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Industrial Production and Capacity Utilization: The 2012 Annual Revision

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The Federal Reserve published revisions to its index of industrial production (IP) and related measures of capacity and utilization on March 30, 2012. Revisions were minor and the overall contour of total IP was little changed. In particular, a decline of 17 percent from December 2007 to June 2009 was followed by steady gains beginning in the second half of 2009 and continuing through early 2012. Measured from fourth quarter to fourth quarter, total IP was reported to have dropped about ¼ percentage point more in 2009, while its gains in both 2010 and 2011 were essentially unchanged from what was previously reported. From the trough of the most recent recession in June 2009 through February 2012, total IP reversed about three-fourths of its peak-to-trough decline.

Table 1. Industrial Production and Capacity Utilization: 2007-11

	2007	2008	2009	2010	2011
	Industrial production - rates of change				
Revised	2.5	-9.0	-5.7	6.3	3.9
Previous	2.5	-9.1	-5.5	6.2	3.8
	Capacity utilization rates				
Revised	80.4	73.2	69.5	75.4	77.7
Previous	81.1	73.6	70.3	76.1	78.1

Note: Rates of change are from the fourth quarter of the previous year to the fourth quarter of the specified year. Utilization rates are for the fourth quarter of the specified year.

The revised IP indexes incorporated from the U.S. Census Bureau's Annual Survey of Manufactures (ASM) detailed data on factory activity for 2010 and revised data for 2009. In addition, the revised estimates include annual data for 2010 both from the Census Bureau's Current Industrial Report (CIR) program and from the U.S. Geological Survey regarding metallic and nonmetallic minerals (except fuels). The monthly estimates of production were updated to incorporate late-arriving or revised monthly or quarterly data on indicators (either outputs from or inputs to production), and they also reflect recalculations of seasonal factors. New data sources were also incorporated into the revised estimates, including replacements for the data from the CIR program, which was discontinued in mid-2011.

NOTE: Charles Gilbert directed the 2012 revision and, with Kimberly Bayard, David Byrne, Norman Morin, and Daniel Vine, prepared the revised estimates of industrial production. Norman Morin and Jessica Stahl prepared the revised estimates of capacity and capacity utilization. Eliot Fuchs provided research assistance.

Capacity utilization rates for recent years were revised down. The revisions showed that the rate of capacity utilization for total industry was 0.7 percentage point lower in the fourth quarter of 2010 and 0.4 percentage point lower in 2011 than previously estimated, primarily as a result of small upward revisions to estimates of industrial capacity. The capacity utilization rate for the fourth quarter of 2008 was revised down 0.3 percentage point, and the rate in the final quarter of 2009 was revised down about 0.8 percentage point. Nonetheless, the revisions did not affect the broad contour of capacity utilization. In 2008, the capacity utilization rate for total industry, at 73.2 percent, was 7.1 percentage points below its long-run (1972–2011) average. Utilization rates fell in the first half of 2009 and then steadily increased through the end of 2011. The level in the fourth quarter of 2011, at 77.8 percent, was 2.5 percentage points below its long-run average.

The revised estimates of capacity and capacity utilization incorporated data for the fourth quarter of 2011 from the Census Bureau's Quarterly Survey of Plant Capacity Utilization (QSPC), which covers the manufacturing sector; new data on capacity in the energy and mining sectors from the U.S. Geological Survey, the U.S. Department of Energy (DOE), and other organizations; physical data on capacity for some manufacturing industries from government and trade organizations; and data on industry capital spending from the 2010 ASM.

TECHNICAL ASPECTS OF THE REVISION

This revision incorporated new comprehensive data from the 2010 ASM and revised data from the 2009 ASM for production and value added by manufacturing industries. Revised price indexes from the Bureau of Economic Analysis (BEA) and updated price indexes constructed by the Federal Reserve for a few selected industries were also incorporated.[1] In addition, the updated production indexes include revisions to the measures of employment and production-worker hours from the monthly Current Employment Statistics survey by the Bureau of Labor Statistics (BLS). The benchmark indexes for logging and publishing (included in the IP index for manufacturing but no longer included under manufacturing in the North American Industry Classification System (NAICS)) were updated through 2010 based on data from the U.S. Forest Service and the Census Bureau.

The revised IP indexes incorporated information from selected CIRs for 2011, the QSPC for 2011, and other annual industry reports. The indexes also incorporated revised or late-arriving monthly and quarterly source data on production, shipments, and inventories.

[1] Price indexes for pharmaceuticals (NAICS 325412), semiconductors (NAICS 334413), and four of the six components of communications equipment (NAICS 3342) are constructed by the Federal Reserve from alternative sources. A table that lists annual and quarterly price indexes for the networking equipment component of communications equipment can be found in table 14 of the published annual revision.

Annual Benchmark Output Indexes and the Conversion to the 2007 North American Industry Classification System

As part of the annual revision, a benchmark output index—defined as nominal gross output divided by a price index—was constructed for each six-digit industry under the NAICS. In this revision, the benchmark indexes were calculated for 1972 forward based on industries defined by the 2007 NAICS; previously the benchmark indexes had been based on the 2002 NAICS definitions of industries. Likewise, the industry basis for capacity and utilization was changed to the 2007 NAICS. The 2007 NAICS included 16 six-digit manufacturing industries that had different coverage than in the 2002 NAICS. For example, one industry included in the 2002 NAICS—laboratory apparatus and furniture manufacturing (NAICS 339111)—was eliminated; its various components were distributed among seven different six-digit industries in the 2007 NAICS.

The conversion to the 2007 NAICS did not affect the number or the structure of individual IP series that are published because the changes to the NAICS occurred at a finer level of industrial detail than the corresponding published IP series. For example, the most-disaggregated IP index that included NAICS 339111 is the IP series for medical equipment and supplies (NAICS 3391), which includes several other six-digit industries (NAICS 339112, 339113, 339114, 339115, and 339116) that are present in both the 2002 NAICS and the 2007 NAICS.

Although the number and structure of the published IP series were not affected by the transition to the 2007 NAICS, the benchmark indexes for some industries needed to be updated. Looking again to the eliminated NAICS 339111, establishments that were assigned to this industry under the 2002 NAICS were reassigned to one of a handful of other industries in the 2007 NAICS. To create a consistent history, the Federal Reserve needed to construct new benchmarks for each receiving industry. The construction of these new benchmarks made use of a concordance between industries under the 2007 NAICS and those under the 2002 NAICS that was issued in 2011 by the Census Bureau as part of the 2007 Economic Census. This concordance showed how shipments from 2002 NAICS industries would have been allocated to 2007 NAICS industries, and vice versa. These estimated allocations were then applied to historical data to construct both gross output estimates and price indexes on a 2007 NAICS basis going back to 1972.[2] Some of the adjustment factors used to align monthly production indicators with benchmarks of IP series were also re-estimated. These new estimates were applied to IP indexes for recent years, as well as to those used only in earlier periods.[3]

Benchmark indexes are measures of real gross output at the six-digit NAICS level. The Census Bureau provides annual values for value added and the cost of materials, which can be

[2] The Census of Manufactures and the ASM report their data based on the most recent industry classification system. Ideally one would like to allocate each establishment that responded to past versions of these surveys to a 2007 NAICS industry. When NAICS superseded the Standard Industrial Classification system in 1997, previous Censuses of Manufactures were recomputed by assigning each respondent to a NAICS industry. For the smaller changes to NAICS since 1997, it has been assumed that the proportion of establishments that moved from one NAICS industry to another under the new classification was constant historically.

[3] The monthly production indicators include product data, production-worker-hour data, and, from the 1960s to 1997, electric power use by industry.

summed to obtain nominal gross output.[4] The benchmark indexes for this revision incorporated new estimates of nominal gross output for 2010, as well as revisions to the 2009 estimates, from the ASM. The IP index is a Fisher index and the individual real gross output benchmarks are aggregated using value-added weights. To obtain real gross output, the measures of nominal gross output were deflated by annual price deflators. Most of the deflators for the IP benchmarks were derived from the industry shipments deflators issued by the BEA in December 2011. The BEA deflators were available on a 2002 NAICS basis, so they needed to be converted to the 2007 NAICS structure before being applied to the detailed nominal gross output data.

Since 2003, the ASM has not included separate data for every six-digit manufacturing industry; some industries are accounted for only in the aggregate data for a larger group of industries. The 2007 Economic Census, however, still contained separate data for each six-digit industry. For 2003 through 2006, the IP benchmark indexes were calculated by allocating the data from these combined industries to their six-digit components based on interpolation between each component's share of the total in the 2002 and 2007 Economic Censuses. Data from the 2008, 2009, and 2010 ASMs were allocated to the component six-digit industries solely based on shares from the 2007 Economic Census.

Changes to Individual Production and Capacity Series

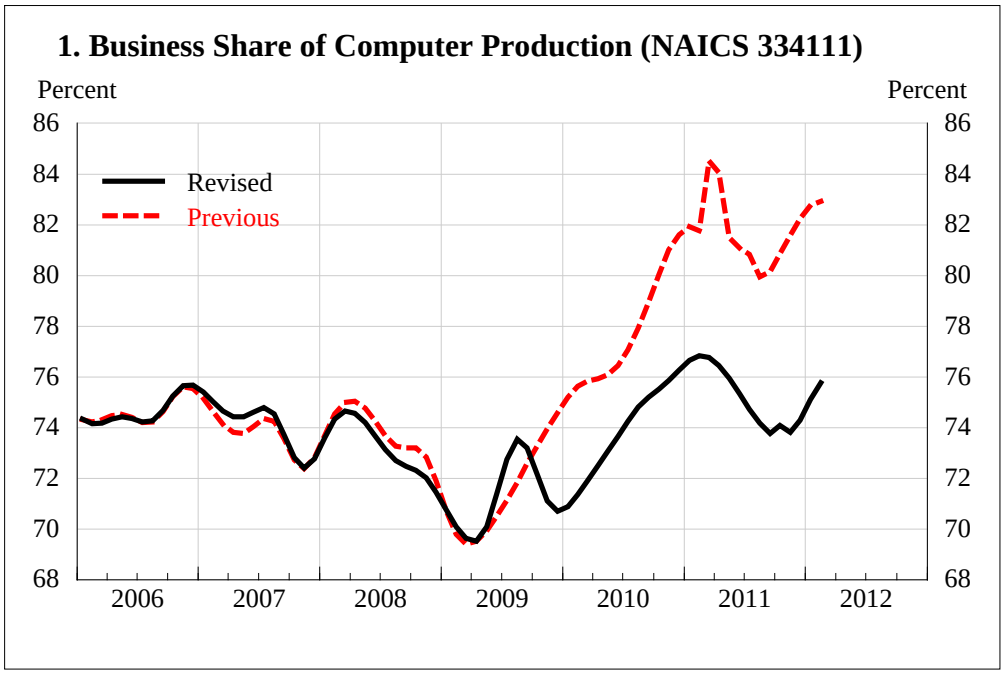
Computers

This revision updated the methods used to calculate four IP series for computers: business desktop computers, consumer desktop computers, business mobile computers, and consumer mobile computers. These four IP series are all components of NAICS 334111. The source data for computers come from the International Data Corporation (IDC) and measure quarterly U.S. domestic absorption of computers. The 2010 annual revision reported that the Federal Reserve received absorption data only for total desktops and total mobiles but had ceased to acquire detailed information on the business and consumer components of these platforms. With this revision the Federal Reserve resumed the acquisition from the IDC of absorption data on business and consumer desktops and mobiles.[5] In addition to current-quarter data, the IDC has provided historical information, so the four IP series can be constructed with a consistent methodology from the beginning of the IDC data in 1994 and continuing through the present. As shown in chart 1, the relative importance of production for the business market varies significantly over time, and the newly acquired IDC data revised down the share for business computer output appreciably.

To construct the IP indexes, the Federal Reserve seasonally adjusted the IDC information on quarterly domestic absorption and smoothed the data using a model of the relationship

[4] Historically, the Census Bureau also provided measures of the cost of resales at the six-digit level, which were included in the nominal benchmark. In recent years, however, the cost of resales has not always been available, so to maintain consistency, the Federal Reserve has excluded the cost of resales from the rates of change for the benchmark indexes from 2003 forward.

[5] Production of multi-user computers, such as servers, is assumed to be exclusively sold to the business market.



between shipments and production. These estimates of nominal production for the U.S. market were then multiplied by an estimate of the ratio of domestic production to domestic absorption by product, based on the Census Bureau's CIRs and additional outside research.

Prior to this revision, the production indexes for computer storage devices and computer terminals (NAICS 334112 and NAICS 334113) and for other computer peripheral equipment (NAICS 334119) were based on nominal shipments data from the quarterly CIR deflated by the relevant BLS producer price indexes for 2007 through the second quarter of 2011, the date of the last published CIR data. For the period after the final CIR data, these IP indexes were extended based on statistical models that predict changes in output based on changes in the production of personal computers and of servers.[6]

Natural gas extraction

This revision incorporated new and timelier information to supplement the primary source data for the IP series for natural gas extraction (NAICS 211111, part). The main source data for this IP series are billions of cubic feet of U.S. natural gas marketed production (wet) from the DOE's Natural Gas Monthly report. The DOE report is generally issued with a three-month lag; for example, when IP is published in mid-April, natural gas data are only available through

[6] Approximately half of the annual variation in the output of storage and terminals and of peripherals is explained by the domestic absorption of personal computers and servers as reported by IDC.

January even though the IP window runs through March.

With this revision, the data from the DOE were augmented by data from Bentek Energy. Bentek provides daily information on the production of natural gas, and the data are available with a lag of only one day. The Federal Reserve converts the data from Bentek to a monthly frequency and uses them as a secondary source to inform early estimates for natural gas extraction until the data from the DOE become available. The timeliness of the Bentek data allows for IP estimates based on source data through the most recent month of the publication window. The incorporation of the Bentek data has been shown to reduce revisions to earlier months for the natural gas extraction index, a series that represented more than 4 percent of total IP in 2011.

Trucks

This revision incorporated new data and methods for estimating the shares of light truck output associated with business output and with consumer output. The IP indexes for light trucks (NAICS 336112) are constructed from data on total assemblies from WardsAuto. Because the IP structure parses industry output into demand-based segments called market groups, it is necessary to assign vehicle assemblies into business and consumer components. The IP indexes use data from the BEA and annual data from CNW Research on the number of leased trucks to help determine the business and consumer shares of both car and truck production. With this revision, the Federal Reserve incorporated monthly data from the National Truck Equipment Association (NTEA) on factory shipments of class 2 and 3 truck chassis and from WardsAuto on factory shipments of light trucks in classes 1 through 3 to extend and interpolate the annual figures for the business share of overall light truck production.[7]

The monthly variable used for this interpolation is a weighted average of indexes (base year 2002) derived from the NTEA data and the WardsAuto data, with a two-thirds weight given to the WardsAuto data (derived from regression results estimating the relative correlation of the two monthly data series with the target annual index). The data from the NTEA are monthly factory shipments of class 2 and class 3 chassis that subsequently have bodies installed and are used by businesses. The data from WardsAuto are shipments of trucks in classes 1, 2, and 3, with a weight of 0.1 attached to class 1 trucks, a weight of 0.4 attached to class 2 trucks, and a weight of 1.0 attached to class 3 trucks to reflect estimates of the percentages of the different classes of trucks being sold to businesses.

Veneer, plywood, and engineered wood product

The capacity series for veneer, plywood, and engineered wood product (NAICS 3212) has been updated with this revision. Previously, the series only used data from the Composite Panel Association (CPA) on the capacity of particleboard and fiberboard producers. With this revision, the capacity estimates continued to use the CPA data but also incorporated information

[7] Trucks are split into eight classes on the basis of vehicle weight, with class 1 trucks being the lightest and class 8 trucks the heaviest. Light trucks comprise classes 1 through 3.

on the capacity of producers of plywood and oriented strand board from APA, the Engineered Wood Association. As a result, the data used to calculate capacity represent a greater share of the industry.

Discontinuation of the U.S. Census Bureau's CIRs

In mid-2011, the U.S. Census Bureau discontinued its CIR program. The CIR data releases provided detailed product information at monthly, quarterly, and annual frequencies for a variety of industries. The last release of monthly data was for July 2011, and the last release of quarterly data was for the second quarter of 2011. The Federal Reserve extensively used the CIRs in its indexes of industrial production and capacity utilization, and their elimination necessitated changes in underlying source data for several IP series. Taken together, the monthly and quarterly CIRs provided physical product data for slightly more than 2.5 percent of total IP.

The following list shows the monthly CIRs that were used in industrial production and, in parentheses, their corresponding IP series:

1. M311J: Fats and Oil: Oilseed Crushings (Corn oil; Soybean and other oilseed processing)

2. M311K: Fats and Oils: Production, Consumption, and Stocks (Fats and oils refining and blending)

3. M313P: Consumption on the Cotton System and Stocks (Fiber, yarn, and thread mills)

With this revision, each of these three affected IP series used production-worker hours to extend the discontinued monthly CIR data.

The list below shows the discontinued quarterly CIRs that were used in industrial production with their associated IP indexes in parentheses:

1. MQ311A: Flour Milling Products (Flour milling and malt)

2. MQ325A: Inorganic Chemicals (Acids, phosphates, and sulfates; Other inorganic chemicals)

3. MQ325B: Fertilizers and Related Chemicals (Other inorganic chemicals; Fertilizer)

4. MQ325F: Paint, Varnish, and Lacquer (Construction paints; Industrial paints)

5. MQ327D: Clay Construction Products (Ceramic tile and refractory; Brick and structural clay tile; Other structural clay product)

6. MQ333W: Metalworking Machinery (Machine tools)

7. MQ334P: Telecommunications (Data networking equipment; Transmission, local loop, and legacy central office equipment; Enterprise and home voice equipment; Satellites and earth station equipment; Wireless system equipment; Radio and TV broadcasting equipment excluding satellites and other communications equipment)

8. MQ334R: Computers and Peripheral Equipment (Computer storage and terminals, business; Computer storage and terminals, consumer; Computer printers and peripheral equipment, business; Computer printers and peripheral equipment, consumer).

Other than the changes to IP series described in the next section, this revision used production-worker hours to extend the IP series associated with the discontinued quarterly CIRs.

Updated Data Sources for Quarterly Series Formerly Covered by CIRs

For some of the IP series that previously relied on quarterly CIRs, the Federal Reserve used alternate measures of physical output to replace the discontinued data. These series and the replacement data sources are described in the following paragraphs.

Fertilizer

With this revision, the IP series for fertilizer (NAICS 32531) used monthly data on nitrogen and phosphate fertilizer from the Fertilizer Institute (TFI) as the primary source of data on output. Previously, the monthly TFI data were used as a secondary source for months for which the quarterly CIR data were not yet available, and they were also used to interpolate the quarterly data to a monthly frequency.

Communications equipment

The IP aggregate index for communications equipment (NAICS 3342) comprises six product-based indexes. Each of the six indexes incorporated quarterly data on nominal shipments at the detailed product level from the Census Bureau's relevant CIRs from the first quarter of 2007 to the second quarter of 2011. With this revision, data from the QSPC are used to extend each of the six IP series from the third quarter of 2011 through the present.

The QSPC, conducted since 2007, reports capacity utilization rates for manufacturing industries at a quarterly frequency. In recent years, the utilization rates from the QSPC for communications equipment have tracked nominal output—as measured by the discontinued CIR—fairly well. With this revision, the nominal data on communications equipment from the CIR were extended based on the change in the industry operating rate from the QSPC and the change in a quarterly interpolation of annual capital services for this industry (constructed from historical investment data and a survey of investment plans).

The deflators for the resulting estimates of nominal output continued to be producer price indexes from the BLS and price indexes constructed by the Federal Reserve staff from price data from Dell'Oro. The four IP indexes within communications equipment for which nominal output is deflated by the Federal Reserve price indexes are Data networking equipment; Enterprise and home voice networking equipment; Wireless network equipment; and Transmission, local loop, and legacy central office equipment. These four product classes accounted for approximately

18 percent of overall communications equipment production in 2011, a share that has declined markedly over the past several years. To construct the quarterly indicator price indexes, the Federal Reserve staff use information on quarterly worldwide unit shipments and revenue for detailed product categories to construct unit values and then aggregate them using a Fisher index formula. At the time of annual benchmarking, information on additional products is included to expand coverage and refine these estimates. The deflators for the remaining two IP indexes (Satellites and earth station equipment; Radio and TV broadcasting equipment (excluding satellites) and other communications equipment) are constructed from BLS producer price indexes and a price index for satellites estimated by the Federal Reserve staff.

Computers

Prior to this revision, the now-discontinued quarterly CIR for computers and peripheral equipment (NAICS 3341) was used for four IP indexes (Computer storage and terminals, business; Computer storage and terminals, consumer; Computer printers and peripheral equipment, business; Computer printers and peripheral equipment, consumer). These four indexes cover all of NAICS 3341 except for Electronic computers (NAICS 334111). Six other IP indexes cover NAICS 334111. These six indexes rely on data from the IDC on U.S. domestic absorption of desktops, mobiles, and servers. In the absence of the CIR data, IDC data on personal computers were used to extend the IP indexes for computer storage and terminals, and IDC data on non-x86 servers were used to extend the IP indexes for computer printers and peripherals.

Weights for Aggregation

The IP index is a Fisher index. The weights for manufacturing industries are derived from value-added measures from the Census of Manufactures and the ASM. The Federal Reserve derives estimates of value added for the electric and gas utility industries from annual revenue and expense data issued by other organizations. The weights for aggregation, expressed as value added per unit, were estimated with the latest data on producer prices for the period after 2010. Table 12 of the published annual revision release shows the annual value-added proportions in the IP index from 2004 through 2011.

Revised Quarterly and Monthly Data

This revision incorporated product data that became available or were revised after the regular six-month reporting window for monthly IP was closed. These data were released with too great a lag to be included with monthly IP estimates but were available for inclusion in the annual revision.

Revised Seasonal Factors

Seasonal factors for all series were re-estimated using data that extend into 2012. Factors for production-worker hours—which adjust for timing, holiday, and monthly seasonal patterns—were updated with data through January 2012. The updated factors for the physical product series, which include adjustments for holiday and workday patterns, used data through December 2011 where available. Seasonal factors for unit motor vehicle assemblies were updated prior to the revision, and projections are on the Board's website.[8]

Pre-adjustment of data to account for the effects of recessions

Seasonal factors for IP were primarily estimated with the Census Bureau's X-12-ARIMA program. Generally speaking, the X-12 procedure separates a time series into three components: trend plus cycle, seasonal, and irregular. The trend-plus-cycle component is based on a moving average of the data, but for some series the moving average does not adequately capture the abruptness of the swings that occur during a recession and subsequent recovery. Consequently, some of the pattern of the recession may bleed into the estimated seasonal factors for the recession period as well as the factors for the years around it. Should that occur, the resulting seasonally adjusted series might look strong both before and after the recession in the calendar months around the month in which the trough of the recession was reached. With the 2010 annual revision, the Federal Reserve introduced a pre-adjustment for many indexes to account for the effects of the recent recession prior to running X-12. The 2012 revision continued those pre-adjustments where necessary.

It has long been known that recessions affect the results of seasonal adjustment procedures that use the ratio-to-moving-average method.[9] Prior to the advent in the 1950s of the Census Bureau's computer programs for estimating seasonal factors, the Federal Reserve's seasonal adjustment procedure estimated the trend-plus-cycle component of the data by fitting a freehand curve (based on a 12-month moving average of the original data) to the major nonseasonal movements in the series. With this technique, sharp movements in the series could be incorporated in the curve without distorting the combined seasonal and irregular components (known as the S-I ratios).

With the adoption of the Census computer programs for estimating seasonal factors, additional measures have occasionally been taken to limit the impact that a recession might have on estimated seasonal factors. In the course of the 1959 revision to IP, the 1957–58 recession was recognized as distorting the seasonal factors, so only data through 1957 were used in the estimation of the seasonal factors.

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[8] See Board of Governors of the Federal Reserve System, "Federal Reserve Seasonal Factors for Domestic Auto and Truck Production," Board of Governors, www.federalreserve.gov/releases/g17/mvsf.htm.

[9] Most of the following material on previous work to remove recession-related distortions from the estimated seasonal factors for IP is condensed from the 1986 manual on Industrial Production. Board of Governors of the Federal Reserve System (1986), Industrial Production, 1986 Edition, with a Description of the Methodology (Washington: Board of Governors), pp. 80–83.

Likewise, when working on the 1976 revision to IP, the Federal Reserve staff deemed that the sharp drop in IP in late 1974 and the subsequent recovery were distorting the factors, so the estimated factors only used data through 1974. In the work on the subsequent 1976–78 revision, however, the 1973–74 recession continued to distort the seasonal factors, but the staff determined that if they only used data up to the recession period they would discard too much information from the period subsequent to the downturn. Two procedures were used to attempt to offset this problem. In the first, the indexes from 1967 to 1973 were linked to the indexes from 1976 to 1978, and seasonal factors were calculated from that series. The second technique involved replacing the values for 1974 and 1975 with more-typical values based on data for the preceding and subsequent years. The results of both procedures were similar.

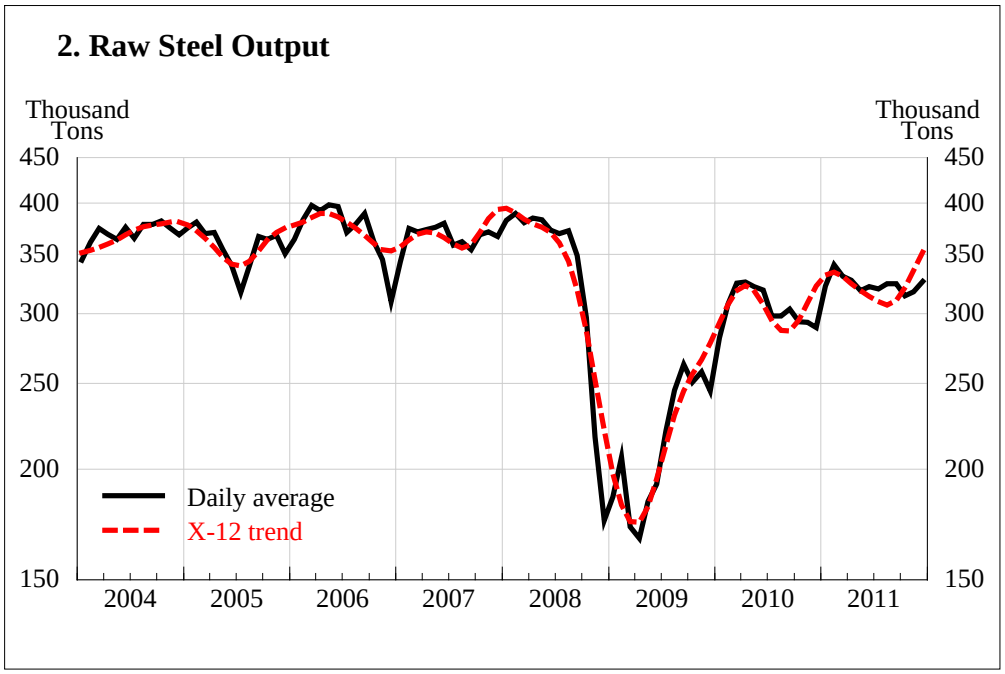
The 1985 annual revision to IP incorporated the Box-Tiao intervention technique. The procedure involved estimating an autoregressive integrated moving average (ARIMA) model with additive outliers specified for the recession period. The values for the additive outliers were then subtracted from the values for the recession period before X-11 was run.[10] For all practical purposes, the resulting series contained values for the recession period that reflected their typical seasonal patterns outside of the recession.

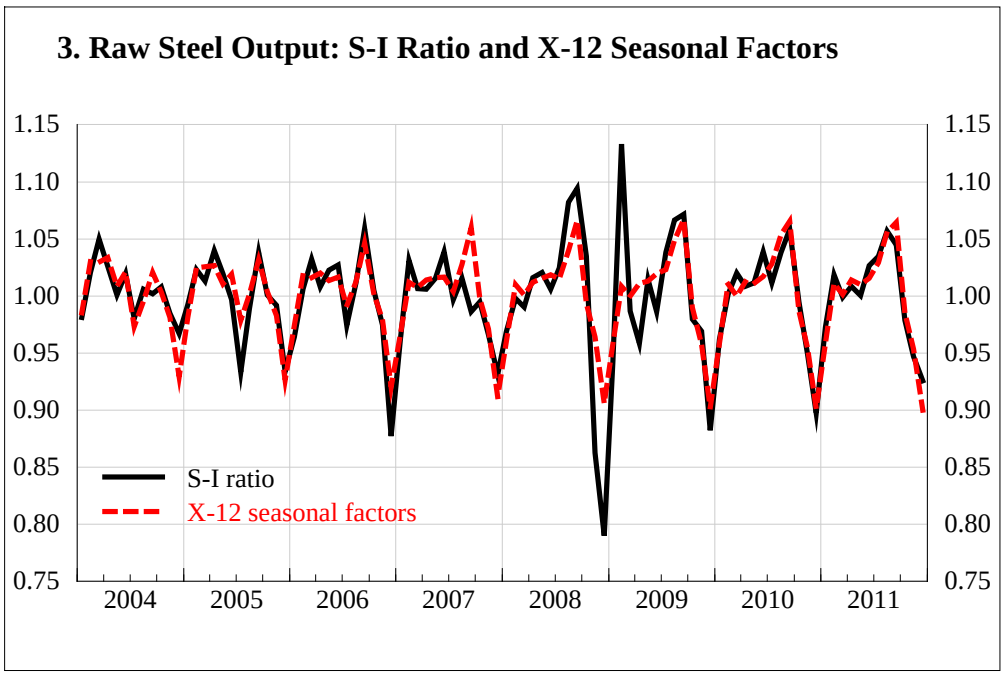
The Box-Tiao intervention technique continued to be used in subsequent annual revisions for periods severely affected by a recession. In addition, some indicator series were filtered using a robust detrending procedure before being fed into X-12. The robust detrending procedure uses a mixture of moving medians and moving averages to estimate a trend for a series (see details in the appendix). The removal of this trend from a series often reduces the spurious recession effect on the seasonal factors.

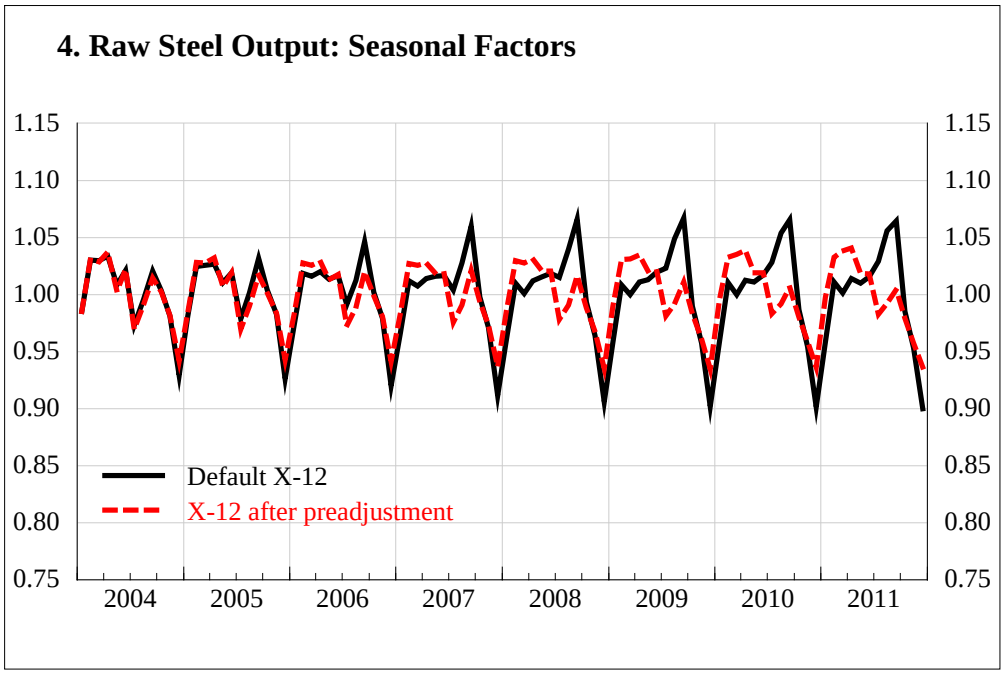
The 2010 annual revision to IP relied on extensive use of the robust detrending procedure along with the specification of additive outliers for the 2008–09 recession for many indexes. The staff determined the additive outliers on a judgmental basis. The staff compared the existing seasonally adjusted indexes with the indexes that were seasonally adjusted after incorporation the recession-period data but that did not have additive outliers specified. Interventions were then specified for those IP indexes for which the revision to the seasonally adjusted series tended to temper the depth of the recession in the period around the trough.

A prime example of the need for pre-adjustment of some series to minimize the impact of the recession on the estimated seasonal factors is the IP index for raw steel, which dropped abruptly in late 2008 and early 2009. The decrease, which averaged about 10 percent a month from October 2008 through April 2009, was then followed by gains that averaged 5 percent a month through the rest of 2009. During this period of rapid contraction and recovery, the output gains and losses did not exhibit their normal seasonal pattern. The solid line in chart 2 represents the average daily output of raw steel for the months from 2004 to 2011 as available when the seasonal factors for IP were estimated for the revision. The dashed line shows its trend, determined by X-12. The unusual pattern of the output swings in 2008 and 2009 is most easily seen in chart 3: The solid line shows the ratio of raw steel output to its trend from X-12 (the S-I

[10] At the time of the 1985 annual revision, X-11 was the current version of the Census computer program for estimating seasonal factors.

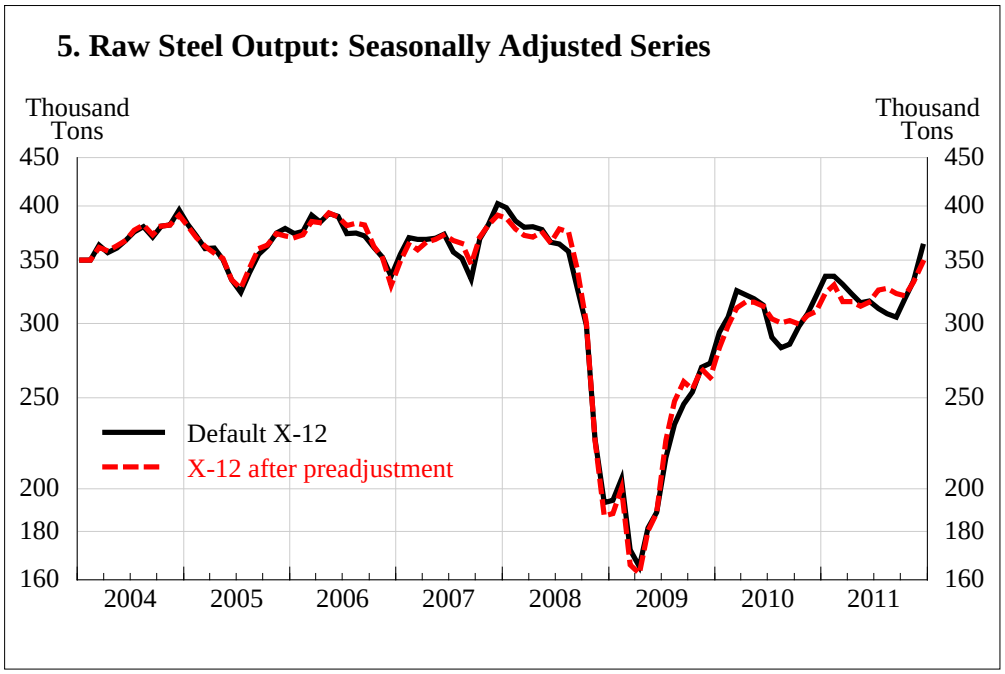

2. Raw Steel Output
Thousand Tons
Thousand Tons
450
400
350
300
250
200
150
Daily average
X-12 trend
2004
2005
2006
2007
2008
2009
2010
2011


3. Raw Steel Output: S-I Ratio and X-12 Seasonal Factors
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
S-I ratio
X-12 seasonal factors
2004
2005
2006
2007
2008
2009
2010
2011



ratio). After being automatically adjusted for extreme values by X-12, this ratio is used to estimate the seasonal factors for the series. The S-I ratio gyrates in a more extreme fashion around the end of 2008 and into 2009 than it does during other periods shown; it also does not exhibit the typical seasonal pattern in that the timing of the crash and rebound leaves the third quarters of both 2008 and 2009 well above their trend. The dashed line in chart 3 represents the seasonal factors estimated by the default X-12 settings. Because X-12 calculates seasonal factors using moving averages, the effect of an anomaly in any period's data diminishes as the estimates move further away from the anomaly. Comparing factors from 2007 forward to those up to 2006, one can see that X-12 translated the new data into factors that are stronger in the third quarter and weaker in the second quarter.

In estimating seasonal factors for the raw steel index, the Federal Reserve pre-adjusted the index with the robust detrending procedure and treated the data from November 2008 through October 2009 as additive outliers—in effect replacing the actual values with more-typical values based on periods outside those 12 months. Chart 4 shows the resulting factors. The solid line represents the seasonal factors from the default X-12 specification, and the dashed line represents the factors calculated by applying X-12 to the pre-adjusted series. Although there is some evolution in the seasonal pattern based on the pre-adjusted series, the basic pattern of a strong early part of the year and a weaker third quarter is evident throughout the time span. Chart 5 shows the raw steel output series seasonally adjusted using default X-12 specifications (solid line) and the series that results from factors estimated using the pre-adjusted data (dashed line). For 2010 and 2011, the series based on default specifications appears strong early in the year only to



fall back by the third quarter, whereas some of this pattern is ameliorated in the series using factors that were estimated with the pre-adjusted data.

APPENDIX: ROBUST DETRENDING ALGORITHM

The robust detrending algorithm comprises the following steps:

1. Let V_1 be the logarithm of variable V.

2. For every period t, let V_2 be the median of the following 13 terms: (V_1[t-5], V_1[t-4], ..., V_1[t+5], median(V_1[t-6],... V_1[t+5]), median(V_1[t-5],..., V_1[t+6])).

3. Let V_3 be V_2 augmented by forecasts and backcasts of V_2 using the latest and earliest six-month averages of 12-month rates of change for V_1.

4. Let V_4 be the 2x12 centered moving average of V_3.

5. Let V_5 be 0.4*V_4+0.6*V_3 for periods when abs(V_4-V_3) is greater than 0.4*std. dev.(V_4-V_3) and otherwise be V_4.

6. Let V_6 be the 13-term Henderson moving average of V_5, normalized to have the same average over the entire date span as V_1.

7. The final trend is V_6 exponentiated.