# Information Processing Equipment and Software in the National Accounts

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# 1. Introduction

In the U.S. national income and product accounts (NIPA's), most of the types of goods in the investment category "information processing (IP) equipment and software" have experienced rapidly changing technology and are thus candidates for inclusion in the new economy. The NIPA price indexes for computers and peripheral equipment, computer software, and communication equipment all, at least in part, include quality adjustments based on hedonic studies. In addition, anecdotal evidence strongly indicates that instruments have also have undergone substantial quality improvements, although no hedonic quality adjustments are currently being made to their prices. Together, these goods make up more than nine-tenths of the category. There is also some evidence that there have been substantial quality improvements for the remaining two types of goods in the category, photocopy and related equipment and office and accounting equipment. Table 1 shows the shares of the components in the category for 1996, the reference year for the NIPA's.

Several recent studies have found that goods in this investment category have had significant roles in an acceleration in both real GDP and labor productivity in the second half of the 1990s. For example, Nordhaus (2001) found more than one-third of the acceleration in labor productivity in 1996-98 versus 1978-95 was due to new economy production, defined as output of machinery, electrical equipment, telephone and telegraph equipment, and software. Similarly, Gordon (1999, 2000) found a sharp acceleration in labor productivity in durable goods manufacturing, and even more sharply in computers manufacturing, and much weaker accelerations in other parts of the business sector for the period 1995:IV to 1999:IV versus 1972:II to 1995:IV. Jorgenson and Stiroh (2000) found that an acceleration in productivity growth was driven by information technology in the late 1990s compared to the early 1990s. Oliner and Sichel (2000) found that the sum of the contributions of the services of information technology capital and multifactor productivity in computers production and computer-related semiconductors production accounted for about two-thirds of the acceleration in labor productivity for the period 1996-99 compared to 1991-95.

Some researchers have urged that additional work be done, particularly on price estimates for equipment based on semiconductors and other rapidly-advancing technologies. For example, Jorgenson (2001) argued that BEA's price indexes for own-account and custom software present a distorted picture because they are partly based on programmer wages and do not allow for improvements in the productivity of computer programmers. Further, he has argued that some communications equipment, particularly transmission gear, has rates of progress that outstrip semiconductors, and that more work is needed to adequately adjust for these improvements in quality.

BEA's strategic plan identifies several initiatives that are designed to improve the estimation of IP equipment and software and the other components of GDP (Landefeld 2001). BEA intends to continue to work with the Census Bureau to improve the quality and timeliness of the business and government surveys and to work with the Bureau of Labor Statistics (BLS) to provide quality-adjusted price indexes for high-tech goods and to expand coverage of high-tech services. BEA also plans to conduct its own research toward developing quality-adjusted price indexes for selected IP components where data may be available to adjust for changing characteristics. In addition, BEA plans to improve its IP equipment and software estimates-particularly the software component-in its input-output tables and in its national income and product and international transactions accounts.

In order to facilitate research leading to improved measurement of information technology, this paper discusses the relationship between private fixed investment in IP equipment and software and GDP, explains how the current- and constant-dollar estimates are prepared, and finally assess recent progress in measurement and plans for improvement.

## 2. IP Equipment and Software Investment and Movements in Real GDP

IP equipment and software investment played important roles in both the acceleration of real GDP during the 1990s and its slowing in 2000-01. The acceleration of real GDP began in late 1995. As shown in table 2, the average rate of growth of real GDP increased from 2.4 percent in 1991-95 to 4.1 percent in 1996-2000. Real IP equipment and software investment played important roles in both the acceleration and the slowing. In 1996-2000, about one-fourth of the increase in the average rate of growth of real GDP was accounted for by IP equipment and software investment, and another fourth was accounted for by all other private fixed investment; more precisely, IP equipment and software investment contributed 0.76 percentage point to the average growth rate of real GDP in 1996-2000.[1]

Real GDP began to slow during 2000; it slowed from 4.0 percent in the first half of the year to 1.6 percent in the second half. In the first half of 2001, real GDP growth slowed to 0.8 percent as the economy slipped into a recession, and real GDP slowed further to 0.2 percent in the second half, as a negative 1.3 percent in the third quarter was slightly more than offset by a positive 1.7 percent in the fourth quarter.

As shown in table 3, this short-run pattern was largely the result of declining or negative contributions to changes in real GDP from both private fixed investment and change in private inventories. The contributions of change in private inventories were negative in every quarter of 2000 and 2001, with the exception of 2000:II. The contributions of IP equipment and software investment declined after 2000:I, and were negative in all four quarters of 2001. The contributions of all other private fixed investment declined sharply in the first half of 2000, and thereafter were negative in all quarters except 2001:I.

[1] A 0.38 percentage point contribution of IP equipment and software investment in 1991-95 was in line with its gradually increasing contributions over the post-WWII era, which ranged from 0.06 percentage points in 1951-60 to 0.33 percentage point in 1981-90. The doubling of its contribution in 1996-2000 was a substantial deviation from its historical trend.

Thus, the contributions of IP equipment and software investment played a large role in the declining trend of real GDP after the beginning of 2000. Chart 1 shows trends using three-quarter centered moving averages.[2] The moving average of GDP growth fell from about 3 percent in both 2000:II and 2000:III to 0.1 percent in 2001:II and 0.2 percent in 2001:III. From 2000:II to 2001:III, the declining contributions of IP equipment and software accounted for about two-fifths of the fall in the trend growth of real GDP, somewhat more than its relative contribution to the acceleration in real GDP from the first to the second half of the 1990s.

## 3. Estimating Private Fixed Investment

In addition to the standard challenges associated with measuring real output, measuring real output in IP equipment and software presents some additional challenges because new products are constantly developed and introduced into this category and because existing product characteristics in this category tend to change more rapidly than product characteristics in other categories. These additional challenges presented by new and changing products include the following:

- **Benchmark extrapolators**. The most recent benchmark input-output (I-O) tables are for 1992 – a year in which some of the products presently included in IP equipment and software did not exist in their present form. Non-benchmark year estimates reflect extrapolations, where the extrapolators must be flexible enough to reflect the current-year's basket of goods and at the same time fit the description of an existing benchmark year component.

- **Source data.** Naturally, new products present problems for BEA's source data agencies. For example, when a new or significantly modified product is introduced into the BLS producer price index (PPI), an appropriate link must be formed. Similarly, when a manufacturer starts shipping a new product, the Census Bureau must determine exactly where to classify the new product. Often with the introduction of new products, survey questionnaires need to be modified.

- **Product knowledge**. It is important for the statistical agencies' analysts to understand the products being measured. As more and more of these products are significantly changed or introduced, it becomes more and more difficult for the analysts to stay current.

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[2] A three-quarter centered moving average is used to describe trends because it acts to smooth quarter-to-quarter erratic movements in real GDP.

## 3.1 Current-Dollar Estimates

IP equipment and software investment, excluding own-account software, is determined in current prices primarily by the “commodity-flow” methodology, with periodic benchmarking to the quinquennial I-O tables. The commodity-flow method is a “supply-side” approach, which traces commodities from their domestic production or importation to their final purchase. (Chart 3 illustrates the commodity flow method.) 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. 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. An alternative estimation method that is used by many countries is a “demand-side” approach, which bases estimates on capital expenditure data collected from purchasers, such as the U.S. Annual Capital Expenditures Survey (ACES).

A supply-side approach is preferable to a demand-side approach for two reasons. First, 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 some IP components such as software. Second, the supply-side approach yields additional detail on type of asset that is generally not available from capital expenditure surveys. Typically, 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 ACES is used along with other information to allocate investment by industry.

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 of totaling somewhat more than $90 billion, more than seven times as much as reported by business in the ACES. 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.

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 data that are available for the annual NIPA estimates. A further abbreviation of the commodity-flow method is used for current-quarterly estimates. An illustrative example using the estimate of private fixed investment in computers and peripheral equipment for 2001:II is shown in table 4. A step-by-step explanation of table 4 follows:

- Manufacturers' industry shipments of computers and related products (line 1) are from the Census Bureau's monthly M3 publication. The adjustment to convert M3 industry shipments to private equipment and software (PES) product shipments (line 2) is derived by comparing corresponding M3 industry shipments to the most recent year's product shipments from the Census Bureau's Annual Survey of Manufacturers (ASM). The difference is product shipments in producer value (line 3). "Producer value," (as opposed to "purchaser value,") indicates that the shipments are valued at the plant and do not reflect trade or transportation margins.

- Next, export supply in producer value (line 4) is subtracted from the product shipments yielding domestic supply, still in producer value (line 6). Exports are derived from the Census Bureau's monthly Foreign Trade (CFT) statistics. The CFT exports are adjusted slightly for coverage (e.g. NIPA territorial adjustment).

- No attempt is made to estimate quarterly inventory changes for any commodities. Accordingly, change in inventories for computers and peripheral equipment are assumed to be zero (line 5).

- Intermediate, household, and government purchases (line 7) are subtracted from domestic supply, producer value. These purchases are derived from detailed benchmark I-0 estimates, the most recent annual estimate for personal consumption expenditures for computers, and the most recent annual estimate for government purchases of computers and peripheral equipment.

- Next, trade and transportation margins (line 8) are added in order to convert the domestic supply to private fixed investment from a producer value to a purchaser value (line 9). The trade and transportation margins are derived from detailed benchmark I-O estimates.
- Import supply (line 10) is derived from the monthly CFT statistics and, like export supply, is adjusted slightly for coverage.

- Intermediate, household, and government purchases (line 11) are subtracted and the trade and transportation margins (line 12) are added. The result is import supply to private fixed investment in purchaser value (line 13).

- The sum of domestic supply to private fixed investment (line 9) and import supply to private fixed investment (line 13) is the total PES extrapolator (line 14). Published PES computers and peripheral equipment (line 15) is derived using the percent change in the extrapolator.[3]

For annual estimates, the ASM is used instead of the M3 to prepare the PES product shipments. (Purchased sofware is an exception – here BEA uses industry receipts from the SAS to estimate prepackaged and custom software sales.)

The commodity-flow method is not used in the estimation of own-account software investment. This own-account investment is measured as the sum of production costs, which include employee compensation–both wage and nonwage–and the costs of intermediate inputs. For 1987-98, own-account software estimates are based on the numbers of programmers and computer systems analysts engaged in the production of non-embedded software or software produced for sale. These numbers are calculated from total numbers programmers and computer systems analysts where the effects of embedded software or software produced for sale are accounted for by limiting the maximum shares of employment in one (or two) digit-SIC-level industries to a maximum of 0.2 percent of total employment in each industry; the limits affect own-account software investment in mining, durable and nondurable goods manufacturing, and business services. (Numbers of programmers and systems analysts in excess of these limits are assumed to be engaged in the production of software for sale or in the production of software that is embedded in or bundled with other products of these industries.) The adjusted estimates are then multiplied by a factor of 0.5 to account for the share of programmers' and computer systems analysts' time that is estimated to be spent doing tasks associated with new investment rather than such activities as minor revisions and upgrades and maintenance. Together, the 0.5 factor and the limiting factor reduce business investment in own-account software to roughly one-quarter of what it would be if they were not included in the calculations. The same 0.5 is used for government programmers and computer systems analysts, but the limiting factor does not come into play.

The adjusted numbers of programmers and computer systems analysts are multiplied by national median wage rates for these occupations as well as by factors that translate from wages to total compensation at the one or two-digit industry level, and summed to get totals for all business and for federal and for state and local governments. The three compensation estimates are then blown up by factors derived from the 1987 and 1992 benchmark I-O tables to obtain total costs–which include intermediate inputs such as supplies, depreciation of physical capital, and management and support costs–to obtain own-account software investment for business and for federal and state and local governments.[4]

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[3] Published estimates for private fixed investment in computers and peripheral equipment can also be found in NIPA table 5.4, line 10.

[4] See Parker and Grimm (2000) for greater detail about the calculation of own-account software, including the adjustments and limiting factor.

The own-account software estimates are thus based on numbers of programmers and computer systems analysts, which are converted to current-dollar estimates by a series of sequential computations. The price indexes used to deflate own-account software are calculated from a weighted average of indexes of compensation for programmers and computer systems analysts and of the intermediate inputs associated with their work. Compensation indexes are estimated separately for business and for government own-account investment.

With the exception of the industry-level ratios that convert wage costs to compensation costs, the data used are from various BLS sources. The compensation ratios are based on industry-level data from NIPA tables 6.2 and 6.3.

For years after the most recent BLS occupation survey, business own-account software investment is extrapolated using NIPA estimates of current-dollar private fixed capital formation in computers and peripheral equipment. This extrapolation is needed because the BLS employment and wage rate estimates are available with a lag of at least two years. The ratio of own-account software to this capital formation is held constant at its 1998 value**;** because this ratio is for current-dollar values, it is unaffected by the tendency for computer prices to decline rapidly.

## 3.2 Real Estimates and Price Indexes

Changes in current-dollar private fixed investment in IP equipment and software reflect market value prices in a particular period. For many purposes, it is necessary to decompose these changes into quantity changes and price changes. The changes in quantities and prices are calculated using a Fisher formula that incorporates weights from two adjacent periods. These annual changes are "chained" (multiplied) together to form time series of quantity and price indexes.[5]

Real estimates, or quantities, can be expressed as index numbers or as "chained dollars." At present, the reference year is 1996 and therefore the quantity indexes equal 100 in 1996. The chain-dollar expression for quantities is essentially an index, however, it is based to the current-dollar value of the reference year. Accordingly, the chained (1996) dollar estimates for 1996 equal the current-dollar estimates for 1996, and other periods' values can be computed by multiplying the 1996 current-dollar values by the corresponding quantity index numbers divided by 100.

Detailed quantity estimates for private fixed investment in IP equipment and software are derived by deflation. That is, detailed current-dollar values are divided by detailed matching price

[5] For more information, see U.S. Department of Commerce, Bureau of Economic Analysis (2001).

indexes.  For the majority of IP equipment and software, the PPI's are the foundation for the price deflator.  A more detailed discussion of the price indexes used to deflate IP equipment and software follows.

### 3.2.1 Detailed price indexes

**Computers and peripheral equipment**.  Computers and peripheral equipment consist of 11 components for both annual and quarterly estimates.  For recent periods the price indexes used to deflate computers and peripheral equipment are derived from BLS PPI's and import price indexes (IPI's).  These PPI's and IPI's are quality adjusted by BLS using hedonic techniques.  Prior to the BLS implementation of quality adjusted computer prices using hedonic techniques, BEA estimated it's own set of detailed quality-adjusted computer price indexes.  While the BEA methods also used hedonic techniques to quality adjust, the two approaches were quite different.[6]  Table 5 presents the detailed deflators used to construct real Private fixed investment in computers and peripheral equipment.

**Software.**  Software consists of 3 components, shown in table 6, for both annual and quarterly estimates.  For recent periods, the price indexes used to deflate software are derived from PPI's, a BEA cost indexes, and a BLS employment cost index (ECI).[7]  Table 6 presents the detailed deflators used to construct real Private fixed investment in software.

**Communication equipment.**  Within communication equipment, 12 components (8 domestic, 4 import) accounted for 98 percent of investment for the 1999 annual estimates and 2 components (domestic total and import total) are used for the quarterly estimates.[8] Ten different price indexes (8 domestic, 2 import) are used to deflate these annual components.  For the quarterly estimates, detailed quarterly indexes corresponding to the annual components are weighted together using current-dollar shares from the most recent year available.  Table 7 presents the detailed deflators used to construct real Private fixed investment in communication equipment.  (Note, component products were defined in the 1992 I-O table, however, current-year extrapolators reflect goods and services produced in the current-year that may not have existed in 1992.  For example, routers, switches and hubs are included in the extrapolator for "Telephone and telegraph wire apparatus.")

**Instruments.**  Within instruments, 21 components (16 domestic, 5 import) accounted for 98 percent of investment for the 1999 annual estimates and 2 components (domestic total

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[6] For more information on the BLS computer price indexes, see Holdway (2001).  For more information on the BEA computer price indexes, please see Wasshausen, D. (2001).

[7] For more information, see Parker and Grimm (2000).

[8] Components with current-dollar shares of less than one percent are not shown.

and import total) are used for the quarterly estimates. Fifteen different price indexes (12 domestic, 3 import) are used to deflate these annual components. As with quarterly estimates for communications equipment, detailed quarterly indexes corresponding to the annual components are weighted together using current-dollar shares from the most recent year available. Table 8 presents the detailed deflators used to construct real Private fixed investment in instruments.

**Photocopy and related equipment.** Within photocopy and related equipment, 13 components (9 domestic, 4 import) accounted for nearly all of investment for the annual estimates of 1999 and 2 components (domestic total and import total) for the quarterly estimates. Nine different price indexes (8 domestic, 1 import) are used to deflate these annual components. Detailed quarterly indexes corresponding to the annual components are weighted together using current-dollar shares from the most recent year available. Table 9 presents the detailed deflators used to construct real Private fixed investment in photocopy and related equipment.

**Office and accounting equipment.** Within office and accounting equipment, 13 components (8 domestic, 5 import) accounted for nearly all of investment for the annual estimates of 1999 and 2 components (domestic total and import total) are used for the quarterly estimates. Six different price indexes (5 domestic, 1 import) are used to deflate these annual components. Detailed quarterly indexes corresponding to the annual components are weighted together using current-dollar shares from the most recent year available. Table 10 presents the detailed deflators used to construct real Private fixed investment in office and accounting equipment.

### 3.2.2 Inventory of hedonic price indexes

Hedonic methods are sometimes used to quality adjust price indexes that are used to deflate several of the components of IP equipment and software:[9]

- **Computers and peripheral equipment**
  All the detailed price indexes used to deflate computers and peripheral equipment employ hedonic methods for quality adjustment. As table 5 indicates, BLS PPI's and IPI's are used to construct the price indexes used to deflate Private fixed investment in computers and peripheral equipment. In the PPI's for computers and peripheral equipment, hedonic functions are used to estimate prices for specified characteristics (like speed). These estimated prices of specified characteristics are then used to quality adjust the price of a newly introduced model so that it is consistent with the discontinued model.[10] The IPI's for computers and peripheral equipment use the estimated characteristics prices from the

[9] For more information on BEA's use of hedonic quality adjustment, see Moulton (2001).

[10] For more information on BLS computer price indexes and an illustrative example, see Holdway (2001).

PPI to quality adjust models as needed.

BEA first introduced quality-adjusted price indexes for computers and peripheral equipment into the NIPA's with its 8th comprehensive revision, released in December 1985. At that time, BEA worked with IBM in a joint effort to develop quality-adjusted price indexes for five types of computing equipment--computer processors, disk drives, printers, and displays (terminals), and tape drives.[11] Hedonic methods were used to estimate coefficients (prices) for various characteristics (speed, memory, etc.). Composite price indexes were then constructed using both reported model prices and, for models not sold in the base year, model prices imputed from the characteristics coefficients. As BLS hedonic PPI's were introduced starting in the early 1990's, BEA switched to using the BLS indexes as deflators.[12]

- **Software**
  In the October 1999 comprehensive revision, software was first recognized as fixed investment. The price index for prepackaged software reflects hedonic methods for quality adjustment for the period 1985-93. For 1985-93, the quality-adjusted price index is estimated by combining the BEA-developed hedonic price indexes and the Oliner-Sichel matched-model indexes. BEA developed hedonic price indexes for two types of prepackaged software--spreadsheets and word processing.[13] These hedonic price indexes are estimated using a methodology that is an extension of earlier work on software prices by Brynjolfsson and Kemerer (1996) and by Gandal (1994). The price index estimates are based on regressions in which the logarithm of prices of prepackaged software is a linear function of selected quality characteristics and of dummy variables for each year of the price observations. The resulting indexes are "regression" price indexes in which the coefficients of the dummy variables for each year are used to construct price index values for the sample periods of the regressions.[14] The individual hedonic price indexes for the two types of software are weighted together to produce a summary hedonic price index for prepackaged software. 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.

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[11] See Cartwright (1986), Cole, et. al. (1986), and Triplett (1986).

[12] For more information on BEA computer price indexes, see Wasshausen (2001).

[13] The data on prices and quality characteristics used to estimate the regressions are obtained from published editions of National Software Testing Laboratories' Ratings Reports. These data are available only until 1994. Hedonic estimates were also made for database software, but the results were not adequate to support the estimation of a price index.

[14] For more information, see Cole et. al. (1986).

- **Communication equipment**
  Two of the detailed price indexes used in the deflation of communication equipment use hedonic methods for quality adjustment: Telephone switching equipment, and local area network (LAN) equipment.

#### 3.2.2.1 Price index for telephone switching equipment

In the July 1997 annual revision of the NIPA's, a quality-adjusted price index for telephone switching equipment that was developed at BEA was adopted. This index covers the period 1985-96 and is based on a hedonic regression explaining the prices of digital telephone switches.

Telephone switches have performed increasingly complex sets of operations over time. At their simplest, electro mechanical switches–which were the best available technology until the early 1980's–performed essentially the same function that human telephone operators did previously; linking the calling telephone line to the called telephone line, and also providing a dial tone. Digital electronic telephone switches–which have supplanted the earlier electro mechanical switches–perform many additional, computer-like functions. For example, they can take an incoming telephone analog voice input, convert it to digital signals, break it up into packets (this allows one line to handle more than one call at a time) that also include information about the call, including the calling number, send the packets to anywhere in the world, each by its own–most efficient–route, reassemble the packets into properly ordered digital signals, reconvert the call to analog voice outputs, and send it to the receiving telephone line. Switch operations are controlled by large-scale computer programs that are custom made for each switch.

BEA's switch price index is based on publicly-available data that were obtained from the Federal Communications Commission, which gathered the data from telephone operating companies to support rate-setting hearings. A hedonic regression for the prices of switches was estimated using as explanatory variables the number of telephone lines of capacity of the switch, the type of switch and its manufacturer, the state that the switch was installed in (different states typically have very different ways of assembling switch networks–to be optimal under different calling densities, patterns, and distances–that affect the costs of the switches used as part of the networks), and the year that the switch was installed. The regression made the log of the switch price a function of the log of the number of lines, 28 quality characteristics dummy variables, and 13 year dummy variables. The data set included installed switches in 20 states that contained 55 percent of the U.S. population and that were chosen to be representative of the various regions of the U.S.

The price index, which is a regression price index, was constructed using the coefficients of the year dummy variables and a smoothing algorithm of $0.6 * P(y) + 0.3 * P(y-1) + 0.1 * P(y-2)$; the smoothing was used to reduce erratic year-to-year movements in the raw index. The index has an average annual rate of decline of 9.1 percent from 1985 to 1996, and the declines range from 4.0 percent in 1991 to 23.1 percent in 1995.

The price index was not extended past 1996 because the Telecommunications Reform Act of 1996 removed a mandatory reporting requirement and telephone operating companies stopped reporting. In any event, in the last half of the 1990s new and radically different switching technologies began to be adopted and very different quality characteristics became important in determining the capabilities and prices of switches.

#### 3.2.2.2 Price index for LAN equipment

In the July 2001 annual revision of the NIPA's, a quality-adjusted price index for LAN equipment was adopted. This price index is published by the Fed, and was developed by Mark Doms and Christopher Forman (2001). A brief description of the price index and its methodology was published in the March, 2001 Federal Reserve Bulletin.

Doms and Forman found rapid rates of decline for prices for all of the types of LAN equipment that they examined. For the period 1995-99, their aggregate index declines at an average rate of 18.0 percent per annum, not greatly different from the 22.7 percent per annum rate of decline for the NIPA price index for computers and peripherals.

### 3.2.3 Hedonic estimates versus other estimates of quality-adjusted prices

There is increasing evidence that carefully constructed hedonic price indexes may differ little from some types of traditional matched-model price indexes.[15] Aizcorbe, Corrado, and Doms (2000) estimated price indexes for desktop personal computers and notebook computers in the period 1994-98 using both hedonic regressions and Fisher chain-weighted matched-model price estimates. They obtained very similar average rates of decline; weighted average annual rates of decline for the two types of computers were 29.1 percent for the matched-model estimates and 29.8 percent for the hedonic estimates. They also found that matched-model and hedonic price indexes yielded very similar estimates for average annual rates of decline for prices of Intel microprocessors in the period 1993-99; 56.3 percent for the matched-model estimates and 57.0 percent for the hedonic estimates.

Similarly, BLS studies found that replacing its matched-model estimates with hedonic estimates only slightly raised the rate of price increase for VCR's, and slightly lowered it for televisions. See Moulton, LaFleur, and Moses (1999) and Liegey and Shepler (1999).

As part of its work to develop price indexes for semiconductors, BEA estimated a hedonic price index–in log-log form–that explained prices of Intel microprocessors as functions of a number of quality characteristics and year dummy variables. The primary use of the hedonic equation was

[15] See Landefeld and Grimm (2000).

to fill in missing price observations where quantity data were available but not prices; the hedonic estimates were used for about a third of the price observations. The augmented set of price observations was used with the quantity observations to construct a Fisher chain-weighted matched-model price index. Over the period 1985-94, the matched-model price index had a somewhat more rapid average rate of decline than did a hedonic regression price index, 27.4 percent versus 22.0 percent; see Grimm (1998). Similar results were obtained for Motorola microprocessors.

As part of the work to develop its quality-adjusted index for digital telephone switches, BEA constructed alternative price indexes based on the average cost per installed telephone line of capacity for two common types of switch–AT&T's 5ESS switch and Northern Telecom's DMS100 switch. For the 1985-95 period, these indexes declined at average rates of 9.0 and 9.1 percent per annum, about the same as the average rate of decline of 9.1 percent for the hedonic price index. Even the year-to-year patterns are roughly similar; for example, the 5ESS price-per-line price index has undergone declines that are generally close to those for the hedonic index ; in contrast the previously-used price index for telephone switches increased slightly over the period (chart 2).

Thus, when matched-model and hedonic price index estimates using the same data sets are compared, the results are often similar and hedonic estimates do not always yield greater rates of decline or lower rates of increase. Dulberger has suggested that, at least with regard to computer chips, the differences in rates of decline between some quality-adjusted price index estimates and the PPI estimates may stem from price patterns that combine with rapid early rates of decline for new models with lags in adding the new models into the PPI sample; see Dullberger (1993).

# 4. Recent Progress and Plans for Improvement

## 4.1 Recent improvements

Several methodological changes were introduced as part of the 2001 annual revision of the NIPA's that led to improved estimates for IP equipment and software investment:

- Improved methodology for estimating quarterly fixed investment in purchased software

  The quarterly estimates of fixed investment in prepackaged and in custom software were improved because 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 in the prepackaged software and computer programming services industries (SIC 7372 and SIC 7371, respectively). 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.

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

  As described above, 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 communication equipment investment. 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 deflate the component of communication equipment that reflects LAN equipment (see Table 7); previously, the PPI for telephone and telegraph apparatus was used to deflate this component.

- Improved methodology for estimating price index used to deflate fixed investment in custom software

  An improved price index is now used in the deflation of custom software that is based on a weighted average of the own-account software price index and the PPI for prepackaged software applications sold separately (nonsuite).[16] The use of the index for nonsuite applications more appropriately reflects the type of existing programs or program modules that are often incorporated into custom software. Previously, the PPI for all prepackaged software applications was used, together with the own-account software price index, to deflate custom software.

## 4.2 Plans for improvement

In 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 (tentatively scheduled to be released in late 2002) and hopes to make additional improvements to the price estimates for custom and own-account software, photocopying equipment, medical equipment, and telecommunications transmission equipment.

### 4.2.1 Improved current-dollar estimates

#### 4.2.1.1 1997 Benchmark I-O Table

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 the Census Bureau that support both the finer-level calculations and allow more direct estimation of the costs of production based on wage costs.[17]

- Improved estimates of intermediate consumption of purchased software

  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, software was treated as intermediate consumption, not as investment. BEA did not make any supplementary adjustments to the 1992 Census to account for intermediate software purchases by manufacturers; the reported census data were used. Consequently, intermediate purchases of software may have been underestimated. 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

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[16] A weighted average is used because custom software consists of a mixture of new programming and existing programs or program modules (including prepackaged software) that are incorporated into new systems.

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

(and possibly other) manufacturers. New sources will be used to derive estimates of purchased 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 from original equipment manufacturer (OEM) software in its annual report. These receipts 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

  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 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, however, these royalties and license fees were not separately identifiable in the foreign trade data.

- Improved estimates of own-account software

  Own-account software estimates in the benchmark 1997 I-O table 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 data available from BLS on an annual basis, beginning with 1997.

  Improvements in the I-O estimates for own-account software will be in three areas. First, new data are available from BLS that separately identifies the number of computer system analysts excluding computer engineers and computer scientists; previously these occupational categories had been combined. The exclusion of computer engineers and computer scientists results in a more accurate measure of the number of persons who are predominantly engaged in the creation of own-account software. Second, adjustments to reduce the total number of computer programmers and systems analysts (in order to avoid double-counting work performed by some of these employees to create embedded software or software produced for sale) will be estimated from 3-digit detail; previously they were estimated primarily from 2-digit detail. The result will be a more finely-tuned set of estimates of the number of computer programers or computer systems analysts who are creating investment in own-account software rather than software to be sold or embedded in or bundled with sales of other goods. Third, BLS now publishes estimates of mean wages of computer programmers and computer systems analysts by industry; previously only median wages had been published. Further, the Census Bureau now publishes estimates of both total costs and wage costs for the custom and prepackaged software industries.  These 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 go 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 go 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.

#### 4.2.1.2 Improved Source Data

The Administration's budget for fiscal year (FY) 2003 includes two Census initiatives which, if funded, could significantly improve the measurement of private fixed investment in IP equipment and software.  The initiatives focus is 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.

! Quarterly Services Indicator. The Census Bureau has proposed collecting and publishing quarterly industry receipts for selected industries, including NAICS categories 5112, “Software publishers,” and 5415, “Computer systems design and related services.”  These industries consist of establishments that are primarily engaged with producing prepackaged and custom software.  Presently, the only representative government survey of the industries that produce prepackaged and custom software is the services annual survey; quarterly or monthly data are not available (except for the information that can be gleaned from financial statements of publicly held corporations).  The availability of such data would greatly improve the accuracy of the NIPA quarterly estimates by providing a more reliable measure of quarterly receipts for software producing industries based on a much larger and more representative sample.  (For more information on how these quarterly estimates are presently prepared, please see first bullet in section 4.1 above.) Scheduled proposed collection begins first quarter 2004, collecting data for fourth quarter 2003.

! Annual coverage of e-business infrastructure.  This initiative would significantly augment information presently available from the ACES and could significantly improve our annual estimates for IP equipment and software investment.  Two major changes affecting IP equipment and software investment are proposed in this component of the e-business initiative and are described below:

1.  To respond quickly to data user needs, a new question for capitalized software will be proposed for the ACES.  Beginning with annual data for 2001, national totals for total

capitalized software, capitalized prepackaged software, capitalized custom software, and capitalized own-account software would be available.

2. Beginning with annual data for 2003, and thereafter, national totals for capitalized and expensed information and communication technology (ICT) equipment and software would be collected and published.[18]

While there are no plans to replace "supply-side" (commodity-flow based) 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 sound basis for judgmental adjustments as needed. In addition, the availability of this new data would help in producing more accurate estimates of investment by industry.

### 4.2.2 Improved price indexes

- Own-account and custom software

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 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.

Function points (FP's) measure software by quantifying its functionality provided to the user based primarily on the logical design.[19] 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

[18] The ICT infrastructure includes expenditures on equipment (such as computers and peripherals), buildings and structures (such as server farms and digital transmission towers) and their maintenance, software, and related services (such as programming and network support staff supporting ICT equipment and structures).

[19] For more information on function points, see Longstreet (2001).

software price index using FP's and BEA will continue to evaluate their research.[20]

! Photocopying equipment, medical equipment, and telecommunications transmission equipment

BEA plans to conduct research on explicit quality adjustment for several products within IP equipment and software. These include photocopying equipment, medical equipment, and telecommunications transmission equipment. Presently, these products are deflated using PPI's and IPI's.

In addition to BEA's work, 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 or improved 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.[21]

#### 4.2.3 Presentational Improvements

BEA plans to feature a new page on its website entitled, "Prices and Output for Information and Communication Technologies." The new page will contain data tables (both previously available and newly available), Survey of Current Business articles, BEA papers and presentations, and miscellaneous materials pertaining to prices and output for information and communication technologies. Presently, many, but not all of these items are available on the BEA website in a variety of locations. The new site will serve as a "one-stop shop" for these products.

##### 4.2.3.1 Featured data tables

Several unpublished data tables will be posted on the new internet page showing real and current-dollar estimates. Examples include tables showing final sales of computer hardware, computer software, and communication equipment and information on hardware and software prices.

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[20] For more information, see McKinsey Global Institute (2001).

[21] See Aron, Dunmore, and Pampush (1997) and Banks (1997).

## 5. Summary

There is evidence that investment in IP equipment and software has had a significant role in an acceleration in both real GDP and in labor productivity in the second half of the 1990's. In view of the increased importance of IP equipment and software as a form of investment, we anticipate that it will continue to play an important role in the future. As such, BEA recognizes the importance of accurately measuring investment in this category, including both estimates for prices and for current-dollar expenditures.

Several important improvements have recently been incorporated into the estimates for IP equipment and software and BEA continues to recognize the importance of pursuing future improvements in the measurement of these estimates. BEA's strategic plan calls for continued work on improvements to the source data, improvements to the methods used for estimation of software, and continued work on developing quality-adjusted price indexes and improved measures of high-tech services. In addition, BEA plans to continue working with the Census Bureau and BLS to support initiatives by those agencies that will lead to more accurate or more timely data for IP equipment and software investment. Furthermore, BEA would like to take a pro-active role in identifying new developments in technology that might lead to earlier incorporation of new products in the national accounts and in other government surveys.

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Table 1.–Components of IP Equipment and Software in 1996

| | Billions of dollars | Percent of total |
|---|---|---|
| **IP equipment and software** | 287.3 | 100.0 |
| Computers and peripheral equipment | 70.9 | 24.7 |
| Software | 95.1 | 33.1 |
| Communications equipment | 65.6 | 22.8 |
| Instruments | 33.3 | 11.6 |
| Photocopy and related equipment | 14.7 | 5.1 |
| Office and accounting equipment | 7.8 | 2.7 |

Source: NIPA table 5.9

Table 2.–Contributions to Average Percent Changes in Real Gross Domestic Product

| | 1991-95 | 1996-2000 | Change |
|---|---|---|---|
| Percent change at annual rate: | | | |
| Gross domestic product | 2.4 | 4.1 | 1.7 |
| Percentage points at annual rates: | | | |
| Private fixed investment | 0.62 | 1.44 | 0.82 |
| Information processing equipment and software | 0.38 | 0.76 | 0.38 |
| Other private fixed investment | 0.24 | 0.68 | 0.44 |
| Change in private inventories | 0.06 | 0.07 | 0.01 |
| Other GDP components, net | 1.70 | 2.59 | 0.89 |

Source: derived from NIPA table 8.2

Table 3.–Contributions to Percent Change in Real Gross Domestic Product

| | 2000 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | I | II | III | IV |
| Percent change at annual rate: | | | | | | | | |
| Gross domestic product | 2.3 | 5.7 | 1.3 | 1.9 | 1.3 | 0.3 | -1.3 | 1.7 |
| Percentage points at annual rates: | | | | | | | | |
| Private fixed investment | 2.24 | 1.49 | 0.44 | 0.09 | -0.33 | -1.74 | -0.97 | -1.96 |
| Information processing equipment and software | 1.22 | 0.89 | 0.61 | 0.64 | -0.62 | -0.95 | -0.46 | -.13 |
| Other private fixed investment | 1.02 | 0.60 | -0.17 | -0.55 | 0.29 | -0.79 | -0.51 | -1.83 |
| Change in private inventories | -2.32 | 1.76 | -0.95 | -0.50 | -2.61 | -0.42 | -0.81 | -2.16 |
| Other GDP components, net | 2.38 | 2.45 | 1.81 | 2.31 | 4.24 | 2.46 | 0.48 | 5.82 |

Source: derived from NIPA table 8.2

## Table 4.–Commodity Flow Example for Computers

[Millions of dollars, seasonally adjusted ast quarterly rates]

| | | Line | 2001:I | 2001:II | % Change |
|---|---|---|---|---|---|
| | Manufacturers industry shipments of computers and related products | 1 | 32,293 | 28,051 | -13.1 |
| | - Adjustment to convert from industry shipments to shipments of PES products | 2 | 5,765 | 4,928 | -14.5 |
| | = Product shipments, producer value \1\ | 3 | 26,528 | 23,123 | -12.8 |
| less | Export supply, producer value \1\ | 4 | 4,670 | 4,367 | -6.5 |
| less | Change in trade inventories \2\ | 5 | 0 | 0 | |
| equals | Domestic supply, producer value | 6 | 21,858 | 18,756 | -14.2 |
| less | Intermediate, household, and government purchases | 7 | 8,786 | 7,556 | -14.0 |
| plus | Trade and transportation margins | 8 | 2,875 | 2,457 | -14.6 |
| equals | Domestic supply to PFI, purchaser value | 9 | 15,948 | 13,657 | -14.4 |
| | Import supply, producer value \1\ | 10 | 9,912 | 9,026 | -8.9 |
| less | Intermediate, household, and government purchases | 11 | 3,985 | 3,658 | -8.2 |
| plus | Trade and transportation margins | 12 | 1,383 | 1,249 | -9.6 |
| plus | = Import supply to PFI, purchaser value | 13 | 7,309 | 6,617 | -9.5 |
| equals | Total PES extrapolator for computers and peripheral equipment | 14 | 23,257 | 20,274 | -12.8 |
| | Total PES computers and peripheral equipment (billions of dollars, annual rate) | 15 | 102.9 | 89.6 | -12.9 |

/1/ Excludes products considered wholly intermediate.
/2/ For quarterly estimates, change in inventories is assumed to be zero.

PES Private fixed investment in equipment and software
PFI Private fixed investment

## Table 5.–Computers and Peripheral Equipment, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| **Domestically produced** | | |
| Computers, excluding PC's | 0.12 | Weighted average of PPI for large-scale computers and PPI for mid-range computers |
| PC's | 0.29 | Weighted average of PPI for PC's and workstations and PPI for portable computers |
| Storage devices | 0.08 | PPI for computer storage devices |
| Computer terminals | 0.00 | PPI for computer terminals |
| Peripheral equipment, NEC | 0.12 | PPI for computer peripheral equipment, NEC |
| Systems integrators | 0.09 | BEA aggregate computer price index |
| **Imported** | | |
| Computers, excluding PC's | 0.02 | IPI for computers |
| PC's | 0.06 | IPI for computers |
| Storage devices | 0.06 | IPI for computer storage devices |
| Computer terminals | 0.08 | IPI for computer displays, including monitors & terminals |
| Peripheral equipment, NEC | 0.08 | IPI for computer printers |

PC's Personal computers
PPI Producer price index
IPI Import price index

## Table 6.–Software, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| Prepackaged | 0.340 | PPI for prepackaged software applications with a -3.15 percent per annum bias adjustment |
| Own-account | 0.333 | BEA Input cost index consisting of compensation cost indexes and an intermediate inputs cost index. |
| Custom | 0.327 | BEA price/cost index reflecting weighted average of prepackaged and own-account percent changes |

BEA Bureau of Economic Analysis

# Table 7.–Communication Equipment, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| **Domestically produced** | | |
| Telephone and telegraph wire apparatus | 0.20 | BEA price index reflecting weighted average of FRB LAN price index and PPI for telephone and telegraph apparatus |
| Telephone switching and switchboard eq. | 0.17 | PPI for telephone switching and switchboard eq. with a -5.7 percent per annum bias adjustment |
| Communication eq., excl.. broadcast | 0.14 | PPI for communication equipment (except wire telephone and broadcast, cable or studio equipment) |
| Search, detection & navigation eq. | 0.10 | PPI for Search, detection, navigation and guidance systems and equipment |
| Force account, communication eq. installation | 0.10 | BEA cost index derived from avg. weekly earnings for electrical workers |
| Industrial process design | 0.05 | PPI for engineering design, analysis, and consulting services |
| Laser systems, excl.. communication | 0.01 | PPI for laser systems and equipment (excl. communication, medical and surveying types) |
| Broadcast related eq. | 0.01 | PPI for broadcast, cable, studio and related communication equipment |
| Other \1\ | 0.01 | Detailed PPI's |
| **Imported** | | |
| Telephone and telegraph wire apparatus | 0.06 | IPI for telecommunications equipment |
| Telephone switching and switchboard eq. | 0.06 | PPI for telephone and telegraph apparatus with a -5.7 percent per annum bias adjustment |
| Broadcast related equipment | 0.05 | IPI for telecommunications equipment |
| Communication equipment, excl. broadcast | 0.04 | IPI for telecommunications equipment |
| Other \1\ | 0.01 | Detailed IPI's |

BEA Bureau of economic analysis
eq. Equipment
excl. Excluding
IPI Import price index
PPI Producer price index

\1\ This component is comprised of several low value items that are deflated separately with the appropriate PPI or IPI.

## Table 8.–Instruments, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| **Domestically produced** | | |
| Surgical and medical instruments and apparatus | 0.24 | PPI for surgical and medical instruments and apparatus, except furniture |
| Analytical and scientific instruments | 0.10 | PPI for laboratory analytical instruments |
| Industrial process design | 0.06 | PPI for engineering design, analysis, and consulting services |
| Laboratory and scientific apparatus | 0.06 | PPI for laboratory apparatus |
| Process control instruments | 0.05 | PPI for industrial process control instruments |
| Physical properties testing and inspection equipment | 0.05 | PPI for physical properties and kinematic testing equipment |
| Surgical appliances and supplies | 0.04 | PPI for surgical, orthopedic and prosthetic appliances and supplies except surgical dressings |
| Surgical and medical and instruments nsk | 0.04 | PPI for surgical and medical instruments and apparatus |
| Integrating and totalizing meters for gas and liquids | 0.03 | PPI for integrating and totalizing meters for gas and liquids |
| Dental professional equipment and supplies | 0.03 | PPI for dental professional equip., incl. dental chairs, units, hand pieces, excl. X-ray |
| Undistributed process control instruments | 0.02 | PPI for industrial process control instruments |
| Nuclear radiation detection & monitoring instruments | 0.01 | PPI for commercial, geophysical, meteorological and general purpose instruments |
| Hospital furniture | 0.01 | PPI for surgical and medical instruments and apparatus |
| Dental laboratory equipment and supplies | 0.01 | PPI for dental professional equip., incl. dental chairs, units, hand pieces, excl. X-ray |
| Undistributed measuring and controlling devices | 0.01 | PPI for measuring and controlling devices, |
| Commercial, geophysical, general purpose instruments | 0.01 | PPI for commercial, geophysical, meteorological and general purpose instruments |
| Other \1\ | 0.01 | Detailed PPI's |
| **Imported** | | |
| Surgical and medical instruments and apparatus | 0.11 | IPI for scientific and medical machinery |
| Analytical and scientific instruments | 0.05 | IPI for recreational equipment and materials |
| Process control instruments | 0.04 | IPI for measuring, testing & control |
| Surgical appliances and supplies | 0.01 | IPI for scientific and medical machinery |
| Dental professional equipment and supplies | 0.01 | IPI for scientific and medical machinery |
| Other \1\ | 0.01 | Detailed IPI's |

excl. Excluding
IPI Import price index
NEC Not elsewhere classified
PPI Producer price index

\1\ This component is comprised of several low value items that are deflated separately with the appropriate PPI or IPI.

## Table 9.–Photocopy and Related Equipment, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| **Domestically produced** | | |
| Photocopying equipment | 0.17 | PPI for photocopying eq. (incl. diffusion and dye transfers, |
| Engineering services | 0.14 | PPI for engineering design, analysis, and consulting services |
| Optical instruments and lenses nec | 0.07 | PPI for optical instruments and lenses |
| Still picture equipment | 0.03 | PPI for still picture equipment |
| Photocopy eq:misc. receipts | 0.01 | PPI for photographic equipment and supplies |
| Motion picture equipment | 0.01 | PPI for motion picture equipment and projection screens |
| Used photocopy equipment | 0.01 | PPI for photographic equipment and supplies |
| Optical instruments and lenses nsk | 0.01 | PPI for laboratory analytical |
| Microfilming blueprinting and whiteprinting eq. | 0.01 | PPI for microfilming, blueprinting and whiteprinting eq. |
| **Imported** | | |
| Photocopying equipment | 0.20 | IPI for recreational equipment and materials |
| Still picture equipment | 0.19 | IPI for recreational equipment and materials |
| Optical instruments and lenses nec | 0.14 | IPI for recreational equipment and materials |
| Motion picture equipment | 0.02 | IPI for recreational equipment and materials |

eq. Equipment
IPI Import price index
NES Not elsewhere specified
PPI Producer price index

## Table 10.–Office and Accounting Equipment, 1999

| Component | Current Dollar Share | Deflator |
|---|---|---|
| **Domestically produced** | | |
| Accounting machines and cash registers | 0.19 | PPI for calculating and accounting machines |
| Used comp hardware, software | 0.14 | PPI for calculating and accounting machines |
| Industrial process design | 0.10 | PPI for engineering design, analysis, and consulting services |
| Mailing letter handling and addressing | 0.09 | PPI for mailing, letter handling, and addressing machines, except parts and attachments |
| Standard typewriters and office machines, n.e.c. | 0.06 | PPI for office machines, NEC |
| Scales and balances except laboratory | 0.05 | PPI for parts, attachments, and accessories for scales and balances |
| Office machines nec, nsk | 0.04 | PPI for office machines, NEC |
| Duplicating | 0.01 | PPI for office machines, NEC |
| **Imported** | | |
| Accounting machines and cash registers | 0.22 | IPI for business machinery and equipment, except computers |
| Scales and balances except laboratory | 0.04 | IPI for business machinery and equipment, except computers |
| Standard typewriters and office machines, n.e.c. | 0.03 | IPI for business machinery and equipment, except computers |
| Mailing letter handling and addressing | 0.01 | IPI for business machinery and equipment, except computers |
| Duplicating | 0.01 | IPI for business machinery and equipment, except computers |

IPI Import price index
NEC Not elsewhere classified
PPI Producer price index

Chart 1.–Real GDP and the Contributions of Private Fixed Investment in Information Processing (IP) Equipment and Software

(3 quarter moving average, percent change at seasonally adjusted annual rate)

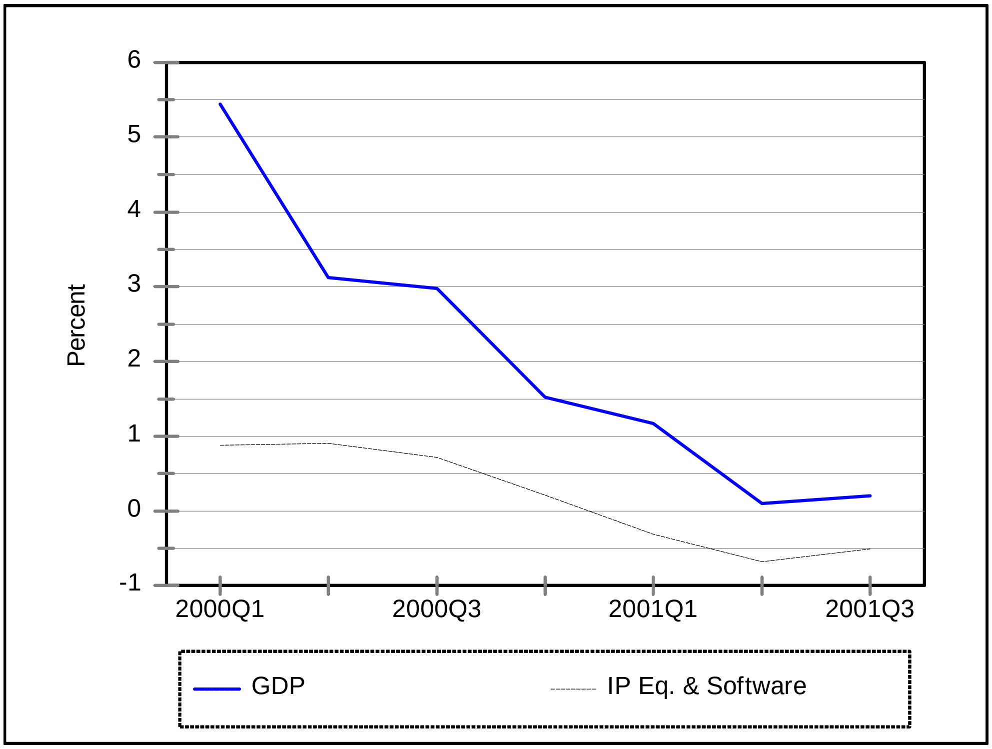
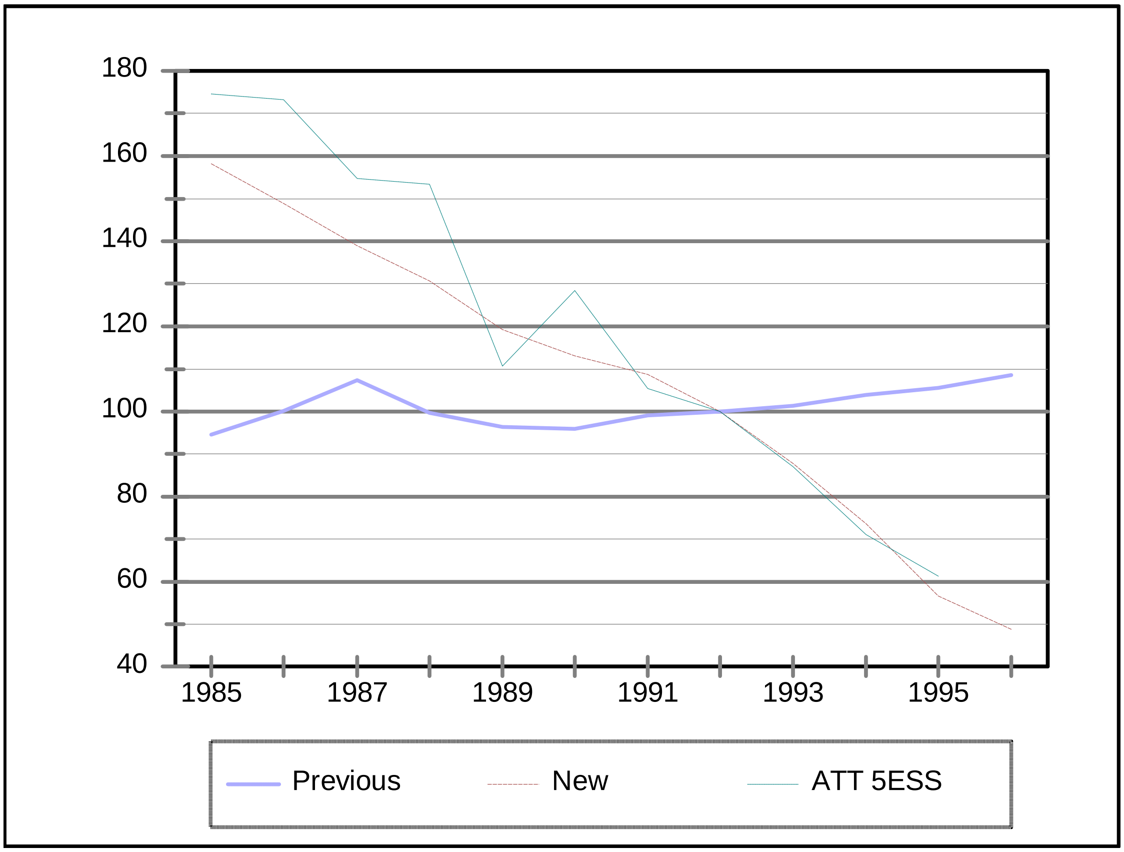


Chart 2.–Telephone Switch Prices

(1992 = 100)



# Chart 3.--Commodity Flow