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Hong Kong Statistical Society
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Bulletin
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Editor's Foreword

This is the first Bulletin of 2007 and is an extremely fruitful one, in which we have summaries for two workshops held in January and February. We would like to express our special thanks to our contributors, C.W.L. Kwan, Raymond Wong and Elsa Lee for their articles. Nevertheless, I would urge you members to contribute some articles for this Bulletin, or, you may inform us some interesting news in statistics.

For this issue, as usual, we have our President's Forum. C.W.L. Kwan gives us a summary on the International Workshop on Econometric Time Series held on 15-16 January at the University of Hong Kong. This workshop was jointly organized by Department of Statistics and Actuarial Science, the University of Hong Kong, the Hong Kong Statistical Society and Department of Econometrics and Operational Research, the Free University of Amsterdam to celebrate the 30th Anniversary of the Hong Kong Statistical Society. Further, the Hong Kong Statistical Society 30th Anniversary Workshop was held on 10 February at the International Finance Centre and Raymond Wong gives us a summary of these talks.

In view of the growing need for statistics relating to globalization of the world economy, the Census and Statistics Department has been conducting studies on the framework for compiling "foreign affiliates trade in services (FATS)" statistics, Elsa Lee introduces the effort and criteria of C&SD made.

Lastly, we are proud to announce in the News that the **Guy Medal** in Silver 2007 was awarded to Professor Howell Tong for his many important contributions. **Congratulations to Professor Howell Tong!**

L.K. Li

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President's Forum

Professor Tony W.K. FUNG

Time flies. I have been the President of the Society for four terms and it is coming to the end.

The Society was founded in 1977 and this year is the 30th Anniversary of the Society. Two workshops have been organized to celebrate the Anniversary. The first one is "International Workshop on Econometric Time Series" which was held on January 15-16, 2007 at the University of Hong Kong. The second workshop entitled "Statistics in Finance and Economics" was held on February 10, 2007 at International Finance Centre in Hong Kong. There were 16 speakers and altogether over 100 participants attended the workshops. I am thankful to Drs Chi-Wai Kwan and Raymond Wong, the University of Hong Kong, for kind assistance in writing reports of the workshops.

As another event to celebrate the 30th Anniversary, the Society together with Department of Applied Mathematics, the Hong Kong Polytechnic University will co-organise a seminar to be delivered by Professor Sir Clive Granger, Nobel Laureate in Economics in 2003. Sir Granger will visit Hong Kong in mid May 2007 and will give one to two lectures. Members will be informed more details about the lectures.

I would like to share with you the exciting news that the Guy Medal in Silver 2007 of the Royal Statistical Society (UK) is awarded to Professor Howell Tong for his many important contributions to time series analysis over a distinguished career, and in particular for his fundamental and highly influential paper "Threshold autoregression, limit cycles and cyclical data", read to the Society in 1980, which paved the way for a major body of work in non-linear time series modelling. Professor Tong is the past president of our Society, and was the Pro Vice-Chancellor of the University of Hong Kong. Congratulations, Howell !!

I would like to take this opportunity to express my gratitude to the Council Members, Leslie Tang (Vice President, C&SD), Howard Wong (General Secretary, C&SD), Raymond Tam (Treasurer, IVE), Teresa Ng (Programme Secretary, City U), Leong-Kwan Li (Publications Secretary, Poly U), Raymond Wong (Membership Secretary, HKU) and Man-Lai Tang (Consultation Services Secretary, Baptist U) and many other members of the Society for their strongest assistance and support during my term as the Society's President.

International Workshop on Econometric Time Series

C W Kwan
The University of Hong Kong

Introduction

An international workshop on Econometric Time Series was held on January 15-16, 2007 at the University of Hong Kong to celebrate the 30th Anniversary of the Hong Kong Statistical Society. The workshop was jointly organized by Department of Statistics and Actuarial Science, University of Hong Kong, Hong Kong Statistical Society and Department of Econometrics and Operational Research, Free University of Amsterdam. The following talks were presented.

- An Introduction to State Space Modelling in Econometrics
  Mr S Y Wong (Free University of Amsterdam)
- Testing for Change Points in Time Series Models and Limiting Theorems for NED Sequences
  Professor Shiqing Ling (HKUST, Math)
- Mixed Portmanteau Tests for Time Series Model
  Professor Heung Wong (HKPU, Appl. Math)
- Value at Risk Estimation Using ICA-GARCH Models
  Mr Edmond Wu (HKU, Statistics and Actuarial Science)
- On Business Cycle Extraction Methods
  Mr S Y Wong (Free University of Amsterdam)
- LAD Estimation for Unit Root Processes with GARCH Errors
  Mr Guodong Li (HKU, Statistics and Actuarial Science)
- Optimization Programs for Rare Event Simulation
  Professor Ad Ridder (Free University of Amsterdam)
- A Multivariate Threshold Stochastic Volatility Model
  Professor Mike So (HKUST, Information and Systems Management)
- Life Cycle Effects of Fertility on Parents' Labor Supply
  Dr Jim Vere (HKU, Econ & Fin)
- On Term Structure Modelling
  Mr Max Mallee (Free University of Amsterdam)
- Measuring the Impact of a Railroad on Interregional Trade Barrier Using a Natural Experiment Approach
  Dr Z Li (HKU, Econ & Fin)

- On Threshold ARCH Models with Gram-Charlier Density
  Mr Xuan Zhou (HKU, Statistics and Actuarial Science)

Over 60 people including myself attended the workshop. The talks that were of interest to me are summarized below.

Summary of selected topics

An Introduction to State Space Modelling in Econometrics

S Y Wong (Free University of Amsterdam)

The state space model provides a flexible approach to time series analysis, especially for simplifying maximum likelihood estimation and handling missing values. For a time series $\{y_t\}$, the linear Gaussian state space model is defined by the state equation and observation equation. The state equation is defined as

$$\alpha_{t+1} = T_t\alpha_t + R_t\zeta_t,\ \zeta_t \sim \text{NID}(0,Q_t),$$

and the observation equation is defined as

$$y_t = Z_t\alpha_t + \varepsilon_t,\ \varepsilon_t \sim \text{NID}(0,G_t),$$

where the initial state distribution, the series α_1 is assumed to follow a normal distribution $N(a_1, P_1)$, ζ_t and ε_s independent for all t, s, and independent from α_1. Observation y_t can be multivariate. The state vector α_t is unobserved. System matrices T_t, Z_t, R_t, Q_t, G_t determine the structure of the model. Many time series model can be expressed in terms of state space model, such as regression with time varying coefficients, ARMA model and unobserved components models.

It was shown that the computation time in estimating an ARMA(1,1) process was reduced a lot when it was in state space form. The following table shows the computing time in seconds for the maximum likelihood (ML) estimates of the ARMA(1,1) process estimated by multivariate normal distribution (MN) and by state space model (SS), where n is the number of observations in the time series.

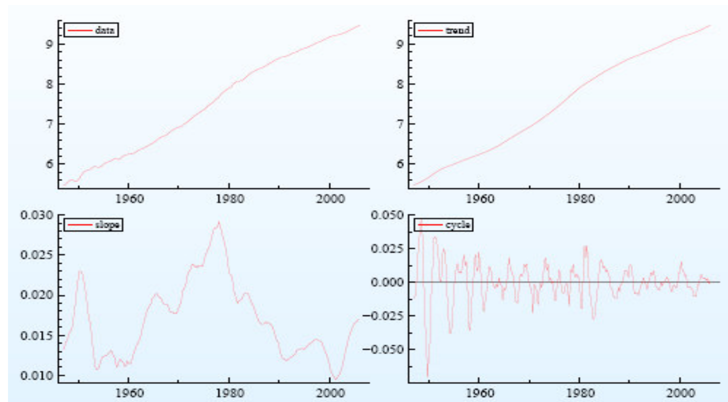
n	500	1000	2000	5000	10000
MN (ML)	0.140	0.562	4.672	229.250	1747.860
SS (ML)	0.016	0.031	0.063	0.140	0.281

Two types of inference of the state from the data and the model were discussed which were the Kalman filter and Kalman smoother. The Kalman filter calculates the mean and variance of the unobserved state, given the observations. The state is Gaussian and thus, the complete distribution is characterized by the mean and variance. The filter is a recursive algorithm in which the current best estimate is updated whenever a new observation is obtained. To start the recursion, we need a_1 and P_1, which are assumed given. However, there are various ways to initialize when a_1 and P_1 are unknown. The Kalman filter calculates the mean and variance conditional on Y_t while on the other hand, the Kalman smoother calculates the mean and variance conditional on the full set of observations Y_n. After the filtered estimates are calculated, the smoothing recursion starts at the last observations and runs until the first.

In the state space model, missing observations are very easy to handle in Kalman filtering. The filter algorithm extrapolates according to the state equation until a new observation arrives. The smoother interpolates between observations. Forecasting requires no extra theory in which we just treats the future observations as missing. The system matrices in a state space model typically depend on a parameter vector. Since the model is completely Gaussian, we could estimate by the maximum likelihood.

Diagnostic checking is based on the analysis of the standardized residuals which is assumed to follow NID(0,1). One could apply standard test for normality, heteroscedasticity and serial correlation. A recursive algorithm is available to calculate smoothed disturbances (auxillary residuals), which can be used to detect breaks and outliers. Likelihood based procedures, LR test, AIC, BIC, could be used for model comparison and evaluating parameter restrictions.

The state space model was illustrated by the logarithm of the US Gross Domestic Product which was obtained quarterly and was seasonally adjusted, from Jan 1947 to Jan 2006. A model with trend-cycle was considered in which the observed GDP was consisted of a trend component and a cycling component. The following figure shows the observed GDP, the extracted trend, slop and cycle. It was shown that the business cycle is 3.746 years.



Testing for Change Points in Time Series Models and Limiting Theorems for NED Sequences

Shiqing Ling (HKUST, Math)

Modelling and predicting the change points in time series is important and useful, particularly in financial time series in which one could predict a potential drop of stock prices and in risk management. This talk first established a strong law of large numbers and a strong invariance principle for the forward and backward sums of the near-epoch dependent (NED) sequences. Used these limiting theorems, the author develops a general asymptotic theory on the Wald test for change points in a general class of time series models under no change-point hypothesis. As an application, the author verifies the assumptions for the long-memory fractional ARIMA model.

For the observed data y_t, the hypotheses adopted to test for the change points in time series are given as,

$$\text{H}_0\text{:}\quad y_y = \phi X_t + \varepsilon_t$$

$$\text{H}_1\text{:}\quad y_t = \begin{cases} \phi X_t + \varepsilon_t & t = 1,\ldots,k \\ \phi_1 X_t + \varepsilon_t & t = k+1,\ldots,n \end{cases},$$

where $\{(X_t, \varepsilon_t)\}$ are i.i.d. The LR-, LM- or Wald-test statistics were derived. If k is given, one could use the Chow (1960) type test or Quandt (1960) type test. However, the critical values are hard to obtain. Two ways to overcome the difficult is (a) to use the edges of unknown change-point interval (James, et al, 1987; Hawkins, 1987; Hansen, 2002; Andrews, 1993 and Bai and Perron, 1998) and (b) to normalize the Quandt-type test which is a Darling-Erdos-type limit (Yao and Davis, 1986; Horváth, 1993, 1995).

The Quandt-type test was extended to time series models (Davis, Huang and Yao, 1995). The test statistics were

$$S_n(k) = \Omega_k\left(\frac{1}{\sqrt{k}}\sum_{t=1}^{k} y_{t-1}\varepsilon_t\right)^2 + \Omega_{nk}^*\left(\frac{1}{\sqrt{n-k}}\sum_{t=k+1}^{n} y_{t-1}\varepsilon_t\right)^2 - \Omega_k\left(\frac{1}{\sqrt{n}}\sum_{t=1}^{n} y_{t-1}\varepsilon_t\right)^2$$

where $\Omega_k = \frac{1}{k}\sum_{t=1}^{k} y_t^2$ and $\Omega_{nk}^* = \frac{1}{n-k}\sum_{t=k+1}^{k} y_t^2$.

To use this method to time series models, one encounters some great challenges. Firstly, one needs to obtain the rate of uniform convergence of the partially sample information matrices based on $\{y_1, \ldots, y_k\}$ and $\{y_{k+1}, \ldots, y_n\}$, respectively, that is, for some $d>0$ it follows that

(a) $\max_{g_n \le k \le n}\left|\frac{1}{k^{1-\delta}}\sum_{t=1}^{k} X_t\right| = o_p(1)$ and

(b) $\max_{g_n \le \tilde{k} \le n}\left|\frac{1}{\tilde{k}^{1-\delta}}\sum_{t=k+1}^{n} X_t\right| = o_p(1)$.

As $n \to \infty$, where $\tilde{k} = n-k$, $g_n = \log\log\log\left(\max\{e^e, n\}\right)$ and $X_t = y_{t-1}^2 - Ey_{t-1}^2$. Secondly, one needs to approximate the score functions based on the subsamples $\{y_1, \ldots, y_k\}$ and $\{y_{k+1}, \ldots, y_n\}$ by the i.i.d. normal random sequences $\{G_{1t} : t = 1, 2, \ldots\}$ and $\{G_{2t} : t = 1, 2, \ldots\}$, respectively, such that

(c) $\max_{g_n \le k < n} k^{\delta}\left|\frac{1}{\sqrt{k}}\sum_{t=1}^{k} y_{t-1}\varepsilon_t - \frac{1}{\sqrt{k}}\sum_{t=1}^{k} G_{1t}\right| = o_p(1)$

(d)
$$\max_{g_n \le k < n} k^{\delta}\left|\frac{1}{\sqrt{k}}\sum_{t=-k}^{-1} y_{t-1}\varepsilon_t - \frac{1}{\sqrt{k}}\sum_{t=-k}^{-1} G_{2t}\right| = o_p(1)$$

for some $\delta > 0$.

For (a) – (d), one needs a new strong law of large numbers (SLLN) and a new strong invariance principle (SIP) for the backward sums of near-epoch dependent (NED) sequences. The author proved two theorems for the SLLN and SIP. Let $\{\varepsilon_t\}$ be a series of independent r.v. vectors, $F_t = \sigma\{\varepsilon_t,$

ε_{t-1}, …} and X_t be a F_t-measurable $m \times 1$ random vector.

Theorem 1. Let $\{X_t : t = 0, \pm1, \dots\}$ be $L^{1+\iota}(\nu)$ NED and $EX_t = 0$ in terms of $\{\varepsilon_t\}$ with $\iota > 0$ and $\nu > 0$. Then there exists a constant $\delta > 0$ such that

$$\text{(a)}\quad \frac{1}{k}\sum_{t=1}^{k} X_t = o\left(1\frac{1}{k^{\delta}}\right) \quad a.s.$$

$$\text{(b)}\quad \frac{1}{k}\sum_{t=-k}^{-1} X_t = o\left(1\frac{1}{k^{\delta}}\right) \quad a.s.$$

Theorem 2. Let X_t be a martingale difference in terms of F_t with and be $L^{2+\iota}(\nu)$ NED in terms of $\{\varepsilon_t\}$ with $\iota > 0$, where $2\nu > 1$ or $2\nu = 1$ and here exist constants $\nu_1 > 0$ and $\iota_1 > 0$ with $2\nu_1 > 1$ such that

$$\sup_{-\infty<t<\infty} \left\| E[X_t \mid F_{k+1}(1)] - E[X_t \mid F_k(t)] \right\|_{2+\iota_1} = O\left(k^{-\nu_1}\right).$$

Then, without changing its distribution, one can redefine $\{X_t\}$ on 2 richer probability spaces together, respectively, with i.d. $m \times 1$ normal vectors with mean zero and covariance matrix Ω, $\{G_{1t}\}$ and $\{G_{2t}\}$, s.t. for some constant $\delta > 0$,

$$\text{(a)}\quad \sum_{t=1}^{k} X_t = \sum_{t=1}^{k} G_{1t} + O\left(k^{\frac{1}{2}-\delta}\right) \quad a.s.$$

$$\text{(b)}\quad \sum_{t=-k}^{-1} X_t = \sum_{t=1}^{k} G_{2t} + O\left(k^{\frac{1}{2}-\delta}\right) \quad a.s.$$

To test for H_0, the author defined the Wald test statistic and the normalized Quandt-type Wald test statistic. Based on the theorems, the author shows that, under specific assumptions and under the null hypothesis, for any $x \in R$,

$$P\left[\hat{W}_n(m) \le x\right] \rightarrow \exp\left(-2e^{-x/2}\right) \quad \text{as } n \rightarrow \infty$$

where $\hat{W}_n(m)$ is the normalized Quandt-type Wald test statistic.

The author applied to and derived the test for long-memory FARIMA models. For a FARIMA(p,d,q) model, under specified assumptions and under H_0, for any x,

$$P\left[\hat{W}_n(p+q+1) \le x\right] \rightarrow \exp\left(-2e^{-x/2}\right) \quad \text{as } n \rightarrow \infty.$$

The performance of the Wald test in finite samples was evaluated by conducting a small simulation for the FARIMA(0,d,0) model. When n = 250, the simulated sizes were very nice at the 0.01 level and were acceptable at the 0.05 level, but they were quite conservative at the 0.1 level. When n was increased to 400, all simulated sizes were nice and close to the nominal levels. Powers increased when n increased from 250 to 400. When $k = [0.9n]$, the powers were lower than those when $k = [0.5n]$.

Optimization Programs for Rare Event Simulation

Ad Ridder (Free University of Amsterdam)

There are events whose probability of occurrence is small, 10^{-6} or smaller, and thus the probability is difficult to calculate exactly.

One could, however, estimate by approximations or simulations.

Consider a random variable X with density h and suppose $\ell(\gamma)$ = P(X>γ) is estimated by simulation, where γ>>E(X). The crude Monte Carlo (CMC) approach is defined as (1) generating X using h, (2) checking if $X>\gamma$ and then (3) repeating until sufficiently times of 'yes'. The performance of CMC is poor as the sample size is O(1/ℓ) where $\ell \to 0$ as $\gamma \to \infty$.

An improved approach is Importance Sampling (IS). IS is implemented by shifting the probability mass of h to the tail by introducing a new density f in which one considers

$$P_h(X > \gamma) = E_h\left(1_{\{X>\gamma\}}\right) = E_f\left[\frac{h(X)}{f(X)}1_{\{X>\gamma\}}\right].$$

Under IS, one (1) generates X using f, (2) check if $X>\gamma$, (3) computes the likelihood ratio $h(X)/f(X)$ and then (4) repeats until sufficiently many 'yes'. Considering a rare event following an exponential distribution, after repeating for 5000 times in a simulation, it has been shown that there were no occurrence of the rare event under CMC while there were 1835 observations under IS and hence the probability of the rare event could be estimated by IS but not CMC under the same sample size.

Both CMC and IS estimates are unbiased. The performance of the estimates could be compared in terms of the variances. A sufficient condition for the fact that the variance of IS estimate is less than the CMC estimate is that $L(X) = h(X)/f(X) \leq 1$. Therefore, selecting the IS-density f could be based on variance minimization. Let the IS-estimator $Y^* = L(X)1_{\{X \in A\}}$. One could solve for f for $\inf\{E_f[(Y^*)^2] : f \in F\}$ where F is a set or class of density functions for the random variable X. Different methods are available for variance minimization including finite differences, stochastic approximation, simultaneous perturbations, score function.

Another approach is the Cross-entropy (CE) in which one consider f^*, the optimal zero-variance density for X given as $f^*(x) = \frac{1_{\{x \in A\}}h(x)}{\ell(x)}$. To find f^*, one could consider Kullback-Leibler method, stochastic approximation, minimum Cross-Entropy (minXent).

The CMC and IS methods were applied to a queueing example. For the same rare event, the CMC method required 20,000 to 200 million cycles while the IS approach required ~700 cycles.

A Report on the 30th Anniversary Workshop of the Hong Kong Statistical Society

Raymond Wong
The University of Hong Kong

Introduction

The workshop was held on 10 Feb 2007 at Two International Finance Centre in Hong Kong to celebrate the 30th anniversary of the Hong Kong Statistical Society and was organized by the Society and the Hong Kong Institute for Monetary Research. Over 50 people attended the workshop.

Four speakers were invited to present talks on various statistical topics. They are:

Speaker: Mr. Fung, Hing-Wang (Census and Statistics Department).
Title: Developments in Economic and Financial Statistics of Hong Kong

Speaker: Prof. Lam, Kin (Hong Kong Baptist University).
Title: How Bayesian inference may induce excess volatility, underreaction and overreaction in financial markets

Speaker: Miss Zhao, Kathryn (Deutsche Bank).
Title: Significance of Volume in Achieving VWAP

Speaker: Prof. Li, Wai-Keung (presented by Dr. Yu, L.H.) (The University of Hong Kong).
Title: On Some Models for Value at Risk

Summary of the speeches

Developments in Economic and Financial Statistics of Hong Kong
H W Fung

The official statistical system of Hong Kong has continuously evolved over time to meet statistical needs of the community, albeit it is already quite comprehensive and of a standard comparable to those of the advanced economies. Besides compiling the more conventional statistics, the Census and Statistics Department has achieved some breakthroughs in the developments of certain new areas of statistics to support informed analysis and decision-making on matters relevant to the continuous economic development of Hong Kong.

The topics to be discussed in this talk aim at underscoring some major developments in economic and financial statistics of Hong Kong in the process of globalization. In particular, statistics on asset management are to be compiled to support Hong Kong's further development into a major international asset management centre in the region.

Asset management is seen as a rising star in the financial market of Hong Kong. Hong Kong has now evolved into both a leading international financial centre and the premier capital formation centre for the Mainland, attributable to a number of competitive advantages of Hong Kong. Hong Kong's stock market is perhaps one of the hottest topics in town in recent months. With a market capitalisation of HK$ 13.3 trillion as at end 2006, Hong Kong's stock market has overtaken Deutsche Borse and Toronto Stock Exchange to become the 6th largest in the world and remain the 2nd largest in Asia in terms of market capitalisation. The Fund Management Activities Survey conducted by the Securities and Futures Commission (SFC) has indicated that the combined fund management business in Hong Kong amounted to some HK$ 4,526 billion as at end 2005, which was about 2 to 3 times of the GDP in 2005, and represented more than 50% growth over the past two years.

As an open economy without restrictions on foreign investment and external trade, Hong Kong has attracted a large number of foreign affiliates to set up businesses in Hong Kong for the production of goods and services. Foreign affiliates trade in services (FATS) statistics are therefore very useful for better understanding the economic contribution of foreign affiliates in Hong Kong. The first set of inward FATS statistics for 2004 has been compiled and released via a feature article in the October 2006 issue of *Hong Kong Monthly Digest of Statistics*. The inward FATS statistics cover a range of operating characteristics of the inward foreign affiliates like employment, value added and compensation of employees. From the inward FATS statistics, we can also see that foreign affiliates generally perform better than local firms in terms of labour productivity because a higher output, measured by value added, is generated by a smaller labour input, measured by staff employed. It is particularly so for the construction industry where foreign affiliates only employed 9% of workers of the industry but generated 27% of value added in 2004, indicating that foreign affiliates have superior technology and know-how than local firms to secure a better rate of return.

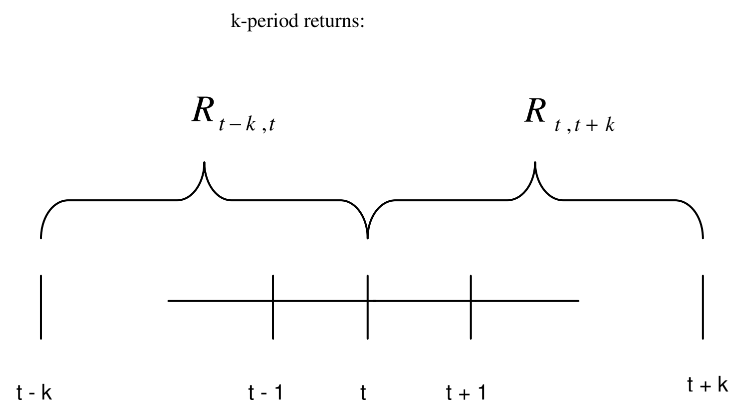
On the other hand, globalization brings about challenges to the compilation of statistics on cross-border capital flows, and international effort to enhance data quality of relevant statistics is highlighted. Moreover, in light of the importance of tourism to Hong Kong's economy as well as the development of Hong Kong towards being a knowledge-based and innovation-driven economy, statistical developments in these areas are also discussed.

Final concluding remarks are: Census and Statistics Department will closely monitor and actively respond to statistical needs arising from ongoing economic developments of Hong Kong and will continue to monitor and address statistical needs arising from economic integration of Hong Kong with the Mainland. They will continuously keep abreast of the international standards and practices in compiling and disseminating official statistics and make sure that our statistical system does not fall short in meeting the requirements for enhancing Hong Kong's status as an international business and financial centre.

How Bayesian inference may induce excess volatility, underreaction and overreaction in financial markets

Kin Lam, (joint work with Taisheng Liu, Wing-Keung Wong)

The talk develops a formal model of weights assignment in a pseudo Bayesian approach induced by investors' behavioural biases. Since Stock prices are determined by earnings and earnings are random and hence markets are volatile. However, market is much more volatile than that explained by earning volatility, this is called excess volatility. Overreaction is the case when loser stocks out-perform winner stocks (three-year formation period and three-year testing period), while underreaction is the case when winner stocks out-perform loser stocks (six month formation period & six month testing period). Overreaction happens in the long-run, i.e. correction may take a long time to be realized. In short-to-medium-run, there may be underreaction. Under-and-overreaction can be expressed in terms of autocorrelation. The following shows the autocorrelation time diagram.



Auto-correlation $Corr(R_{t-k,t}, R_{t,t+k})$

= first order auto-correlation of k-period return < 0 (for large k)

The proposed model is structured as below:

(1) Economic structure: earnings follow a random walk, i.e.

$$N_t = N_{t-1} + y_t$$

Where $y_t \sim N(\mu;\sigma_y^2)$

(2) Investor's belief: he has complete knowledge of the economic structure, except that μ is unknown and has to be estimated from data. In the beginning, μ has a vague prior and

(3) Bayes' law:

Likelihood:

$$L(\mu)=\prod_{i=1}^{t} L\left(y_{t-i+1} \mid \mu\right)$$

Posterior distribution:

$$P\left(\mu \mid y_1, \ldots, y_t\right) \propto \prod_{i=1}^{t} L\left(y_{t-i+1} \mid \mu\right)$$

Besides, instead of placing equal weights to all observations in the model, the investor attaches different weights to past observations, these weights represent investors' cognitive biases, say ω_1 to observation y_t, ω_2 to observation y_{t-1}, and etc. With the pseudo Bayesian approach, we have

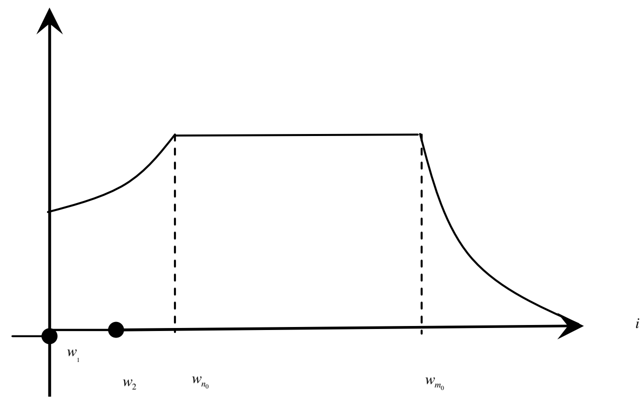
Pseudo likelihood:

$$L(\mu)=\prod_{i=1}^{t} L\left(y_{t-i+1} \mid \mu\right)^{\omega_i}$$

Posterior distribution:

$$P\left(\mu \mid y_1, \cdots, y_t\right) \propto \prod_{i=1}^{t} L\left(y_{t-i+1} \mid \mu\right)^{\omega_i}$$

Weights induced by investors' conservatism and representative heuristics are assigned to observations in the earning shocks of stock prices as an illustration in the following diagram.



The prices and returns in the model are

Prices: $$P_t=\frac{N_t}{r}+\frac{(1+r)}{r^2} \frac{w_t y_1+\ldots+w_1 y_t}{s_t}$$

where

$$s_t=w_1+w_2+w_3+\ldots\ldots+w_t$$

One period return: $R_{t+1}=P_{t+1}-P_t$

k - period return: $R_{t+k}=P_{t+k}-P_t$

The final concluding remarks are that this quantitative behavioural model enables us to deduce the followings. (1) Market volatility will result from investor' biased heuristics. The more conservative/representative are the heuristics, the more volatile is the market. (2) Investors' behavioural biases give rise to short-term underreaction and long-term overreaction in the market. The more conservative/representative are the heuristics, the larger is the return auto-correlation, and the larger is the momentum/contrarian trading profit. (3) Investors' behavioural biases induce a magnitude effect in the under-and-overreaction phenomena, i.e. the more severe is the earning shock, the larger is the market autocorrelation and the larger is the momentum/contrarian trading profit. (4) The magnitude effect described in (3) is convex in nature.

Significance of Volume in Achieving VWAP
Zhao, Kathryn

Algorithmic trading is placing a buy or sell order of a defined quantity into a quantitative model that automatically generates the timing of orders and the size of orders based on goals specified by the parameters and constraints of the algorithm. Algorithms are to anticipate volume curves, react dynamically to complex market signals, and trade with stealth to minimize market impact and trading costs.

The Volume Weighted Average Price (VWAP) strategy is probably the most heavily used algorithm in electronic trading of equities. VWAP aims to achieve an average execution price based on the VWAP benchmark over a user-defined time period, spreads the order proportionally to the historical volume distribution, actively tracks the market movement and adjusts the price and quantity of live submissions and can dynamically adapt itself to changes of volumes. Traders' performance is usually measured by how far away their executions are from the VWAP.

The proposed methodology for modeling volume curves based on historical market data is one that requires statistical clustering followed by mathematical smoothing. In addition, instead of using the Average Daily Volume (ADV) in predicting daily volume, the author considers autoregressive models plus weekly seasonality to explore a better proxy for daily volume. Long memory effect of the error term ε is also incorporated into the model.

The adapted methodology for trading illiquid equities is fixed effect regression on panel data and the final model is the following partial adjustment model:

$$P_{t+1} - P_t = \alpha(P_t - VWAP) + \beta + \varepsilon_{t+1} \quad ,$$

where α and β are fixed unknown parameters in the model.

The conclusions are that volume curves are crucial for achieving the VWAP benchmark, clustering is needed to avoid volume noises, predicted daily volume is a better input into algorithms than traditional ADV, illiquid stocks require special treatment. That is, separating illiquid stocks from their liquid counterparts, substantial improvements are possible for the existing VWAP strategies to achieve their benchmarks.

On Some Models for Value at Risk

W. K. Li and P. L. H. Yu (joint work with S. Jin)

In recent years, value-at-risk (VaR) has become the standard tool for market risk measure and management. To estimate VaR accurately, the academia introduced different approaches and methods. The first important development is RiskMetrics (J.P. Morgan, 1994). This approach assume that the return of a portfolio is normally distributed and the VaR = Mean – 1.64σ_t for 5% VaR, where $\sigma_t^2 = \lambda \sigma_{t-1}^2 - (1 - \lambda) X_{t-1}^2$. Here X_t is the return of the asset. Other typical developments are GARCH models (Engle, Bollerslev); extreme value theory (Danielsson & Vries, Embrechets et al.); and mixtures of normals (Hull, 2002).

For better VaR estimation, Engle and Manganelli [2004] introduced the conditional autoregressive value-at-risk (CAViaR) model to estimate the VaR directly by quantile regression. They proposed direct VaR models:

$$\mathrm{VaR}_t = \beta_0 + \sum_{i=1}^{p} \beta_i \mathrm{VaR}_{t-i} + l(\beta_{p+1}, \ldots, \beta_{p+q}; \mathcal{F}_{t-1}),$$

where F_{t-1} denotes the past information up to time t - 1. Quantile regression was used to estimate the parameters.

Model return series often exhibit nonlinearity features. They can be modeled by self-excited threshold autoregressive model (SETAR, Tong and Lim, 1980) as

$$x_t = \begin{cases} \phi x_{t-1} + a_t & x_{t-d} > c, \\ \phi' x_{t-1} + a'_t & x_{t-d} \leqslant c \end{cases}.$$

where a_t and a'_t are white noise process and $\varnothing \neq \varnothing'$.

To entertain the nonlinearity and structural change in the VaR, the authors propose to model VaR_t directly by the following two models:

SETAR direct VaR model

If the underlying process is a two-regime threshold pure GARCH process, then

$$\mathrm{VaR}_t = \begin{cases} (a_0 + a_1 x_{t-1}^2 + b_1 \mathrm{VaR}_{t-1}^2)^{1/2} & \text{if } x_{t-d} > \gamma, \\ (a'_0 + a'_1 x_{t-1}^2 + b'_1 \mathrm{VaR}_{t-1}^2)^{1/2}, & \text{otherwise.} \end{cases}$$

Mixture-GARCH direct VaR model

If x_t is assumed to be a mixture-GARCH(1,1) process, then

$$\mathrm{VaR}_t = Z_t(a_{10} + a_{11} x_{t-1}^2 + b_{11} \mathrm{VaR}_{t-1}^2)^{1/2}$$
$$(1 - Z_t)(a_{20} + a_{21} x_{t-1}^2 + b_{21} \mathrm{VaR}_{t-1}^2)^{1/2},$$

where $Z_t = 1$ with probability π when x_t comes from the first component and $Z_t = 0$ with probability 1- π when it comes from the second component.

Some theoretical results such as the following theorem are presented in the speech.

If x_t follows a TGARCH process (1), then the VaR_t^2 process follows a TGARCH process (3). If x_t follows a mixture-GARCH(1,1) process (2), then the VaR_t process also follows an mixture-GARCH(1,1) process (4).

$$\mathrm{VaR}_t^2 = a_0^{(j)} + a_1^{(j)} x_{t-1}^2 + b_1^{(j)} \mathrm{VaR}_{t-1}^2 \quad \gamma_{j-1} \le x_{t-d} < \gamma_j, \tag{3}$$

$$\begin{aligned} \mathrm{VaR}_t^2 &= Z_t(a_{10} + a_{11}x_{t-1}^2 + b_{11}\,\mathrm{VaR}_{t-1}^2) \\ &\quad +(1-Z_t)(a_{20} + a_{21}x_{t-1}^2 + b_{21}\,\mathrm{VaR}_{t-1}^2), \end{aligned} \tag{4}$$

where C_η is the lower (left-tail) η-th quantile of the standard normal distribution, $a_1^{(j)} = C_\eta^2 \alpha_1^{(j)}$, $b_1^{(j)} = \beta_1^{(j)}$, $j = 1, \ldots, k$; Z_t is defined as before; $a_{k0} = C_\eta^2 \cdot \alpha_{k0}$, $a_{k1} = C_\eta^2 \cdot \alpha_{k1}$ and $b_{k1} = \beta_{k1}$, $k = 1, 2$.

Their models inherit all the advantages of the CAViaR model and enhance the nonlinear structure. Finally their methods are applied to the S&P 500, Hang Seng, Nikkei and Nasdaq indices to illustrate the models. Their conclusions are that the conditional autoregressive value-at-risk model seems to be worthy of further explanation and the threshold GARCH direct VaR model and mixture GARCH direct VaR model can capture the nonlinearity of the VaR process.

Development of Statistics on Foreign Affiliates Trade in Services (FATS) for Hong Kong

Elsa L Y LEE
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Background

With increasing globalisation of the world economy, it becomes popular for firms of an economy to deliver services to foreign customers through setting up affiliated companies abroad. In view of the growing need for statistics relating to such activities, the Census and Statistics Department (C&SD) has been conducting studies on the framework for compiling "foreign affiliates trade in services (FATS)" statistics.

Mode of Supply of Services

Under the General Agreement on Trade in Services (GATS) of the World Trade Organization (WTO), which establishes a set of rules and disciplines governing the use of trade measures in trade in services (TIS) by WTO members, international TIS covers services supplied via the following 4 modes of supply:

Mode 1 : ***Cross border supply***, which takes place with the service purchaser and service provider remaining in their home territory. Examples are provisions of communications and cargo forwarding services.

Mode 2 : ***Consumption abroad***, which takes place with the service purchaser of an economy moving outside his/her home territory and consuming services in another economy. Examples of such exports of services are the provision of services to tourists, provision of medical treatment to non-residents, and provision of education services to students from other countries/territories.

Mode 3 : ***Commercial presence***, which takes place with services provided by the service provider of an economy through establishing affiliated companies in another economy. An example is the setting up of local offices in different economies by an international airline.

Mode 4 : ***Presence of natural persons***, which takes place with an individual of an economy moving into another economy and providing services in that economy. It may be the temporary employment of foreigners and self-employed individuals going abroad or employees sent abroad by their companies to provide services.

A synthetic view of the above modes of supply is shown in **Chart 1**, which is extracted from the *Manual on Statistics of International Trade in Services* (*MSITS*)[1].

The conventional TIS covers services provided via modes 1, 2 and 4. However, for mode 3, as foreign affiliates established in an economy are resident entities of that economy, their services provided in that economy are regarded as transactions between residents, and are not recorded in conventional TIS statistics.

Growing Needs for FATS Statistics

In the *MSITS,* FATS statistics are recommended to be compiled for measuring the activities of the commercial presence of service suppliers in foreign markets through affilitates. Currently, some advanced economies like the U.S.A. have compiled FATS statistics for some years. Under the lead of EuroStat, selected FATS statistics are compiled by quite a number of member countries of the European Union.

Hong Kong currently compiles TIS statistics covering transactions between Hong Kong residents and non-residents, which cover services supplied via modes 1, 2 and 4. In view of the growing importance of FATS statistics, C&SD has over the past years launched studies on developing the statistical framework for compiling inward and outward FATS statistics for Hong Kong.

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[1] The *Manual on Statistics of International Trade in Services* was jointly published by the United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations Conference on Trade and Development, and the World Trade Organization in December 2002.

Concepts and Coverage of FATS

According to the *MSITS*, foreign affiliates covered in FATS statistics should be majority-owned foreign affiliates (MOFA), which are defined as firms with a single foreign investor, or an associated group of foreign investors acting in concert, owning more than 50% of the ordinary shares or voting power. The concept of majority ownership is used to ensure final management control of the foreign investors. This is also in line with the definition of ownership and control of GATS.

FATS statistics may be developed for both foreign-owned affiliates in the compiling economy (inward FATS) and foreign affiliates located outside the compiling economy (outward FATS). As recommended in the *MSITS*, FATS statistics should cover a wide range of operating characteristics of foreign affiliates including output, employment, value added, exports and imports of goods and services, number of establishments, compensation of employees, gross fixed capital formation, etc. They can be used to assess various aspects of the globalisation phenomenon and to monitor the business presence of foreign affiliates.

Inward FATS Statistics for Hong Kong

Inward FATS statistics measure the commercial presence of foreign service suppliers through setting up affiliates in the local economy. To facilitate analysis of their economic contribution in Hong Kong, the first set of inward FATS statistics for 2004 has been compiled and published via a feature article on "Inward Foreign Affiliates Trade in Services for Hong Kong" in the October 2006 issue of the *Hong Kong Monthly Digest of Statistics*.

Hong Kong's inward FATS statistics are compiled based on :

(a) data of establishments (e.g. employment, value added, business receipts, operating expenses, compensation of employees, etc.) collected through the Programme of Annual Economic Surveys (PAES); and

(b) information on source of investment as obtained from the Survey of External Claims, Liabilities and Income (SECLI).

The SECLI is an integrated survey that collects data, such as direct investment, portfolio investment, financial derivatives and other investment, for compiling the Balance of Payments accounts of Hong Kong. The frame of SECLI provides information on enterprise structure such that it can be used to identify MOFA in Hong Kong.

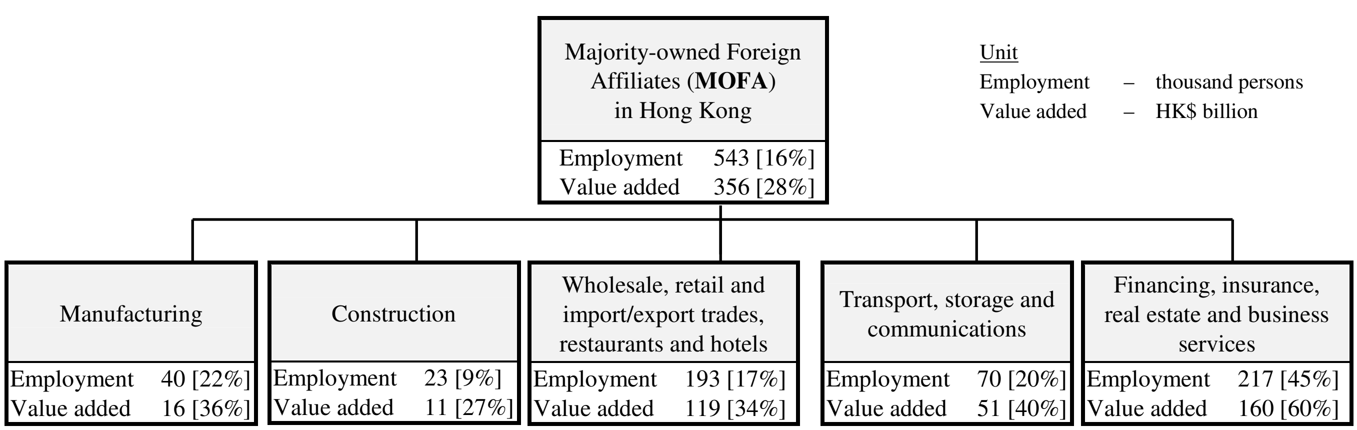
The PAES collects annual data on the structural and operating characteristics of various industries in Hong Kong. The MOFA identified from the SECLI can then be matched against the PAES sample to obtain statistics on the operating characteristics of the MOFA in Hong Kong.

In 2004, MOFA in Hong Kong employed 543 000 persons, up by 4.4% as compared with 2003. In terms of total employment, contribution of MOFA in Hong Kong was 16%. Value added contributed by MOFA in Hong Kong amounted to $356.4 billion in 2004, up by 8.1% over 2003. In terms of GDP at factor cost, contribution of MOFA in Hong Kong was 28%.

The results show the high degree of openness of the Hong Kong economy and the significant commercial presence of foreign affiliates.

The dominance of MOFA is most apparent in the industry of financing, insurance, real estate and business services, where they hired 45% of staff (217 000) and generated 60% of value added ($160 billion) for the industry in 2004.

The inward FATS statistics also showed that foreign affiliates generally perform better than local firms in terms of labour productivity because a higher output, measured by value added, is generated by a smaller labour input, measured by staff employed. It is particularly so for the construction industry where foreign affiliates only employed 9% of workers of the industry but generated 27% of value added in 2004, indicating that foreign affiliates have superior technology and know-how than local firms to secure a better rate of return.



Figures in square brackets are the percentage shares of MOFA establishments in the industries covered.

The inward FATS statistics provide a more comprehensive picture of foreign affiliates in Hong Kong. With a view to providing more detailed information on inward FATS for analysis, studies are being undertaken to further enhance the data sources. Trial compilation of other variables and further breakdowns (e.g. both by origin of investment and economic activity in Hong Kong) will be attempted.

While inward FATS statistics are compiled as useful measures of economic activities of foreign affiliates in Hong Kong, the following cautions should be taken when interpreting the statistics :

(a) The majority ownership concept of MOFA (i.e. more than 50% of the ordinary share being owned by a single foreign investor) differs from the rules relating to direct investment ownership in the *Balance of Payments Manual, Fifth Edition,* in which 10% ownership is used as the lower threshold for direct investment.

(b) The majority ownership concept adopted in the compiling inward FATS statistics is that of immediate holder instead of ultimate beneficial ownership due to data limitation.

(c) If a firm is identified as a MOFA, figures relating to its operating characteristics are entirely included in the inward FATS statistics. No apportionment by percentage of source of investment is made to its contributions.

(d) Economic contributions of MOFA in the "agriculture and fishing" industry and the "community, social and personal services" industry are assumed to be negligible.

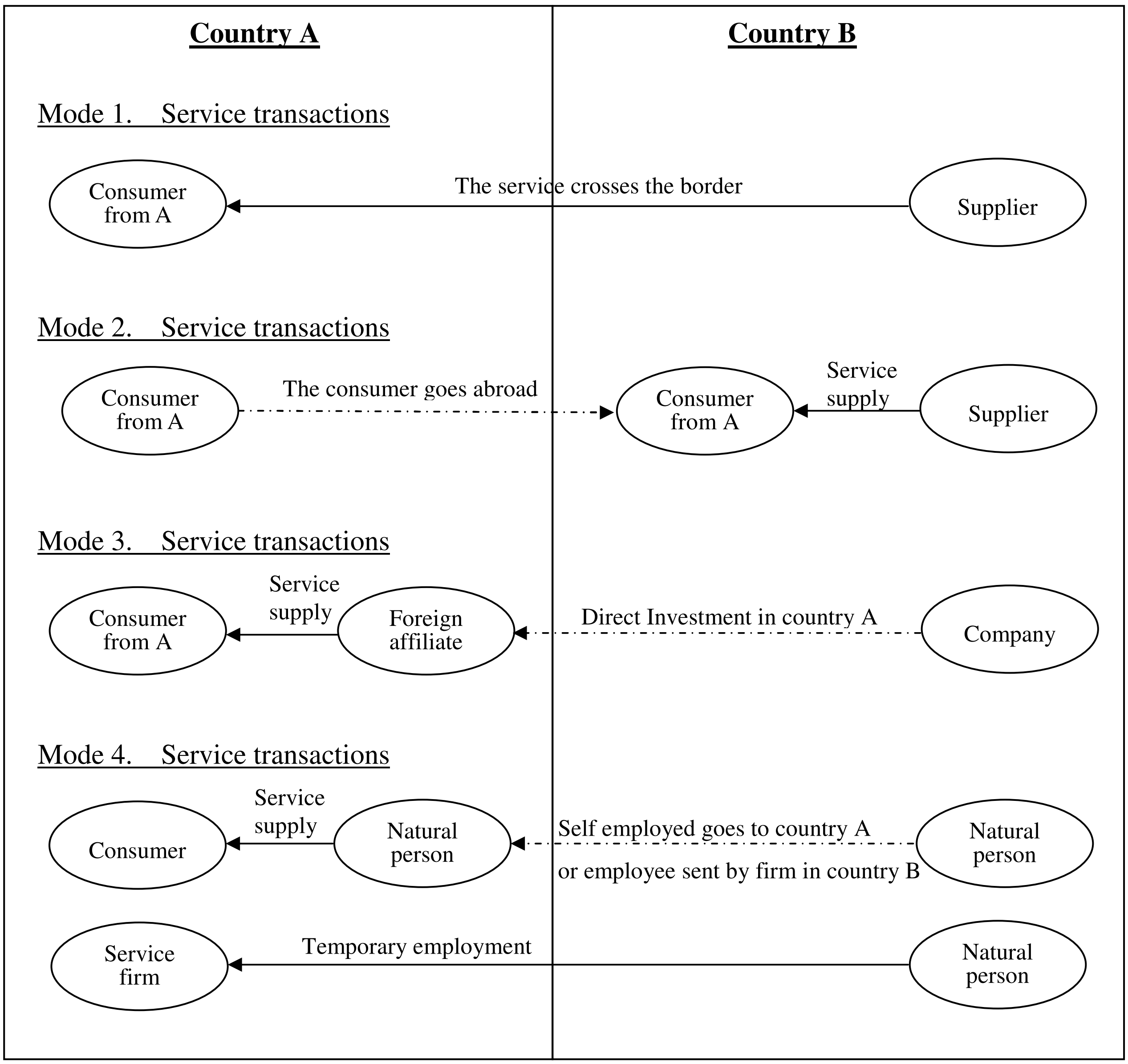
Outward FATS Statistics for Hong Kong

Outward FATS statistics provide useful information for understanding how companies of an economy conduct their business activities abroad. Such statistics are useful for the economy to negotiate and monitor trade and investment agreements with other economies.

Outward FATS statistics for Hong Kong will measure the operation and activities of affiliates of Hong Kong companies located outside Hong Kong. As the required data will have to be collected from Hong Kong companies regarding the operations and activities of their affiliates located outside Hong Kong, data collection might be relatively more difficult.

Studies are being undertaken on the feasibility of collecting data for compiling Hong Kong's outward FATS statistics. Hong Kong companies with MOFA outside Hong Kong will first be identified from the SECLI and data of their MOFA (including number of affiliated companies, number of employees and business receipts) will then be collected by survey from the Hong Kong companies identified.

Chart 1. Synthetic view of modes of supply



Source : Extracted from the *Manual on Statistics of International Trade in Services*

News

Annual General Meeting for the 2006/07 Session

The Annual General Meeting (AGM) for the 2006/07 Session of the Hong Kong Statistical Society will be held on 22 March 2007 (Thursday) at 6:30 p.m. at the Immigration Officers Mess, Immigration Department, 20/F, Immigration Tower, 7 Gloucester Road, Wan Chai, Hong Kong. A Chinese style dinner will be held after the AGM. Members are welcome to bring along their guests to the dinner.

Department of Statistics and Actuarial Science, The University of Hong Kong

The Royal Statistical Society (UK) has announced in the March 2007 issue of the RSS News that the Guy Medal in Silver 2007 is awarded to Professor Howell Tong for his many important contributions to time series analysis over a distinguished career, and in particular for his fundamental and highly influential paper "Threshold autoregression, limit cycles and cyclical data", read to the Society in 1980, which paved the way for a major body of work in non-linear time series modelling. Previous recipients of the medal, which was inaugurated in 1893, include Maurice Bartlett, George Box, David Cox, Henry Daniels, David Kendall, Peter McCullagh, C. R. Rao, Adrian Smith, Peter Whittle, and others.

Professor Tong is currently Distinguished Visiting Professor of the Department, and was Pro Vice-Chancellor of the University of Hong Kong. He will be visiting the Department in mid March for about one and a half months.

For information, Professor John Aitchison, former Head of the Department, was also a recipient of the Guy Medal in Silver.

Dr Stephen M.S. Lee was promoted to Professor in December, 2006. His main research area is in bootstrap methodology.

Dr H.L. Yang was promoted to Professor in December, 2006. His main research area is in risk theory.