Technical note on seasonal adjustment for M0

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Contents

List of Figures

List of Tables

1 M0

We analyse the monthly data for M0 from April, 1994 onwards. M0 is also referred to as the reserve money. Figure 1 shows the original plot of the series. The plot does has moderate seasonal fluctuations, however if we look at the more recent data, we do find some fluctuations. Fig 2 shows a recent plot of the series, starting from April, 2005.

Figure 1 M0 (Non seasonally adjusted)

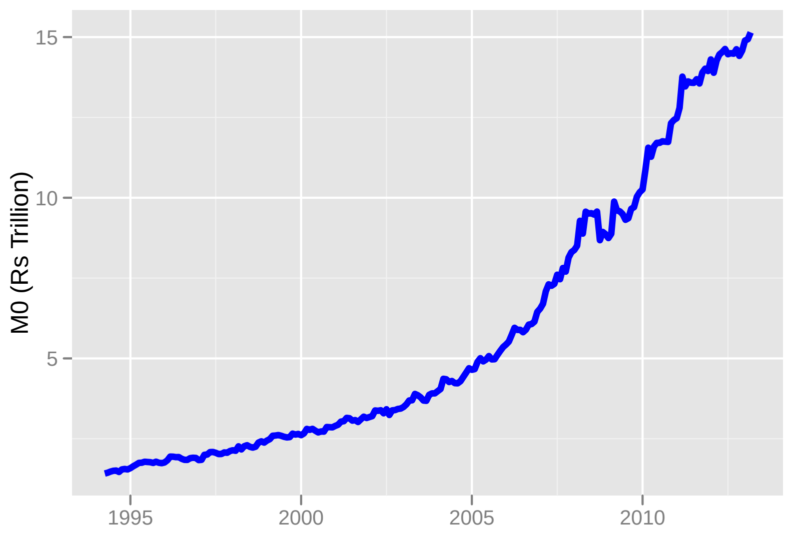
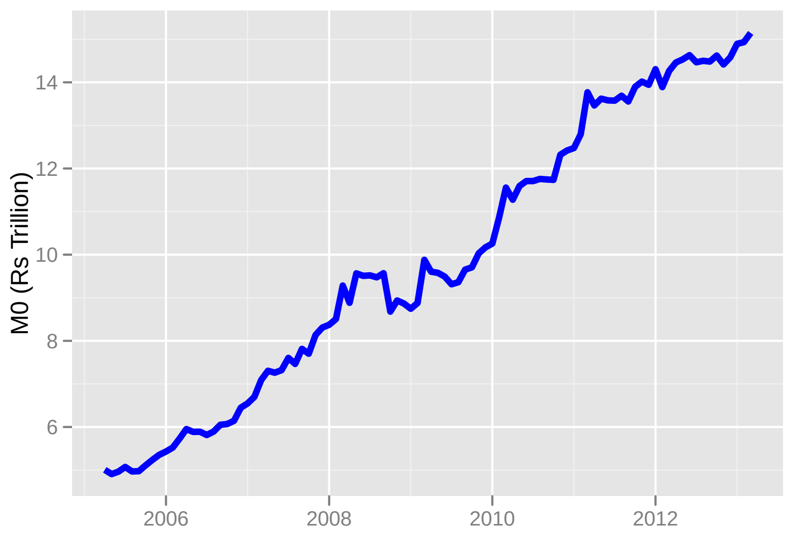


Figure 2 M0 (Non seasonally adjusted- recent data)



On the basis of these plots, we examine the presence and magnitude of seasonal fluctuations in the series.

2 Steps in the seasonal adjustment procedure

A visually appealing way of looking at the raw data is to plot the growth rates in each of the months across the years, for instance, 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 3 Monthly growth rates across the years

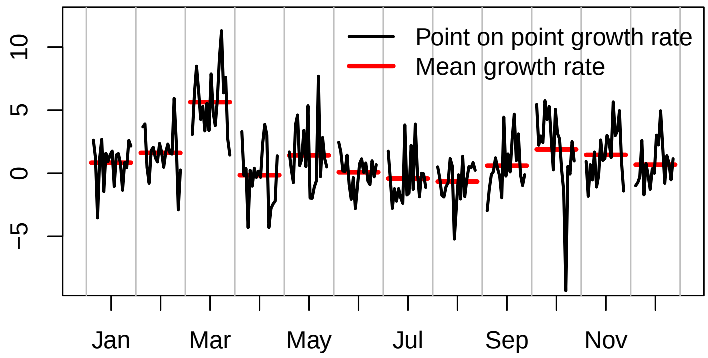


Figure 3 shows peaks in the month of March. The mean growth rate of March over February is greater than the growth rates in other months across the years. We now look at the various steps involved in the seasonal adjustment of M0.

2.1 Pre-adjustment analysis

We rely on a simple seasonal dummy model to detect whether a series is additive or multiplicative seasonality. We use a simple approach and include a set of dummy variables to control for stable seasonality. This approach helps us assess the presence of seasonal variations in a series. We can estimate:

$$\begin{aligned} y_t = \beta_0 + \beta_1 \text{Jan}_t + \beta_2 \text{Feb}_t + \beta_3 \text{Apr}_t + \beta_4 \text{May}_t + \beta_5 \text{Jun}_t \\ + \beta_6 \text{Jul}_t + \beta_7 \text{Aug}_t + \beta_8 \text{Sep}_t + \beta_9 \text{Oct}_t + \beta_{10} \text{Nov}_t + \beta_{11} \text{Dec}_t + \epsilon_t \end{aligned}$$

where Jan_t, Feb_t .... Nov_t are dummy variables. In this formulation, March is the base month. The residual of the regression gives the seasonally adjusted series. We compare the standard deviation of the growth rate for the additive and log transformed regression and choose the one that is lower. *In the case of M0, the seasonal dummies are not significant, hence this approach is not relied upon to detect the presence of additive or multiplicative seasonality.*

We compare the performance of the additive and multiplicative models by looking at the standard deviation of the growth rate of the adjusted series obtained through additive and multiplicative models in the X-12-ARIMA program. With additive specification, the program gives the warning *Estimation failed to converge during the automatic model identification procedure.* and ask for a change of model. Hence multiplicative model is chesen for M0.

2.2 Seasonal adjustment

Seasonal adjustment is done with X-12-ARIMA method. Since the model selection criteria point towards multiplicative seasonality, log transformation of the series is performed.

Figure 4 M0 (NSA and SA)

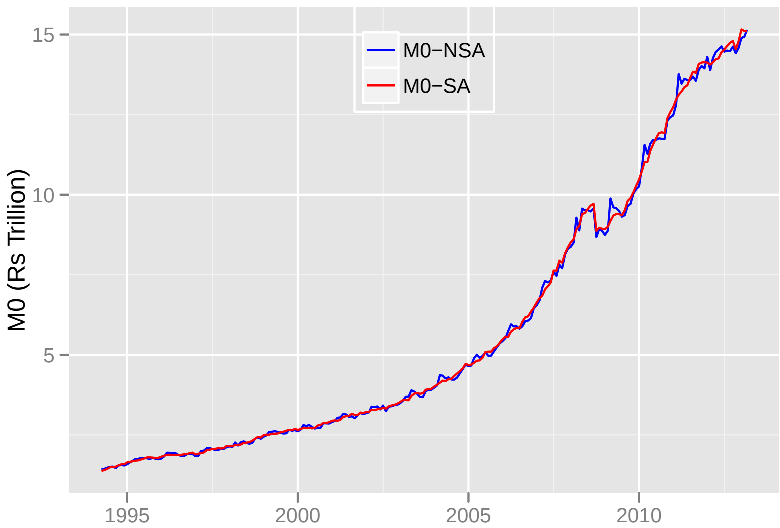


Figure 4 shows the non-seasonally and seasonally adjusted M0 series. The moderate seasonal peaks are suppressed after seasonal adjustment. We look at the plots of the growth rates to see the extent of noise reduction after adjustment.

Figure 5 M0 (NSA and SA- point on point growth rates)

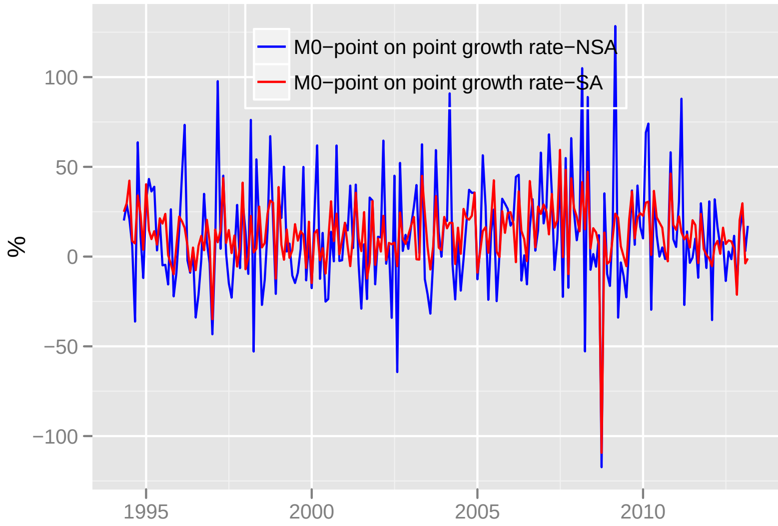


Figure 5 shows the point on point growth of the raw and seasonally adjusted series. Figure shows that noise is reduced after adjustment. This is also evident through the standard deviation of the growth rate of the raw and adjusted series. The standard deviation of the growth rate of the raw series is 31.18 and that of the adjusted series is 16.5.

2.3 Diagnostic checks

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

2.3.1 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 1 is desirable to show identifiable seasonality in the series. The value of M7 for M0 is 0.32.

2.3.2 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

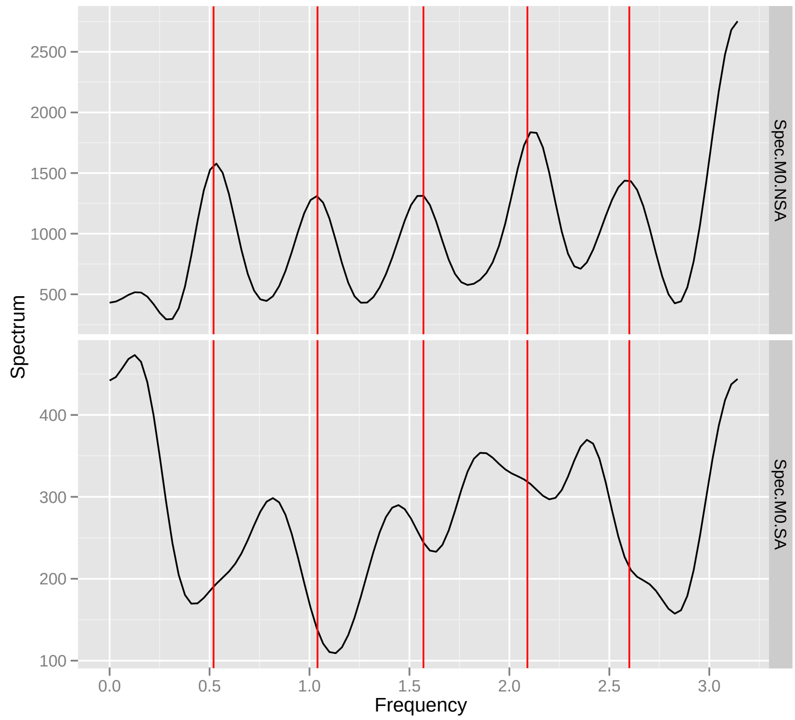
which the month on month changes of the seasonally adjusted values is unstable i.e exceeding the threshold value.
The seasonal adjustment produced by the procedure chosen should not be used if A% > 25.0 (> 15.0 is considered problematic) or if M M % > 40.0.

For M0 series, the programme gives the warning that the range 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)**

2.3.3 Spectral analysis

Figure 6 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. For example the peak at 1.04 correspond to 6 months which is eliminated after seasonal adjustment. Other peaks seen in the lower panel of the figure are not at seasonal frequencies.

Figure 6 M0 Spectral plot (NSA and SA)



0.52 = pi/6 (annual seasonality), 1.04 = pi/3,
1.57 = pi/2, 2.09 = 2pi/3, 2.6 = 5 pi/6

Figure 6 shows that seasonal adjustment effectively removes peaks at seasonal frequencies-0.52, 1.04, 1.57, 2.09 and 2.6 corresponding to 12, 6, 4, 3 and 2.4 months.

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 (month or quarter).

Table 1 shows the year on year growth and seasonally adjusted annualized rate in percent, point on point.

Table 1 Year on year and point on point growth rates

	year.on.year.growth	point.on.point.growth
2008 Jan	27.87	22.29
2008 Feb	26.97	14.08
2008 Mar	30.93	41.51
2008 Apr	21.60	15.19
2008 May	31.77	47.23
2008 Jun	29.91	4.51
2008 Jul	25.18	15.82
2008 Aug	26.94	13.50
2008 Sep	22.48	6.64
2008 Oct	12.69	-109.35
2008 Nov	9.84	13.40
2008 Dec	6.69	-4.03
2009 Jan	4.45	-2.57
2009 Feb	4.37	10.93
2009 Mar	6.43	23.92
2009 Apr	8.11	21.66
2009 May	0.12	5.74
2009 Jun	-0.18	0.09
2009 Jul	-2.17	-5.36
2009 Aug	-1.20	20.76
2009 Sep	0.87	36.28
2009 Oct	11.85	10.13
2009 Nov	12.25	21.86
2009 Dec	14.73	24.20
2010 Jan	17.29	22.71
2010 Feb	22.39	30.05
2010 Mar	16.97	30.62
2010 Apr	17.40	0.88
2010 May	21.05	36.62
2010 Jun	23.36	21.83
2010 Jul	25.72	18.96
2010 Aug	25.61	16.11
2010 Sep	21.67	2.87
2010 Oct	20.92	-2.66
2010 Nov	22.81	46.27
2010 Dec	22.10	17.62
2011 Jan	21.61	14.87
2011 Feb	17.77	22.39
2011 Mar	19.14	13.46
2011 Apr	19.41	9.56
2011 May	17.48	12.18
2011 Jun	16.00	5.03
2011 Jul	15.94	20.26
2011 Aug	16.42	17.58
2011 Sep	15.41	-3.62
2011 Oct	18.39	23.80
2011 Nov	18.78	4.19
2011 Dec	12.27	0.93
2012 Jan	14.68	-1.02
2012 Feb	8.55	-5.31
2012 Mar	3.59	5.95
2012 Apr	7.41	8.72