MODELLING AND FORECASTING THE KUALA LUMPUR COMPOSITE INDEX RATE OF RETURNS USING GENERALISED AUTOREGRESSIVE CONDITIONAL HETEROSCEDASTICITY MODELS

MAIYASTRI

DOCTOR OF PHILOSOPHY
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By

MAIYASTRI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

November 2004

This Thesis is dedicated to:

My Mother

CHAMSIAH BT ZAINUDDIN
And

My late Father

ABDUL MUTHALIB BIN ABDUL MUNAF
May Allah rest his soul in heaven

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman: Associate Professor Kassim Haron, Ph.D.

Faculty: Science

The work in this thesis is concerned with the modelling and forecasting of the KLCI's returns with a 'complete' technique. The selection of the model for estimation is not only based on the value of the goodness of fit test, but also on the test of the stability of parameters obtained, the checking of the characteristic of the standardized residual such as the ARCH-LM test, Ljung-Box test, asymmetry test (SB, NSB, and PSB test). Its distribution is examined by *qq*-plot. The forecasting is carried out by using the multi-step-ahead forecast.

This study also proposes the PCA(Principal Component Analysis) as an alternative method to compare the performance of several GARCH models. It is found that this method has a clear edge over its rival because PCA uses actual values of the goodness of fit test criteria (LogL, SBC, and AIC in estimation and RMSE, MAE,

AMAPE and MAPE in forecasting) and hence the inability to specify exactly the relative positions of each of the competing models as faced by the ranking method may be overcome. Another plus point is that, this method enables models to be classified into several distinct groups ordered in such a way that each group is made up of models with about the same level of fitting and forecasting abilities.

The characteristics of the numerous tests in modelling for GARCH have been checked by Monte Carlo simulation. The tests are the ARCH-LM test, the SB, NSB and PSB tests, the parameters constancy test and the ARCH remaining test (to test whether the standardized residual still contain signs of conditional heteroscedasticity). The results show that the ARCH remaining test is inconsistent, but the other tests are accurate and stable for all experiments.

Since the volatility of the KLCI's returns series is non-uniform, the data is split into three periods of time. In the beginning, the division of the data is based on the plot of the returns, but for the later part, it is based on the distribution of the returns. Methods for correcting the outliers and splitting the heterogeneous data are proposed. The EM algorithm is applied to split the heterogeneous data, and the estimated parameters are used to correct the outlying data using the Mahalanobis Distance.

The last part of the thesis is concerned with the validation of the model obtained for fitting the GARCH model for the new data set (January 2001-April 2004 or Period IV). It is found that the pattern of the new data set resembles of Period III, and both

models are also the same. Finally, the model selected for Period IV is used to determine the VaR (Value at Risk) of the KLCI. The VaR at the 5% level for next 5 trading days (the next week) starting from the forecast origin on the 30th April 2004 is RM 35,492.55, which means that if someone invest RM 1 million in the KLSE, and if some extraordinary event happens, the maximum loss incurred for the next 5 trading days (starting from the forecast origin on the 30th April 2004) with 95% probability is RM 35,492.55.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

PEMODELAN DAN PERAMALAN PULANGAN INDEKS KOMPOSIT KUALA LUMPUR MENGGUNAKAN MODEL 'GENERALISED AUTOREGRESSIVE CONDITIONAL HETEROSCEDASTICITY'

Oleh

MAIYASTRI

November 2004

Pengerusi: **Profesor Madya Kassim Haron, Ph.D.**

Fakulti: **Sains**

Kajian dalam teisis ini adalah berkaitan dengan pemodelan dan peramalan pulangan KLCI dengan teknik yang 'lengkap'. Pemilihan model untuk penganggaran tidak hanya berdasarkan kepada nilai ujian kebagusan penyuaian, akan tetapi juga berdasarkan kepada ujian kestabilan parameter yang diperolehi, pemeriksaan ke atas ciri reja terpiawai seperti ujian ARCH-LM, ujian Ljung-Box, ujian asimetri (ujian SB, NSB, dan PSB) dan pemeriksaan ke atas taburannya berdasarkan plot *qq*. Peramalan dilakukan dengan ramalan multi-langkah kehadapan

Kajian ini juga mencadangkan PCA(Principal Component Analysis) sebagai kaedah alternatif untuk membandingkan pencapaian beberapa model GARCH. Kaedah yang dicadangkan mempunyai kelebihan yang ketara ke atas lawannya, kerana PCA menggunakan nilai sebenar dari ujian kebagusan penyuaian (LogL, SBC, dan AIC

dalam penganggaran dan RMSE, MAE, AMAPE dan MAPE dalam peramalan), dan oleh itu ketidak upayan untuk menyatakan dengan tepat kedudukan secara relatif setiap model yang bersaing seperti yang dihadapi oleh kaedah pangkat dapat diatasi. Kelebihan lain ialah kaedah ini juga dapat mengklasifikasikan model ke dalam beberapa kumpulan berbeza, disusun sedemikian rupa supaya setiap kumpulan terdiri daripada model dengan paras keboleh penyuaian dan peramalan yang hampir sama.

Simulasi Monte Carlo digunakan untuk memeriksa ciri-ciri pelbagai ujian dalam pemodelan GARCH. Ujian-ujian tersebut adalah ujian ARCH-LM, ujian-ujian SB, NSB and PSB, ujian kemalaran parameter, uji baki ARCH (bagi menguji sama ada reja terpawai masih menunjukkan tanda-tanda keheteroskedastisiti bersyarat). Keputusan menunjukkan bahawa uji baki ARCH tidak konsisten tetapi ujian-ujian lain adalah tepat dan stabil dalam semua eksperimen.

Disebabkan kemeruapan siri pulangan KLCI tidak seragam, data dipisahkan kepada tiga tempoh masa. Pada permulaan studi pembahagian data adalah berdasarkan kepada plot pulangan, akan tetapi untuk bahagian seterusnya ianya berdasarkan kepada taburan pulangan. Kaedah untuk membetulkan nilai-nilai terpencil dan memisahkan data heterogen dicadangkan. Algoritma EM digunakan untuk memisahkan data heterogen dan anggaran parameternya digunakan untuk membetulkan data terpencil dengan mengguankan Jarak Mahalanobis.

Bahagian akhir tesis ini berkaitan dengan pengesahan model yang telah diperolehi untuk menyuaikan model GARCH pada set data baru (Januari 2001-April 2004 atau Tempoh IV). Didapati bahawa corak set data baru menyerupai corak pada Tempoh III, maka kedua model untuk kedua set data boleh disimpulkan sama. Terakhir model yang diperolehi pada Tempoh IV digunakan untuk menentukan 'VaR' KLCI. 'VaR pada aras 5% untuk 5 hari perdagangan kehadapan (satu minggu kehadapan) bermula pada awal peramalan pada tarikh 30hb April 2004 adalah RM 35,492.55, artinya jika seseorang melakukan pelaburan sebesar satu juta Ringgit (pada tarikh 30hb April 2004) untuk tempoh lima hari kehadapan dan terjadi sesuatu di luar kawalan pada pasaran modal, maka dengan kebarangkalian 95 peratus kerugian yang akan dialami jika melabur di KLSE adalah tidak melebihi RM 35,492.55.

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I certify that an Examination Committee met on **8th November 2004** to conduct the final examination of **Maiyastri** on her **Doctor of Philosophy** thesis entitled "**Modelling and Forecasting the KLCI's Rate of Returns Using GARCH Models**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded a relevant degree. Members of the Examination Committee are as follows:

Isa bin Daud, Ph.D.,
Associate Professor
Faculty of Sciences
Universiti Putra Malaysia
(Chairman)

Noor Akma Ibrahim, Ph.D.,
Associate Professor,
Faculty of Sciences
Universiti Putra Malaysia
(Member)

Mohd. Rizam bin Abu Bakar, Ph.D.,
Associate Professor,
Faculty of Sciences
Universiti Putra Malaysia
(Member)

Zainodin bin Hj. Jubok, Ph.D.,
Professor,
Faculty of Graduate Studies
Universiti Malaysia Sabah
(Independent Examiner)

_____

ZAKARIAH ABD. RASHID, Ph.D.,
Professor /Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

Kassim Haron, Ph.D.
Associate Professor
Faculty of Sciences
Universiti Putra Malaysia
(Chairman)

Habshah Midi, Ph.D.
Associate Professor
Faculty of Sciences
Universiti Putra Malaysia
(Member)

Mahendran Shitan, Ph.D.
Faculty of Sciences
Universiti Putra Malaysia
(Member)

_____
AINI IDERIS, Ph.D.
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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MAIYASTRI

Date:

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