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Efficiency gains for seasonal adjustment by joint modelling of disaggregated series

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Efficiency Gains for Seasonal Adjustment by Joint Modelling of Disaggregated Series

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CERTIFICATION

I, Carole Louise Birrell, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Mathematics and Applied Statistics, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Carole Louise Birrell

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Abstract

Governments and businesses use data collected over time as indicators of the social, economic and business conditions of the country. These may then be used for policy and planning decisions, calculation of national accounts and monitoring of economic activity. The production and publication of seasonally adjusted series, in addition to unadjusted figures, is standard practice for government statistical agencies. In general, there are two main approaches to seasonal adjustment, namely a filter-based approach and a model-based approach. Filter-based methods estimate time series components, such as the trend and seasonal factors, by application of a set of filters to the original series. Model-based methods of seasonal adjustment are more specific to each series, and are thereby more flexible.

Time series resulting from aggregation of several sub-series can be seasonally adjusted directly or indirectly. With model-based seasonal adjustment, the sub-series may also be considered as a multivariate system of series and hence the analysis may be done jointly. This approach has considerable advantage over the indirect method, as it utilises the covariance structure between the sub-series.

The focus of this thesis is on examining how the accuracy of seasonally adjusted series can be improved by using the sub-series. A model-based approach to seasonally adjusting an aggregated series is carried out with two different methods. The first method utilises an univariate basic structural model (BSM) for the aggregated series. The second method utilises a multivariate basic structural model for the sub-series. In basic structural models, the series components are modelled individually, and then put into state space form. The Kalman filter is applied to obtain estimates of the aggregate series components and the prediction mean squared errors.

The variance of the seasonally adjusted series given by the two methods is studied through their relative efficiency. A particular emphasis of the thesis is on how the similarity of and differences between disaggregated series affect the efficiency of the two approaches to seasonal adjustment.

Results indicate that gains are attainable under specified conditions which rely on the values of the parameters of not only the seasonal component, but also the non-seasonal components. These results demonstrate the impact on relative efficiency of relationships among sub-series parameters, both between series (i.e. within components) and within series (i.e. between components).

The impact of the length of the time series on the accuracy of seasonally adjusted series is of particular interest. A simulation study investigates the parameter estimates obtained given varying series lengths and the subsequent effects on the accuracy of the time series components given by the Kalman filter. These effects are measured by the naïve bias in the prediction mean squared error and by the revision error. A bootstrap correction is applied to the estimated prediction mean squared error for both the univariate and multivariate approaches.

A single indicator measure is developed for predicting whether the properties of the disaggregated series (or sub-series) will lead to gains in the accuracy of the seasonally adjusted aggregated series. The quasi-likelihood method is applied to obtain the indicator measure of relative efficiency. It is shown to be directly related to the relative efficiency measure obtained with the Kalman filter.

Another application of the quasi-likelihood indicator is in identifying an appropriate grouping of the K sub-series into $r < K$ series. The grouping can considerably reduce the number of estimated parameters, while the accuracy of the seasonally adjusted series is maintained.

The integrated approach of this thesis to the seasonal adjustment of aggregated series thus provides a pathway to improved efficiency and an understanding of the conditions under which improvements may be achieved.

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List of Abbreviations

ABS	Australian Bureau of Statistics
AMB	ARIMA-model-based
AR	autoregressive
ARIMA	autoregressive integrated moving average
ARMA	autoregressive moving average
BLS	Bureau of Labor Statistics
BSM	basic structural model
CPS	Current Population Survey
IGLS	iterative generalised least squares
KF	Kalman filter
KS	Kalman smoother
LLS	local level seasonal
MSE	mean squared error
QL	quasi-likelihood
PMSE	prediction mean squared error
RMSE	root mean squared error
SEA	survey error autocorrelations
SEATS	Signal Extraction in ARIMA Time Series
SSF	state space form
STAMP	Structural Time series Analyser, Modeller and Predictor
SUTSE	seemingly unrelated time series equations
TRAMO	time series regression with ARIMA noise, missing values, and outliers
UC	unobserved components