

**UNIVERSITY OF WARWICK**  
**WARWICK BUSINESS SCHOOL**  
**PhD Finance**

Econometric Analysis of Financial Markets

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This is an advanced course, concentrating on the application of econometric methods in the study of financial markets. The vast majority of the methods involve time series data and we will not consider cross section nor Panel data methods at all except in passing. I will however spend sometime on point processes when covering high frequency methods. An outline of topics follows although we will not have sufficient time to complete all and what we cover will be determined once I see how fast we can move and your own tastes. I would prefer that we consider a few important topics in detail rather a larger number superficially. In contrast to previous years I intend to spend more time covering basic econometric theory and methods before turning to look at topics in Financial Econometrics. I will leave you to learn R or SPLUS by yourself but will expect that you have the ability to carry out the assessment in one of these languages. We will also consider the Bayesian Package WINBUGS when looking at MCMC methods and the estimation of Stochastic Volatility models. WINBUGS and R are both open source packages and freely available on the web from various servers.

Each topic/lecture will have some required reading and a number of optional references; the recommended reading is indicated in bold. My lecture notes are the basis of a book I have been writing for Cambridge University Press and are in various stages of completion and will be supplied as we go along. All the relevant reading should have been included on the course CD. A course web-site will be set up where you will be able to download supplementary material and data sets. It is critical to the learning process that the issues and techniques covered in the course are also applied and you can get SPLUS 7 and the Financial Econometrics Module for SPLUS from the Computer services store given Warwick has a site licence. I hope to carry out a number of applied exercises to back up the theory and I would expect you to be fairly fluent in using SPLUS or R by the fourth week. I am happy to be contacted by email whenever you feel the need.

Assessment for the course will be by a piece of empirical work which will be carried out during the summer term.

Basic Econometric references for the course are:

**Christian Gourieroux and Alain Monfort, Statistics and Econometric Models, volumes 1 and 2, Cambridge University Press.**

Christian Gourieroux and Alain Monfort, Simulation Based Econometric Methods, Oxford University Press

Amemiya Takeshi, Advanced Econometrics, Harvard University Press.

Russell Davidson and James MacKinnon, Estimation and Inference in Econometrics, Oxford University Press

James Davidson, Econometric Theory, Blackwells, 1999

Apart from my own notes there are several texts that cover some of the Financial Econometrics material that we will need to look at and these are;

**Singleton K.J. Empirical Dynamic Asset Pricing: Model Specification and Econometric Assessment , Princeton University Press, 2006.**

Christian Gourieroux and Joana Jasiak, (2000) Financial Econometrics, Princeton University Press.

Ruel Tsay, (2002), Analysis of Financial Time Series, Wiley.

Campbell J.Y, Lo A. and MacKinley A.C., (1997), The Econometrics of Financial Markets, Princeton University Press. (CLM )

Mills T., (1999), The Econometric Modelling of Financial Time Series, Cambridge University Press., 2<sup>nd</sup> Edition (TM)

Taylor S., (2005), Modelling Volatility, John Wiley. (ST )

## COURSE OUTLINE

### 1: A Review of Econometric Theory and Tools of Inference

- i. Basic Concepts; Stochastic processes, time series, basic distribution theory, Misspecification and The Econometric Model Building Process and the appropriate selection of statistical tools. The Least squares Estimator in a misspecified model- what are the econometric issues?
- ii. Identification Theory
- iii. Exogeneity, Ancillarity, Sufficiency and Efficiency
- iv. Brief Introduction to Asymptotic Expansions and Finite Sample Distribution theory
- v. Asymptotic Distribution Theory for estimation and inference:-
  - a. Estimation: optimal properties of estimators, Maximum Likelihood, Pseudo MLE, Method of Moments, GMM, Efficient MoM, M-Estimators, Simulation MLE (Indirect Estimation), Simulated Method of Moments, Non Parametric and Semi Parametric Methods, Bayesian Methods, Quantile Regression

- b. Inference: Size, Power and optimal properties of hypothesis tests, Likelihood Based Hypothesis Tests- 2<sup>nd</sup> order asymptotic equivalence, Maximum likelihood specification testing and Conditional Moment Tests
- vi. Bootstrap Methods, Monte Carlo Markov Chain, MCMC. Data Snooping

Reading:

My own notes and various chapters from:

Singleton K.J. Empirical Dynamic Asset Pricing: Model Specification and Econometric Assesment, Princeton University Press, 2006

Amemiya Takeshi, Advanced Econometrics, Harvard University Press.

Christian Gourieroux and Alain Monfort, Statistics and Econometric Models, volumes 1 and 2, Cambridge University Press.

Christian Gourieroux and Alain Monfort, Simulation Based Econometric Methods, Oxford University Press

Pagan A. and Ullah A.,(1999), Non-parametric Econometrics, Cambridge University Press.

Semi-parametric Inference - special issue of *Journal of Applied Econometrics*

Horowitz Joel, (1996) Bootstrap Methods in Econometrics, Theory and Numerical Performance, Proceedings of the 7th World Congress of the Econometric Society, Cambridge University Press

2: An Introduction to Computational Financial Econometrics Using SPLUS with FinMetrics and R:

Introduction to programming in S and standard econometric procedures in SPLUS using the Financial Econometrics Module and R.

In terms of reading there is really just the manual for SPLUS which is provided on the CD and then various tutorials which can be found on the web apart from the tutorial provided on the course CD. The Financial Econometrics module FINMETRICS has an accompanying book: Modelling Financial Time Series with SPLUS by Eric Zivot and Jiahui Wang published by Springer. R is an open source program with large library of contributed routines based on one form of the S language. SPLUS is a very powerful and extensive commercial package also based on the S language.

References:

The basic references for S-PLUS are the online manuals- however you might want to consider buying one of the following.

Venables W.N. and Ripley B.D., Modern Applied Statistics in S-PLUS. ( and R)

Krause A. and Olsen M.(1997), The Basics of S and S-PLUS (Krause & Olson). Second edition

Everitt, B.S., A Handbook of Statistical Analyses Using S-Plus

Lam Longhow, (1999) An introduction to S-PLUS for Windows,

### 3: Stylised Empirical Facts of Financial Returns:

How to measure Skewness, Kurtosis, Long memory, ARCH, volatility and risk, Extremes, Mixtures of Distributions Hypothesis, time deformation

TM: Chapters 2 , 3 and 6; CLM: Appendix; TM: Chapter 5;ST: Chapter 2.

Pagan A., (1996), The Econometrics of Financial Markets, *Jnl of Empirical Finance* Vol 3, pps 15-102.

#### i. Characterising Distributions and stylized facts:

Ding Z. and Granger C., (1996), Modelling volatility persistence of speculative returns: a new approach, *Jnl. of Econometrics*, 73, pps 185-213.

Bekaert G., Erb C., Harvey C. and Viskanta T., (1998), Distributional Characteristics of Emerging Market Returns and Asset Allocations, *The Journal of Portfolio Management*, Winter, pps 102-116.

Mills, T., (1995), Modelling Skewness and Kurtosis in the London Stock Exchange FT-SE Index Return Distributions., *Statistician*, vol 44, Issue 3, pps 323-332.

Boothe P. and Glassman D. (1987), "The Statistical Distribution of Exchange Rates: Empirical Evidence and Economic Implications", *Journal of International Economics*, 22, pp. 297-319.

Special Issue of *Jnl of Econometrics*, 73,(1996) on Long Memory Processes

Hsieh D.,(1988), The Statistical Properties of Daily Foreign Exchange Rates: 1974-1983, *Journal of International Economics*, 24, pps 129-45.

Ding Z. , Granger C. and Engle R.F., (1993), A long memory property of stock market returns and a new model, *Journal of Empirical Finance*, vol. 1, No.1, pps 83-106.

Baillie R.T. (1996), Long Memory Processes and Fractional Integration in Econometrics, *Jnl of Econometrics*, 73, pps 5-59.

Granger C. and Ding Z., (1996), Varieties of long memory models, *Jnl of Econometrics*, 73, pps 61-77.

Granger C. and Ding Z., (1995), Some Properties of Absolute Returns, An Alternative Measurement of Risk, *Annales d'economie et de statistique*, 40,67-91.

Bollerslev T. and Mikkelsen, (1996), Modelling and pricing long memory in stock market volatility, *Jnl of Econometrics*, 73, pps 151-184.

#### ii. Time Deformation; and the Volume, Volatility Relationship

Stock J.H. (1988), "Estimating Continuous-Time Processes Subject to Time Deformation", *Journal of the American Statistical Association*, 77-85.

Clark P. (1973), A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices, *Econometrica*, Jan, pps 135-55.

Lamoureux C. and Lastrapes W., (1990), Heteroskedasticity in Stock Return Data: Volume versus GARCH effects, *Jnl of Finance*, vol 45, no.1, pps. 221-229.

Ané T. and Hélyette Geman, Order Flow, Transaction Clock, and Normality of Asset Returns, *Jnl of Finance*, vol 55, no.5, October.

Tauchen G.E. and Pitts M., (1983), The price variability-volume relationship on speculative markets, *Econometrica*, Vol51, no. 2, pps 485-506.

- Andersen, T. (1996) Return Volatility and Trading Volume: an Information Flow Interpretation of Stochastic Volatility, *Jnl of Finance*, vol 51, no.1, pps 169-204.
- Gallant R., P.E. Rossi and G. Tauchen, (1992) *Stock Prices and Volume*, *Review of Financial Studies*, 5, 871-908.
- Stock J. (1987), Measuring Business Cycle Time, *Jnl. of Political Economy*, pps 1240-61
- Mandelbrot B., (1973), Comments on "A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices", by Peter Clark., *Econometrica*, Jan, pps. 157-59.
- Dacoronga M. et al (1996), Changing time scale for short term forecasting in financial markets, *Jnl. of Forecasting*, vol 15, pps 203-227.
- Ghysels E., Gouriéroux C., and Jasiak J., (1997a), *Market Time and Asset Price Movements: Theory and Estimation*, in Statistics in Finance, edited by D. Hand and S. Jacka, Edward Arnold, London.
- Asea P. and Mthuli Ncube, (1997), *Heterogeneous Information arrival and Option Pricing*, *NBER Working Paper 5950*, available in full text mode on the web at <http://netec.mcc.ac.uk/WoPEc/data/Papers/nbrnberwo5950.html>
- Chang C.W., Chang J.S.K. and Lim K-G., (1998) Information- time Option Pricing: theory and empirical evidence, *Journal of Financial Economics*, 48, 211-242. Or on the web at <http://www.elsevier.nl:80/cas/tree/store/finec/sub/1998/48/2/960.pdf>
- Karpoff J., (1987), The Relationship between Price Changes and Trading Volume: A Survey, *Jnl of Financial and Quantitative Analysis*, vol 22, no.1, pps 109-126.
- Lamoureux C. and Lastrapes W., (1994), Endogenous Trading Volume and Momentum in Stock Return Volatility, *Jnl of Business and Economic Statistics*, April, vol 12, no.2, pps 253-260.

### iii. Stochastic Volatility

- Ghysels E., Gouriéroux C., and Jasiak J., (1997), Trading patterns, time deformation and stochastic volatility in foreign exchange markets, in Nonlinear Modelling of High Frequency Financial Time Series, Edited by C. Dunis and B. Zhou, Wiley, New York.
- Jacquier E., N.G. Polson and P.E. Rossi, (1994), Bayesian Analysis of Stochastic Volatility Models, *Jnl. of Business and Economic Statistics*, 12, 371-417.
- Taylor S., (1994), Modelling Stochastic Volatility, *Mathematical Finance*, 4, 183-204.

## 4: Measuring Dependency Amongst Non-Gaussian Assets

- Malvergne Y. and Didier Sornette, Extreme Financial Risks, from Dependence to Risk Management, Springer Verlag.
- Bouye E. and M. Salmon, (2000), On measuring the dependence between non-gaussian returns in finance. FERC WP, Cass University Business School.
- Longin F. and Bruno Solnik, (2001) Extreme Correlation of International Equity Markets, *Jnl of Finance*, April.
- Bouyé E., V. Durrleman, A. Nickeghbali, G. Riboulet and T. Roncalli, (2000), Copulas of Finance- A Reading Guide some Applications, FERC WP

- Embrechts, P., McNeil, A., Straumann, D.: Correlation and dependence in risk management: properties and pitfalls In: Risk Management: Value at Risk and Beyond, ed. M.A.H. Dempster, Cambridge University Press, Cambridge, pp. 176-223, <http://www.math.ethz.ch/~strauman/preprints/pitfalls.pdf>
- Bouye E. and M.Salmon (2002) Dynamic Copula Quantile Regressions and Tail Area Dynamic Dependence in Forex Markets, FERC WP, <http://www.city.ac.uk/cubs/ferc/wpapers/fxnber2.pdf>

## 5: Basic Concepts in Forecasting with Symmetric and Asymmetric Loss Functions;

Dynamic Conditional Quantile Predictors, Interval Forecasts and Distributional Forecasting, Bagging Conditional Model Sets and Bayesian Model Averaging

- Granger C. and Newbold P., (1986) Forecasting Economic Time Series, Academic Press, 2nd Edition, Chapter 4 (in particular).
- Christoffersen P. and Diebold F. (1996) "Further Results on Forecasting and Model Selection Under Asymmetric Loss," *Journal of Applied Econometrics*, 11, 561-72.
- Christoffersen P. and Diebold F., "Optimal Prediction Under Asymmetric Loss", *Econometric Theory*.
- Christoffersen, P. (1998), "Evaluating interval forecasts", *International Economic Review*, 841-862.
- Berkovitz, J. (2001), "Testing Density Forecasts, with Applications to Risk Management", *Journal of Business and Economic Statistics*, 19, 4, 465-474.
- Wallis, K.F. (2001), "Chi-squared Tests of Interval and Density Forecasts, and the Bank of England's Fan Charts", *International Journal of Forecasting* (forthcoming).
- Leitch C. and Tanner J.E., (1991), Economic Forecast Evaluation: Profits versus the Conventional Error Measures, *American Economic Review*, Vol 81, No.3, pps 580-590.
- Granger Clive W.J (1992), Forecasting Stock Market Prices: Lessons for Forecasters, *International Journal of Forecasting*, 8, 3-13.
- Diebold, Francis X. and R . Mariano (1995), Comparing Predictivity Accuracy, *Journal of Business & Economic Statistics*, 13, 253-263.
- Pesaran H. and Timmermann A., (1995), Predictability of Stock Returns: Robustness and Economic Significance, *Journal of Finance*, Vol 50, No.4, pps 1201-1228.
- Pesaran H. and Timmermann A., (1992), A Simple Nonparametric Test of Predictive Performance, *Jnl. of Business and Economic Statistics*, vol 10, No.4, pps 461-465.
- Diebold F. and Lopez (1996) "Forecast Evaluation and Combination," in G.S. Maddala and C.R. Rao (eds.), Handbook of Statistics, Amsterdam: North-Holland, 241-268.
- Satchell S. and Timmermann A., (1995), An Assessment of the Economic Value of Nonlinear Foreign Exchange Rate Forecasts, *Journal of Forecasting*, Vol 14, pps 477- 497.
- West, K.D., Edison, H.J. and Cho, D. (1993), A Utility-Based Comparison of Some Models of Exchange Rate Volatility, *Journal of International Economics*, 35, 23-45.
- Gourieroux C. and Joana Jasiak, (2005), Dynamic Quantiles, mimeo.
- Hansen P., Asger Lunde and James Nason, (2005) Model Confidence Sets and Forecasting Models, wp. Federal Reserve Bank of Atlanta, 2005-7

## **6: The Econometrics of Transactions Level Data**

Point processes, Autoregressive duration modelling, modelling order books, liquidity and information flow

Books in this area include:

- Maureen O'Hara, (1997) Market Micro-Structure Theory, Blackwell  
ISBN 0-631—20761-9
- Richard K. Lyons(2002), The Microstructure Approach to Exchange Rates , The MIT Press; ISBN: 026212243X
- Luc Bauwens, Pierre Giot, (2001) Econometric Modelling of Stock Market Intraday Activities, Kluwer Academic. ISBN: 079237424X
- Markus K.Brunnermeier, ( 2001) Asset Pricing under Asymmetric Information - Bubbles, Crashes,Technical Analysis and Herding Oxford University Press, Oxford, ISBN: 0198296983
- Ramazan Gencay et al, (2001), An Introduction to High Frequency Finance Theory and Applications, Harcourt, ISBN: 0122796713
- Christian Dunis and Bin Zhou, (1998), Nonlinear Modelling of High Frequency Financial Time Series, Wiley, ISBN 0-471-97464-1
- Hautsch Nikolaus,(2005) , Modelling Irregularly Spaced Financial Data, Springer Lecture Notes in Economics and Mathematical Systems, no. 539.

### **Predictability in transactions level data**

Hillman, R. and Salmon M.,(2001), Intrinsic Stationarity, investigating predictability in real time forex transactions, FERC discussion paper

### **Introduction and Autoregressive Conditional Duration Models**

- Goodhart C.and O'Hara M.,(1997), High Frequency data in Financial Markets: issues and applications, *Jnl. of Empirical Finance*, 4, 73-114.
- O'Hara, M. (1999) ,Making Market Microstructure Matter, *Financial Management* 28, 83-90.
- Madhavan, A. (2000), Market Microstructure: A Survey", *Journal of Financial Markets* 3, 205-258.
- Hasbrouck J. (1996), Modeling Microstructure Time Series, in G.S. Maddala and C. R. Rao (eds.) Statistical Methods in Finance (Handbook of Statistics, Volume 14, North-Holland).

- Engle R. and Russell J., (1998), Autoregressive Conditional Duration; a new model for irregularly spaced transaction data, *Econometrica*, 66, 1127-1162.
- Engle R. and Russell J., (1997), Forecasting the frequency of changes in quoted foreign exchange prices with the autoregressive conditional duration model, *Jnl. of Empirical Finance*, 4, 187-212.
- Bauwens L. and Giot P., (1998), The Logarithmic ACD model: an application to the bid-ask quote process of three NYSE stocks, *Annales d'Economie et Statistique*.  
<http://www.core.ucl.ac.be/econometrics/Bauwens/Papers/logacd13.pdf>
- Lo A., Craig MacKinlay and June Zhang, Econometric Models of Limit-Order Executions,  
<http://web.mit.edu/alo/www/Papers/limit10.pdf>
- Zhang, M.Y., J.R. Russell, and R.S. Tsay (2001). "A Nonlinear Autoregressive Conditional Duration Model with Applications to Financial Transaction Data," *Journal of Econometrics*.

### **Levy Processes, Compound Poisson and BIN Models**

- Barndorff-Nielsen Ole E. and Shephard Neil, (2002), Modelling by Levy processes for financial econometrics, Levy Processes -- Theory and Applications, eds in Barndorff-Nielsen, O. and Mikosch T. and Resnick S. Birkhauser,  
<http://www.nuff.ox.ac.uk/economics/papers/2000/w3/levyvolp2.ps>
- Rydberg Tina and Shephard Neil, (2000), A Modelling Framework for Prices and Times of Trades made on the New York Stock Exchange, in Nonlinear and Nonstationary Signal Processing, eds W.J.Fitzgerald, Richard Smith, A.T. Walden, Peter Young, CUP. <http://www.nuff.ox.ac.uk/users/rydberg/newton2.pdf>
- Rydberg Tina and Shephard Neil, (1999), The dynamics of trade-by-trade price movements: decomposition and models. *Working Paper, Nuffield College, Oxford*.  
<http://www.nuff.ox.ac.uk/users/rydberg/neil7.pdf>
- Engle R. and Lunde A., (1998), Trades and Quotes: a bivariate point process, DP 98-07 University of California, San Diego  
<http://weber.ucsd.edu/~mbacci/engle/bivpoint1.pdf>

### **Realised Volatility**

- Andersen, T., Bollerslev, T., Diebold, F.X. and Labys, P., (2003) , "Modeling and Forecasting Realized Volatility," *Econometrica* , Vol 71, no.2, 579-625..  
<http://www.ssc.upenn.edu/~fdiebold/papers/paper43/abd14.pdf>
- Andersen, T. Bollerslev, T., Diebold, F.X. and Labys, P. (2001) , "The Distribution of Realized Exchange Rate Volatility," *Journal of the American Statistical Association* , 96, 42-55.  
<http://www.ssc.upenn.edu/~fdiebold/papers/paper31/final2.pdf>
- Andersen, T., Bollerslev, T., Diebold, F.X. and Ebens, H. (2001), "The Distribution of Realized Stock Return Volatility," *Journal of Financial Economics* , 61, 43-76.  
<http://www.ssc.upenn.edu/~fdiebold/papers/paper41/abde.pdf>



- Andersen, T., Bollerslev, T., Diebold, F.X. and Labys, P. (1999), "(Understanding, Optimizing, Using and Forecasting) Realized Volatility and Correlation," Manuscript, Northwestern University, Duke University and University of Pennsylvania. Published in revised form as "Great Realizations," *Risk*, March 2000, 105-108. <http://www.ssc.upenn.edu/~fdiebold/papers/paper29/temp.pdf>
- Andersen, T., Bollerslev, T., Diebold, F.X. and Labys, P. (2000), "Exchange Rate Returns Standardized by Realized Volatility are (Nearly) Gaussian," *Multinational Finance Journal*, 4, 159-179. <http://www.ssc.upenn.edu/~fdiebold/papers/paper28/abd13.pdf>

### **Dynamic Models of Liquidity**

- Dufour A. and Engle R., (1999), Time and the Price Impact of Trade, USCD DP 99-15 <http://www.econ.ucsd.edu/papers/files/ucsd9915.pdf>
- Jon Danielsson and Richard Payne, (2001) Measuring and explaining liquidity on an electronic limit order book: evidence from Reuters D2000-2, <http://risk.lse.ac.uk/rr/files/JD-RP-01-2-22-982870682-7.pdf>
- Hillman R, Marsh I. and Salmon M., (2001), Dynamic measures of Liquidity in a limit order book, (2001) FERC discussion paper.

## **8: Econometric Issues in Risk Management**

### **a) Basic Theory: Value at Risk and Expected Shortfall**

- Christoffersen P.F., J. Hahn and A. Inoue, (1999), Testing, Comparing and Combining Value-at-Risk Measures. Wharton FIC Working Paper 99-44.
- Christoffersen P. (1998), Evaluating Interval Forecasts, *International Economic Review*, 39, 841-862.
- Engel J. and M. Gizycki, Conservatism, accuracy and Efficiency: Comparing Value at Risk Models, mimeo
- Acerbi C. et al (2001), Expected Shortfall as a Tool in Risk Management, mimeo.
- Acerbi C. and D. Tasche (2001), On the Coherence of Expected Shortfall. Mimeo.
- Diebold, Francis, Todd Gunther and Anthony Tay, (1997), Evaluating Density Forecasts, working paper, University of Pennsylvania.
- El Jahl L., William Perraudin and Peter Selin, (1999), Value at Risk for Derivatives, *Jnl of Derivatives*

### **b) Extreme Value Theory and Quantile Estimation in Value at Risk:**

- Danielson Jon and de Vries Casper, (1997), Value at Risk and Extreme Returns, mimeo, London School of Economics.

- Engle R.F. and Simone Manganelli, (1999), CAViaR, Conditional Autoregressive Value at Risk by Regression Quantiles,.
- Danielson J, Phillipp Hartmann and Casper de Vries, (1998), The Cost of Competitiveness: Extreme Returns, Value at Risk and the Basle Multiplication Factor, *Risk*, January
- Danielson Jon and de Vries Casper, (1997), Robust Tail Index and Quantile Estimation, *Journal of Empirical Finance*.

## 9: Density Estimation and Extracting Information from Financial Markets

- Tay Anthony and Ken Wallis, Density Forecasting: A Survey, (1999) *Journal of Forecasting*
- Clews R. Nikos Panigirtzoglou and James Proudman, (2000), Recent Developments in Extracting Information from Options Markets, *Bank of England Quarterly Bulletin*, Feb, pps 50-60.
- Jackwerth J. C. and Rubenstein M., (1996), Recovering Probability Distributions from Option Prices, *Journal of Finance*, Vol 51, No.5, December, pps 1611-1652.
- Bahra B., (1997), Implied Risk Neutral Probability Density Functions from Option Prices: Theory and Application, *Bank of England Working Paper No.66*.
- Bahra B., (1996), Probability Distributions of Future Asset Prices implied by Option Prices, *Bank of England Quarterly Bulletin*, August pps 299-311.
- Cooper N. and Talbot J., (1999), The Yen Dollar Exchange Rate in 1998: Views from the Option Markets, *Bank of England Quarterly Bulletin*, Feb, pps 68-76.
- Abadir K.M. and M. Rockinger, Density Embedding Functions, Mimeo, University of York.
- Ait-Sahalia Yacine, (1996) Non-parametric Pricing of Interest Rate Derivative Securities, *Econometrica*, Vol 64, No.3, May, Pps 527-560.
- Cont Rama, Beyond Implied Volatility, (1998) mimeo ECONOPHYSICS website.
- Ait-Sahalia Yacine and Andrew Lo, (1997) Non-parametric Estimation of State Price Densities Implicit in Financial Asset Prices, Mimeo MIT
- Yacine Ait-Sahalia, H.Wang and Francis Yared, Do Option Prices Correctly Price the Probabilities of Movement of the underlying Asset? Mimeo (1999)
- Jackwerth J. C. ,(1997) Recovering Risk Aversion from Option Prices and Realized Returns, mimeo London Business School.

## 10: Fixed Income Econometrics

### a) Estimating the Yield Curve with Macro Factors

- Ang, A. and Piazzesi, M. (2000), "A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables," Working Paper, Columbia University.
- Hall, A.D., Anderson, H.M. and Granger, C.W.J. (1992), "A Cointegration Analysis of Treasury Bill Yields," *Review of Economics and Statistics*, 74, 116-126.
- Pagan, A.R., Hall, A.D. and Martin, V. (1996), "Modeling the Term Structure," in C.R Rao and G.S. Maddala (eds.), Handbook of Statistics, 91-118. Amsterdam: North-Holland.

- Balduzzi, P., S. R. Das, S. Foresi, and R. Sundaram (1996), " A Simple Approach to Three Factor Affine Term Structure Models," *Journal of Fixed Income*, 6,43-53.
- Cox, J .C., Ingersoll, J .E. and Ross, S.A. ( 1979), "Duration and Measurement of Basis Risk," *Journal of Business*, 52, 51-61.
- Cox, J.C., Ingersoll, J.E. and Ross, S.A. (1985), "A Theory of the Term Structure of Interest Rates," *Econometrica*, 53,385-407.
- Duffie, D. and Kan, R. ( 1996 ), " A Yield-Factor Model of Interest Rates," *Mathematical Finance*, 6,379-406.
- Duffee, G. (2001), "Term premia and interest rate forecasts in affine models," *Journal of Finance*, forthcoming.
- Hull, J. and White, A. ( 1990), "Pricing Interest-Rate-Derivative Securities," *Review of Financial Studies*,3, 573-592.
- Nelson, C.R. and Siegel, A.F. (1987), "Parsimonious Modeling of Yield Curves," *Journal of Business*, 60,473-489.
- Swanson, N .R. and White, H. ( 1995), " A Model-Selection Approach to Assessing the Information in the Term Structure Using Linear Models and Artificial Neural Networks," *Journal of Business and Economic Statistics*, 13,265-275.
- Vasicek, O. ( 1977), " An Equilibrium Characterization of the Term Structure," *Journal of Financial Economics*, 5, 177-188.

**b) Estimating Inflation Expectations and Predicting the Real Economy from the Yield Curve**

Campbell Harvey

- Deacon M. and Derry A., (1994), Deriving estimates of inflation expectations from the prices of UK government bonds, *Bank of England Working Paper no.23*.
- Breedon F.J. and Chanda J,(1997), The information Content of the inflation term structure, *Bank of England Working Paper no.75*.
- Svensson L, (1992), Monetary Policy with flexible exchange rates and forward interest rates as indicators, *Banque de France, Cahiers economique et monetaires*, 43,305-332.
- Frankel J.A. and C.S.Lown (1994), An indicator of future inflation extracted from the steepness of the interest rate yield curve along its entire length, *Quarterly Journal of Economics*, 437,517-530.
- Soderlind P.,(1995), Forward interest rates as indicators of inflation expectations, mimeo

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