EFFECTIVENESS OF RECURSIVE ESTIMATION OF TIME SERIES ANALYSIS AND FORECASTING

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by

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A thesis submitted to University of Moratuwa for the Degree of Master of Philosophy

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Declaration

I hereby certify that the work done in this Dissertation is a result of my own effort where, reference is made to the work of authors and this is acknowledged in the text. This Dissertation has not been submitted for another degree.

UOM Verified Signature

T.M.J.A.Cooray ....

Name of the Candidate Signature 31/07/2003

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ABSTRACT

This study is about practical forecasting and analysis of time series, to investigate the effectiveness of recursive estimation of time series analysis and forecasting performance for real data sets. It addresses the question of how to analyze time series data, identify structure, explain observed behavior, modeling those structure and how to use insight gained from the analysis to make informed forecasts. For the purpose of the study total production of paddy and total demand of electricity in Sri Lanka were used. Those values were obtained from the Annual Bulletin, published by the Central Bank of Sri Lanka.

The thesis is organised into two parts. The first part is a course of methods and theory. Time series modelling concepts are described with 'abstract' definitions related to actual time series to give empirical meaning and facilitate understanding. Formal algorithms are developed and methods are applied to analyze data. Two detailed case studies are presented, illustrating the practicalities that arise in time series analysis forecasting. The second part is a course of applied time series analysis and forecasting. It shows how to build the models and perform the analyses shown in the first part using the our own software called "Space" and another downdable software called the "BATS" application program

The first few chapters are concerned with sing theoretical aspects of en-bloc time series models such as the seasonal decomposition method exponential smoothing method, Winter's seasonal method, and the ARIMA methodology to describe the behaviour of the data series. Even though fairly general, these model do not account for the uncertainties due to the specific choice of trend / seasonal/ level. The main drawbacks in this study are its lack of accessing model uncertainties, when choosing the recursive estimation of time series models based on the Kalman filter. Therefore we used an approach that incorporates all uncertainties involved in the time series modelling simultaneously.

Dynamic state space models provided an excellent basis for constructing and forecasting models for a number of reasons. In particular recursive estimation of time series based on the use of discounting techniques proved to be extremely useful in practice. Many practitioners have a natural feel for the discounting

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concept, and furthermore when one discounting factor has been specified, the standard technique may be utilised. in addition to that the Kalman filter based on state space form and Bayesian models can be used to analyse the incomplete data set using EM algorithms.

The last two chapters were devoted for empirical evaluation of data series in order to investigate the effectiveness of recursive estimation of time series. According to the forecast performance of recursive time series models are much more accurate than the en-bloc models. This means that the mean percentage error (MAPE) recursive estimation of time series model is relatively small (nearly 0.5%) so that this method gives higher degrees of accuracy. The recursive estimation of time series models can play an important role of time series modelling. However, these procedures are based on the predictor-corrector type algorithms. Hence without identifying the appropriate structure the variation of parameters could be implemented in contrast to "en-bloc" procedure s which could be used only after assuming the specific type of parameter variation.

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1. Cooray, T.M.J.A. and M. Indralingam (2001), Missing value Estimation of Time Series Data Using a Spread Sheet, Sri Lankan Journal of Applied statistics volume 2 (published)

2. Cooray, T.M.J.A. and M. Indralingam (2002) Auto regressive Modelling Approach to Forecasting Paddy Yield, Sri Lankan Journal of Applied statistics volume 3 (to be appeared)

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4. Cooray, T.M.J.A. and M. Indralingam (2003), Modelling Sector wise Demand for Sri Lanka using Bayesian Techniques, Journal of Science, Eastern University Sri Lanka.(to be appeared)

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ABBREVIATIONS

ACF	Autocorrelation function
AIC	Akaike's Information Criterion
ARIMA(p,d,q)	Autoregressive Integrated moving averages of order p, d and q, where p order of autoregressive terms and q order of moving averages terms and d number of differenced required
ARMA(p,q)	Autoregressive of order p and moving averages of order q
AR	Autogressive components
MA	Moving averages components
BATS	Bayesian Applied Time Series Soft ware
BIC	Schwarz Information Criterion
B	Backward operator
∇	Difference operator
ρ_k	Autocorrelation function of lag k
$\hat{\rho}_k$	Sample autocorrelation at lag k
φ_{kk}	Partial autocorrelation function of lag k
$\hat{\varphi}_{kk}$	Sample autocorrelation at lag k
Eq^n	Equation
ME	Mean error
MAE	Mean absolute error
MAPE	Mean absolute percentage error
MSS	Mean sum of squares
$MS_E(P)$	Error mean sum squares

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C_p	Mallows C_p statistic
R(K)	Autocovariance function of lag k
ARIMA(p,d,q)(P,D,Q)$_S$	Seasonal autoregressivs integrated moving model of normal components p,q and seasonal components P and Q and differenced d for normal components and D for seasonal components respectively
OLS	Ordinary least squares
CHI	Chi-squared statistic
GDP	Gross Domestic Products
RSS	Regression sum of squares
RSP	Residual Sum of Product
SSE	Sum of Squares of Error

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