
The Q-Group®

THE INSTITUTE FOR QUANTITATIVE RESEARCH IN FINANCE

Seminar Review Spring 2014: “Factors, Active Management, and Exotic Assets”

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Overview and Summaries

Spring 2014 Q-Group Meeting Summary

Diana R. Harrington
Seminar Reviewer
Babson College

David Modest
Seminar Reviewer
Blue Mesa Capital

In the Spring 2014 Q Group meetings entitled “Factors, Active Management, and Exotic Assets,” there were three distinct topics and a few wild cards. The first topic that several presenters addressed was returns from things for which we have little data.

Elroy Dimson, London Business School said that collectibles such as art, stamps and musical instruments, have long attracted high prices and provided higher returns than returns from other assets except equities. Emotional assets are under-researched, and one, wine, is even more interesting to Dimson, the son of a wine merchant. Using data he collected he painstakingly concluded that the economic return is good, but wine, as with other collectables, has a psychic dividend that financial assets cannot provide. His presentation was interesting indeed, with only one caveat -- it might have been a better topic for a late afternoon, just before the participants adjourned for a glass of wine.

Wine returns are hard to gather, as are the returns from some financial assets such as private equity. Andrew Ang, Columbia University, used a new approach to generating a private equity transactions-based rate-of-return series that can be used for performance evaluation, risk management, and asset allocation. Superior to data constructed from non-market estimates of book value, he uses information from actual cash flows accruing to limited partners to estimate returns. He discusses the data and the differences in return for different segments of the private equity market.

Andrew Patton, Duke University, looked at the impact of a less transparent asset, hedge funds, on the asset markets. He said that there is little empirical evidence that connects the activity of hedge funds to returns in underlying asset markets. He looked at the ability of a measure of hedge fund illiquidity to predict the returns of portfolios of international equities, corporate bonds, and currencies from 1994 to 2011. His illiquidity measure is based the autocorrelation in hedge fund returns. Patton posited a model where hedge funds are the marginal market maker and low hedge fund liquidity leads to higher asset returns. He found that the predictive power of hedge fund illiquidity is somewhat stronger following negative market returns.

Of enduring interest to Q Group participants is what underlies equity returns and whether it can be modeled profitably. Juahani Linnainmaa, University of Chicago, focused on the Fama-French (FF) model and why the model does not work better in practice: he turned to the model itself for an explanation. He asked whether all value stocks or small stocks are created equal. Not quite, he said: small stocks co move with other small stocks and value stocks co move with other value stocks, but not all versions of size and value are compensated with higher average returns. HML and SMB are bundles of multiple “baby factors,” and value and size come in different flavors he said. Thus a strategy that combines value and profitability is very attractive.

Another view of the FF model was presented by Stephen Thorley, Brigham Young University. Asked to name the three factors in the FF model, he said that some will answer the market, size, and value, while others will answer beta, size, and value. Where is the market, he asked? He said it can only be found by splitting the middle term ($\beta_i R_M$) of the basic market model into a market constant and a relative beta factor. Commercial providers of equity risk models typically include both a market factor and a beta factor, along with variations of the size and/or value factors, in their models. He showed that the beta anomaly in the U.S. equity market over the last half century is larger than either the size or value anomalies, second only to momentum, and even more evident in larger capitalization stocks.

Momentum continues as a focus of Lu Zhang, Ohio State University. He focused at the firm and how momentum is created through investment decisions. Zhang used a neoclassical investment framework, pioneered by James Tobin and utilized by John Cochrane in a similar finance context, to examine whether the cross-section of expected returns of momentum sorted portfolios are consistent with a production-based asset pricing model. Previous research had clearly shown that this cross-section of expected returns is not consistent with the Fama-French three- or four-factor models. In his work, Zhang appeared to succeed in capturing average momentum profits and the reversal of momentum in long horizons, long-run risks in momentum, and the interaction of momentum with several firm characteristics. However, the model failed to reproduce the procyclicality of momentum as well as its negative interaction with book-to-market.

Searching for other sources of returns Guofu Zhou, Washington University, looked to investor sentiment. Zhou started by saying that many, including John Maynard Keynes, have said that investor sentiment is a key factor in determining stock prices. Building on work by others, Zhou created what he called the aligned sentiment indicator that is robust to the inclusion of the macroeconomic predictors and is economically valuable. Furthermore, using the indicator can lead to a doubling of monthly Sharpe Ratios. The forecasting power of sentiment, Zhou said, comes from the investor's under reaction to cash flow information rather than discount rate predictability.

Active fund management's ability to outperform passive benchmarks depends on management's raw skill in identifying investment opportunities, the supply of those opportunities, and the competition to harvest them -- or does it? Lubos Pastor, University of Chicago, looked at what we know about the skill-scale performance interaction. Using cleaner data and more robust techniques than previous researchers, he found strong evidence of decreasing returns to scale at the industry level. As for skill, it appeared that active funds had become more skilled over time, although their performance had not improved due to the increase in the size of all actively managed money. Based on his findings, he had wise advice for investors and practitioners

Three topics had been in the news and were topics during the meetings. The first was the continuing interest in high frequency trading and its impacts on investors, a hot topic of discussion by market regulators and the U.S Congress, made hotter by the recent publication of Michael Lewis' *Flash Boys*. The second, also a concern of us all and the U.S. Congress, was the impact of the shift on retirement programs from defined benefits programs to defined

contribution programs, 401(k)s. The third, basketball, was on many of the participants' minds since the 2014 NCAA final was on the Monday night of the meetings.

Larry Harris, University of Southern California, a Q Group stalwart, presented an extra session for participants on Monday afternoon. He provided a primer on high frequency trading and its impact on the costs and speed trading. He provided updated data, much insight and some recommendations for the future.

Peter Cramton, University of Maryland, laid out a very specific market structure he said would curtail some of the problems that exist in high frequency trading (HFT), notably, front running. He said that the HFT arms race is an optimal response from market participants given the current market design. He believes that continuous-time trading and continuous limit order book are basic flaws in modern financial market design. He proposed replacing continuous-time trading with discrete-time frequent batch auctions: uniform-price sealed-bid double auctions conducted at frequent, but discrete, time intervals (e.g., every 1 second or 100ms). This market design, he argued, would be a minimal departure from the current system where the arms race is never-ending, harms liquidity and is socially wasteful. The cost to investors of this change would be a very short wait time-to-trade.

Jack Van DerHei, Employee Benefit Research Institute, asked an important question: are 401(k) plans markedly worse in meeting the participants' goal of retirement when compared to defined benefit plans? To gain some insight he proposed a comparative analysis of future benefits from private sector, voluntary-enrollment 401(k) plans, and stylized, final-average-pay, defined-benefit and cash-balance plans. He developed a procedure to determine the generosity parameter, the percentage of the average salary per years of service used to calculate the pension annuity, needed to produce 401(k) retirement income equivalent to that of median defined benefit plans. He presented the results of simulations based on varying the core inputs to his base model.

To assuage the angst of those who leaned toward the televised NCAA basketball championship game on Monday evening, the Q group hosted Roger Noll, Professor of Economics Emeritus, Stanford University as a guest dinner speaker. He provided real insight into the state of college sports, and how it got where it is, the impact on schools and players, and what may have led to the recent action by Northwestern University football players to gain the right to collective bargaining. Summaries are great, but you should have been there. Virtually no one left to see the game when they could stay and listen to Noll explain the state of college sports and the changes that are sure to come.

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Scale and Skill in Active Management

Lubos Pastor¹

Booth School of Business University of Chicago

Active fund management's ability to outperform passive benchmarks depends on management's raw skill in identifying investment opportunities, the supply of those opportunities, and the competition to harvest them. Pastor points out that one potential constraint facing active managers is decreasing returns to scale. He says that if skill impacts performance, then skill and scale interact. The result could be that a more skilled large fund can underperform a less skilled small fund. To understand skill, Pastor says, we must understand the effects of scale. This is exactly what Pastor and his colleagues set out to do.

Pastor asks, what do we know about the skill scale performance interaction? He says that there are two hypotheses regarding the interaction between performance and scale. The first is that decreasing returns to scale are related to fund size. The second is that decreasing returns are related to the aggregate size of all actively managed funds. Whether scale has an impact on returns at either level is not clear. The fund-level hypothesis has been tested in a number of recent studies with mixed results.

Pastor says there are two challenges in estimating the effect of fund size on performance. The first is the endogeneity of fund size: skill might be correlated with both size and performance. A simple OLS estimate of the size-performance relationship is likely to suffer from an omitted-variable bias in that skill is an unobservable variable. The second challenge is the bias that results from the positive, contemporaneous correlation between changes in fund size and unexpected fund returns. To deal with this, Pastor develops a recursive demeaning procedure that eliminates the bias.

To test the model he uses CRSP and Morningstar data from 1979 to 2011 for domestic active equity mutual funds with assets of \$15 million or more. The two different datasets are used to cross-check all of the data and the analysis only relies on the intersection of data that can be cross-validated. This results in a sample of 350,000 monthly observations of 3,126 funds. The researchers implicitly associate the skill with the fund - not the manager running the fund. For example, there is a certain skill associated with Fidelity's Magellan fund - independent of whether it was being managed by Peter Lynch, Morris Smith or Jeff Vinik.

Using cleaner data and more robust techniques than previous researchers, Pastor finds at the industry level there is strong evidence of decreasing returns to scale. This evidence is stronger for high-turnover, high-volatility, and small-cap funds. At the fund level, there is mixed evidence of decreasing and insignificant returns to scale after removing econometric biases. As for skill, it appears that active funds have become more skilled over time, although their performance has

¹ coauthors Robert F. Stambaugh and Lucian A. Taylor, Wharton School of the University of Pennsylvania.

not improved due to the increase in the size of all actively managed money. In addition there is a negative age-performance relationship: a fund's performance decreases over its lifetime, and younger, newly entering funds seem to be more skilled and outperform older funds.

Pastor says that their conclusions are robust when:

1. Controlling for business cycle variables and family size.
2. Trimming extreme outliers in FundSize.
3. Different functional forms for FundSize.
4. Alternate benchmark-adjustments:
 - a. Fama-French.
 - b. Morningstar benchmark with estimated betas.

Pastor has advice for practitioners and investors.

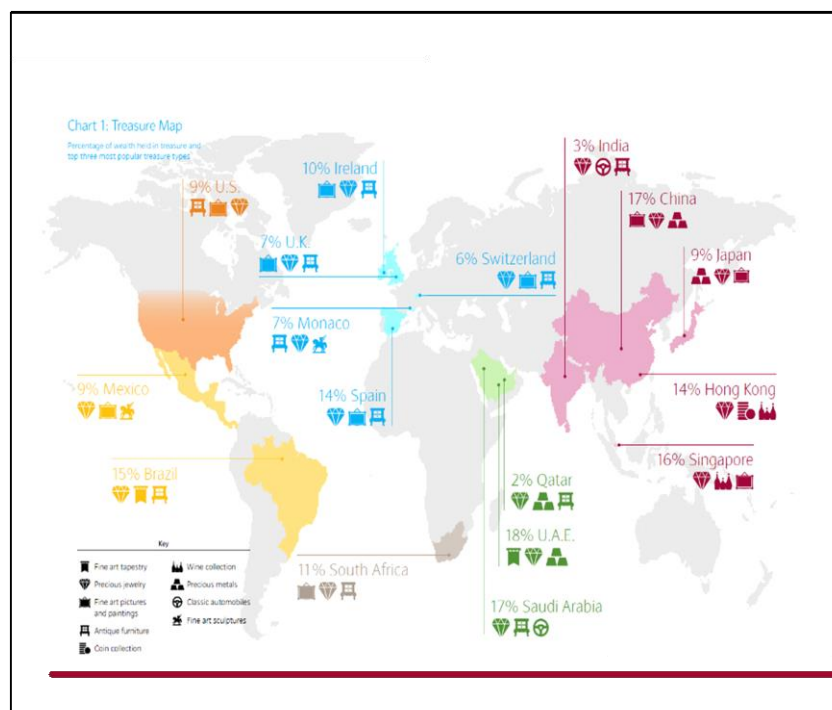
1. Practitioners: Be aware that you are more skilled than your predecessors, but so are your competitors. While it is harder for an active manager to outperform in a larger industry, especially if they manage high-turnover, high-volatility, and small-cap funds, staying away from crowded trades/strategies/industries provides opportunity for better performance.
2. Investors: Invest in young funds since fund performance deteriorates over time due to competition and they are relatively more skilled.

The Investment Performance of Art and Other Collectibles

Elroy Dimson²

London Business School; Cambridge Judge Business School

Dimson starts by saying that collectibles have long attracted high prices and have been perceived as potentially interesting investments. Using a map below, he shows investments by high net worth investors in collectables --stamps, musical instruments and art around the world.



For each of the major collectables, long term returns outperformed those from bills, bonds, and gold. However equity, in part because of its dividends, outperformed them all. Dimson's interest in another collectible, wine, is more than that of a researcher. He is part of a family with a long history of being wine merchants in London.

Wine as a collectable asset, he says, that provides a challenge for the following reasons. First, it ages into being a collectible, thus making its price path challenging to understand. Second, there are no studies of wine's long-term return-generating process. Third, there is an Interaction between drinkability/collectability and financial returns. Fourth, with no puns intended, wine, as an asset is illiquid, heterogeneous, lacks transparency, has high transaction costs, and has no future cash flows beyond a potential resale. It is, Dimson says, an asset of passion, and emotional assets are under-researched.

² coauthored with Christophe Spaenjers, HEC Paris.

Dimson distinguishes two types of wine: low-quality wines that decrease in quality over time; high-quality wines that improve in quality. Both the value of consuming a bottle of wine and the pleasure of owning a bottle depend on its quality, type, age, and buyer's wealth. The fundamental value of a bottle of wine at each date is max of the benefit of immediate consumption or the present value of consumption at maturity plus the psychic dividend received until then.

To examine the returns from wine, Dimson creates a database of investment-quality wine prices since 1899. He limits the data to five Bordeaux first growths (premiers crus) collecting data from wine auctions and from a dealer. In total he has prices for 9,492 year/château/vintage/transaction combinations. The following chart shows the price per bottle in British pounds from 1899 to 2012 in real and nominal terms.

Price per bottle (in GBP)

Period	Nominal				Real			
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
1899-1909	0.25	0.17	0.07	0.88	0.23	0.16	0.06	0.86
1910-1919	0.36	0.20	0.07	1.00	0.26	0.15	0.06	0.87
1920-1929	0.51	0.24	0.06	1.50	0.24	0.12	0.03	0.73
1930-1939	0.53	0.28	0.13	1.33	0.30	0.16	0.07	0.75
1940-1949	1.88	1.09	0.35	4.38	0.80	0.47	0.15	1.85
1950-1959	1.51	0.66	0.42	3.50	0.45	0.22	0.15	1.19
1960-1969	4.31	9.65	1.25	150.00	0.82	1.86	0.24	29.09
1970-1979	29.96	58.30	1.33	1,050.00	2.22	3.83	0.16	53.75
1980-1989	90.84	157.45	3.33	2,090.00	2.96	4.97	0.13	62.56
1990-1999	174.05	358.15	11.00	7,150.00	3.55	6.97	0.25	135.10
2000-2009	300.34	542.81	26.21	8,250.00	4.86	8.95	0.39	132.03
2010-2012	758.46	1,161.84	80.50	8,510.00	10.04	15.63	1.04	110.42

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Dimson creates a model that separates the impact on price of chateau, vintage, transaction type and age as shown below.

$$\ln(P_{i,j,l,t}) = \alpha_i + \alpha_j + \alpha_l + \alpha_t + \beta'X_{j,t} + \varepsilon_{i,j,l,t}$$

Château fixed effects

Vintage year fixed effects

Transaction type fixed effects

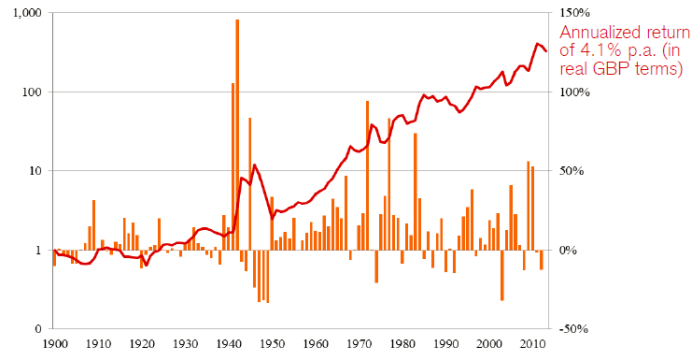
Year of sale fixed effects

Age polynomial

However, there is multicollinearity between time, vintage and age. Thus, he replaces vintage effects with variable measuring production and weather. In addition, since the effect of again may depend on vintage quality, he interacts the age polynomial with weather quality. He then compares the returns from wine to other assets. To do this, he first creates a deflated price index, shown below.

Deflated price index

- Negative real return over first quarter of 20th century
- Boom and bust around WW2
- Strong growth in last half-century, but periodic setbacks (often in recession)



In comparison to other collectables and assets, wine outperforms them all, except for equities, with which it has a positive correlation. Dimson concludes by saying

1. Since 1900, emotional assets beat bonds, Treasury bills, and gold.
2. Long-term returns were not as high as some enthusiasts assert.
3. Given waves in market and transaction costs, a long view is needed.
4. Higher returns in some submarkets reflect changing wealth or tastes.
5. Benefits from diversification and from inflation-hedging are still unclear.

Still, he says, there is a psychic dividend that financial assets cannot provide.

Estimating Private Equity Returns from Limited Partner Cash Flows

Andrew Ang³
Columbia University

Ang's research focus is on private equity, a major institutional asset class and a significant portion of the investments in portfolios of college endowments, foundations, pension funds, and sovereign wealth funds. He notes that there is one big problem that private equity poses for all investors -- the lack of a transactions-based rate-of-return series that can be used for performance evaluation, risk management, and asset allocation. He notes that there is some return private equity information available, however, most is constructed from non-market estimates of book value, multi-year internal rates of return, or multiples of investment. Ang says these are not sufficiently reflective of the actual returns since they are estimates.

Ang uses the experience of the Harvard University endowment during the 2008 Financial Crisis to set the scene. Harvard was an early adopter of the endowment model, a model that lauds the diversification benefits of alternative assets. Despite the supposed benefits of a broadly diversified portfolio, Harvard's endowment lost 27% of its value from June 2008 to June 2009. At the same time, it found that almost 2/3 of its portfolio was illiquid or semi-liquid thus making portfolio re-allocations difficult and hampering the university's ability to use endowment distributions for essential university support. In addition to the losses, the potential demands of future private equity capital calls caused further significant distress. Available data on private equity returns had been misleading and had biased risk estimates downward, until 2008.

Ang reports on the attempt to create a more accurate market-based private equity return index. He and his collaborators develop a method to estimate a time series of private equity returns based on actual cash flows accruing to limited partners. The data is the cash flow data set of Preqin, purchased as of June 2011, that contains quarterly aggregated investments, distributions, and net asset values (NAVs) made by private equity funds. Ang then estimates the returns from private equity and its various sub classes from 1993 to 2011.

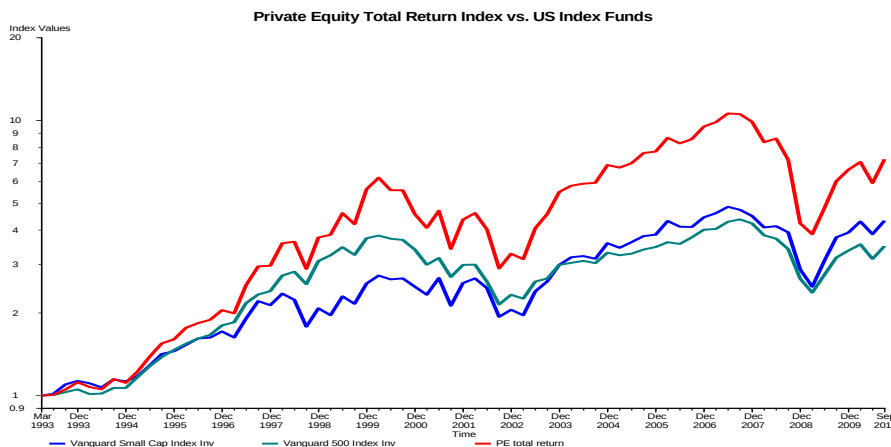
To estimate private equity rates of return, Ang uses a net present value (NPV) investment framework). Ang and his fellow researchers allow the discount rate/rate of return for private equity to vary each period. They then obtain the returns (aka discount rates) that most closely result in a NPV of all private equity cash flows in their sample that is equal to zero. So long as at least one fund in each quarter has a positive or negative cash flow, the procedure produces the quarterly time series of estimated private equity rates of return.

One of the key questions that Ang asks is, how do the returns to private equity compare to returns to liquid market investments with similar systematic risk? In order to answer this question, he posits a functional form for private equity rates of return where the private equity risk premium is sum of a:

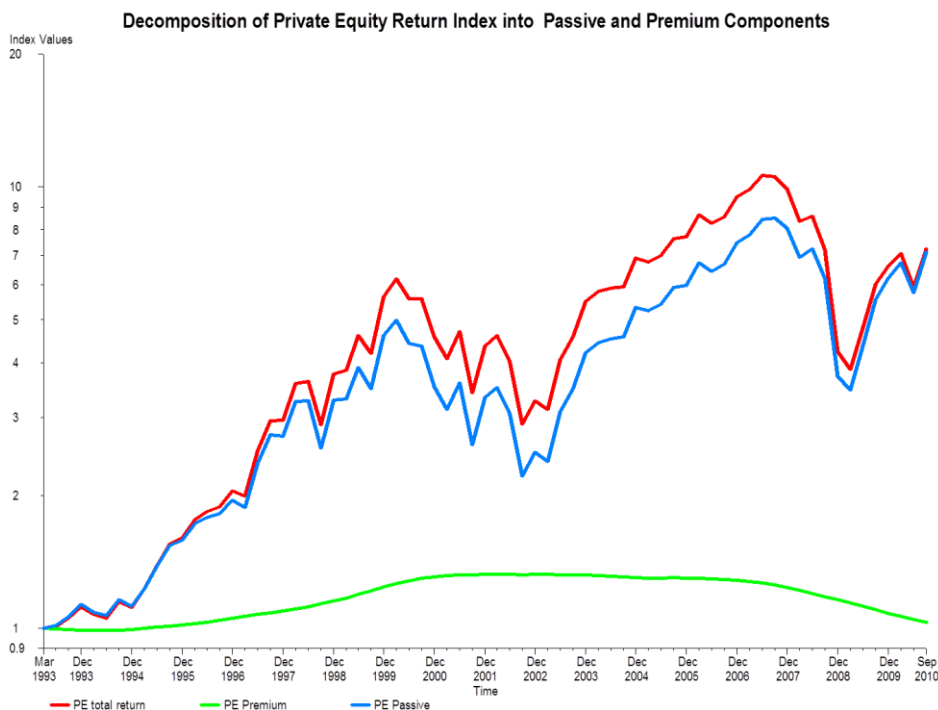
³ Coauthored with Bingxu Chen, Columbia University, William N. Goetzmann, Yale School of Management and NBER, and Ludovic Phalippou, Saïd Business School and Oxford-Man Institute, University of Oxford.

1. Time invariant constant.
2. Premia attributable to exposure to the systematic risk of liquid market factors.
3. Private equity specific latent factor that varies over time.

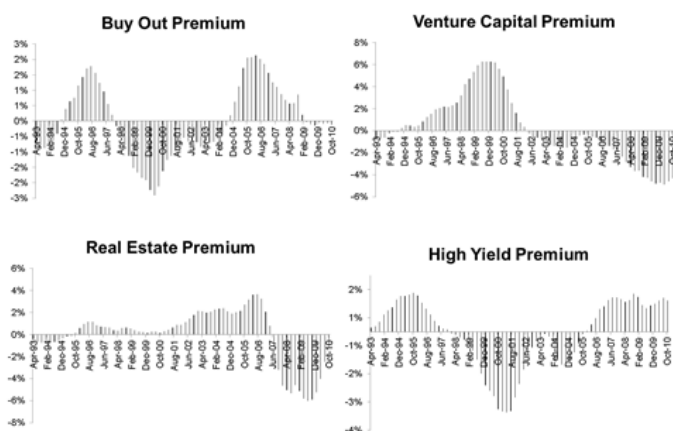
The graph below compares Ang's estimated private equity index with the returns on small stocks (bottom line) and the S&P500 (second line from the bottom).



Over this time period, private equity outperformed both equity indices -- ignoring any differences in risk. As to the sources of return, the following chart shows the total private equity return (top line), the risk premium (the lowest line) and the active private equity premium (the lowest and flattest line).



The charts below show disaggregated risk premiums for the four classes of private equity: buy-outs, venture capital, real estate, and high yield.



The dramatic drop in premiums post 2001 was largely due to the private equity focus on real estate and/or venture capital. This is information that, Ang says, would have been useful to Harvard University when building its endowment portfolio pre the financial crisis.

In conclusion, Ang says this approach to estimating the historical time series of returns to private equity is quite general, requires only information about cash contributions and distributions accruing to limited partners, and is robust to sparse data. By decomposing the private equity returns into components due to traded factors and a time-varying private equity premium he finds strong cyclicity in the premium component that differs according to fund type. In addition, he says, this study provides support for an earlier hypothesis (Kaplan and Strömberg 2009) that capital market segmentation helps to determine the private equity premium.

Investor Sentiment Aligned: A Powerful Predictor of Stock Returns

Guofu Zhou⁴
Washington University

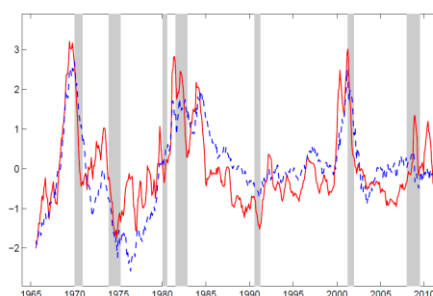
Zhou starts by saying that many, including John Maynard Keynes, have said that investor sentiment is a key factor in determining stock prices. Since sentiment is unobservable, most empirical research has focused on whether stock prices move too much to have been generated by changes in subsequent fundamentals.

Zhou looks to work by Baker and Wurgler (2006, 2007) who suggested there is a role for sentiment in explaining expected returns. BW created a sentiment index that included the following as proxies for sentiment:

1. Closed-end fund discount rate
2. Share turnover
3. Number of IPOs
4. First-day returns of IPOs
5. Dividend premium
6. Equity share in new issues

Their index tried to mitigate the measurement error in any one of the above proxies and to create a more reliable sentiment signal. However, they did not find statistical significance when using their investor sentiment index to predict the stock market.

Zhou attributes BW's weak findings to the principal components approach they used to combine the 6 proxies. He tries a different approach, partial least squares (PLS). He uses the BW proxies and a PLS methodology to extract the combination of the 6 proxies that best explain stock market returns. Zhou says that PLS better aligns the sentiment and calls his approach *aligned investor sentiment*. Forecasts using the BW index and Zhou's *aligned investor sentiment* approach are shown in the chart below. The solid line is the *aligned investor sentiment* (IS^{PLS}) and the dashed line is the BW investor sentiment index (IS^{BW}). The predictions are different.



⁴ coauthored with Dashan Huang, Fuwei Jiang, and Jun Tu, Singapore Management University.

As are the predictive results for each of the two models, show in the chart below.

Table 2: In-sample Forecasts of Aggregate Stock Market

α (%)	t-stat	β (%)	t-stat	R^2 (%)
Panel A: Aligned Investor Sentiment, IS^{PLS}				
$R_{t+1}^m = \alpha + \beta IS_t^{PLS} + \epsilon_{t+1}$				
0.31*	1.62	-0.55**	-2.53	1.54
Panel B: Baker and Wurgler's Investor Sentiment, IS^{BW}				
$R_{t+1}^m = \alpha + \beta IS_t^{BW} + \epsilon_{t+1}$				
0.31*	1.61	-0.24	-1.21	0.30

Although the R^2 s are quite modest, Zhou's *aligned investor sentiment* and BWs investor sentiment index models show that high positive sentiment is a negative indicator of future returns. Zhou points out that the slope coefficient for the his sentiment indicator suggests that a one standard deviation increase is associated with an economically large, 0.55%, decrease in expected excess market returns over the subsequent month.

When Zhou compares the predictive strength of his model to other approaches he concludes that it outperforms multiple macroeconomic indicators as shown in the table below.

Table 4: Compare With Economic Predictors

Panel A: Univariate Regressions				Panel B: Bivariate Regressions				
$R_{t+1}^m = \alpha + \psi Z_t^k + \epsilon_{t+1}$				$R_{t+1}^m = \alpha + \beta IS_t^{PLS} + \psi Z_t^k + \epsilon_{t+1}$				
	ψ (%)	t-stat	R^2 (%)	β (%)	t-stat	ψ (%)	t-stat	R^2 (%)
				-0.55*	-2.53			1.54
DP	0.47	0.99	0.20	-0.55*	-2.51	0.42	0.88	1.70
DY	0.54	1.13	0.26	-0.54*	-2.50	0.46	0.99	1.73
EP	0.21	0.43	0.05	-0.55*	-2.52	0.15	0.30	1.57
DE	0.36	0.50	0.07	-0.56**	-2.54	0.40	0.56	1.63
SVAR	-1.09***	-2.27	1.23	-0.54*	-2.58	-1.05***	-2.27	2.70
BM	0.15	0.20	0.01	-0.56**	-2.53	0.19	0.25	1.56
NTIS	-3.70	-0.33	0.03	-0.55**	-2.45	-0.21	-0.02	1.54
TBL	-0.07	-0.94	0.19	-0.54*	-2.32	-0.03	-0.47	1.59
LTY	0.00	-0.05	0.00	-0.57**	-2.47	0.03	0.37	1.57
LTR	0.15**	2.22	1.07	-0.53*	-2.43	0.14**	2.10	2.51
TMS	0.23**	1.83	0.61	-0.53*	-2.37	0.20*	1.58	2.00
DFY	0.46	0.90	0.23	-0.60**	-2.68	0.65*	1.27	2.00
DFR	0.18	0.89	0.36	-0.55**	-2.58	0.18	0.94	1.90
INFL	0.18	0.27	0.02	-0.55**	-2.54	0.16	0.24	1.56

Z_t^k is one of the 14 macroeconomic variables from Goyal and Welch (RFS, 2008) that are popular predictors of equity premium in the literature

Zhou concludes that the statistical significance of the *aligned sentiment indicator* is robust to the inclusion of the macroeconomic predictors and is economically valuable. It can lead to a doubling of monthly Sharpe Ratios. The forecasting power of sentiment, Zhou says, comes from the investor's under reaction to cash flow information rather than discount rate predictability.

The Economics of Big Time College Sports

Roger Noll
Stanford University

Roger Noll, Professor of Economics Emeritus, Stanford University gave an enthralling Monday evening Q Group dinner talk about *The Economics of Big Time College Sports*.

Noll began his talk by noting that college sports have seen a tremendous growth in revenue over the last 30 years. The key driver behind this growth was a landmark anti-trust decision that the NCAA lost in 1984 regarding its control of television rights. Prior to this anti-trust decision, live telecasts of NCAA sporting events could only occur with NCAA approval. NCAA limited broadcasts to two each Saturday. The reasons, they argued, if more events were televised no one would attend live events. The NCAA reasoned, falsely, that this would severely hurt member schools' revenue: revenue from television rights were small relative to school revenues from tickets, trinkets and team apparel. Nothing could have ended up being farther from the truth.

Since the anti-trust decision in 1984, nominal college sports revenue has grown 8-9% (6-7% in real terms). The revenue boom has created great tension in colleges and universities across that country as an enormously profitable business was thrust upon them by the NCAA. One obvious question is, has this enormous growth in revenue caused big time sports to be profitable for the schools in general, or had unintended consequences?

There are currently 120 universities that play Division1 football, 300 that play Division 1 basketball, and there are no barriers to entry. A big-time college sport is a highly competitive industry, and has continued to attract new entrants. As economists know, Noll says, a big increase in revenue does not necessarily lead to bigger profits if competition is sufficiently high, and competition is very high.

Noll points out that this tends to be a winner-take-all industry where huge rewards flow to the winners. As a result, competition for inputs for winning, players, has grown fiercer and fiercer. The NCAA controls only one input, the players, by restricting the size and number of scholarships. As a result, input costs for players are clear and fixed, while the revenues are not. In the race to win players increasingly more has been spent on what attracts them -- coaches, athletic facilities, and administrators.

Noll asks whether this has led big time college sports to be more profitable. Except for the top twenty schools, his answer is a clear no! Compounding the problem, he notes that universities are non-profit institutions that know they must stay non-profit, and decisions are decentralized. This has led most athletic departments to spend all of their revenue increases on coaches, stadiums and training facilities. Noll uses as an example of Duke University's basketball coach's salary: Mike Krzyzewski earned roughly \$300,000 in 2000. By 2012 it was over \$5 million.

A regression of the athletic revenue of a school on a set of explanatory variables, including won-loss record and quality of the conference, the regression explains almost all of the variability but none of it depends on the school itself. Player recruitment is the key to success. The success of a team is almost

entirely determined by how many 4- and 5-star rated high school athletes are recruited, and most of them go to the top 20 universities.

This is a winner-take-all industry, Noll points out. New players often choose a coach more than the school. To produce a good team, a school must hire and keep an iconic coach. Since player costs are fixed, the marginal revenue product of the players goes to the coaches, and coaches that can attract the best players are able to earn a higher salary and more benefits. Noll reports on an interview with Nick Saban, the head football coach at Alabama. He discussed the 2 main values of new facilities: it helps athletes; it protects the student athlete from the distraction of campus life.

Big time college sports have seen a dramatic rise in effective demand. In response, colleges have spent more and more on their athletic programs. Since success drives revenue, the shadow cost of going to class has gotten higher and higher. There is thus an incentive to require players to put more and more time into practice; a problem noted in the player testimony during Northwestern University's football players' petition to be able to be unionized. Northwestern is clearly a school with high admission standards and where the students have, what Noll calls, real majors, but practice demand are high. One former quarterback, who is behind the push to unionize, was not allowed select his preferred major, pre-med, if he wanted to play football. Clearly the balance between academics and athletics is much worse at places that take academics far less seriously.

Noll's says that the current system is unsustainable and in the process of imploding. The NCAA must either stop being so commercial or give some to the players. One simple solution would be to raise scholarships to cover the full cost of attending school. He concludes that conferences should be allowed to compete without collusion, and set their own rules. It is clear to him that if the NCAA exists at all in 3 years, it will not be the same.

Fittingly, many participants left the talk in haste to watch Kentucky and Connecticut compete in the NCAA basketball final.

Dissecting Factors

Juhani Linnainmaa⁵
University of Chicago

It is the widely used Fama French (FF) equity pricing model and its problems that intrigue Linnainmaa. Because the model cannot price corner portfolios when stocks are sorted by size and book-to-market value, Fama and French (1996) themselves rejected the three factor model. In spite this rejection by the creators, the FF model remains widely used by academics and practitioners nearly twenty years later. Curious about the problems with FF, instead of further mapping the model's boundaries, Linnainmaa turns to the model itself for an explanation of its problems.

The idea behind the FF model is that stocks co-move with other stocks of their type. Thus value co-move with value, growth with growth and small stocks with others in their category. But, Linnainmaa says, stocks based on style and cap can be in the group for many reasons, not all of which earn a premium or discount. This leads him to ask two questions: are all value stocks (and small stocks) created equal; if not, what are the implications for performance evaluation and “new” anomalies?

Small stocks Linnainmaa points out, co-move with other small stocks and value stocks co-move with other value stocks, but not all versions of size and value are compensated with higher average returns. HML and SMB can each be split into two systematic parts with different risk premia, one with a positive price of risk and the other with a zero price of risk. Because of the mismatch between covariances and average returns, the three-factor model incorrectly penalizes some small and value stocks. Simply, Linnainmaa says, not all flavors of size and value are compensated with higher average returns.

How can this happen? A value a stock can be deemed value if it has always been a value firm, or when the market value of its equity decreases or the book value of the equity increases. Similarly a company is small if it was small at the time of its IPO or when the market value of equity decreases. These different reasons for categorization result in a mismatch between covariances and average returns. Thus, the three-factor model does not condition on enough information to pick up on these distinctions: a small value stock, gets penalized in alphas while a large growth stock gets a credit. In fact, the two strategies, HML and SMB, really are bundles of multiple factors Linnainmaa calls “baby factors.” The strategies themselves each can be split into two systematic parts each with different risk premia: one with a positive price of risk; one with a zero risk price.

To look at this Linnainmaa takes the part of firm size orthogonal to value and project it on long-term changes in the market value of equity. The priced components are the projections and the unpriced components are the residuals. The results of this analysis are shown below.

⁵ coauthored with Joseph Gerakos from the University of Chicago.

Sorting variable	$\hat{\alpha}$	Portfolio decile		High – Low	
		1	10	$\hat{\alpha}$	R^2
Current: ome_t	$\bar{r}^e$	0.62 (2.39)	0.42 (2.45)	-0.20 (-1.10)	
	CAPM	0.09 (0.60)	0.01 (0.24)	-0.08 (-0.43)	7.6%
	FF	-0.11 (-1.76)	0.04 (1.31)	0.15 (2.13)	85.6%
Priced: $\widehat{ome}_t$	$\bar{r}^e$	0.83 (3.45)	0.47 (2.29)	-0.36 (-2.73)	
	CAPM	0.32 (2.60)	-0.01 (-0.10)	-0.33 (-2.45)	1.2%
	FF	0.09 (1.15)	0.01 (0.15)	-0.08 (-0.81)	48.5%
Unpriced: ome_t^e	$\bar{r}^e$	0.57 (2.25)	0.42 (2.45)	-0.15 (-0.89)	
	CAPM	0.04 (0.28)	0.01 (0.25)	-0.03 (-0.16)	8.7%
	FF	-0.14 (-2.37)	0.03 (1.27)	0.17 (2.64)	86.4%

Linnainmaa then asks how this insight this would impact mutual fund performance evaluation. Answer this he creates an augmented model that includes the insights into priced and unpriced factors. The original and augmented models are shown below.

$$r_{j,t} - r_{f,t} = \alpha_j + b_j \text{MKTRF}_t + s_j \text{SMB}_t + h_j \text{HML}_t + e_{j,t}$$

$$r_{j,t} - r_{f,t} = \alpha_j + b_j \text{MKTRF}_t + s_j \text{SMB}_t + s_{j,\text{control}} me_{t,\text{control}}^e + h_{j,\text{control}} bm_{t,\text{control}}^e + e_{j,t},$$

Where: $r_{j,t}$ is fund_j's month_t return net of fees, $r_{f,t}$ is the one-month Treasury bill rate, MKTRF_t is the return on the value-weighted market portfolio in excess of the Treasury bill rate, SMB_t and HML_t are the size and value factors of the three-factor model, $bme_{t,\text{control}}$ is the month_t return on a long-short portfolio based on the unpriced part of book-to-market, and $me_{t,\text{control}}^e$ is the month_t return on a long-short portfolio based on the unpriced part of size.

Using this augmented model Linnainmaa finds that estimated alphas shift significantly to the right. He says that most managers trade the uncompensated flavors of size and value and thus do not offset the costs they impose on investors for their skill. He reports that in 2010 only 2% of fund managers had enough skill to cover the costs they imposed on investors. Using the augmented model, up to 18% of fund managers had cost-offsetting skill.

Linnainmaa concludes his presentation talking about the power of gross profit as an addition to the model. He says that a strategy that combines value and profitability is very attractive. On the basis of this work, managers should be aware that HML and SMB are bundles of multiple factors, some of which are not priced. To deal with this, the manager must either clean the value signal by taking into account recent changes in the market value of equity or combine book-to-market with gross profitability so as to separate “good” value from “bad” value.

The Not So Well-Known Three-and-One-Half Factor Model

Steven Thorley⁶

Brigham Young University Marriott School of Management

Asset pricing theory in financial economics has developed well beyond Sharpe's (1964) original CAPM. There were unexpected outcomes from using this model to study equity returns: realized alphas of low (high) beta portfolios are reduced (increased) when a beta factor was included. Today's equity researchers and others using the equity pricing models conceptualize the 3-factor Fama-French (FF) model, shown below, as a tool for studying market return and the size and value characteristics of equity.

Thorley asks, what are the three factors in the FF model? He says that some analysts will answer the market, size, and value, while others answer beta, size, and value. So is it the return that on the capitalization-weighted market portfolio, or the return that from the CAPM beta? Theoretically, the return to the beta factor is the market return. Empirically, it is not, and the two are not even close. Commercial providers of equity risk models typically include a market and a beta factor, along with variations of the size and/or value factors, in their models.

To understand the problems addressed by commercial providers, Thorley creates a variation of the basic market model, by splitting the middle term ($\beta_i R_M$) into a market constant and a relative beta factor, hence the name three-and-half factor model.

For his analysis of the importance of this innovation, he uses the following model:

$$R_i = A + B1 \text{ beta}_i + B2 \text{ size}_i + B3 \text{ value}_i + B4 \text{ mom}_i + e_i$$

Where A, B1, B2, B3 and B4 are parameters (factor returns) estimated from cross sectional regressions, N is the number of securities in each cross-section, and beta, size, value, and momentum (mom) are stock-specific factor sensitivities. These types of factor models are at the core of practitioner equity risk management models.

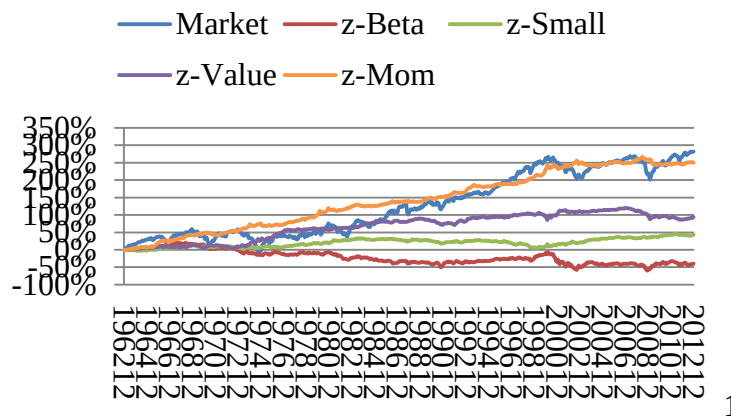
Under the assumptions that the CAPM is true, $B2=B3=B4=0$ in the above equation and the coefficient B1 in each cross-sectional regression should equal the return on the market portfolio. He standardizes the cross sectional variations in betas to have unit variance and allows the pure beta factor return to be different from R_M to create the following model.

$$R_i = A + RMF + B1 (\text{beta}_i - 1) + B2 \text{ size}_i + B3 \text{ value}_i + B4 \text{ mom}_i + e_i$$

Thorley empirically examines whether this is true. His primary results are summarized in the following chart where the returns are, from the top right down, the market, momentum, value, small and beta at the bottom. The prefix z identifies they are standardized.

⁶ co-authors Roger Clarke and Harindra Silva

Figure 1: Cumulative Factor Returns from 1963 to 2012



It is readily apparent that the CAPM null hypothesis: $B_2=B_3=B_4=0$ seems violated. Further, the risk premium associated with the $(\beta_i - 1)$ factor, which should equal RMF, is virtually non-existent. Over the 1963-2012 period, the average annual estimated factor returns are RMF, 5.64%, beta, -0.79%, size, 0.86%, value, 1.88% and momentum of 4.99%. It is interesting that the estimated $(\beta_i - 1)$ factor has significant factor volatility (7% annual standard deviation) and hence is important for risk management. It just does not appear to be a significantly priced factor.

Thorley reviews how the cross-sectional regression parameters can be thought of as factor mimicking portfolios where the intercept corresponds to a portfolio whose weights sum to one and all other parameters correspond to zero net investment portfolios. In practice, these factor mimicking portfolios have a high correlation to the FFs SMB, HML, and UMD (momentum) portfolios.

Finally, Thorley uses two different specifications of equation the second equation for the purposes of portfolio performance measurement with data from a set of ETFs. One specification of the equation forces the coefficient $B_1=0$ and allows RMF to have a slope coefficient different from 1.0. In the second specification, B_1 is freely estimated and the slope coefficient on RMF is set equal to 1.0, as specified in the second formula above. He finds estimated annual alphas that can differ by as much as 3% depending on the specification.

Thorley concludes that:

1. The market's influence on individual security returns can be split into a capitalization-weighted market portfolio and a pure beta factor
2. The beta anomaly in the U.S. equity market over the last half century is larger than either the size or value anomalies, second only to momentum, and is more evident in larger capitalization stocks.
3. The beta anomaly presents challenges for portfolio performance measurement and opportunities in portfolio construction. In fact, returns-based performance measurement for the MSCI Minimum Volatility Index indicates that selecting low beta stocks provides most of the value added in low volatility strategies.

4. In most cases a separate beta factor should be incorporated in portfolio performance calculations to avoid misperceptions about the source and magnitude of the alpha when the market beta is materially different from one.

It is important that much of the variation in the performance of economic sector portfolios is explained by their differential exposures to a separate beta factor. Understanding this distinction between the market and beta factors in the not-so-well-known three-and-one-half factor model should help avoid misperceptions about the sources of portfolio performance.

A Primer on Fast Electronic Markets

Larry Harris⁷

Marshall School of Business University of Southern California

In the Spring 2010 Q Group meetings Harris had provided a primer on electronic markets. Events, including the recent publication of Michael Lewis' *Flash Boys*, and increased concern by regulators and Congress, has elevated the importance of understanding these markets. As a result Harris agreed to provide an optional tutorial for Q participants on the markets and updated the data from 2010 "Equity Trading in the 21st Century."

Harris describes electronic order matching systems and says they are very cheap to operate once built. The systems do exactly what they are programmed to do and maintain perfect audit trails. These systems have largely displaced floor-based trading systems in all instruments for which order-driven markets are viable. He goes on to describe:

1. Types of Electronic Traders
2. Main Proprietary Strategies including Liquidity Trading and Parasitic Low Latency Strategies
3. Electronic Buy-Side Traders
4. Needs for Speed
5. How To Trade Fast
6. Why Electronic Traders Are Efficient

He says that the efficiency of electronic trading strategies led to their widespread adoption by proprietary traders, buy-side traders, and their brokers. At the same time electronic traders have displaced traditional dealers, arbitrageurs, and brokers in electronic order-driven markets.

The update of the empirical results from his 2010 "Equity Trading in the 21st Century" shows, Harris says, that market quality in the U. S. has remained high by all measures, despite concerns expressed by some practitioners and regulators. Improvements in market quality have benefited small traders and new evidence indicates that it also has benefited the institutional trader executing very large orders over many days.

While he finds this encouraging, he notes that certain changes in market structure could produce even better markets. He has particular concerns about maker/taker pricing and its cousin, taker/maker pricing. The later represents a subversion of the sub penny rule of Regulation NMS with the attendant implications for front-running trading. Also of concerned is front-running of large institutional traders by traders employing computerized pattern recognition systems. Large institutional traders could be protected from these strategies by a simple change in trade

⁷ coauthored with James J. Angel, McDonough School of Business Georgetown University and Chester S. Spatt, Tepper School of Business Carnegie Mellon University.

reporting procedures. Finally, he notes that high frequency traders are engaged in a dissipative arm's race that is not benefiting public investors. A slight random delay in order processing could reduce the importance, and thus the costs, of winning this race.

Various proposals to change market structure are troubling and he believes they would damage market quality substantially. Foremost among these are proposals to impose transaction costs on trading and minimum resting times on quotes. Both proposals would hurt liquidity without producing the desired improvements in market quality.

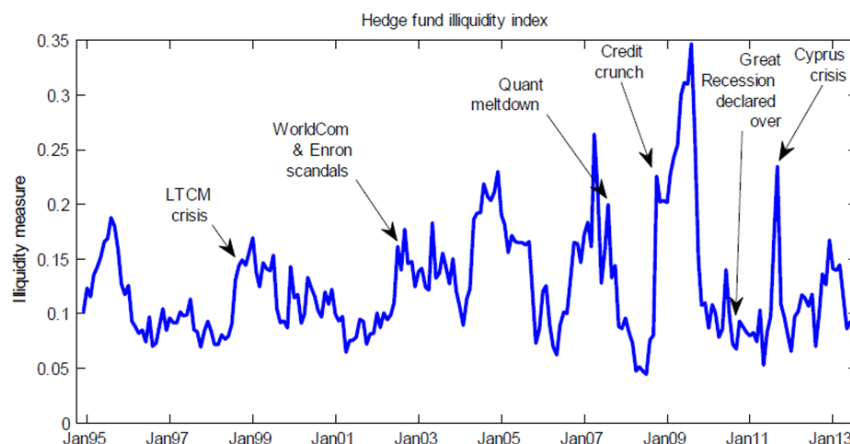
With so much current controversy about equity market structure, taking a fresh look at the structure of our markets from a broad perspective is important. Harris concludes that the empirical results show that the markets are functioning reasonably well despite the many calls for change. At the same time, various economic distortions and principal-agency problems suggest that market structures could be enhanced to better serve investors. Such changes should be guided by sound economic and legal principles when their application is well understood. When they are not, pilot studies and policy phase-ins can produce additional economic evidence that could improve policy decisions. However, regulators should not create pilot studies simply to defer good policies that are politically difficult to implement.

Impact of Hedge Funds on Asset Markets

Andrew Patton⁸
Duke University

Hedge funds have sparked enormous interest from a number of different constituencies: wealthy individuals and institutional investors interested in high returns with promised low risk; academics interested in the returns and risks underlying these returns; regulators and policymakers who are wary about the industry since the collapse of Long-Term Capital Management nearly sparked a financial crisis. Collapses of other major hedge funds have perpetuated the concerns that such collapses again could impact the underlying asset markets. Patton says that these concerns are understandable. While the global hedge fund industry has about U.S. \$1.5 trillion of assets, their substantial leverage and the high levels of trading means their impact may be disproportionately large. In spite of this importance, little empirical evidence connects the activity of hedge funds to returns in underlying asset markets. Patton seeks to correct this.

Patton looks at the ability of a measure of hedge fund illiquidity to predict the returns of 72 portfolios of international equities, corporate bonds, and currencies from 1994 to 2011. The illiquidity measure is based on the autocorrelation in hedge fund returns. In particular, he uses an equally-weighted average of the autocorrelations from a sample of 30,000 hedge funds created by merging data from HFR, TASS, CISDM, Morningstar and Barclay Hedge. The individual fund autocorrelation coefficients used for the underlying analysis are based on simple rolling window estimates using 12 months of data. He excludes negative individual fund correlation coefficient estimates to create “trimmed” estimates. The equally weighted average correlation Patton calls an illiquidity measure. In the chart below you see the illiquidity measure over time, annotated for hedge-fund industry events.



The chart below shows Patton’s average hedge fund illiquidity measure by hedge-fund strategy.⁹

⁸ Co-authors Mathias Kruttli and Tarun Ramadorai.

Styles	Equally Weighted			AUM Weighted		
	Average	Std Dev	Corr. with All	Average	Std Dev	Corr. with All
CTA	0.085	0.035	0.720	0.022	0.013	0.591
Directional Traders	0.115	0.054	0.857	0.029	0.028	0.865
Emerging Markets	0.136	0.070	0.791	0.044	0.028	0.688
Fixed Income	0.174	0.051	0.788	0.055	0.025	0.750
Funds of Funds	0.153	0.088	0.958	0.061	0.053	0.972
Global Macro	0.093	0.034	0.777	0.028	0.018	0.817
Multi-Strategy	0.146	0.055	0.905	0.060	0.031	0.920
Relative Value	0.103	0.039	0.657	0.026	0.033	0.648
Security Selection	0.111	0.037	0.876	0.046	0.018	0.797
All	0.126	0.053	1.000	0.046	0.027	1.000

Patton presents evidence of the hedge fund illiquidity measure's ability to predict aggregate returns for a variety of markets. It has, he says, statistically significant predictive ability for all the equity markets (shown below), 75% of the corporate bond indices and 2/3 of currency markets. There is significant forecasting ability to about 6 months in the future, Patton finds, and his findings are robust.

Country	$\bar{R}^2$	γ	signif	γ	sign	Country	$\bar{R}^2$	γ	signif	γ	sign
Australia	8.220	**	+			Japan	2.745	**	+		
Austria	3.954	**	+			Netherlands	3.255	**	+		
Belgium	2.608	**	+			New Zealand	4.722	**	+		
Canada	3.057	**	+			Norway	4.509	**	+		
Denmark	2.920	**	+			Singapore	6.560	**	+		
Finland	1.327	**	+			Spain	3.836	**	+		
France	2.148	**	+			Sweden	4.022	**	+		
Germany	1.611	**	+			Switzerland	1.739	**	+		
Hong Kong	4.638	**	+			UK	4.025	**	+		
Ireland	2.741	**	+			US	1.583	**	+		
Italy	1.632	**	+								
Across 21 countries						3.422 (21/0)					

The apparent ability of hedge fund autocorrelations to predict these asset class returns raises two questions: are these autocorrelations primarily a reflection of hedge fund illiquidity; is hedge fund illiquidity causing future higher expected returns or could there be a different transmission mechanism?

Patton posits a model where hedge funds are the marginal market maker and low hedge fund liquidity leads to higher asset returns. In that model, hedge funds require a certain amount of liquidity as they face potential outflows from redemptions. The basic argument is that when hedge fund liquidity is low, hedge funds market makers will skew the bid-ask spread such that the mid-price is below fair market value. Thus, one would expect small bid-ask bounce from noise trader purchases and large bid-ask spread bounce from noise trader sales. In equilibrium, this causes expected returns to be high when autocorrelations are high. To test this, Patton examines whether the predictive power of the illiquidity measure is greater for more illiquid assets and stronger following market declines when liquidity is likely to be less. The following

⁹ Several participants asked if the magnitude of the correlation might in part reflected index construction problems related to on-time reporting for some of the strategies.

table shows show the predictive power is somewhat stronger following negative returns. He takes this as evidence supporting this hypothesis.

Predictive power is greater for illiquid assets						
All models also include a fixed effect and all competitor variables						
Variable	Estimates and t-stats					
	Int'l Equities		US corp bonds		Currencies	
ρ_t	1.166** (3.066)	1.179** (2.900)	0.229* (1.955)	0.375** (3.137)	0.203 (1.255)	0.206 (1.134)
$\rho_t^{I_{Sml}Cap}$	0.272** (2.128)					
$\rho_t^{I_{LowTurn}}$		0.248** (2.161)				
$\rho_t^{I_{HiYield}}$			0.666** (2.626)			
$\rho_t^{I_{LongMat}}$				0.197** (2.713)		
$\rho_t^{I_{HiSpr}}$					0.269** (2.229)	
$\rho_t^{I_{HiInt}}$						0.264** (2.463)

Patton concludes by saying that he believes these results are a useful addition to the literature on hedge funds: the model liquidity provides additional testable predictions, which are (mostly) borne out in the data.

The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response

Peter Cramton¹⁰
University of Maryland

Cramton starts with some anecdotes about the current state of electronic, high-frequency trading, especially in light of last week's publication of Michael Lewis's *Flash Boys*:

- In 2010, Spread Networks invested \$300mm to dig a high-speed fiber optic cable from NYC to Chicago. It shaves round-trip data transmission time from 16ms to 13ms.
- Within three years, Spread's fiber optic cable was obsolete.
- Industry observers joke that 3ms is an eternity and that next innovation will be to dig a tunnel, thus avoiding the planet's pesky curvature.
- Microwave technology has advanced sufficiently bringing the round-trip NY-Chicago transmission time from 10ms to 9ms and now to 8.5ms.
- Analogous races are occurring throughout the financial system, sometimes measured as finely as nanoseconds.
- Last month a *Business Wire* reported on the use of lasers to transmit data.

Cramton says that the HFT arms race is an optimal response from market participants given the current market design. He believes, however, that continuous-time trading and continuous limit order book are basic flaws in modern financial market design. He proposes replacing continuous-time trading with discrete-time frequent batch auctions: uniform-price sealed-bid double auctions conducted at frequent, but discrete, time intervals (e.g., every 1 second or 100ms). He argues this would be a minimal departure from the current system where the arms race is a never-ending, and the market design harms liquidity and is socially wasteful. The cost to investors of this change would be very short wait time-to-trade.

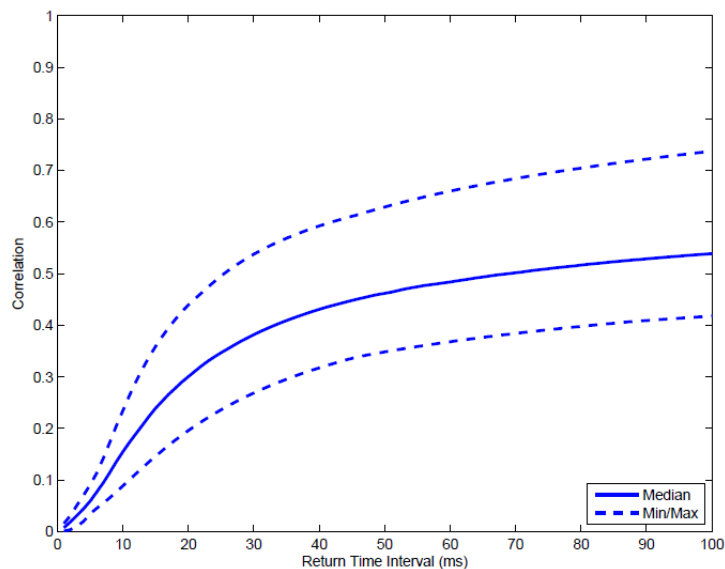
One of the arguments against discrete time batch auctions is that may facilitate break-downs in correlations across assets which normally would be highly correlated. Cramton argues that correlations break down for technical reasons at some trade frequency even under continuous trading. The following table, for instance, shows pairwise correlations of related companies' stock prices at various horizons.

¹⁰ co-authored with Eric Budish, University of Chicago Booth School of Business and John Shim, University of Chicago Booth School of Business.

	1 ms	100 ms	1 sec	10 sec	1min	10 min	30 min
HD-LOW	0.008	0.101	0.192	0.434	0.612	0.689	0.704
GS-MS	0.005	0.094	0.188	0.405	0.561	0.663	0.693
CVX-XOM	0.023	0.284	0.460	0.654	0.745	0.772	0.802
AAPL-GOOG	0.001	0.061	0.140	0.303	0.437	0.547	0.650

While all pairs are highly correlated at a one-minute interval, the correlations start to break down at intervals of ten seconds or less.

This following chart depicts the correlation between the returns of the E-mini S&P 500 future (ES) and the SPDR S&P 500 ETF (SPY) bid-ask midpoints as a function of the return time interval for every year from 2005 to 2011.



As is readily apparent, in 2005 the pairwise correlation had completely broken down (i.e. was below 10%) at a 100ms trade interval. By 2011, that level of breakdown did not occur until trade intervals of less than 10ms were reached. This chart, Cramton says, is a clear depiction of the high-frequency arms race.

At short enough trade horizons, there is room for arbitrage between the ES future and the SPY ETF. The following table presents data, over the January 2005 to December 2011 period, for arbitrage opportunities between the E-mini S&P 500 future (ES) and the SPDR S&P 500 ETF (SPY).

	Mean	Percentile						
		1	5	25	50	75	95	99
# of Arbs/Day	891	107	174	289	446	915	2723	8164
Qty (ES Lots)	12.93	0.20	0.20	1.20	4.00	11.20	49.00	135.40
Per-Arb Profits (Index Pts)	0.09	0.05	0.05	0.06	0.08	0.11	0.15	0.23
Per-Arb Profits (\$)	\$91.68	\$0.59	\$1.08	\$5.08	\$16.08	\$48.28	\$247.74	\$885.46
Total Daily Profits - NYSE Data (\$)	\$82k	\$5k	\$9k	\$18k	\$33k	\$59k	\$210k	\$741k
Total Daily Profits - All Exchanges	\$312k	\$27k	\$40k	\$76k	\$131k	\$224k	\$763k	\$2,812k
% ES Initiated	90.65%							
% Good Arbs	99.99%							
% Buy vs. Sell	49.57%							

Cramton goes on to estimate annual potential value of ES-SPY arbitrage at \$75mm, suspecting it is an underestimate. Furthermore, he says, ES-SPY is just the tip of the iceberg when it comes to the value of execution speed - one of many potential arbitrage opportunities.

He concludes his talk with some of the open questions: Isn't the arms race just healthy competition? What's the market failure? Why hasn't some exchange tried it? What is the equilibrium if there are both batch and continuous exchanges operating in parallel? What would be the mechanics? What are some of the likely unintended consequences? What is the optimal time interval? What would be the role of trading halts? What trade information should exchanges release and when? What are the adverse information impacts from a structure that will still allow faster traders to act on news between the batch auctions? Interesting proposal, intriguing questions.

The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response

Lu Zhang¹¹
Ohio State University

The momentum premium, which is observable within and across most asset classes, is perhaps the most difficult of the asset pricing anomalies to explain as a rationale outcome of financial market equilibrium. Hence, the bulk of the momentum literature has adopted behavioral models to explain the momentum premium using conservatism, self-attributive overconfidence, and slow information diffusion as justifications.

Zhang uses a neoclassical investment framework, pioneered by James Tobin and utilized by John Cochrane in a similar finance context, to examine whether the cross-section of expected returns of momentum sorted portfolios are consistent with a production-based asset pricing model. Previous research has clearly shown that this cross-section of expected returns is not consistent with the Fama-French three- or four-factor models.

The intuition underlying Zhang's model is as follows. Suppose rational investors revise upward their expectations about earnings and output in the future. *Ceteris paribus*, this will lead to an increase in stock prices. However if stock prices rise, firms should immediately raise their investment in capital stock since the price has risen relative to the cost of capital, resulting in a contemporaneous increase in investment growth and investment return at the same time as increased stock returns. As Cochrane notes, if there are lags in the investment process then investment will not actually rise for a period of time, but orders or investment plans should rise immediately. Further, if the production function recognizes investment lags --which Zhang does not -- the investment returns should still move at the same times as the stock return.

The relationship between stock returns and investment returns depend on a number of restrictive assumptions as well as careful timing alignment of the data for empirical purposes. Zhang, in his paper, discusses in detail the efforts they undertake to construct and align the data. Among key assumptions:

- 1) All firms have identical constant returns to scale production functions whereby each firm's operating profits are a constant proportion κ of the firms' operating revenue; where the proportionality constant κ is the same across all firms. Hence, all firms are assumed to have identical operating margins regardless of their industry or operating efficiency, and there are no winners and losers across firms in terms of operating margins.
- 2) Firms pay an adjustment cost to alter their capital stock through investment or disinvestment. The adjustment costs are assumed to be of a quadratic functional form and do not depend on the firm's industry or the nature of the firm's capital. The after-tax marginal cost of an investment is given by: $(1 + (1 - \tau) a (I_{it}/K_{it}))$ where a is a parameter

¹¹ coauthored with Laura Xiaolei Liu, Hong Kong University of Science and Technology.

to be estimated in the empirical work, I_{it} is the investment by firm i at date t , K_{it} is the capital stock of firm i at date t , and τ is the corporate tax rate.

- 3) Markets for capital are sufficiently competitive and friction free such that firms can optimally adjust their capital stock each period so that firms' expected investment returns ($E_t[r^I_{t+1}]$) are equilibrated to the point that: $E_t[M_{t+1} r^I_{t+1}] = 1$ where M_{t+1} is the stochastic discount factor. In principle, this allows firms to short capital as well to be long capital.
- 4) Similarly capital markets are assumed sufficiently competitive and friction free such that expected stock returns ($E_t[r^S_{t+1}]$) are equilibrated to the point that: $E_t[M_{t+1} r^S_{t+1}] = 1$.

The empirical work in the paper relies on the equilibrium relations given in the last two points above, and the resultant moment restriction:

$$E_t[r^S_{t+1} - r^{Iw}_{t+1}] = 0 \quad (1)$$

on firms' stock and investment returns where $E_t[r^{Iw}_{t+1}]$ is the firm's levered investment return.

Zhang uses the moment restriction in (1) above to estimate the two unknown parameters a and κ on 10 price momentum and 10 earnings momentum portfolios. The key results of the paper are panels below.

Panel A: Data, HML loadings							Panel B: Model, HML loadings					
	Low	2	3	4	High	All	Low	2	3	4	High	All
Low	0.28	0.29	0.37	0.48	0.42	0.37	0.65	0.64	0.64	0.65	0.66	0.65
2	0.58	0.40	0.73	0.66	0.92	0.66	0.71	0.70	0.69	0.70	0.72	0.70
3	0.84	0.58	0.57	0.84	0.93	0.75	0.76	0.76	0.76	0.76	0.77	0.76
4	0.50	0.54	0.70	0.74	0.83	0.66	0.82	0.81	0.81	0.82	0.85	0.82
High	1.05	1.04	0.99	0.90	1.34	1.07	0.96	0.93	0.94	0.96	1.01	0.96
All	0.65	0.57	0.67	0.72	0.89		0.78	0.77	0.77	0.78	0.80	

The results in Panel A show the well-known cross-sectional variability in average returns for the 10 momentum portfolios, ranging from 10.74% per year for the low momentum portfolio to 19.22% for the high momentum portfolio. The corresponding Fama-French alphas are -0.21% and 7.29%. The spread between the Fama-French alphas of the top and bottom price decile momentum portfolios is a large and significant. The next-to-bottom row of Panel A shows similar alphas for Zhang's production-based asset pricing model. Here the alphas are dramatically reduced, with the spread between the high-momentum and low-momentum portfolios only -0.90% and not statistically significant.

The production investment model, which is fit based on the returns of the 10 momentum-decile portfolios, appears to succeed in capturing average momentum profits. In addition, the model captures the reversal of momentum in long horizons, long-run risks in momentum, and the interaction of momentum with several firm characteristics. However, the model fails to reproduce the pro-cyclicality of momentum as well as its negative interaction with book-to-market.

“How Much Would it Take? Achieving Retirement Income Equivalency between Final-Average-Pay Defined Benefit Plan Accruals and Voluntary Enrollment 401(k) Plans in the Private Sector”

Jack Van DerHei
Employee Benefit Research Institute

Van Derhei asks an important question and one that is becoming more and more critical as the pension crisis widens and expands in the U.S.: what is enough and are 401(k) plans markedly worse in meeting than goal of retirement relative to defined benefit plans? To gain some insight he proposes a comparative analysis of future benefits from private sector, voluntary-enrollment 401(k) plans, and stylized, final-average-pay, defined-benefit and cash-balance plans. He develops a procedure to determine the generosity parameter, the percentage of the average salary per years of service used to calculate the pension annuity, needed to produce 401(k) retirement income equivalent to that of median defined benefit plans.

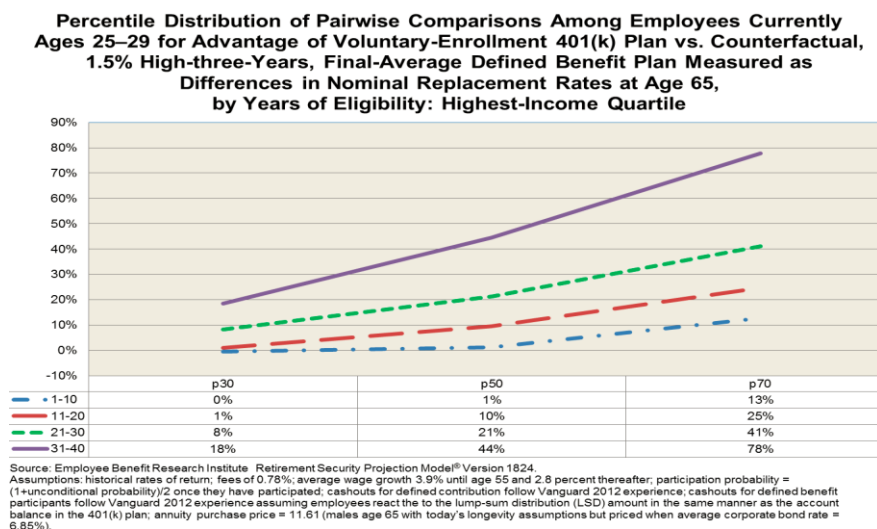
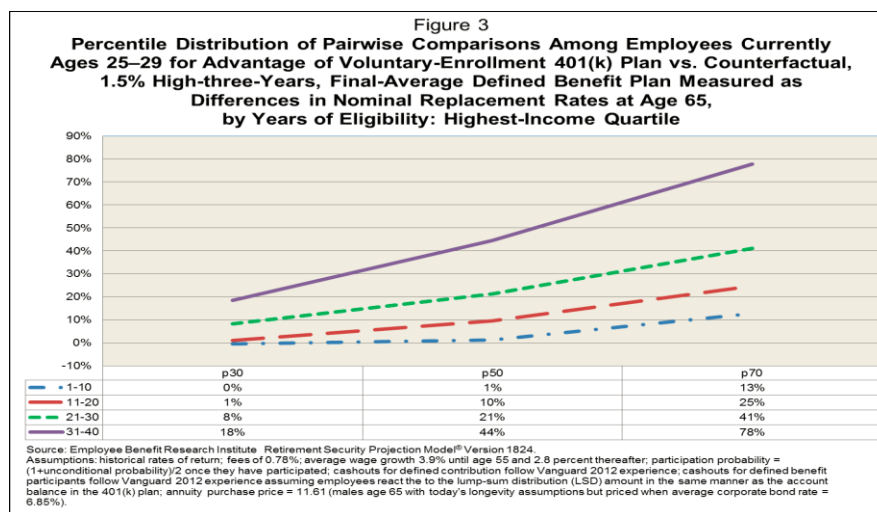
Van DerHei creates the base model he will use to in determining the required generosity parameter. For the base model he assumes:

1. Historical rates of return -- stochastic variables with log normal distribution and mean arithmetic real returns of 8.6 percent for equities, 2.6 percent for bonds.
2. Fees of 0.78 percent.
3. Wage growth of 3.9 percent until 55 and 2.8 percent thereafter.
4. Participation probability equal to $((1 + \text{unconditional probability before participation})/2)$ once the individuals have participated.
5. Cash outs for 401(k) that follow the Vanguard 2012 experience.
6. Cash outs for defined benefit terminated based assumption that participants react similarly to 401(k) participants based on LSD, lump sum distribution.
7. Annuity purchase price of 12.34 for males at 65 years of age.

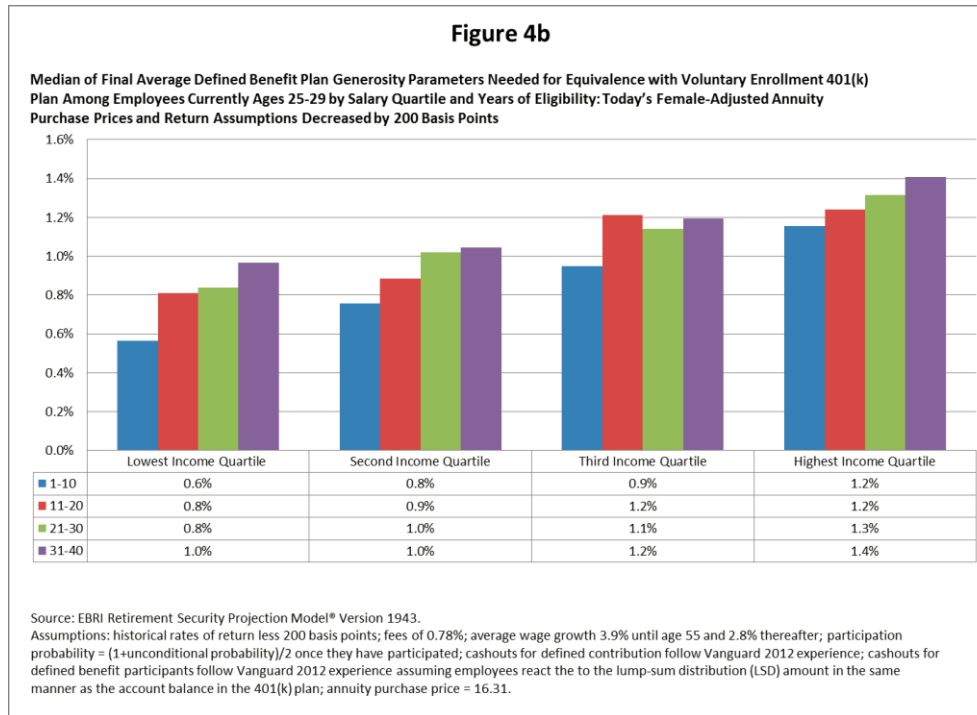
With his base case he performs sensitivity analysis using the following tests:

1. Reducing rates of return by 200 basis points.
2. Increasing annuity purchase prices to reflect low bond yields at the time.
3. #1 and #2 simultaneously.
4. Assuming real-wage growth does not drop to zero after age 55.
5. Assuming conditional-participation rates do not increase once an employee has participated in a 401(k) plan.
6. Assuming no cash outs at job change.
7. Changing the defined benefit LDP generosity parameter from median to 75th percentile.

He provides graphs of his simulations. Shown below is the simulation result for younger employees in the lowest income quartile. The subsequent chart shows the same for younger workers in the highest income quartile.



For each of the parameter changes in each simulation he provides a graph showing the impact of the change. The chart below shows the magnitude of the defined benefit generosity parameter changes needed to equal 401(k) plans for ages 25-29 when purchase prices and return assumptions are decreased by 200 bp.



Van DerHei's study looks only at voluntary enrollment plans. With the upward trend in automatic enrollment (AE), opt out, adoption plans; Van DerHei plans to repeat this study when sufficient data is available. The charts are interesting for various groups.

These charts were prepared for the U.S. Congress as they consider the issues surrounding retirement and retirement plans. Much more could be done with the data. Van DerHei concludes with an offer. He says that Employee Benefit Research Institute has considerable data and it is available to researchers. He encourage those at Q to communicate with him about the data and/or if they with ideas for further research.