Financial Econometrics Research Centre

WORKING PAPERS SERIES

WP08-02

A Short Note on the Problematic Concept of Excess Demand in Asset Pricing Models with Mean-Variance Optimization

Reiner Franke

A Short Note on the Problematic Concept of Excess Demand in Asset Pricing Models with Mean-Variance Optimization

Reiner Franke*
Department of Economics
University of Kiel
Kiel, Germany

First Draft
March 2008

Abstract

Referring to asset pricing models where demand is proportional to excess returns and said to be derived from a mean-variance optimization problem, the note formulates what probably is common knowledge but hardly ever made an explicit subject of discussion. This is an insufficient distinction between the desired holding of the risky asset on the part of the speculative agents, which is the solution to the optimization problem and usually directly presented as excess demand, and the desired change in this holding, which is what should reasonably constitute the excess demand on the market. The note arrives at the conclusion that in models with a market maker the story of the maximization of expected wealth should be dropped.

*Mail to franke@iksf.uni-bremen.de. Financial support from EU STREP ComplexMarkets, contract number 516446, is gratefully acknowledged.

This note makes an elementary observation in asset pricing models that derive the speculative agents' formulation of excess demand from myopic mean-variance optimization of expected wealth. These models are often not sufficiently clear about their precise notion of demand and the corresponding changes in the assets the agents are holding.

The presentation of the mean-variance optimization approach usually begins with the equation for the wealth dynamics. If for concreteness the risky asset is a large stock or market index that pays a dividend y_t per share at the beginning of the market period t, and the risk-free asset pays a fixed rate of return r, the evolution of the wealth of an agent of type h from period t to period $t+1$ is described as

$$W_{h,t+1} \;=\; (1+r)\,W_{h,t} \;+\; [p_{t+1} + y_{t+1} - (1+r)p_t]\,z_{h,t} \tag{1}$$

where in addition p_t is the (uniform) price at which the asset is traded in period t, and $z_{h,t}$ is said to be "the number of shares of the risky asset *purchased*" at time t (emphasis added). The latter quotation can be found in Hommes et al. (2005, p. 1046) or He and Li (2007, p. 3400), and there are many other papers speaking of "purchasing" or "buying".

More precisely, $z_{h,t}$ is a desired quantity which, however, can always be realized in these models. The optimization problem itself uses (1) as its wealth constraint, subject to which the expected value of a CARA utility function $U = U(W_{h,t+1}) = -\exp(-\mu_h\, W_{h,t+1})$ is to be maximized, or in an equivalent formulation the term $E_{h,t}(W_{h,t+1}) - (\mu_h/2)\, V_{h,t}((W_{h,t+1})$ (where $\mu_h > 0$ is the agent's risk aversion coefficient and $E_{h,t}$, $V_{h,t}$ are his conditional expectations and conditional variance).[1] The explicit solution to this problem is

$$z_{h,t} \;=\; \frac{E_{h,t}[p_{t+1} + y_{t+1} - (1+r)p_t]}{\mu_h\, V_{h,t}[p_{t+1} + y_{t+1} - (1+r)p_t]} \tag{2}$$

If one goes back to the derivation of eq. (1), the formulation that $z_{h,t}$ is the number of shares *purchased* at time t is found to be somewhat careless. To see this let $a_{h,t}$ and $b_{h,t}$ be the number of shares and the risk-free asset (bonds) which are in the portfolio of agent h at the beginning of period t. At that time he has also received the dividends and interest payments, so his wealth is (dropping the index h)

$$W_t \;=\; p_t\, a_t \;+\; b_t \;+\; a_t\, y_t \;+\; r\, b_t \tag{3}$$

[1] CARA stands for constant absolute risk aversion.

The agent invests his income on shares and bonds, while for speculative reasons he may also exchange shares for bonds or *vice versa*. Denote the shares and bonds he wishes to hold at the beginning of the next period as a^d_{t+1} and b^d_{t+1}, respectively. The shares are bought at the current price p_t and, of course, subject to the constraint

$$W_t \;=\; p_t\, a^d_{t+1} \,+\, b^d_{t+1} \tag{4}$$

With the change in the market price and the new dividends and interest receipts, the wealth at the beginning of t+1 amounts to (3) dated one period forward (and a^d, b^d in place of a and b). Using (4), rearrangement of this equation leads to

$$\begin{aligned} W_{t+1} &= p_{t+1}\, a^d_{t+1} \,+\, b^d_{t+1} \,+\, a^d_{t+1}\, y_{t+1} \,+\, r\, b^d_{t+1} \\ &= (1+r)(p_t\, a^d_{t+1} \,+\, b^d_{t+1}) \;+\; [p_{t+1} + y_{t+1} - (1+r)p_t]\, a^d_{t+1} \\ &= (1+r)\, W_t \;+\; [p_{t+1} + y_{t+1} - (1+r)p_t]\, a^d_{t+1} \end{aligned} \tag{5}$$

It follows that $z_{h,t}$ in (1) must be the desired *holding* of the risky asset. In contrast to the remark on (1), what agent h "purchases" on the market is not the entire stock $a^d_{h,t+1}$ of the asset he wishes to hold but just the difference from his actual holding $a_{h,t}$ at the beginning of period t.

The problem is more serious than a careless use of words. Turning to the notion of demand it is reasonably also the aggregate differences between the agents' desired and actual holdings that constitute the period t excess demand d_t on the market, and not the sum of the desired holdings themselves. Hence with H groups of speculative agents on the market,

$$d_t \;=\; \sum_{h=1}^{H} a^d_{h,t+1} \;-\; \sum_{h=1}^{H} a_{h,t} \;=\; \sum_{h=1}^{H} z_{h,t} \;-\; \sum_{h=1}^{H} a_{h,t} \tag{6}$$

It can now be argued that d_t is identical to $\sum_h z_{h,t}$ if the total number of shares remains constant and is conveniently set equal to zero. This is indeed a consistent situation in models that employ a Walrasian auctioneer for continuous market clearing, $d_t \equiv 0$. One has then only to be aware that in a deterministic equilibrium the income from dividends and interest is exclusively invested in bonds, which implies that the proportion of wealth held in shares is steadily decreasing. This is the price one has to pay for a CARA utility function in whose maximization the level of current wealth is eliminated.

The idea that $\sum_h z_{h,t}$ can be identified with $\sum_h a^d_{h,t+1}$ does not work if market disequilibrium is admitted. The standard story abstains from rationing but instead introduces a market maker who, besides quoting the price, absorbs any excess of supply from the market and serves any excess of demand from his inventory. As in this context the assumption that the total number of shares is fixed has to include the inventory $a_{m,t}$ of the market maker, it now reads,

$$\sum_{h=1}^{H} a_{h,t} \ + \ a_{m,t} \ = \ \text{const} \tag{7}$$

In this identity $a_{m,t}$ is obviously fluctuating over time. Therefore, in a market maker setting, the sum $\sum_{h=1}^{H} a_{h,t}$ in (6) *cannot* be treated as a constant. In other words, a claim that $\sum_{h=1}^{H} z_{h,t}$ represents market excess demand would be unwarrantable.[2]

Two alternative consequences could be drawn from that. On the one hand, one may resort to the interpretation that the relevant notion of demand formulated on the market is that of desired holdings. The model would then be consistent but, we may say, too academic.

On the other hand, it may be postulated that $z_{h,t}$ as it is given by (2) is not the agent's desired holding but his desired change in the asset. In this way the equation loses its optimization flavour; at least (2) cannot be sold as the solution to the maximization of expected wealth. Nevertheless, the right-hand side of (2) makes perfect economic sense, saying that excess demand is proportional to the expected excess return on the asset and discounted by some measure of risk or volatility.

Another price that has to be paid in the latter option should, however, not go unnoticed. As eq. (2) determines the desired as well as the realized change in the risky asset, the agent's position is a mere appendix to the model that does not feed back on demand. Especially in a stochastic framework his position may thus easily wander around and become unduly large, with a positive or negative sign. This feature would certainly not be compatible with the risk constraints of real traders (that is, constraints in addition to their concerns about volatility).

[2] Incidentally, the models in the two papers from which the quotation on the term $z_{h,t}$ in eq. (1) was taken do include a market maker.

If the latter observation is taken seriously, one is back to the problem that consistency requires the model to keep track of the individual holdings of the asset. As an outlook, a straightforward specification to guard against excessive positions may be mentioned. It maintains the original demand $z_{h,t} = a^d_{h,t+1} - a_{h,t}$ at its core but revises it downward (upward) in proportion to the current positive (negative) deviations of $a_{h,t}$ from some target level.[3]

In conclusion, for an appropriate interpretation of models with a market maker and some mean-variance optimization formula it would be helpful for the reader if they were more explicit about their notion of demand. To us it seems most reasonable if they completely dropped their story of the maximization of expected wealth.

References

Franke, R. and Asada, T. (2008), "Incorporating positions into asset pricing models with order-based strategies", Working Paper, University of Kiel and Chuo University Tokyo.

He, X.-Z. and Li, Y. (2007), "Power-law behaviour, heterogeneity, and trend chasing", *Journal of Economic Dynamics and Control*, 31, 3396–3426.

Hommes, C., Huang, H. and Wang, D. (2005), "A robust rational route to randomness in a simple asset pricing model", *Journal of Economic Dynamics and Control*, 29, 1043–1072.

[3] And a similar rule for the market maker's price quotes with which he seeks to limit his inventory. The numerical effort for introducing these concepts into the original models would be minimal. If they are sufficiently simple, even an analytical treatment can still be possible; see Franke and Asada (2008) for such an analysis in the framework of the seminal Beja–Goldman model (whose formulation of demand is sometimes said to be compatible with mean-variance optimization).

List of other working papers:

2008

1. Roman Kozhan and Rozalia Pal, Firms' Investment under Financial Constraints: A Euro Area Investigation, WP08-07
2. Roman Kozhan and Mark Salmon, On Uncertainty, Market Timing and the Predictability of Tick by Tick Exchange Rates, WP08-06
3. Roman Kozhan and Mark Salmon, Uncertainty Aversion in a Heterogeneous Agent Model of Foreign Exchange Rate Formation, WP08-05
4. Roman Kozhan, Non-Additive Anonymous Games, WP08-04
5. Thomas Lux, Stochastic Behavioral Asset Pricing Models and the Stylized Facts, WP08-03
6. Reiner Franke, A Short Note on the Problematic Concept of Excess Demand in Asset Pricing Models with Mean-Variance Optimization, WP08-02
7. Alexandra Dias, Semi-parametric estimation of joint large movements of risky assets, WP08-01

2007

1. Timur Yusupov and Thomas Lux, The Efficient Market Hypothesis through the Eyes of an Artificial Technical Analyst: An Application of a New Chartist Methodology to High-Frequency Stock Market Data, WP07-13
2. Liu Ruipeng, Di Matteo and Thomas Lux, True and Apparent Scaling: The Proximity of the Markov- Switching Multifractal Model to Long-Range Dependence, WP07-12
3. Thomas Lux, Rational Forecasts or Social Opinion Dynamics? Identification of Interaction Effects in a Business Climate Survey, WP07-11
4. Thomas Lux, Collective Opinion Formation in a Business Climate Survey, WP07-10
5. Thomas Lux, Application of Statistical Physics in Finance and Economics, WP07-09
6. Reiner Franke, A Prototype Model of Speculative Dynamics With Position-Based Trading, WP07-08
7. Reiner Franke, Estimation of a Microfounded Herding Model On German Survey Expectations, WP07-07
8. Cees Diks and Pietro Dindo, Informational differences and learning in an asset market with boundedly rational agents, WP07-06
9. Markus Demary, Who Do Currency Transaction Taxes Harm More: Short-Term Speculators or Long-Term Investors?, WP07-05
10. Markus Demary, A Heterogenous Agents Model Usable for the Analysis of Currency Transaction Taxes, WP07-04
11. Mikhail Anufriev and Pietro Dindo, Equilibrium Return and Agents' Survival in a Multiperiod Asset Market: Analytic Support of a Simulation Model, WP07-03
12. Simone Alfarano and Michael Milakovic, Should Network Structure Matter in Agent-Based Finance?, WP07-02
13. Simone Alfarano and Reiner Franke, A Simple Asymmetric Herding Model to Distinguish Between Stock and Foreign Exchange Markets, WP07-01

2006

1. Roman Kozhan, Multiple Priors and No-Transaction Region, WP06-24
2. Martin Ellison, Lucio Sarno and Jouko Vilmunen, Caution and Activism? Monetary Policy Strategies in an Open Economy, WP06-23
3. Matteo Marsili and Giacomo Raffaelli, Risk bubbles and market instability, WP06-22
4. Mark Salmon and Christoph Schleicher, Pricing Multivariate Currency Options with Copulas, WP06-21

5. Thomas Lux and Taisei Kaizoji, Forecasting Volatility and Volume in the Tokyo Stock Market: Long Memory, Fractality and Regime Switching, WP06-20
6. Thomas Lux, The Markov-Switching Multifractal Model of Asset Returns: GMM Estimation and Linear Forecasting of Volatility, WP06-19
7. Peter Heemeijer, Cars Hommes, Joep Sonnemans and Jan Tuinstra, Price Stability and Volatility in Markets with Positive and Negative Expectations Feedback: An Experimental Investigation, WP06-18
8. Giacomo Raffaelli and Matteo Marsili, Dynamic instability in a phenomenological model of correlated assets, WP06-17
9. Ginestra Bianconi and Matteo Marsili, Effects of degree correlations on the loop structure of scale free networks, WP06-16
10. Pietro Dindo and Jan Tuinstra, A Behavioral Model for Participation Games with Negative Feedback, WP06-15
11. Ceek Diks and Florian Wagener, A weak bifucation theory for discrete time stochastic dynamical systems, WP06-14
12. Markus Demary, Transaction Taxes, Traders' Behavior and Exchange Rate Risks, WP06-13
13. Andrea De Martino and Matteo Marsili, Statistical mechanics of socio-economic systems with heterogeneous agents, WP06-12
14. William Brock, Cars Hommes and Florian Wagener, More hedging instruments may destabilize markets, WP06-11
15. Ginwestra Bianconi and Roberto Mulet, On the flexibility of complex systems, WP06-10
16. Ginwestra Bianconi and Matteo Marsili, Effect of degree correlations on the loop structure of scale-free networks, WP06-09
17. Ginwestra Bianconi, Tobias Galla and Matteo Marsili, Effects of Tobin Taxes in Minority Game Markets, WP06-08
18. Ginwestra Bianconi, Andrea De Martino, Felipe Ferreira and Matteo Marsili, Multi-asset minority games, WP06-07
19. Ba Chu, John Knight and Stephen Satchell, Optimal Investment and Asymmetric Risk for a Large Portfolio: A Large Deviations Approach, WP06-06
20. Ba Chu and Soosung Hwang, The Asymptotic Properties of AR(1) Process with the Occasionally Changing AR Coefficient, WP06-05
21. Ba Chu and Soosung Hwang, An Asymptotics of Stationary and Nonstationary AR(1) Processes with Multiple Structural Breaks in Mean, WP06-04
22. Ba Chu, Optimal Long Term Investment in a Jump Diffusion Setting: A Large Deviation Approach, WP06-03
23. Mikhail Anufriev and Gulio Bottazzi, Price and Wealth Dynamics in a Speculative Market with Generic Procedurally Rational Traders, WP06-02
24. Simonae Alfarano, Thomas Lux and Florian Wagner, Empirical Validation of Stochastic Models of Interacting Agents: A "Maximally Skewed" Noise Trader Model?, WP06-01

2005

1. Shaun Bond and Soosung Hwang, Smoothing, Nonsynchronous Appraisal and Cross-Sectional Aggreagation in Real Estate Price Indices, WP05-17
2. Mark Salmon, Gordon Gemmill and Soosung Hwang, Performance Measurement with Loss Aversion, WP05-16
3. Philippe Curty and Matteo Marsili, Phase coexistence in a forecasting game, WP05-15
4. Matthew Hurd, Mark Salmon and Christoph Schleicher, Using Copulas to Construct Bivariate Foreign Exchange Distributions with an Application to the Sterling Exchange Rate Index (Revised), WP05-14
5. Lucio Sarno, Daniel Thornton and Giorgio Valente, The Empirical Failure of the Expectations Hypothesis of the Term Structure of Bond Yields, WP05-13
6. Lucio Sarno, Ashoka Mody and Mark Taylor, A Cross-Country Financial Accelorator: Evidence from North America and Europe, WP05-12
7. Lucio Sarno, Towards a Solution to the Puzzles in Exchange Rate Economics: Where Do We Stand?, WP05-11
8. James Hodder and Jens Carsten Jackwerth, Incentive Contracts and Hedge Fund Management, WP05-10
9. James Hodder and Jens Carsten Jackwerth, Employee Stock Options: Much More Valuable Than You Thought, WP05-09

10. Gordon Gemmill, Soosung Hwang and Mark Salmon, Performance Measurement with Loss Aversion, WP05-08
11. George Constantinides, Jens Carsten Jackwerth and Stylianos Perrakis, Mispricing of S&P 500 Index Options, WP05-07
12. Elisa Luciano and Wim Schoutens, A Multivariate Jump-Driven Financial Asset Model, WP05-06
13. Cees Diks and Florian Wagener, Equivalence and bifurcations of finite order stochastic processes, WP05-05
14. Devraj Basu and Alexander Stremme, CAY Revisited: Can Optimal Scaling Resurrect the (C)CAPM?, WP05-04
15. Ginwestra Bianconi and Matteo Marsili, Emergence of large cliques in random scale-free networks, WP05-03
16. Simone Alfarano, Thomas Lux and Friedrich Wagner, Time-Variation of Higher Moments in a Financial Market with Heterogeneous Agents: An Analytical Approach, WP05-02
17. Abhay Abhayankar, Devraj Basu and Alexander Stremme, Portfolio Efficiency and Discount Factor Bounds with Conditioning Information: A Unified Approach, WP05-01

2004

1. Xiaohong Chen, Yanqin Fan and Andrew Patton, Simple Tests for Models of Dependence Between Multiple Financial Time Series, with Applications to U.S. Equity Returns and Exchange Rates, WP04-19
2. Valentina Corradi and Walter Distaso, Testing for One-Factor Models versus Stochastic Volatility Models, WP04-18
3. Valentina Corradi and Walter Distaso, Estimating and Testing Sochastic Volatility Models using Realized Measures, WP04-17
4. Valentina Corradi and Norman Swanson, Predictive Density Accuracy Tests, WP04-16
5. Roel Oomen, Properties of Bias Corrected Realized Variance Under Alternative Sampling Schemes, WP04-15
6. Roel Oomen, Properties of Realized Variance for a Pure Jump Process: Calendar Time Sampling versus Business Time Sampling, WP04-14
7. Richard Clarida, Lucio Sarno, Mark Taylor and Giorgio Valente, The Role of Asymmetries and Regime Shifts in the Term Structure of Interest Rates, WP04-13
8. Lucio Sarno, Daniel Thornton and Giorgio Valente, Federal Funds Rate Prediction, WP04-12
9. Lucio Sarno and Giorgio Valente, Modeling and Forecasting Stock Returns: Exploiting the Futures Market, Regime Shifts and International Spillovers, WP04-11
10. Lucio Sarno and Giorgio Valente, Empirical Exchange Rate Models and Currency Risk: Some Evidence from Density Forecasts, WP04-10
11. Ilias Tsiakas, Periodic Stochastic Volatility and Fat Tails, WP04-09
12. Ilias Tsiakas, Is Seasonal Heteroscedasticity Real? An International Perspective, WP04-08
13. Damin Challet, Andrea De Martino, Matteo Marsili and Isaac Castillo, Minority games with finite score memory, WP04-07
14. Basel Awartani, Valentina Corradi and Walter Distaso, Testing and Modelling Market Microstructure Effects with an Application to the Dow Jones Industrial Average, WP04-06
15. Andrew Patton and Allan Timmermann, Properties of Optimal Forecasts under Asymmetric Loss and Nonlinearity, WP04-05
16. Andrew Patton, Modelling Asymmetric Exchange Rate Dependence, WP04-04
17. Alessio Sancetta, Decoupling and Convergence to Independence with Applications to Functional Limit Theorems, WP04-03
18. Alessio Sancetta, Copula Based Monte Carlo Integration in Financial Problems, WP04-02
19. Abhay Abhayankar, Lucio Sarno and Giorgio Valente, Exchange Rates and Fundamentals: Evidence on the Economic Value of Predictability, WP04-01

2002

1. Paolo Zaffaroni, Gaussian inference on Certain Long-Range Dependent Volatility Models, WP02-12
2. Paolo Zaffaroni, Aggregation and Memory of Models of Changing Volatility, WP02-11
3. Jerry Coakley, Ana-Maria Fuertes and Andrew Wood, Reinterpreting the Real Exchange Rate - Yield Diffential Nexus, WP02-10

4. Gordon Gemmill and Dylan Thomas , Noise Training, Costly Arbitrage and Asset Prices: evidence from closed-end funds, WP02-09
5. Gordon Gemmill, Testing Merton's Model for Credit Spreads on Zero-Coupon Bonds, WP02-08
6. George Christodoulakis and Steve Satchell, On th Evolution of Global Style Factors in the MSCI Universe of Assets, WP02-07
7. George Christodoulakis, Sharp Style Analysis in the MSCI Sector Portfolios: A Monte Caro Integration Approach, WP02-06
8. George Christodoulakis, Generating Composite Volatility Forecasts with Random Factor Betas, WP02-05
9. Claudia Riveiro and Nick Webber, Valuing Path Dependent Options in the Variance-Gamma Model by Monte Carlo with a Gamma Bridge, WP02-04
10. Christian Pedersen and Soosung Hwang, On Empirical Risk Measurement with Asymmetric Returns Data, WP02-03
11. Roy Batchelor and Ismail Orgakcioglu, Event-related GARCH: the impact of stock dividends in Turkey, WP02-02
12. George Albanis and Roy Batchelor, Combining Heterogeneous Classifiers for Stock Selection, WP02-01

2001

1. Soosung Hwang and Steve Satchell , GARCH Model with Cross-sectional Volatility; GARCHX Models, WP01-16
2. Soosung Hwang and Steve Satchell, Tracking Error: Ex-Ante versus Ex-Post Measures, WP01-15
3. Soosung Hwang and Steve Satchell, The Asset Allocation Decision in a Loss Aversion World, WP01-14
4. Soosung Hwang and Mark Salmon, An Analysis of Performance Measures Using Copulae, WP01-13
5. Soosung Hwang and Mark Salmon, A New Measure of Herding and Empirical Evidence, WP01-12
6. Richard Lewin and Steve Satchell, The Derivation of New Model of Equity Duration, WP01-11
7. Massimiliano Marcellino and Mark Salmon, Robust Decision Theory and the Lucas Critique, WP01-10
8. Jerry Coakley, Ana-Maria Fuertes and Maria-Teresa Perez, Numerical Issues in Threshold Autoregressive Modelling of Time Series, WP01-09
9. Jerry Coakley, Ana-Maria Fuertes and Ron Smith, Small Sample Properties of Panel Time-series Estimators with I(1) Errors, WP01-08
10. Jerry Coakley and Ana-Maria Fuertes, The Felsdtein-Horioka Puzzle is Not as Bad as You Think, WP01-07
11. Jerry Coakley and Ana-Maria Fuertes, Rethinking the Forward Premium Puzzle in a Non-linear Framework, WP01-06
12. George Christodoulakis, Co-Volatility and Correlation Clustering: A Multivariate Correlated ARCH Framework, WP01-05
13. Frank Critchley, Paul Marriott and Mark Salmon, On Preferred Point Geometry in Statistics, WP01-04
14. Eric Bouyé and Nicolas Gaussel and Mark Salmon, Investigating Dynamic Dependence Using Copulae, WP01-03
15. Eric Bouyé, Multivariate Extremes at Work for Portfolio Risk Measurement, WP01-02
16. Erick Bouyé, Vado Durrleman, Ashkan Nikeghbali, Gael Riboulet and Thierry Roncalli, Copulas: an Open Field for Risk Management, WP01-01

2000

1. Soosung Hwang and Steve Satchell , Valuing Information Using Utility Functions, WP00-06
2. Soosung Hwang, Properties of Cross-sectional Volatility, WP00-05
3. Soosung Hwang and Steve Satchell, Calculating the Miss-specification in Beta from Using a Proxy for the Market Portfolio, WP00-04
4. Laun Middleton and Stephen Satchell, Deriving the APT when the Number of Factors is Unknown, WP00-03

5. George A. Christodoulakis and Steve Satchell, Evolving Systems of Financial Returns: Auto-Regressive Conditional Beta, WP00-02
6. Christian S. Pedersen and Stephen Satchell, Evaluating the Performance of Nearest Neighbour Algorithms when Forecasting US Industry Returns, WP00-01

1999

1. Yin-Wong Cheung, Menzie Chinn and Ian Marsh, How do UK-Based Foreign Exchange Dealers Think Their Market Operates?, WP99-21
2. Soosung Hwang, John Knight and Stephen Satchell, Forecasting Volatility using LINEX Loss Functions, WP99-20
3. Soosung Hwang and Steve Satchell, Improved Testing for the Efficiency of Asset Pricing Theories in Linear Factor Models, WP99-19
4. Soosung Hwang and Stephen Satchell, The Disappearance of Style in the US Equity Market, WP99-18
5. Soosung Hwang and Stephen Satchell, Modelling Emerging Market Risk Premia Using Higher Moments, WP99-17
6. Soosung Hwang and Stephen Satchell, Market Risk and the Concept of Fundamental Volatility: Measuring Volatility Across Asset and Derivative Markets and Testing for the Impact of Derivatives Markets on Financial Markets, WP99-16
7. Soosung Hwang, The Effects of Systematic Sampling and Temporal Aggregation on Discrete Time Long Memory Processes and their Finite Sample Properties, WP99-15
8. Ronald MacDonald and Ian Marsh, Currency Spillovers and Tri-Polarity: a Simultaneous Model of the US Dollar, German Mark and Japanese Yen, WP99-14
9. Robert Hillman, Forecasting Inflation with a Non-linear Output Gap Model, WP99-13
10. Robert Hillman and Mark Salmon , From Market Micro-structure to Macro Fundamentals: is there Predictability in the Dollar-Deutsche Mark Exchange Rate?, WP99-12
11. Renzo Avesani, Giampiero Gallo and Mark Salmon, On the Evolution of Credibility and Flexible Exchange Rate Target Zones, WP99-11
12. Paul Marriott and Mark Salmon, An Introduction to Differential Geometry in Econometrics, WP99-10
13. Mark Dixon, Anthony Ledford and Paul Marriott, Finite Sample Inference for Extreme Value Distributions, WP99-09
14. Ian Marsh and David Power, A Panel-Based Investigation into the Relationship Between Stock Prices and Dividends, WP99-08
15. Ian Marsh, An Analysis of the Performance of European Foreign Exchange Forecasters, WP99-07
16. Frank Critchley, Paul Marriott and Mark Salmon, An Elementary Account of Amari's Expected Geometry, WP99-06
17. Demos Tambakis and Anne-Sophie Van Royen, Bootstrap Predictability of Daily Exchange Rates in ARMA Models, WP99-05
18. Christopher Neely and Paul Weller, Technical Analysis and Central Bank Intervention, WP99-04
19. Christopher Neely and Paul Weller, Predictability in International Asset Returns: A Re-examination, WP99-03
20. Christopher Neely and Paul Weller, Intraday Technical Trading in the Foreign Exchange Market, WP99-02
21. Anthony Hall, Soosung Hwang and Stephen Satchell, Using Bayesian Variable Selection Methods to Choose Style Factors in Global Stock Return Models, WP99-01

1998

1. Soosung Hwang and Stephen Satchell, Implied Volatility Forecasting: A Compaison of Different Procedures Including Fractionally Integrated Models with Applications to UK Equity Options, WP98-05
2. Roy Batchelor and David Peel, Rationality Testing under Asymmetric Loss, WP98-04
3. Roy Batchelor, Forecasting T-Bill Yields: Accuracy versus Profitability, WP98-03
4. Adam Kurpiel and Thierry Roncalli , Option Hedging with Stochastic Volatility, WP98-02
5. Adam Kurpiel and Thierry Roncalli, Hopscotch Methods for Two State Financial Models, WP98-01