Intervention Analysis in Seasonal Adjustment

In some Consumer Price Index (CPI) series, a process known as seasonal adjustment is used to identify and factor out seasonal movements. The resulting seasonally adjusted data reflect an estimate of nonseasonal price movements. The CPI uses the Bureau of the Census X-12-ARIMA software to calculate factors for seasonal adjustment of both historical and current series. Some CPI series are adjusted using the intervention analysis feature of the Census X-12 seasonal adjustment process..

Intervention analysis seasonal adjustment allows nonseasonal economic phenomena, such as outliers and level shifts, to be factored out of indexes before calculation of seasonal adjustment factors. (An *outlier* is an extreme value for a particular month. A *level shift* is a change or shift in the price level of a CPI series caused by an event, such as a sales tax increase or oil embargo, occurring over 1 or several months.) The result is an adjustment based on a representation of the series with the seasonal pattern emphasized. Intervention analysis seasonal adjustment also makes it possible to account for seasonal shifts, resulting in a better seasonal adjustment in the periods before and after the shift occurred. For those CPI series adjusted using intervention analysis seasonal adjustment techniques the resulting seasonal factors better represent the true seasonal pattern than factors calculated without these techniques. The seasonal factors are applied to the original unadjusted series. Level shifts and outliers, removed for the calculation of seasonal factors, are present in the seasonally adjusted series.

When X-12-ARIMA is used to perform intervention analysis seasonal adjustment, unusual events are modeled as part of the seasonal adjustment process. X-12-ARIMA's built-in regression variables are used for directly estimating the effects of sudden level changes and other disruptions and removing those effects before calculation of the seasonal factors. For a comprehensive discussion of X-12-ARIMA and intervention analysis seasonal adjustment, see "Improvements to CPI Procedures for Intervention Analysis Seasonal Adjustment" in the December 1996 issue of the *CPI Detailed Report*.

In January 2004, BLS adjusted the series listed below using intervention analysis seasonal adjustment techniques. BLS examined these series using the 8-year span from January 1996 through December 2003.

Butter
Carbonated drinks
Cheese and related products
Dairy and related products
Educational books and supplies
Electricity
Fats and oils
Fresh whole milk
Fuel oil
Fuel oil and other fuels
Gasoline, all types
Gasoline, unleaded midgrade
Gasoline, unleaded premium
Gasoline, unleaded regular
Ice cream and related products
Motor fuel
New cars
New trucks
New vehicles
Nonalcoholic beverages and beverage materials
Nondurables less food and apparel
Nondurables less food, beverages, and apparel
Other household fuels
Pork
Utility (piped) gas service
Water and sewerage maintenance

Data for the following series are available beginning in December 1997. These series were examined using the 6-year span from December 1997-December 2003.

Admission to sporting events
Bacon, breakfast sausage, and related products
Beverage materials including coffee and tea
Breakfast sausage and related products
Juices and non-alcoholic drinks
Milk
New cars and trucks
Other poultry including turkey
Other processed fruits and vegetables
Other sweets

For each series that was adjusted using X-12-ARIMA intervention analysis seasonal adjustment, a list of level shifts is provided in the table below, along with the identified causes (events). Outliers are also included in the list.

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Consumer Price Index series – intervention analysis seasonal adjustment

Series	Level shift period(s)	Event	Outliers
Admission to sporting events	None	Not applicable	11/99
Bacon, breakfast sausage, and related products	1/00-3/00	Response to low pork production	None
Beverage materials including coffee and tea	6/98 8/98 1/00	Sharply higher coffee production Sharply higher coffee production Coffee supply shortage concerns	10/99, 1/01
Breakfast sausage and related products	1/00-3/00 6/03	Response to low pork production Response to low pork production	7/02, 2/03, 8/03
Butter	5/96-8/96	Tight dairy markets, favorable demand supported by economic expansion, and limited growth in milk output as a result of poor feed and forage conditions	11/97, 12/97, 11/98, 12/99, 2/00, 4/02
	10/96-1/97	Good stocks remaining, coupled with increased fall production	
	5/98-10/98	Response to declining domestic butter output and stocks	
	10/98-5/99	Substantial increase in milk production by the first quarter of 1999 added to already large inventories of butter	
	3/01-7/01	Early year drop in milk production was slow to recover. Demand for dairy products remained strong.	
Carbonated drinks	4/02-6/02	Promotions associated with significant new brand introductions	8/01, 11/03
	9/02	Return to normal level of promotions	
Cheese and related products	4/96-9/96	Tight dairy markets, favorable demand supported by economic expansion, and limited growth in milk output as a result of poor feed and forage conditions	
	9/98-1/99	Response to very strong demand for milkfat items, coupled with stagnant milk production for much of the period	
	7/99-10/99	Response to a generally tight cheese market, accompanied by strong demand	
	4/01-6/01	Early year drop in milk production was slow to recover. Demand for dairy products remained strong.	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Dairy and related products	5/96-10/96	Tight dairy markets, favorable demand supported by economic expansion, and limited growth in milk output as a result of poor feed and forage conditions	4/00
	4/99	Substantial increase in milk production	
	10/99	Reaction to tight dairy markets, as increases in milk output were absorbed by strong cheese demand	
Educational books and supplies	11/99	Greater than normal sale on educational reference books	None
	1/00	Adjustment from greater than normal sale on educational reference books	
	11/01-12/01	Greater than normal sale on educational reference books	
	2/02	Adjustment from greater than normal sale on educational reference books	
	11/03-12/03	Changes in end of year pricing policies for general reference books	
Electricity	4/01-6/01	Increasing demand due to warmer than expected weather and raising rates to aid the conservation of supplies	6/96, 11/97
	2/03-5/03	Declining natural gas supplies, reaching historical lows in May, caused a reduction in electricity output relative to demand	
Fats and oils	5/98-10/98	Response to declining domestic butter output and stocks	4/00, 11/00, 4/01, 11/01
	10/98-5/99	Increased domestic and imported oil supply exceeded demand	
	11/99	Anticipation of larger-than-normal soybean and other crops, coupled with a higher demand for butter	
	6/01	Response to a decrease in domestic milk output, combined with increasing oil demand	
	1/02-8/02	Response to large supplies of oils, particularly soybean oil	
	12/02-2/03	Response to depleted soybean oil stocks from record 2001 domestic crushing and exporting, coupled with increased domestic demand	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Fresh whole milk	11/98-2/99	Response to very strong demand for milkfat items, coupled with stagnant milk production for much of the period	7/98
	4/99	Substantial increase in milk production	
	10/99	Reaction to tight dairy markets, as increases in milk output were absorbed by strong cheese demand	
	11/99-1/00	Continued increase in milk production, spurred by good returns to farmers and favorable feed and forage conditions	
	7/03-9/03	Reaction due to high cheese prices, as well as tight milk supplies	
Fuel oil	10/96	Suppliers’ policy of keeping limited inventories on hand, coupled with consumer expectations of a cold winter, resulted in price increases	2/00, 3/00, 9/00
	12/00-3/01	Positive storage and inventory build-up because of warmer weather trends and slowing economy	
	9/01-12/01	Positive storage and inventory build-up because of warmer weather trends and slowing economy	
	2/03-3/03	Low inventories due to rising crude oil prices, political uncertainty within oil supplying regions and Iraq, and increased broad demand for fuels	
	3/03-5/03	End of winter and end of major combat operations in Iraq	
Fuel oil and other fuels	10/96	Suppliers’ policy of keeping limited inventories on hand, coupled with consumer expectations of a cold winter, resulted in price increases	2/00, 3/00
	9/00	Robust economy, low inventory, winter refills, and uncertainty about Middle East supply	
	1/01-3/01	Positive storage and inventory build-up because of warmer weather trends and slowing economy	
	9/01-12/01	Positive storage and inventory build-up because of warmer weather trends and slowing economy	
	2/03-3/03	Low inventories due to rising crude oil prices, political uncertainty within oil supplying regions and Iraq, and increased broad demand for fuels	
	3/03-3/05	End of winter and end of major combat operations in Iraq	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Gasoline, all types	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	
Gasoline, unleaded midgrade	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Gasoline, unleaded premium	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	
Gasoline, unleaded regular	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Gasoline, unleaded regular	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	
Ice cream and related products	4/96-9/96	Tight dairy markets, favorable demand supported by economic expansion, and limited growth in milk output as a result of poor feed and forage conditions	11/03
	7/98-11/98	Response to very strong demand for milkfat items, coupled with stagnant milk production	
	5/01-7/01	Early year drop in milk production was slow to recover. Demand for dairy products remained strong.	
	3/03-6/03	Sluggish demand for dairy food “treats”	
Juices and non-alcoholic drinks	5/02	Promotions associated with significant new brand introductions in carbonated drinks	7/03
	9/02	Return to normal level of promotions for carbonated drinks	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Milk	11/98-2/99	Response to very strong demand for milkfat items, coupled with stagnant milk production	7/98
	4/99	Substantial increase in milk production	
	10/99	Reaction to tight dairy markets, as increases in milk output were absorbed by strong cheese demand	
	11/99-1/00	Continued increase in milk production, spurred by good returns to farmers and favorable feed and forage conditions	
	7/03-9/03	Reaction due to high cheese prices, as well as tight milk supplies	
Motor fuel	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refiners in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	
New cars	9/01-12/01	Combined effects of a model changeover with high demand created by financing incentives	5/98, 6/98, 8/98, 1/03, 2/03, 8/03
	12/01-2/02	Use of price rebates by domestic manufacturers, replacing previous financing incentive programs	
New cars and trucks	9/01-12/01	Combined effects of a model changeover with high demand created by financing incentives	8/98, 1/00, 2/00, 1/03, 2/03, 8/03
	12/01-2/02	Use of price rebates by domestic manufacturers, replacing previous financing incentive programs	
New trucks	5/98	Price drop in trucks, resulting from loyalty rebates offered by American auto makers	11/96, 6/98, 1/00, 2/00, 1/03, 2/03
	9/01-12/01	Combined effects of a model changeover with high demand created by financing incentives	
	12/01-2/02	Use of price rebates by domestic manufacturers, replacing previous financing incentive programs	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
New vehicles	9/01-12/01	Combined effects of a model changeover with high demand created by financing incentives	5/98, 6/98, 8/98, 1/03, 2/03, 8/03
	12/01-2/02	Use of price rebates by domestic manufacturers, replacing previous financing incentive programs	
Nonalcoholic beverages and beverage materials	2/97-7/97	Coffee price increases due to labor problems in Columbia and supply problems in Brazil	7/03
	5/02	Promotions associated with significant new brand introductions in carbonated drinks	
	9/02	Return to normal level of promotions for carbonated drinks	
Nondurables less food and apparel	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 4/01, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected motor fuel supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refineries in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Nondurables less food, beverages, and apparel	4/99	Anticipated cutback of crude oil production by OPEC and other countries	3/00, 8/00, 5/01, 6/01, 9/01
	6/99-9/99	Realized effects of a decrease in supply of crude oil by OPEC and other countries	
	6/00	Effects of implementing a new EPA requirement for reformulated gasoline	
	10/01-12/01	Return to a normal balance of expected motor fuel supply and demand following a period of speculative supply	
	2/02-4/02	Effect of a significant decrease in imported crude and refined oil	
	12/02-3/03	Anticipation of Iraq war combined with effects of an oil strike in Venezuela	
	3/03-5/03	Oil strike in Venezuela ends, with faster than expected increases in oil supply	
	7/03-9/03	All time record demand for auto fuel, complicated by supply problems due to electrical blackouts at refineries in the Northeast and Midwest during late summer	
	9/03-11/03	Recovering domestic inventories following record high summer demand and refinery problems in the Northeast and Midwest	
Other household fuels	9/96-12/96	Demand increase in anticipation of a cold winter, declining supply due to a cold European winter, new inventory policies, and increased instability in the Middle East	2/00, 3/00
	1/97-4/97	Declining demand for residential oil heat due to a warm spring season	
	9/00	Winter fill-ups, low inventories, and good economy	
	12/00-1/01	High refill rates among consumers and good economy	
	1/01-4/01	Positive storage and inventory build-up because of warmer weather trends and slowing economy	
	1/03-3/03	Intense winter weather and increasing demand	
	3/03-5/03	End of intense winter and declining demand	

CPI series – intervention analysis seasonal adjustment-continued

Series	Level shift period(s)	Event	Outliers
Other poultry including turkey	11/01	Large production increase in October due to increased turkey slaughter and heavier overall bird weights	1/99, 7/00, 2/01, 12/01, 11/02, 7/03
	9/02	Marketing response to clear surplus stock heading into the holiday season	
Other processed fruits and vegetables	None	Not applicable	11/99, 5/00, 3/02, 12/02, 9/03
Other sweets	None	Not applicable	3/99, 4/00, 3/02
Pork	1/00-3/00	Response to low pork production	None
Utility (piped) gas service	5/00-7/00	High demand due to economic growth plus increased gas use for electricity	1/97, 2/97, 11/00
	8/00-10/00	High demand due to economic growth plus increased gas use for electricity	
	12/00-1/01	Low inventories for the expected demand of the winter heating season	
	2/01-4/01	Warmer than expected weather resulting in more than adequate gas supplies	
	5/01-10/01	Continued adequate gas supplies, warmer than expected weather, and slowing economy	
	1/03-3/03	Supply problems in Venezuela, onset of colder than expected weather, and historically low storage levels	
Water and sewerage maintenance	3/96	Incorrect service priced; price increase erroneously attributed to environmental clean-up charge passed on to consumers	11/96, 11/00, 12/00, 12/02, 3/03
	7/96	Return to pricing of correct service	
	6/97-8/97	Dry season pricing in California	