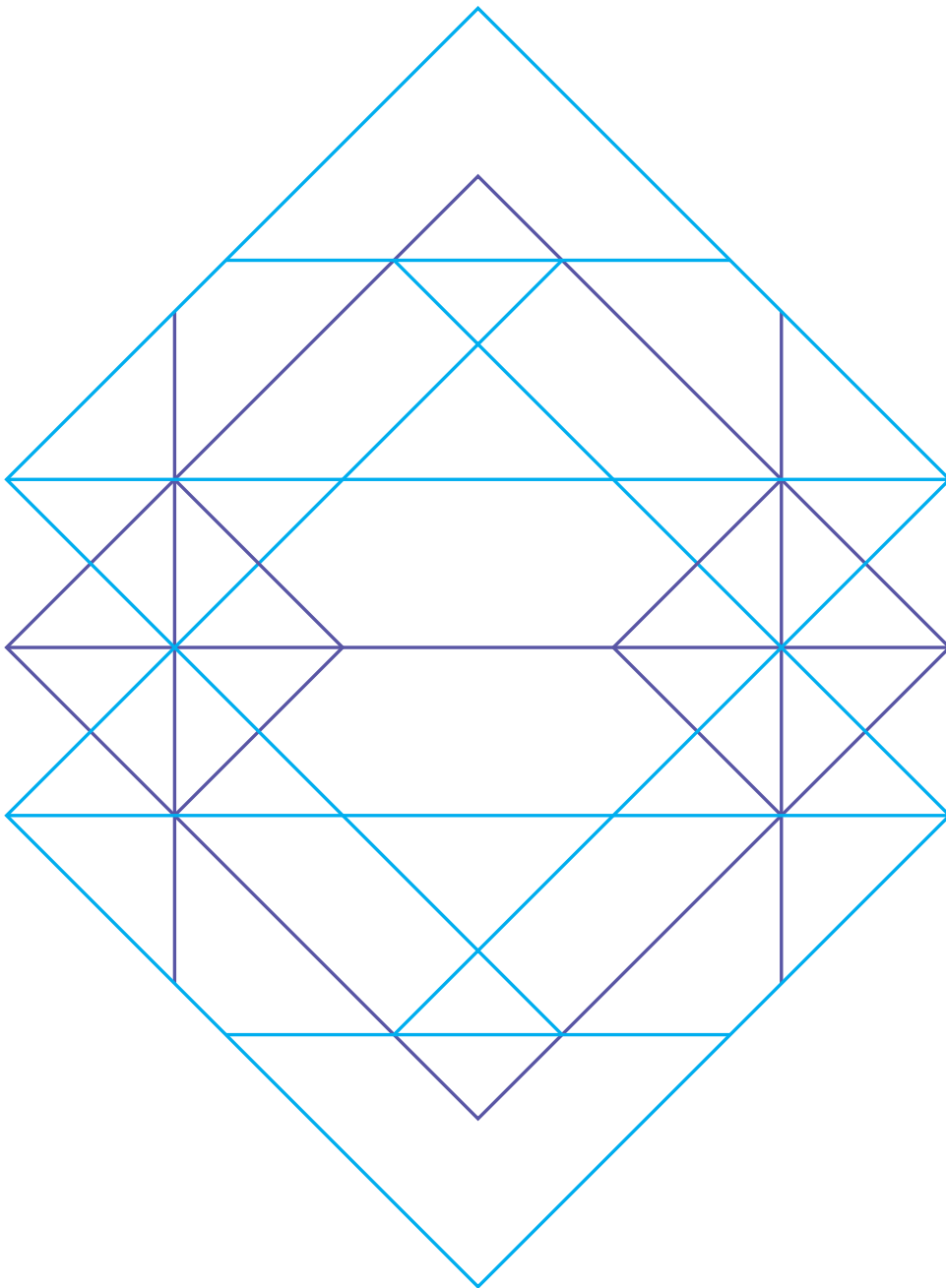




Alternative Thinking | 3Q17

Systematic versus Discretionary



Contents

Executive Summary	03
Introduction	04
Systematic Fundamental — A Perceived Oxymoron	06
Concentration vs. Diversification	08
Empirical Evidence — The Best of Both Worlds Includes Both	10
Conclusion	13
References	14
Appendix	15
Disclosures	18

Executive Summary

- The terms ‘quantitative’, ‘systematic’ and ‘rules-based’ are often used interchangeably; they represent an investment approach that is often perceived to be in direct opposition to what a ‘fundamental’, ‘discretionary’ or ‘stock-picking’ approach may be.
- While it is fair to contrast systematic and discretionary approaches, we stress that they are not opposites. Indeed, both systematic and discretionary managers pursue the same objective and both can be fundamentally-oriented. That is, they can use very similar inputs, but in different ways, to try and achieve the singular goal of improving investment performance.
- Neither systematic nor discretionary managers are inherently superior. Each has the ability to deliver good investment outcomes and, as we show in the data, there is little evidence that one approach is better than the other.
- The historical correlations between excess returns from systematic and discretionary managers are low, which suggests that many investors may benefit from incorporating both types into their allocations.
- Importantly, historical correlations among systematic investors are also low, as low as they are among discretionary investors, suggesting that the notion that ‘all quants trade on the same signals’ is misplaced.

Introduction

Over the years, two main approaches have evolved in active management: systematic and discretionary investing. To put it simply: systematic (commonly associated with the term ‘quant’) generally applies a more repeatable and data-driven approach, relying on computers to identify investment opportunities across many securities; in contrast, a discretionary approach involves in-depth analysis across a smaller number of securities and relies more on information that is not always easily codified.¹

To date, assets under active management tend to be dominated by discretionary managers, with systematic approaches remaining a minority — albeit a growing one.² Among mutual funds, the assets under management (AUM) share of systematic managers has grown to 14% from 9% in 1999 (Abis (2017)), while among hedge funds it has reached 26% (Harvey et al. (2016)). Among institutional equity funds, about a quarter of assets are managed by systematic investors (according to eVestment U.S. Large Cap Core universe, based on funds’ self-reported investment approach). Finally, among active fixed income funds, even a casual analysis reveals that very few are systematic.³

In spite of the growing popularity of systematic managers, there are still a number of myths and misconceptions about them. These misconceptions broadly relate to the notions that systematic managers supposedly use ‘black box’ processes created by machines without any human insights; they are boring in their diversification and lack good stories; and they all do the same thing. **Exhibit 1** provides a summary of these myths and contrasts them with reality (acknowledging that we are not unbiased on this matter).⁴

In the rest of this report, we will clear up some terminology issues related to systematic and discretionary investing, emphasizing the possibility that an asset manager can be both systematic *and* fundamental (cf. the first myth in Exhibit 1). We also discuss the similarities and differences between systematic and discretionary managers and present some relevant empirical evidence. We conclude that while neither approach seems to consistently outpace the other in raw returns, the diversification applied by systematic managers may give them an edge in risk-adjusted returns. We also observe equally low correlations among both groups of managers (cf. the last myth in Exhibit 1), as well as *between* the two groups, indicating that they can be excellent complements in investor portfolios.

-
- 1 Throughout this report we use the term ‘discretionary’ as the opposite of ‘systematic’, but we stress that also systematic investing requires discretion or judgment. However, that judgment is mainly used for designing investment strategies and risk control rules, not for second-guessing and overruling them on a case-by-case basis.
 - 2 Two studies, both aptly titled “Man Versus Machine”, classify active equity mutual funds (Abis (2017)) and hedge funds (Harvey et al. (2016)) into these two groups using algorithmic textual analysis of prospectuses and other fund documents. Another way to classify managers relies on self-reporting (for example, in the eVestment database of institutional managers which we use below). A third way could be to use simple portfolio statistics to classify managers; as we will show below, systematic managers tend to have a larger number of positions, lower tracking errors, and higher portfolio turnover. However, it turns out to be difficult to identify two clearly distinct groups of systematic and discretionary managers with the help of such statistics.
 - 3 Israel, Palhares and Richardson (2016)
 - 4 Asness et al. (2015) discusses some of these myths in the context of value investing. Another misconception beyond this report is the notion that “systematic equals passive”. Systematic strategies may involve high turnover, limited capacity, tactical timing, and proprietary signals – all characteristics that are hard to reconcile with passive investing. Only market-cap weighted indices are truly passive in that they are almost buy and hold and they can be held by all investors while markets clear. We intend to cover the broad “Active vs Passive” topic in a future *Alternative Thinking*.

Exhibit 1

Myths/Misconceptions on Systematic Managers

Myth/Misconception	Reality
'Black boxes' - Hard to understand - No grounding in fundamentals	- Investment inputs, processes and resulting holdings can be transparent - Many systematic managers use fundamental inputs
Machine rules humans - No human judgment, overreliance on numbers - Backward-looking, too history-dependent	- Human judgment is used to design, revise and, in many cases, implement strategies - Models can include forward-looking signals (e.g. to forecast earnings, calculate implied volatilities etc.) - Both discretionary and systematic managers use (some) historical data, but well-designed investment processes can avoid overfitting to the past
Lack of conviction - Too diversified - Benchmark-hugging	- Repeatable processes allow better diversification along many dimensions - Diversifying across well-rewarded factors and diversifying away idiosyncratic risks can improve risk-adjusted returns - Concentration can easily raise active risk but may or may not raise active return
Lack of stories, 'magic' - Use less information on single companies	- Boring can be virtuous - Systematic managers rely on their processes; discretionary managers rely on single-stock stories or themes
All systematic managers do the same thing - Crowding and deleveraging concerns	- Heterogeneous designs lead to heterogeneous portfolios and returns - Systematic managers are no more correlated than discretionary managers

Source: AQR. The above may not encompass all myths/misconceptions.

Systematic Fundamental — A Perceived Oxymoron

We have noted the division of active managers into two categories: systematic and discretionary. While there are certainly differences between the two approaches, there are also similarities, with potential overlap between the two. In particular, there may be similarities in the kinds of characteristics a manager may look for when selecting securities.

Take, for example, active equities:⁵ a typical approach for discretionary managers is to try to understand the underlying fundamentals of a company, perhaps by looking at accounting statements (for example, income statements, balance sheets, and cash-flow statements). In general, fundamental discretionary managers, from Benjamin Graham to Peter Lynch and their modern-day followers, tend to look for companies that trade for less than what they are worth; companies with a potential future event or catalyst that could change their prospects; or those with resilient business models, to name a few examples. But these are also characteristics (or factors) a systematic model can screen for: cheap companies (systematic managers call that value), showing signs of improvement (systematic managers call that momentum), and offering high quality and consistent profitability (systematic managers call that defensive or quality). There are even ways to quantify management intent or

what management may be signaling about their particular company (e.g., using textual analysis of management commentary, analyzing changes to corporate policies, corporate insiders' trades in their company's stock, etc.). The key here is really just lexicon. What a discretionary manager may call a 'thematic' approach, a systematic process calls a 'factor-based' approach.⁶ **Exhibit 2** highlights some of the similarities between the two approaches, while noting the different vocabulary used by each camp.

Of course, every discretionary manager does not care equally much about all the fundamental themes listed in Exhibit 2, just as every systematic manager does not give the same weight to each listed factor.⁷ Let us consider the world's most famous investor, Warren Buffett.⁸ In his early years, he focused on value but once paired with Charlie Munger in Berkshire Hathaway, he gives as much weight to quality and safety of the business as to value. Given their pride in a very long investment horizon, they also emphasize the quality of management, while caring less about shorter-term themes like catalysts or sentiment. In contrast, such pro-cyclical considerations were central to another legendary investor George Soros in both his macro investing and stock selection. Activist investors like Carl Icahn and Daniel Loeb are famed for creating their own catalysts and trying to influence market sentiment.

5 While both systematic and discretionary approaches can be applied across a variety of asset classes, in this report, we focus on stock selection for illustrative purposes.

6 Systematic strategies may be based on publicly-known factors or on more proprietary signals. We do not focus on this distinction in this report.

7 For example, Ben Graham listed the following themes in *The Intelligent Investor*: adequate size of the enterprise; a sufficiently strong financial condition; earnings stability; dividend record; earnings growth; moderate P/E ratio; and moderate ratio of price to assets. Steven Greiner mapped these themes to systematic factors in his book *Ben Graham Was a Quant*.

8 Our colleagues' earlier studies demystify discretionary managers by linking their long-run return sources to some systematic factors. Specifically, articles *Buffett's Alpha* (2013) and *Superstar Investors* (2016) analyze the return history of Buffett (and those of other star managers, such as Lynch and Soros) with the help of factor regressions. Buffett loaded heavily on value and quality or defensive factors, while Soros loaded mainly on momentum factors. It was much harder to link Lynch's track record to consistent factor tilts.

Exhibit 2 Commonalities Between Approaches

Fundamental Themes		Systematic Factors
Cheap	Companies that trade for less than what they are worth	Value
With a Catalyst	With a potential event that could change their earnings or price potential	Momentum
Strong Customer Base	Companies with customers that have good prospects	Indirect Momentum
Safe	Those with resilient business models that can hold up across market environments	Stability
Sound Accounting Practices	Companies with conservative accounting practices	Earnings Quality
Not Fighting the Sentiment	Favored by informed investors	Investor Sentiment
Trustworthy Management	Where Management is acting in shareholders' best interests	Management Signaling

Source: See Appendix.

Overall, the commonalities in Exhibit 2 underscore how many systematic managers, AQR included, can actually build trading rules based on fundamental inputs.⁹ Such a systematic fundamental approach hardly deserves to be called a ‘black box.’¹⁰

A systematic approach that is grounded in economic intuition requires human oversight (machines do not run the show). More generally, discretion is involved in the design of models and their revisions over time. While historical experience is an important input, models are not naively backward-looking. Good systematic

managers are vigilant against hindsight and overfitting to the in-sample backtest experience, and they strive to keep improving their models based on new data and additional research.

By now, hopefully we have convinced you that economic intuition is important and that a systematic process can rely on the same drivers of returns as a discretionary one. In fact, both systematic and discretionary managers can rely on fundamental inputs. Ultimately, the term ‘systematic fundamental’ may not be an oxymoron after all.

9 Some observers consider price-based strategies such as momentum and trend following to be inherently anti-fundamental. We disagree because a large part of momentum effects can be traced back to common investor underreaction to fundamental news. Indirect momentum is even more obviously fundamental in nature, as it relies on relations between economically-linked companies; for example between customers and their suppliers.

10 The ‘black box’ label may be more appropriate for systematic strategies which identify attractive investments in complex ways, such as machine learning and artificial intelligence. Even when these methods use fundamental data as raw material, the algorithms may be so complex that economic intuition is lost. The reality, however, is that these boundaries can be fuzzy, and a given systematic manager may use both fundamental and more ‘black-box approaches’ in different strategies.

Concentration vs. Diversification

We have briefly covered the overlap in approaches, but there are also important differences, most notably in portfolio implementation and construction. Discretionary managers tend to spend considerable time learning about a handful of companies that they know really well; they typically follow a ‘best ideas’ investment approach among this subset and tend to build concentrated portfolios in which the average number of holdings may be less than 100. In contrast, a systematic manager typically evaluates every stock in the investment universe, sometimes over thousands of companies. A repeatable process enables much greater breadth: applying similar ideas across many stocks and even other asset classes. This is an advantage if the ideas are repeatable and efficacious: applying a good idea to more investment opportunities can improve outcomes.¹¹ So, systematic investors are able to take small positions across many different securities, and potentially achieve better diversification and risk control.

Even though the two approaches build different portfolios, a more pertinent question is how skilled a particular manager may be. To examine this question, we can turn to an illustrative example. Suppose we’re evaluating an ‘above-average’ manager who picks individual stocks with 53% directional accuracy or ‘hit rate’ (i.e., the likelihood an individual stock outperforms is slightly better than a random coin toss). Theory says that if you have a small edge, you can magnify that edge by applying it across a larger number

of securities: investment success is a function of both skill (hit rate) and breadth (number of stocks picked). This means that the more stocks the above-average manager picks, the greater the likelihood this manager will outperform, reflecting the benefits of diversification. We illustrate this with a stylized example which evaluates portfolio success rate as the probability that more than half the stocks in the portfolio outperform.¹² By this metric, the overall portfolio success rate — that is, the likelihood that the majority of stock picks outperform — increases from 56% of the time when the manager picks 30 stocks to 90% of the time when he builds a diversified portfolio of 500 stocks.¹³

Now, what if a different manager picked fewer stocks with a higher level of skill, perhaps by studying fewer companies in greater detail? How good would that manager have to be to match the benefits of diversification? We can compare this concentrated manager to the diversified manager we discussed above. **Exhibit 3** shows the breakeven level of ‘skill’ required for a concentrated manager who picks only 30 stocks to match the overall portfolio success rate for the diversified manager who picks a larger number of stocks with 53% accuracy. The concentrated manager must be much more skillful, requiring a 59% per-stock hit rate to match the overall portfolio success of the diversified manager holding 200 stocks, and a 63% per-stock hit rate to match the portfolio success of the diversified manager holding 500 stocks.

11 Grinold’s (1989) Fundamental Law of Active Management says that if you have a small edge, you can magnify that edge by applying it across a larger number of securities: investment success is a function of both skill (hit rate) and breadth (number of stocks picked).

12 Of course, this is a very simplistic measure, but it gives us a straightforward illustration of why more breadth and diversification are a good thing. See Edwards and Lazzara (2016) for more on the challenges of concentration.

13 Calculated using the hypothetical probability of outperformance for each type of manager, assuming a binomial distribution – further details in Exhibit 3. Intuitively, this reflects the notion that as the number of stocks in the portfolio gets larger, the probability that more than half the stocks outperform increases (i.e., gets closer to 1, assuming a per-stock hit rate of 53%).

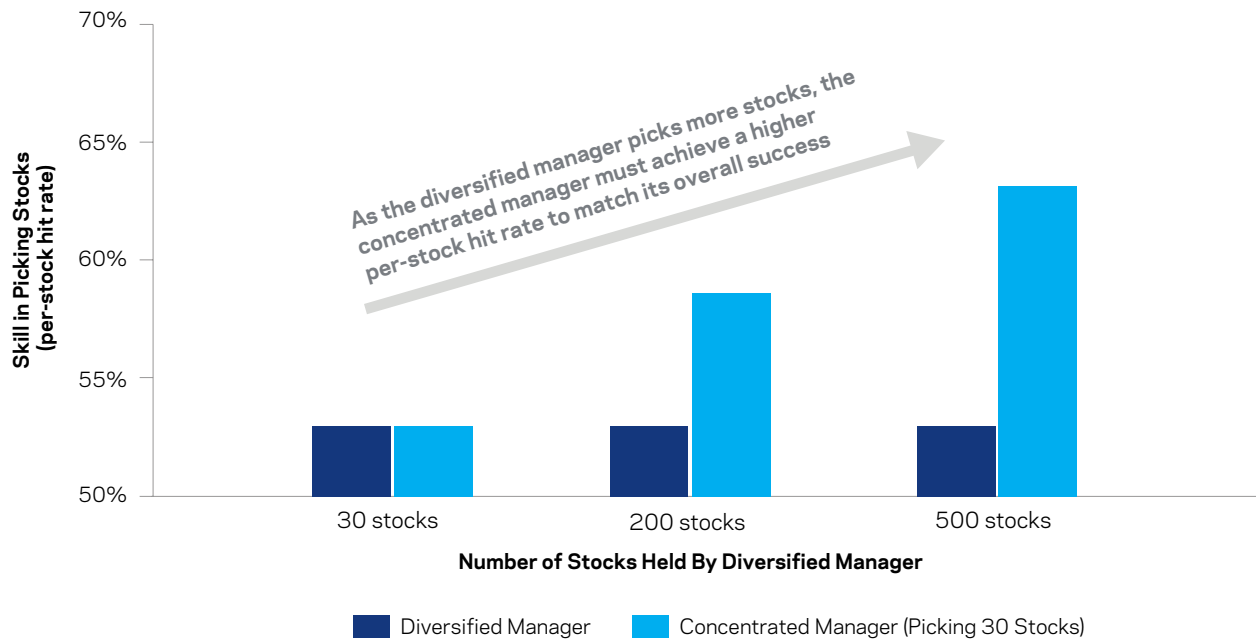
So, clearly there is a benefit to diversification, and this is an advantage for systematic managers rather than a handicap (cf. the third myth in Exhibit 1). But discretionary managers have

their own edges over systematic peers, including perhaps the ability to also use some non-quantifiable information. What does the empirical evidence say about the net effect?

Exhibit 3

Skill Required for a Concentrated Manager to Match Diversification Benefits

A manager picking only 30 stocks must achieve these per-stock hit rates to match the portfolio success rate of a more diversified manager



Source: AQR. For illustrative purposes only. AQR analysis calculates the hypothetical probability of outperformance for each type of manager, assuming a binomial distribution. In this example, the number of observations are the stocks in each portfolio (Concentrated = 30; Diversified = 30, 200, and, 500), the probability of success is the probability of picking outperforming stocks (e.g. a hit rate of 53% for the Diversified manager) and success is defined as the probability of observing more than half of stocks outperforming in each portfolio. No representation is being made that any asset manager, fund, or account will or is likely to achieve profits or losses similar to those shown herein. In fact, there are frequently sharp differences between hypothetical results and the actual results subsequently realized by any particular model. Please read important disclosures at the end of this document. Diversification does not eliminate the risk of investment loss.

Empirical Evidence — The Best of Both Worlds Includes Both

Do discretionary managers outperform systematic managers, or vice versa? A number of studies have relied on eVestment data on institutional asset managers to attempt to answer this question.¹⁴ The general consensus is that the two approaches have similar investment outcomes in terms of returns, but that systematic managers tend to have lower risk. One of the earliest studies, Lakonishok and Swaminathan (2010), shows that systematic and discretionary approaches have had similar performance in some universes (e.g., U.S. Large Cap Value), but that the systematic approach has had more difficulty in certain universes (e.g., U.S. Large Cap Growth). The authors also find, importantly, that the average pairwise correlations between systematic managers are just as low as those between discretionary managers. Our estimates with more recent data concur with these findings. During the past decade, pairwise correlations of excess returns among systematic managers averaged 0.13 in the five universes we study below, compared to 0.12 among discretionary investors. This result contradicts the last myth in Exhibit 1 which alleged that all systematic managers do the same thing. In fact, there is a surprising heterogeneity among systematic managers' design decisions when constructing portfolios, which translates to quite varied portfolios and returns.¹⁵

Perhaps less surprisingly, the pairwise correlations between systematic and discretionary managers are even lower in both the Lakonishok-Swaminathan

study and our more recent analysis, highlighting useful complementarity.¹⁶

There have been a few other studies since Lakonishok and Swaminathan (2010). McQuiston et al. (2017) also use eVestment data to find that discretionary managers in the U.S. Large Cap universe earn higher returns on average, but at the cost of higher risk; they also find that systematic managers' active returns are less sensitive to market conditions. Abis (2017) analyzes the CRSP mutual fund database to detect what investment process different managers follow. She finds that systematic funds have slightly lower alphas (by up to about 0.2%) than discretionary funds. Harvey et al. (2016) analyze systematic and discretionary hedge funds. In the equity hedge fund space, the two approaches earn similar risk-adjusted returns; among macro hedge funds, systematic managers have outperformed their discretionary peers.

To complement the prior literature, we examine the eVestment database across a number of different equity investment universes. We focus on 10-year performance numbers, recognizing the tradeoff between using a longer estimation period on one hand and limiting our attention to only 10+ year old strategies on the other. **Exhibit 4** presents average performance statistics for discretionary and systematic managers across various investment universes, as of 3/31/2017.

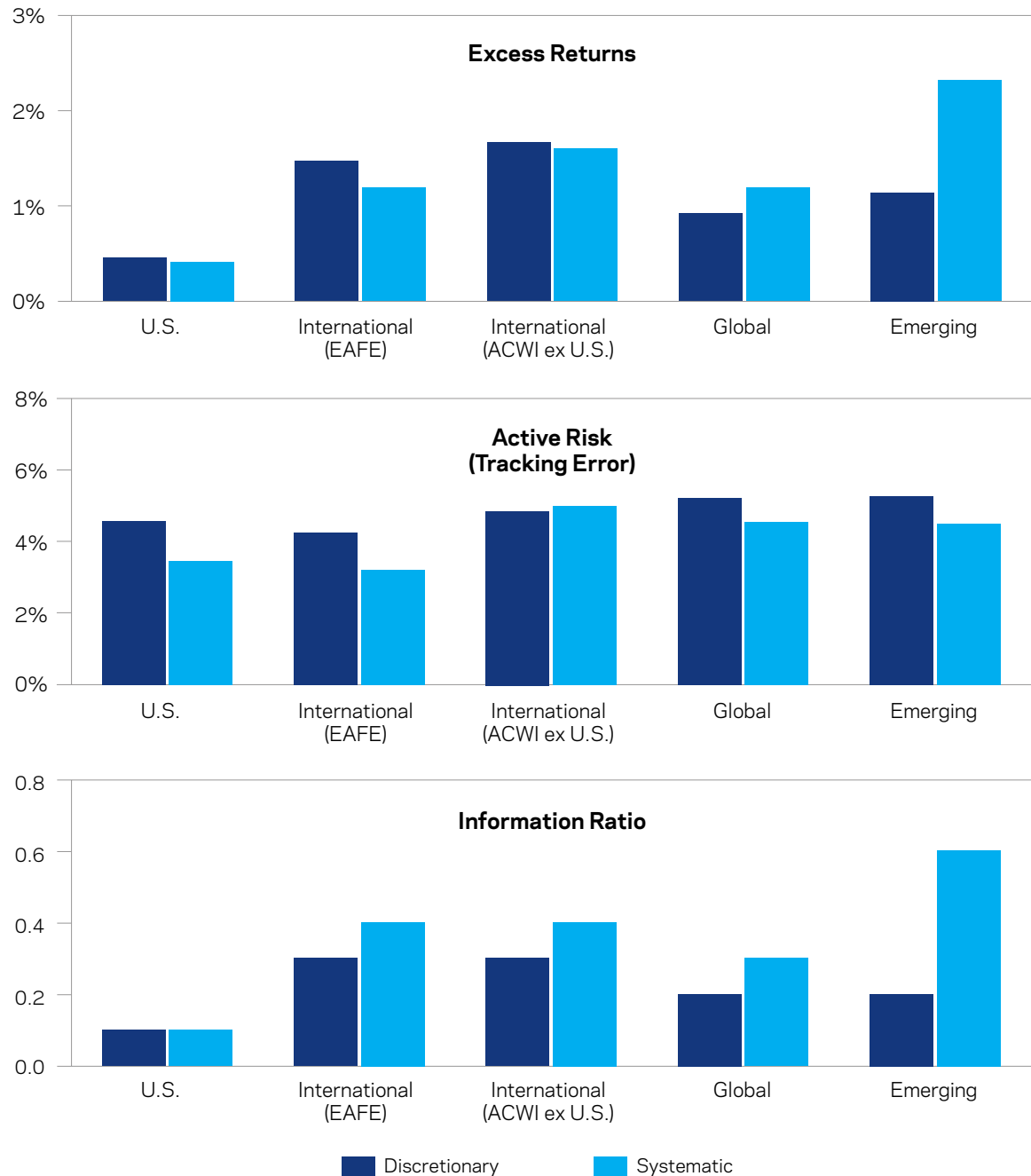
14 One of the benefits of eVestment is that managers can self-report whether they would classify their investment approach as 'Quantitative' (i.e., systematic) or 'Fundamental' (i.e., discretionary). For consistency, we will utilize the latter terms.

15 See, for example, Israel, Jiang and Ross (2017).

16 The average pairwise correlation between individual systematic and discretionary managers over the past decade ranges between 0.02 and 0.05 in the five universes we study. Even if we take the systematic and discretionary manager universes as a whole, diversifying away idiosyncratic differences between individual managers, the correlation between the systematic and the discretionary groups' excess returns ranges between 0.05 and 0.43 in the five universes.

Exhibit 4

Performance Characteristics for Discretionary and Systematic Groups of Active Institutional Equity Managers in the eVestment Database, April 2007 to March 2017



Source: AQR analysis based on eVestment data. Note that eVestment categorization relates to quantitative versus fundamental, which we refer to as systematic and discretionary, respectively. The average annualized excess returns (gross of fees), tracking error, and information ratio, computed separately for discretionary and systematic managers, and separately for the large cap universes of U.S., EAFE, Global, Emerging, and ACWI. The performance statistics are computed using managers' preferred benchmarks and are as of 3/31/2017. Only funds with "Active" product status are included in the analysis, eVestment database, accessed on 7/5/2017. The number of strategies in each universe for systematic and discretionary managers (in this order) are as follows: U.S. - 140, 511; International (EAFE) - 24, 83; International (ACWI ex-U.S.) - 11, 55; Global - 33, 118; and; Emerging - 5, 24.

The first graph on annualized excess of benchmark returns shows that it's close to a tie between the two approaches: choosing a discretionary or systematic approach does not seem to affect the level of average returns investors are earning. The second graph shows that there is a clearer difference in active risk: systematic funds exhibit, on average, a lower level of tracking error (e.g., 3.5% vs 4.5% in U.S. markets; 4.5% vs 5.0% in Emerging, etc.). Only in ACWI ex U.S. mandates, across 11 managers with 10+ years of history, do we see that systematic managers have slightly higher active risk, on average, than discretionary managers (5.0% vs 4.8%). The benefit of having similar returns and lower tracking error is a higher information ratio, as shown in the last graph in Exhibit 4.¹⁷

Overall, the evidence suggests that the two approaches yield similar performance, with somewhat lower active risk in systematic strategies. If anything, the risk-adjusted returns (information

ratios) appear mildly higher for systematic, but we do not think that this is the main point here. The key takeaway is that both approaches have their merit and can be valuable in the context of an investor's overall portfolio. We are big believers in diversification. To the extent investors can find two skilled and lowly correlated managers, they should pursue both and diversify across investment processes. Ultimately, the relative weights to systematic and discretionary approaches depend on each investor's underlying beliefs. Investors who seek higher risk on their specified dollar allocation may choose a discretionary manager who may be more concentrated than a systematic one. In contrast, investors who are more sensitive to risk, particularly risk relative to the benchmark, may elect to put a higher weight on systematic products. Such portfolios tend to be better diversified not only across individual securities, but also across specific dimensions of risk: industry, country or currency exposures.

17 The results here are shown gross of fees. Systematic managers tend to have about 10bp lower fees than discretionary managers, providing a small advantage in net returns.

Conclusion

The primary goal for active managers is to generate excess returns through active risk taking — however, the way in which various managers do this can be quite different. One difference is about how they utilize information when constructing portfolios, whether systematically across a broad set of securities or discretionarily on a narrow subset.

A concentrated discretionary manager creates the opportunity for outsized excess returns (either positive or negative), while a diversified systematic

manager creates the potential for more consistent performance. Ultimately, investors should focus on identifying managers that can outperform — whether they happen to follow a discretionary or systematic process. While we believe that repeatable, transparent investment processes offer a long-run edge, diversifying across high-quality managers using both systematic and discretionary approaches is arguably the most reliable road to long-run investment success.

References

Abis, Simona (2017), “Man vs. Machine: Quantitative and Discretionary Equity Management,” INSEAD.

AQR Alternative Thinking, Fourth Quarter 2016, “Superstar Investors”.

Asness, Cliff, A. Frazzini, R. Israel, and T. Moskowitz (2015), “Fact, Fiction, and Value Investing,” *The Journal of Portfolio Management*, Vol. 42, No. 1.

Edwards, Tim, and C. Lazzara (2016), “Fooled by Conviction,” S&P Global Research.

Frazzini, Andrea, D. Kabiller and L. Pedersen (2012), “Buffett’s Alpha,” National Bureau of Economic Research working paper, No. 19681.

Greiner, Steven (2011), *Ben Graham Was a Quant*, Wiley.

Grinold, Richard (1989), “The Fundamental Law of Active Management”, *The Journal of Portfolio Management*, Vol. 15, No. 3

Harvey, Campbell, S. Rattray, A. Sinclair and O. Van Hemert (2016), “Man vs Machine: Comparing Discretionary and Systematic Hedge Fund Performance,” Man AHL.

Israel, Ronen, S. Jiang and A. Ross (2017), “Craftsmanship Alpha,” AQR White Paper.

Israel, Ronen, D. Palhares and S. Richardson (2016), “Common Factors in Corporate Bond and Bond Fund Returns”, forthcoming in the *Journal of Investment Management*

Lakonishok, Josef and B. Swaminathan (2010), “Quantitative vs. Fundamental,” *Canadian Investment Review*.

McQuiston, Karen, H. Parikh and S. Zhi (2017), “The Impact of Market Conditions on Active Equity Management,” PGIM Institutional Advisory & Solutions.

Appendix

Research supporting investment themes in Exhibit 2: selected articles from independent and AQR-affiliated researchers.

*AQR-affiliated research

Value

Fama, Eugene, K. French (1992), "The Cross-Section of Expected Stock Returns," *Journal of Finance*, 47, 427-465

Fama, Eugene, K. French (1996), "Multifactor Explanations of Asset Pricing Anomalies," *Journal of Finance*, 51, 55-84

*Asness, Clifford, T. Moskowitz, L. Pedersen (2013), "Value and Momentum Everywhere," *Journal of Finance*, 68, 929-985

*Asness, Clifford, A. Frazzini, (2013), "The Devil in HML's Details," *Journal of Portfolio Management*, 39, 49-68

*Ellahie, Atif, M. Katz, S. Richardson (2015), "Risky Value," working paper

Momentum

Jegadeesh, Narasimhan, S. Titman (1993), "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," *Journal of Finance*, 48, 65-91

Jegadeesh, Narasimhan, S. Titman (2002), "Cross-Sectional and Time-Series Determinants of Momentum Returns," *Review of Financial Studies*, 15, 143-157

*Cohen, Lauren, A. Frazzini (2008), "Economic Links and Predictable Returns," *Journal of Finance*, 63, 1977-2011

*Asness, Clifford, T. Moskowitz, L. Pedersen (2013), "Value and Momentum Everywhere," *Journal of Finance*, 68, 929-985

*Li, Ningzhong, S. Richardson, İ. Tuna (2014), "Macro to Micro: Country Exposures, Firm Fundamentals and Stock Returns," *Journal of Accounting and Economics*, 58(1), 1-20

Earnings Quality

Sloan, Richard (1996), "Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings?" *The Accounting Review*, 71 (3), 289-315

Hirshleifer, David, K. Hou, S.H. Teoh (2012), "The Accrual Anomaly: Risk or Mispricing?" *Management Science*, 58 (2), 320-335

*Richardson, Scott, R. Sloan, M. Soliman, (2005), "Accrual Reliability, Earnings Persistence and Stock Prices," *Journal of Accounting and Economics*, 39

*Bradshaw, Mark, S. Richardson, R. Sloan (2001), "Do Analysts and Auditors Use Information in Accruals?," *Journal of Accounting Research* 39(1), 45-74

*Richardson, Scott (2003), "Earnings Quality and Short Sellers," *Accounting Horizons* Supplement 69-81

*Momente, Francesco, F. Reggiani, S. Richardson (2015), "Accruals and Future Performance: Can It Be Attributed to Risk?," *Review of Accounting Studies* 20(4), 1297-1333

Stability

Jensen, Michael, F. Black, M. Scholes (1972), "The Capital Asset Pricing Model: Some Empirical Tests," Praeger Publishers

Haugen, Robert, N. Baker (1991), "The Efficient Market Inefficiency of Capitalization-Weighted Stock Portfolios," *Journal of Portfolio Management*, 17 (1), 35-40

Clarke, Roger, H. de Silva, S. Thorley, (2006), "Minimum-Variance Portfolios in the U.S. Equity Market," *Journal of Portfolio Management*, 33 (1), 10-24

Novy-Marx, Robert (2012), "The Other Side of Value: The Gross Profitability Premium," *Journal of Financial Economics*, 108 (1), 1-28

*Frazzini, Andrea, L. Pedersen (2010), "Betting Against Beta"

*Asness, Clifford, A. Frazzini, L. Pedersen (2013), "Quality Minus Junk"

*Penman, Stephen, S. Richardson, Í. Tuna (2006), "The Book-to-Price Effect in Stock Returns: Accounting for Leverage," *Journal of Accounting Research* 45(2), 427-467

Investor Sentiment

Desai, Hemang, K. Ramesh, S. Thiagarajan, B. Balachandran (2002), "An Investigation of the Informational Role of Short Interest in the Nasdaq Market," *Journal of Finance*, 57, 2263-2287

Asquith, Paul, P. Pathak, J. Ritter, (2005), "Short Interest, Institutional Ownership, and Stock Returns," *Journal of Financial Economics*, 78 (2), 243-276

Xing Yuhang, X. Zhang, R. Zhao (2010), "What Does the Individual Option Volatility Smirk Tell Us About Future Equity Returns?" *Journal of Financial and Quantitative Analysis*, 45 (3), 641-662

*Duffie, Darrell, N. Garleanu, L. Pedersen (2002), "Securities Lending, Shorting and Pricing," *Journal of Financial Economics*, 66, 307-33

*Bradshaw, Mark, S. Richardson, R. Sloan (2006), "The Relation Between Corporate Financing Activities, Analysts' Forecasts and Stock Returns," *Journal of Accounting and Economics* 42(1-2), 53-85

Management Signaling

Michaely, Roni, R. Thaler, K. Womack (1995), "Price Reactions to Dividend Initiations and Omissions: Overreaction or Drift?" *Journal of Finance*, 50 (2), 573-608

Baker, Malcolm, J. Wurgler (2002), "Market Timing and Capital Structure," *Journal of Finance*, 2002, 57 (1)

Pontiff, Jeffrey, A. Woodgate (2008), "Share Issuance and Cross-Sectional Returns," *Journal of Finance*, 63 (2), 921-945

This document has been provided to you solely for information purposes and does not constitute an offer or solicitation of an offer or any advice or recommendation to purchase any securities or other financial instruments and may not be construed as such. The factual information set forth herein has been obtained or derived from sources believed by the author and AQR Capital Management, LLC ("AQR") to be reliable but it is not necessarily all-inclusive and is not guaranteed as to its accuracy and is not to be regarded as a representation or warranty, express or implied, as to the information's accuracy or completeness, nor should the attached information serve as the basis of any investment decision. This document is intended exclusively for the use of the person to whom it has been delivered by AQR, and it is not to be reproduced or redistributed to any other person. The information set forth herein has been provided to you as secondary information and should not be the primary source for any investment or allocation decision. Past performance is not a guarantee of future performance.

This material is not research and should not be treated as research. This paper does not represent valuation judgments with respect to any financial instrument, issuer, security or sector that may be described or referenced herein and does not represent a formal or official view of AQR. The views expressed reflect the current views as of the date hereof and neither the author nor AQR undertakes to advise you of any changes in the views expressed herein.

The information contained herein is only as current as of the date indicated, and may be superseded by subsequent market events or for other reasons. Charts and graphs provided herein are for illustrative purposes only. The information in this presentation has been developed internally and/or obtained from sources believed to be reliable; however, neither AQR nor the author guarantees the accuracy, adequacy or completeness of such information. Nothing contained herein constitutes investment, legal, tax or other advice nor is it to be relied on in making an investment or other decision. There can be no assurance that an investment strategy will be successful. Historic market trends are not reliable indicators of actual future market behavior or future performance of any particular investment which may differ materially, and should not be relied upon as such.

The information in this paper may contain projections or other forward-looking statements regarding future events, targets, forecasts or expectations regarding the strategies described herein, and is only current as of the date indicated. There is no assurance that such events or targets will be achieved, and may be significantly different from that shown here. The information in this document, including statements concerning financial market trends, is based on current market conditions, which will fluctuate and may be superseded by subsequent market events or for other reasons.

Information for readers in Australia: AQR Capital Management, LLC, is exempt from the requirement to hold an Australian Financial Services License under the Corporations Act 2001, pursuant to ASIC Class Order 03/1100 as continued by ASIC Legislative Instrument 2016/396, (as extended by instrument). AQR is regulated by the Securities and Exchange Commission ("SEC") under United States of America laws and those laws may differ from Australian laws.

Information for readers in Canada: This material is being provided to you by AQR Capital Management, LLC, which provides investment advisory and management services in reliance on exemptions from adviser registration requirements to Canadian residents who qualify as "permitted clients" under applicable Canadian securities laws. No securities commission or similar authority in Canada has reviewed this presentation or has in any way passed upon the merits of any securities referenced in this presentation and any representation to the contrary is an offence.

Information for readers in Middle East: AQR Capital Management (Europe) LLP (DIFC Representative Office) is regulated by the Dubai Financial Services Authority of the Dubai International Financial Centre as a Representative Office (firm reference number: F007651). Its principal place of business is Gate Village 10, Level 3, Unit 4, DIFC, Dubai, UAE. This marketing communication is distributed on behalf of AQR Capital Management, LLC.

Information for readers in the EEA: AQR in the European Economic Area is AQR Capital Management (Germany) GmbH, a German limited liability company (Gesellschaft mit beschränkter Haftung; "GmbH"), with registered offices at Maximilianstrasse 13, 80539 Munich, authorized and regulated by the German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin"), with offices at Marie-Curie-Str. 24-28, 60439, Frankfurt am Main and Graurheindorfer Str. 108, 53117 Bonn, to provide the services of investment advice (Anlageberatung) and investment broking (Anlagevermittlung) pursuant to the German Securities Institutions Act (Wertpapierinstitutsgesetz; "WpIG"). The Complaint Handling Procedure for clients and prospective clients of AQR in the European Economic Area can be found here: <https://ucits.aqr.com/Legal-and-Regulatory>.

Information for readers in the United Kingdom: The information set forth herein has been prepared and issued by AQR Capital Management (Europe) LLP, a UK limited liability partnership with its office at Charles House 5-11, Regent St., London, SW1Y 4LR, which is authorised and regulated by the UK Financial Conduct Authority ("FCA").

Information for readers in APAC:

This presentation may not be copied, reproduced, republished, posted, transmitted, disclosed, distributed or disseminated, in whole or in part, in any way without the prior written consent of AQR Capital Management (Asia) Limited (together with its affiliates, "AQR") or as required by applicable law. This presentation and the information contained herein are for educational and informational purposes only and do not constitute and should not be construed as an offering of advisory services or as an invitation, inducement or offer to sell or solicitation of an offer to buy any securities, related financial instruments or financial products in any jurisdiction. Investments described herein will involve significant risk factors which will be set out in the offering documents for such investments and are not described in this presentation. The information in this presentation is general only and you should refer to the final private information memorandum for complete information. To the extent of any conflict between this presentation and the private information memorandum, the private information memorandum shall prevail. The contents of this presentation have not been reviewed by any regulatory authority in Hong Kong. You are advised to exercise caution and if you are in any doubt about any of the contents of this presentation, you should obtain independent professional advice.

AQR Capital Management (Asia) Limited is licensed by the Securities and Futures Commission ("SFC") in the Hong Kong Special Administrative Region of the People's Republic of China ("Hong Kong") pursuant to the Securities and Futures Ordinance (Cap 571) (CE no: BHD676).

AQR Capital Management (Asia) Limited

Unit 2023, 20/F, One IFC, 1 Harbour View Street, Central Hong Kong, Hong Kong

Licensed and regulated by the Securities and Futures Commission of Hong Kong (CE no: BHD676).

China: This document does not constitute a public offer of any fund which AQR Capital Management, LLC ("AQR") manages, whether by sale or subscription, in the People's Republic of China (the "PRC"). Any fund that this document may relate to is not being offered or sold directly or indirectly in the PRC to or for the benefit of, legal or natural persons of the PRC. Further, no legal or natural persons of the PRC may directly or indirectly purchase any shares/units of any AQR managed fund without obtaining all prior PRC's governmental approvals that are required, whether statutorily or otherwise. Persons who come into possession of this document are required by the issuer and its representatives to observe these restrictions.

Singapore: This document does not constitute an offer of any fund which AQR Capital Management, LLC ("AQR") manages. Any fund that this document may relate to and any fund related prospectus that this document may relate to has not been registered as a prospectus with the Monetary Authority of Singapore. Accordingly, this document and any other document or material in connection with the offer or sale, or invitation for subscription or purchase, of shares may not be circulated or distributed, nor may the shares be offered or sold, or be made the subject of an invitation for subscription or purchase, whether directly or indirectly, to persons in Singapore other than (i) to an institutional investor pursuant to Section 304 of the Securities and Futures Act, Chapter 289 of Singapore (the "SFA") or (ii) otherwise pursuant to, and in accordance with the conditions of, any other applicable provision of the SFA.

Korea: Neither AQR Capital Management (Asia) Limited or AQR Capital Management, LLC (collectively "AQR") is making any representation with respect to the eligibility of any recipients of this document to acquire any interest in a related AQR fund under the laws of Korea, including but without limitation the Foreign Exchange Transaction Act and Regulations thereunder. Any related AQR fund has not been registered under the Financial Investment Services and Capital Markets Act of Korea, and any related fund may not be offered, sold or delivered, or offered or sold to any person for re-offering or resale, directly or indirectly, in Korea or to any resident of Korea except pursuant to applicable laws and regulations of Korea.

Japan: This document does not constitute an offer of any fund which AQR Capital Management, LLC ("AQR") manages. Any fund that this document may relate to has not been and will not be registered pursuant to Article 4, Paragraph 1 of the Financial Instruments and Exchange Law of Japan (Law no. 25 of 1948, as amended) and, accordingly, none of the fund shares nor any interest therein may be offered or sold, directly or indirectly, in Japan or to, or for the benefit, of any Japanese person or to others for re-offering or resale, directly or indirectly, in Japan or to any Japanese person except under circumstances which will result in compliance with all applicable laws, regulations and guidelines promulgated by the relevant Japanese governmental and regulatory authorities and in effect at the relevant time. For this purpose, a "Japanese person" means any person resident in Japan, including any corporation or other entity organised under the laws of Japan.



www.aqr.com