SURE-AUTOMETRICS ALGORITHM FOR MODEL SELECTION IN MULTIPLE EQUATIONS

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DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2016

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Abstrak

Ketidaktentuan dalam proses pembinaan model dapat dijelaskan oleh pakar pemodelan kerana pengetahuan tersirat yang diperoleh melalui pengalaman menjalankan penyelidikan. Sementara itu, pengamal yang kebiasaannya bukan pakar dan kurang pengetahuan statistik akan berhadapan dengan kesukaran semasa proses pemodelan. Maka, algoritma yang disertai panduan langkah demi langkah adalah bermanfaat dalam pembinaan, pengujian dan pemilihan model. Bagaimanapun, kebanyakan algoritma pemilihan model seperti *Autometrics* hanya tertumpu pada pemodelan persamaan tunggal yang aplikasinya adalah terhad. Oleh itu, kajian ini bertujuan membangunkan algoritma bagi pemilihan model dalam persamaan berganda yang memfokuskan kepada model S*eemingly Unrelated Regression Equations* (*SURE*). Algoritma tersebut dibangunkan dengan menyepadukan model *SURE* dan strategi carian oleh *Autometrics*; maka dinamakan *SURE-Autometrics*. Prestasinya dinilai dengan menggunakan ujikaji simulasi Monte Carlo berdasarkan lima model spesifikasi, tiga tahap kekuatan korelasi antara ralat, dan dua saiz sampel. Dua set G*eneral Unrestricted Models* (GUMS) kemudiannya diformulasi dengan menambah beberapa pemboleh ubah tidak relevan terhadap model spesifikasi tersebut. Prestasi tersebut ditentukan melalui peratusan keupayaan algoritma *SURE-Autometrics* berupaya menyingkirkan pemboleh ubah tidak relevan dalam GUMS awalan yang terdiri daripada dua, empat dan enam persamaan. *SURE-Autometrics* juga ditentusahkan menggunakan dua set data sebenar melalui perbandingan ramalan ukuran ralat telahan dengan lima algoritma pemilihan model dan tiga prosedur bukan algoritma. Dapatan daripada uji kaji simulasi mencadangkan bahawa *SURE-Autometrics* berprestasi baik apabila bilangan persamaan dan bilangan pemboleh ubah relevan dalam model spesifikasi sebenar adalah minima. Aplikasi terhadap data sebenar menunjukkan bahawa beberapa model mampu meramal dengan tepat jika data tidak mempunyai masalah kualiti. Algoritma pemilihan model secara automatik ini adalah lebih baik berbanding prosedur bukan algoritma yang memerlukan pengetahuan dan masa tambahan. Kesimpulannya, prestasi pemilihan model bagi persamaan berganda menggunakan *SURE-Autometrics* bergantung pada kualiti data dan kompleksiti dalam model *SURE*.

Kata kunci: Pemilihan model, Algoritma *SURE-Autometrics*, S*eemingly unrelated regression equations*.

Abstract

The ambiguous process of model building can be explained by expert modellers due to their tacit knowledge acquired through research experiences. Meanwhile, practitioners who are usually non-experts and lack of statistical knowledge will face difficulties during the modelling process. Hence, algorithm with a step by step guidance is beneficial in model building, testing and selection. However, most model selection algorithms such as *Autometrics* only concentrate on single equation modelling which has limited application. Thus, this study aims to develop an algorithm for model selection in multiple equations focusing on seemingly unrelated regression equations (SURE) model. The algorithm is developed by integrating the SURE model with the *Autometrics* search strategy; hence, it is named as *SURE-Autometrics*. Its performance is assessed using Monte Carlo simulation experiments based on five specification models, three strengths of correlation disturbances and two sample sizes. Two sets of general unrestricted models (GUMS) are then formulated by adding a number of irrelevant variables to the specification models. The performance is measured by the percentages of *SURE-Autometrics* algorithm that are able to eliminate the irrelevant variables from the initial GUMS of two, four and six equations. The *SURE-Autometrics* is also validated using two sets of real data by comparing the forecast error measures with five model selection algorithms and three non-algorithm procedures. The findings from simulation experiments suggested that *SURE-Autometrics* performed well when the number of equations and number of relevant variables in the true specification model were minimal. Its application on real data indicated that several models are able to forecast accurately if the data has no quality problem. This automatic model selection algorithm is better than non-algorithm procedure which requires knowledge and extra time. In conclusion, the performance of model selection in multiple equations using *SURE-Autometrics* is dependent upon data quality and complexities of the SURE model.

Keywords: Model selection, *SURE-Autometrics* algorithm, Seemingly unrelated regression equations.

Acknowledgement

In the name of Allah, the Most Gracious and the Most Merciful.

Alhamdulillah, all praises to Allah for the strengths and His blessing for completing this thesis. I would like to express my sincere appreciation to my supervisor, Dr. Suzilah Ismail for her extraordinary support in this study, for her patience, motivation, enthusiasm, and immense knowledge. Her guidance really helps me in writing of this thesis.

Besides my supervisor, I would like to thanks my friends and colleagues for their encouragement and insightful comments.

My sincere acknowledgement also goes to my husband, Tengku Mohd Nazli Tengku Mansor, my families, and those who indirectly contributed to my research. I love you all.

Finally, I am very grateful with my employer, Universiti Utara Malaysia for giving me chances to pursue this study. Without their financial support and scholarship, this research would never end with success. Thank you very much.

Declaration Associated with the Thesis

Parts of this thesis have been presented and published for the following occasions:

1. Independence Test in *SURE-Autometrics* Algorithm
   Presented at the *International Symposium on Forecasting* (ISF), Prague, Czech Republic, June 27 – 29, 2011.

2. Lag Variable Reduction in Multiple Models Selection Algorithm
   Published in the Proceedings of *International Conference on the Analysis and Mathematical Applications in Engineering and Science* (AMAES), Curtin University, Sarawak Malaysia, January 19 – 22, 2014.

3. Assessing the Simulation Performances of Multiple Models Selection Algorithm
   Published in the Proceedings of *5th International Conference on Computing and Informatics* (ICOCI), Istanbul, Turkey, August 11 – 13, 2015.

4. Algorithmic Approaches in Model Selection of the Air Passengers Flows Data
   Published in the Proceedings of *5th International Conference on Computing and Informatics* (ICOCI), Istanbul, Turkey, August 11 – 13, 2015.

5. Analysis of *SURE-Autometrics* Algorithm Performance using Simulation Experiment
   Journal of Information and Communication Technology (forthcomings)

6. Empirical Study of *SURE-Autometrics* via Air Passengers Flow Data
   Journal of Advanced Digital Technology (forthcomings)

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

DGP	data-generating process
e.g.	for example
et al.	and others
etc.	and so forth
FGLS	feasible generalised least squares
GDP	gross domestic product
GETS	general-to-specific
GLS	generalised least squares
GRMSE	geometric root mean square error
GUM	general unrestricted model of single equation
GUMS	general unrestricted model of multiple equations
i.e.	that is
LM	Lagrange Multiplier
MC-QLR	Monte Carlo-Quasi Likelihood Ratio
MI	Multivariate independent
OLS	ordinary least squares
RMSE	root mean square error
SUM	specific unrestricted model of single equation
SUMS	specific unrestricted model of multiple equations
SURE	seemingly unrelated regression equations
UK	United Kingdom
US	United States

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Statistical modelling normally has inexplicit processes due to a tacit or personal knowledge. This can be gained through experience where modellers combined their judgmental knowledge and theoretical studies at some point in the modelling process (Magnus & Morgan, 1999). Generally, the process commence with a model formulation which involves specification of identified variables and followed by estimation procedure. Then it is validated through a series of evaluations where re-specification will be required according to certain criteria such as diagnostic testing, goodness of fit and hypothesis testing of the parameters.

The specification of model involves choosing which variables to include or exclude from the model while maintaining the consistencies with the observed data. According to Magnus (1999), the selection of predictor variables could be based on two basic modelling approaches where it can possibly starts from a simple model and expand it, or from a general model which subsequently reduce to a more simplified form. The first approach is known as specific-to-general or bottom-up where it uses the theory to provide an initial specification. Then, it is refined by adding or subtracting the variables or substitutes the coefficients estimator according to modeller's prior belief or data exploration techniques such as Cochrane-Orcutt transformation. On the contrary, the second approach starts with a general model formulated based on information collected from theories, previous empirical research evidence, institutional knowledge, and common sense (Hendry & Doornik, 2014). This initial model which comprises of all the candidate variables is then refined by the

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