Volume Title: Measuring and Accounting for Innovation in the Twenty-First Century

Volume Authors/Editors: Carol Corrado, Jonathan Haskel, Javier Miranda, and Daniel Sichel, editors

Volume Publisher: University of Chicago Press

Volume ISBNs: 978-0-226-72817-9 (cloth); 978-0-226-72820-9 (electronic)

Volume URL: https://www.nber.org/books-and-chapters/measuring-and-accounting-innovation-twenty-first-century

Conference Date: March 10–11, 2017

Publication Date: April 2021

Chapter Title: BEA Deflators for Information and Communications Technology Goods and Services: Historical Analysis and Future Plans

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Chapter URL: https://www.nber.org/books-and-chapters/measuring-and-accounting-innovation-twenty-first-century/bea-deflators-information-and-communications-technology-goods-and-services-historical-analysis-and

Chapter pages in book: p. 553 – 572

14

BEA Deflators for Information and Communications Technology Goods and Services

Historical Analysis and Future Plans

Erich H. Strassner and David B. Wasshausen

14.1 Introduction

The Bureau of Economic Analysis (BEA) strives to ensure that the price indexes used to construct inflation-adjusted measures in the National Income and Product Accounts (NIPAs) and industry economic accounts (IEAs) accurately capture improvements in quality. The accuracy of BEA's featured measures, including inflation-adjusted (i.e., "real") GDP, consumer spending, and business investment, depends on this important goal. Moreover, it is often the high-profile, innovative goods and services that reflect rapidly changing technologies and notable improvements in quality that garner significant attention from the research community, further highlighting the need for accurate measures. These innovative goods and services are often the subject of important economic studies, including understanding their role in explaining changes in multifactor productivity (MFP).[1]

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Michael Armah, Hussein Charara, Michelle Grier, and Greg Prunchak contributed to this chapter. Special thanks to Ana Aizcorbe for her helpful review and comments, as well as her ongoing efforts to improve Bureau of Economic Analysis (BEA) price deflators. The views expressed in this chapter are solely those of the authors and not necessarily those of the US Bureau of Economic Analysis or the Department of Commerce. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see https://www.nber.org/books-and-chapters/measuring-and-accounting-innovation-21st-century/bea-deflators-information-and-communications-technology-goods-and-services-historical-analyses-and.

1. Traditionally, the focus has been on ICT equipment, including Byrne and Corrado (2015), Byrne and Corrado (2017a), Byrne and Corrado (2017b), and Byrne, Oliner and Sichel (2017).

BEA has traditionally placed a high value on collaboratively developing and implementing quality-adjusted prices for innovative products, including information and communications technology (ICT) goods and services. This commitment began in the mid-1980s, when BEA first introduced quality-adjusted price indexes for computers and peripheral equipment that had been developed jointly by BEA and IBM. Quality-adjusted prices for semiconductors were developed and implemented by BEA in the 1990s, followed by the introduction of hedonic, quality-adjusted prices for photocopying equipment developed by BEA in the early 2000s. Also in the early 2000s, BEA began devoting considerable resources to improving the price indexes for purchased custom software and software developed in-house.

With an aim toward facilitating and encouraging further price research, this chapter first provides a historical perspective and an analysis of BEA's ICT prices, including an overview of the sources and methods used to construct BEA's quality-adjusted prices. In the second part of the chapter, we discuss current work and future plans for continuing to ensure the accuracy of BEA's price indexes and corresponding inflation-adjusted measures. The appendix provides an update that assesses recent progress in price measurement as reflected in BEA's 15th comprehensive update of the NIPAs, released July 27, 2018.

14.2 Historical Overview of BEA's ICT Prices

BEA first introduced quality-adjusted price indexes for computers and peripheral equipment into the NIPAs with its eighth comprehensive update, released in December 1985. 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, displays (terminals), and tape drives.[2] 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. The estimates of the computer deflators covered the period 1972–84, and the indexes were extended back to 1969 using information from other studies of computer prices. Prior to 1969, the deflator was held constant at the 1969 level.

During the 1987 NIPA annual update, a price index for personal computers (PCs) was introduced beginning with 1983. The PC price index was a chained matched-model price index based on IBM PC's, judgmentally

Another important area is software: see, for example, Abel, Berndt, and White (2003) on Microsoft's PC software products and Copeland (2013) on prepackaged software. Others have studied the associated services: Greenstein and McDevitt's (2012) work on broadband services, and Byrne, Corrado and Sichel's (2018) work on cloud computing services.

2. See Cartwright (1986), Cole et al. (1986), and Triplett (1986).

adjusted by BEA to take into account quality changes associated with the introduction of new models and to take into account models of other manufacturers.[3]

In 1991, the Bureau of Labor Statistics (BLS) began publishing quality-adjusted producer price indexes (PPIs) for computers. Soon after, BLS began publishing PPIs for peripheral equipment. As these PPIs became available, they replaced BEA's judgmental indicators and extrapolators for the quarterly NIPA computer price indexes. Eventually, PPIs also replaced BEA's annual quality-adjusted computer price indexes.[4]

In December 1991, BEA released its ninth comprehensive update of the NIPAs, and as part of it, several improvements in the price indexes for computers were incorporated. Among the most important of these improvements was the preparation of a separate price index for imports, which was used in the deflation of imported computers in private fixed investment and in imports of goods. The new index used import weights to combine separate indexes for imported mainframes, imported personal computers, imported printers, and domestic and imported direct access storage devices (DASD) and display terminals. The import price index for PCs was a Paasche chain-type matched-model price index, using prices and quantities from trade sources. The import price indexes for mainframes and printers were derived from existing BEA databases that were separated into imported and domestically produced models. The regression equations were modified to include a dummy variable, which took the value of 1 for imported models and the value of 0 for domestically produced models. Another significant improvement introduced during this revision was to develop separate regression equations and price indexes for four types of printers: serial impact, serial nonimpact, line-fully-formed, and page. In addition, the computer price indexes were extended back to 1959 based on indexes developed in several independent studies.[5]

In January 1996, BEA released its 10th comprehensive update of the NIPAs. With this release, BEA introduced quality-adjusted price indexes for memory and for microprocessor metal-oxide semiconductor integrated circuits (chips) beginning with 1981. The new quality-adjusted semiconductor price indexes were constructed by BEA using different methodologies for memory chips and for microprocessor chips. The price index for memory chips was quality adjusted using the price per bit of data storage capacity and the type of memory chip. Seven types of memory chips were weighted together to produce a summary price index for memory chips. The

3. See Cartwright and Smith (1988) and US Department of Commerce, Bureau of Economic Analysis (1987).

4. The PPIs for computers and peripheral equipment were typically superior to BEA's price indexes because they were available at a much greater frequency, reflected larger samples, and reflected more precise hedonic functions.

5. See Triplett (1989).

price index for microprocessor chips was quality adjusted using a "matched-model" approach. Most of the data used consisted of observed prices from major US manufacturers that BEA purchased from International Dataquest Corporation. Some price data were estimated using hedonic regressions that link chip prices to various performance characteristics.[6]

Also with this release, BEA replaced its previously featured fixed-weighted Laspeyres price measure with a Fisher chain-type price index. This resulted in a significant improvement by minimizing substitution bias not only in aggregate computer price indexes but also in aggregate quantity and price measures, such as gross domestic product and gross domestic purchases.[7] In accordance with the change in the featured measure, Fisher chain-type price indexes for detailed computer price indexes replaced traditional fixed-weighted measures wherever possible.

In October 1999, BEA released its 11th comprehensive update of the NIPAs. With this release, BEA modified the hedonic function used to impute laser printer prices and adopted the Fisher chain-type formula for estimating detailed printer price indexes. Moreover, a key feature of this update was the recognition of business and government expenditures for software as fixed investments. A major requirement of recognizing these expenditures as final demand included the need to develop quality-adjusted price indexes for prepackaged, custom, and "own-account" software.[8] Price indexes were developed for all three components, beginning with 1959, and reflected several different approaches, including hedonic modeling.[9]

In December 2003, BEA released its 12th comprehensive update of the NIPAs, and with this release, BEA introduced a new quality-adjusted price index for photocopying equipment. The new price began with 1992 and used a biennial hedonic regression model in which the natural logarithm of the price of a model of photocopying equipment was regressed on the following independent variables: the natural logarithm of the multicopy speed; quality-characteristic dummy variables for color, capability, multifunctionality, and capacity; and a time dummy variable that takes on the value 1 if the *ith* photocopy model was sold in the second year of the biennial regression datasets.[10]

With the 2003 update, BEA also incorporated an improved price index for investment in own-account and custom software. Previously, the price index for own-account and custom software was a pure input-cost index calculated from a weighted average of compensation rates for computer programmers

6. See Grimm (1998).
7. See Landefeld and Parker (1995).
8. Own-account software consists of in-house expenditures for new or significantly enhanced software created by business enterprises or government units for their own use.
9. See Parker and Grimm (2000).
10. See Moylan and Robinson (2003).

and systems analysts and the costs of intermediate inputs associated with their work; it assumed no changes in productivity. The improved price index was constructed as a weighted average of the percentage changes in the input-cost index (75 percent weight) and the BLS PPI for "prepackaged software applications sold separately" (25 percent weight), which did reflect changes in productivity.

Finally, also as part of the 2003 comprehensive update, BEA fully incorporated a Federal Reserve Board (FRB) price index for local area network equipment that more accurately captured quality improvements than the existing BEA price index. The improved FRB price was first adopted in the 2001 NIPA annual update and was incorporated back to 1992 with this update.[11]

In both the 13th and 14th comprehensive updates of the NIPAs—released in July 2009 and July 2013, respectively—little attention was focused on developing improved price indexes for ICT goods and services.[12] Looking forward and beginning with the 15th comprehensive update of the NIPAs to be released in July 2018, BEA is committed to reinvigorating its efforts to continually seek ways to explicitly improve prices for the types of innovative products that embrace rapidly changing technologies and drive economic growth.

14.3 Current Work and Future Plans

There is a renewed effort within BEA to more actively engage in the development and incorporation of improved price indexes for ICT goods and services, with an aim toward better measuring and accounting for innovation in national accounts statistics. As noted in a recent *Journal of Economic Perspectives* article, BEA has embarked on several initiatives with statistical agency partners as well as academic researchers to leverage alternative data sources to improve the measurement of high-tech goods and services prices.[13] As BEA prepares for its forthcoming comprehensive update of the national accounts, including both the NIPAs and the industry economic accounts (IEAs), there are three areas of focus with respect to improving price indexes: (1) software, (2) electromedical equipment, and (3) communications equipment (including cell phones). Each of these products experiences rapid rates of innovation and is associated with state-of-the-art technologies that present challenges when using standard matched-model techniques to construct quality-adjusted price indexes. In the remainder of

11. See Moulton, Seskin, and Sullivan (2001).

12. While price research related to ICT products waned a bit over this period, it is important to note that BEA continued to conduct important price research in other areas, including health care and research and development.

13. See Groshen et al. (2017).

this section, we will discuss plans and preliminary findings for each of these three ICT products, followed by a discussion of where BEA plans to focus next on price index improvement.

14.3.1 Software

Private fixed investment in software was over $350 billion in 2016 and accounts for about 15 percent of all private nonresidential fixed investment. BEA recognizes three types of software, and each presents its own unique set of measurement challenges: (1) prepackaged, (2) custom, and (3) own-account.

As part of the 2017 annual NIPA update, BEA improved the price index used to deflate fixed investment in prepackaged software, beginning with the first quarter of 2014.[14] The improved price index replaced the BLS PPI for "application software publishing" with the broader PPI for "software publishing, except games." The PPI for "software publishing, except games" captures movements in the prices of systems software publishing, which accounts for a large share of total investment spending on prepackaged software, as well as in the prices of application software publishing.[15] As part of the 2018 comprehensive update, BEA will incorporate this improved price index prior to 2014.

Constructing accurate, quality-adjusted price indexes for both custom and own-account software inherently presents challenges due to the very nature of these one-off products. The challenges are further compounded for pricing own-account software because there are no market transactions associated with this type of in-house production. Currently, both price indexes reflect a weighted average of the BEA prepackaged software price index and a BEA input-cost index that is based on BLS data on wage rates for computer programmers and systems analysts and on intermediate input costs associated with the production of software. BEA is actively pursuing data purchases and alternative methodologies that can be used to develop improved prices for these hard-to-measure products. Among them is a database that tracks prices, functionality, and quality of software projects. Here, the functionality is measured using an industry-accepted metric referred to as "function points," which can be used to compute a functional size measurement of a given software application. The database has over 8,000 observations spanning the years 2006–13. BEA is exploring several different techniques, including hedonic modeling, to estimate quality-adjusted prices for custom and own-account software using these data. Heterogeneity in price per function point across the database suggests that function points are not necessarily homogenous and that more does not necessarily mean

14. See McCulla, Khosa, and Ramey (2017).

15. This limitation in the producer price index for "application software publishing" and resultant bias in national accounts statistics was first raised by Byrne and Corrado (2017b).

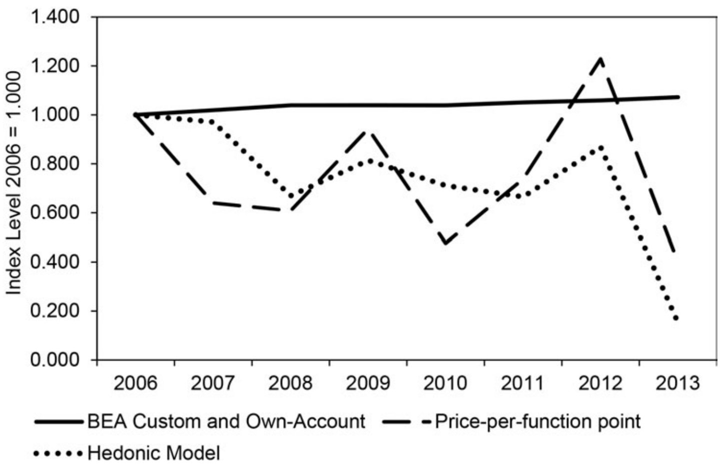

Fig. 14.1 Custom and own-account software price indexes

better. As part of this research, hedonic modeling is used to control for a variety of factors, including client size, client industry, computing platform, maturity of the firm, project type, and project size. Preliminary results indicate average rates of decline in the price index range from about 10 percent to 25 percent compared with the current price index, which shows an average rate of increase of about 1 percent over that same period. The notable range in average annual price declines and volatile behavior of the alternative prices speak to the challenge of estimating accurate price indexes for these products. Figure 14.1 presents the published BEA price index, a price-per-function point price index, and a price index derived using hedonic methods with control variables described above. The figure illustrates overall price trends as well as the volatile nature of these data.

The goal of this ongoing research is to develop an output-based price index or to discover new information that will better inform our current methodology. For example, we are also studying the possibility of introducing an explicit productivity adjustment to the input-cost index. The database described above also includes variables that track hours to complete each of the software projects, and these data may provide valuable insights to productivity trends for custom software development.

14.3.2 Electromedical Equipment

Private fixed investment in electromedical equipment was over $40 billion in 2016 and includes magnetic resonance imaging equipment, ultrasound scanning devices, and CT-scan machinery. These types of medical equipment embody rapid rates of product innovation, much like computers and semiconductors, that can present challenges when using standard matched-model techniques. BEA has completed some preliminary research for selected imaging equipment using data from ECRI, a nonprofit organization that collects data on hospital purchases of equipment. The ECRI database is rich and includes prices and attributes for all types of electromedical machinery. Preliminary results from this research suggest average annual rates of decline for selected electromedical equipment are about 10 percent.

14.3.3 Communications Equipment

In the 2010 NIPA annual update, BEA expanded its use of quality-adjusted price indexes from the FRB industrial production index program to deflate business purchases of three types of communication equipment: telephone switching equipment, carrier line equipment, and wireless networking equipment. (A fourth FRB price index was already being used to deflate data networking equipment.) Looking forward to the 2018 NIPA comprehensive update, including the 2012 Benchmark Input-Output accounts, BEA plans to better align its detailed communication equipment products with more current classifications that are consistent with the FRB's detailed price indexes. Moreover, BEA is currently collaborating with the FRB with an aim toward taking over the preparation of selected FRB communication equipment prices.

BEA is also conducting research on ways to improve its price index for smartphones. In collaboration with others, including researchers from the FRB, BEA completed a pilot study of iPhone prices for the years 2015–16. The pilot used data purchased from JD Power, and BEA has expanded the purchase to include historical data beginning with 2004. Smartphones clearly embody rapid rates of product innovation and are strong candidates for additional price research. Figure 14.2 illustrates the rapid rate of product innovation for selected smartphones since 2008.

14.3.4 What's Next?

As noted at the beginning of this section, there is a renewed effort within BEA to continually engage in the evaluation and development of improved price indexes, especially those for ICT goods and services. In addition to ongoing research for the aforementioned products, BEA is actively identifying priority sectors for exploratory research into the adequacy of current price measures. Several different criteria have guided BEA price research priorities, including the availability of data, the size of the sector, the likelihood of bias, and the extent of existing external research that would make BEA's work duplicative. Several products meet these criteria for BEA's near-term price research, including both wired and wireless telecommunications services, additional medical equipment (nonimaging), medical supplies (e.g., stents), cloud computing, and ride-sharing platform services.

An alternative approach BEA considers when setting its price research agenda is to target goods and services produced and used by "advanced" industries. The identification of "advanced" industries is somewhat subjec-

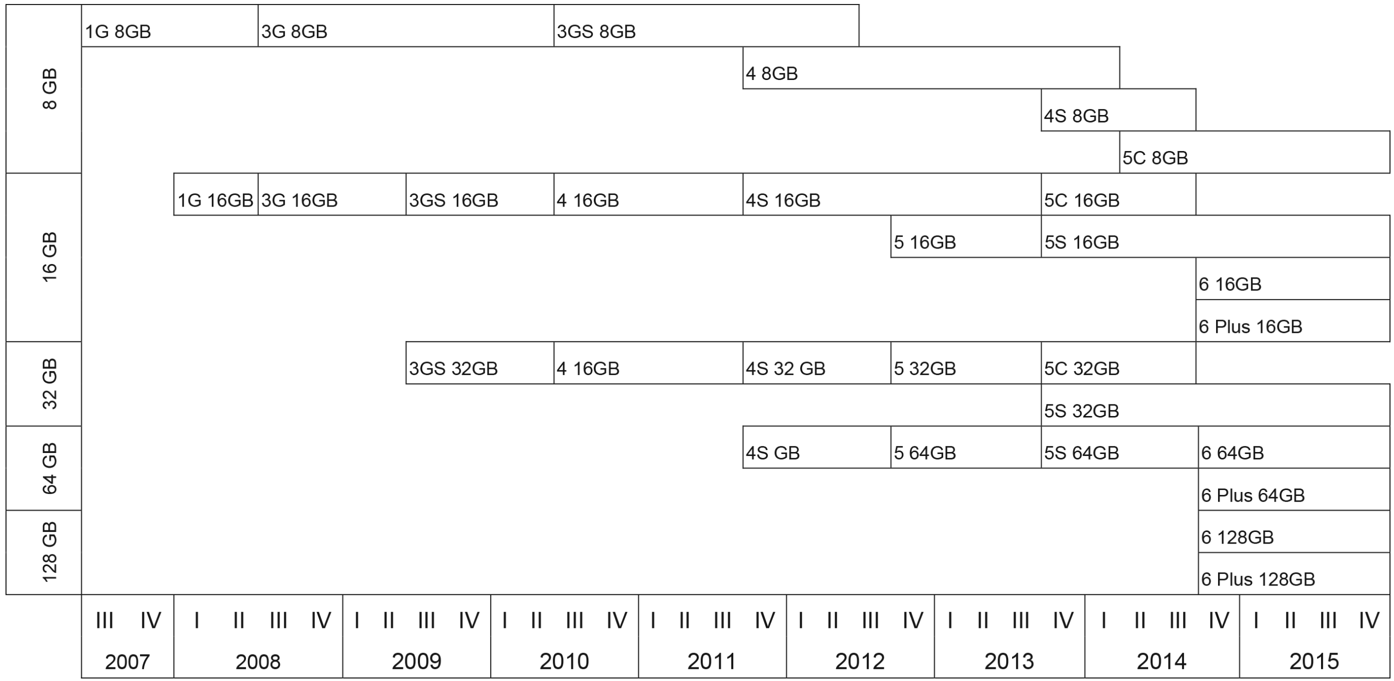

Fig. 14.2 **Apple iPhone launches**
Source: Yadav (2014).

tive; however, there are metrics that are common across a number of studies. For example, a 2015 Brookings report examines an industry's R&D spending per worker as well as the share of workers in an industry whose occupations require a high degree of STEM (science, technology, engineering, and math) knowledge.[16]

While the definition of "advanced" industries may not be precise, the basic idea of focusing research on industries with relatively high R&D spending and STEM knowledge is to hone in on those industries that are more likely than others to be engaged in the production and/or usage of hard-to-measure, rapidly changing goods and services. It is important to emphasize that these industries need not solely be the producers of such goods and services to receive BEA attention but could also be users of such goods and services. This is an important qualification because a growing share of sophisticated goods and services is being imported and used by US industries, and the prices for these goods and services impact measured real imports and measured real value added at the industry level.[17]

The advent of smartphones and the rapidly changing technologies that underlie their production and usage illustrate this challenge. For example, the underlying research and development embodied in the iPhone is largely produced domestically, whereas the actual manufacturing of the iPhone occurs outside of the United States. As noted previously, BEA is conducting research on ways to improve its price index for smartphones, and any improvement in the price index for smartphones would necessarily be reflected in all relevant components of GDP, including fixed investment, personal consumption, and imports of goods. Under this alternative approach targeting "advanced" industries, additional attention may also be given to developing improved price indexes for the private fixed investment in the research and development devoted to the production of that smartphone. Finally, focusing on "advanced" industries identifies private-sector production of high-tech equipment that is purchased not only by the private sector but also by the government, including military aircraft, weapons, instruments, and communications equipment.

14.4 Conclusion

BEA has a rich history of developing quality-adjusted price indexes for various types of information and communications technology goods and services. Most, if not all, of these products embody the innovative spirit with which we strive to accurately measure in BEA's national accounts statistics. These products often present significant measurement challenges

16. See Muro et al. (2015).
17. See Samuels et al. (2015) for a discussion of how imports and import prices affect estimates of industry growth and productivity.

when using traditional approaches, especially when they are required to be produced at high frequencies. As Groshen et al. (2007) note, "The task of calculating price indexes and output in the 21st century, and doing so in a way that provide timely monthly data within budget constraints, is not for the rigid or the fainthearted."

BEA will continue to tackle these types of challenging products using a variety of source data and methods, including hedonic modeling, matched-model, and fixed-effect regressions. The required source data are often not sufficiently available at high monthly frequencies and instead may only be available annually. In these cases, BEA will first construct "best" annual price indexes and then force the higher-frequency monthly price indexes to conform with that "best" annual price index. While we recognize that this is not always feasible for all statistical programs, we believe these alternative approaches should be more widely considered.

Appendix

Results from the 2018 Comprehensive Update

On July 27, 2018, the BEA released the initial results of the 15th comprehensive update of the NIPA. The incorporation of improved price measures for ICT goods and services was an important feature of this comprehensive update, and in this appendix, we present those results and assess overall progress toward incorporating improved ICT deflators into BEA's national accounts statistics.

14.A1 Software

The BEA price index for prepackaged software was improved to reflect the use of a more appropriate PPI. This improvement was first introduced in the 2017 annual NIPA update beginning with 2014, and with this comprehensive update, that improvement has been carried back to 2007.[18] Over the period 2007–17, the revised BEA prepackaged software price index shows an average annual rate of decline of 3.6 percent compared with a decline of 2.6 percent in the previously published material. Figure 14.3 presents the revised and previously published price indexes for private fixed investment in prepackaged software.

The revised BEA price indexes for custom and own-account software reflect, for the first time, an explicit adjustment to account for changes in productivity to the input-cost index component. These price indexes con-

18. See McCulla, Khosa, and Ramey (2017).

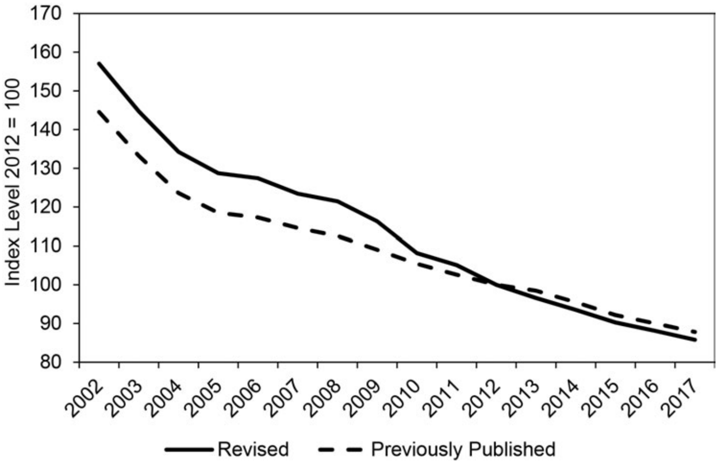

Fig. 14.3 Price indexes for private fixed investment in prepackaged software

tinue to be estimated using a weighted average of the BEA prepackaged software price index and a BEA input-cost index that is based on BLS data on wage rates for computer programmers and systems analysts and on intermediate-input costs associated with the production of software. While the prepackaged software price reflects actual market prices and therefore captures changes in productivity, the input-cost index did not, and therefore BEA implemented an explicit productivity adjustment beginning with 1997. The adjustment reflects estimates for MFP for private nonfarm business published by the BLS as well as research conducted by BEA using reports from academic, commercial, and public sources. For 1997–2006, the trends in the BLS MFP for private nonfarm business were largely consistent with the trends derived by BEA using private data that included information on prices, functionality, size, and hours required to complete a given custom software project. Over this period, the productivity adjustment to the BEA input-cost index is about 1.5 percentage points per year. For 2007 forward, productivity trends for the creation of custom software derived by BEA showed slightly larger gains than the published BLS MFP for nonfarm private business. Deviations in trend between these two independent measures are neither surprising nor problematic because they are measuring different things. The productivity adjustment applied by BEA over this period reflects a judgmental combination of these two measures and was, on average, 0.8 percentage point. A combination of the internal BEA-derived custom-software productivity measure and the broader BLS MFP measure was chosen, reflecting the imprecise and conservative nature of this adjustment. Figure 14.4 presents the major components of the BEA input-cost index as well as the input-cost index with and without the productivity adjustment. The figure illustrates the overall effect of the adjustment as well as the fact that the adjustment is not applied to the components; rather, it is

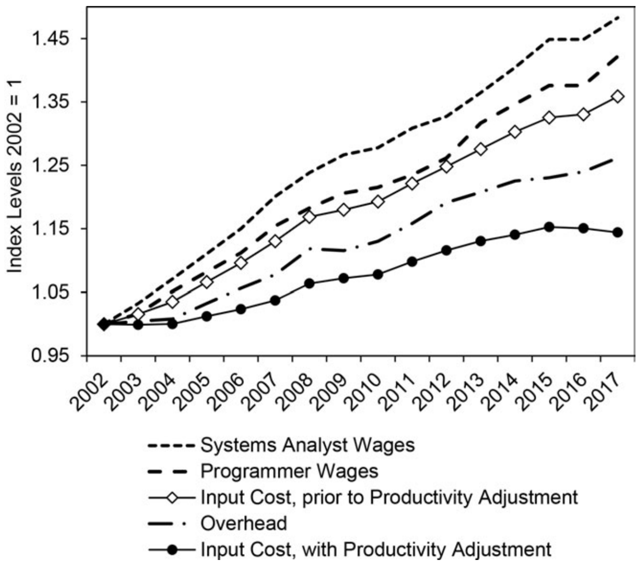

Fig. 14.4 BEA input-cost indexes for custom and own-account software

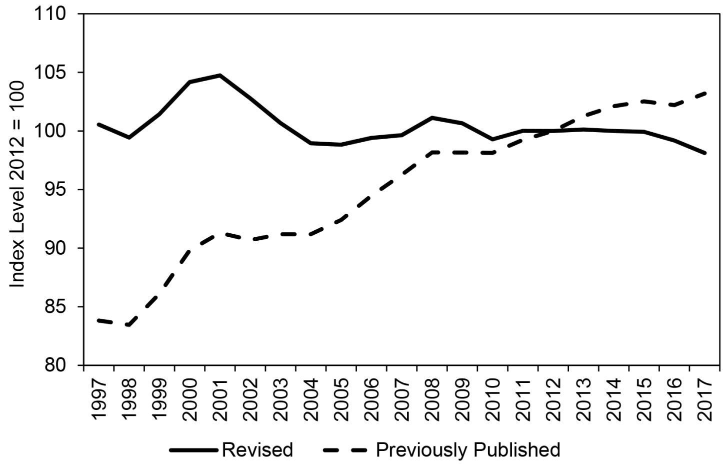

Fig. 14.5 Price indexes for private fixed investment in custom and own-account software

only applied to the aggregate input-cost index. Over the period 1997–2017, the revised BEA custom and own-account software price indexes show an average annual rate of decline of 0.1 percent compared with an increase of 1.0 percent in the previously published material. Figure 14.5 presents the revised and previously published price indexes for private fixed investment in custom and own-account software.

Although a significant amount of BEA resources were invested in developing a new, output-based price index for custom and own-account software, BEA was unable to produce a reliably stable price measure. While the available data included thousands of observations and dozens of valuable software characteristics, the resultant indexes were simply too volatile to trust. Dozens of models were tested, including pooled, biennial, and fixed-effects regressions. Some of these models yielded promising statistical results; however, more research and more data are required in order to develop accurate price indexes required for BEA's national accounts statistics.

14.A2 Electromedical Equipment

BEA introduced newly developed annual estimates of quality-adjusted price indexes for selected components of electromedical equipment, including magnetic resonance imaging equipment, ultrasound scanning devices, and CT-scan machinery. These types of medical equipment embody rapid rates of product innovation that can present challenges when using standard matched-model techniques. The new annual price indexes were developed using data from ECRI that included information on purchases of medical equipment by health care providers and were constructed using a (weighted) fixed-effects regressions model that yielded similar results to those derived using a matched-model approach. The estimated prices from the fixed-effects regressions were chosen over those from the matched model because the fixed-effect regressions were able to better handle some of the volatile transaction-level data and, as a result, were a bit smoother.[19]

These new price indexes better account for changes in product quality than the previously used price indexes, which were based on monthly PPIs and monthly international price indexes (IPIs). The improved price indexes were incorporated beginning with 2002 and are used to deflate annual private fixed investment and exports and imports of electromedical equipment. The previously used PPIs and IPIs will be used in conjunction with the newly developed annual indexes to estimate the higher-frequency quarterly prices. Over the period 2002–17, the revised BEA price index for private fixed investment in electromedical equipment decreases 4.7 percent at an average annual rate; the previously published price index decreased 0.4 percent. Figure 14.6 presents revised and previously published price indexes for private fixed investment in electromedical equipment.

14.A3 Communication Equipment

BEA price indexes for communication equipment were updated, reflecting the incorporation of the revised and newly available FRB communica-

19. Ana Aizcorbe, a senior researcher with BEA, developed these new and improved electromedical equipment price indexes. Additional details regarding these indexes will be published separately at a later date.

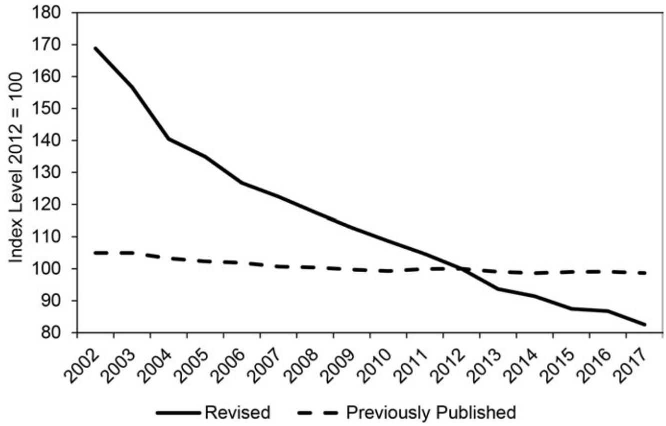

Fig. 14.6 Price indexes for private fixed investment in electromedical equipment

tion equipment price index.[20] In addition to the traditional communication equipment price indexes BEA uses from the FRB, a newly developed price index for smartphones was incorporated for the first time beginning with 2002. This newly available price index will be used to deflate consumer spending, private fixed investment, and imports of cellular phones. Previously, cellular phones were not separately deflated in any of these final demand categories and instead were deflated as part of aggregated series that included cellular telephones. These aggregated series were deflated using FRB prices, PPIs, IPIs, and consumer price indexes (CPIs) that implicitly included cellular phones. Beginning with January 2018, BLS introduced explicit quality adjustments for smartphones using hedonic modeling methods. Although a separate category for smartphones is not published as part of BLS's CPI program, these quality-adjusted prices for smartphones are reflected in the published CPI for "telephone hardware, calculators and other consumer information items." Within this category, cellular phones account for approximately half of the sample.[21] BEA plans to carefully study this improved CPI with an aim toward better understanding the underlying changes in the prices for smartphones.

In addition to incorporating revised and newly available FRB price indexes, the detailed commodity structure that underlies private fixed investment in communication equipment was updated to reflect benchmarking to BEA's 2012 Supply-Use tables, which in turn are based on newly incorporated detailed data from the 2012 Economic Census. Table 14.1 shows the

20. For details, see "Quality-Adjusted Price Indexes for Communications Equipment," June 1, 2018, Federal Reserve Board's Industrial Production and Capacity Utilization-G.17, https://www.federalreserve.gov/releases/g17/commequip_price_indexes.htm.

21. For more information, see the Consumer Price Index factsheet for telephone hardware, calculators, and other consumer information items on the BLS website (https://www.bls.gov/cpi/factsheets/telephone-hardware.htm).

Table 14.1 **Private fixed investment in communications equipment**

Line	Description	Deflation level[a]	2012 current-dollar investment level[b]	Old deflator description	New deflator description
1	Communication equipment		104,789		
2	Communications equipment—imports		56,239		Blank indicates no change
3	Telephone and telegraph wire and cable	x	319	BLS IPI for telecommunication equipment	
6	Television receivers	x	10,930	BLS IPI for home entertainment equipment	
7	Consumer high-fidelity components	x	817		
9	Telephone switching and switchboard equipment	x	868	FRB enterprise voice equipment	
10	Telephone and telegraph wire apparatus		3,175		
11	Data communication apparatus	x	232	FRB data networking equipment	
12	Other telephone and telegraph wire apparatus	x	2,943	FRB transmission equipment	
13	Communication equipment, ex. broadcast	x	36,291	FRB wireless networking equipment	Weighted composite of FRB cellular phones and FRB wireless networking equipment price indexes
14	*Radio station equipment*		*17,569*		
15	***Cellular handsets—cell phones***		***7,406***		
16	*Antenna systems, sold separately*		*260*		
17	*Other communication systems and equipment*		*2,328*		
18	*Wireless networking equipment*		*8,727*		
20	Broadcast-related equipment	x	2,700	BLS IPI for telecommunication equipment	
21	Intercommunication equipment	x	27		
22	Search, detection, and navigation equipment	x	1,113	BLS IPI for scientific and medical machinery	
23					
24	Communications equipment—domestic		48,550		
25	Other services on missiles + space vehicles	x	310	BLS PPI for civilian aircraft	
26	Telephone and telegraph wire and cable	x	2	BLS PPI for copper wire and cable	

30	Consumer high-fidelity components	x	10	BLS PPI for speakers and commercial sound equipment	
32	Telephone switching and switchboard equipment	x	1,481	FRB enterprise voice equipment	
33	Telephone and telegraph wire apparatus		4,194		
34	Data communication apparatus	x	207	FRB data networking equipment	
35	Other telephone and telegraph wire apparatus	x	3,987	FRB transmission equipment	
36	Force account, tel. equipment installation	x	7,155	BLS average weekly earnings of building equipment contractors	
37	Industrial process design	x	5,774	BLS PPI for engineering services	
39	Used communication equipment	x	54	BLS PPI for communications equipment mfg	
40	Communication equipment, ex. broadcast	x	9,764	FRB wireless networking equipment	Weighted composite of FRB cellular phones and FRB wireless networking equipment price indexes
41	*Radio station equipment*		*1,979*		
42	***Cellular handsets—cell phones***		***375***		
43	*Antenna systems, sold separately*		*467*		
44	*Other communication systems and equipment*		*4,622*		
45	*Wireless networking equipment*		*472*		
46	*Radio and TV broadcasting and wireless equipment, nsk*		*1,848*		
47	Broadcast-related equipment	x	2,290	BLS PPI for broadcast, studio, and related electronic equipment	
48	Intercommunication equipment	x	1,040	BLS PPI for communications equipment mfg	
49	Search, detection and navigation equipment	x	16,478	BLS PPI for search, detection, navigation, and guidance systems and equipment	

Notes: PPI: Producer Price Index; IPI: Import Price Index; FRB: Federal Reserve Board; I-O: BEA Input-Output Accounts; BLS: Bureau of Labor Statistics.

[a]x indicates the level at which deflation occurs.

[b]BEA's benchmarked 2012 supply-use tables were not yet published at the time of this chapter's submission. The values presented in this table are preliminary and subject to change.

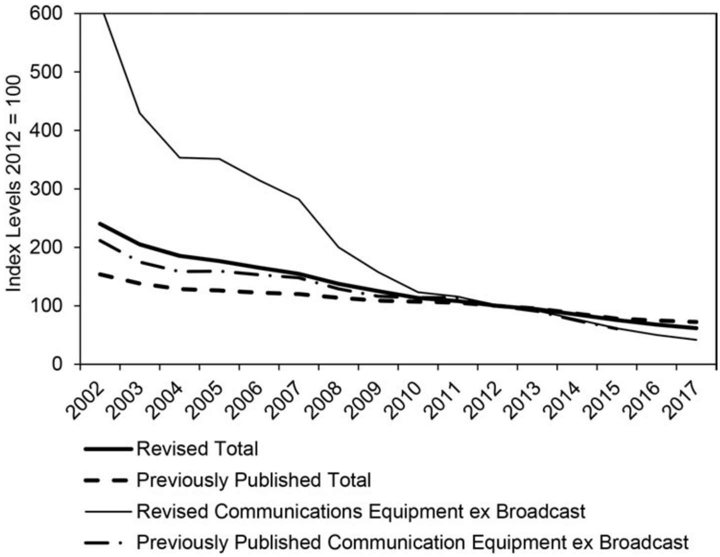

Fig. 14.7 Price indexes for private fixed investment in communications equipment

detailed commodity structure, including the nominal values that underlie the inflation-adjusted measures. Table 14.1 also presents descriptions of the detailed price indexes used to deflate communication equipment, including how the newly introduced smartphone price index was incorporated. Overall, private fixed investment in communication equipment was revised to $16.3 billion from $104.8 billion (table 14.1, line 1). The leading contributor to the upward revision was both imported and domestically produced "communication equipment ex. broadcast" (table 14.1, lines 13 and 40, respectively). Over the period 2002–15, the composite price index, including the new smartphone price index, used to deflate this category declines at an average annual rate of about 16 percent; the previously published corresponding price declined at an average annual rate of about 9 percent. Over the period 2002–17, the revised BEA price index for private fixed investment in communication equipment decreases 8.6 percent at an average annual rate; the previously published price index decreased 4.9 percent. Figure 14.7 presents revised and previously published price indexes for private fixed investment in communications equipment as well as the component "communication equipment ex. broadcast."

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