UNIVERSITI PUTRA MALAYSIA

ECONOMETRIC FORECASTING MODELS FOR SHORT TERM NATURAL RUBBER PRICES

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By

AYE AYE KHIN

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

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Dedication

To

My parents, sisters, brothers, husband and son for their love and support

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

ECONOMETRIC FORECASTING MODELS FOR SHORT TERM NATURAL RUBBER PRICES

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February 2010

Chairman: Associate Professor Dr. Eddie Chiew Fook Chong, PhD

Faculty: Agriculture

This study presents a number of short-term *ex-post* forecasts of single equation model, Multivariate Autoregressive Moving Average (MARMA) model, simultaneous supply-demand and price system equation model, and Autoregressive Integrated Moving Average (ARIMA) model, and ARCH-type models of natural rubber (NR) SMR20 (Standard Malaysia Rubber of grade 20) prices in the world NR market. The ARCH-type models (Autoregressive Conditional Heteroskedasticity) used include the GARCH (1,1) (Generalized ARCH) model, EGARCH (1,1) (The Exponential GARCH) model, PARCH (1,1) (The Power ARCH) and CGARCH (1,1) (The Component GARCH) model. These were developed for *ex-post* forecast of short-term monthly SMR20 prices in the world NR market.

Natural rubber is a vital commodity used in the manufacture of a wide range of rubber-based products. Over 20 million families are dependent on rubber cultivation for their livelihood in the world NR market. The years 1997 to 1999 and as well as in the year 2000 were turbulent years for the economies in South-East and East Asia. In 2008, the

extremely low prices due to the outbreak of the global recession. It experienced during these years contributed to price volatility and instability in many countries, especially rubber smallholders in South East Asia. Moreover, the crude petroleum oil price is an important component of synthetic rubber. A fall in the crude petroleum oil price relates to synthetic rubber. It influences a declining share of synthetic rubber in total rubber consumption, and also a weak currency exchange affects in the NR producing countries because most commodities are traded in US dollar. This could be a good reason for taking the current NR price forecasting study. It would be also a direction of short term NR price movement for policy formulation. Furthermore, the conceptual economic framework of this study was a good starting point for discussion and perceptive of short-term *ex-post* forecast of NR price forecasting models developed, with the opportunity of using some of these factors later in the other study for the forecasting of rubber prices.

The model specifications were developed in order to discover the inter-relationships between NR production, consumption and prices of SMR20, to forecast the NR price of SMR20 using single equation model, MARMA model, simultaneous system equation of supply-demand and price forecasting model, ARIMA model, and ARCH-type models, to analyze and compare the various NR price forecasting models individually in terms of their comparative price forecasting accuracy and to determine which between the models are more efficient. The models were utilized using monthly data from January 1990 to December 2008 as estimation period, providing a total of 228 observations and data was used as an *ex-post forecasts*. All data (variables) were tested for unit root test using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test and were found to be stationary at first difference. The Granger causality test was tested for the direction of a Granger causality relationship between two variables.

Based on these forecasts, world natural rubber price (SMR20) is solved dynamically for *ex-post* forecasts and estimated to decrease to around USD 1386.43 per MT in December 2008, a decrease of 60.7 percent from July 2008 with USD 3530.96 per MT. The values of the forecasting accuracy of the Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Root Mean Percent Error (RMPE), Theil's Inequality Coefficients (U) criteria and Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SC) of simultaneous supply-demand and price system equation model were comparatively smaller than the values generated by single equation model, MARMA model and ARIMA model, and ARCH-type models. These statistics suggested that the forecasting performance of the simultaneous supply-demand and price system equation model was more efficient than single equation model, MARMA model and ARIMA model, and ARCH-type models for *ex-post forecast* in estimating the price of SMR20 in the next 6 months or so in the world NR market.

If the growth of the global economy, especially in developed countries and large developing countries continues to be stable, over the forecasting periods, further strengthening of natural rubber price would be expected. Comparative *ex-post* and *ex-ante* forecasts of NR prices and determination of *long-tem* and *short-term* forecasts of NR supply, demand and prices using the various forecasting models which were not attempted for this study, could also be potentially beneficial for future work. Significantly, short-term *ex-post* forecast of NR price forecasting generated from the single equation model, MARMA model, simultaneous supply-demand and price system equation model, and ARIMA model, and ARCH-type models developed in this study could be provided a useful test of the validity of the model and also beneficial to producers and consumers as well as traders and planners for policy analysis in the world NR market.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doctor of Philosophy.

MODEL EKONOMETRIK UNTUK RAMALAN HARGA BAGI GETAH ASLI DALAM JANGKA MASA PENDEK

Oleh

Aye Aye Khin

Februari 2010

Pengerusi: Profesor Madya Dr. Eddie Chiew Fook Chong, PhD

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Kajian ini membentangkan sejumlah ramalan ex-post jangka pendek bagi model satu tempoh, model Multivariate Autoregressive Moving Average (MARMA), serentak model bekalan permintaan dan persamaan sistem harga, dan model Autoregressive Integrated Moving Average (ARIMA), dan model ARCH-type harga getah asli (NR) SMR20 (Malaysia Standard Rubber gred 20) dalam dunia pasaran NR. Model ARCH-type (Taklik Autoregresif Heteroskedasticity) digunakan termasuk model GARCH (1,1) (GERBANG Am), model EGARCH (1,1) (GARCH Eksponen), model PARCH (1,1) (GERBANG Kuasa) dan CGARCH (1,1) (Komponen GARCH). Model ini dibangunkan untuk ramalan ex-post bulanan jangka pendek harga SMR20 dalam dunia NR.

Getah asli adalah satu komoditi amat penting yang digunakan secara meluas pengeluaran getah berasaskan produk. Lebih 20 juta keluarga bergantung pada penanaman getah sebagai punca rezeki mereka dalam dunia pasaran NR. Pada tahun 1997 hingga 1999 dan tahun 2000 merupakan tahun kegawatan ekonomi itu di Tenggara dan Asia Timur. Pada 2008, harga sangat rendah kerana kemelesetan global. Tahun-tahun ini telah menyumbang kemudahruapan harga dan ketidakstabilan dalam kebanyakan negara,

terutama pekebun kecil getah di Asia Tenggara. Tambahan pula, harga minyak petroleum mentah adalah satu komponen penting getah sintetik . Kejatuhan dalam harga minyak petroleum mentah berkait rapat dengan getah sintetik. Ia mempengaruhi penurunan saham getah sintetik dalam penggunaan getah keseluruhan, dan pertukaran mata wang yang rendah lemah akan member kesan kepada negara-negara yang mengeluarkan NR kerana kebanyakan komoditi dalam beli dolar AS. Ini mungkin satu alasan yang baik untuk mengambil jual beli kajian ramalan harga NR semasa. Ia akan juga suatu arahan pergerakan harga NR dalam tempoh singkat untuk pembentukan dasar. Tambahan pula, rangka ekonomi konsepsi kajian ini adalah permulaan untuk yang baik perbincangan dan perseptif ramalan ex-post dalam jangka masa pendek bagi model ramalan harga NR yang telah dibangunkan, dengan peluang menggunakan beberapa faktor-faktor ini dalam kajian yang lain untuk ramalan harga getah.

Model-model itu telah dibangunkan dengan tujuan untuk mendapatkan hubung kait antara pengeluaran NR, penggunaan dan harga SMR20, untuk meramalkan harga NR SMR20 menggunakan model satu tempoh, model MARMA, persamaan sistem serentak bekalan permintaan dan model ramalan harga, model ARIMA, dan model ARCH-type, bagi menganalisis dan bandingkan pelbagai model ramalan harga NR secara individu dalam soal ramalan harga mereka yang ketepatan komparatif dan bagi menentukan yang antara model-model itu lebih efisien. Model-model itu menggunakan data bulanan daripada tempoh Januari 1990 hingga Disember 2008 sebagai tempoh anggaran, menyediakan sejumlah 228 pengawasan dan data telah digunakan seperti satu ramalan-ramalan ex-post. Semua data (pembolehubah-pembolehubah) telah diuji untuk unit ujian punca menggunakan ujian Augmented Dickey-Fuller (ADF) dan ujian Phillips-Perron (PP) dan telah didapati pegun pada perbezaan pertama. Ujian Granger telah diuji untuk mengarahkan hubungan Granger dengan dua pembolehubah.

Berdasarkan ramalan-ramalan ini, harga getah asli dunia (SMR20) telah diselesaikan secara dinamik untuk ramalan ex-post dan dianggarkan berkurangan kepada USD 1386.43 se MT pada bulan Disember 2008, pengurangan 60.7 peratus mulai Julai 2008 dengan USD 3530.96 se MT. Nilai-nilai ketepatan ramalan Root Mean Square Error (RMSE), min ralat mutlak (MAE), Root Mean Percent Error (RMPE), Theil Inequality Coefficients (U) kriteria dan Akaike Information Criterion (AIC) dan Schwarz Bayesian Information Criterion (SC) serentak bekalan permintaan dan model persamaan sistem harga secara perbandingan adalah lebih kecil daripada nilai-nilai yang dihasilkan oleh model satu tempoh, model MARMA, persamaan sistem serentak bekalan permintaan dan model ramalan harga, model ARIMA, dan model ARCH-type. Perangkaan ini telah mencadangkan prestasi ramalan serentak bekalan permintaan dan model persamaan sistem harga lebih efisien daripada model satu tempoh, model MARMA dan model ARIMA, dan model ARCH-type untuk ramalan ex-post dalam menganggarkan harga SMR20 dalam tempoh datang 6 bulan yang akan dating atau dalam dunia pasaran NR.

Jika pertumbuhan ekonomi global, terutama sekali dalam negara-negara maju dan negara-negara besar sedang membangun berterusan untuk stabil, mengenai tempoh ramalan, harga getah asli dijangka lebih kuat akan datang. Ex-post perbandingan dan ex-ante ramalan harga dan keazaman NR dalam ramalan jangka masa panjang dan pendek bagi bekalan NR, permintaan dan harga menggunakan model peramalan pelbagai yang bukan dicuba untuk kajian ini, boleh menjadi berpotensi bermanfaat untuk kerja akan datang. Secara significan, ramalan ex-post jangka masa pendek bagi peramalan harga NR dihasilkan dan pada model satu tempoh, model MARMA, model bekalan permintaan serentak and persomaan system harga dan model ARIMA and model ARCH-type telah dibangunkan dalam kajian ini dapat menyediakan ujian kesahihan model yang berguna dan berfaedah kepada pergeluar dan pengguna serta peniaga-peniaga dan perancang analisis polisi dalam dua pasaran NR.

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I certify that a Thesis Examination Committee has met on 11 of February 2010 to conduct the final examination of Aye Aye Khin on her thesis entitled "Econometric Forecasting Models For Short Term Natural Rubber Prices" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded for the degree of Doctor of Philosophy.

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This thesis was 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 were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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AYE AYE KHIN

Date:

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller Test
AIC	Akaike Information Criterion
ANRPC	Association of Natural Rubber Producing Countries
ARCH	Autoregressive Conditional Heteroskedasticity Model
ARIMA	Autoregressive Integrated Moving Average Model
CGARCH	The Component GARCH Model
EGARCH	The Exponential GARCH Model
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GARCH	Generalized ARCH Model
IMF	International Monetary Fund
IRC	International Rubber Conference
IRCo	International Rubber Consortium of Thailand, Indonesia and Malaysia
IRRDB	International Rubber Research Development Board
IRSG	International Rubber Study Group
MAE	Mean Absolute Error
MARMA	Multivariate Autoregressive Moving Average Model
MRB	Malaysian Rubber Board
MRE	Malaysia Rubber Exchange
MRELB	Malaysian Rubber Exchange and Licensing Board
MRRDB	Malaysia Rubber Research and Development Board
OECD	Organization for Economics Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PARCH	The Power ARCH Model

PP	Phillips-Perron Test
RAS	The Rubber Association of Singapore
RMPE	Root Mean Percent Error
RMSE	Root Mean Square Error
RRIM	Rubber Research Institute of Malaysia
RSS1	Ribbed Smoke Sheet Rubber of Grade 1
SC	Schwarz Bayesian Information Criterion
SICOM	Singapore Commodity Exchange Inc
SMR20	Stand Malaysia Rubber of Grade 20
TOCOM	Tokyo Commodity Exchange Inc
U	Theil's Inequality Coefficients Criteria
UNCTAD	United Nations Conference on Trade and Development
USDA	United States Department of Agriculture

CHAPTER I

INTRODUCTION

The chapter begins with a discussion of the background of world natural rubber (NR) industry followed by economic development of world NR industry, factors influenced NR prices in current world NR industry and the research problem. The objectives of the study are then described. An elaboration on the significance of the study and organization of the study concludes this chapter.

1.1 Background of World Natural Rubber Industry

Rubber is a vital commodity used in the manufacture of a wide range of rubber-based products. Rubber plays a major role in the socio-economic fabric of many developing countries. Rubber is derived from latex, a milky fluid obtained from the *Hevea brasillensis* (Euphorbiaceae) tree. Rubber is a native of the Amazon basin in South America and has spread to other countries of South-East and South Asia such as Malaysia, Indonesia, Thailand, Sri Lanka and India during late 19th century (The Encyclopedia of Malaysia, 2007).

In 1818, the rubber industry started with Charles Macintosh in Europe. He was an industrial chemist of the chemical industry, and was eager to make use of the waste products of the new coal gasification process. James Syme, a medical student, found that coal tar naphtha was a good solvent for rubber. So, Macintosh's specific skill came in exploiting the naphtha-based rubber solution as a waterproofing layer