Selected readings

August 2004

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Introduction

Robert F. Engle, New York University Stern School of Business Professor, has been awarded the 2003 Nobel Prize in Economics. He shares the prize with Clive W. J. Granger

(See Selecting Readings May 2004 <u>http://europa.eu.int/comm/eurostat/Public/datashop/print-</u> product/EN?catalogue=euroindicators&product=LN-SR052004-EN&mode=download).

Engle has been honoured for "methods of analysing economic time series with timevarying volatility (ARCH)". Until the 1980s, both researchers and practitioners in financial markets used models in which volatility was assumed constant over time. In the early 1980s Robert Engle developed a new concept that he termed autoregressive conditional heteroskedasticity, ARCH, to take in account volatility. He demonstrated that it accurately captures the properties of many time series and developed methods for statistical modelling of time-varying volatility.

On financial markets, random fluctuations over time - volatility - are particularly significant because the value of shares, options and other financial instruments depends on their risk. Modelling volatility or, in other words, the covariance structure of asset returns, is essential. Fluctuations can vary considerably over time; turbulent periods with large fluctuations are followed by calmer periods with small fluctuations.

Engle's research topics include Cointegration, Weak Exogeneity, Band Spectrum Regression, Autoregressive Conditional Duration (ACD), Conditional Autoregressive Value at Risk (CAViaR), and Dynamic Conditional Correlation (DCC). He has applied these methods to analyse equities, options, currencies, interest rates and market microstructure. His recent research interests include methods to analyze large systems of assets, real time volatility, market microstructure, and extreme market movements.

Robert F Engle received a B.A. in Physics from Williams College in 1964, a MS in Physics from Cornell University in 1966, and a Ph.D. in Economics from Cornell in 1969. He was a first assistant professor at Massachusetts Institute of Technology (MIT) from 1969-74, and then associate professor. He moved to the University of California, San Diego in 1975, becoming an associate professor and then a full professor in 1977. He was chair of the Department of Economics from 1990 to 1994. Currently he is Michael Armellino Professor in the Management of Financial Services at NYU's Stern School of Business, Department of Finance. He is a Council member of the Econometric Society, a member of the American Academy of Arts and Sciences and of the American Statistical Association, a member of the editorial board of real Estate Economics for the year 2004. He lectures widely to both academic and practitioner audiences.

During his career he got several awards and honours, amongst them: the Roger F. Murray Prize Competition of the Institute for Quantitative Research in Finance, 1991; the Excellence in Teaching from MIT Graduate Economics Association, in 1974-1975.

The following list is a non-exhausting, subjective selection of Engle's publications, please have a look at <u>http://pages.stern.nyu.edu/~rengle/</u> for a more detailed list.

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Focus on : Robert F. Engle

"Multiperiod Forecast Error Variances of Inflation Estimated from Arch Models," (with D. Kraft), UCSD Discussion Papers N81 (1981)

Abstract: The uncertainty about the value of a variable k periods in the future, conditioned on current information, is taken to be the conditional variance of the k-period forecast error. Because the ARCH model of Engle allows the conditional variance to depend on elements of the information set, changes in uncertainty over time can be modelled. The conventional time-series expression for forecast variance is seen to be a special case of the expression for the conditional forecast variance from the ARCH model. The multiple-step prediction variance, which usually grows with forecast horizon, has the property that it can decrease the farther ahead one forecasts. An empirical example with inflation demonstrates this behaviour. A time-series of one-year ahead inflation variances exhibit substantial movement in the early 1950's, and a slight increase in the mid-1970's, compared to the 1960's.

Abstract available at:

http://cdi.mecon.gov.ar/INVESTIGACIONES/ENGLE.PDF (page 59)

"Autoregressive Conditional Heteroskedasticity With Estimates of the Variance of U.K. Inflation," Econometrica 50 (1982): 987-1008.

Access to full text is restricted to JSTOR subscribers. See http://www.jstor.org for details.

Ordering information:

http://econpapers.hhs.se/article/ecmemetrp/v_3A50_3Ay_3A1982_3Ai_3A4_3Ap_3A987 -1007.htm

"A General Approach to Lagrange Multiplier Model Diagnostics," Journal of Econometrics 20 (1982): 83-104.

Abstract: A diagnostic test can be formulated by taking the current model as the null hypothesis and a particular form of misspecification as the alternative. The general approach of this paper is to calculate the score for some alternative and base a test on its distribution under the null. This distribution is derived in two theorems corresponding to different models. Such a test is a Langrange Multiplier test and is asymptotically optimal. these tests can be formulated as ways of looking at the residuals for particular types of non-randomness. The tests are simple to calculate even when the alternative may be very complicated. Examples are given of tests for omitted variables and block-recursive structures.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(82)90104-X

"Exogeneity," (with D. F. Hendry and J. F. Richard), Econometrica 51 (1983): 277-304.

Access to full text is restricted to JSTOR subscribers. See http://www.jstor.org for details.

Ordering information:

http://econpapers.hhs.se/scripts/search.asp?ft=&ftp=false&adv=true&wp=on&art=on&bk chp=on&soft=on&pl=&auth=on&mh=100&sort=rank&lgc=AND&aus=Engle&kw=Exog eneity&kwp=false&jel=&ni=&nit=epdate

"Alternative Algorithms for the Estimation of Dynamic Factor, MIMIC, and Varying Coefficient Regression Models," (with M. Watson), Journal of Econometrics 23 (1983): 385-400.

Abstract: This paper provides a general approach to the formulation and estimation of dynamic unobserved component models. After introducing the general model, two methods for estimating the unknown parameters are presented. Both are algorithms for maximizing the likelihood function. The first is based on the method of Scoring. The second is the EM algorithm, a derivative-free method. Each iteration of EM requires a Kalman filter and smoother followed by straightforward regression calculations. The paper suggests using the EM methods to quickly locate a neighbourhood of the maximum. Scoring can then be used to pinpoint the maximum and calculate the information matrix.

Abstract available at: <u>http://dx.doi.org/10.1016/0304-4076(83)90066-0</u>

"Estimates of the Variance of U.S. Inflation Based on the ARCH Model," Journal of Money, Credit and Banking 15 (1983): 286-301.

Access to full text is restricted to JSTOR subscribers. See http://www.jstor.org for details.

"Combining Competing Forecasts of Inflation Based on a Bivariate ARCH Model," (with D. Kraft and C.W.J. Granger), Journal of Economic Dynamics and Control 8 (1984): 51-165.

Abstract: This paper sets out the basic structure of the bivariate generalization of Engle's ARCH model. Conditions which guarantee that the conditional covariance matrix is well defined are summarized, as are estimation and hypothesis testing. The process is used to combine forecasts where the weights are allowed to vary over time. Forecast errors from competing models are treated as a bivariate ARCH process so that the conditional covariance matrix adapts over time. At each point in time these conditional estimates of the variances and covariances are used to construct the optimal weights for combining the forecasts. Consequently, when one model is fitting well, its variance will be reduced and its weight will be increased. Two models of US inflation are constructed; one is a stylized monetarist model while the other is a mark-up model. The forecast errors are modeled as a simple bivariate ARCH process. Diagnostic tests reveal that this has overly restricted the parameterization of the covariance matrix. An approximation to the theoretically anticipated factor structure model is then estimated. The results in both cases show the weights varying over the sample period in moderately interpretable fashion.

Abstract available at:

http://dx.doi.org/10.1016/0165-1889(84)90031-9

"Small-Sample Properties of ARCH Estimators and Tests," (with D. Hendry and D. Trumble), Canadian Journal of Economics 18 (1985): 66-93.

Access to text is restricted to JSTOR subscribers. See http://www.jstor.org for details.

Available at:

http://economics.ca/cje/en/online.php

"Wholesale and Retail Prices: Bivariate Modeling with Forecastable Variances," (with C.W.J. Granger and R. Robins), in Model Reliability, ed. D. Belsley and E. Kuh, MIT Press (1986): 1-17.

Book description: This book addresses an often neglected aspect of econometrics, the question of how to assess the specification, strengths, weaknesses, limits, and sensitive features of a model. The contributions are the result of a five-year inter-university research project to improve understanding of concepts of model reliability.

Book available at:

http://mitpress.mit.edu/catalog/item/default.asp?tid=9824&ttype=2

"Modelling the Persistence of Conditional Variances," (with T. Bollerslev), Econometric Reviews 5 (1986): 1-50.

Abstract: This paper will discuss the current research in building models of conditional variances using the Autoregressive Conditional Heteroskedastic (ARCH) and Generalized ARCH (GARCH) formulations. The discussion will be motivated by a simple asset pricing theory which is particularly appropriate for examining futures contracts with risk averse agents. A new class of models defined to be integrated in variance is then introduced. This new class of models includes the variance analogue of a unit root in the mean as a special case. The models are argued to be both theoretically important for the asset pricing models and empirically relevant. The conditional density is then generalized from a normal to a Student-t with unknown degrees of freedom. By estimating the degrees of freedom, implications about the conditional kurtosis of these models and time aggregated models can be drawn. A further generalization allows the conditional variance to be a non-linear function of the squared innovations. Throughout, empirical estimates of the logarithm of the exchange rate between the United States dollar and the Swiss franc are presented to illustrate the models.

Abstract available at:

http://cdi.mecon.gov.ar/INVESTIGACIONES/ENGLE.PDF

(page 57)

"Estimation of Time Varying Risk Premia in the Term Structure: the ARCH-M Model," (with D. M. Lilien and R. P. Robins), Econometrica 55 (1987): 391-407.

Abstract: The expectation of the excess holding yield on a long bond is postulated to depend upon its conditional variance. Engle's ARCH model is extended to allow the conditional variance to be a determinant of the mean and is called ARCH-M. Estimation and infer ence procedures are proposed, and the model is applied to three interest rate data sets. In most cases the ARCH process and the time varying risk premium are highly significant. A collection of LM diagnostic tests reveals the robustness of the model to various specification changes such as alternative volatility or ARCH measures, regime changes, and interest rate formulations. The model explains and interprets the recent econometric failures of the expectations hypothesis of the term structure. Copyright 1987 by The Econometric Society.

Abstract available at:

http://econpapers.hhs.se/article/ecmemetrp/v_3A55_3Ay_3A1987_3Ai_3A2_3Ap_3A391 -407.htm

"Co-integration and Error Correction: Representation, Estimation and Testing," (with C.W.J. Granger), Econometrica 55 (1987): 251-276.

Abstract: The relationship between cointegration and error correction models, first suggested by Granger, is here extended and used to develop estimation procedures, tests, and empirical examples. A vector of time series is said to be cointegrated with cointegrating vector a if each element is stationary only after differencing while linear combinations a8xt are themselves stationary. A representation theorem connects the moving average , autoregressive, and error correction representations for cointegrated systems. A simple but asymptotically efficient two-step estimator is proposed and applied. Tests for cointegration are suggested and examined by Monte Carlo simulation. A series of examples are presented. Copyright 1987 by The Econometric Society.

Abstract available at:

http://econpapers.hhs.se/article/ecmemetrp/v_3A55_3Ay_3A1987_3Ai_3A2_3Ap_3A251 _76.htm

"Forecasting and Testing in Co-integrated Systems," (with B. S. Yoo), Journal of Econometrics 35 (1987): 143-159.

Abstract: This paper examines the behaviour of forecasts made from a co-integrated system as introduced by Granger (1981), Granger and Weiss (1983) and Engle and Granger (1987). It is established that a multi-step forecast will satisfy the co-integrating relation exactly and that this particular linear combination of forecasts will have a finite limiting forecast error variance. A simulation study compares the multi-step forecast accuracy of unrestricted vector autoregression with the two-step estimation of the vector autoregression imposing the co integration restriction. To test whether a system exhibits co-integration, the procedures introduced in Engle and Granger (1987) are extended to allow different sample sizes and numbers of variables.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(87)90085-6

"A Capital Asset Pricing Model with Time Varying Covariances," (with T.P. Bollerslev and J.M. Wooldridge), Journal of Political Economy 96 (1988): 116-131.

Abstract: The capital asset pricing model provides a theoretical structure for the pricing of assets with uncertain returns. The premium to induce risk-averse investors to bear risk is proportional to the nondiversifiable risk, which is measured by the covariance of the asset return with the market portfolio return. In this paper, a multivariate, generalized-autoregressive, conditional, heteroscedastic process is estimated for returns to bills, bonds, and stocks where the expected return is proportional to the conditional covariance of each return with that of a fully diversified or market portfolio. It is found that the conditional covariances are quite variable over time and are a significant determinant of the time-varying risk premia. The implied betas are also time varying and forecastable. Copyright 1988 by University of Chicago Press.

Abstract available at:

http://econpapers.hhs.se/article/ucpjpolec/v_3A96_3Ay_3A1988_3Ai_3A1_3Ap_3A116-31.htm

"Merging Short and Long Run Forecasts: An Application of Seasonal Cointegration to Monthly Electricity Sales Forecasting," (with C. W. J. Granger and J. J. Hallman), Journal of Econometrics 40 (1989): 45-62.

Abstract: When forecasts of a series Y_t must be made for several horizons, it is a common practice to build different models to forecast different horizons. This paper shows how the information in the several models can be combined in an error-correction framework to yield a single set of forecasts which outperform those from the separate models. The notions of seasonal integration and cointegration are introduced. The methods are applied to forecasting monthly commercial electricity sales with some success. Also reported are results of some simulation experiments designed to evaluate their effectiveness

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(89)90029-8

"Seasonal Integration and Cointegration," (with S. Hylleberg, C.W.J. Granger, and B.S. Yoo) Journal of Econometrics 44 (1990): 215-238.

Abstract: This paper develops tests for roots in linear time series which have a modulus of one but which correspond to seasonal frequencies. Critical values for the tests are generated by Monte Carlo methods or are shown to be available from Dickey-Fuller or Dickey-Hasza-Fuller critical values. Representations for multivariate processes with combinations of seasonal and zero-frequency unit roots are developed leading to a variety of autoregressive and error-correction representations. The techniques are used to examine cointegration at different frequencies between consumption and income in the U.K.

Abstract available at:

<u>doi:10.1016/0304-4076(90)90080-D</u>

"Asset Pricing with a Factor ARCH Covariance Structure: Empirical Estimates for Treasury Bills," (with V. K. Ng and M. Rothschild), Journal of Econometrics 45 (1990): 213-237.

Abstract: In this paper we suggest using the FACTOR-ARCH model as a parsimonious structure for the conditional covariance matrix of asset excess returns. This structure allows us to study the dynamic relationship between asset risk premia and volatilities in a multivariate system. One and two FACTOR-ARCH models are successfully applied to pricing of Treasury bills. The results show stability over time, pass a variety of diagnostic tests, and compare favorably with previous empirical findings.

Abstract available at: http://dx.doi.org/10.1016/0304-4076(90)90099-F

"Meteor Showers or Heat Waves? Heteroskedastic Intra-daily Volatility in the Foreign Exchange market," (with T. Ito and W.L. Lin), Econometrica 58 (1990): 525-542.

Abstract: This paper seeks to explain the causes of volatility clustering in exchange rates. Careful examination of intra-daily exchange rates provides a test of two hypotheses--heat waves and meteor showers. The heat wave hypothesis is that the volatility in one market is

predicted only by the past of that market. The meteor shower hypothesis is that intra-daily volatility spills over from one market to the next. Using the GARCH model to specify the heteroskedasticity across intra-daily market segments, we find that the empirical evidence is generally against the null hypothesis of the heat wave. Using a volatility type of vector autoregression we examine the impact of news in one market on the time path of per-hour volatility in other markets. Copyright 1990 by The Econometric Society.

Abstract available at:

http://econpapers.hhs.se/article/ecmemetrp/v_3A58_3Ay_3A1990_3Ai_3A3_3Ap_3A525 -42.htm

"Time-Varying Volatility and the Dynamic Behaviour of the Term Structure," (with V. K. Ng) National Bureau of Economic Research, NBER, Working Papers No. 3682 (1991)

Abstract: In this paper, we consider a framework with which the cross sectional and time series behaviour of the yield curve can be studied simultaneously. We examine the relationship between the yield curve and the time-varying conditional volatility of the Treasury bill market. We demonstrate that differently shaped yield curves can result given different combinations of volatility and expectations about future spot rates. Moreover, adjusting the forward rate for the volatility related liquidity premium can improve its performance as a predictor of future spot rates at least for the period from August 1964 to August 1979.

Available at:

http://papers.nber.org/papers/w3682.pdf

"Implied ARCH Models from Options Prices," (with C. Mustafa), Journal of Econometrics 52 (1992): 289-311.

Abstract: This paper estimates the implied stochastic process of the volatility of an asset from the prices of options written on the asset. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is used to parameterize the process. Then the GARCH model implied by the option market is estimated by a generalized simulation minimization method from option price data. The persistence of volatility shocks implied by options on the Standard & Poor's 500 is found to be similar to that estimated from historical data on the index itself. However, the implied persistence after the meltdown in October 19, 1987 was much weaker. We use post October 19, 1987 data on the cash market prices to verify the correctness of the option markets' use of the less persistent model.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(92)90074-2

"A Multi-Dynamic Factor Model for Stock Returns," (with V. K. Ng and M. Rothschild), Journal of Econometrics 52 (1992): 245-266.

Abstract: In this paper, we define dynamic and static factors and distinguish between the dynamic and static structure of asset excess returns. We examine the value-weighted market portfolio as a dynamic factor and propose an intuitively appealing procedure to search for more dynamic factors. We find evidence that the market is a dynamic factor but a three-dynamic-factor model is superior in modelling the decile portfolios. The two additional factors are correlated with a January dummy and Bond risk premium and with

production growth and a recession dummy, respectively. We found that small firms are more sensitive to the January/Bond risk factor, while large firms are more sensitive to the Production/Recession factor. We found that after accounting for the systematic risk corresponding to the three dynamic factors, there is not much of a static component of asset risk premium and there is no evidence for a higher 'unexplained' return on small firm portfolios.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(92)90072-Y

"Semi-Parametric ARCH Models," (with G. Gonzalez-Rivera), Journal of Business and

Economic Statistics 9 (1991): 345-359.

Abstract: A semiparametric ARCH model is introduced with conditional first and second moments given by ARMA and ARCH formulations, and a conditional density that is approximated by a nonparametric density estimator. For several densities, the relative efficiency of the quasi-maximum likelihood estimator is compared with maximum likelihood under correct specification. These potential efficiency gains for a fully adaptive procedure are compared in a Monte Carlo experiment with the observed gains from using the semiparametric procedure, and it is found that the estimator captures a substantial proportion of the potential. The estimator is applied to daily stock returns and to the British pound/dollar exchange rate

Abstract available at:

http://econpapers.hhs.se/article/besjnlbes/v_3A9_3Ay_3A1991_3Ai_3A4_3Ap_3A345-59.htm

"Measuring Risk Aversion From Excess Returns on a Stock Index," (with R. Chou and A. Kane), Journal of Econometrics 52 (1992): 201-224.

Abstract: Measuring risk aversion from excess returns on a stock index presents two obstacles: 1. the time path of the stock-index variance needs to be modelled and estimated, and 2. other components of wealth must be accounted for. We distinguish two measures that relate the risk premium to variance: 1. the measure of risk aversion which, by the single-factor CAPM, would be the slope coefficient in the linear relation between the mean excess return and the variance of the overall risky portfolio of the representative investor, and 2. the slope coefficient in the linear relationship between the mean excess return on a stock index and its variance. Even when risk aversion is constant, the latter can vary significantly with the relative share of stocks in the risky wealth portfolio, and with the beta of unobserved wealth on stocks. We introduce a statistical model with ARCH disturbances and a time-varying parameter in the mean (TVP ARCH-M). The model decomposes the predictable component in stock returns into two parts: the time-varying price of volatility and the time-varying volatility of returns. The relative share of stocks and the beta of the excluded components of wealth on stocks are instrumented by macroeconomic variables. The ratio of corporate profit over national income and the inflation rate are found to be important forces in the dynamics of stock price volatility.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(92)90070-8

"A multi-dynamic-factor model for stock returns," (with V. Ng and M. Rothschild), Journal of Econometrics 52 (1992): 245-266.

Abstract: In this paper, we define dynamic and static factors and distinguish between the dynamic and static structure of asset excess returns. We examine the value-weighted market portfolio as a dynamic factor and propose an intuitively appealing procedure to search for more dynamic factors. We find evidence that the market is a dynamic factor but a three-dynamic-factor model is superior in modelling the decile portfolios. The two additional factors are correlated with a January dummy and Bond risk premium and with production growth and a recession dummy, respectively. We found that small firms are more sensitive to the January/Bond risk factor, while large firms are more sensitive to the Production/Recession factor. We found that after accounting for the systematic risk corresponding to the three dynamic factors, there is not much of a static component of asset risk premium and there is no evidence for a higher 'unexplained' return on small firm portfolios.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(92)90072-Y

"Seasonal Cointegration: The Japanese Consumption Function," (with C.W.J. Granger, S. Hylleberg, and H.S. Lee), Journal of Econometrics 55 (1993): 275-298.

Abstract: A theory of seasonal cointegration and integration is discussed in Hylleberg, Engle, Granger, and Yoo (1990) and tests for seasonal unit roots are also developed. To estimate and test for seasonal cointegration at each frequency, a two-step procedure similar to the one suggested by Engle and Granger (1987) is investigated in this paper. Using Japanese dataon consumption and income, evidence in favour of seasonal cointegration at frequency ¹/₄ is found. An economic interpretation of this cointegrating relation is presented using the notion of a slightly impatient borrowing-constrained utilitymaximizing consumer. While the test statistics for noncointegration occurring at the frequency ¹/₂ of a cycle have the same distribution as the test statistic obtained for the zero frequency case by Engle and Granger (1987) and Engle and Yoo (1987), the distribution of the test statistics for noncointegration at the frequency ¹/₄ (and ³/₄) is derived based on the asymptotic distribution theory for testing a pair of complex roots on the unit circle [Ahtola and Tiao (1987), Chan and Wei (1988)]. The critical values and evidence on the power of the test are obtained through Monte Carlo simulations.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(93)90016-X

"Testing Superexogeneity and Invariance in regression models," (with D. Hendry), Journal of Econometrics 56 (1993): 119-139.

Abstract: This paper introduces tests of superexogeneity and invariance. Under the null hypothesis the conditional model exhibits parameter constancy, while under the alternative shifts in the process of the independent variables induces shifts in the conditional model. The test is sensitive to particular types of parameter nonconstancy, especially with changing variances and covariances. We relate the test to rational expectations models and the Lucas critique. An empirical example of money demand finds prices and interest rates superexogenous in a conditional model, but when the inflation specification changes, superexogeneity fails although standard specification tests do not.

Abstract available at:

http://dx.doi.org/10.1016/0304-4076(93)90103-C

"Time Varying Volatility and the Dynamic Behavior of the Term Structure," (with V. K. Ng), Journal of Money, Credit and Banking 25 (1993): 336-349.

Abstract: In this paper, the authors consider a framework in which the cross-sectional and time-series behavior of the yield curve can be studied simultaneously. They examine the relationship between the yield curve and the time-varying conditional volatility of the Treasury bill market. The authors demonstrate that different shaped yield curves can result given different combinations of volatility and expectations about future spot rates. Moreover, adjusting the forward rate for the volatility related forward premium can improve its performance as a predictor for the future spot rate.

Abstract available at:

http://econpapers.hhs.se/article/mcbjmoncb/v_3A25_3Ay_3A1993_3Ai_3A3_3Ap_3A33 6-49.htm

"Common Volatility in International Equity Markets," (with R. Susmel), Journal of Business and Economic Statistics 11 (1993): 167 - 176.

Abstract: In this article, the authors take advantage of the time-varying structure of stockreturns variances to investigate whether two international stock markets share the same volatility process. They use a test recently developed by R. F. Engle and S. Kozicki (1990). This test is also used to assess the validity of a one-factor autoregressive conditional heteroskedasticity model. The authors find that some international stock markets have the same time-varying volatility.

Abstract available at:

http://econpapers.hhs.se/article/besjnlbes/v_3A11_3Ay_3A1993_3Ai_3A2_3Ap_3A167-76.htm

"Common Persistence in Conditional Variances," (with T. Bollerslev), Econometrica 61 (1993): 167-186.

Abstract: A common finding in many of the recent empirical studies with the ARCH class of models applied to high frequency financial data concerns the apparent persistence of shocks for forecast of the future conditional variances. It is likely that several different variables share this same implied long-run component, however. In that situation, the variables are defined to be copersistent in variance. Conditions for copersistence to occur in the linear multivariate GARCH model are presented. These conditions parallel the conditions for linear cointegration in the mean. A simple empirical example with foreign exchange rate data illustrates the ideas. Copyright 1993 by The Econometric Society.

Abstract available at:

http://econpapers.hhs.se/article/ecmemetrp/v_3A61_3Ay_3A1993_3Ai_3A1_3Ap_3A167 -86.htm

"Testing for Common Features," (with S. Kozicki), Journal of Business and Economic Statistics 11 (1993): 369 – 380.

Abstract: This article introduces a class of statistical tests for the hypothesis that some feature that is present in each of several variables is common to them. Features are data

properties such as serial correlation, trends, seasonality, heteroscedasticity, autoregressive conditional heteroscedasticity, and excess kurtosis. A feature is detected by a hypothesis test taking no feature as the null, and a common feature is detected by a test that finds linear combinations of variables with no feature. Often, an exact asymptotic critical value can be obtained that is simply a test of over-identifying restrictions in an instrumental variable regression. This article tests for a common international business cycle.

Abstract available at:

http://econpapers.hhs.se/article/besjnlbes/v_3A11_3Ay_3A1993_3Ai_3A4_3Ap_3A369-80.htm

"Common Trends and Common Cycles," (with F. Vahid), Journal of Applied Econometrics 8 (1993): 341-360.

Abstract: The existence of a serial correlation common feature among the first differences of a set of I(1) variables implies the existence of a common cycle in the Beveridge-Nelson-Stock-Watson decomposition of those variables. A test for the existence of common cycles among cointegrated variables is developed. The test is used to examine the validity of the common trend-common cycle structure implied by Flavin's excess sensitivity hypothesis and Campbell and Mankiw's mixture of rational expectations and rule-of-thumb hypothesis for consumption and income. Linear independence between the cointegration and the cofeature vectors is exploited to decompose consumption and income into their trend and cycle components. Copyright 1993 by John Wiley & Sons, Ltd.

Abstract available at:

http://econpapers.hhs.se/article/jaejapmet/v_3A8_3Ay_3A1993_3Ai_3A4_3Ap_3A341-60.htm

"Measuring and Testing the Impact of News on Volatility," (with V. K. Ng) Journal of Finance 48 (1993): 1749-1778

Abstract: This paper defines the news impact curve which measures how new information is incorporated into volatility estimates. Various new and existing ARCH models including a partially nonparametric one are compared and estimated with daily Japanese stock return data. New diagnostic tests are presented which emphasize the asymmetry of the volatility response to news. Our results suggest that the model by Glosten, Jagannathan, and Runkle is the best parametric model. The EGARCH also can capture most of the asymmetry; however, there is evidence that the variability of the conditional variance implied by the EGARCH is too high.

Abstract available at:

http://www.afajof.org/asp/abs/00221082-di992040-99p0233d.asp?id=60686168647374759399919514314414514614714814&art_lnk=/asp/ar ticlejstore.asp?user=60686168647374759399919514314414514614714814&jofireg=

"A Long Memory Property of Stock Market Returns and a New Model," (with Z. Ding and C.W.J. Granger), Journal of Empirical Finance 1 (1993): 83-106.

Abstract: A 'long memory' property of stock market returns is investigated in this paper. It is found that not only there is substantially more correlation between absolute returns than returns themselves, but the power transformation of the absolute return $|r_{t_1}|^d$ also has quite high autocorrelation for long lags. It is possible to characterize $|r_{t_1}|^d$ to be 'long memory'

and this property is strongest when d is around 1. This result appears to argue against ARCH type specifications based upon squared returns. But our Monte-Carlo study shows that both ARCH type models based on squared returns and those based on absolute return can produce this property. A new general class of models is proposed which allows the power bof the heteroskedasticity equation to be estimated from the data.

Abstract available at:

http://dx.doi.org/10.1016/0927-5398(93)90006-D

"Do Bulls and Bears Move Across Borders? International Transmission of Stock Returns and Volatility," (with W.-L. Lin and T. Ito), Review of Financial Studies 7 (1994): 507-538.

Abstract: This article investigates empirically how returns and volatilities of stock indices are correlated between the Tokyo and New York markets. Using intradaily data that define daytime and overnight returns for both markets, we find that Tokyo (New York) daytime returns are correlated with New York (Tokyo) overnight returns. We interpret this result as evidence that information revealed during the trading hours of one market has a global impact on the returns of the other market. In order to extract the global factor from the daytime returns of one market, we propose and estimate a signal-extraction model with GARCH processes. Article published by Oxford University Press on behalf of the Society for Financial Studies in its journal, The Review of Financial Studies.

Abstract available at:

http://econpapers.hhs.se/article/ouprfinst/v_3A7_3Ay_3A1994_3Ai_3A3_3Ap_3A507-38.htm

"GARCH Gammas," (with J. Rosenberg), Journal of Derivatives 2 (1995): 47-59. Also as NBER Working Paper N. 5128 (1995)

Abstract: This paper addresses the issue of hedging option positions when the underlying asset exhibits stochastic volatility. By parameterizing the volatility process as GARCH, and utilizing risk-neutral valuation, we estimate hedging parameters (delta and gamma) using Monte-Carlo simulation. We estimate hedging parameters for options on the Standard and Poor's 500 index, a bond futures index, a weighted foreign exchange rate index, and an oil futures index. We find that Black-Scholes and GARCH deltas are similar for all the options considered, while GARCH gammas are significantly higher than BS gammas for all options. For near the money options, GARCH gamma hedge ratios are higher than BS hedge ratios when hedging a long term option with a short term option. Away from the money, GARCH gamma hedge ratios are lower than BS.

Available at:

http://papers.nber.org/papers/w5128

"Multivariate Simultaneous GARCH," (with K. Kroner), Econometric Theory 11 (1995): 122-150 and Economics Working Paper Series from the Department of Economics, UC San Diego No. 89-57R (1993).

Abstract: This paper presents theoretical results in the formulation and estimation of multivariate generalized ARCH models within simultaneous equations systems. A new parameterization of the multivariate ARCH process is proposed and equivalence relations are discussed for the various ARCH parameterizations. Constraints sufficient to guarantee the positive definiteness of the conditional covariance matrices are developed, and

necessary and sufficient conditions for covariance stationarity are presented. Identification and maximum likelihood estimation of the parameters in the simultaneous equations context are also covered.

Available at:

http://www.econ.ucsd.edu/papers/files/ucsd8957r.pdf

"Estimating Common Sectoral Cycles," (with J. V. Issler), Journal of Monetary Economics 35 (1995): 83-113.

Abstract: We investigate in this paper the degree of short-run and long-run comovement in U.S. sectoral output data by estimating sectoral trends and cycles. A theoretical model based on Long and Plosser (1983) is used to derive a reduced form for sectoral outputs from first principles. Cointegration and common-cycle tests are performed; sectoral output data seem to share a relatively high number of common trends and a relatively low number of common cycles. A special trend-cycle decomposition of the data set is performed, and the results indicate a very similar cyclical behavior across sectors and very different behavior for trends. In a variance decomposition analysis, prominent sectors such as Manufacturing and Wholesale/Retail Trade exhibit relatively important transitory shocks

Abstract available at:

http://dx.doi.org/10.1016/0304-3932(94)01188-G *****

"ARCH: Selected Readings," Oxford University Press (1995).

Description: In the early 1980s, R. F. Engle pioneered the econometric technique of Auto-Regressive Conditional Heteroskedasticity (ARCH), which has subsequently generated a very considerable literature. This collection brings together readings on ARCH models, both applied and theoretical, half by Engle himself and half by other econometricians working in the field. It begins with an introduction by the editor which traces the development of the field.

Description and ordering information:

http://www.oup.co.uk/isbn/0-19-877432-X

"Seasonal Common Features: Global Unemployment," (with S. Hylleberg), Oxford Bulletin of Economics and Statistics 58 (1996): 615-630. Reprinted in "The Econometrics of Economics Policy", ed. A. Banerjee and D. Hendry, Blackwell Publishers (1997).

Book description: The collection of papers, by the leading practitioners in the field, deals with various aspects of the econometric evaluation of models designed to investigate the effects of economic policies, including forecasting, structural stability testing and simulating policy responses.

Ordering information:

http://www.blackwellpublishing.com/book.asp?ref=0631203435&site=1

"Forecasting the Frequency of Changes in Quoted Foreign Exchange Prices with the ACD Model," (with J. R. Russell), Journal of Empirical Finance 12 (1997):187-212.

Abstract: This paper applies the Autorecressive Conditional Duration model to Foreign Exchange quotes arriving on Reuters screens. The Autoregressive Conditional Duration model, developed in Engle and Russell (1995) [Engle, R., Russell, J., 1995. Autoregressive conditional duration; a new model for irregularly spaced time series data, University of California, San Diego, unpublished manuscript.], is a new statistical model for the analysis of data that does not arrive in equal time intervals. When Dollar/Deutschmark data are examined, it is clear that many of the price quotes are simply noisy repeats of the previous quote. By systematically thinning the sample, a measure of the time between price changes is developed. These price durations are modelled with the ACD to obtain estimates of the instantaneous intensity of price changes. This measure is related to standard measures of volatility but is formulated in a way that incorporates the information in the irregular sampling intervals. A simple market microstructure model implies that the bid-ask spread should have predictive power for the volatility which is supported by the data. A model of price leadership however, is not supported.

Abstract available at:

doi:10.1016/S0927-5398(97)00006-6

"Conditional Volatility of Exchange Rates Under a Target Zone", (with Y.-F. Gau), Discussion Paper No. 97-06 (1997).

Abstract: To study the impact of institutional features of target zones on the conditional volatility of exchange rates, this paper proposes a simple and intuitive model to incorporate the announced information in the bands. Observing the statistical characteristics of the EMS cross rate returns- mean reversion and heteroskedasticity, we fit a GARCH(1,1)-MA(1) specification incorporating the deviation of exchange rates from the central parity. This model allows us to easily examine the relationship between the conditional volatility and the position of spot rates. We find in particular, that for the Irish punt and Italian lira DM rates, the conditional volatility increases as the exchange rate approaches the edges of the band. We extend the above univariate model to a multivariate setting to take account of the cross country interactions in the EMS, by including a vector consisting of all EMS currencies' positions in the GARCH equation. The estimation results show that other currencies' positions do affect the conditional volatility of a specific EMS currency. Understanding the importance of intra-ERM coherence and the multilateral commitment on the central parity, we follow Pill (1994) to derive an effective band model to examine how the multilateral grid affects the conditional volatility. However, the estimation results suggest that the full set of all deviations from official central parity of each member country explains the volatility better than does simply the deviation from the effective band.

Available at:

<u>ftp://weber.ucsd.edu/pub/econlib/dpapers/ucsd9706.pdf</u>

"ARCH Models," (with D. Nelson and T. Bollerslev) in Handbook of Econometrics, Volume IV, ed. R.Engle and D. McFadden, North Holland (1994), 2959-3038.

Abstract: This chapter evaluates the most important theoretical developments in *ARCH* type modelling of time-varying conditional variances. The coverage include the specification of univariate parametric *ARCH models*, general inference procedures,

conditions for stationarity and ergodicity, continuous time methods, aggregation and forecasting of *ARCH models*, multivariate conditional covariance formulations, and the use of model selection criteria in an *ARCH* context. Additionally, the chapter contains a discussion of the empirical regularities pertaining to the temporal variation in financial market volatility. Motivated in part by recent results on optimal filtering, a new conditional variance model for better characterizing stock return volatility is also presented.

Abstract and ordering information:

http://www1.elsevier.com/homepage/sae/econworld/hes.htm

"Codependent cycles," (with F. Vahid), Journal of Econometrics 80 (1997): 199-221.

Abstract: This paper extends the work of Engle and Kozicki (1993) to test for comovement in multiple time series when their cycles are not exactly synchronized. We call these codependent cycles and show that testing and estimation in this case will be a Generalized Method of Moments test and estimation procedure. We also show that the Tiao and Tsay (1985) proposed test for scalar components models of order (0, q) can be seen as a test for codependent cycles based on a consistent, but sub-optimal, estimate of the cofeature vector. We assess the small sample performance of the proposed tests through a series of simulations. Finally we apply this test to investigate comovement between durable and non-durable consumption expenditures.

Abstract available at:

http://dx.doi.org/10.1016/S0304-4076(97)00032-8

"Autoregressive Conditional Duration: A New Model for Irregularly Spaced Transaction Data," Econometrica 66 (1998): 1127-1162.

Abstract: This paper proposes a new statistical model for the analysis of data which arrives at irregular intervals. The model treats the time between events as a stochastic process and proposes a new class of point processes with dependent arrival rates. The conditional intensity is developed and compared with other self-exciting processes. Because the model focuses on the expected duration between events, it is called the Autoregressive Conditional Duration (ACD) model. Asymptotic properties of the Quasi Maximum Likelihood estimator are developed as a corollary to ARCH model results. Strong evidence is provided for duration clustering for the financial transactions data analyzed; both deterministic time-of-day effects and stochastic effects are important. The model is applied to the arrival times of trades and therefore is a model of transaction volume, and also to the arrival of other events such as price changes. Models for the volatility of prices are estimated with price based durations, and examined from a market microstructure point of view.

Available at:

ftp://weber.ucsd.edu/pub/rengle/acd.pdf

"Correlations and Volatilities of Asynchronous Data," (with P. Burns and J. Mezrich), Journal of Derivatives summer (1998): 1-12

Abstract: Asset prices are typically measured when markets close however the closing times may differ across markets. As a result the returns appear to have predictability and correlations are understated. This will distort the value of portfolios, value at risk measures, and hedge strategies. A solution is proposed. Prices can be "synchronized" by

computing estimates of the values of assets even when markets are closed, given information from markets which are open. From these prices, synchronized returns are defined and can be used to perform standard calculations including measuring time varying volatilities and correlations with GARCH. The method is applied to G7 index data.

Available at:

ftp://weber.ucsd.edu/pub/econlib/dpapers/ucsd9730r.pdf

"Stochastic Permanent Breaks," (with A. Smith), The Review of Economics and Statistics 81 (1999): 553-574.

Abstract: This paper aims to bridge the gap between processes where shocks are permanent and those with transitory shocks by formulating a process in which the long run impact of each innovation is time varying and stochastic. Frequent transitory shocks are supplemented by occasional permanent shifts. The stochastic permanent breaks (STOPBREAK) process is based on the premise that a shock is more likely to be permanent if it is large than if it is small. This formulation is motivated by a class of processes that undergo random structural breaks. Consistency and asymptotic normality of quasi maximum likelihood estimates is established and locally best hypothesis tests of the null of a random walk are developed. The model is applied to relative prices of pairs of stocks and significant test statistics result.

Available at:

ftp://weber.ucsd.edu/pub/econlib/dpapers/ucsd9803.pdf

"A Permanent and Transitory Component Model of Stock Return Volatility", (with G.J. Lee), in ed. R.F. Engle and H. White, Cointegration, Causality, and Forecasting: A Festschrift in Honor of Clive W.J. Granger, Oxford University Press (1999) 475-497.

Abstract: In this paper, we develop a statistical unobserved component model for stock market volatility. The volatility, which is measured by the conditional variance of stock returns, is decomposed into a permanent or long-run and a transitory or short-run component. The transitory component is mean-reverting towards the trend component. Analysis of US and Japanese stock data supports the decomposition and reinforce the common finding in the literature of persistent stock return volatility. The component model is successful in describing the effect of 'October 87' Crash' on stock volatility changes. We hypothesize that the 'leverage effect' as discussed in Black (1976) and Christie (1982) is a short-run phenomenon in the stock market and there is no asymmetric structure of volatility in the long run. The data strongly supports this hypothesis for US and Japanese stock indices

 Available in postscript format at:

 ftp://weber.ucsd.edu/pub/econlib/dpapers/

 File No. ucsd9244r.ps.gz

"The Econometrics of Ultra High Frequency Data," Econometrica 68 (2000): 1-22.

Abstract: Ultra-high frequency data are complete transactions data which inherently arrive at random times. Marked point processes provide a theoretical framework for analysis of such data sets. The ACD model developed by Engle and Russell (1995) is then applied to IBM transactions data to develop semi-parametric hazard estimates and measures of instantaneous conditional variances. The variances are negatively influenced by surprisingly long durations as suggested by some of the market micro-structure literature.

Available at:

ftp://weber.ucsd.edu/pub/econlib/dpapers/ucsd9615.pdf

"Time and the Price Impact of a Trade," (with A. Dufour), The Journal of Finance V55N6 (2000): 2467-2498.

Abstract: We use Hasbrouck's (1991) vector autoregressive model for prices and trades to empirically test and assess the role played by the waiting time between consecutive transactions in the process of price formation. We find that as the time duration between transactions decreases, the price impact of trades, the speed of price adjustment to traderelated information, and the positive autocorrelation of signed trades all increase. This suggests that times when markets are most active are times when there is an increased presence of informed traders; we interpret such markets as having reduced liquidity.

Available at:

http://weber.ucsd.edu/~mbacci/engle/291.pdf

"Testing the Volatility Term Structure Using Option Hedging Criteria," (with J. Rosenberg), Journal of Derivatives, (2000) V8N1, pp 10-28

Abstract: The Black-Scholes formula assumes future volatility is a constant and known parameter, but this is now well-known to be untrue. A variety of models with time-varying volatility have been introduced, but there is no consensus on which one is the best, or even on how to answer that question properly. Engle and Rosenberg propose that the appropriate test of the efficacy of a given volatility model should be how well it can hedge an options position. They consider five models: Black-Scholes (BS), a BS variant with mean-reverting implied volatility, and three forms of GARCH-based model. They test how well each one is able to hedge against changing volatility by comparing their performance in a hedge of one straddle with another. The most accurate model out of sample is the GARCH components-with-leverage model. By contrast, a delta-vega hedge based on the BS model was poor, frequently leading to higher variance for the hedge than for the unhedged position.

Abstract available at:

http://www.iijournals.com/JOD/default.asp?SM=ALL&DatePeriod=0&OB=D&Catalog=I IJ&Page=13&PID=105&SearchStr=Testing+the+Volatility+Term+Structure+Using+Opti on+Hedging+Criteria&PageMove=1

"Value at risk models in finance, " (with S. Manganelli), ECB Working Paper No. 75, (2001) Published in: Risk Measures for the 21st Century, "A Comparison of Value at Risk Models in Finance", edited by G. Szego, Wiley & Sons, (2004).

Abstract: Value at Risk (VaR) has become the standard measure that financial analysts use to quantify market risk. VaR is defined as the maximum potential change in value of a portfolio of financial instruments with a given probability over a certain horizon. VaR measures can have many applications, such as in risk management, to evaluate the performance of risk takers and for regulatory requirements, and hence it is very important to develop methodologies that provide accurate estimates. The main objective of this paper is to survey and evaluate the performance of the most popular univariate VaR methodologies, paying particular attention to their underlying assumptions and to their logical flaws. In the process, we show that the Historical Simulation method and its variants can be considered as special cases of the CAViaR framework developed by Engle and Manganelli (1999). We also provide two original methodological contributions. The first one introduces the extreme value theory into the CAViaR model. The second one concerns the estimation of the expected shortfall (the expected loss, given that the return exceeded the VaR) using a simple regression technique.

The performance of the models surveyed in the paper is evaluated using a Monte Carlo simulation. We generate data using GARCH processes with different distributions and compare the estimated quantiles to the true ones. The results show that CAViaR models are the best performers with heavy-tailed DGP.

Available at:

http://www.ecb.int/pub/pdf/scpwps/ecbwp075.pdf

"GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics", Journal of Economic Perspectives, V15N4 (2001): 157-168.

Abstract: ARCH and GARCH models have become important tools in the analysis of time series data, particularly in financial applications. These models are especially useful when the goal of the study is to analyze and forecast volatility. This paper gives the motivation behind the simplest GARCH model and illustrates its usefulness in examining portfolio risk. Extensions are briefly discussed.

Abstract available at:

http://econpapers.hhs.se/article/aeajecper/v_3A15_3Ay_3A2001_3Ai_3A4_3Ap_3A157-168.htm

"New Frontiers in ARCH Models," Journal of Applied Econometrics, V17N2 (2002): 425-446.

Abstract: In the 20 years following the publication of the ARCH model, there has been a vast quantity of research uncovering the properties of competing volatility models. Wideranging applications to financial data have discovered important stylized facts and illustrated both the strengths and weaknesses of the models. There are now many surveys of this literature. This paper looks forward to identify promising areas of new research. The paper lists five new frontiers. It briefly discusses three-high-frequency volatility models, large-scale multivariate ARCH models, and derivatives pricing models. Two further frontiers are examined in more detail-application of ARCH models to the broad class of non-negative processes, and use of Least Squares Monte Carlo to examine non-linear properties of any model that can be simulated. Using this methodology, the paper analyses more general types of ARCH models. The volatility of volatility is defined, estimated and compared with option-implied volatilities. Copyright © 2002 John Wiley & Sons, Ltd.

Abstract available at:

http://www3.interscience.wiley.com/cgi-bin/abstract/99019442/ABSTRACT

"Dynamic Conditional Correlation - A Simple Class of Multivariate GARCH Models, Journal of Business and Economic Statistics, V20N3 (2002): 339-350.

Abstract: Time varying correlations are often estimated with multivariate generalized autoregressive conditional heteroskedasticity (GARCH) models that are linear in squares and cross products of the data. A new class of multivariate models called dynamic conditional correlation models is proposed. These have the flexibility of univariate GARCH models coupled with parsimonious parametric models for the correlations. They

are not linear but can often be estimated very simply with univariate or two-step methods based on the likelihood function. It is shown that they perform well in a variety of situations and provide sensible empirical results.

Available at:

http://pages.stern.nyu.edu/~rengle/dccfinal.pdf

"Risk and Volatility: Econometric Models and Financial Practice," Nobel Lecture, forthcoming in American Economic Review.

A text version of the lecture will be available at: http://www.nobel.se/economics/laureates/2003/engle-lecture.html

"Impacts of Trades in an Error-Correction Model of Quote Prices," (with A. Patton), Journal of Financial Markets, V7N4 (2004)

Abstract: In this paper we analyze and interpret the quote price dynamics of 100 NYSE stocks with varying average trade frequencies. We specify an error-correction model for the log difference of the bid and the ask price, with the spread acting as the errorcorrection term, and include as regressors the characteristics of the trades occurring between quote observations, if any. We find that short duration and medium volume trades have the largest impacts on quote prices for all one hundred stocks, and that buyer initiated trades primarily move the ask price while seller initiated trades primarily move the bid price. Trades have a greater impact on quotes in both the short and the long run for the infrequently traded stocks than for the more actively traded stocks. Finally, we find strong evidence that the spread is mean reverting.

Available at:

http://weber.ucsd.edu/~mbacci/engle/402.pdf

"A Multiple Indicators Model for Volatility Using Intra-Daily Data," (with G. M. Gallo), presented at "Joint Statistical Meetings" (2002).

Abstract: Many ways exist to measure and model financial asset volatility. In principle, as the frequency of the data increases, the quality of forecasts should improve. Yet, there is no consensus about a "true" or "best" measure of volatility. In this paper we propose to jointly consider absolute daily returns, daily high-low range and daily realized volatility to develop a forecasting model based on their conditional dynamics. As all are non-negative series, we develop a multiplicative error model that is consistent and asymptotically normal under a wide range of specifications for the error density function. The estimation results show significant interactions between the indicators. We also show that onemonth-ahead forecasts match well (both in and out of sample) the market-based volatility measure provided by an average of implied volatilities of index options as measured by VIX. Keywords: volatility modeling, volatility forecasting, GARCH, VIX, high-low range, realized volatility.

Available at:

http://pages.stern.nyu.edu/~rengle/Multiple%20Indicators-Gallo.pdf

"New Frontiers in ARCH Models" Journal of Applied Econometrics, V17N5 (2002): 425-446.

Summary: In the 20 years following the publication of the ARCH model, there has been a vast quantity of research uncovering the properties of competing volatility models. Wideranging applications to financial data have discovered important stylized facts and illustrated both the strengths and weaknesses of the models. There are now many surveys of this literature. This paper looks forward to identify promising areas of new research. The paper lists five new frontiers. It briefly discusses three—high-frequency volatility models, large-scale multivariate ARCH models, and derivatives pricing models. Two further frontiers are examined in more detail—application of ARCH models to the broad class of non-negative processes, and use of Least Squares Monte Carlo to examine non-linear properties of any model that can be simulated. Using this methodology, the paper analyses more general types of ARCH models. The volatility is defined, estimated and compared with option-implied volatilities.

Available at:

http://pages.stern.nyu.edu/~rengle/New%20Frontier.pdf

"Dynamic Conditional Correlation - A Simple Class of Multivariate GARCH Models," Journal of Business and Economic Statistics, V17N5 (2002).

Abstract: Time varying correlations are often estimated with Multivariate Garch models that are linear in squares and cross products of the data. A new class of multivariate models called dynamic conditional correlation (DCC) models is proposed. These have the flexibility of univariate GARCH models coupled with parsimonious parametric models for the correlations. They are not linear but can often be estimated very simply with univariate or two step methods based on the likelihood function. It is shown that they perform well in a variety of situations and provide sensible empirical results.

Available at:

http://pages.stern.nyu.edu/~rengle/dccfinal.pdf

"Theoretical and Empirical Properties of Dynamic Conditional Correlation Multivariate Garch", (with K. Sheppard) NBER WP8554 (2002).

Abstract: In this paper, we develop the theoretical and empirical properties of a new class of multivariate GARCH models capable of estimating large time-varying covariance matrices, Dynamic Conditional Correlation Multivariate GARCH. We show that the problem of multivariate conditional variance estimation can be simplified by estimating univariate GARCH models for each asset, and then, using transformed residuals resulting from the first stage, estimating a conditional correlation estimator. The standard errors for the first stage parameters remain consistent, and only the standard errors for the correlation parameters need be modified. We use the model to estimate the conditional covariance of up to 100 assets using S&P 500 Sector Indices and Dow Jones Industrial Average stocks, and conduct specification tests of the estimator using an industry standard benchmark for volatility models. This new estimator demonstrates very strong performance especially considering ease of implementation of the estimator.

Abstract available at:

http://econpapers.hhs.se/paper/cdlucsdec/2001-15.htm

"CAViaR: Conditional Autoregressive Value At Risk By Regression Quantiles," (with S. Manganelli), Forthcoming in Journal of Business and Economic Statistics (1999).

Abstract: Value at Risk (VaR) has become the standard measure of market risk employed by financial institutions for both internal and regulatory purposes. VaR is defined as the value that a portfolio will lose with a given probability, over a certain time horizon (usually one or ten days). Interpreting the VaR as the quantile of future portfolio values conditional on current information, we propose a new approach to quantile estimation that does not require any of the extreme assumptions invoked by existing methodologies (such as normality or i.i.d. returns). The Conditional Autoregressive Value at Risk or CAViaR model moves the focus of attention from the distribution of returns directly to the behavior of the quantile. We specify the evolution of the quantile over time using an autoregressive process and use the regression quantile framework introduced by Koenker and Bassett to determine the unknown parameters. Utilizing the criterion that each period the probability of exceeding the VaR must be independent of all the past information, we introduce a new test of model adequacy, the Dynamic Quantile (DQ) test. Applications to real data provide empirical support to this methodology.

Available at:

http://pages.stern.nyu.edu/~rengle/CAVIAR.pdf -

"The Econometric Analysis of Discrete-Valued Irregularly-Spaced Financial Transactions Data Using a New Autoregressive Conditional Multinomial Model," (with J. Russell), under revision.

Abstract: This paper proposes a new approach to modelling financial transactions data. A new model for discrete valued time series is proposed in the context of generalized linear models. Since the model is specified conditional on both the previous state, as well as the historic distribution, we call the model the Autoregressive Conditional Multinomial (ACM) model. When the data are viewed as a marked point process, the ACD model proposed in Engle and Russell (1998) allows for joint modelling of the price transition probabilities and the arrival times of the transactions. In this marked point process context, the transition probabilities vary continuously through time and are therefore duration dependent. Finally, variations of the model allow for volume and spreads to impact the conditional distribution of price changes. Impulse response studies show the long run price impact of a transaction can be very sensitive to volume but is less sensitive to the spread and transaction rate.

Abstract available at:

http://econ.ucsd.edu/papers/abstracts/9810.html

*** "Trade and Quotes: A Bivariate Point Process," (with A. Lunde), forthcoming in

Journal of Econometrics.

Abstract: Recent empirical work has studied point processes of transactions in financial markets and observed clear time dependent patterns in these arrival times. However these studies do not examine the timing of quoted price changes. This paper formulates a bivariate point process to jointly analyze transaction and quote arrivals. In microstructure models, transactions may reveal private information which is then incorporated into new prices. This paper examines the speed of this information flow and the circumstances which govern it. One of the main conclusions are that conditional on past quote times, the impact of trade information is to make quote durations longer when there is more

information flow rather than less. This is interpreted as evidence that limit order suppliers become more cautious in the presence of apparent informational trading.

Abstract available at:

http://econ.ucsd.edu/papers/abstracts/9807.html

"Conditional Volatility of Exchange Rates Under a Target Zone," (with Y.-F. Gau), under revision.

Abstract: To study the impact of institutional features of target zones on the conditional volatility of exchange rates, this paper proposes a simple and intuitive model to incorporate the announced information in the bands. Observing the statistical characteristics of the EMS cross rate returns- mean reversion and heteroskedasticity, we fit a GARCH(1,1)-MA(1) specification incorporating the deviation of exchange rates from the central parity. This model allows us to easily examine the relationship between the conditional volatility and the position of spot rates. We find in particular, that for the Irish punt and Italian lira DM rates, the conditional volatility increases as the exchange rate approaches the edges of the band. We extend the above univariate model to a multivariate setting to take account of the cross country interactions in the EMS, by including a vector consisting of all EMS currencies' positions in the GARCH equation. The estimation results show that other currencies' positions do affect the conditional volatility of a specific EMS currency. Understanding the importance of intra-ERM coherence and the multilateral commitment on the central parity, we follow Pill(1994) to derive an "effective band" model to examine how the multilateral grid affects the conditional volatility. However, the estimation results suggest that the full set of all deviations from official central parity of each member country explains the volatility better than does simply the deviation from the effective band.

Abstract available at:

http://econ.ucsd.edu/papers/abstracts/9706.html

"Measuring, Forecasting and Explaining Time Varying Liquidity in the Stock Market", (with J. Lange), Journal of Financial Markets, V4N2 (2001):113-142.

Abstract: The paper proposes a new measure of market liquidity, VNET, which directly measures the depth of the market. VNET is constructed from the excess volume of buys or sells during a market event defined by a price movement. As this measure varies over time, it can be forecast and explained. Using NYSE TORQ data, it is found that market depth varies positively but less than proportionally with past volume and negatively with the number of transactions. Both findings suggest that over the day high volumes are associated with an influx of informed traders and reduce market liquidity. The timing of events plays an intimate role in the analysis. High expected volatility as measured by the ACD model of Engle and Russell (1997) reduces expected liquidity. Finally, market depth is smaller when the one-sided trading volume is transacted in a shorter than expected time, providing an estimate of the value of patience.

Abstract available at:

http://econ.ucsd.edu/papers/abstracts/9712r.html

"Testing the Volatility Term Structure Using Option Hedging Criteria," (with J. Rosenberg), Journal of Derivatives, V8N1 (2000): 10-28.

Abstract: The volatility term structure (VTS) reflects market expectations of asset volatility over different horizons. These expectations change over time, giving dynamic structure to the VTS. This paper evaluates volatility models on the basis of their performance in hedging option price changes due to shifts in the VTS. An innovative feature of the hedging approach is its increased sensitivity to several important forms of model misspecification relative to previous testing methods. Volatility hedge parameters are derived for several volatility models incorporating different predicted VTS dynamics and information variables. Hedging tests using S&P500 index options indicate that the GARCH components with leverage VTS estimate is most accurate. Evidence is obtained for mean reversion in volatility and correlation between VTS shifts and S&P500 returns. While a convexity hedge dominates the volatility hedges for the observed sample, this result appears to be due to sample selection bias.

Available at:

http://weber.ucsd.edu/~mbacci/engle/Vts0398.pdf

"Theoretical and Empirical Properties of Dynamic Conditional Correlation Multivariate GARCH," (with K. Sheppard), Stern Finance Working Paper Series, FIN-01-027 (2001).

Abstract: In this paper, we develop the theoretical and empirical properties of a new class of multivariate GARCH models capable of estimating large time-varying covariance matrices, Dynamic Conditional Correlation (DCC) Multivariate GARCH. We show that the problem of multivariate conditional covariance estimation can be simplified by estimating univariate GARCH models for each asset's variance, and then, using transformed residuals resulting from the first stage, estimating a time-varying conditional correlation estimator. The standard errors of the first stage parameters remain consistent, and only the standard errors for the correlation parameters need be modified. We use the model to estimate the conditional covariance of up to 100 assets using S&P 500 Sector Indices and Dow Jones Industrial Average stocks, and conduct specification tests of the estimator using an industry standard benchmark for volatility models. This new estimator demonstrates very strong performance especially considering the ease of implementation of the estimator.

Available at:

http://pages.stern.nyu.edu/~rengle/Dcc-Sheppard.pdf

"Asymmetric Dynamics in the Correlations of Global Equity and Bond Returns," (with L. Cappiello and K. Sheppard), under revision

Abstract: This paper investigates asymmetries in conditional variances, covariances, and correlations in international equity and bond returns. The analysis is carried out through an asymmetric version of the Dynamic Conditional Correlation (DCC) model of Engle (2002), which is particularly well suited to examine correlation dynamics among assets. Particular attention is given to whether changes in the correlation of international asset markets demonstrate evidence of asymmetric response to negative returns. Widespread evidence is found that national equity index return series show strong asymmetries in conditional volatility, yet little evidence is seen that bond index returns exhibit this behavior. However, both bonds and equities exhibit asymmetry in conditional correlation,

although in systematically different manners. The paper also examines the strong worldwide linkages in the dynamics of volatility and correlation, finding subtle but important differences between equity and bond second moment dynamics. It is also found that beginning in January 1999 with the introduction of the Euro, there is significant evidence of a structural break in correlation, although *not* in volatility. The introduction of a fixed exchange rate regime leads to near perfect correlation among bond returns within EMU countries, which is not surprising in consideration of the monetary policy harmonization within the EMU. However, the increase in return correlation is not restricted to EMU countries and equity return correlation both within and outside the EMU also increases after January 1999.

Available at:

http://pages.stern.nyu.edu/~rengle/Asymmetric%20Dynamics.pdf

"Time-Varying Betas and Asymmetric Effects of News: Empirical Analysis of Blue Chip Stocks," (with Y.-H. Cho), under revision

Abstract: We investigate whether or not a beta increases with bad news and decreases with good news, just as does volatility. Using daily returns for 25 stocks in a double beta model with EGARCH specifications, we show that news asymmetrically affects the betas of individual stocks. We find that betas depend on two source of news: market shocks and idiosyncratic shocks. Some stock betas depend on both while others depend on one. We categorize each stock return as belonging to one of three beta process models, a joint, an idiosyncratic, and a market model based on the role of market shocks and idiosyncratic shocks. Our conclusions differ from those of Braun, Nelson and Sunnier (1995) who worked with monthly aggregated data in a bivariate EGARCH model. We believe that stock price aggregation in this previous research resulted in a loss of cross sectional variation and consequently lead to weak results. If the asymmetric effect is more readily apparent in daily data, then this may again explain previous researchers' inability to detect asymmetric effects. Our findings shed light on the controversy as to whether abnormalities in stock returns results from overreaction to information or from changes in expected returns in an efficient market. Finding an asymmetric effect in betas leads us to conclude that abnormalities can, at least partially, be explained by changes in expected returns through a change in beta.

Available at:

<u>ftp://weber.ucsd.edu/pub/rengle/355.PDF</u>

"Macroeconomic Announcements and Volatility of Treasury Futures," (with L. Li). under revision

Abstract: Utilizing open-close returns, close-close returns and volume data, we examine the reaction of the Treasury futures market to the periodically scheduled announcements of prominent U.S. macroeconomic data. Heterogeneous persistence from scheduled news vs. non-scheduled news is revealed. Strong asymmetric effects of scheduled announcements are presented: positive shocks depress volatility on consecutive days, while negative shocks increase volatility. Announcement-day shocks have small persistence, but great impacts on volatility in the short run. Investigation into volume data shows that announcement-day volume has lower persistence than non-announcement-day volume. No statistically significant risk premium manifests on the release dates. Compared with the implied volatility and realized volatility data, we find our model successful in forming both in-sample and out-of-sample multi-step forecasts. Distinctions

are made and tested among microstructure theories that differ in predictions of the impact of scheduled macroeconomic news on volatility and volatility persistence. Asymmetric effects between positive and negative shocks from scheduled news call for further exploration of microstructure theory.

Abstract available at:

http://econ.ucsd.edu/papers/abstracts/9827.html