Technical note on seasonal adjustment for Consumer price index (Industrial workers)

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Contents

1 CPI IW **2**

1.1 Additive versus multiplicative seasonality 2

2 Steps in the seasonal adjustment procedure **3**

2.1 Seasonal adjustment with X-12-ARIMA 3

2.2 Diagnostic checks 5

2.2.1 Validation of the automodel choice by X-12-ARIMA 5

2.2.2 Presence of identifiable seasonality 6

3 Year on year growth versus seasonally adjusted point on point growth **6**

4 Spectral representation **7**

5 Sliding span diagnostics **7**

6 Revision history diagnostics **8**

7 Accounting for India-specific moving holiday effects **10**

List of Figures

1 CPI IW (Non seasonally adjusted) 2

2 Monthly growth rates across the years 3

3 CPI IW (NSA and SA) 4

4 ACF of residuals 6

5 CPI Spectral plot (NSA and SA) 7

6 RMSE of revisions 9

7 RMSE of revisions 10

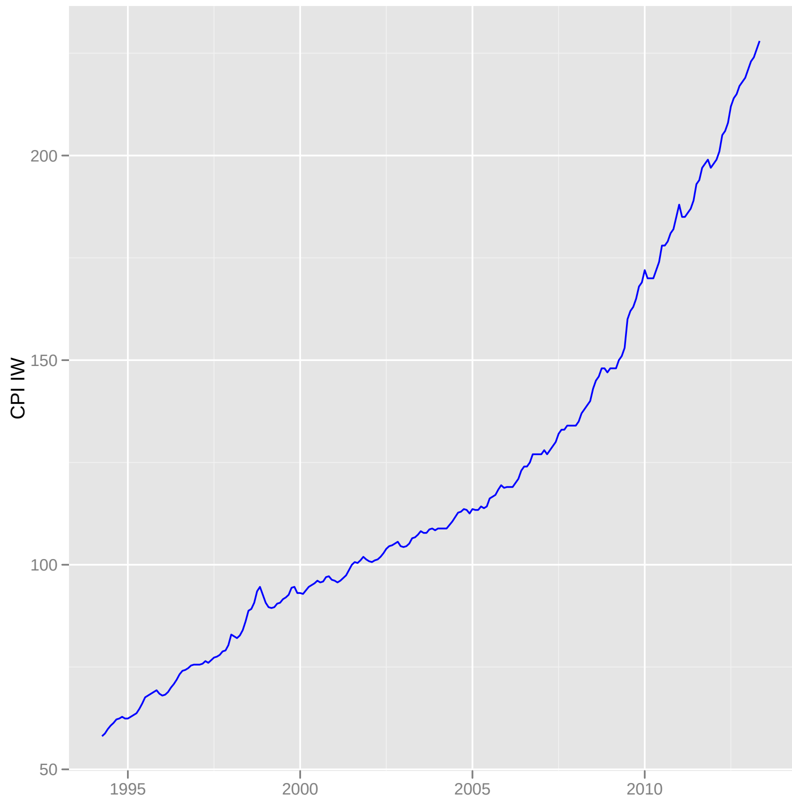
List of Tables

1 Year on year and point on point growth rates 12

1 CPI IW

We analyse the monthly data for CPI IW from April, 1994 onwards. Figure 1 shows the original plot of the series. In such a non-seasonally adjusted series, it is difficult to discern a trend as the seasonal variations may mask the important characteristics of a time series.

Figure 1 CPI IW (Non seasonally adjusted)



1.1 Additive versus multiplicative seasonality

X-12-ARIMA has the capability to determine the mode of the seasonal adjustment decomposition to be performed i.e whether multiplicative or additive seasonal adjustment decomposition is appropriate for the series. For CPI (Industrial workers), multiplicative seasonal adjustment is considered appropriate on the basis of the model selection criteria.

2 Steps in the seasonal adjustment procedure

Given that seasonality exists, it is important to model seasonality before the application of seasonal adjustment procedure. Seasonality in time series can be deterministic or stochastic. Stochastic seasonality can be stationary or non-stationary.

A visually appealing way of looking at the raw data is to plot the growth rates in each of the months across the years i.e the growth of April over March in each of the years from 1994 onwards. This gives us some idea of the presence of seasonal peaks, if any in the series. The nature of seasonality can also be inferred intutively from the plot before the application of the testing procedures.

Figure 2 Monthly growth rates across the years

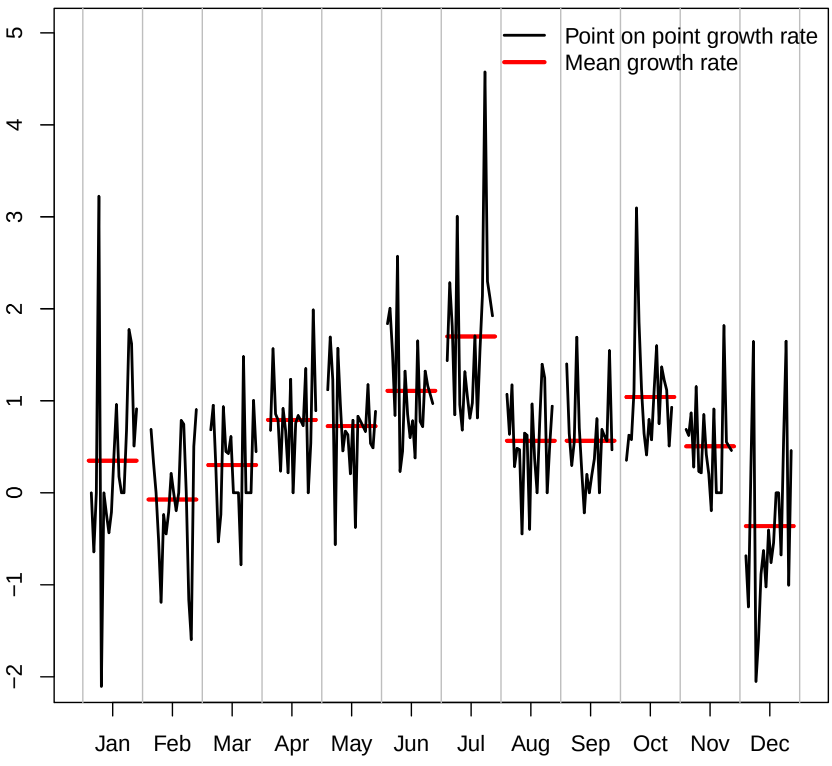


Figure 2 does not reveal distinct seasonal peaks. The level of seasonality is not as high as seen in IIP and its components.

2.1 Seasonal adjustment with X-12-ARIMA

Seasonal adjustment is done with X-12-ARIMA method.

Figure 3 CPI IW (NSA and SA)

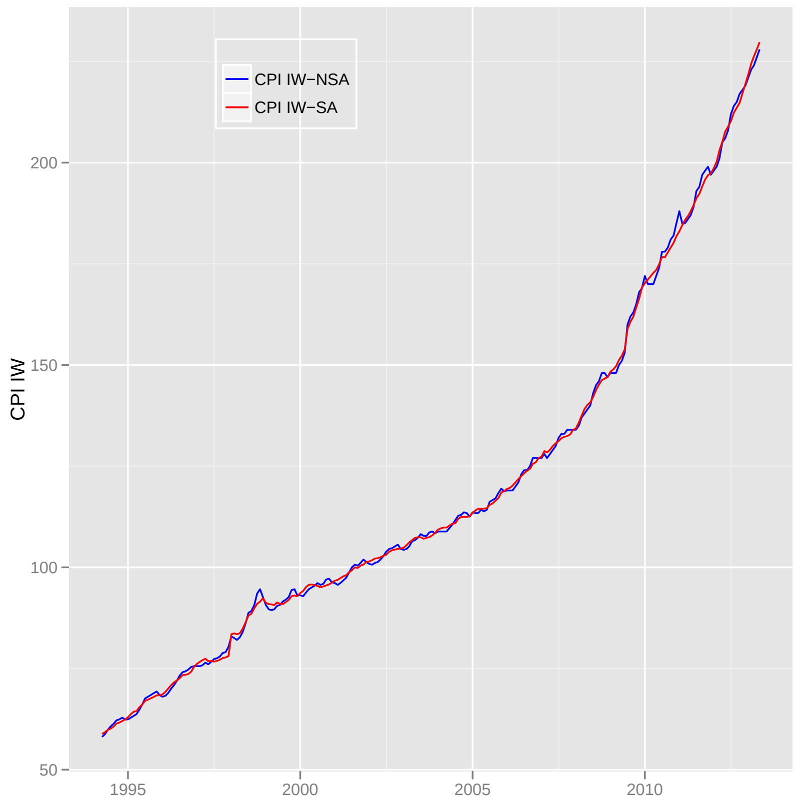


Figure 3 shows the non-seasonally and seasonally adjusted CPI IW

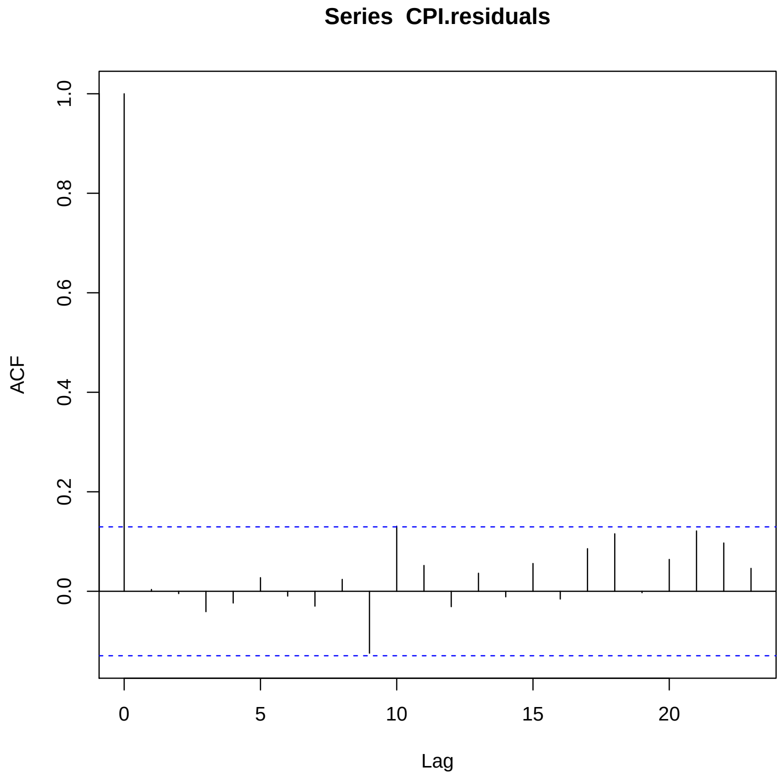
2.2 Diagnostic checks

After seasonal adjustment, a series of diagnostic checks are performed through relevant tests and quality assessment statistics.

2.2.1 Validation of the automodel choice by X-12-ARIMA

A test of validation of the auto model choice by X-12-ARIMA is the randomness of the residuals of the ARIMA model. The Ljung-Box test is conducted on the residuals of the fitted ARIMA model to check whether or not the residuals are white noise. The ACFs of the residuals are plotted to check for randomness.

Figure 4 ACF of residuals



The figure 4 does not reveal significant autocorrelation amongst the residuals.

2.2.2 Presence of identifiable seasonality

The statistic M7 shows the amount of moving seasonality present relative to stable seasonality. It shows the combined result for the test of stable and moving seasonality in the series. A value lesser than 0.7 is desirable to show identifiable seasonality in the series. The value of M7 statistic for CPI IW is 0.465.

CPI IW shows identifiable seasonality on the basis of the M7 statistic.

3 Year on year growth versus seasonally adjusted point on point growth

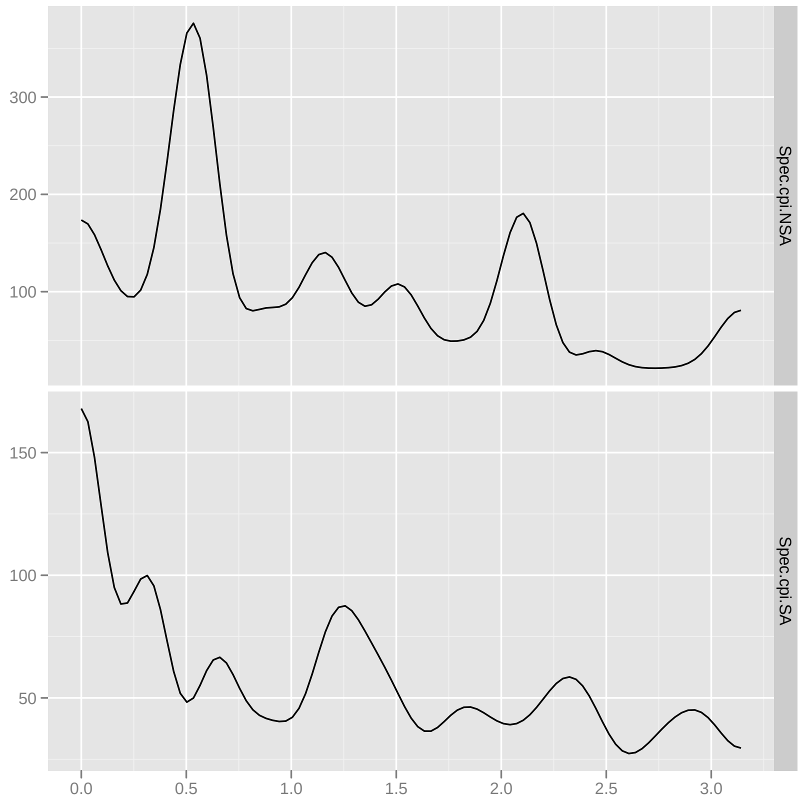
Growth rates can be computed either year on year or point on point. The year on year growth rate is computed as the percentage change with respect to the corresponding month (or quarter) in the preceding year, while the point on point growth rate is computed as the percentage change with respect to the preceding period.

Table 2 shows the year on year growth and seasonally adjusted annualized rate in percent, point on point.

4 Spectral representation

Figure 5 shows the spectral plot of the growth rate of the unadjusted and seasonally adjusted series. Spectral plot, an important tool of the frequency domain analysis shows the portion of variance of the series contributed by cycles of different frequencies.
The x-axis represent frequency from 0 to pi (3.14). The seasonal frequencies are pi/6 (0.52 on the x-axis), pi/3 (1.04 on the x-axis) , pi/2 (1.57 on the x-axis), 2pi/3 (2.09 on the x-axis) and 5 pi/6 (2.6 on the x-axis). In terms of periods (months); they are 12 months, 6 months, 4 months, 3 months and 2.4 months.
The figure at the lower panel shows that peaks at seasonal frequencies are eliminated after seasonal adjustment. For example the first peak at 0.52 correspond to 12 months which is eliminated after seasonal adjustment. Other peaks seen in the lower panel of the figure are not at seasonal frequencies.

Figure 5 CPI Spectral plot (NSA and SA)



5 Sliding span diagnostics

Sliding span diagnostics are descriptive statistics of how the seasonal adjustments and their month-to-month changes vary when the span of data used to calculate them is altered in a systematic way.
It is based on the idea that for a month common to more than one overlapping spans, the

percent change of its adjusted value from the different spans should not exceed the threshold value and for a month common to more than one span, the difference between the month on month change from the different spans should not exceed the threshold value (the threshold value being 0.03).
Sliding span gives the percentage of months (A%) for which the seasonal adjustment is unstable (the difference in the seasonally adjusted values for a particular month from more than one span should not exceed 0.03). It also gives the percentage of months (MM%) for which the month on month changes of the seasonally adjusted values is unstable i.e exceeding the threshold value.
The seasonal adjustment produced by the procedure chosen should not be used if A% > 25.0 (> 15.0 is considered problematic) or if M M % > 40.0.
For CPI (Industrial workers) the programme gives the warning that the range of the means of the seasonal factors is too low for sliding span measures to be reliable. Hence this diagnostic measure is not relied for this series. **The sliding span diagnostics is not reliable when the range of the seasonal factors in a particular span is low (less than 5).**

6 Revision history diagnostics

We generate the revision history diagnostics for different series. For a given series y_t where t = 1,. T , we define $A_{t|n}$ to be the seasonal adjustment of y_t calculated from the series y_1 , y_2 , . , y_n , where $t \leq n \leq T$. The concurrent seasonal adjustment of observation t is $A_{t|t}$ and the most final adjustment of observation t is $A_{t|T}$. The percent revision of the seasonally adjusted series is defined to be:

$$R_t = \frac{A_{t|T} - A_{t|t}}{A_{t|t}}$$

This revision in the levels is reported by the X-12-ARIMA programme. The programme also reports the revisions in the month on month change in the seasonally adjusted values. Let $C_{t|n}$ denote the month to month change in the seasonally adjusted series at time t calculated from the series y_1 , y_2 , . , y_n. $C_{t|n}$ is calculated as:

$$C_{t|n} = \frac{A_{t|n} - A_{t-1|n}}{A_{t-1|n}}$$

The revision for these changes is:

$$R_t = C_{t|T} - C_{t|t}$$

Figure 6 shows the root mean square error of the revisions of the month on month changes of the seasonally adjusted values normalized by the standard deviation of the month on month change in the seasonally adjusted series. The figures range from 0.38 to 0.5.

Figure 6 RMSE of revisions

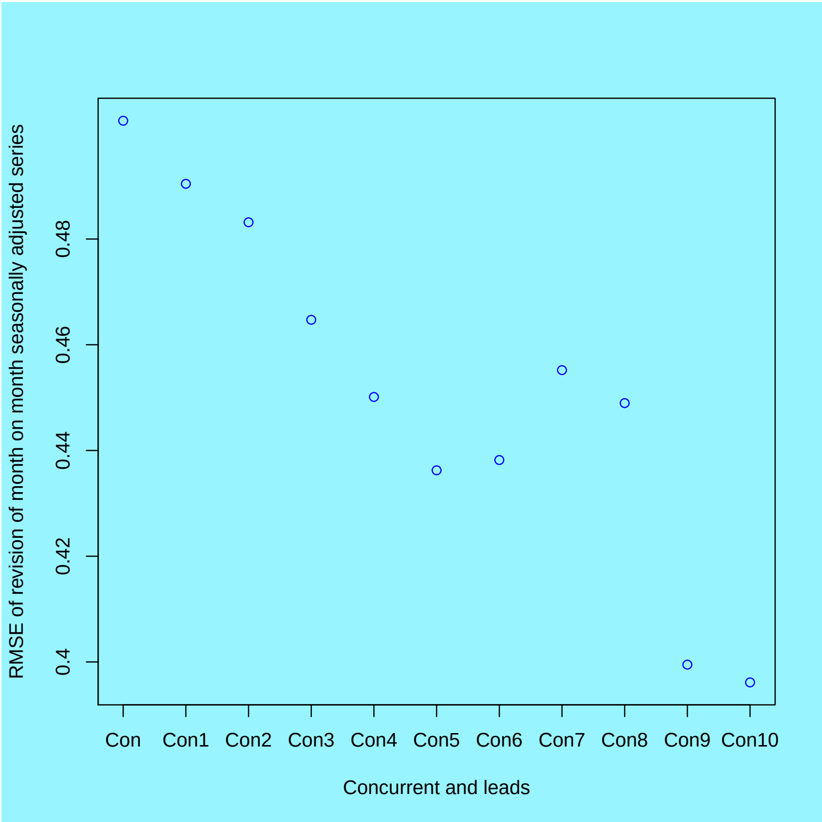
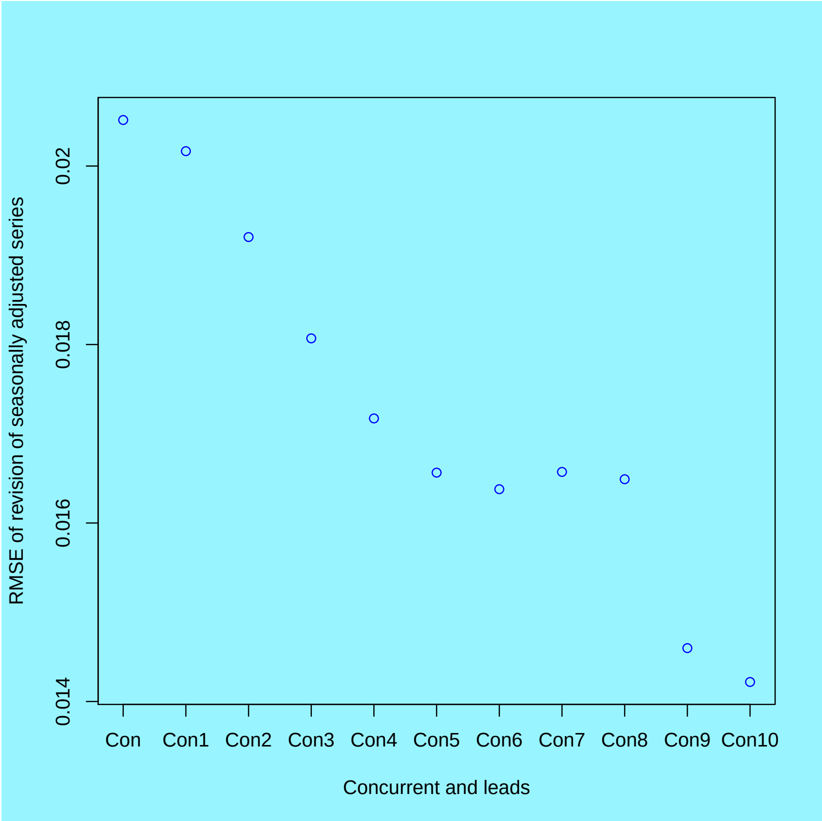


Figure 7 shows the root mean square error of the revisions of the seasonally adjusted series normalized by the standard deviation of the seasonally adjusted series. The figures range from 0.014 to 0.020.

Figure 7 RMSE of revisions



7 Accounting for India-specific moving holiday effects

Accounting for moving holiday effect is a crucial component of pre-treatment of the series before the application of seasonal adjustment method. X-12-ARIMA is capable of handling the moving holiday effects through the inclusion of regressors for Easter Sunday, Labor Day, and Thanksgiving Day. These are important moving holidays for U.S time series.

We use the GENHOL program of X-12-ARIMA to analyse India-specific moving holiday effect. The program generates regressor matrices from holiday date file to enable X-12-ARIMA, estimation of complex moving holiday effects. It has the capability to generate regressors for before the holiday interval, surrounding the holiday interval and past the holiday interval.

The key assumption is that the fundamental structure of a time series changes for a fixed number of days before, after or for a fixed interval surrounding the holidays. We estimate the effect of Diwali which is an important moving holiday in Indian scenario. We estimate the effect with different specifications about the number of days around the festival. However we did not find significant results for diwali effect on CPI (IW).

Table 1 Year on year and point on point growth rates

	Y.o.Y.growth	Point.on.point.growth
2009 Jan	10.45	11.19
2009 Feb	9.63	4.62
2009 Mar	8.03	6.11
2009 Apr	8.70	12.22
2009 May	8.63	8.32
2009 Jun	9.29	12.17
2009 Jul	11.89	38.90
2009 Aug	11.72	13.42
2009 Sep	11.64	9.51
2009 Oct	11.49	16.39
2009 Nov	13.51	16.05
2009 Dec	14.97	19.36
2010 Jan	16.22	7.85
2010 Feb	14.86	6.19
2010 Mar	14.86	5.53
2010 Apr	13.33	6.09
2010 May	13.91	4.87
2010 Jun	13.73	9.90
2010 Jul	11.25	12.22
2010 Aug	9.88	-0.69
2010 Sep	9.82	8.36
2010 Oct	9.70	7.85
2010 Nov	8.33	7.96
2010 Dec	9.47	10.78
2011 Jan	9.30	7.97
2011 Feb	8.82	9.84
2011 Mar	8.82	8.04
2011 Apr	9.41	6.26
2011 May	8.72	7.88
2011 Jun	8.62	9.66
2011 Jul	8.43	10.73
2011 Aug	8.99	6.85
2011 Sep	10.06	11.40
2011 Oct	9.39	10.36
2011 Nov	9.34	6.74
2011 Dec	6.49	2.46
2012 Jan	5.32	7.86
2012 Feb	7.57	10.04
2012 Mar	8.65	16.48
2012 Apr	10.22	12.50
2012 May	10.16	14.46
2012 Jun	10.05	7.16
2012 Jul	9.84	7.82
2012 Aug	10.31	11.82
2012 Sep	9.14	6.90
2012 Oct	9.60	6.73
2012 Nov	9.55	13.31
2012 Dec	11.17	12.45
2013 Jan	11.62	12.89
2013 Feb	12.06	14.32
2013 Mar	11.44	9.38
2013 Apr	10.24	9.30