Factor Investing

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Man Group Academic Advisory Board

The **Academic Advisory Board** brings together a group of respected academics from the fields of Finance and Econometrics with Man Group's market practitioners to debate topics at the intersection of academic finance and asset management. Its aim is to provide Man Group's investment managers with alternative perspectives on key issues, and to challenge and develop investment processes by introducing new and insightful ideas. The collaboration continues to bear fruit: members have co-authored a number of **academic papers**, and the discussions have led to material developments to a variety of Man Group strategies.

Initially meeting as the Man AHL Academic Advisory Board in 2014, the board held a discussion on whether momentum was a behavioural phenomenon. Since then, the group has expanded to include colleagues from Man Numeric, Man Solutions and Man GLG, providing a forum for debate where the academics can meet with thought leaders from Man Group's investment teams to spur new insights on contemporary themes.

This year, the focus was on factor investing. Previous topics include **momentum as a behavioural phenomenon**, **overfitting and its impact on the investor**, **skewness** and **crowding**.

Factoring Investing: Executive Summary

Part I: Origins of Factors and Equities

What are factors? How has our understanding of factors evolved from the first studies in the 1960s to the menagerie of factors now documented in the academic literature?

Variety of explanations: Broadly speaking, explanations for factors fall into three categories: (i) risk-based, relating to compensation for bearing risk; (ii) friction-based, relating to costs incurred in financial transactions; and (iii) behavioural, relating to investors' psychological biases. Factors that lack a rational economic motivation (typically, those relying on a behavioural explanation) are sometimes referred to as anomalies or mispricings. The distinction between risk factors and anomalies is not always made clear.

Classical factors: The value factor may be a reward for risk as well as incorporating mispricing. The momentum factor is likely a behavioural phenomenon. 'Quality' is a term that captures many concepts and so the quality factor can be hard to pin down.

Playing the player: It matters who is on the other side of the trade, e.g. investors dislike negative skewness and are willing to pay for protection against it, leading to the short-volatility premium.

Part II: Factors in Other Asset Classes

To what extent can factors discovered in equity markets be translated to other asset classes? Which factors are specific to particular asset classes? Can we time factors?

Some equity factors translate well to other asset classes: For credit, the translation is natural, since corporate bonds include an equity component. In other cases, the behavioural biases of investors can explain the portability of factors across asset classes. Paucity of data has been an impediment to factor research outside of equities. Academics usually have good quality data for stocks, but not necessarily for other asset classes.

Carry: Carry describes the return earned from holding an asset through time in an otherwise unchanging world. The carry premium may be a reward for risk: you quietly make money for a while and then suddenly lose quickly, with losses associated with a risk event, such as a spike in market volatility.

Timing: Timing factors is hard, but there is evidence supporting specific cases, like timing value with valuation spreads. Momentum in factor performance may arise from capital moving gradually into, or out of, factors.

Part III: Practicalities of Factor Investing

Are academic studies off-the-shelf recipes for investing? Or are the size of measured returns predicated on unrealistic assumptions? Do the expected returns from factor investing fall as the factor's popularity rises?

The usual suspects: Factor investing is still investing and so subject to all the usual considerations, including: transactions costs, herding and crowding, risk management, and continuing development.

Double-edged sword of data: More and better data will lead to more discoveries. However, analysing large quantities of data requires scientific discipline. Data mining will always uncover patterns, but it is unlikely to identify which patterns are important and which are spurious. Methods need to control for lucky findings to ensure that investment strategies have the best possible chance of delivering excess returns in the future.

Academic assumptions: Academic studies help us understand markets. They have provided evidence of historical high factor returns. However, capturing returns in practice can require additional details and skills. These include accounting for transactions costs, borrowing costs, timing of trades, stamp taxes, etc. What appears to look good in an academic journal might not look good when implementation costs are taken into account.

Adapt, adapt, adapt: With growing interest in factor investing, crowding is a potential issue. It is imperative to start with well-conceived ideas, continually improve, and focus on risk management and execution. The world will change, some opportunities will be arbitraged away and others will arise.

1. Origins of Factors and Equities

What are factors?

Cam Harvey (CH): Traditionally, a factor is a source of systematic, undiversifiable risk; and there is a relation between assets' expected returns and their covariance with the candidate factor. The academic literature sometimes confuses factors and anomalies. Recently, however, almost any long-short portfolio with a statistically significant average return is described as a factor. If there is no covariance relation with individual assets, I would call it an anomaly.

Nick Barberis (NB): There are three broad classes of explanations for factors: risk-based explanations, friction-based (which are mainly associated with liquidity) and behavioural explanations relating to mispricings. I am more persuaded by the behavioural explanations, which fall in two camps. First, there are investors' beliefs. This captures over-extrapolating past fundamentals or past returns, overconfidence and sticky beliefs – not reacting enough to information. Second, there are investors' preferences. The central idea is prospect theory; for example, the idea that people like lottery-type payoffs, that they have a preference for positive skewness.

Edward Fang (EF): As a practitioner, I care less about the explanations for factors, except to the extent that they hint at how lasting the underlying phenomenon will be. For example, if it is a risk-based explanation, it is likely to persist as long as investors are risk averse. If the explanation is mispricing, then it may get arbitraged away.

NB: First, if you know the economic story, then you may be able refine the strategy to improve profitability. Second, if it is risk based, maybe you don't want to invest in it too aggressively because you or your clients are averse to this risk. It would be helpful for your clients to know that their returns are compensation for certain types of risk. If they are strongly averse to those risks then they may not want to invest so heavily. I am puzzled when sophisticated practitioners say that they don't really care about explanations, or that explanations are for academics.

Neil Shephard (NS): In traditional statistics, you write down some theory – from economics or behavioural finance – you take the theory to the data, you find out what the p-value is, and you go home and have a cup of tea. That doesn't describe how modern empirical work is done. Model discovery is now part of the empirical endeavour and we have moved beyond rejecting results simply because they are not a priori anchored in theory. Part of the focus is now on making inference given that you have an empirical discovery process. If I discover a factor, how do I control for the probability that it is not a real one? Model discovery inevitably leads to model misspecification. This poses a problem for factor investing, particularly when there are structural shifts.

Shanta Puchtler (SP): I often ask whether we are playing the players or playing the cards. The players are just as important as the cards.

Otto Van Hemert (OVH): The ease with which we can identify investors on the other side of a trade will vary by factor. With momentum, perhaps it is investors with strong behavioural biases. The low-vol phenomenon is possibly due to actors with leverage constraints in the market, while the ones who don't face those constraints can benefit from investing in low vol using leverage. For factors such as value or size, it is less clear who is on the other side.

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Keith Haydon (KH): It's clear who's on the other side of a short-vol trade. In my experience, investors dislike short vol because they imagine the downside is more lurid than it actually is. That's clearly a behavioural bias.

What is the history of factor research?

CH: We started with the CAPM[1] and market beta. The economic case for illiquidity is strong. I am also convinced that skewness is a rational risk factor, or – more accurately – coskewness, which is the contribution an asset makes to the skewness of a well-diversified portfolio. Investors don't like negative skewness.

1. Capital asset pricing model. See, for example, W.F. Sharpe, "Capital asset prices: A theory of market equilibrium under conditions of risk", Journal of Finance, 1964

OVH: Beta, illiquidity and skewness: that is not exactly the Fama-French 3-factor model.[2]

CH: A simple implementation of size is not a risk factor for me. A firm could be small because it is in distress. It could also be small because it is young and growing. Value is interesting because it combines risk and mispricing. It makes sense that assets with deep value are risky, even after accounting for their market beta.

NB: The early tests of the CAPM in the 1970s are quite supportive. There is a view that everything is figured out. Then the first anomalies start coming along. Basu publishes on value in 1977.[3] He hints at a behavioural story: low PE[4] stocks are too cheap and so have a higher average return. This is a courageous thing to say in the 1970s when the CAPM and EMH[5] dogma rule. There are also rational stories for value. It may hedge certain aspects of labour-income risk. Additionally, value firms have more physical capital and so are going to perform worse during downturns. Banz publishes on size in 1981.[6] He states that there is no theoretical foundation for the effect. The size premium historically has not been very strong, but a recent paper by Asness et al. says that if you control for quality, the size premium comes through more strongly.[7] De Bondt and Thaler write their famous paper on long-term reversals in 1985.[8] Then Jegadeesh and Titman publish their momentum paper in 1993.[9] The motivation is observing practitioners trading momentum. Here, it is harder to tell a risk story. If a stock has gone up in the recent year, it is not obvious that it is now riskier. There are several behavioural stories: extrapolating past returns, sticky beliefs and some prospect theory explanations. Overall, there's a mix of rational and behavioural stories for value and momentum. A common view is that the rational stories have more credence for value and the behavioural stories more credence for momentum.

How should stock value be measured?

Edward Cole (EC): The book-to-price ratio is sensitive to accounting standards and depends on the treatment of intangibles. You can't escape accounting inconsistencies completely, but you can get a broader view of value by looking at more than one measure, so don't put all your eggs in one basket.

Ben Funnell (BF): I'm surprised that some factors have ever worked given how variable accounting has been. Free cash flow yield is a fantastic characteristic. It has been very good in the left tail. I find it odd that little work is done to understand why a particular stock has a high or low free cash flow yield. Firms can generate cash in unsustainable ways and these firms need to be weeded out. To address this, we adjust free cash flow yield so that we avoid taking long positions in low-capex stocks and short positions in high-capex stocks.

Matthew Sargaison (MS): If genuinely 'cheap' stocks exist, then value should work. Over time, cheap stocks should revert to mean, but some have profited from shorting value recently. The only explanation is that value is a crowded trade.

Andrew Freestone (AF): Underappreciated, cheap assets are increasingly being taken private, and as such, disappearing from view. The growth of private markets may affect the performance and composition of value factors.

CH: First, if we are not sure what value is, we should use a combination of value indicators. Second, we should improve the measures. The US economy of 1977[10] was different to that of today. Intangibles were not a big deal. We can adjust for that. Third, there has been a structural change in the market. The number of names has come down dramatically. Private markets are playing a bigger role. That has an impact on what the expected returns are for factors like value.

SP: At Man Numeric, we describe factors as having a lot of 'hair' on them. That hair comes in two forms. One is risk. If you build a value strategy, it comes with baggage, such as a small- or large-cap bias, or an anti-growth bias. If you can shave the hair,

2. Fama and French's three factors are the market portfolio, size and value. See E.F. Fama and K.R. French, "The cross-section of expected stock returns", Journal of Finance, 1992. **3.** S. Basu, "Investment performance of common stocks in relation to their price-earnings ratios", Journal of Finance, 1977 **4.** Price-to-earnings. **5.** Efficient markets hypothesis. See, for example, E.F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work", Journal of Finance, 1970. **6.** R.W. Banz, "The relationship between return and market value of common stocks", Journal of Financial Economics, 1981. **7.** C. Asness, A. Frazzini, R. Israel, T.J. Moskowitz, and L.H. Pedersen, "Size matters, if you control your junk", Journal of Financial Economics, 2018. **8.** W.F.M. De Bondt and R. Thaler, "Does the Stock Market Overreact?", Journal of Finance 1985. **9.** N. Jegadeesh and S. Titman, "Returns to buying winners and selling losers: Implications for stock market efficiency", Journal of Finance, 1993. **10.** See note 3.

you can improve the strategy. Second, you can adapt value measures based on other characteristics. For growth stocks, revenue multiples may make better value metrics. A firm may not be profitable in the short term, but it can still have value if it has strong revenues relative to its industry. Analysts' price targets can provide an alternative to suspect accounting data. Hopefully, the analyst has spent some time looking at the accounts and made suitable adjustments.

BF: I'm willing to make a bet that value does well when inflation accelerates. The risk-free rate will rise and the present value of future cash flows will fall. Investors in quality and growth, which may be crowded, will rotate into value. Also, if you have high sales to assets, you can pass through input inflation much quicker. So, the shorter the duration, the better you will do in inflation.

EC: Comparing returns of Fama-French HML[11] by decade to annualised inflation by decade, the best returns were in the '40s, '70s and '80s. Inflation was above 4% in each case. The worst decades were the '20s, '30s and in the current decade, where inflation was low or negative. Of course, there are many explanatory variables that chip away at that naïve relationship. More recent evidence shows some relation between inflation and value, but this disappears when adjusting for sector exposures within value portfolios, which have recently been skewed towards banks, materials and energy.

What about accounting factors such as profitability? Is profitability a good measure of quality?

NB: Profitability is relatively new in the academic literature. It's too early to converge on a single explanation, but one is behavioural: sticky beliefs. If a firm announces good news about profitability, investors take time to extract the news from the announcement and then act.

EC: In emerging markets, there has been a strong bias towards buying quality in the past 15-20 years. This may be because there are so many poor-quality assets in emerging markets. It doesn't feel like a recent idea to me.

CH: We have perhaps five different notions of value and they are all highly correlated. Quality, however, is all over the place. It is hard to define what it is.

EF: We studied profitability at least a decade ago, but only started investing in it more recently. We found it pays-off in a counter-cyclical way. It coincides with increased risk aversion, when the economy is going down and the market is not doing well. We try and take out this cyclical behaviour and use it as a more consistent alpha factor.

NB: That makes it more puzzling. If quality pays off in bad times, investors should be willing to accept low average returns for it.

2. Factors in Other Asset Classes

Do factors documented for stocks naturally extend to other asset classes?

NB: Some of the main behavioural explanations for anomalies in the equity market naturally translate across asset classes. I would expect many of the anomalies to translate as well. The fact that they do translate is evidence in favour of the behavioural view. Some of the rational stories for factors are particular to equity markets, and don't translate to other asset classes. The investor base can differ across asset classes. However, I don't think we should automatically assume that institutional investors are rational. There is plenty of evidence that some institutional investors don't trade very sensibly. Even in markets where there is an institutional investor base, I think some of the anomalies with behavioural, psychological bases may translate.

CH: Risk factors should apply to all assets. A basic consumption model can have the same source of risk no matter what the asset actually is. In 1993, Fama and French developed a 5-factor model to explain the average returns of both equities and fixed income.[12] They added a term premium and a default premium to equity-market, value and size factors.

11. HML is Fama and French's value factor. Data are available from French's website: **https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html**.
12. E.F. Fama and K.R. French, "Common risk factors in the returns on stocks and bonds", Journal of Financial Economics, 1993.

> Academics have really good data for stocks, but the same can't be said for corporate bonds. This is where the opportunities lie: there is room for a lot more work on this topic.

What factors should we consider for corporate bonds?

CH: Some equity factors should be important for credit because corporate bonds have an equity component. However, it is complicated by the equity sensitivity of corporate bonds varying with credit quality.

AF: You have to be careful with corporate bonds. It's a large universe by number of instruments and it's a large universe by value. There is a long tail where most discretionary managers actually trade. Some big funds trade very big instruments, but most other participants trade small instruments. The liquidity of bonds drops off as you go down the tail, and it drops off as you move away from issuance. A consequence of this is that price transparency is much lower for corporate bonds than in other asset classes. If I test a bond's price even in small size, it is unlikely to be where it is marked on screen. You have to be careful believing the prices provided by data vendors.

SP: The names of our credit metrics sound the same as our equity metrics. However, methodologically, they are very different. We use some of our equity signals to trade bonds, such as trends in earnings. We use bond momentum to trade equities, focusing on information not already captured by equity momentum. Security selection remains an interesting problem for systematic investment in corporate bonds. Data are bad and limited. Liquidity is poor and hard to deal with. The market is fragmented. It's like the equity markets of 25 years ago. That makes it pretty attractive to us!

NB: There are thousands of papers on equity factors. There are a handful on corporate bond factors. Academics have really good data for stocks, but the same can't be said for corporate bonds. This is where the opportunities lie: there is room for a lot more work on this topic.

What about factors in macro assets? Let's start with trend.

KH: Macro hedge funds have proved hideously unreliable when employing strategies that ignore recent price data. There is a big universe of CTAs and related funds that has lasted for 30 years. CTAs have been pretty robust. They have risk-management frameworks that are entirely consistent with the anomalies they are trying to mine. If you just follow prices, mining the source of the return and managing the risk are the same job. I also find it reassuring that managers trading equity factors often have thousands of positions. It is difficult to succeed without breadth of positions or frequency of turnover. It is hard to find macro factors with either; and they are sensitive to paradigm shifts. The world can look remarkably stable for a remarkably long time, and then it turns a corner and you have no precedent in the data.

SP: There's a risk of overfitting. You have only a few instruments, short histories, limited samples. It is easy to get convinced that something works because you fit it.

OVH: On breadth, you can apply trend across all assets consistently. You may have to tune value concepts by asset class. Paradigm shifts and central bank policy changes can make value or carry concepts less persistent. Trend has this natural risk-management component to it, because you cut your losers and you run your winners.

KH: I put trend in a separate bucket. The thing that I feel most confident about is the observation that there are lots of trend firms around. Trend has a self-regulating system, but value is exactly the opposite. You buy something and its price falls, so it looks more attractive. However, your risk-management process should be telling you to sell it. The situation gets worse the longer it goes on.

What about carry?

MS: Carry is what you get paid for holding an asset if the world doesn't change: the time value of the assets. With an upward-sloping term structure, you get paid for holding a long-duration bond, but much less for a short-duration bond.

NB: Carry has a limited footprint in academic research. For years, it focused on currencies: investing in high interest-rate currencies and shorting low interest-rate currencies. It was only recently that a paper by Koijen at al. broadened the definition.[13] In currencies, there is no convergence of opinion as to what's driving it. Verdelhan

13. R.S.J. Koijen, T.J. Moskowitz, L.H. Pedersen, and E.B. Vrugt, "Carry", Journal of Financial Economics, 2018.

and co-authors argue that carry loads on risk factors.[14] The trade performs poorly in bad economic times. It performs poorly when volatility rises, making it unattractive and therefore compensates with a high average return. There isn't a well-established behavioural story.

CH: I think of carry as closer to a risk factor than, say, momentum. You quietly make money until at some point you lose, tied to a volatility spike or other event.

And value?

BF: We developed a fair-value measure for bonds, but its estimates of the term premium have very large standard errors. We compare a broad array of equity yields, adjusting for inflation and long- and short-end yields. If equities look cheap on a 3-year lookback against fixed income, that is a pretty reliable bullish indicator in our view. There is a symmetric bearish indicator.

EC: Using Shiller's data back to the 19th century[15], I looked at the spread between the earnings yield and the bond yield, in nominal terms and real terms, and investigated its relationship to subsequent returns. Shiller's CAPE[16] is well-known to have been a good indicator for 10-year forward real returns. With yield spreads, if you had the good fortune to buy at an exceptionally high spread – say, top percentile – then your returns were high. But spreads in the middle of the distribution bore no relation to future returns.

Seasonality?

OVH: There are two broad views of seasonality. One is that some risk factors have seasonal components. Directly targeting seasonal effects picks up and aggregates those seasonal components. This is a risk story since the underlying sources are risk factors. The other notion is behavioural. Investors perform some tasks at frequencies dictated by the calendar: annually, monthly, or – what I find most compelling – daily. There is a paper that describes daily patterns, such as persistence in asset prices rising at particular times of the day.[17] The reasoning is flow based. The same actors trading at the same time of the day for multiple days.

Finally, what about factor timing? Is it possible?

NB: This is under-studied in the academic literature, where the focus has been on understanding unconditional average returns. There is much less work on timing these things, but it seems important. A recent paper by Ilmanen et al. analysed many methods across asset classes.[18] The broad message was quite negative for timing. There is supportive evidence in specific cases: valuation spreads for timing value; and cross-sectional momentum doing poorly after poor market performance and higher volatility. There also seems to be factor momentum at short horizons. Malcom Baker and Jeffrey Wurgler have insightful papers on how market sentiment can predict the performance on factors.[19]

CH: It's hard enough to write down a list of credible factors, let alone time the size of their premia. The most compelling research I've seen uses momentum to time factors.[20]

OVH: The more factor investing becomes prevalent, the more you might expect factor timing to work: particularly momentum on factors as investors move into popular factors and out of unpopular ones.

MS: I think that common risk models are more important than flows. Many CIOs go to the same conferences and hear about the latest updates to factor risk models. They implement the updates at the same time, making the same adjustments to their factor hedges.

SP: There is a risk-model arbitrage. Popular risk models publish their methodology. You can predict the impact of changing volatilities and covariances, and trade ahead of it.

14. See, for example, H. Lustig, N. Roussanov, and A. Verdelhan, "Common Risk Factors in Currency Markets", Review of Financial Studies, 2011. **15.** Available from **http://www.econ.yale.edu/~shiller/data.htm**. **16.** Cyclically adjusted price-earnings ratio. **17.** D. Lou, C. Polk, and S. Skouras, "A tug of war: Overnight versus intraday expected returns", Journal of Financial Economics, 2019. **18.** A. Ilmanen, R. Israel, T.J. Moskowitz, A. Thapar, and F. Wang, "Factor premia and factor timing: A century of evidence", AQR working paper, 2019. **19.** See, for example, M. Baker and J. Wurgler, "Investor sentiment and the cross-section of stock returns", Journal of Finance, 2006. **20.** S. Ehsani and J. Linnainmaa, "Factor momentum and the momentum factor", NBER working paper, 2019.

> It is a big warning sign when neither the data nor the code is available.

OVH: There is a similar effect with trend following. There is some predictability in evolving trend signals, especially when large returns fall out of popular lookback windows.

3. Practicalities of Factor Investing

Reproducibility

NS: In many areas of science, researchers document their empirical discovery methods before they start. For example, in drug trials, researchers document the data collection and processing methods at the outset. If the model discovery strategy is not documented, it is not reproducible. Scientific researchers routinely deposit their data and code. In the absence of errors in the code, you should be able to reproduce their results. Finance is lagging, partly because you often require a licence to access the data. However, you would expect the code to be produced. It is a big warning sign when neither the data nor the code is available. Unfairly, data mining has a terrible reputation in economics. Data mining itself is a glorious thing. What could be more glorious than mining data or mining evidence? But data mining must be done in a disciplined scientific way.

CH: Reproducibility is fundamental to the credibility of the field.[21] The top finance journals are inconsistent in their requirement for code or data to be submitted. Outright falsification or fabrication is rare. More common is looking at the data, deleting certain years at the beginning of the sample, choosing the method that gives the best fit, and then convincing yourself that this was your original plan. This is soft misconduct, but it affects the credibility of the whole field. At most schools, a single publication in one of the top three journals leads to tenure. It doesn't matter if the results are wrong and the paper never gets a citation. In the practice of finance, it is different. What is the incentive to create a trading strategy that looks great in backtest but doesn't work out of sample? It is no good for your firm. It is no good for your career.

Anthony Ledford (AL): You will limit researchers to very short careers if they are only allowed to look at the data once. Unless you are always going to be looking at something new or different, you are going to bring some baggage with you. If you work on these data for a decade, you are going to start to know them extremely well.

NS: That's fine. Looking at the data is not the problem. The problem is pretending that you haven't looked. You must be clear about what you've done. Flag potential biases to your readers. Academics have reputations. There are researchers who have a reputation for being very careful and there are others who don't. One of the nice things about having the code is that you can change it. You can vary parameters and see if the results disappear. Having access to a long appendix of robustness checks is never the same as having the freedom to add another diagnostic test that the authors didn't know about. The code just makes the barriers to interacting with empirical discovery so much lower.

NB: I agree that we need to tighten up academic finance. We need to safeguard the credibility of the field. However, so far, I don't believe that this problem has seriously distorted our understanding of the world. If a published result is found not to be robust, then word quickly gets around. The anomalies that get the most focus are probably robust and genuine.

CH: We are in relatively good shape in finance mainly because the CRSP[22] and Computstat[23] datasets are widely available, and it is low cost to replicate.

What do we need to be mindful of when it comes to academic assumptions?

NS: There are the usual questions about whether investors could have traded at the prices assumed; whether all assets are liquid enough to be traded; whether transaction costs are included or reasonable; and whether enough time has been allowed between making decisions and executing trades.

21. C.R. Harvey, "Replication in Financial Economics", Critical Finance Review, forthcoming. Available at https://ssrn.com/abstract=3409466. **22.** See http://www.crsp.com/. **23.** See https://www.spglobal.com/marketintelligence/en/documents/compustat-brochure_digital.pdf.

CH: Almost all the papers published in finance assume zero transaction costs. Across the 400 factors discovered with significant t-statistics, if you haircut the returns for transaction costs, you will substantially degrade many of them. Much of the premium of the Fama-French HML factor comes from shorting small and micro caps. That's hard to do, if you can do it at all. The transaction costs would be enormous. However, transaction costs can vary greatly by asset manager, which needs to be considered.

SP: The deviation between an idealised portfolio and an actual tradeable portfolio will vary. That gap tends to open up in times of market stress and in emerging markets; the opportunities look great, but you can't actually capture the return. It's a perennial challenge. And it's not just transaction costs. It's also borrowing costs, timing of trades, stamp taxes, etc. The list is as long as your arm. In practice, we also include sector, industry, currency, country and region controls. But, the big change happens when you turn on a risk model to constrain factor exposures.

Let's focus on post-discovery decay.

NB: There is some research on post-publication decay. The best-known paper is by McLean and Pontiff.[24] They compare factor returns in the discovery sample to returns in the sample after that, but before publication. This comparison is used to measure data mining. They then look at returns post-publication and relative to the second sample – that is used to measure arbitrage activity. They find significant drops in both, suggesting there was some data mining and some arbitrage activity.

OVH: Applying factors in other asset classes is another way of testing out of sample. You also see some pre-sample studies taking it to the extreme, using data from two centuries.[25] You have to wonder how reliable that data is. The positive note from those papers is that, although premia decline, they are still positive.

NB: Some of the signals have clearly weakened over time: short-term reversals and post earnings announcement drift, to name a couple. Other things have stayed reasonably stable. There is an argument that mispricings that are less risky to arbitrage will disappear more quickly.

What mistakes do practitioners make?

> "The 'peso problem' is an issue for practitioners and academics."

SP: The young researcher may sacrifice rigour to try and build a reputation. Whatever is involved in that – whether it's overfitting, selective data usage or something else – is ultimately detrimental to the performance of the business. Yet, it is built into the incentive structure and the work structure. One thing we face is how to manage those expectations and that incentive structure.

MS: It is not just about incentives, it is also human nature. It's about having a brief moment of glory.

CH: The 'peso problem' is an issue for practitioners and academics. You implicitly assign a zero probability to a crash event because there is no instance of the event in your sample data.

KH: I am happier allocating to investment processes that are self-discovering or adaptive. The main reason I trust factor investing is not because of the academic research, but because I can see all the capital following it. I trust in the cultures that quant businesses like Man AHL and Man Numeric have developed, which evolve in the face of changing circumstances. It's very unusual to be flexible enough to evolve and change when things go wrong, but not change so fast you lose your core skills. Some managers discover anomalies and stick to them dogmatically. They refuse to change their ways even when they no longer work. Man AHL and Man Numeric may have started with a Fama-French type approach, but they have moved further and further away from it, without ever leaping or jumping. Allocators should have enough information to avoid strategies with no potential to be useful. I don't like the idea of weighting a portfolio hard towards one idea versus any other idea, but that doesn't mean that I take all comers.

24. R.D. McLean and J. Pontiff, "Does academic research destroy stock return predictability?", Journal of Finance, 2016. **25.** See, for example, G. Baltussen, L. Swinkels, and P. Van Vliet, "Global factor premiums", Robeco working paper, 2019.

What should you pay a manager for allocating to factors?

SP: I think that you can drive a bus through this question because there is a quality spectrum. A monthly rebalanced book-to-market ETF should cost very little. Buying 30+ well-conceived factors that are being continually improved in a well-built portfolio that is traded efficiently should cost much more. It is up to the buyer to decide what they want. Do they want a value ETF with tons of hair on it? Or do they want a well-built diversified portfolio that is beta-neutral and incorporates a risk model?

KH: You should not charge based on how difficult something is, but how much money you can make. Someone might find a phenomenally difficult way of making an extremely small amount of money, but that's not worth much. Utility and difficulty do not need to coincide.

What does the future hold for factor investing?

KH: I am confused by the discussion of factors that are not viewed as constant. For example, the performance of quality in darker environments and FX carry conditional on volatility. We have also flirted with the idea that value returns are conditional on rising rates or higher rates. I wonder how many factors are conditional on something really quite important, something we've assumed is fixed but isn't.

MS: We witnessed an event in early September: the biggest momentum reversal in over a decade. What is the impact of crowding on reversals? Who was unwinding? Investors must want to know why you can suddenly get a massive reversal on one day.

> "The cost of doing expansive machine learning research has fallen, so we should be able to make interesting, potentially tradeable discoveries in a cheap way."

BF: In August, the 10-year rallied more than 50 basis points, which is massive. Economic data got weaker. But, really, it was a convexity event with a lot of hedging by insurance companies and mortgage markets. Ex post, commentators are saying that this was the biggest convexity event since 2008. August was really bad for value because of the bond yield move. When that convexity event finished – an event which exaggerated yield moves – you had a gravitational move back up, and that shook investors out of their positions.

EC: By some accounts, discretionary asset managers' conviction in high-quality, bond-proxy and growth stocks has never been higher. Expectations that value will outperform over the next year are at their lowest since 2008, and they dropped precipitously in August as bond yields collapsed.

NS: The cost of doing expansive machine learning research has fallen, so we should be able to make interesting, potentially tradeable discoveries in a cheap way. We should try to understand how to quantify model risk in this environment. There are many researchers using machine learning, but I'm not sure they can do machine learning and inference at the same time. Machine learning is great at finding patterns, but it is not necessarily great at identifying whether they are important.

KH: That sounds like learning in a foreign language how to ask a question but without having learnt how to understand the answer.

Final words from the academic advisors.

NS: There is a lot of research going on with text. Some people are trading off it, so it seems asset prices react to text data. There hasn't been much on this in the academic literature, which tends to be a bit slower. I imagine that eventually this will be standardised. That's a new form of data that we haven't seen before. Could that be a factor?

CH: The world will change. New assets will emerge that we are not even thinking about today. Man Group has done a good job of embracing new assets. Man Group needs to think about what those assets might be, and be the first to harvest the excess returns that result from initial mispricings. I believe that a smaller proportion of future discoveries will come from academics, and the reason is the cost of data. Most schools have some standardised data: CRSP, Compustat, maybe one or two others sources. New datasets are expensive. I see a shift in research towards companies that are willing to purchase the data, employ a high-quality quant team and invest in computing power.

> There is room for optimism. The world will change and new opportunities will arise.

NB: We've learnt a lot in the past two or three decades. The Nobel Prize was awarded for work in empirical finance in 2013.[26] We have learnt about aggregate asset classes and about cross-sectional patterns. We have learnt a lot about the structure of the data. It remains challenging to find the underlying drivers. There is progress to be made there. I suspect that the pace of learning over the coming decades will not be quite so rapid. At the same time, the world – and institutions – change. Changing institutions will have a friction-based impact on prices, which we might be able to exploit. There is room for optimism. The world will change and new opportunities will arise.

26. The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2013 was awarded jointly to Eugene F. Fama, Lars Peter Hansen and Robert J. Shiller "for their empirical analysis of asset prices." For more details, see **https://www.nobelprize.org/prizes/economic-sciences/2013/press-release/**.

Authors

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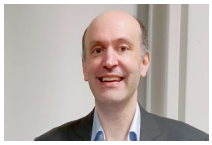
Professor of Finance at the Yale School of Management



Nicholas Barberis is the Stephen and Camille Schramm Professor of Finance at the Yale School of Management, where he works on behavioral finance, and specifically on building psychologically-realistic models of market fluctuations and investor behavior. He is the co-author, with Richard Thaler, of the most-cited survey of behavioral finance research. He is the founder and lead instructor of the Yale Summer School in Behavioral Finance. In 2015, he took over from Robert Shiller and Richard Thaler as the organiser of the leading academic conference in behavioral finance. Professor Barberis holds a B.A. in Mathematics from Cambridge University and a Ph.D. in Business Economics from Harvard. He joined the Man Group Academic Advisory Board in 2013.

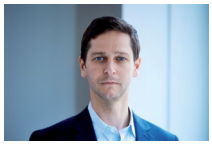
Campbell Harvey
Professor of Finance at Duke University

Professor Campbell R. Harvey, an expert financial economist, has been an investment strategy advisor to Man Group since 2005 and has contributed to a variety of research produced by the firm. Most recently, Professor Harvey co-authored 'The Impact of Volatility Targeting', which won 'Outstanding Article of 2018' from the prestigious Journal of Portfolio Management. His prior research on differentiating luck from skill won 'Best Article' in both the 2016 and 2015 Bernstein Fabozzi/Jacobs Levy Awards, and he has published more than 125 scholarly articles on topics spanning investment finance, emerging markets, corporate finance, behavioural finance, financial econometrics and computer science.

Neil Shephard
Frank B. Baird, Jr, Professor of Science, Professor of Economics and Statistics, Harvard University

Neil Shephard is the Frank B. Baird Jr., Professor of Science at Harvard University, holding his professorship in the Economics Department and the Statistics Department. He has been Chair (Head of Department) of the Statistics Department at Harvard since 2014. Before joining Harvard University in 2013, Neil was a professor at Nuffield College, Oxford University, for 23 years. He was also the founding director of the Oxford-Man Institute from 2007-2011. Neil is an elected fellow of the Econometrics Society and the British Academy, and has been awarded the Guy Medal in Silver by the Royal Statistical Society and an Honorary Doctorate by Aarhus University. He has served as an associate editor of Econometrica since 2002.

Edward Cole
Man GLG, Managing Director



Edward Cole is responsible for investment strategy at Man GLG. He joined Man Group in 2015, co-managing emerging-market equity strategies until the end of 2018. He started his career in 2001 working for specialist Eastern European-focused investment banks as an equity strategist during the period of EU accession for former communist-bloc countries, and moved to JPMorgan in 2005 as a global emerging market equity strategist. He has worked in investment management since 2007, managing long-only, long/short and multi-strategy emerging market funds. Edward graduated from the University of Bristol with a BSc in Politics and from the London School of Economics with an MSc in International Development.

Edward Fang
Man Numeric, Deputy Director of Research

Edward Fang joined Man Numeric in the summer of 2005 after he completed his doctorate degree in economics from Duke University. He has been actively engaged in a broad spectrum of research ranging from bottom-up alpha models to top-down dynamic asset allocation and alternative investment products. Ed has also been responsible for developing and managing several innovation portfolios within the Numeric Absolute Return strategy and Alternative Beta strategy. He obtained his Bachelor of Science degree with honors in economics and management information science from Fudan University in China. Ed is also a CFA charterholder.

Andrew Freestone
Man Solutions, Portfolio Manager

Andrew Freestone is a Portfolio Manager at Man Solutions. He joined Man Group in November 2012 and worked as a portfolio manager at Man GLG before moving to his current role. Prior to this, Andrew worked at Partners Capital and Monitor Group. Andrew received a Master of Financial Economics from the University of Toronto and an MA in Mathematics from the University of Cambridge. He also holds the CFA and CAIA designations.

Ben Funnell
Man Solutions, Portfolio Manager

Ben Funnell is the joint lead Portfolio Manager within Man Group's multi-asset offering. Previously, he was a lead portfolio manager and chief equity strategist at Man GLG. Prior to joining Man GLG in 2005, he spent 11 years at Morgan Stanley, the last nine of those years on the European Equity Strategy team, which he co-headed in his final three years at the firm. He was educated in modern languages at Durham University, UK.

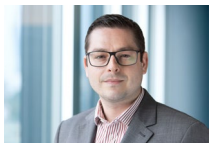
Keith Haydon
Man Solutions, CIO

Keith Haydon is Chief Investment Officer of Man Solutions. Keith is also a member of the Man Solutions Risk and Portfolio Committee and a member of the Man Group Executive Committee. Prior to this, Keith was Chairman of Man FRM. Before joining Man FRM in 2004, Keith held positions as a multi-asset macro proprietary trader at Morgan Stanley, HSBC and Deutsche Bank. Keith holds a Bachelor's Degree in History from the University of Cambridge.

Otto Van Hemert
Man AHL, Head of Macro Research

Otto van Hemert is Head of Macro Research at Man AHL. Prior to joining Man AHL in 2015, Otto ran a systematic global macro fund at IMC for over three years. Before that he headed Fixed Income Arbitrage, Credit, and Volatility strategies at AQR, and was on the Finance Faculty at the New York University Stern School of Business where he published papers in leading academic finance journals. Otto holds a PhD in Economics and Masters Degrees in Mathematics and Economics.

Edward Hoyle
Man AHL, Senior Quantitative Analyst



Edward Hoyle joined Man AHL in 2017 and is a Senior Quantitative Analyst. Edward contributes to the team's objective of maximising expected performance with research spanning individual trading signals through to high-level portfolio construction, monitoring and analytics. Prior to joining Man AHL, Edward spent more than seven years in the research team at Fulcrum Asset Management, where he was involved in all aspects of systematic investment. Early in his career, he spent two years as an actuarial analyst at Allianz Insurance. Edward received an MSci in Mathematics (first class honours) from University College London, and a PhD in Mathematics from Imperial College London, where he was a member of the Mathematical Finance group.

Anthony Ledford
Man AHL, Chief Scientist

Dr Anthony Ledford is Man AHL's Chief Scientist and Academic Liaison. Dr Ledford is based in the Man Research Laboratory (Oxford) and has overall responsibility for Man AHL's strategic research undertaken there. Prior to joining Man AHL in 2001, he lectured in Statistics at the University of Surrey. Dr Ledford read Mathematics at Cambridge University, holds a PhD from Lancaster University in the development and application of multivariate extreme value methods and is a former winner of the Royal Statistical Society's Research Prize.

Shanta Puchtler
Man Numeric, President

Shanta Puchtler is President and Chief Executive Officer of Man Numeric and a member of the Man Group Executive Committee. Shanta was named Man Numeric's CEO in January 2017 and President in January 2016. Formerly, he was Chief Investment Officer and Head of Research, directing research efforts focused on new alpha sources, product design, and risk modeling. Prior to joining Man Numeric in 1999, Shanta was an electronic commerce technology analyst at Forrester Research, a Cambridge-based market research firm. He also co-founded an electronic commerce company which focused on the analysis of on-line buying behaviour. Prior to this, Shanta worked as a management consultant and taught at schools in the US and Asia. Shanta holds a Bachelor's Degree in Computer Science from Dartmouth College and is a CFA charterholder.

Matthew Sargaison
Man AHL, Co-CEO and CIO

Matthew Sargaison is Co-Chief Executive Officer and Chief Investment Officer at Man AHL, and a member of the Man Group Executive Committee. Before assuming the Co-CEO role, Matthew has held numerous positions within Man AHL, including CIO, with overall responsibility for investment management and research from 2012 and 2017, as well as Chief Risk Officer between 2009 and 2012. Before re-joining Man AHL in 2009, he spent 13 years working at Deutsche Bank, Barclays Capital and UBS. Matthew originally worked for Man AHL from 1992 to 1995 as a trading system researcher and institutional product designer. Matthew holds a degree in Mathematics from the University of Cambridge and a Master's Degree in advanced computer science from the University of Sheffield.

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