PPI and CPI seasonal adjustment: an update

A new update of BLS seasonal adjustment procedures ensures that differences between seasonally adjusted PPI and CPI series are due to the underlying unadjusted data, and not to differences in seasonal adjustment methods; in a further improvement, PPI and CPI analysts are now coordinating their efforts

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In November 2006, the first-released[1] seasonally adjusted producer price index (PPI) for gasoline jumped 17.9 percent, while the seasonally adjusted consumer price index (CPI) for gasoline fell 1.6 percent. The disparity between the two series resulted from differences in the indexes' seasonal factors for gasoline. Seasonal factors are applied to unadjusted indexes to remove within-year seasonal patterns from time series, allowing for more comparable month-to-month index analysis.

An initial investigation indicated that methodological differences in the PPI and CPI were responsible for the differences in seasonal factors for gasoline. In particular, the PPI and CPI differed in their selection of data points to model as interventions for the series. Intervention modeling is used during the estimation of seasonal factors to remove the effects of nonseasonal events that can distort the observed seasonal patterns of an index.

In 2007, the Bureau of Labor Statistics (BLS, the Bureau) undertook an effort to further investigate differences in seasonal adjustment methods between the PPI and the CPI, with an eye toward developing a more unified approach to seasonal adjustment. PPI analysts and CPI analysts worked together and with a group of BLS time-series experts to develop that approach.

Several methodological changes were implemented as a result of the investigation. A new set of processes was introduced to build intervention models for time series, to assist with the selection of time series for intervention modeling, and to identify similar PPI and CPI time series for joint modeling. This article presents the updated seasonal adjustment procedures.

The next section provides an overview of general PPI and CPI modeling procedures. Then, the third and fourth sections describe the processes used by the CPI and PPI, before and after the investigation, to select time series for intervention modeling and to develop intervention models. Following that, the fifth section presents time series selected for joint modeling work and the sixth section gives examples of series that were affected by the new seasonal adjustment procedures.

PPI and CPI seasonal adjustment

The Bureau publishes seasonally adjusted PPI and CPI time-series data on a monthly basis. Both the PPI and the CPI utilize direct and indirect seasonal adjustment methods. Direct

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seasonal adjustment is accomplished by applying seasonal factors to unadjusted data to remove within-year seasonal patterns. Indirect adjustment is a method of seasonal adjustment used for aggregate series; in this method, two or more directly adjusted component indexes are combined into higher level time series.

In the PPI, commodity-based and stage-of-processing indexes are eligible for seasonal adjustment. In 2009, the Bureau published 1,226 commodity-based PPIs and 52 stage-of-processing PPIs. The vast majority of the PPI commodity data is directly seasonally adjusted. By contrast, the Bureau seasonally adjusts all of its stage-of-processing PPIs by means of an indirect method. The CPI's entire set of 368 item-level indexes is eligible for seasonal adjustment. The Bureau uses direct adjustment for its lower level CPI indexes and indirect adjustment for all upper level aggregate indexes. Lower level indexes track price change for specific commodities over time, whereas upper level indexes track price change for groupings of lower level commodity indexes. Upper level indexes are constructed by using consumer expenditure weight data to combine lower level indexes.

Direct adjustment. The Bureau tests all PPI and CPI series that are eligible for direct adjustment for seasonality, and if seasonality is found, the series are seasonally adjusted. Both seasonality testing and direct seasonal adjustment are accomplished with the use of X-12 ARIMA, a software package published by the U.S. Census Bureau for seasonal adjustment applications. Seasonal adjustments are based on the X-11 variant of the Census II seasonal adjustment method.[2] X-11 is a filter-based approach, employing moving averages to estimate trend and seasonal components in turn. Components are refined through several iterations of weighted moving averages. X-12 ARIMA uses a multiplicative time-series decomposition model by default:

$$Y_t = T_t S_t I_t.$$

In this model, Y_t is the value of the observed series, T_t represents the trend-cycle component, S_t is the seasonal component, and I_t is the irregular component. The multiplicative model is appropriate when a series has increasing variation with time, as is often seen with PPI and CPI series. To enable the use of symmetric moving-average filters on a series, X-12 ARIMA uses an ARIMA (Auto-Regressive Integrated Moving Average) modeling facility to forecast and backcast observations at the endpoints of the data.

Among the many diagnostics that are available for assessing the quality and stability of seasonal adjustments are F-tests for the presence of stable and moving seasonality and quality control statistics from X-11.[3] Data that facilitate graphical analysis also are available, including the unadjusted and adjusted series frequency spectra.[4] Exhibit A-1 in the appendix provides a summary of diagnostic tools examined and used by BLS seasonal adjustment analysts, as well as a list of frequently employed graphs.

The Bureau utilizes three primary measures to determine whether a particular PPI or CPI should be seasonally adjusted: $F(s)$, M7, and Q. $F(s)$ is a measure of stable seasonality, M7 determines the amount of moving seasonality relative to the amount of stable seasonality, and Q is a weighted average of several diagnostic statistics. (See exhibit A-1 in the appendix for quality control statistical seasonality thresholds.)

Indexes that are found to exhibit a level of seasonality warranting adjustment are directly adjusted by applying a seasonal factor to the unadjusted index according to the formula

$$I_s = \frac{I_u}{\text{SF}}(100),$$

where
I_s is the seasonal index value,
I_u is the unadjusted index value, and
SF is the seasonal factor.

Seasonal factors indicate the seasonal pattern of a time series and are derived from historical unadjusted data. The Bureau typically uses 8 years of unadjusted monthly data in developing factors and testing seasonality for both the PPI and the CPI.

Intervention analysis. Nonseasonal events such as natural disasters or wars can distort the underlying seasonal pattern of an index. Intervention analysis entails estimating and removing the effects of these events from indexes prior to testing them for seasonality and developing seasonal factors. The goals of intervention analysis are to determine whether a seasonal pattern exists and to correctly estimate seasonal factors in spite of any distortion that might arise in the pattern. The Bureau applies intervention analysis to selected directly adjusted PPI and CPI indexes. (See later.)

The Bureau uses X-12 ARIMA to conduct both CPI and PPI intervention analysis, a method in which ARIMA models that include prespecified intervention variables are estimated for a time series. These variables are used to identify the statistical significance and relative effects of nonseasonal events on time series. In cases where a nonseasonal event is found to significantly affect a time series, the effects of the event can be removed from the original time series by using the estimated coefficients from the ARIMA model. Three types of intervention variables are employed: outliers, level shifts, and ramps.

Outlier variables are specified as AO = 1 for $t = t_0$ and AO = 0 for $t \neq t_0$, where t_0 is the month of the nonseasonal event.

Level-shift variables are specified as LS = –1 for $t < t_0$ and LS = 0 for $t \geq t_0$, where t_0 is the month of the nonseasonal event.

Ramp variables are specified as RP = –1 for $t \leq t_0$, RP = $[(t - t_0)/(t_1 - t_0)] - 1$ for $t_0 < t < t_1$, and RP = 0 for $t \geq t_0$, where t_0 is the first data point of the nonseasonal event and t_1 is the last data point.

After nonseasonal effects are removed from the original time series, standard direct seasonal adjustment methods as described earlier are applied to the indexes to test for seasonality and to develop seasonal factors.

Indirect adjustment. High-level indexes, such as the PPI for Finished Goods and the All Items CPI, are indirectly seasonally adjusted by aggregating lower level series that are components of higher level indexes. Seasonally adjusted components are used when available (that is, when the lower level index was shown to be seasonal and a seasonal index was calculated); otherwise, unadjusted indexes are used.

The Bureau indirectly adjusts all of its PPI stage-of-processing indexes, as well as any indexes that are aggregates of intervention indexes. In this manner, interventions estimated for lower level indexes are indirectly included in aggregate indexes. The Bureau indirectly seasonally adjusts the All Items CPI index and 54 other aggregate series.[5]

Yearly revisions and projected factors. Each year, with the release of the January data, the PPI and CPI seasonal factors are recalculated to reflect price movements that occurred during the just-completed calendar year. Seasonal factors are recalculated 5 years back, and all seasonally adjusted data are updated on the basis of these new factors. For example, in January 2007 factors were recalculated from 1999–2006 data and seasonal data from 2002–06 were updated in accordance with the new set of factors. After the yearly revision, the PPI and the CPI for the upcoming year are calculated with the previous year's set of seasonal factors. For instance, the 2006 factors, from the January 2007 revision, are used to calculate indexes throughout 2007.

Selection of intervention candidates

Pre-2007 candidate selection procedures for the PPI. More than 1,200 PPI indexes are currently eligible for direct seasonal adjustment. Conducting intervention modeling on this entire set of indexes is not feasible because of resource constraints. Consequently, the Bureau performs intervention modeling on only a relatively small set of PPIs, referred to as *intervention candidates*.

Prior to 2007, PPIs were selected as intervention candidates on the basis of four criteria: the index must have been a six-digit commodity index, the index must have been a currently seasonally adjusted index that was going to fall out of seasonal adjustment due to failing quality control statistics for 3 consecutive years, the index must have had a relative importance of greater than 1 percent of a major stage-of-processing index, and there must have been an identifiable shock causing a distortion in the seasonal pattern of the index.

Indexes meeting these four criteria were added to the set of PPI intervention candidates. Once an index was so added, it typically remained a candidate unless the Bureau believed that the index no longer exhibited any statistically significant seasonal pattern.

CPI's pre-2007 candidate selection procedures. The CPI conducted a yearly analysis of all its time series to determine which of them to include as intervention candidates. Among the factors analyzed were the candidate status of the series the previous year, information from commodity analysts, the results of a visual inspection of all eligible series, large events (such as a hurricane) that could affect unrelated series, and substantial changes in diagnostic behavior. In cases where the analysis indicated benefits from intervention modeling, the series was included as a candidate.

Updated candidate selection procedures. As mentioned earlier, prior to 2007 the Bureau utilized a relative-importance rule in selecting PPI candidates. This rule ensured that intervention work was directed toward important and visible series. The PPI continues to utilize the 1.0-percent relative-importance rule, and the CPI has now implemented a similar rule. The rule requires candidates to have a relative importance of 0.5 percent of the U.S. city average All Items CPI or be a subset of an already qualifying component series.

Previously, the Bureau would consider adding a PPI as a candidate only if it were a currently seasonally adjusted index that was in danger of becoming unadjusted as a result of exhibiting failing quality control statistics for

3 consecutive years, whereas all CPIs were analyzed each year as potential candidates. The Bureau then removed the requirement that a PPI needed to fail the quality control criteria for 3 consecutive years in order to become a candidate. Now all PPIs and CPIs that meet the relative-importance criteria are examined each year. This change improves seasonal factor estimation by ensuring that all important indexes have the potential to become intervention candidates.

Automatic outlier detection (including level-shift detection) is now implemented for both the PPI and the CPI as a primary tool for assisting in candidate selection. X-12 automatic outlier and level-shift detection is a regression-based program that searches for and identifies statistically significant intervention variables. Each year, the program is run on all series that are eligible for intervention analysis. (That is, they meet the relative-importance criteria.) Indexes for which automatic outlier detection finds significant interventions are then analyzed further as potential intervention candidates.

Intervention modeling

Pre-2007 PPI modeling procedures. Before 2007, the Bureau utilized a number of sources of information in developing PPI intervention models, including analyses of extreme values detected by X-12, graphical analyses of time series, analyst price notes, and quality control statistics. Although all of these sources of information were used to develop the models, analyses of extreme values detected by X-12 received the most consideration in the overall PPI procedure.

Generally, the Bureau sought to include a minimal number of interventions in a PPI model, modeling the least number of interventions necessary to allow the series to pass the seasonality thresholds. In fact, in cases where an intervention candidate passed quality control thresholds without any intervention modeling, program rules precluded the Bureau from including any interventions in the seasonal model.

In selecting potential interventions, the Bureau included the most significant interventions in its PPI models and required the absolute value of all *t*-statistics to be greater than 3.0 for intervention variables. All ramps, level shifts, and outliers utilized in the models required economic explanations. The Bureau did not, and still does not, publish these explanations, but does document them for internal use.

Pre-2007 CPI modeling procedures. To develop intervention models, CPI seasonal adjusters analyzed a number of diagnostic statistics, including seasonal factor graphs, first-difference graphs, quality control statistics, prior adjusted series, and automatic outlier detection. These diagnostic statistics were analyzed to determine the effects of modeling specific data points on CPI seasonal factors, as well as to determine whether the modeling of these data points was statistically supported. The Bureau generally required the absolute value of *t*-statistics for all CPI intervention variables to be greater than 3.0, but would accept lower *t*-statistics in some cases. The Bureau also examined market data and commodity analyst price notes to help identify potential CPI intervention points.

After seasonal adjusters developed potential intervention models, CPI adjusters consulted with commodity analysts to try to reach a consensus on a "best" intervention model. The Bureau usually did not place the same importance on the CPI as it did on the PPI in attempting to include a minimal number of interventions in a model; therefore, the CPI models that were developed often were larger than the PPI models. Nor did the Bureau apply to the CPI the PPI's constraint of not modeling interventions in cases where the candidate passed quality control thresholds without any intervention modeling.

The CPI required, and still requires, that all ramps and level shifts included in seasonal models be accompanied by economic explanations, which are published yearly in the January CPI detailed report. Outliers did not need specific explanations, but events surrounding an outlier were often noted.

Updated modeling procedures. The Bureau has developed a multistep process for modeling both PPI and CPI intervention series. The first step is to use X-12 automatic outlier and level-shift detection to identify potential intervention points. The use of this tool provides the Bureau's PPI and CPI programs with a statistically based and replicable means for identifying potential outliers.

X-12, however, does not search for ramps, which the Bureau uses as a modeling tool for both the PPI and the CPI. Therefore, additional analysis is implemented to select intervention points. This analysis includes graphical examination of the original time series, the study of price trend analysis developed by PPI industry analysts and CPI commodity analysts for internal BLS use, communication with commodity and industry analysts, examination of interventions modeled in previous years, and analysis of residuals from the ARIMA model. A combination of these tools is used by PPI and CPI seasonal adjusters to identify potential intervention models for a series.

The Bureau requires statistical and economic justifications for all modeled PPI and CPI interventions. Intervention variables should generally have t-statistics with absolute values greater than 3, and all modeled interventions should have economic explanations. In addition, the Bureau changed its policy regarding intervention modeling for PPI candidates that have passing quality control statistics. Now the PPI uses the CPI method of allowing intervention modeling for candidates whose quality control statistics exhibit seasonality. Allowing this kind of modeling ensures that nonseasonal events will be modeled for each index and that the effects of these events will not distort seasonal factors.

Further steps are taken for PPI and CPI series that exhibit a great deal of similarity. For these series, seasonal adjusters from the programs meet to compare and discuss models. The goal is to coordinate intervention decisions between the two programs for similar series. Communication also allows the programs to benefit from each other's expertise and helps to avoid large discrepancies in modeling decisions. Such discrepancies can lead to situations in which similar series exhibit consistent unadjusted movements but different seasonally adjusted movements. (The next section, on concordance series, describes the process for selecting these comparable series.)

Once several potential models have been developed, information criteria are used for further comparison. Information criteria help determine the appropriate number of estimated parameters to include in a model. The criteria weigh the benefits of adding variables to the model by numerically rewarding the increase in fit generated by an additional variable but numerically penalizing the model for the loss in degrees of freedom associated with the additional parameter. Two frequently used information criteria are the Akaike and Bayesian criteria. Akaike, however, has been shown to asymptotically overstate the number of parameters to include in a model. The Bayesian attempts to correct for this deficiency by being stricter than Akaike in terms of penalizing the loss of degrees of freedom. Both criteria are analyzed during modeling, but the Bayesian is given more weight because of Akaike's tendency to select models with too many parameters. Carefully analyzing information criteria helps to ensure that models are not overfit, a condition that tends to make the models excessively complex and exhibit poor out-of-sample predictive performance.

After final drafts of the intervention models are completed, CPI and PPI analysts meet jointly to discuss the series that have been selected for seasonal adjustment coordination. Any changes resulting from this meeting are incorporated into the final models.

Concordance series

To assist in seasonal adjustment coordination between the PPI and CPI, a series concordance was developed. The concordance identifies PPI and CPI series eligible for intervention analysis that might benefit from data exchange or coordinated seasonal adjustment. In order to be included in the concordance, a series must be eligible for intervention analysis in both programs.

Using the PPI 1.0-percent relative-importance rule as a starting point for the concordance, analysts identified all PPI series having a relative importance of greater than 1.0 percent of either the finished, intermediate, or crude goods indexes as potential concordance series. For 2007, 50 series were identified on the basis of the relative-importance criterion.[6] Along with these 50 series, any current PPI seasonal candidates that did not pass the 1.0-percent rule were included, bringing the total number of series to 58. (The current set of PPI intervention candidates includes several indexes that make up less than 1.0 percent of a major stage of processing. Historically, these indexes have been intervention candidates, and the Bureau chose to keep them as such.)

CPI series were then matched to the 58 PPI series on the basis of similarity of title. After the initial matching, corresponding indexes were further analyzed to determine whether they exhibited similar enough movements to warrant PPI-CPI seasonal adjustment coordination. It turned out that many series with somewhat similar titles between programs proved imperfect matches and were not included in the final concordance table. The final concordance table is updated annually to reflect changes in relative-importance calculations and potential new series that arise each year. This table is presented as exhibit 1.

Examples

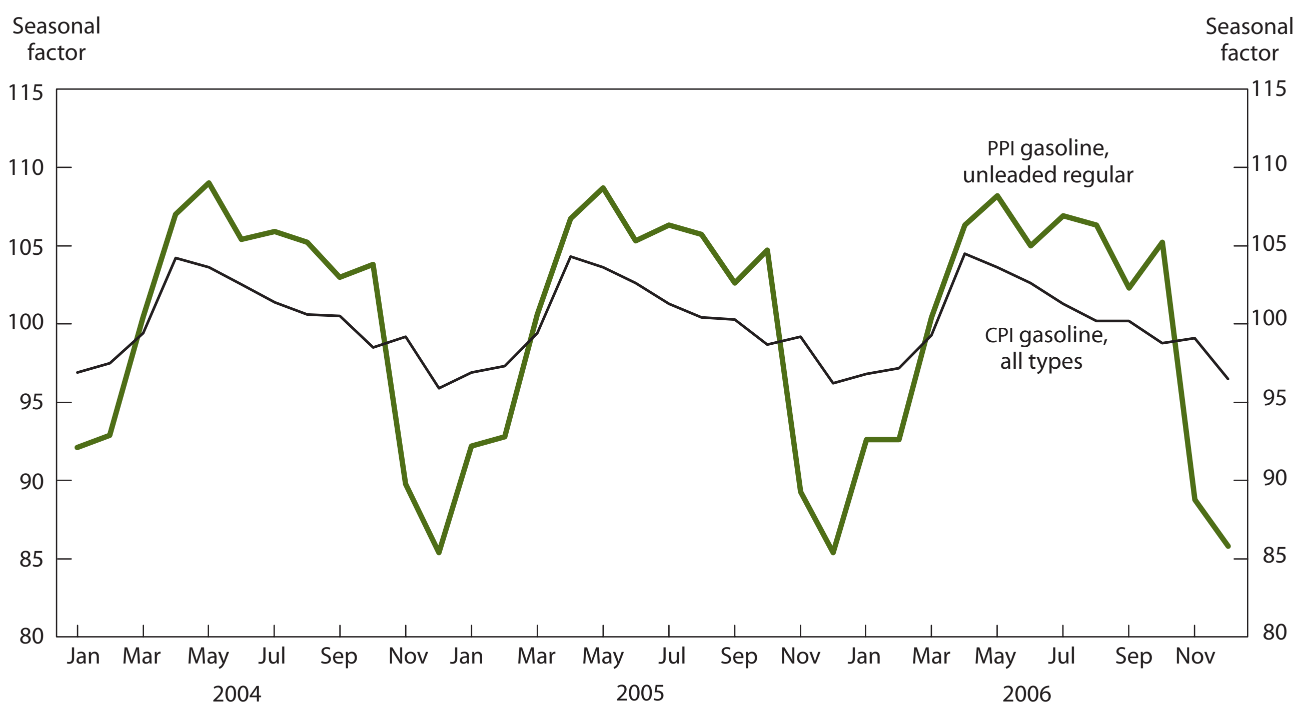
This section presents examples of series that were analyzed and, in most cases, substantially affected by the modified PPI and CPI seasonal adjustment procedures.

Gasoline. In the 2006 annual seasonal adjustment revision, the Bureau tested its three PPI gasoline series (regular, midpremium, and premium) for seasonality, and the quality control statistics for all three series indicated seasonality. Consequently, no interventions were modeled because of the program's rule prohibiting intervention work on series whose quality control statistics met

Exhibit 1. Producer Price Index (PPI) and Consumer Price Index (CPI) final concordance list

PPI finished-goods series greater than 1 percent of major stage-of-processing index and adjusted by intervention analysis seasonal adjustment (IASA)					Closest CPI series			
Item code	Title	Relative importance	Seasonally adjusted	IASA, 2006	Item code	Title	Seasonally adjusted	IASA, 2006
054121	Residential electric power	7.84	Y	N	SEHF01	Electricity	Y	Y
141101	Passenger cars	4.10	Y	N	SETA01	New vehicles	Y	Y
057104	Unleaded regular gasoline	4.00	Y	N	SS47014	Gasoline, unleaded regular	Y	Y
055121	Residential natural gas	3.00	Y	Y	SEHF02	Utility (piped) gas service	Y	Y
022105	Other meats, fresh, frozen, or canned	.60	Y	N	SEFE	Other meats	Y	N
057103	Unleaded premium gasoline	.76	Y	N	SS47016	Gasoline, unleaded premium	Y	Y
057105	Unleaded midpremium gasoline	.36	Y	N	SS47015	Gasoline, unleaded midgrade	Y	Y
057302	Home heating oil and other distillates (fuel oil #2)	.74	Y	Y	SEHE01	Fuel oil	Y	Y
054321	Industrial electrical power	2.76	Y	N	SEHF01	Electricity	Y	Y
054221	Commercial electrical power	4.72	Y	N	SEHF01	Electricity	Y	Y
016101	Milk for fluid use	4.70	Y	N	SEFJ01	Milk	Y	N

Chart 1. Seasonal factors for gasoline, 2006 revision, 2004–06



the predetermined seasonality thresholds. The CPI, by contrast, included 22 intervention variables in its seasonal model for gasoline.

The PPI and CPI seasonal factors for gasoline from the 2006 revision differed substantially as a result of the different intervention models used by the two programs. Chart 1 presents the seasonal factors for CPI gasoline (all types) and PPI unleaded regular gasoline. Recall that seasonal factors reflect the expected seasonal pattern of a time series on the basis of historical data and are applied to the unadjusted data to create seasonal data.

The PPI and CPI seasonal factors exhibit similar seasonal patterns (rising in the spring and declining throughout fall and winter), but differ in terms of volatility and size. In addition, during several months the seasonal factors project opposite directional movements in the gasoline indexes. For example, from October to November, the PPI expects a large seasonal decrease in gasoline prices, whereas the CPI anticipates a small seasonal increase.

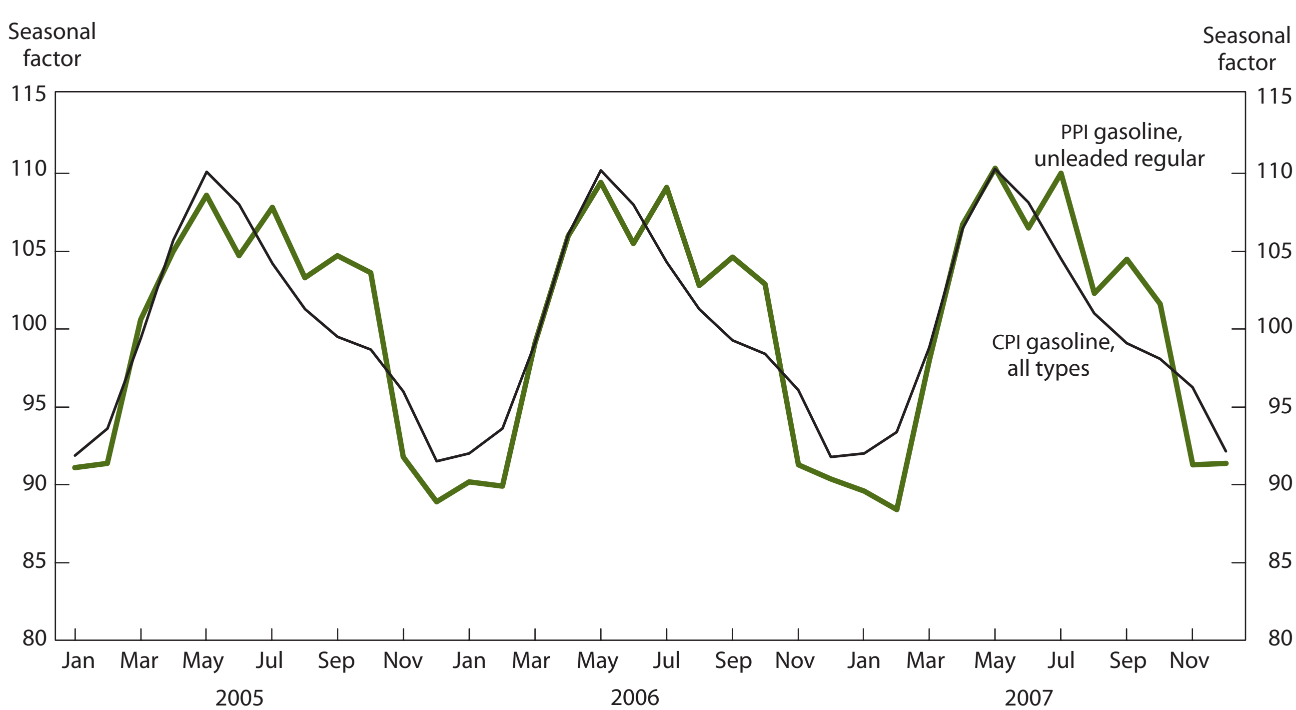
For the 2007 annual seasonal adjustment revision, the Bureau implemented the updated PPI and CPI modeling procedures discussed in the previous two sections. The Bureau was no longer precluded from modeling PPI gasoline series data points as interventions in spite of quality control statistics that indicated seasonality in the unmodeled series. The Bureau also relied more heavily on automatic outlier and level-shift detection, ARIMA model residual analysis, information criteria, analyst input, and cross-program coordination to develop both its PPI and CPI intervention models. As a result, the PPI intervention model increased in size, whereas the CPI model decreased.

Six intervention variables were in the 2007 PPI model, compared with none in the 2006 model. The number of intervention variables in the CPI model fell from 22 in 2006 to 4 in 2007. The 2007 PPI and CPI gasoline intervention models also shared several variables; for example, both modeled a ramp from March 2003 to May 2003.

Chart 2 presents the seasonal factors for PPI and CPI gasoline resulting from the 2007 seasonal revision. Comparing the two charts shows that the 2007 revision's seasonal factors (derived with the use of updated procedures) resulted in much more similar seasonal factors than those produced during the 2006 revision. The 2007 revision's PPI and CPI seasonal factors, shown in chart 2, are closer in terms of size and volatility than the 2006 revision's factors, presented in chart 1. The discrepancy in seasonal factors from October to November, present in the 2006 revision's gasoline factors, is corrected in the 2007 revision. The PPI and CPI factors both project that gasoline prices will show a seasonal decline from October to November, based on the 2007 seasonal revision.

Table 1 compares the 2007 monthly percent changes in

Chart 2. Seasonal factors for gasoline, 2007 revision, 2005–07



the PPI and CPI for gasoline, calculated with seasonal factors from the 2006 and 2007 seasonal revisions. The table also displays the absolute values of the difference between the monthly CPI and PPI percent changes for both the 2006 and 2007 revisions.

Table 1 shows that the absolute difference between the percent changes in the PPI and CPI for gasoline was smaller in 9 of the 12 months of 2007 when calculated on the basis of seasonal factors from the 2007 revision as opposed to seasonal factors from the 2006 revision. The average absolute difference for 2007 fell from 7.2 percent, on the basis of the 2006 revision, to 4.6 percent, on the basis of the 2007 revision. (Recall that the 2007 revision used the updated seasonal adjustment procedures, whereas the 2006 revision did not.)

Natural gas. In 2006, on the basis of the existing seasonal adjustment procedure, the PPI modeled only one intervention for natural gas, whereas the CPI model included eight ramps and one outlier. Chart 3 compares the CPI and PPI seasonal factors from the 2006 revision.

Although the PPI and CPI seasonal factors appear somewhat similar in terms of their overall pattern, several substantial differences are present between the two sets of factors. Most important, CPI factors project that natural gas prices will rise in April, May, and June, whereas PPI factors project a decline in those 3 months.

For the January 2007 seasonal revision, the Bureau used the updated modeling procedures for both PPI and CPI natural gas, resulting in much more similar intervention models than those from the 2006 revision. The CPI model consisted of three ramps and one outlier, the PPI model four level shifts and two outliers. All periods modeled as interventions for the CPI were also modeled by the PPI. The PPI model, however, included interventions in two additional periods.

Chart 4 presents PPI and CPI natural gas factors based on the 2007 seasonal revision. The two indexes' natural gas seasonal factors from the 2007 revision were substantially more similar to each other than those from the 2006 revision (shown in chart 3). Factors from both programs projected similar natural gas seasonal pricing patterns for most of the year, including the previously problematic period from April through June.

Table 2 compares the 2007 monthly percent changes for the PPI and CPI for natural gas, calculated with seasonal factors from the 2006 and 2007 seasonal revisions. The table shows that the absolute difference between the percent changes in the PPI and CPI for natural gas was smaller in 9 of the 12 months of 2007, calculated on the basis of seasonal factors from the 2007 revision as opposed to seasonal factors from the 2006 revision. The average absolute difference for 2007 fell from 2.6 percent, on the basis of the 2006 revision, to 1.9 percent, on the basis of the 2007 revision. In all 3 months in which seasonal factors projected counterdirectional movement in the 2006 revision (April, May, and June), absolute

Table 1. Comparison of Producer Price Index (PPI) and Consumer Price Index (CPI) percent changes in gasoline, 2006 revision and 2007 revision

[1-month percent changes]

Month in 2007	2006 revision			2007 revision		
	CPI	PPI	Absolute difference	CPI	PPI	Absolute difference
January	–3.2	–13.4	10.2	–2.5	–5.7	3.2
February	.5	6.1	5.6	–.7	7.6	8.3
March	10.6	7.9	2.7	6.7	5.5	1.2
April	4.8	8.2	3.4	2.4	5.2	2.8
May	10.8	8.8	2.0	5.7	7.2	1.5
June	–1.2	–1.9	.7	–.1	–1.4	1.3
July	–1.9	3.9	5.8	.2	2.4	2.2
August	–5.1	–14.0	8.9	–2.6	–8.0	5.4
September	.6	8.1	7.5	2.5	1.8	.7
October	1.3	–3.8	5.1	.9	1.7	.8
November	9.5	37.2	27.7	12.1	28.9	16.8
December	1.1	–5.2	6.3	2.9	–8.5	11.4
Average absolute difference	…	…	7.2	…	…	4.6

Table 2. Comparison of Producer Price Index (PPI) and Consumer Price Index (CPI) percent changes in natural gas, 2006 revision and 2007 revision

[1-Month percent changes]

Month in 2007	2006 revision			2007 revision		
	CPI	PPI	Absolute difference	CPI	PPI	Absolute difference
January	–3.0	–2.4	0.6	–3.0	–1.4	1.6
February	5.0	3.1	1.9	3.0	2.9	.1
March	3.0	5.0	2.0	2.2	3.7	1.5
April	–1.0	.6	1.6	–1.0	.4	1.4
May	–.9	.8	1.7	.5	.7	.2
June	–.1	2.2	2.3	.8	1.9	1.1
July	–1.7	2.9	4.6	–1.8	3.6	5.4
August	–4.2	–7.5	3.3	–2.4	–6.4	4.0
September	–1.0	1.9	2.9	–.3	–.2	.1
October	.7	–2.0	2.7	.7	–1.7	2.4
November	.9	–4.0	4.9	.6	–1.8	2.4
December	2.3	–.7	3.0	.5	–2.1	2.6
Average absolute difference	…	…	2.6	…	…	1.9

Chart 3. Seasonal factors for natural gas, 2006 revision, 2004–06

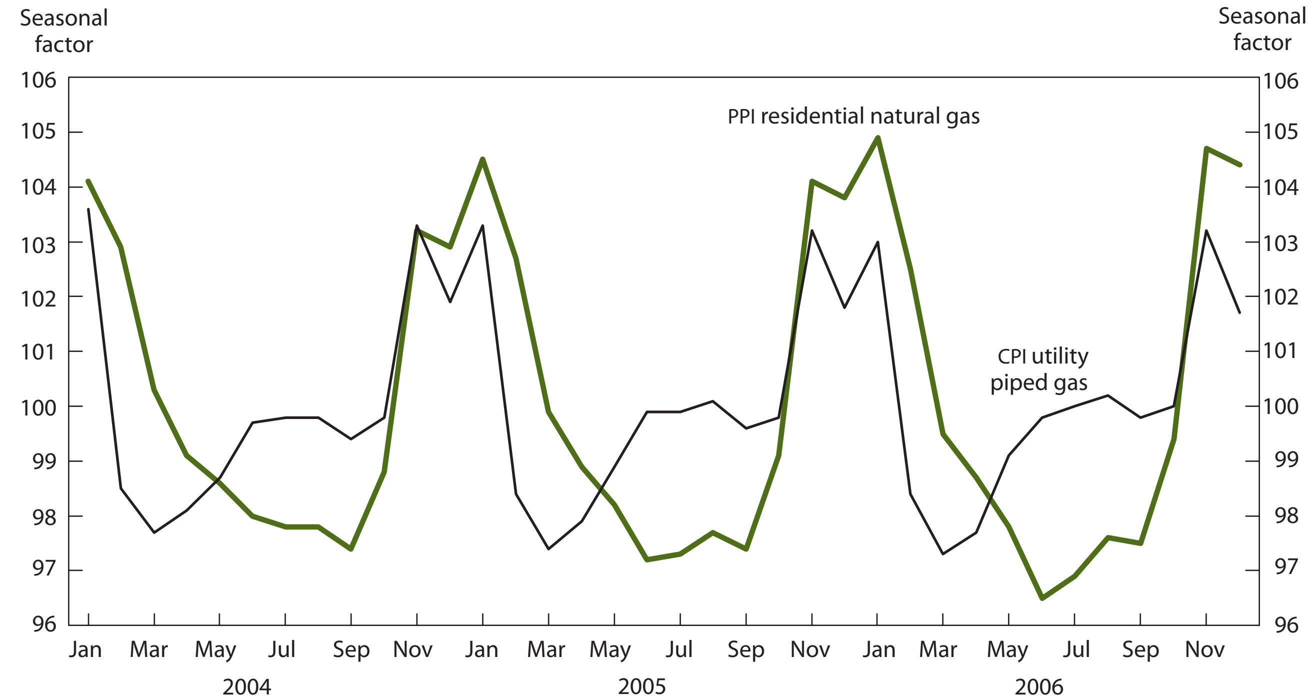
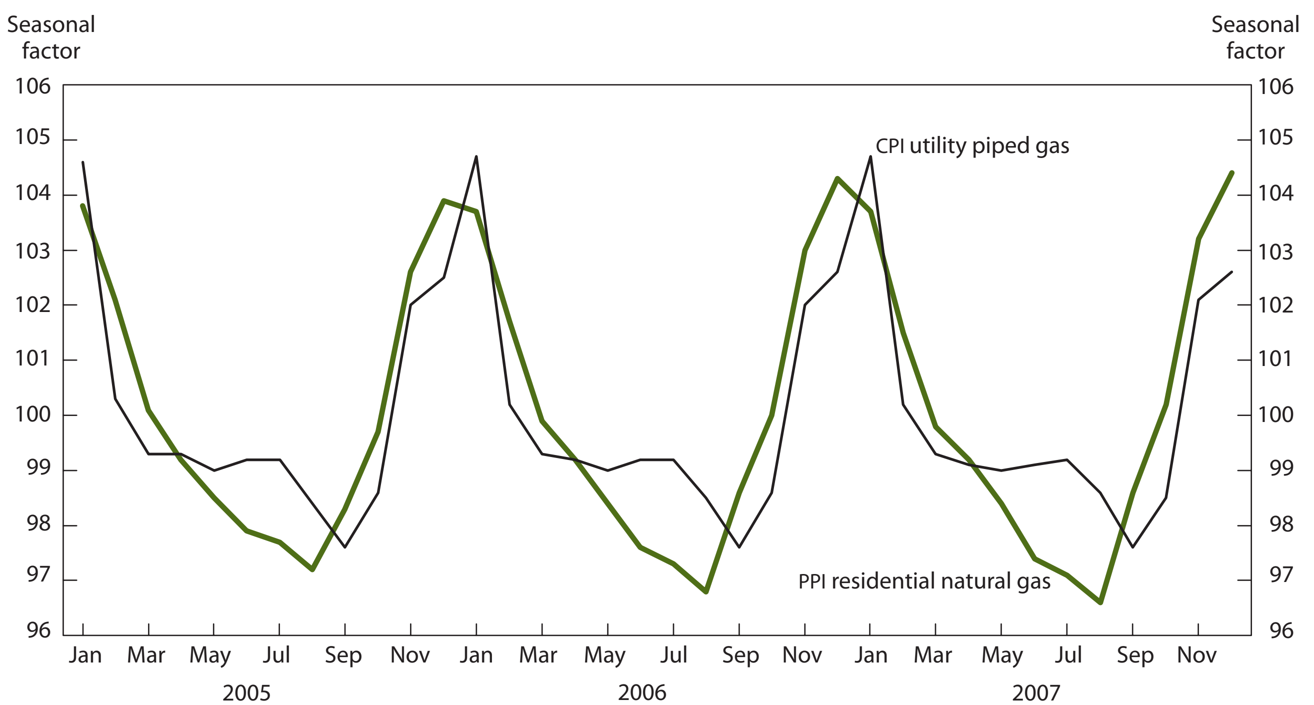


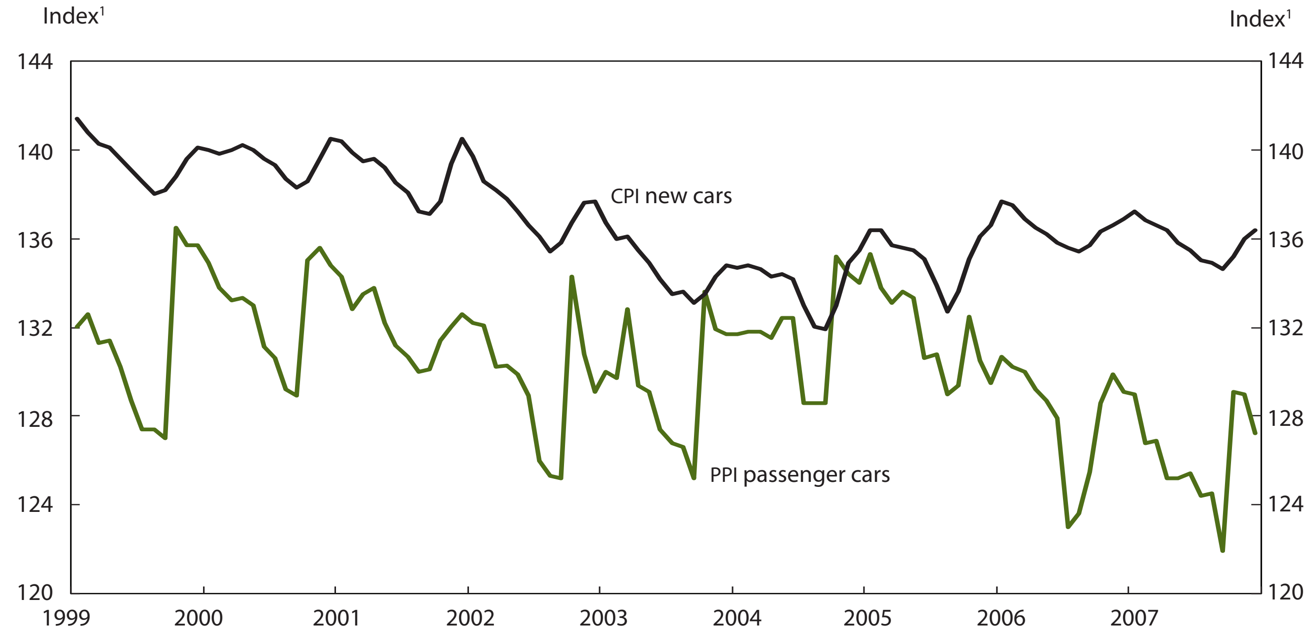
Chart 4. Seasonal factors for natural gas, 2007 revision, 2005–07



differences lessened subsequent to the 2007 revision.

Cars. The Bureau publishes a CPI time series for new cars and an analogous PPI series for passenger cars. Despite the fact that they both have the word "cars" in their title, the two series behave differently.[7] The seasonality of the CPI for new cars corresponds to a changeover in model each September. The corresponding PPI model

Chart 5. Consumer Price Index (CPI) for new cars and Producer Price Index (PPI) indexes for passenger cars, 1999–2007



[1] CPI: 1982–84 = 100; PPI: 1982 = 100.

changeover, by contrast, generally occurs in October and exhibits a more abrupt transition compared with the CPI series, and the PPI series is generally more volatile.[8] The application of rebates to vehicle prices in each program is also different: PPI pricing measures consumer and dealer cash rebates, as well as low-interest financing offers, while the CPI uses an average of manufacturer and dealer rebates for each model over the previous 30 days. The latter approach affects both the magnitude and timing of the impact of rebates on CPIs relative to PPIs. Also, the CPI ceased directly measuring financing incentives as a part of its vehicle series in 1999.

Chart 5 contains the published unadjusted data for the preceding PPI and CPI car series. The chart reveals differences in trend, seasonality, and overall volatility between the series. A recurrent strong seasonal pattern is apparent in both series, but the timing and magnitude of seasonal peaks and troughs are different.

Although the Bureau publishes PPI and CPI series for cars, the differences between the two price series render explicit collaboration on seasonal adjustment intervention modeling difficult. In the end, it was decided to share relevant information on events affecting the automobile market, but not to attempt full PPI and CPI collaboration on seasonal adjustment intervention modeling for cars.

DIFFERENCES IN SEASONAL ADJUSTMENT TREATMENTS for similar data series can be driven by differences either in underlying series data or in the procedures used to arrive at the seasonal adjustment. The Bureau of Labor Statistics recently updated its PPI and CPI seasonal adjustment procedures to ensure that differences in seasonal series are a result of the underlying unadjusted data, as opposed to differences in seasonal adjustment methods.

Procedures were updated for the selection of intervention candidates as well as intervention modeling. For candidate selection, both programs now implement a relative-importance criterion, utilize automatic outlier detection, and allow all series that meet the relative-importance threshold to become candidates for seasonal adjustment. For intervention modeling, both programs now use a standard set of tools, including automatic outlier detection, information criteria, graphical analysis, and residual analysis.

To improve PPI and CPI seasonal adjustment further, a specific set of series was identified in which PPI and CPI seasonal adjusters coordinated their efforts. This collaborative approach to the seasonal adjustment of important series, such as volatile energy commodities, allows the Bureau to present the most consistent treatment possible of seasonal adjustment. □

Notes

[1] The first release of a seasonally adjusted price index occurs along with the regular monthly release of unadjusted indexes. Indexes in the current year are adjusted by means of seasonal factors from the corresponding month of the previous year.

[2] See Julius Shiskin, Allan H. Young, and John C. Musgrave, "The X-11 Variant of the Census Method II of the Seasonal Adjustment Program," Technical Paper no. 15 (U.S. Department of Commerce, Bureau of the Census, revised February 1967).

[3] See John Lothian and Marietta Morry, "A Set of Quality Control Statistics for the X-11-ARIMA Seasonal Adjustment Method" (Ottawa, ON, Statistics Canada, October 1978).

[4] The *spectrum*, or *spectral density*, graph measures relative contributions of frequencies to overall fluctuations in the series. The *x*-axis measures time, in cycles per quarter. Seasonal effects in quarterly data can be observed at frequencies of 0.25 and 0.5 cycle per quarter. The *y*-axis, or ordinate, is 10 times the logarithm of the spectrum amplitudes for the first difference of the series. (For details on the spectrum diagnostics in X-12-ARIMA, see David F. Findley, Brian C. Monsell, William R. Bell, Mark C. Otto, and Bor-Chung Chen, "New Capabilities and Methods of the X-12-ARIMA Seasonal Adjustment Program," *Journal of Business and Economic Statistics*, April 1998, pp. 127–77, on the Internet at **www.census.gov/ts/papers/jbes98.pdf** (visited July 22, 2010).)

[5] For additional information on indirect CPI adjustment, see "Aggregation of Dependently Adjusted Seasonally Adjusted Series" (Bureau of Labor Statistics, no date), on the Internet at **www.bls.gov/cpi/cpisatn2001.pdf** (visited July 22, 2010).

[6] The year 2007 was the focus of this analysis because that year was the first year the Bureau updated the seasonal adjustment procedures described in this article.

[7] For a detailed discussion of their differences, see Maria Bustinza, Daniel Chow, Thaddious Foster, Tod Reese, and David Yochum, "Price measures of new vehicles: a comparison," *Monthly Labor Review*, July 2008, pp. 19–32.

[8] *Ibid*., p. 20.

APPENDIX: Diagnostic tools and frequently employed graphs

Exhibit A-1. Seasonal adjustment diagnostics from X-12-ARIMA

X-11 seasonality metrics		
Diagnostic	**Description**	**Seasonality criterion**
F(*s*)	One-way analysis-of-variance (ANOVA) test for presence of stable seasonality	*F*(*s*) ≥ 7.0
F(*m*)	One-way ANOVA test for presence of moving seasonality	*F*(*m*) ≤ 3.0
M7	Amount of moving seasonality relative to amount of stable seasonality	M7 < 1.0
Q	Weighted average of M1–M11 quality statistics	*Q* < 1.0
Model evaluation and selection diagnostics		
Diagnostic	**Description**	**Criterion**
AIC	Akaike information criterion, a measure of goodness of fit	Minimize
BIC	Bayesian information criterion, a selection method for models with different numbers of parameters	Minimize
Graphic analysis		
Description		
Original series and seasonally adjusted series for X-12-ARIMA output		
Graphic plot of seasonal factors for X-12-ARIMA output		
Original and prior adjusted seasonal series, for jobs with intervention analysis seasonal adjustment models		
Spectra of the original and of the differenced seasonally adjusted series		
Seasonal factors by month		