

## #03

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## Risk & Reward #03/2024

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### An NLP-driven approach to controversy screening for sustainable investments

Margit Steiner, PhD, and Ananthalakshmi Ranganathan, PhD

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### Factors and equity market concentration

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#### Systematic investing evolving: tactical asset allocation, algorithms, and artificial intelligence

Kenneth Blay, Alexandar Cherkezov, Scott Hixon and Alessio de Longis

A conversation with three experienced quantitative portfolio managers on systematic approaches that are increasingly being adopted to achieve investor objectives.

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Systematic investing is a disciplined strategy, founded on explicit rules and principles. Yet, like everything in asset management, it continues to evolve. Advances in computing power and artificial intelligence are driving change in processes and decision making. Quantitative techniques are being integrated into a wide array of strategies. This edition of Risk & Reward delves into these ongoing shifts.

For example, our colleagues have developed a cutting-edge tool for ESG monitoring that leverages Natural Language Processing (NLP) – a branch of AI that efficiently analyzes text. This tool reveals insights that a human reader might overlook due to biases or time constraints. Built on the premise that financially significant ESG controversies garner substantial media attention, the tool systematically analyzes news reports to identify the issues that really matter.

Next, we explore a classic theme in factor investing and a key feature of markets today: extreme concentration, particularly in the US, where a handful of tech mega-caps have come to dominate index composition and performance. Do you believe that quantitative strategies can't adapt to the new normal? With the right tools, style factors can still thrive, even in highly concentrated markets. Discover what our experts have uncovered.

In addition, we feature an in-depth interview with three leading quantitative portfolio managers from Invesco. They share their views on the latest developments in the space and the changes brought about by theoretical advances, increasing computing power, sophisticated algorithms, artificial intelligence, and evolving client preferences.

We hope you'll find this edition of Risk & Reward informative and inspiring.

Best regards,

**Stephanie Butcher**  
Senior Managing Director and  
Co-Head of Investments

**Tony Wong**  
Senior Managing Director and  
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# An NLP-driven approach to controversy screening for sustainable investments

By Margit Steiner, PhD, and Ananthalakshmi Ranganathan, PhD

This ESG monitoring tool uses a dictionary-based approach to identify financially material controversies. Comparing its results with third-party assessments demonstrates the tool's efficacy in capturing controversial practices that lead to significant stock price reactions.

**Today's investors give crucial consideration to environmental, social, and governance (ESG) controversies. Often tied to specific events or practices, controversies can significantly harm a company's reputation, or damage brand trust, and may lead to legal penalties and operational disruptions. But, assessing such impacts requires determining what exactly constitutes a financially material controversy.**

To this end, various third-party providers have developed a broad array of systematic controversy assessments. For example, MSCI scores ESG incidents on a 0-10 scale based on severity and type across environment, human rights, labor rights, customers, and governance, while Sustainalytics uses a 1-5 severity scale. London Stock Exchange Group (LSEG) assesses controversies across 23 topics with a market-cap bias correction and Vigeo Eiris, part of Moody's ESG Solutions assesses controversies based on severity, frequency, and responsiveness across six areas. Thus, despite their similar goals, the methodologies and criteria differ across providers, limiting comparability between assessments.

Given the importance of ESG controversies for asset allocation decisions and the challenges posed by the divergent





Since controversial practices or behaviors often lead to increased media coverage, our approach involves analyzing a comprehensive news corpus to identify spikes in relevant news activity.

methodologies, we have explored a novel approach to ESG controversy screening. Analyzing news flow and applying natural language processing (NLP) techniques, our aim is to supplement the common vendor assessments using a bespoke approach that can be tailored to any topic to provide a more targeted evaluation of financial impact and help investors make more informed decisions.

**An NLP-based controversy monitoring tool**

Since controversial practices or behaviors often lead to increased media coverage, our approach involves analyzing a comprehensive news corpus to identify spikes in relevant news activity.

Treating this as a standard text classification problem, identifying and categorizing news items as controversy-related or not, we begin with a rule-based dictionary screening. A dictionary is a compilation of terms and phrases used to sort underlying data into predefined categories. While more advanced methods like BERT (Bidirectional Encoder Representations from Transformers) offer deep contextual understanding, the dictionary approach is generally more transparent and easy to maintain.

For our dictionaries, we first identify the categories of interest. Given the extensive range of ESG sub-categories, we refer to the Vigeo Eiris dataset to prioritize the most prevalent controversies and organize them into distinct groups. In this article,

we will confine ourselves to the social domain (S). Here, we find the most prevalent areas of controversy to be: consumer data security and privacy, discrimination, fundamental human rights, workplace health and safety standards, labor standards, modern slavery, product safety standards and stakeholder interests (table 1).

For each of these categories, we compile a list of relevant terms and phrases indicative of controversial behavior, using automated keyword extraction followed by a manual review. For example, controversies in the category consumer data security and privacy often relate to issues such as ‘data breach’ and ‘privacy violation’. Similarly, terms like ‘child labor’ and ‘forced labor’ help pinpoint violations in labor standards and also warrant inclusion in the dictionaries. This methodology ensures a targeted and efficient approach to controversy detection, allowing us to monitor each category with a high degree of specificity and accuracy.

**Abnormal news flow indicator**

The next step is to construct an indicator of controversy news flows. Our premise is that major controversies initially attract heightened media attention, leading to an abnormal increase in news coverage of the companies involved.

We use news data from RavenPack, which provides approximately 5 million news headlines per month. This coverage spans 300,000 entities across more than 130 countries, encompassing over 98% of

Table 1  
**Identified categories and high-level keywords**

<b>Consumer data security and privacy</b>	<b>Labor standards</b>
Data breach Privacy violation Consumer fraud Identity theft	Child labor Forced labor Minimum wage Working hours Union rights
<b>Discrimination</b>	<b>Modern slavery</b>
Gender discrimination Racial discrimination Age discrimination Disability discrimination Racial profiling	Human trafficking Debt bondage Exploitation Involuntary servitude
<b>Fundamental human rights</b>	<b>Product safety standards</b>
Freedom of speech Physical abuse Sexual abuse	Product defects Safety standards Regulatory compliance Hazardous materials Consumer safety
<b>Workplace health and safety standards</b>	<b>Stakeholder interests</b>
Workplace accidents Occupational health Safety violations Hazardous conditions	Terrorist financing Civil conflict Social conflict

Source: Invesco.

the global investable market. We focus on a sample of around 9,500 companies globally each month, starting in January 2014. For over 75% of these companies, at least one news item is published every month.

In general, larger companies are more likely than their smaller counterparts to have controversial news items reported. Hence, we standardize the controversial news volume per company using a one-year lookback window:

$$A_{it} = \frac{C_{it} - \bar{C}_{i(t-1,t-365)}}{s.d(C_{i(t-1,t-365)})}$$

where  $C_{it}$  is the total number of controversies identified for company  $i$  on day  $t$ ,  $\bar{C}_{i(t-1,t-365)}$  is the mean number of controversies during the previous year for company  $i$ ,

and  $s.d(C_{i(t-1,t-365)})$  is the associated standard deviation during the previous year for company  $i$ .

### Dictionary-based vs. vendor-identified controversial events

To find whether controversies surrounding a company's behavior are financially material, we document price reactions on the day of the highest media coverage of controversies as indicated by the abnormal news flow indicator. To capture the most severe controversial events, we focus on the top percentiles. Using a 252-day estimation window, a baseline is established for typical price behavior, with an event window spanning from five days before to five days after the coverage peak. In total, we identified 446 events with our approach.

Table 2

### Mean average abnormal returns in times of controversy, based on abnormal news activity (446 in total)

Event window	Mean average abnormal return (%) (daily)		Mean average abnormal return (%) (cumulative)	
		t-stat		t-stat
-5	-0.15	-1.50	-0.15	-1.50
-4	-0.15	-1.26	-0.30	-2.12
-3	-0.13	-1.26	-0.43***	-2.67
-2	-0.10	-0.97	-0.53***	-3.05
-1	-0.25***	-2.58	-0.78***	-3.81
0	-0.31***	-2.74	-1.09***	-4.43
1	-0.01	-0.05	-1.10***	-4.29
2	0.06	0.62	-1.04***	-3.88
3	0.14	1.31	-0.90***	-3.38
4	0.06	0.59	-0.84***	-2.98
5	0.10	0.78	-0.74**	-2.33

\*\*\* significant at the 1% level, \*\* significant at the 5% level, \* significant at the 10% level.  
Source: Invesco.

Table 3

### Mean average abnormal returns in times of controversy, events identified as critical and either reactive or non-responsive by Vigeo Eiris (175 in total)

Event window	Mean average abnormal return (%) (daily)		Mean average abnormal return (%) (cumulative)	
		t-stat		t-stat
-5	-0.48*	-1.82	-0.48*	-1.82
-4	0.01	0.03	-0.47	-0.97
-3	-0.14	-0.65	-0.61	-1.16
-2	0.02	0.10	-0.58	-1.04
-1	0.22	0.92	-0.36	-0.59
0	-0.79	-1.28	-1.15	-1.36
1	-0.52	-1.60	-1.67*	-1.73
2	-0.15	-0.67	-1.82*	-1.82
3	-0.34	-0.97	-2.16*	-1.95
4	0.07	0.38	-1.61	-1.50
5	-0.28	-1.31	-1.89*	-1.73

\*\*\* significant at the 1% level, \*\* significant at the 5% level, \* significant at the 10% level.  
Source: Invesco.



Controversial events have a significant negative impact on stock prices.

Table 4  
**Mean average abnormal returns in times of controversy, events identified as critical and non-responsive by Vigeo Eiris (43 in total)**

Event window	Mean average abnormal return (%) (daily)		Mean average abnormal return (%) (cumulative)	
		t-stat		t-stat
-5	-0.06	-0.24	-0.06	-0.24
-4	0.09	0.21	0.04	0.08
-3	-0.91*	-1.71	-0.87	-1.06
-2	0.45	1.15	-0.42	-0.60
-1	0.15	0.35	-0.27	-0.30
0	-3.02*	-2.16	-3.29**	-2.48
1	-2.03*	-2.36	-5.32***	-2.80
2	-0.01	-0.04	-5.34***	-2.80
3	-1.10	-0.96	-6.44**	-2.43
4	0.14	0.46	-4.41**	-2.36
5	0.28	1.40	-4.13**	-2.22

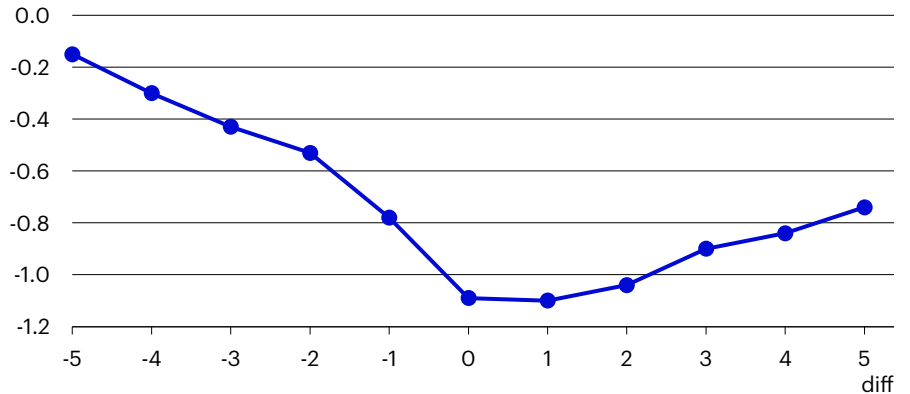
\*\*\* significant at the 1% level, \*\* significant at the 5% level, \* significant at the 10% level.  
 Source: Invesco.

As shown in table 2 and figure 1 (chart A), controversial events have a significant negative impact on stock prices. The cumulative mean average return declines substantially, particularly around the event date. This reflects the financial materiality of these controversies and the efficacy of our approach.

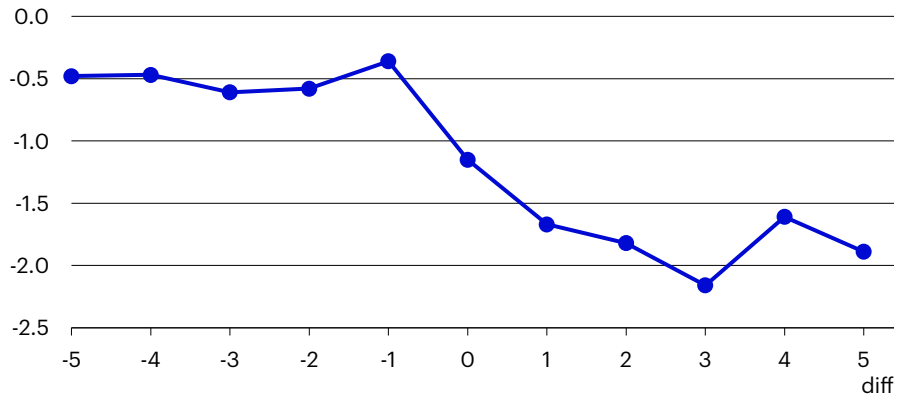
For comparison, we now look at controversies identified by Vigeo Eiris. Vigeo Eiris assesses each detected controversy qualitatively, distinguishing four levels of severity (Minor, Significant, High, Critical) and responsiveness (Proactive, Remediative, Reactive, Non-Communicative). Since we anticipate a material impact when a

Figure 1  
**Mean cumulative average abnormal return, based on abnormal news activity (chart A) and Vigeo Eiris (critical and either reactive or non-responsive, chart B)**

(Chart A) meanCAR

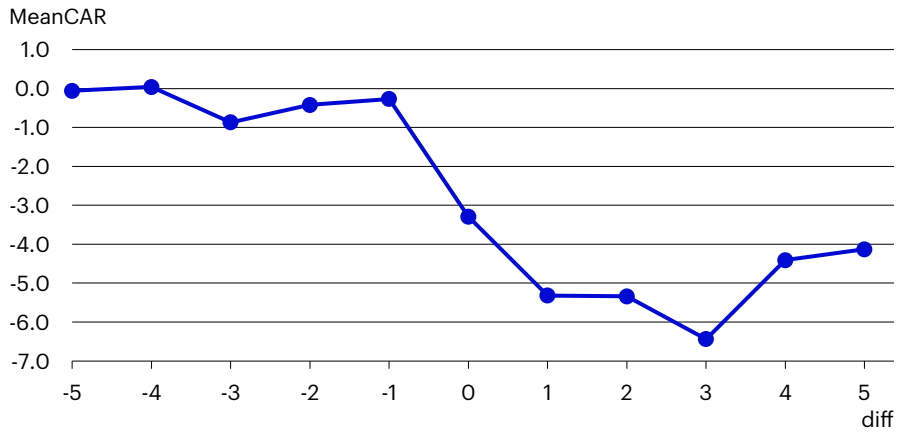


(Chart B) meanCAR



Source: Invesco.

Figure 2  
**Mean cumulative average abnormal return, based on controversies identified as critical and non-responsive by Vigeo Eiris**



Source: Invesco.

company is involved in severe controversies, we consider controversies that are both critical and either reactive or non-responsive (table 3 and figure 1, chart B). Furthermore, we perform a specific analysis of those critical controversies which are non-responsive to map the consequences of inaction (table 4).

We can see from table 3 and figure 1 (chart B) that there is no statistically significant drop in returns for events identified by Vigeo Eiris as critical and either reactive or non-responsive, with Average Abnormal Returns (AAR) showing no statistical significance. In contrast, Table 4 and figure 2, which focuses on critical and non-responsive controversies, reveal significant negative Cumulative Average Abnormal Returns (CAAR) from the event day onwards. This suggests

that both quantitative measures (such as abnormal news activity) and qualitative assessments (like those by Vigeo Eiris) can identify financially relevant controversies, however, underscoring the importance of understanding the nuances in external vendor classifications.

**Conclusion**

Our controversy monitoring tool, utilizing dictionary-based approaches, effectively identifies financially material controversies via the abnormal news flow indicator, which captures controversial practices that lead to significant stock price reactions. Hence, this may serve as a complementary screening and alert system, capable of addressing bespoke topics outside standard classifications, additionally ensuring timely and comprehensive identification of financially material controversies.



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 Margit Steiner conducts research on quantitative equity investment strategies. Her current work focuses on natural language processing and machine learning.



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# Factors and equity market concentration

By Khanika Gadzhieva and Erhard Radatz

We examine the behavior of global equity factors in the context of increased equity market concentration and show how well-designed equity style factors can effectively diversify a portfolio.

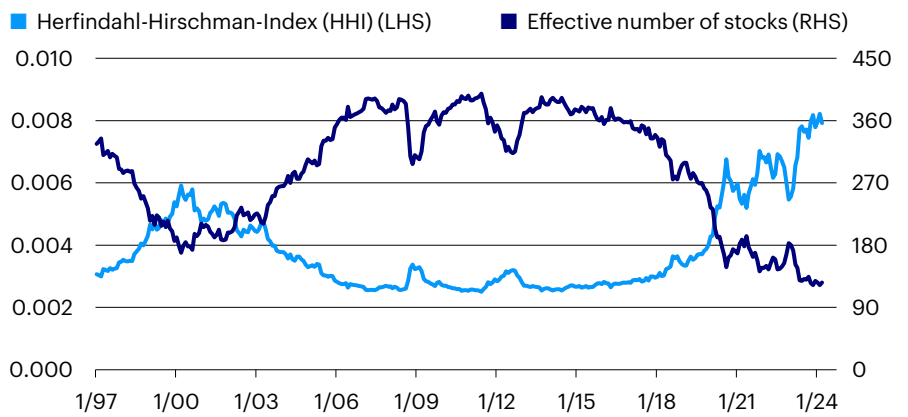
**Global equity markets have become visibly more concentrated over the past 25 years. Today, the top 10 MSCI World stocks (by market value) have the highest cumulative index weight since 1997.**

Figure 1 shows the Herfindahl-Hirschman index (HHI), a commonly used measure of market concentration, for the MSCI World Index.<sup>1</sup> From 1997 to early 2007, the HHI was on a downward trend before leveling off and remaining roughly constant for ten years and slowly picking up around 2016. HHI for the MSCI World then increased rapidly during and after the Covid crisis. Thus, someone invested in the broad market index over the past 20 years would have effectively been invested in roughly 380 stocks at the peak vs. 125 on average over the past 6 months.

It is true that equity markets have often been dominated by specific sectors. However, while the dominance of a particular sector

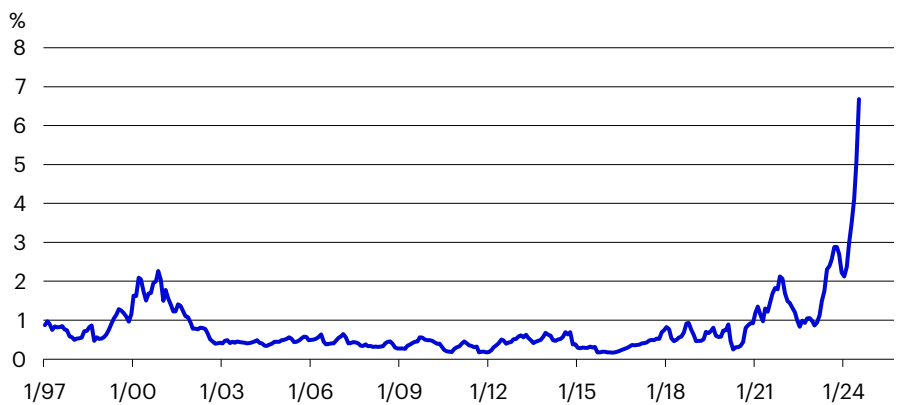


Figure 1  
**Concentration of the MSCI World Index**



Source: Invesco calculation based on the MSCI World Index holdings at month end from January 1997 to March 2024.

Figure 2  
**Contribution of idiosyncratic risk to total risk of MSCI World**



Source: Invesco calculations based on monthly risk decomposition from January 1997 to July 2024.

may not pose significant problems, the dominance of idiosyncratic risks from only a handful of stocks is far more likely to be problematic. Indeed, as figure 2 shows, the contribution of idiosyncratic risk to total risk has risen rapidly since around 2020.

**Factor performance**

We will now analyze equity factor performance for four different concentration regimes:

- (1) low and falling concentration,
- (2) low and rising concentration,
- (3) high and falling concentration,
- (4) high and rising concentration.

Figure 3 plots these scenarios over time.

Table 1 shows that, most of the time over the past 25 years, market concentration has been low and increasing. Under this regime, the market factor earned a moderate average return of 1.5% p.a., while the Fama-French factors size (small minus big, SMB) and value (high minus low, HML) returned -2.6% and -2.3%, respectively. The Fama-French momentum factor (winners minus losers, WML) was flat.

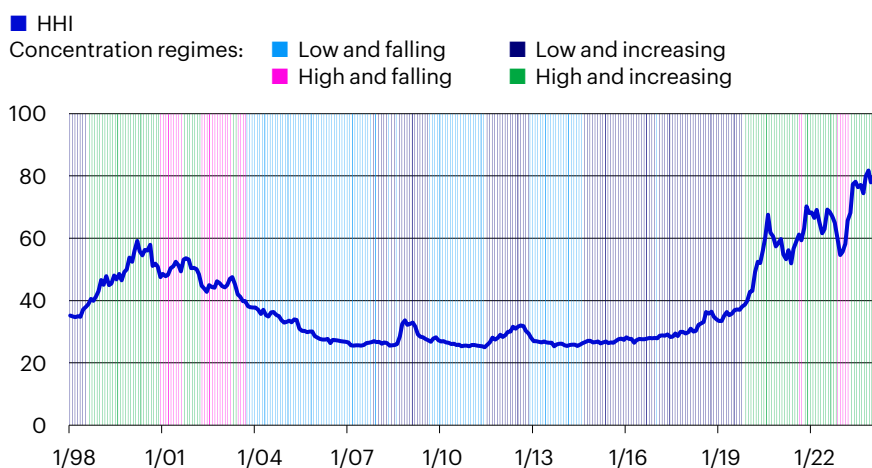
The market factor saw its best average performance (almost 16% p.a.) in months with low and falling market concentration, i.e., from October 2003 to December 2007, from September 2009 to June 2011 and from December 2012 to August 2014. It was weakest when market concentration was high and falling – precisely when the Fama-French factors exhibited their strongest returns. However, there are only 32 months in which market concentration was high and falling, mainly after the dot-com bubble from 2001 to 2003.

We also observe that the volatilities of all factors increase with higher concentration. Even though the market factor is more volatile than other factors in almost all regimes, the steepest increase in volatility with higher concentration can be seen for the Fama-French value factor (HML). Overall, factors seem to be a source of diversification. However, given the variation in returns and risk, the naively defined factors can be a source of unrewarded risk in certain market environments. As markets are notoriously difficult to time, investors might thus prefer factors that deliver consistent results over different regimes.



The volatilities of all factors increase with higher concentration.

Figure 3  
Concentration regimes over time



Source: Invesco calculations based on the MSCI World Index holdings at month end from January 1997 to March 2024. The months with HHI value above average HHI for the whole period are considered 'high' and the months with HHI value below average HHI for the whole period are considered 'low'. The months with positive 12-month rolling average month-on-month HHI change are considered 'increasing', while the months with negative 12-month rolling average month-on-month HHI change are considered 'falling'.<sup>2</sup>

Given these considerations, it is important to think thoroughly about factor construction. Enhanced factors are neutralized relative to market risk and do not take industry bets. Well-constructed factors avoid overemphasizing high factor signals at the expense of a broader dispersion of risk. This may limit portfolio concentration and minimize idiosyncratic risks.<sup>3</sup>

Table 2 shows the returns and volatilities of enhanced factors, which exhibit much less variation throughout the different market concentration regimes and deliver stronger risk-adjusted performance. Just like the Fama-French value factor, the enhanced value factor seems to offer support, especially in periods of high and falling market concentration, where the average annualized market performance as proxied by the MSCI World Index returns in excess of risk-free returns has struggled most.<sup>4</sup>

#### Some additional testing

Additional tests will help to see whether the average annualized performance of the MSCI World and the equity factors are significantly different under the various concentration regimes. First, we assess whether volatilities vary significantly across the four regimes. Table 3 reports the results of a Levene's test, which suggest that there is heterogeneity in volatilities for both the market and style factors.

Next, we look at whether average monthly returns for different factors across the four concentration regimes are significantly different. Assuming no equal variance, the results of the Analysis of Variance (ANOVA) test in table 4 indicate that the differences in performance for the market factor, Fama-French size and enhanced value are significant at a 5% significance level.

Table 1  
Factor performance under different concentration regimes

Concentration regime	# Months	Market	Size (SMB)	Value (HML)	Momentum (WML)
<b>Return</b>					
Low and falling	96	15.9%	2.6%	3.1%	9.9%
Low and increasing	104	1.5%	-2.6%	-2.3%	1.0%
High and falling	32	-9.3%	12.1%	17.8%	13.1%
High and increasing	83	9.0%	-2.7%	2.3%	5.2%
<b>Volatility</b>					
Low and falling	96	10.7%	5.0%	4.5%	6.4%
Low and increasing	104	17.1%	4.9%	6.7%	14.2%
High and falling	32	16.4%	7.9%	12.6%	19.0%
High and increasing	83	18.6%	8.7%	14.7%	18.2%
<b>Risk-adjusted return</b>					
Low and falling	96	1.49	0.53	0.68	1.55
Low and increasing	104	0.09	-0.53	-0.34	0.07
High and falling	32	-0.56	1.54	1.41	0.69
High and increasing	83	0.48	-0.31	0.15	0.29

Source: Kenneth R. French library. Invesco monthly calculations from January 1998 to March 2024.

Table 2

## Performance of enhanced factors under different concentration regimes

Concentration regime		Enhanced Value (VAL)	Enhanced Quality (QAL)	Enhanced Momentum (MOM)	MSCI World
<b>Return</b>	Low and falling	3.3%	2.8%	5.9%	14.7%
	Low and increasing	1.8%	3.4%	3.4%	1.7%
	High and falling	14.8%	5.1%	3.8%	-12.1%
	High and increasing	4.9%	6.4%	4.6%	8.8%
<b>Volatility</b>	Low and falling	3.0%	1.9%	3.7%	10.5%
	Low and increasing	5.1%	2.6%	6.4%	16.9%
	High and falling	5.8%	4.3%	11.6%	16.7%
	High and increasing	8.7%	3.9%	7.3%	18.4%
<b>Risk-adjusted return</b>	Low and falling	1.11	1.43	1.60	1.40
	Low and increasing	0.35	1.29	0.54	0.10
	High and falling	2.52	1.18	0.33	-0.73
	High and increasing	0.57	1.65	0.64	0.48

Source: Invesco monthly calculations from January 1998 to March 2024. Enhanced factors are long/short market and dollar-neutral factor portfolios. MSCI World is in excess of risk-free returns.

The results indicate that the market and style factors show some variation in returns and volatilities depending on whether concentration in public equity markets is high or low and whether the trend is increasing or decreasing. Style factors demonstrate the ability to provide diversification to the market factor, with the most notable example of the value factor in times of high and falling market concentration. Finally, diversifying

underlying signals and minimizing idiosyncratic risk when constructing factors makes them more robust and consistent throughout various concentration regimes.

**Diversification via size?**

Often, an allocation to small caps is suggested to reduce the concentration risk of a portfolio. A rather easy way to achieve this is to invest in an equally weighted index that is largely a combination

Table 3  
Levene's test

Variable	F-Value	p-Value
<b>Market</b>	6.2	0.000413
<b>SMB</b>	8.7	0.000015
<b>HML</b>	27.8	0.000000
<b>WML</b>	12.4	0.000000
<b>VAL</b>	24.8	0.000000
<b>QAL</b>	15.2	0.000000
<b>MOM</b>	7.9	0.000044
<b>MSCI World</b>	6.7	0.000231

Source: Kenneth R. French library. Invesco monthly calculations from January 1998 to March 2024. Enhanced factors are long/short market and dollar-neutral factor portfolios. MSCI World is in excess of risk-free returns.

Table 4  
ANOVA test

Variable	F-Value	p-Value
<b>Market</b>	2.7	0.047441
<b>SMB</b>	3.8	0.012092
<b>HML</b>	2.7	0.051882
<b>WML</b>	1.0	0.380321
<b>VAL</b>	3.6	0.015280
<b>QAL</b>	1.8	0.154582
<b>MOM</b>	0.3	0.806850
<b>MSCI World</b>	2.7	0.048326

Source: Kenneth R. French library. Invesco monthly calculations from January 1998 to March 2024. Enhanced factors are long/short market and dollar-neutral factor portfolios. MSCI World is in excess of risk-free returns.

Table 5

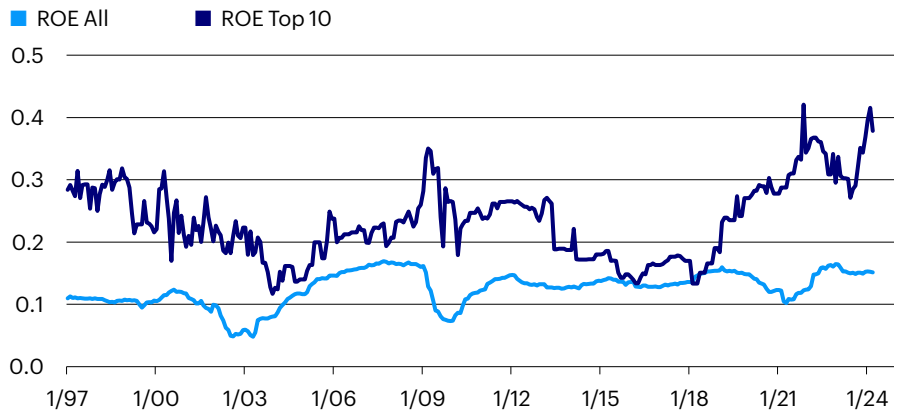
## Results for market-weighted and equal-weighted S&amp;P 500 in comparison

Concentration regime	Return		Volatility		Risk-adjusted return	
	Market-weighted	Equal-weighted	Market-weighted	Equal-weighted	Market-weighted	Equal-weighted
<b>Low and falling</b>	14.3%	3.3%	10.0%	3.0%	1.43	1.11
<b>Low and increasing</b>	4.4%	-1.5%	16.0%	5.0%	0.28	-0.29
<b>High and falling</b>	-13.6%	6.4%	17.6%	7.1%	-0.77	0.90
<b>High and increasing</b>	12.2%	0.9%	19.0%	7.6%	0.64	0.12

Source: Invesco monthly calculations from January 1998 to March 2024. The concentration regimes are not recalculated based on the S&P Index but remain based on the MSCI World Index.

Figure 4

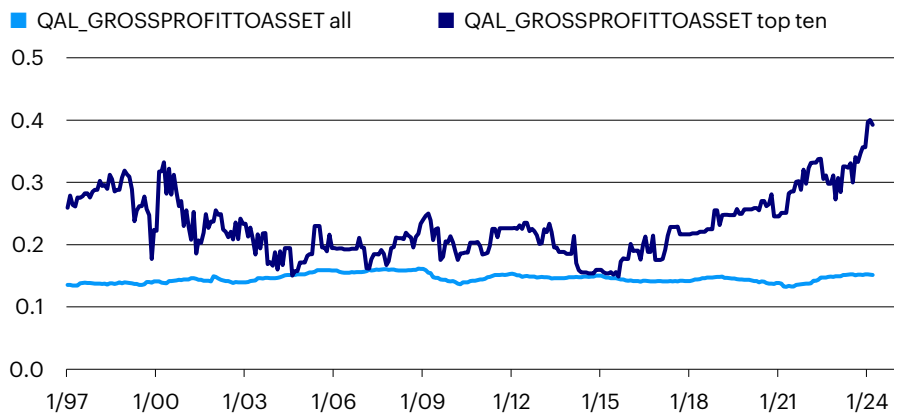
**Average ROE of the MSCI World and its top 10 stocks by market capitalization**



Source: Invesco calculations based on the MSCI World Index holdings at month end from January 1997 to March 2024.

Figure 5

**Average gross profits to assets ratio of the MSCI World and its top 10 stocks**



Source: Invesco calculations based on the MSCI World Index holdings at month end from January 1997 to March 2024.

of a market and a size factor. However, the size factor suffers from the shortcomings addressed above. Investing in an equal-weighted index means naively allocating to size, which can result in unintended biases in the portfolio, including higher market beta, positive value exposure, and negative momentum exposure.

Table 5 shows the risk and return characteristics of the market value-weighted and the equal-weighted S&P 500 Index.<sup>5</sup> The small size tilt of the equal-weighted index provides some support in times of high and falling market concentration (perhaps due to positive value exposure), but has been a source of unrewarded risk when market concentration was low and increasing. Even if designed differently, size fails to satisfy the criteria for a proper factor framework, such as economic theory, robust risk and return evidence, cross-asset and cross-region validation, and implementability.<sup>6</sup>

**Fundamentals of the top 10 stocks**

In addition to the naive definition of the size factor, the relative quality of small-cap stocks (which reportedly deteriorated over the past few years) might have been a reason

for the unsatisfactory results.<sup>7</sup> Therefore, we now look at some anecdotal evidence about the quality characteristics of the top 10 MSCI World stocks (by market capitalization).

Figure 4 compares their average ROE to that of the MSCI World Index; figure 5 compares their average gross profit to assets ratio. As the graphs show, both quality indicators have almost always been higher for the top 10 stocks. Secondly, again for both metrics, the difference between the top 10 average and the overall index was higher in the late 1990s and early 2000s and has been steadily rising again since around 2015.

This suggests that the current concentration might not be due to stretched valuations but is rather a result of certain companies expanding their profitability lead. In fact, it looks like periods of high market concentration coincide with periods of increased divergence between the selected metrics of the top 10 stocks and the overall index. The correlations of HHI with the average gross profit to assets ratio and ROE of the top 10 stocks are 0.8 and 0.6, respectively.



This suggests that the current concentration might not be due to stretched valuations but is rather a result of certain companies expanding their profitability lead.

## Conclusion

Today's high market concentrations lead some investors to consider hedging concentration risk. Equity market factors have historically provided diversification under various market concentration regimes, whereas the value factor offered strongest support under the high and falling concentration regime, when the market factor had its worst performance.

Well-balanced style factor construction can achieve consistency of factor returns over different concentration regimes. Naive strategies such as equal-weighted indices, on the other hand, can help increase exposure to equity factors but don't prevent unwanted biases and can introduce unrewarded risks.

## Notes

1 Adelman, M.A. (1969). The index is calculated as a sum of squared market shares, using the following formula:

$$HHI = \sum_{i=1}^N (MS_i)^2$$

- 2 While the HHI values are difficult to interpret in absolute terms, it is useful for defining different concentration regimes based on the development of the index over time. For reference, the lowest HHI value for a MSCI World Index assuming number of holdings being 1400 would be 0.005, while the most concentrated portfolio consisting of only one security would have HHI of 10000.
- 3 Additionally, diversifying the underlying factor signals can help achieve more consistent factor performance. Taking the example of value, with intangibles playing an increasingly important role in companies' valuation, the simple book-to-market ratio to define the value factor is not enough to adequately capture whether a company is undervalued. Moreover, it can make the valuation and performance metrics more volatile (Berkin, Dugar & Pozharny, 2024). Using more signals other than the book-to-market ratio for the value factor helps capture valuation effects that are not reflected in the book-to-market ratio and diversify factor performance, yielding more consistent performance.
- 4 In the following, MSCI World Index performance in excess of risk-free returns is used as an implementable market beta factor strategy. The definition of the Fama-French market factor is somewhat different but is expected to be consistent with the MSCI World Index performance. Both factors are used in the following calculation to showcase the consistency.
- 5 The concentration regimes are not recalculated based on the S&P index but remain based on the MSCI World Index.
- 6 Gupta et al. (2022).
- 7 Blitz & Hanauer (2020).



## References

Adelman, M. A. (1969): Comment on the "H" Concentration Measure as a Numbers-Equivalent. *The Review of Economics and Statistics*, 51(1), 99-101. <https://doi.org/10.2307/1926955>

Berkin, Dugar, and Pozharny (2024): *Classical Stock Valuation in the Modern Era of Intangibles*.

Blitz, David and Hanauer, Matthias Xaver (2020): *Settling the Size Matter*. Available at SSRN: <https://ssrn.com/abstract=3686583> or <http://dx.doi.org/10.2139/ssrn.3686583>

Gupta, Raol, and Roscovan (2022): *Factor Investing: From Theory to Practice*. *The Journal of Beta Investment Strategies*.



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# Systematic Investing Evolving: tactical asset allocation, algorithms, and artificial intelligence

Systematic investing has been evolving. Over the past several decades, advances in finance theory, computing power, alternative data sources, and trading – alongside practical, real-world experience in applying quantitative methods to address investor needs – have expanded the use cases for systematic approaches within investment management. Once focused mainly on market and security forecasting methods, generally based on price and volume data, it then evolved to exploiting risk premia and financial anomalies.

Today, the transparency and efficiency of systematic investing offers investors the ability to incorporate a broad range of approaches to address their unique preferences and objectives while also carefully managing risk. However, this continuing evolution has many investors still coming to grips with systematic investing, including understanding its benefits and potential role in their portfolios. To help answer some of their questions, Kenneth Blay of the Global Thought Leadership team sat down with three experienced systematic investment managers for their perspective.

## Systematic Investing Today Everything old is new again – only better

### Kenneth Blay

To begin, it would be helpful to get your perspective on what systematic investing is in practice today. Many people believe that systemic investing began with factor investing. Others, however, say it was around well before the notion of factors. Systematic investing has also changed in a lot of different ways over time. What is systematic investing today and what have you seen in terms of its evolution over the past 10 to 20 years?

### Scott Hixon

I don't believe that systematic investing evolved out of factor investing. I think it's the other way around. I think factor investing came out of systematic tactical allocation, which has been around for a long time. It's just become more refined. Part of that refinement is a loosening of the focus on asset classes to a more factor-based approach.

Thirty years ago, most systematic investors didn't think about factors. Back then, it was more about overweighting stocks versus bonds, small-cap versus large-cap, or U.S. versus non-U.S. Those things are still important, but we now also consider factors. Broadly speaking, systematic investing is just a quantitative approach to determining where to deploy capital in a portfolio.

Today, systematic investing has become more and more precise about the exposures and factors we're trying to target in a portfolio – whether that's because there's potentially more return available or better



risk management. That's been the biggest change in systematic investing I've seen over my 35-year career.

#### **Alexandar Cherkeзов**

Yes, that's what is really new – the intersection of systematic and factor investing. We now look at factors more dynamically and from a macro perspective.

#### **Alessio de Longis**

That's right. The bottom-up, security-level systematic approach used in factor investing has now been integrated into the top-down asset class-level approach of systematic tactical allocation.

Systematic tactical strategies always existed in the global macro space, whether as asset allocation, currency trading, or general CTA (commodity trading advisor) programs, which are multi-asset-class trend following approaches – and therefore quantitatively based.

That original form of systematic tactical investing permeated to the security level as single-security strategies, some of which are factor-based. But systematic, quantitative rules-based investing predates factors, whether implemented at the asset class or the security level.

#### **Kenneth Blay**

So, is it just the increase in the breadth of the opportunity set considered by systematic strategies that has driven investor interest in employing these approaches, or has something else changed?

#### **Alessio de Longis**

The most dramatic change I've experienced in my 20 years in this industry is that the sophisticated quantitative strategies that were once accessible only to institutional investors and a certain subset of clients are now available to a much broader base of investors. We've seen a democratization of systematic investing – quantitative, rules-based, systematic, and factor strategies are pervasive in the retail world today. This change has been driven by the advent of ETFs, index-based strategies, and other low-cost solutions.

Nowadays, even retail investors are familiar with such traditional quantitative concepts as low volatility, momentum, carry, and value. Sophistication itself has been democratized – it's more accessible now to everybody and has been made significantly more affordable.

#### **Alexandar Cherkeзов**

In the last 10 years, data has also become much more available. Alternative datasets are now being explored. Computational power is getting stronger and cheaper. This gives us opportunities to add value by enhancing traditional factors. For instance, textual data from transcribed earnings calls is now being analyzed to extract sentiment and other information. The analysis can be done very quickly as compared to reading through the transcripts of the calls.

#### **Scott Hixon**

It's not only alternative datasets but the general availability of data that has changed. Thirty years ago, there was very little internet to speak of. Now, central banks around the world have all of their data – money supply, CPI, anything you want – accessible at the touch of a button. That makes all the calculations and fundamental thinking that goes into building a quantitative, systematic process substantially easier than it was 30 years ago.

### **Man, machine, and systematic investing** Intuition, computation, and portfolio management

#### **Kenneth Blay**

In his 1959 Portfolio Selection book, Harry Markowitz discussed how the work required to produce portfolios can be divided between man and machine. This notion is central to systematic investing, as it has been the machine that has provided tremendous scale for what is done by the human. With advances in technology, how much of systematic investing is now done by machines and what still depends on people?

#### **Scott Hixon**

Today, the computational work is delegated entirely to the machine, while the higher-level thinking required for overseeing the investment process and understanding more abstract relationships is left to the humans. The math is easy, but understanding cause and effect and more fundamental relationships is much harder. And it's not clear to me that machines have really figured that out.

#### **Alexandar Cherkeзов**

It's important to have a process that doesn't just repeat the data but looks for an economic rationale. We also want strategies that are robust across different geographies and different asset classes. Moreover, strategies need to be implementable – considering things like trading frequency, transaction costs, and time zones – and not something that only works on paper.

#### **Alessio de Longis**

Now that computation and automation have been delegated to machines and we've benefitted from speed of execution, our value add as managers is in going back to the fundamentals, back to intuition, as we evaluate and input the parameters to those quantitative rules.

There is also a lot of competition in the systematic investing space, with many firms offering similar strategies. This is a function of the fact that many of the ideas that drive these types of strategies are published in peer-reviewed journals, which raises the bar on portfolio managers and researchers to innovate in more thoughtful and clever ways. I think the challenge for us is to do that.



**Kenneth Blay**

Speaking of intuition, it seems that having a clear and intuitive story about why you want to pursue a strategy is important for market acceptance by investors – you can't just offer black boxes. Is this a constraint on what can be done with systematic investing?

**Scott Hixon**

It keeps the mainstream systematic strategies from getting too complicated. A segment of the market will be into machine learning and other similar techniques. But, by and large, big institutional players and the sophisticated Registered Investment Advisors are going to be much more reluctant to accept such approaches, precisely because it's hard to explain the performance behavior.

There's also a career risk: When a strategy breaks and you can't explain why, that's kind of the worst possible outcome, particularly in working with big institutions. Your client's investment staff will have to go to their board and explain why plan-level performance was poor. And if it's, 'Well, we don't really know – it was this machine learning technique or some high-powered math,' that's just not going to play well.

**Kenneth Blay**

Systematic investing today includes algorithms that identify market regimes and make tactical portfolio adjustments. Years ago, some might have called this market timing – and that had a very negative stigma to it. Today, there is a much broader acceptance of these regime-based and tactical approaches by academics as well as professional investors. What has changed that has resulted in the greater acceptance of these approaches?

**Alessio de Longis**

If there is one term that has been taken completely out of context, it's 'market timing'. There is such a negative stigma attached to it. As such, it might be useful to reset the conversation around this idea.

We are active investors – risk takers. We need to take positions different from a benchmark. The moment you have an active weight, you are making a timing decision, period.

To clarify a bit further, the negative stigma attached to market timing generally comes from the idea of trying to time the direction of the equity market. The investment industry now understands that making directional calls on any basis – whether on interest rates or the equity market – is very difficult. So, the industry has moved more to harvesting anomalies or factors within markets while remaining market neutral.

An entire industry has created successful strategies, and it has delivered attractive returns to investors for 30 years using market-neutral equity strategies that harvest equity factor premia, market-

neutral foreign exchange (FX) strategies that harvest FX carry, FX value, and so on. The asset management industry as a whole moved to delivering alpha on a market-neutral basis – and that's how the negative stigma to market timing arose. The consensus was, 'Don't bother with timing.' There's a much more solid value proposition you can deliver to investors by focusing on generating alpha within a market, rather than timing the market as a whole.

**Scott Hixon**

I agree, but I also think it goes back to my earliest years in the business, when the market timing decision was, 'Do I overweight equities or do I overweight bonds?'

Back then, there wasn't the focus on risk management that there is today. When you make a bet without a focus on managing risk and you get it spectacularly wrong, that contributes to the negative stigma around market timing.

**Kenneth Blay**

It might surprise many investors that Harry Markowitz, in his 1959 Portfolio Selection book, explains how investors might systematically address the issue of probability distributions changing through time as a function of changing market conditions. In other words, the person who introduced us all to strategic asset allocation, which many investors assume to mean holding static allocations, recognized the need to adjust portfolio allocations as markets changed. This notion is aligned with what systematic investors have been doing all along – managing portfolios to changing market conditions and risk. Ironically, where dynamic/tactical strategies were once viewed as introducing risk to a portfolio, they are now being viewed as a tool for managing risk. Why do you think this is? Could it be that these strategies are now more focused on risk management?

**Scott Hixon**

That's why I think it's much more acceptable now to be a market timer or a tactical allocator – because you're going to do it within a risk-controlled framework. If you get it wrong, it's not going to be a scenario where you had 100% in bonds when stocks were up 30%.

**Alexandar Cherkezov**

I would add that the data-driven and evidence-based nature of systematic investing has enhanced confidence in these approaches. So has its repeatability – the rules are documented, and you can explain them. I think the transparency of systematic approaches has also helped.

**Kenneth Blay**

So, transparency and a focus on risk management have driven the broader acceptance of systematic investment strategies?

**All**

Yes. Absolutely!

## The advantages of investing systematically

### Fewer behavioral biases and dynamic portfolio management through a repeatable team-based process

#### Kenneth Blay

We've talked about what systematic investing is, how it has evolved, and what is driving its increasing adoption. As seasoned practitioners who have worked with clients in developing, implementing, and managing these strategies, what are the key benefits to investors of systematic investing?

#### Alessio de Longis

First, it reduces behavioral biases. These include overreacting or underreacting to changing information and reacting imprudently to performance.

Discretionary investing, without any mediating process, is more prone to overconfidence in winners and underconfidence in losers. Systematic investing, meanwhile, imposes a transparent and quantifiable discipline on the investment process, which generally includes risk budgeting and attribution processes. It's very deliberate in terms of the links between the inputs and outputs of investment performance. The reduction of bias is a big benefit of over discretionary approaches that might be more susceptible to emotions.

To be clear, the distinction is between discretionary and systematic investing, not between fundamental and systematic investing. Fundamental investing can be done systematically.

The second benefit is an improved investor experience. Systematic strategies are more dynamic and more tactical than buy-and-hold strategies. Investors are always encouraged to focus on the long term and to stick to their risk-return preferences and objectives. The reality is that one-year performance matters – and three-year performance matters. Systematic strategies seek to provide a better investor experience through a deliberate, transparent, and dynamic investment process.

#### Scott Hixon

I completely agree. Return distributions have fat tails. And one way to deal with those fat tails is to be somewhat tactical. A key reason investors would want some dynamism in their portfolio is to deal with some of those fat tail events. If you just rely on a 2030 buy-and-hold strategy, fat tail events may have a significant impact on your long-term performance.

#### Alexandar Cherkezov

Without a doubt, systematic investing helps to mitigate the emotional implications of investing. However, I'll also point out a third key benefit of systematic approaches – which is that they are typically team-based. There is

substantially less key-person risk because there is a formalized and well-defined process.

#### Alessio de Longis

That's a very important point. The star portfolio manager model was risky. The team-based approach embeds a whole suite of controls and involves more people in the infrastructure and maintenance of systems.

Which brings us to the biggest benefit of systematic investing: Namely, if the process is well-outlined, you can have a reasonable expectation that the process is repeatable – and that performance is repeatable. Because the rules are clear. When conducting due diligence on a discretionary strategy, even when the performance is stellar, it's very difficult to answer the question, 'Is this repeatable?'

#### Kenneth Blay

One of the aspects of incorporating dynamic approaches in portfolios that is often overlooked is the fact that they can allow for shifts in overall portfolio allocations that might otherwise not be possible within a reasonable timeframe. Making changes to allocations can be a time-intensive process, especially for institutional investors. From preparing documentation of proposed changes, to scheduling an investment committee meeting, to presenting and approving the change, and finally to trading and implementing the change – making a change can sometimes take days, if not, weeks. This can be a limiting aspect to portfolio management. Incorporating systematic dynamic strategies can allow for portfolios to react more quickly to changing market conditions. Would you agree?

#### Alessio de Longis

Completely. At the institutional level, team-based discretionary processes suffer from slow decision making in a way that systematic strategies do not.

#### Scott Hixon

For investment management, time is often of the essence. These strategies can offer investors an edge in that respect.

## Systematic investing and you

### Considerations for those looking at systematic strategies

#### Kenneth Blay

How should investors go about assessing systematic strategies? How should they choose one process over another?

#### Scott Hixon

When I'm thinking about choosing a systematic strategy, I first want to understand when does it work, when does it not work, and where are its weaknesses.

Investors need to know whether a strategy's performance matches the manager's story about how the process

works. If the manager tells you, 'I am going to do X in this kind of environment,' and the performance doesn't back that up, you need to think hard about that mismatch.

What it then comes back to is the transparency of the investment process. How much transparency is there? Take that transparency, marry it with the performance results, and make sure that everything matches with what's being said.

#### **Alexandar Cherkezov**

There are also certain risks around over-fitting the data or over-prioritizing the strategy. In the due diligence process, ask questions that uncover how robust the strategy is. For example, if a parameter is 0.80, and we change it to 0.85 and the strategy collapses, that's a warning sign. So, try different parameterizations.

Also ask whether the team has data quality checks relating to accuracy and on-time availability. A smaller or less experienced team may not have the same level of data accuracy checks – but these quality controls are paramount for any data-driven strategy.

#### **Kenneth Blay**

What about trading cost considerations?

#### **Scott Hixon**

Trade execution costs have come way down. There are still pockets where things are expensive to trade, but those are small, niche asset markets. The trading function has become much more integrated with the overall management of the strategies.

#### **Alexandar Cherkezov**

Automation has really changed things. Where the manager once had to decide how much to trade, we now have systems that calculate precisely how much to trade. And it happens much faster. This also allows teams to manage multiple portfolios for many clients simultaneously. So systematic strategies are more scalable.

#### **Kenneth Blay**

How should investors think about incorporating systematic strategies into their existing portfolios?

#### **Alessio de Longis**

Assuming comparable risk-adjusted excess returns between systematic strategies and discretionary strategies, investors should look for low correlation and seek to diversify excess returns. After all, discretionary fundamental and systematic strategies follow diametrically opposed investment processes with different speeds of execution and different wavelengths in terms of investment horizons and repositioning. Ideally, introducing systematic strategies into a portfolio will be a matter of integration, not substitution.

But there are spaces where strict systematic strategies tend to perform better than discretionary strategies. These include large, liquid markets such as large-cap equities in the US and other developed markets.

We've researched the frequency and the percentage of benchmark outperformers, and the percentage of active manager success using a discretionary approach is much higher in small-caps, mid-caps, high-yield, and emerging markets – the less liquid, more idiosyncratic segments of the markets.

So, one approach to adoption of systematic investing could be to focus more due diligence on strategies in the more liquid, more efficient markets, where harvesting factors represents a larger percentage of performance and risk. In less efficient, more idiosyncratic markets, returns may be better captured by solid discretionary active management.

#### **Scott Hixon**

Remember that picking managers for tactical or active allocation is ultimately a zero-sum game. If you took all the participants and netted out their positions, you'd end up with no weight, because for every underweight there's an overweight.

Investors, therefore, have to consider the impact of over-diversification – when you over-diversify, you may lose expected alpha.

## **Artificial intelligence and the future of systematic investing** Human understanding, intelligent machines, and investing

#### **Kenneth Blay**

Technological advances figure large in the evolution of systematic investing. Today, the driving technology seems to be AI. How do you see AI impacting systematic investing?

#### **Scott Hixon**

I don't expect wide acceptance of AI-centered strategies by big institutional clients. There will always be a niche interest in black boxes based on machine learning, natural language processing, and so on. But the biggest application I see for AI is in indicator or factor selection, where it's already being applied to help understand what's important in the data, rather than to make the investment decision itself.

#### **Alexandar Cherkezov**

AI is forcing everybody to stay open-minded, to remain very adaptable, to learn and change quickly. It was not very long ago that Excel didn't exist. Then Excel was the tool for years. And now there are other programming languages that work with Excel. Today, we work with R and Python programming languages. You'll have to be able to change with whatever AI brings to systematic investing.

#### **Alessio de Longis**

I think the winners in the industry will be those who achieve better performance without excessive complication. Those who innovate well won't necessarily be those who add complicated math. What drives me every day when I parameterize

strategies is thinking about the trade-offs. I'm always very wary of over-inflated back tests. No matter what we produce on a spreadsheet, I discount it by at least a third, if not more, in formulating return expectations.

**Kenneth Blay**

There's also intense interest in how AI will change the people side of the man-machine divide. What kinds of investment professionals will thrive in an AI-driven world? What skills will be most important?

**Scott Hixon**

The best investors will be those with a good fundamental understanding of how markets work, and who can marry that understanding with quantitative-mathematic discipline. As

I said before, doing the math is the easy part. We need people who recognize that investing is not a physical science – it's a social science. And if you attack investing problems only in physical science terms, you're likely to get the wrong answer.

The hardest people to find are those who have programming experience and who also think about economics and social behavior. We'll continue to depend on investment teams who understand how people behave, and that it's not always rational.

**Kenneth Blay**

Thank you all for sharing your insights with us!



**References**

Markowitz, H. M. 1959. Portfolio Selection: Efficient Diversification of Investments, second ed. Malden, Massachusetts: Blackwell Publishers.



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