounts: Exports and imports documents compiled monthly by the Census

**Table 1.–Principal Source Data and Estimating Methods Used in Preparing Estimates
of Annual Current-Dollar Prepackaged and Custom Software Capital formation–Continued**

Component	1992 Value (billions of dollars)	1999 Value (billions of dollars)	Benchmark year estimates	Other years
Custom	0.2	0.2	with adjustments by BEA for valuation (1995 forward).	Bureau, with adjustments by BEA for valuation.
Equals: Supply to domestic final uses	46.7	147.1	Calculated as a residual.	Calculated as a residual.
Prepackaged	21.2	67.9		
Custom	25.5	79.2		
Less: Personal consumption expenditures	2.3	6.0	Detail from the input-output estimates.	Retail-control method, using retails sales from the Census Bureau's Annual Survey of Retail Trade.
Prepackaged	2.3	6.0		
Custom	0.0	0.0		
Equals: Supply to domestic fixed capital formation	44.4	141.1	Calculated as a residual.	Calculated as a residual.
Prepackaged	18.9	61.9		
Custom	25.5	79.2		
Business capital formation	33.4	106.7	Detail from the input-output estimates.	Ratios of business to total software fixed capital formation of each type in benchmark year held constant.
Prepackaged	16.6	54.4		
Custom	16.8	52.3		
Government capital formation	11.0	34.4	Detail from the input-output estimates.	Ratios of government to total software fixed capital formation of each type in benchmark year held constant.
Prepackaged	2.3	7.5		
Custom	8.7	26.9		
General government	10.7	31.2	Detail from the input-output	Ratios of general government to

**Table 1.–Principal Source Data and Estimating Methods Used in Preparing Estimates
of Annual Current-Dollar Prepackaged and Custom Software Capital formation–Continued**

Component	1992 Value (billions of dollars)	1999 Value (billions of dollars)	Benchmark year estimates	Other years
Prepackaged	2.2	7.0	estimates.	total software fixed capital formation of each type in benchmark year held constant.
Custom	8.5	24.2		
Federal	7.9	22.2	Detail from the input-output estimates.	Ratios of Federal government to total software fixed capital formation of each type in benchmark year held constant.
Prepackaged	1.0	3.0		
Custom	6.9	19.2		
State and local	2.8	9.0	Detail from the input-output estimates.	Ratios of State and local government to total software fixed capital formation of each type in benchmark year held constant.
Prepackaged	1.2	4.0		
Custom	1.6	5.0		
Government enterprises	1.4	3.2	Detail from the input-output estimates.	Ratios of government enterprises to total software fixed capital formation of each type in benchmark year held constant.
Prepackaged	1.2	0.6		
Custom	0.2	2.7		