

# Technical note on seasonal adjustment for Exports

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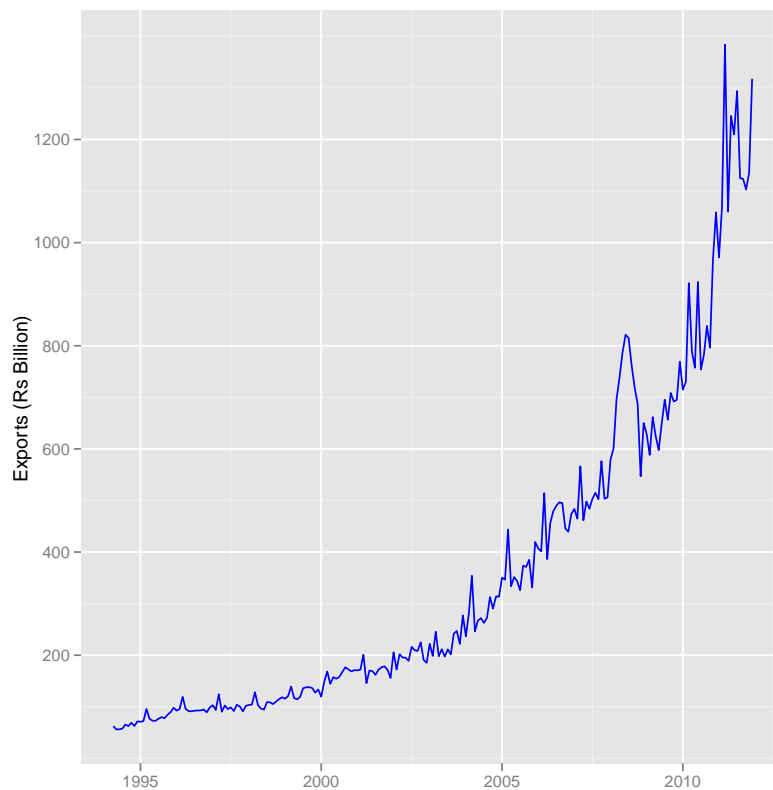
# 1 Exports

We analyse the monthly data for exports in Rs.Billion 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.

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**Figure 1** Exports (Non seasonal adjusted)

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## 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 the given series, multiplicative seasonal adjustment is considered appropriate on the basis of the model selection criteria. The plot of the series also shows multiplicative seasonal adjustment.

## 2 Steps in the seasonal adjustment procedure

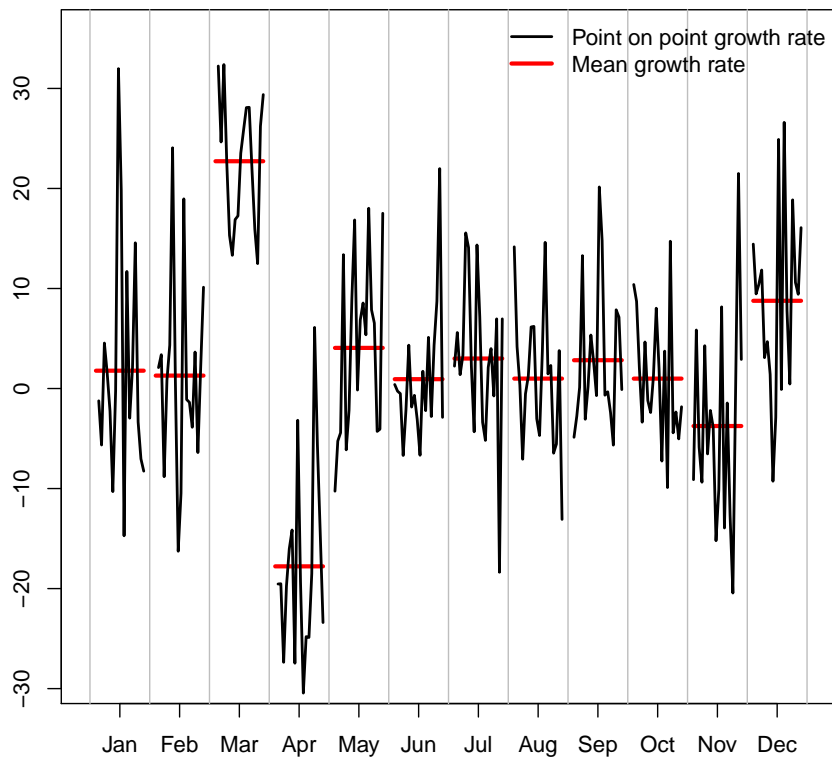
Given that seasonality exists, it is important to model seasonality before the application of seasonal adjustment procedure. Seasonality in time series can be deterministic or stochastic. Stochastic seasonality can be stationary or non-stationary.

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.

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**Figure 2** Monthly growth rates across the years

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Figure 2 shows seasonal peak in the month of March.

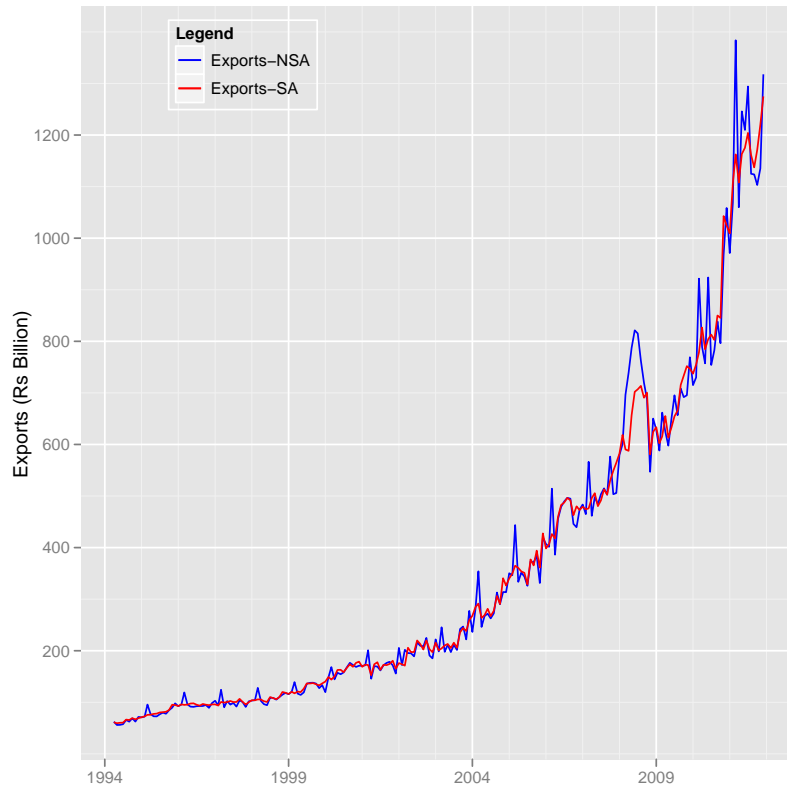
### 2.1 Seasonal adjustment of Exports with X-12-ARIMA

Seasonal adjustment is done with X-12-ARIMA method. Seasonal dummy is not added in the specification of the RegARIMA model on the basis of the results of HEGY and Canova Hansen tests.

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**Figure 3** Exports (NSA and SA)

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

## 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 does not reveal significant autocorrelation amongst the residuals.*

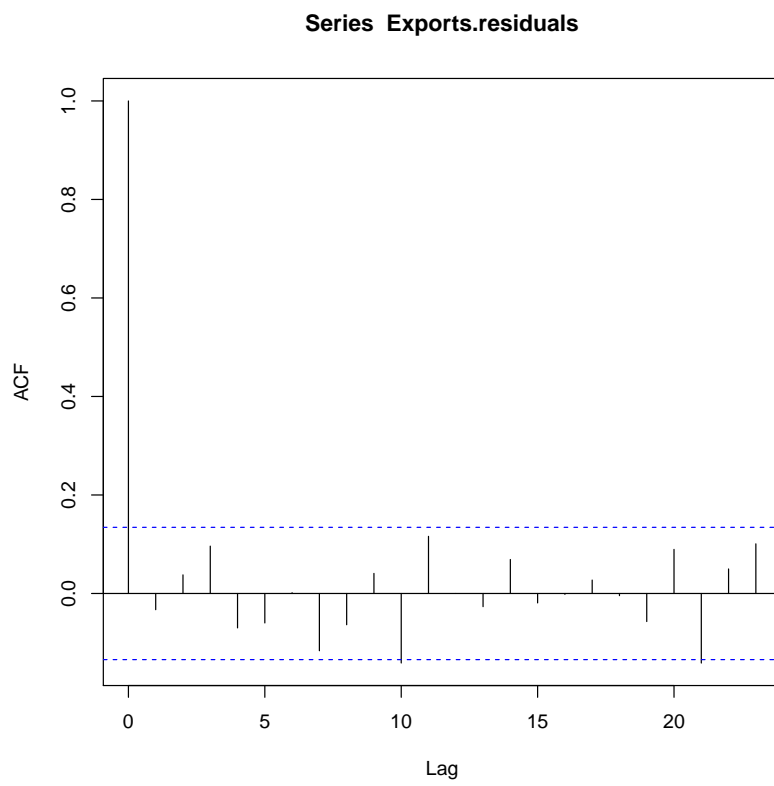
### 2.2.2 Presence of identifiable seasonality

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

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**Figure 4** ACF of residuals

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value lesser than 0.7 is desirable to show identifiable seasonality in the series. The value of M7 statistic for exports is 0.453

*Exports 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 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.

Figure shows that seasonal adjustment removes the contribution to variance from cycles with seasonal frequencies.

### 5 Sliding spans 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).

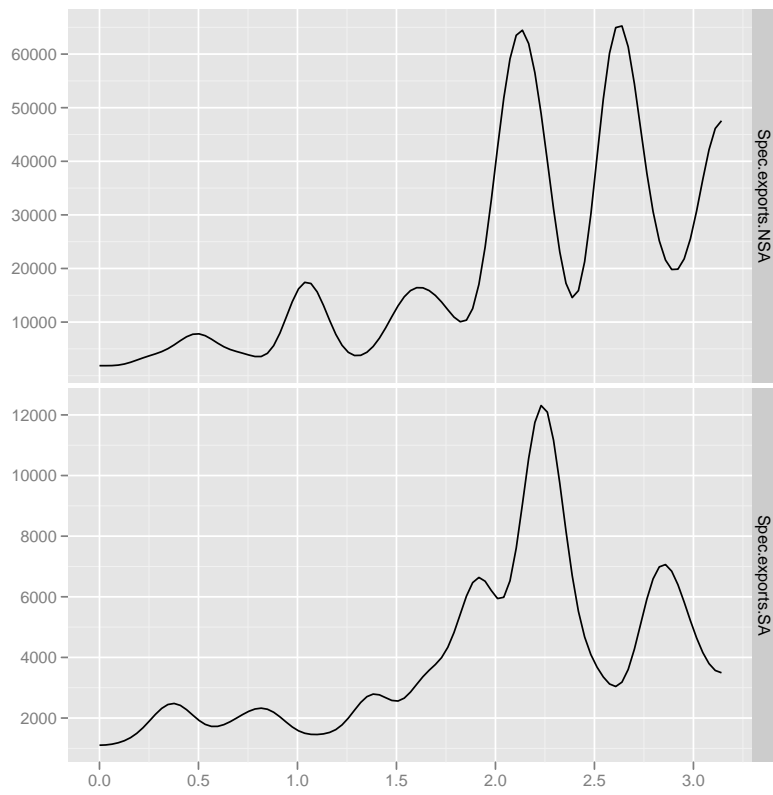
Sliding span gives the percentage of months (A%) for which the seasonal adjustment is unstable (the difference in the seasonally adjusted values for a particular month from more than one span should not exceed 0.03). It also gives the percentage of months (MM%) for which the month on month changes of 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 MM% > 40.0.

For exports A% is 19.4 and MM% is 35.3. A% is considered a critical statistic for the series.

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**Figure 5** Exports Spectral plot (NSA and SA)

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## 6 Revision history diagnostics

We generate the revision history diagnostics for different series. For a given series  $y_t$  where  $t = 1, \dots, T$ , we define  $A_{t|n}$  to be the seasonal adjustment of  $y_t$  calculated from the series  $y_1, y_2, \dots, y_n$ , 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  $y_1, y_2, \dots, y_n$ .  $C_{t|n}$  is calculated as:

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

The revision for these changes is:

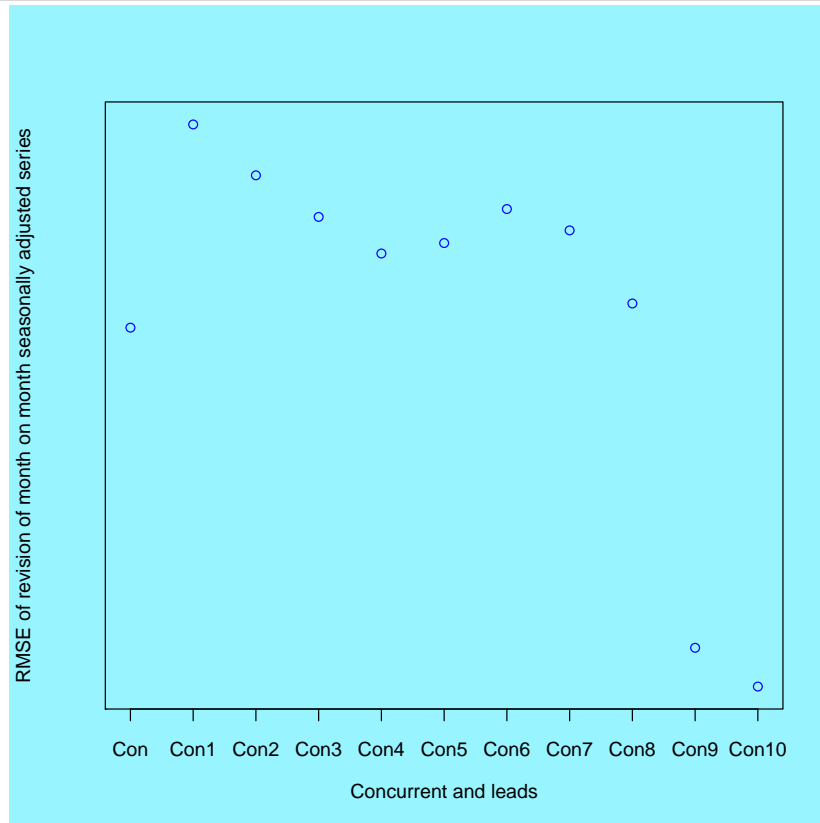
$$R_t = C_{t|T} - C_{t|t}$$

Figure 6 shows the root mean square error of the revisions of the month on month change in the seasonally adjusted series normalized by the standard deviation of the month on month change in the seasonally adjusted series. The figures range from 0.17 to 0.21.

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**Figure 6** RMSE of revisions

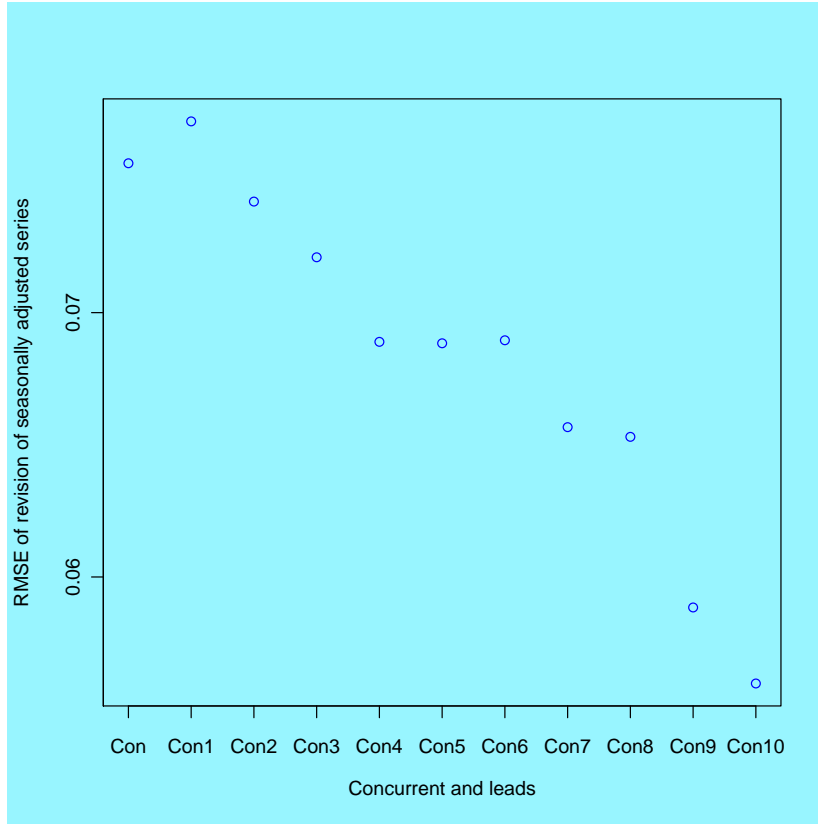
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**Figure 7** RMSE of revisions

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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 0.05 to 0.08.

## 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 exports.

**Table 1** Year on year and point on point growth rates

	Y.o.Y.growth	Point.on.point.growth
2006 Jan	16.22	-84.64
2006 Feb	15.89	24.60
2006 Mar	15.91	56.80
2006 Apr	15.78	-24.29
2006 May	29.68	115.07
2006 Jun	39.39	58.10
2006 Jul	50.12	11.58
2006 Aug	32.90	22.01
2006 Sep	33.35	-11.22
2006 Oct	15.83	-72.69
2006 Nov	32.64	43.69
2006 Dec	12.93	-17.82
2007 Jan	18.80	15.99
2007 Feb	15.80	-12.44
2007 Mar	10.12	4.37
2007 Apr	19.51	49.42
2007 May	9.23	22.70
2007 Jun	1.00	-61.18
2007 Jul	2.86	27.10
2007 Aug	3.71	51.38
2007 Sep	1.53	-23.38
2007 Oct	29.27	63.35
2007 Nov	14.59	41.66
2007 Dec	6.78	33.71
2008 Jan	19.83	36.73
2008 Feb	29.21	72.67
2008 Mar	22.96	-55.98
2008 Apr	60.04	-5.45
2008 May	58.09	133.31
2008 Jun	69.70	80.25
2008 Jul	61.97	8.26
2008 Aug	48.09	11.29
2008 Sep	43.18	-39.21
2008 Oct	19.28	16.86
2008 Nov	8.63	-224.84
2008 Dec	28.54	86.93
2009 Jan	8.45	17.27
2009 Feb	-2.06	-60.48
2009 Mar	-4.97	26.46
2009 Apr	-15.47	74.39
2009 May	-24.06	-79.13
2009 Jun	-20.86	37.81
2009 Jul	-14.72	40.37
2009 Aug	-13.88	20.18
2009 Sep	-1.53	86.59
2009 Oct	0.61	29.77
2009 Nov	27.13	29.80
2009 Dec	18.29	-8.29
2010 Jan	13.77	-15.42
2010 Feb	24.11	28.61
2010 Mar	39.26	36.50
2010 Apr	26.40	72.29