Technical note on seasonal adjustment for Index of industrial production (Capital goods)

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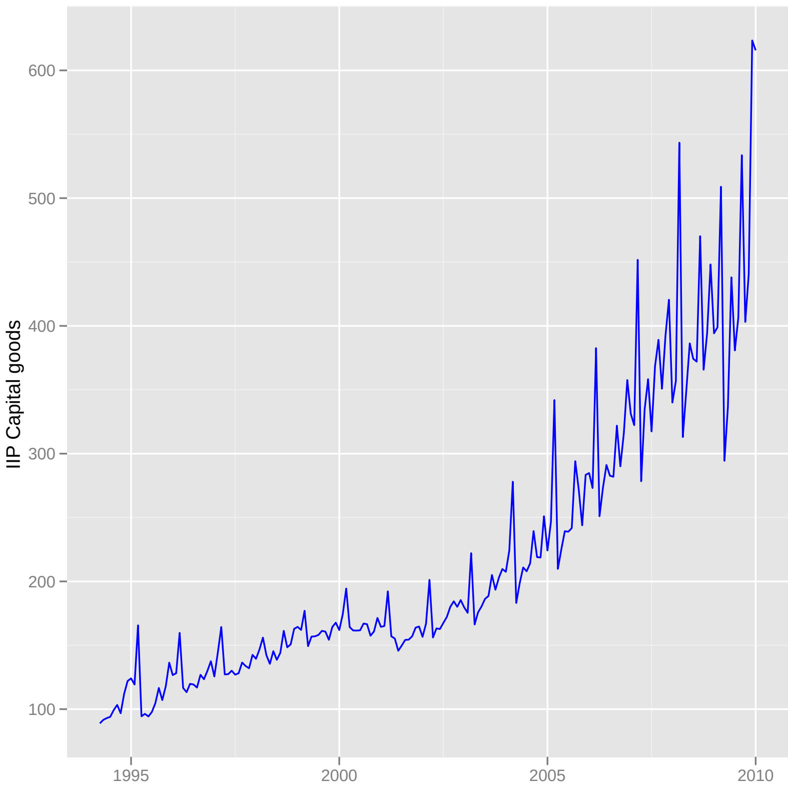
1 IIP Capital goods

We analyse the monthly data for IIP Capital goods from April, 1994 onwards. Figure 1 shows the original plot. The plot shows seasonal peaks which are increasing over time. In 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 IIP Capital goods (Non seasonal 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 Index of industrial production (Capital goods), 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

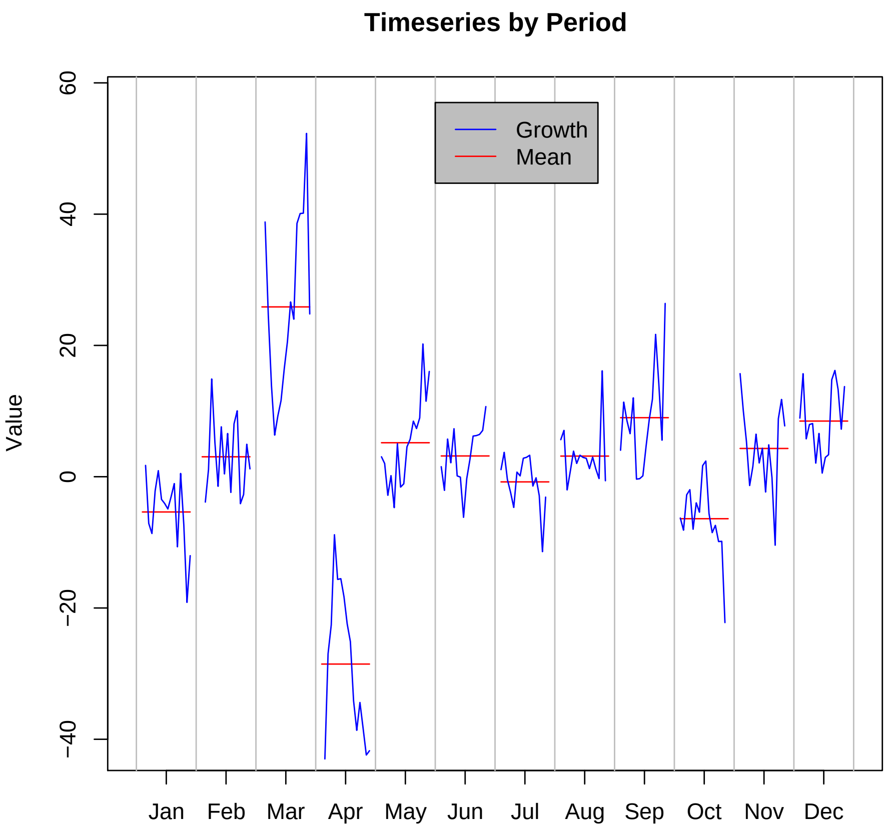


Figure 2 shows seasonal peaks in the month of March and to a lesser extent in December. The growth rates in each of the months do not show a stable pattern. Intutively, seasonality in the series cannot be inferred to be deterministic.

2.1 Tests for identifying the nature of seasonality

We test for the nature of seasonality using HEGY and Canova Hansen test.
Under the null hypothesis of the HEGY test, nonstationary unit root behavior exists not only at the long run (or zero) frequency, but also at some or all of the seasonal frequencies.
The Canova Hansen test takes the opposite approach. The null hypothesis is stationarity with deterministic seasonality.

Table 1 HEGY test statistics

	Stat.	p-value
tpi_1	2.43	0.10
tpi_2	-0.30	0.10
Fpi_3:4	7.32	0.06
Fpi_5:6	1.79	0.01
Fpi_7:8	2.98	0.01
Fpi_9:10	2.01	0.01
Fpi_11:12	1.01	0.01
Fpi_2:12	3.95	
Fpi_1:12	4.14	

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 Canova & Hansen test
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 Null hypothesis: Stationarity.
 Alternative hypothesis: Unit root.
 Frequency of the tested cycles: pi/6 , pi/3 , pi/2 , 2pi/3 , 5pi/6 , pi ,

 L-statistic: 1.626
 Lag truncation parameter: 14

 Critical values:

0.10 0.05 0.025 0.01
2.49 2.75  2.99 3.27
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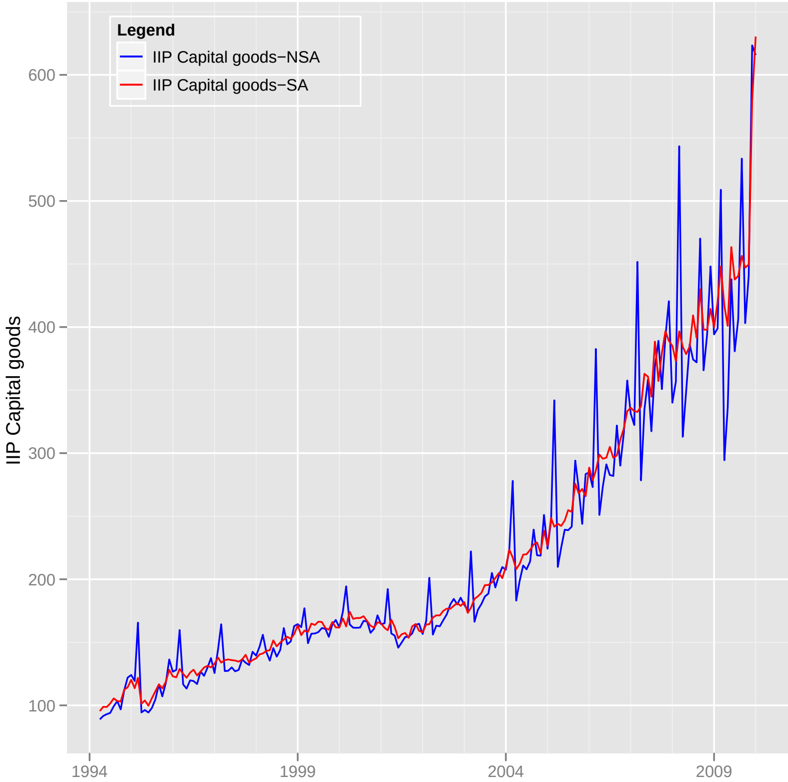
These tests suggest that there is deterministic seasonality in IIP Capital goods.

2.2 Seasonal adjustment of IIP Capital goods with X-12-ARIMA

Seasonal adjustment is done with X-12-ARIMA method. Seasonal dummy is added in the specification of the RegARIMA model on the basis of the results of HEGY and Canova Hansen tests.

Figure 3 shows the non-seasonally and seasonally adjusted IIP Capital goods. The seasonal peaks are dampened after seasonal adjustment.

Figure 3 IIP Capital goods (NSA and SA)



2.2.1 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 IIP Capital goods is 0.448
IIP Capital goods series show identifiable seasonality on the basis of M7 statistic.

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

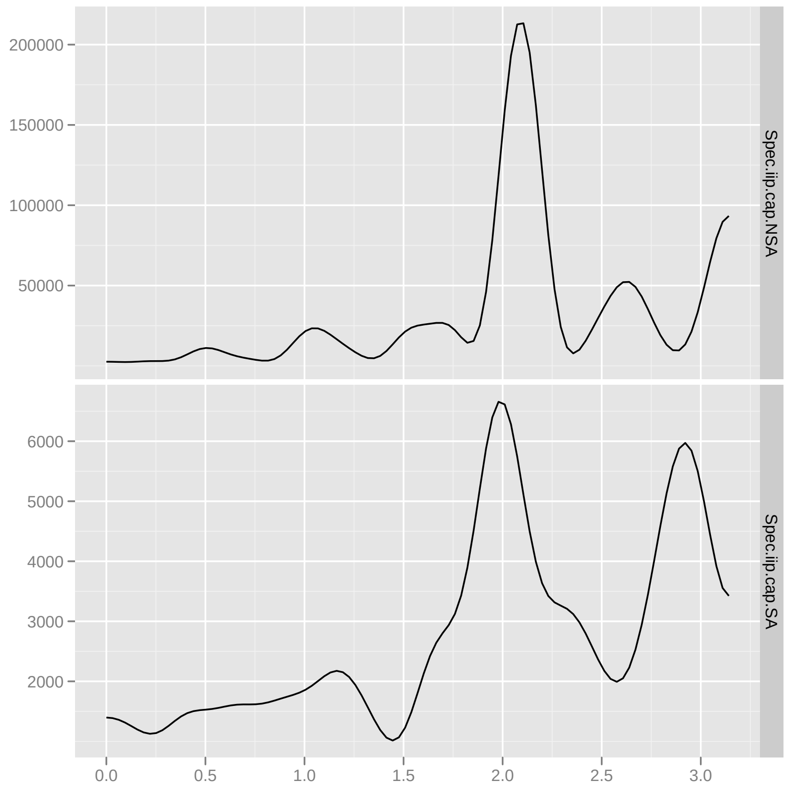
Growth rates can be computed either year on year or point on point. The year on year growth rate is computed as the percentage change with respect to the corresponding month (or quarter) in the preceding year, while the point on point growth rate is computed as the percentage change with respect to the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

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

4 Spectral representation

Figure 4 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 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. Other peaks seen in the lower panel of the figure are not at seasonal frequencies.

Figure 4 IIP (Capital goods) 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 Index of industrial production (Capital goods) A% is 4.9 and MM% is 14.7 which are well within the threshold range. **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:

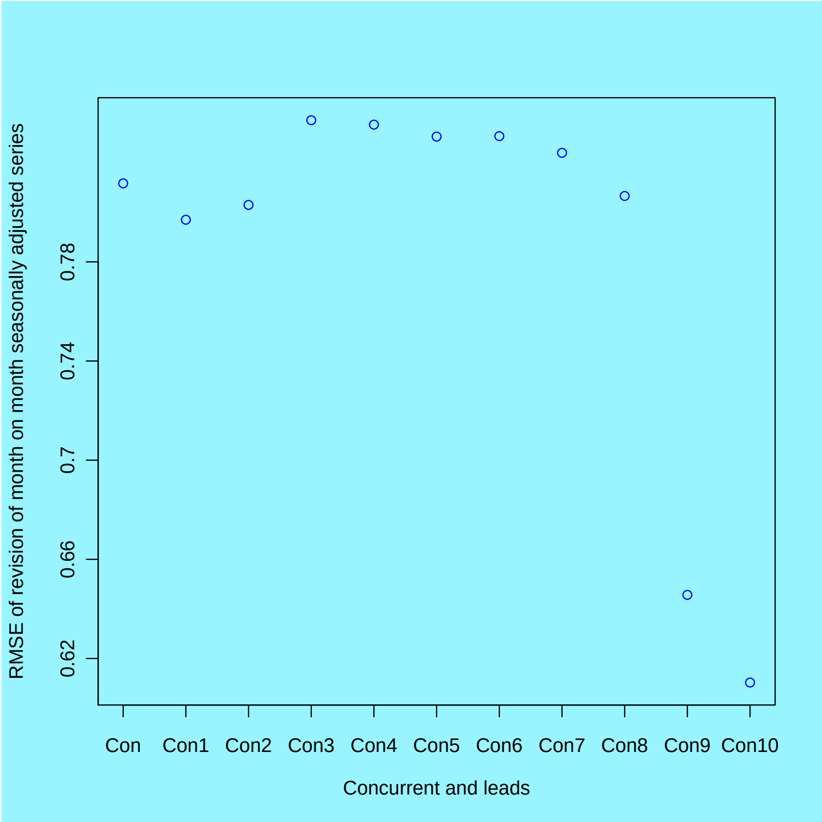
$$C_{t|n} = \frac{A_{t|n} - A_{t-1|n}}{A_{t-1|n}}$$

The revision for these changes is:

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

Figure 5 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 values. The figures range from 0.56 to 0.75.

Figure 5 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. For estimating Diwali effect, we assume that the level of economic activity changes 5 days before Diwali (including the day on which Diwali falls). Regression variable for Diwali is not found to be significant for IIP (Capital goods).

Table 2 Year on year and point on point growth rates

	Y.o.Y.growth	Point.on.point.growth
2006 Jan	27.03	98.27
2006 Feb	10.70	-42.17
2006 Mar	11.90	32.93
2006 Apr	19.64	51.51
2006 May	21.45	-13.40
2006 Jun	21.65	3.50
2006 Jul	18.33	34.00
2006 Aug	16.63	-34.42
2006 Sep	9.45	7.58
2006 Oct	6.54	48.70
2006 Nov	29.44	33.87
2006 Dec	26.18	50.51
2007 Jan	16.33	10.20
2007 Feb	18.02	-9.89
2007 Mar	18.06	-2.01
2007 Apr	10.92	16.21
2007 May	22.38	88.06
2007 Jun	23.08	-7.24
2007 Jul	12.27	-54.51
2007 Aug	30.76	143.35
2007 Sep	20.88	-100.53
2007 Oct	20.92	71.78
2007 Nov	24.20	53.87
2007 Dec	17.59	-22.84
2008 Jan	2.63	-12.73
2008 Feb	10.70	-38.21
2008 Mar	20.30	73.64
2008 Apr	12.43	-37.41
2008 May	4.27	-18.63
2008 Jun	7.81	19.14
2008 Jul	17.93	74.61
2008 Aug	0.92	-53.49
2008 Sep	20.84	112.58
2008 Oct	4.25	-92.76
2008 Nov	0.48	-0.28
2008 Dec	6.56	48.84
2009 Jan	15.94	-42.66
2009 Feb	11.80	58.70
2009 Mar	-6.35	77.73
2009 Apr	-5.94	-86.45
2009 May	-3.58	-47.10
2009 Jun	13.38	174.04
2009 Jul	1.74	-68.66
2009 Aug	9.25	7.81
2009 Sep	13.48	42.58
2009 Oct	10.23	-24.89
2009 Nov	11.78	6.90
2009 Dec	39.12	304.97
2010 Jan	56.19	100.57