

Comment

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STL is an attractive replacement of X-11 and easy for statisticians to accept. Although STL replaces many points in X-11 by modern statistical methods it still conforms much more closely to X-11 than does Baysea, another seasonal adjustment method introduced by a statistician (Akaike 1981) for the same purpose.

STL and X-11 share the idea of interactive smoothing and robust estimation, while Baysea formulates the problem in a Bayesian framework. Thus robust estimation is incorporated in the Bayesian estimation. It is well known that there is a confrontation between the two approaches to robust estimation, one being the model-implicit *m*-estimator approach and the other being the model-explicit Bayesian approach (see Box (1980) and Professor Huber's comments in the Discussion of the paper). STL takes the former approach and Baysea takes the latter approach. As an applied time series analyst, I am more interested in seeing how these two different approaches are practical and effective in real data analysis rather than introducing the same argument into seasonal adjustment problems.

In the analysis of typical seasonal data such as the carbon dioxide data of Figure 1 and Figure 3 we will probably get more or less the same results by applying STL, X-11, and Baysea. However, for rather short macroeconomic data such as the U.S. unemployment data of Figure 5 it is often the case that we get quite different results according to which seasonal adjustment

procedure is used. A data set which seems to be even more difficult to analyse than the U.S. unemployment data is the New Zealand balance of payments data in Figure D1 (Ozaki and Thomson 1987). The solid line in the figure shows the trend obtained by STL and the dotted line shows the trend obtained by Baysea. The difference of the two trends near the end of the series is obviously very important for the government. STL, which is giving a more optimistic view of the economy is not necessarily preferable because it is implying that it is also likely to change into a very pessimistic view when some more recent data is available.

The question is: what is causing such differences? Of course we will get different results if we use different estimation methods. However, it must be noted that the reason is not only because we used two different methods, but also it is because of the very nature of the data. The balance of payments data can be regarded as the difference of the two multiplicative data sets, credits and debits. Since the data can take negative values, we cannot apply the logarithmic transformation. For this data, only additive treatment is possible no matter which seasonal adjustment method we employ. The difference of two multiplicative data sets has, however, a very different character from ordinary additive data. The amplitude of the seasonal components increase exponentially with the increase of trend. The variation of irregular components also increases as trend increases. Neither STL nor Baysea is ready to treat such data properly. An interesting problem

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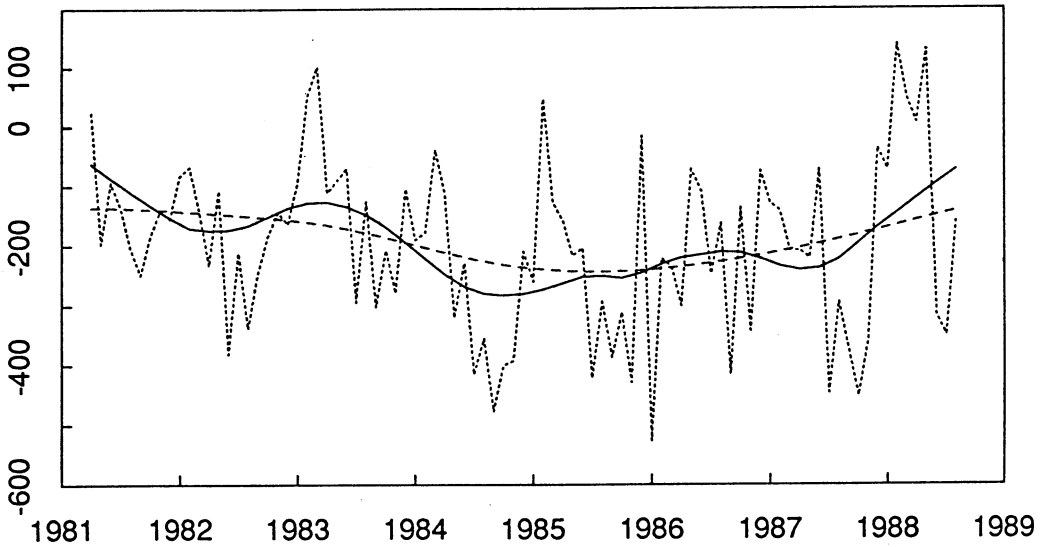


Fig. D1. New Zealand Balance of Payment Data and Estimated Trends —: STL-Trend, : Baysea Trend.

is how robust they are to that kind of situation.

A problem is not only the treatment of differenced series of two multiplicative series. There is also a problem in the treatment of simple multiplicative data. Both STL and Baysea suggest taking logarithmic transformation for multiplicative data and applying the additive method. However in X-11, multiplication and division operations are applied instead of additions and subtractions to the untransformed original data. They also assume the central value of the irregular and seasonal components of multiplicative data to be 1, suggesting the requirement that the sum of seasonal components s_i to be $s_1 + s_2 + \dots + s_{12} = 12$ instead of $s_1 s_2 \dots s_{12} = 1$. Although X-11 has been accepted as a standard and most reliable seasonal adjustment procedure, this peculiar mixing attitude of the multiplicative and the additive has been ignored by statisticians. Certainly it needs to be analysed under the light of modern statistics.

In 1950's to 1970's, spectrum estimation, first by means of the frequency domain approach and later by the time domain approach, was one of the major topics in time series analysis. Nowadays, we can estimate spectrum in the time domain with ARMA models, using their exact maximum likelihood and AIC. However applied time series analysts would never completely give up using the frequency domain approach because both approaches compensate each other well. I welcome and congratulate STL not only because it brings reasonable results to seasonal adjustment but also because it is based on very different ideas and methods from its counterpart, Baysea.

The above comments are based on ideas arising from discussions with Dr P.J. Thomson of Victoria University of Wellington, New Zealand in our joint research work and also due to discussions with Dr V. Haggan-Ozaki of Sophia University, Japan.

References

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Rejoinder

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1. Additions to STL

We are very impressed with the energy with which the discussants probed STL and compared it to other procedures. Based on these discussions and our own thoughts we now have a list of features – some of them “bells and whistles” as Trewin aptly puts it – that we would like to see added to STL. The list will be given at the end of our rejoinder. We hope that researchers in the seasonal adjustment community will involve themselves in these additions, just as a number of the discussants already have done.

Nothing in the discussions leads us to believe that the fundamental ideas of STL are unsound. These fundamentals are

- basing all smoothing (with the exception of three equal-weight moving averages) on loess
- basing the robust estimation on iterated weighted least squares
- using the backfitting algorithm, as X-11 does, to iterate between seasonal and trend smoothings

- providing for seasonal cycles of any length period, for missing values, and for a wide and nearly continuous range of amounts of smoothing of the trend and seasonal components
- keeping the system as simple as possible
- designing the software in a modular, easy-to-alter fashion.

Comments of discussants that indicated displeasure with performance characteristics can be addressed either by using STL in a different way or by using some of the additions on our list.

2. Open and Closed Systems

Changing STL or adding to it is straightforward because it is an *open system*: one that can be readily understood and altered if necessary. When STL does not perform as desired in some application, it often is possible to diagnose the problem and find a solution. Furthermore, software implementations can have a simple, modular