Comment

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Current interest in the problem of the decomposition of a time series into seasonal, trend and irregular components includes three approaches:

i. An unobserved components model based approach is proposed by Box, Hillmer and Tiao (1978), Hillmer and Tiao (1982) and extended by Box, Pierce, and Newbold (1987) to estimate trend and growth rate. This approach assumes that an observable time series can be decomposed into additive seasonal, trend, irregular and (when appropriate) cyclic components. The observed time series is assumed to be generated by an ARIMA model with the individual components assumed to be generated by ARIMA models which are to be estimated.

ii. A structural model approach developed by Harvey (1984) is based on the work of Harrison and Stevens (1976). Applications of this approach appear in Harvey and Todd (1983) and Harvey and Durbin (1986), both with discussions. The models proposed here allow for slowly changing trend, seasonal and cyclic components and are formulated in a manner which makes them amenable to being expressed in state space form. This allows for the likelihood function to be constructed in terms of the prediction error decomposition by using the Kalman filter. Once estimates of the parameters have been computed, the Kalman filter can be applied to obtain predictions of future observations, and hence estimates of the individual components, using a smoothing parameter.

iii. Graphical and computer intensive methods, including SABL (Cleveland, Devlin, and Terpenning 1981; Cleveland and Terpenning 1982) and now STL, where the seasonal-trend decomposition procedure is based on local fitting procedures (Cleveland and Devlin 1988).

While there is a relationship between the first two approaches – specific models can be written down for each component part of the observable series – the third approach is based on locally weighted regression techniques (called loess by the authors of the paper under discussion).

The SABL procedure, for which the software is readily available in the statistical package S (see Becker and Chambers 1984), is a procedure which presents graphical displays of a series, together with its components of trend, seasonal and irregular. In SABL, after an initial transformation (if required) to allow the use of an additive decomposition of the transformed data, a number of smoothers based on moving medians are used to obtain initial estimates of trend and seasonal. The irregular component series is computed and robustness weights based on the irregular values at each time point are determined. Updated estimates of the trend and seasonal are then computed.

As the authors point out, STL consists of two recursive procedures, one consisting of an inner loop which effectively carries out the decomposition of the observed series into components, and an outer loop which adjusts for the effect of outliers.

In SABL the algorithm first determines

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an appropriate power transformation of the data (by minimizing the interaction between trend and seasonal) to arrive at an additive components decomposition prior to the application of the procedure. The question arises as to whether or not an initial transformation is also advisable prior to the application of STL.

STL has six parameters to be specified in order to apply the logarithm; the choice of a number of these determines the degree of smoothing in each component. The authors present a diagnostic graphical method to assist in deciding "how much of the variation of the data other than trend should go in the seasonal component and how much in the remainder." The post trend smoothing also requires the application of an appropriate low pass filter, such as loess, 'to get a component with the desired variation.' According to the authors, the procedure is such that the trend and seasonal components should not compete for variation in the data.

In the other two approaches, i and ii above, it is assumed that each component follows a nondeterministic structure which is to be determined. Consequently each component has a disturbance term associated with it and the magnitude of the variances of the disturbances are of interest. Indeed Hillmer and Tiao (1982, p. 66) argue that the seasonal and trend components should be slowly evolving and so they seek to maximize the innovative variance of the irregular component. They refer to this as a canonical decomposition.

The choice of particular parameters in STL determines the proportion of the variation associated with each of the trend, seasonal and irregular components. As the authors state 'we do not want the trend and seasonal components to compete for variation in the data.' They have put a consider-

able amount of effort into describing the role of each of the six parameters and give some guidance as to how each may be selected. They present some discussion based on eigenvalues and frequency response functions, but I am not clear as to what the underlying criteria are with respect to the distribution of the total variation between the components, other than the quote from the authors given in the previous paragraph. Hillmer and Tiao stated exactly what they meant by a canonical decomposition. Can a similar type of statement be made for this procedure with regard to the allocation of the variation between the seasonal, trend and irregular components?

In the application of SABL, occasional users always have a slight degree of uneasiness that they have oversmoothed or undersmoothed the trend and seasonal components through the choice of the filter bandwidth. With this in mind, even though the authors have given some detail to the choice of smoothers and the degree of smoothing, as in the case of SABL, for 'first or occasional users' of STL there may still be some doubt as to whether they have chosen the 'most suitable' set of parameters for the application of the procedure.

As one who has used, and appreciated, the SABL package I would be interested to hear the authors' comments on the advantages of the more computer intensive STL procedure compared to SABL. Comments on the merits of STL over the unobserved components model based approach, i above, and the structural model approach, ii above, would also be of interest, given that these two approaches are not computer intensive. (It is worth noting that a (menu driven) software package based on ii is now available commercially).

I have very much enjoyed reading this paper and commend the authors for a sub-

stantial contribution to an important area of time series analysis that has received, and will continue to receive, considerable attention from researchers.

References

Becker, R.A. and Chambers, J.M. (1984). S – An Interactive Environment for Data Analysis and Graphics. Belmont: Wadsworth.

Box, G.E.P., Hillmer, S.C., and Tiao, G.C. (1978). Analysis and Modelling of Seasonal Time Series. In Seasonal Analysis and Economic Time Series, ed. A. Zellner, Washington D.C.: US Department of Commerce, Bureau of the Census, 309–334.

Box, G.E.P., Pierce, D.A., and Newbold, P. (1987). Estimating Current Trend and Growth Rate in Seasonal Time Series. Journal of the American Statistical Association, 82, 276–282.

Cleveland, W.S., Devlin, S.J., and Terpenning, I.J. (1981). The SABL Statistical and Graphical Methods. Murray Hill, NJ: Bell Laboratories.

Cleveland, W.S. and Terpenning, I.J. (1982). Graphical Methods for Seasonal Adjustment. Journal of the American Statistical Association, 77, 52–61.

Cleveland, W.S. and Devlin, S.J. (1988). Locally-weighted Regression: An Approach to Regression Analysis by Local Fitting. Journal of the American Statistical Association, 83, 596–610.

Harvey, A.C. and Todd, P.H.J. (1983). Forecasting Economic Time Series With Structural and Box-Jenkins Models: A Case Study. Journal of Business and Economic Statistics, 1, 299–315.

Harvey, A.C. (1984). A Unified View of Statistical Forecasting Procedures. Journal of Forecasting, 3, 245–275.

Harvey, A.C. and Durbin, J. (1986). The Effects of Seat Belt Legislation on British Road Casualties: A Case Study in Structural Time Series Modelling (with discussion). Journal of the Royal Statistical Society, Ser. A, 149, 187–227.

Harrison, P.J. and Stevens, C.F. (1976). Bayesian Forecasting. Journal of the Royal Statistical Society, Ser. B, 38, 205–247.

Hillmer, S.C. and Tiao, G.C. (1982). An ARIMA-model-based Approach to Seasonal Adjustment. Journal of the American Statistical Association, 77, 63–70.

Comment

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The authors have developed a new method for dealing with an important problem in applied statistics. All statistical agencies

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report time series and to make these reports intelligible to the users, data must be decomposed so the important components can be described numerically and graphically.

We have not only read and enjoyed their