香港統計學會
Hong Kong Statistical Society
c/o Department of Statistics & Actuarial Science,
The University of Hong Kong, Pokfulam Road, Hong Kong
http://www.hkss.org.hk

Bulletin
Volume 26 No. 2
December 2003

Editor's Foreword

There is a good news in the society of Statistics. The 2003 Nobel prize in Economics was awarded to two distinguished econometricians Professor C.W.J. Granger of the University of California, San Diego and Professor R.F. Engle of New York University. It is a significant evidence that Statistics is a very useful subject. In order to let members know the contributions of these two Nobel Laureates, Prof. W.K. Li kindly wrote an article regarding their major works on time series analysis.

The Statistical Project Competition (SPC) for Secondary School Students is one of the more successful activities organized by the Society. Letters of invitation have been sent out and briefing sessions have been held. A report on the event was written by the organizing committee this year.

Profs. W.K. Li and Philip Yu attended the conference organized by the Korean Statistical Society and submitted a report on this trip.

Finally, I urge members to submit articles to this Bulletin.

P.S. Chan

CONTENTS

(Vol. 26/No.2, December 2003)

President's Forum

Professor Tony W.K. FUNG

It is with regret that we have to report the death of Professor Hu Hsiao-Sheng, the oldest member of our Society. Professor Hu was born in 1918. He was Head of Department of Economics of the Chinese University of Hong Kong and Baptist College. The Society would like to send condolences to Professor Hu's family.

As mentioned in the last issue of the Bulletin, I expected that a HKSS member would submit an article on the contributions of the Nobel Laureates in Economics 2003. Professor W.K. Li has submitted his article, and I am indebted to his kind assistance.

Last year, the Korean Statistical Society (KSS) invited our Society to organise a session on risk management in their Autumn Conference. On behalf of the Society, Professor W.K. Li and Dr. Philip Yu attended the Conference during 31 October – 1 November, 2003. Both of them presented their research findings in the session. I may visit Korea too in the next few months for further exchange/collaboration between the KSS and HKSS.

The "Statistical Project Competition for Secondary School Students" has been running smoothly. I am thankful to the Organising Committee for their hard work. The Committee will need many adjudicators for the event, and your assistance to become the adjudicators is very much appreciated.

The Nobel Laureates in Economics: 2003: their contributions

W.K. Li
The University of Hong Kong

The 2003 Nobel prize in Economics was awarded to two distinguished econometricians Professor C.W.J. Granger of the University of California, San Diego and Professor R.F. Engle of New York University. R.F. Engle was also associated with UC San Diego earlier. Actually one may regard both Nobel Laureates as statisticians since the Nobel prize was awarded to them based on their contributions to time series analysis. I will briefly summarize broadly below what contributions these two gentlemen have made to time series analysis and financial econometrics.

First, those of R.F. Engle. In the press release of the Nobel award it is noted that the major contribution of R.F. Engle is to the modeling of time-varying volatility in financial time series. As is well known, there are many ways to define volatility and the variance of the stock return is one possible way. In 1982, Engle published in *Econometrica* the first paper on the so-called, "autoregressive conditional heteroscedasticity (ARCH) model" which can model the time-varying features of volatility which is present in many financial time series. This model can help one to understand better the behaviour of financial series especially in answering questions like: what is the future risk associated with an investment portfolio?, what variables are affecting the volatility of an asset? and what is the future price of an option on an asset, which according to the famous Black-Scholes formula depends on the volatility of the underlying asset? Let R_t be the return of an asset which is usually defined as the log-difference of the asset price, i.e., $R_t = ln\ P_t - ln\ P_{t-1}$, where P_t is the asset price at time t. (For simplicity, the mean of R_t is assumed to be zero and that R_t is uncorrelated over time.) Specifically, an ARCH model of order one (an ARCH(1) model) takes the form

$$R_t = \sigma_t \varepsilon_t$$

where ε_t is independent standard normal with mean 0 and variance

$$\sigma_t^2 = \alpha_0 + \alpha R_{t-1}^2 \qquad (1)$$

Note that σ_t^2 is the conditional variance of R_t given R_{t-1}. Subsequent to the 1982 paper there has been an explosion of papers on generalizations of the ARCH model and applications of these models to financial data. An important generalization is that of Bollerslev (1986) where the conditional

variance at time *t-1* is also involved in the equation for σ_t^2, i.e.,

$$\sigma_t^2 = \alpha_0 + \alpha R_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \qquad (2)$$

Equation (2) is called a generalized ARCH (GARCH) model of order (1,1) or simply a GARCH(1,1) model. The GARCH family and its generalizations can model the following stylized facts of financial returns: (1) the distribution of financial returns usually have a fatter tail than that given by a normal distribution; (2) clustering of high volatility periods and (3) volatility is higher during a bear market than in a bull market (See e.g. Nelson, 1991 and Li & Li, 1996).

As an example, consider the daily closing Hang Seng Index (1980) (Figure 1). Denote the corresponding returns by R_t. A so-called ARCH in the mean model for R_t is given by

$$R_t = \underset{(0.062)}{0.162}\sigma_t^2 + a_t,$$

where (3)

$$Var\,(a_t | a_{t-1}) = \sigma_t^2$$
$$= \underset{(0.0001)}{0.0003} + \underset{(0.1170)}{0.2491}\, a_{t-1}^2$$

That is, a_t is an uncorrelated noise process with an ARCH(1) specification (a_t satisfies equation (1)). Note that here the conditional variance σ_t^2 also serves as an explanatory variable for the return series R_t. The figures in parenthesis are the standard errors. Model (3) is called an ARCH-M or ARCH in the mean (Engle, Lilien & Robins, 1987) model as $0.162\,\sigma_t^2$ is the conditional mean of R_t given R_{t-1}. In other words, using (3) one can predict tomorrow's return based on today's closing return of the HSI. Engle and his collaborators are able to derive a whole series of models and methodologies, like the ARCH-M model, for handling volatility changes. Bollerslev et al. (1994) consists of a comprehensive review.

Because of space, we now turn to the contribution of Professor C.W.J. Granger. The press release for the 2003 Nobel prize award recognized that, "Clive Granger demonstrated that the statistical methods used for stationary time series could yield wholly misleading results when applied to the analysis of nonstationary data. His significant discovery was that specific combinations of nonstationary time series may exhibit stationarity, thereby allowing for correct statistical inference. Granger called this phenomenon cointegration. He developed methods that have become invaluable in systems where short-run dynamics are affected by large random disturbances and long-run dynamics are restricted by economic equilibrium relationships. Examples include the relations between wealth and consumption, exchange rates and price levels, and short and long-term interest rates."

Back in 1974, Granger and Newbold noticed dubious results could exist when fitting regression relationship of the form

$$Y_t = \beta X_t + a_t. \quad (4)$$

where X_t and Y_t are two (possibly nonstationary) economic time series and a_t is zero mean independent identically distributed (i.i.d.) noise process. Specifically, a high R^2 could be observed even if Y_t and X_t should be independent.

Note that if (4) is true then Y_t and X_t on both sides must exhibit similar features. (Otherwise, (4) does not make sense.) For example, if X_t has a (random) "trend" then Y_t must also have a (random) "trend". Equivalently, (4) holds means that there is a β such that

$$Y_t - \beta X_t = a_t.$$

That is, the common feature, the random trend in Y_t and X_t has been removed by the regression (4) because a_t is an *i.i.d.* sequence with no trend. If this is the case we say that X_t and Y_t are cointegrated. An example of cointegration is given in Figures 2 and 3 where the two interest rate series appear to "trend" together and therefore cointegrated.

Granger went further to propose an appropriate model for time series exhibiting cointegration. See for example, Engle and Granger (1987). Such a model is called an error-correction model and has found important applications in testing economic theories such as the hypothesis of purchasing power parity; the permanent income hypothesis; present value theory and the term structure of interest rates.

Granger has in fact made many other contributions to time series analysis. Some of the major ones include the idea of fractional differencing or long memory time series (Granger and Joyeux, 1980). A time series has long memory if the absolute value of its autocovariances sum to infinity. In contrast, the popular stationary autoregressive moving-average models have short memory. The simplest non-trivial long memory time series can be defined as a fractionally differenced process as follows. Let B be the lag operator, $BX_t = X_{t-1}$ and a_t an *i.i.d.* noise process. A long memory time series X_t is given by

$$(1-B)^d X_t = a_t \quad (5)$$

where $|d|<1/2$ and the L.H.S. is interpreted as a power series expansion in B. Granger shows that long memory process can arise as a result of aggregating a large number of heterogenous but short memory autoregressive processes of order one. The possibility of a long memory component in financial time series has been picked up by many researchers resulting in long memory GARCH or Fractionally Integrated GARCH (FIGARCH) models.

Another contribution made by Granger is the concept of Granger causality. Of course, "what is causality?" is a big philosophical question since the time of Plato. Granger's approach is by means of additive prediction power. According to Granger (1969), a time series X_t causes another time series Y_t if Y_t can be better predicted by using past observation of

X_t in addition to past observations of Y_t then by using only past observations of Y_t. Clearly, the concept of Granger causality can be easily extended to study causality relationships of volatility in financial time series. The title of the paper by Hendry and Mizon (1999), "The pervasiveness of Granger causality" suggested clearly the importance and impact of the concept of Granger causality.

Other contributions of Granger include the introduction of bilinear time series models in a 1978 monograph co-authored by A.P. Andersen; improving forecast performances by combining several different forecasts (Granger & Bates, 1969) and spectral analysis of economic time series (Granger & Hatanaka, 1964).

The Department of Statistics and Actuarial Science of the University of Hong Kong is also particularly grateful for having Professor C.W.J. Granger as a keynote speaker in two of the major events organized by the Department back in July, 1999. The first one was the Hong Kong International Workshop on Statistics and Finance (a proceedings was published in 2000 by the Imperial College Press where Professor Granger and his collaborators contributed two articles.) The second one is the Symposium on Financial Risk and Statistics which was held at the Conrad Hotel, Hong Kong, July 1999. Finally, this author is also grateful for having Professor C.W.J. Granger as his Ph.D. thesis examiner back in 1981.

Certainly both gentlemen are well deserved for the 2003 Nobel prize in Economics. The statistics profession has also been given, via these two awardees, the recognition for its contributions to the Society. We look forward to seeing more statisticians receiving recognitions of this kind in future.

References

Bollerslev, T.: 1986, Generalized autoregressive conditional heteroskedasticity, *Journal of Econometrics* **31**, 307-327.

Bollerslev, T., Engle, R.F. and Nelson, D.B.: 1994, ARCH models, *in* R.F. Engle and D.L. McFadden (eds), *Handbook of Econometrics*, Vol. 4, North-Holland, Amsterdam, 2959-3038.

Engle, R.F.: 1982, Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation, *Econometrica* **50**, 987-1007.

Engle, R.F. and Granger, C.W.J.: 1987, Co-integration and error-correction: Representation, estimation and testing, *Econometrica* **55**, 251-276.

Engle, R.F., Lilien, D.M. and Robins, R.P.: 1987, Estimating time-varying risk premia in the term structure: The ARCH-M model, *Econometrica* **55**, 391-407.

Granger, C.W.J.: 1969, Investigating causal relations by econometric models and cross-spectral methods, *Econometrica* **37**, 424-438.

Granger, C.W.J. and Andersen, A.P.: 1978, *Introduction to Bilinear Time Series Models*, Vandenhoeck and Ruprecht, Gőttingen.

Granger, C.W.J. and Bates, J.: 1969, The combination of forecasts, *Operations Research Quarterly* **20**, 451-468.

Granger, C.W.J. and Hatanaka, M.: 1964, *Spectral Analysis of Economic Time Series*, Princeton University Press, Princeton, NJ.

Granger, C.W.J. and Joyeux, R.: 1980, An introduction to long-memory time series models and fractional differencing, *Journal of Time Series Analysis* **1**, 15-30.

Granger, C.W.J. and Newbold, P.: 1974, Spurious regressions in econometrics, *Journal of Econometrics* **2**, 111-120.

Hendry, D.F. and Mizon, G.E.: 1999, The Pervasiveness of Granger Causality in Econometrics, *in* R.F. Engle and H. While (Eds.), *Cointegration, Causality and Forecasting*, Oxford University Press, pp.102-134.

Li, C.W. and Li, W.K.: 1996, On a double threshold autoregressive heteroscedastic time series model, *Journal of Applied Econometrics* 11, 253-274.

Nelson, D.B.: 1991, Conditional heteroskedasticity in asset returns: A new approach, *Econometrica* **59**, 347-370.

Figure 1. HSI 1980 log of daily closing

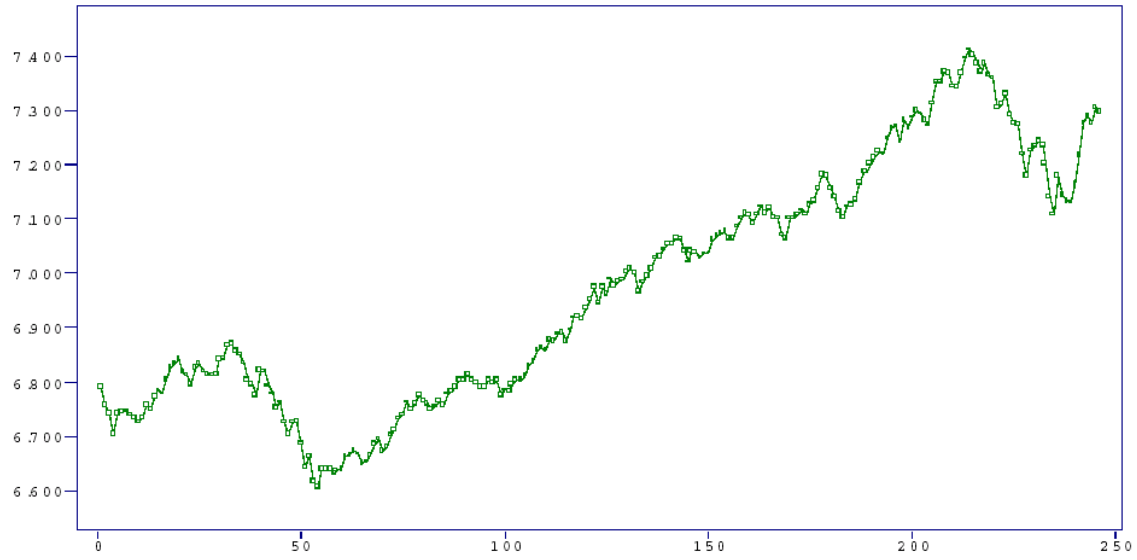


Figure 2. Centered Logarithms of US Federal Fund Rate

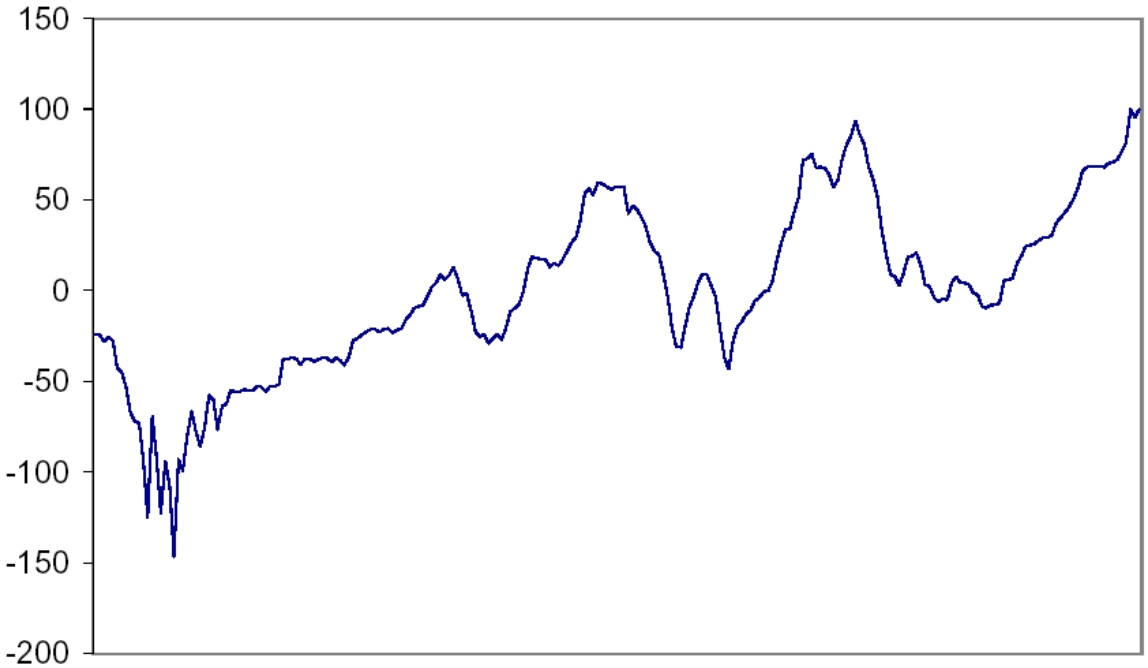
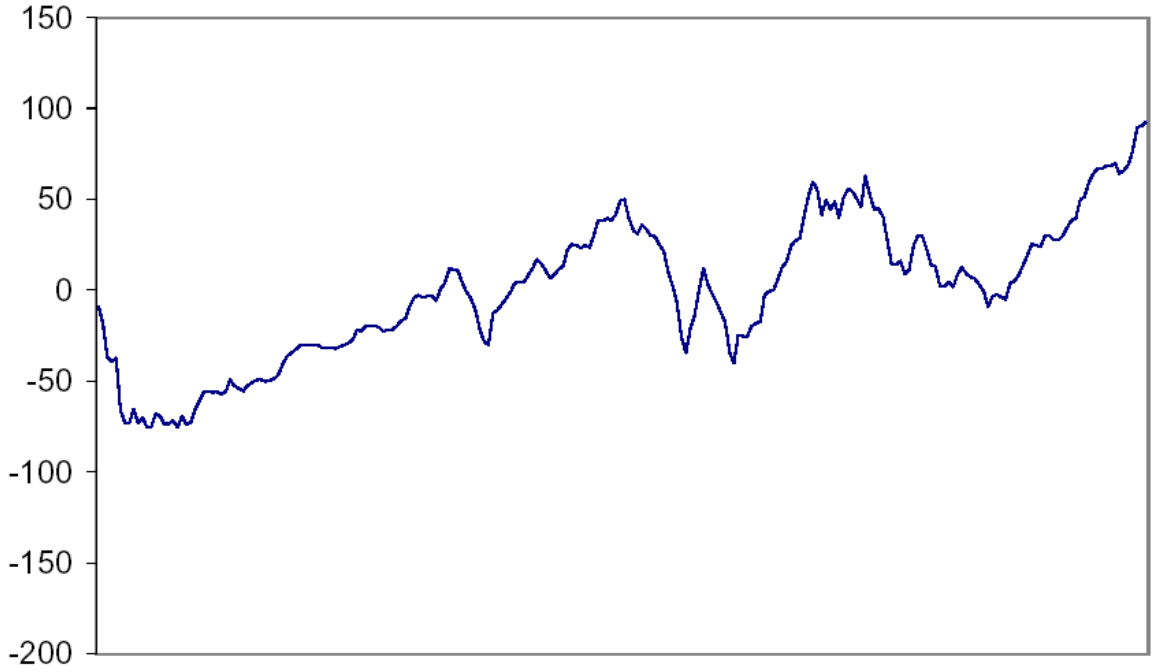


Figure 3. Centered Logarithms of 90-day US Treasury Bill Rate



The 2003 Autumn Conference of the Korean Statistical Society

W.K. Li and Philip Yu
The University of Hong Kong

As a major statistical society in Asia the Korean Statistical Society holds a Spring and an Autumn conference in Korea each year. In 2003, the Autumn conference was held at the Seoul National University from October 31st to November 1st. This time there were two international sessions in addition to the 21 other local sessions. One of the international sessions was focused on multivariate statistics and the other was focused on statistical risk management. The Hong Kong Statistical Society was invited to organise the session on risk management. Three speakers were arranged in that session. Dr. Philip Yu of HKU delivered a paper on estimating value-at-risk using GARCH models (a joint paper with Dr. Mike So of HKUST); Dr. S. Kim of Chung-Ang University, Korea, delivered a paper on modelling threshold-asymmetric ARCH time series via random power transformation, and Professor W.K. Li of HKU delivered a paper on value-at-risk models (a joint paper with S. Jin and P. Yu). The conference also featured the Ilsong Lecture which was delivered by Professor Fujikoshi of the Hiroshima University of Japan. Professor Fujikoshi is a world renowned statistician and he spoke on multivariate analysis for the case when the dimension is large compared to the sample size. As its president, Professor Fujikoshi also represented the Japan Statistical Society. There were some 300 participants from Korea and the risk management session was well received. Unfortunately, the local sessions were mostly delivered in Korean. Nevertheless, a few of these had been very well prepared so that we had no difficulties in understanding the speakers. Our Korean hosts were very kind and took very good care of us. We were given a warm welcome by Professor Woochul Kim, the President of the Korean Statistical Society, Professor Young Il Kim, the Director of Planning and Business, and other members of the Board of Directors of the Society. We have made many Korean friends and we expect that there will be more exchanges between HKSS and KSS in the future. We took this opportunity to thank the Korean Statistical Society for their invitation and hospitality.

After the session on risk management

At the Conference dinner

Two aliens in Seoul

Statistical Project Competition for Secondary School Students

Organizing Committee for the 2003/04 Statistical Project Competition

Since 1986/87, the Statistical Project Competition (SPC) for Secondary School Students has been an annual event of the Hong Kong Statistical Society (HKSS). The SPC aims at promoting a sense of civic awareness and encouraging students to understand the local community in a scientific and objective manner through the proper use of statistics. All students attending Secondary 3 to 7, or studying at equivalent educational levels, in schools are eligible to enter. The SPC is divided into two Sections, namely, "Junior Section for Secondary 3 to 5 students" and "Senior Section for Secondary 6 and 7 students".

Briefing seminar and exhibition of past winning projects

This year's SPC is its 18th round. To help participants prepare for the SPC, three identical sessions of briefing seminar and exhibition of past winning projects were held on 22 November 2003 at the City University of Hong Kong. More than 600 teachers and students attended the event.

In each briefing session, Prof. Tony FUNG, the HKSS President / Mr. K C LEUNG, the HKSS Vice-President presented an opening address and briefed participants of the SPC. Ms Teresa NG of the City University of Hong Kong, the Chief Adjudicator of this year's SPC, explained details about the adjudication process/criteria, and highlighted some remarks based on reports submitted in past years. Representatives from the Census and Statistics Department introduced major issues in data analysis and presentation, sources and channels of obtaining official statistics. At the end of each session, winning teams of the 2002/03 SPC were invited to share with participants their valuable experience in preparing for their statistical reports.

Selected topic of the thematic project for the 2003/04 SPC

Participants may opt to work on a special theme in order to compete for the "Hang Seng Bank Prize for the Best Thematic Project". The selected topic of the thematic project for this round is "Hong Kong is a knowledge-based society".

Submission of reports and announcement of results

For this round of SPC, the deadline for submission of entries is 28 February 2004. All participants will be informed of the results of the SPC in April 2004. The prize presentation ceremony will be held on 24 April 2004.

Further details of the 2003/04 SPC can be found at the HKSS website (http://www.hkss.org.hk).

News

University of Hong Kong

The University of Hong Kong has decided to re-locate its Department of Statistics and Actuarial Science from the Faculty of Social Sciences to the Faculty of Science, effective from July 1, 2004. The Department however will continue its teaching commitment in, and research collaboration with, the Social Sciences Faculty.

The Actuarial Science students of all years will be enrolled in the Faculty of Science, starting form July 1. The current statistics students will complete their BSS(Stat) degree in the Faculty of Social Sciences.

From 2004-05, students will be able to study statistics at HKU through different programmes as follows:

a) B.Sc. - Statistics programme, with the option of selecting the Risk Management Theme after admission.

b) B.Sc. - Statistics programme, with a Major in either (i) Statistics or (ii) Risk Management, and with a complementing Major or Minor in the Faculty of Science, Social Sciences, or any other faculty where Major/Minor options are available.

c) B.Soc.Sc. in Social Sciences Faculty, and choosing Statistics or Risk Management as one of the Majors.

Professor Hu Hsiao-Sheng (1918-2004)

Professor Hu Hsiao-Sheng passed away on 7 February, 2004, at the age of eighty-five. He was one of the oldest members of the Society. Professor Hu was born in Fu Zhou, China. He graduated at Xia Men University, China and finished his postgraduate study in USA. Professor Hu was Head of Department of Economics at the Chinese University of Hong Kong and Baptist College.