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Trend following is one of the best-known dynamic investment strategies. In simple terms, trend-following strategies measure the strength of price trends in different asset classes and take long and/or short positions in markets that are trending either up or down. The strategy is data-driven and typically implemented systematically with little-to-no discretion. The strategies tend to be risk-managed, with a focus on diversification and measuring risk across a long-short global portfolio. Despite its critics, it remains a popular method for investing in changing trends in global asset classes, particularly during times of stress. For the typical trend-following investor, events such as Black Friday (November 26, 2021), which was a big sell-off day for the strategy, remind us how, from time to time, just like with equity markets, we can experience extreme events. The magnitude of Black Friday inspired us to consider a quantitative method for measuring the amount of turbulence (or big moves in return) an investor may experience in a typical trend-following investment. We examine how often turbulence is high on both a daily and a monthly basis, and we use a novel method to classify which forces are driving turbulence: magnitude surprises or correlation surprises.

DEFINING TURBULENCE

Turbulence is defined as violent or unsteady movement. From an investment perspective, turbulence occurs when similar assets are behaving somewhat out of the ordinary. To define turbulence in trend-following returns more explicitly, we use the methodology described by Kinlaw and Turkington (2013). In their paper, they develop a simple method to measure the total amount of turbulence for a given period relative to expectations. Their measure also allows for the amount of turbulence to be decomposed into two forces: magnitude surprise and correlation surprise. Magnitude surprise is how much the overall magnitude of the surprise was out of the ordinary, and correlation surprise is how much the move was out of the ordinary relative to current prevailing correlations. Intuitively, magnitude surprise is similar to a large shock pushing returns in extreme directions, and correlation surprise is driven more by changing cross-asset relationships. For trend-following strategies, a magnitude surprise is an event that results in a large magnitude change in returns where most managers have a similar response, either positive or negative. Correlation surprise often occurs when managers that seem similar behave differently for a wide range of underlying reasons. By decomposing manager returns into magnitude and correlation surprise, we can examine what drives turbulence at both a daily and monthly frequency, which can help to classify extreme events.

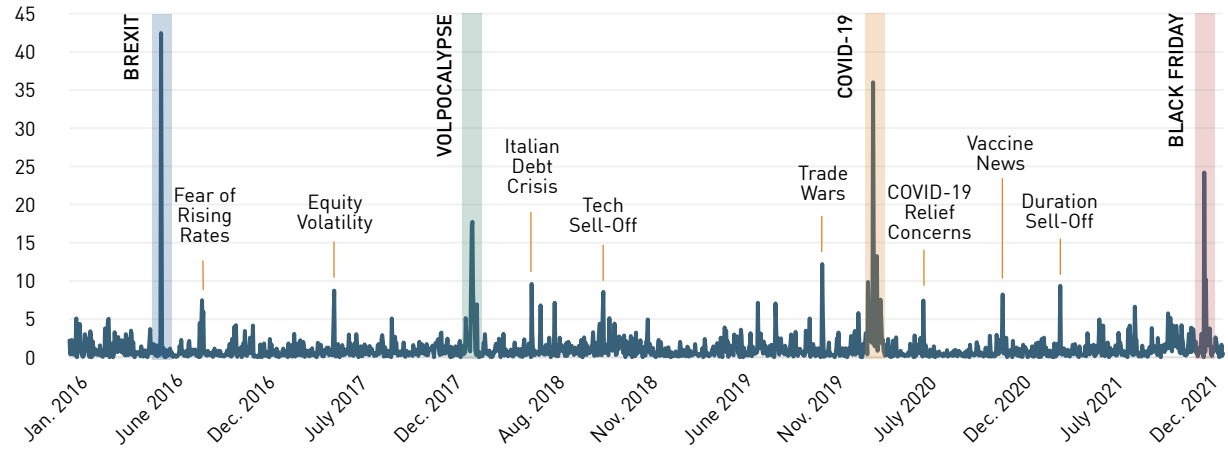
MEASURING TURBULENCE IN TREND FOLLOWING

Using returns from the five largest '40-Act managed futures managers from January 2015 to December 2021,[1] we measure the level of turbulence decomposed into magnitude surprise and correlation surprise using the method of Kinlaw and Turkington (2013), described above.[2] Figure 1 plots the turbulence in trend-following returns on a daily basis during this period. Over the five-year period, turbulence is relatively low, but a few dates were relatively or extremely turbulent, including Brexit, Volpocalypse, COVID-19, and Black Friday. To examine the rare events in more detail, table 1 lists the top 20 most-turbulent days for trend following during this period. For context, table 1 also includes a description, the level of turbulence, the percentile for magnitude surprise, the percentile for correlation surprise,[3] the corresponding global multi-asset market returns, and the return of the SG Trend Index for each of the 20 days. Focusing on the most-turbulent days for trend following, we can see that, for the most part, magnitude surprise is close to the 100th percentile, whereas correlation surprise varies from event to event. To show this relationship more clearly, figure 2 plots the percentile values for magnitude surprise and correlation surprise during the top 20 most-turbulent days for trend following. For example, Black Friday was in the 100th percentile for magnitude surprise but only the third percentile for correlation surprise over the entire five-year period of this study. This suggests that Black Friday was a shock or large magnitude shift across all managers. On the other hand, the COVID-19 Relief Concerns (June 11, 2020) recorded turbulence that was relatively high, with magnitude surprise in only the

Figure 1

MEASURED TURBULENCE IN TREND-FOLLOWING RETURNS (DAILY)

Daily values for turbulence in trend-following returns, January 2016–December 2021. To proxy trend-following investors, a set of the five largest managed futures '40-Act mutual funds with daily data are used to quantify the level of turbulence across these managers.



Source: Bloomberg, AlphaSimplex.

Table 1

TOP 20 MOST-TURBULENT DAYS FOR TREND FOLLOWING, JANUARY 2016–DECEMBER 2021

Date	Event	Turbulence	Magnitude Surprise (Percentile)	Correlation Surprise (Percentile)	MSCI World Index	JPM Bond Index	GSCI Index	U.S. Dollar Index	SG Trend Index
6/24/2016	Brexit	42.4	100%	52%	−4.9%	0.9%	−3.0%	2.1%	2.9%
3/9/2020	COVID-19 Pandemic	36.0	100%	32%	−7.2%	0.8%	−11.7%	−1.1%	0.7%
11/26/2021	Black Friday / Omicron	24.2	100%	3%	−2.2%	0.8%	−7.1%	−0.7%	−4.4%
2/6/2018	Volpocalypse	17.8	95%	89%	−0.2%	0.2%	−0.9%	0.0%	−1.8%
2/5/2018	Volpocalypse	17.3	100%	4%	−3.1%	0.1%	−1.1%	0.4%	−4.1%
3/16/2020	COVID-19 Pandemic	13.2	99%	41%	−9.5%	0.2%	−6.5%	−0.7%	0.8%
12/2/2019	Trade Wars	12.2	99%	47%	−0.7%	−0.5%	0.4%	−0.4%	−2.2%
3/12/2020	COVID-19 Pandemic	11.4	96%	64%	−9.9%	−0.7%	−4.4%	1.0%	−0.8%
11/30/2021	Omicron Outbreak	10.2	99%	39%	−1.7%	0.4%	−3.7%	−0.4%	−2.1%
2/27/2020	COVID-19 Pandemic	9.9	98%	51%	−3.6%	0.1%	−2.2%	−0.5%	−1.8%
5/29/2018	Italian Debt Crisis	9.6	97%	51%	−1.1%	0.3%	−1.0%	0.4%	−2.1%
2/26/2021	Duration Sell-Off	9.4	100%	20%	−1.2%	0.3%	−2.4%	0.8%	−2.6%
3/13/2020	COVID-19 Pandemic	9.2	97%	54%	5.9%	−0.9%	−0.7%	1.3%	−0.9%
5/18/2017	Equity Volatility	8.7	90%	79%	−0.1%	0.1%	−0.1%	0.3%	−0.5%
10/11/2018	Tech Sell-Off	8.6	100%	11%	−2.1%	0.3%	−1.9%	−0.5%	−3.7%
2/07/2018	Volpocalypse	8.2	98%	43%	0.1%	−0.2%	−1.7%	0.7%	−1.4%
11/09/2020	Vaccine News	8.2	99%	19%	1.3%	−0.7%	3.1%	0.5%	−2.7%
3/23/2020	COVID-19 Pandemic	7.6	97%	47%	−3.0%	0.8%	0.8%	−0.3%	0.7%
9/9/2016	Fear of Rising Rates	7.5	99%	22%	−2.1%	−0.5%	−2.1%	0.3%	−3.0%
6/11/2020	COVID-19 Relief Concerns	7.4	79%	94%	−5.0%	0.6%	−4.0%	0.8%	0.3%

Top 20 most-turbulent days for trend following, January 2016-December 2021. For comparison, the returns for equities (MSCI World Index), bonds (JPM Bond Index), currencies (U.S. Dollar Index), and commodities (GSCI Index) are provided along with the SG Trend Index.

79th percentile but correlation surprise in the 94th percentile relative to the same five-year period. This daily event would be characterized by unexpected dispersion across managers with a moderate shock in returns.

TROUBLE IN TURBULENCE

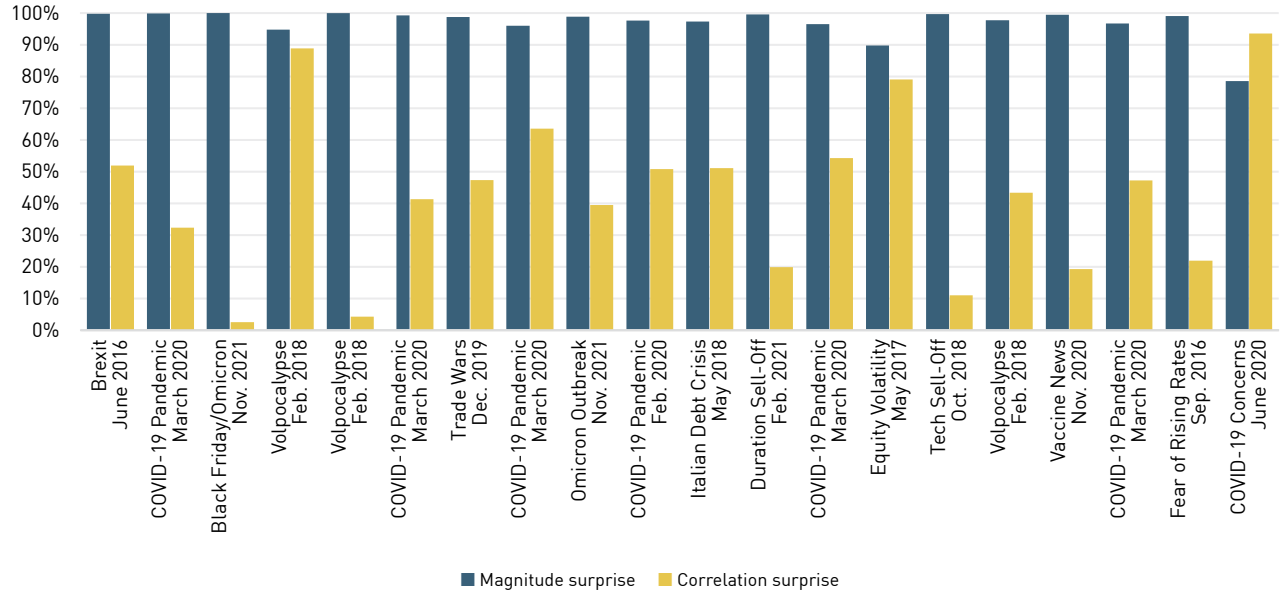
As seen in figure 1, turbulence in trend-following returns is relatively low, except in extreme scenarios. These events happen rarely and they generally do not persist on a daily basis for very long.

From table 1, we can see that the COVID-19 drawdown period has six turbulent days over the course of five weeks and Volpocalypse has three consecutive days (February 5–7, 2018). From table 1, most-turbulent days are

Figure 2

MAGNITUDE AND CORRELATION SURPRISE PERCENTILES (DAILY)

Percentile values for magnitude and correlation surprise during top 20 most-turbulent days for trend following, January 2016–December 2021.

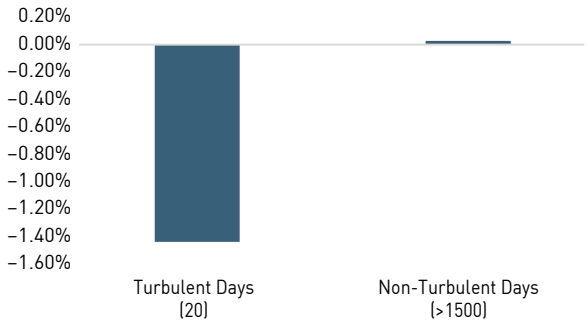


Source: Bloomberg, AlphaSimplex.

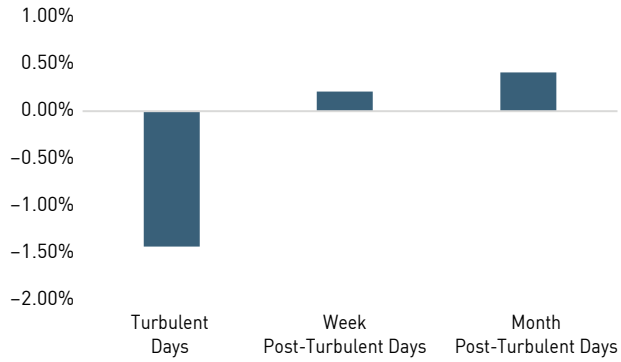
Figure 3

TROUBLE IN TURBULENCE

(A) Average daily returns on turbulent and non-turbulent days



(B) After the storm: Average returns after turbulent days



3A: Average return for trend following on the 20 most-turbulent days and on non-turbulent days (i.e., excluding the 20 most-turbulent days). Source: Bloomberg, AlphaSimplex.

3B: Average return on the 20 most-turbulent days versus the average return of the following week and the following month. Source: Bloomberg, AlphaSimplex.

difficult for trend following as seen from SG Trend Index returns in the final column. One simple question investors may consider is what happens after a turbulent day for trend following. To examine this, figure 3A plots the average daily return during turbulent days versus non-turbulent days. Figure 3B plots the average returns of the following week and the following month. Figure 3A shows that turbulent days, although rare, are difficult for trend-following returns, whereas returns on non-turbulent days have been positive on average. Figure 3B shows that, despite some overlap in these days, especially for COVID-19 and Volpocalypse, future returns tend to be positive despite the negative shock of a turbulent event. To summarize, turbulent days happen rarely and they are predominately magnitude surprises. When extreme turbulence occurs, it tends to be negative for trend following, but this turbulence does not tend to persist and subsequent performance has tended to be positive after extreme events.

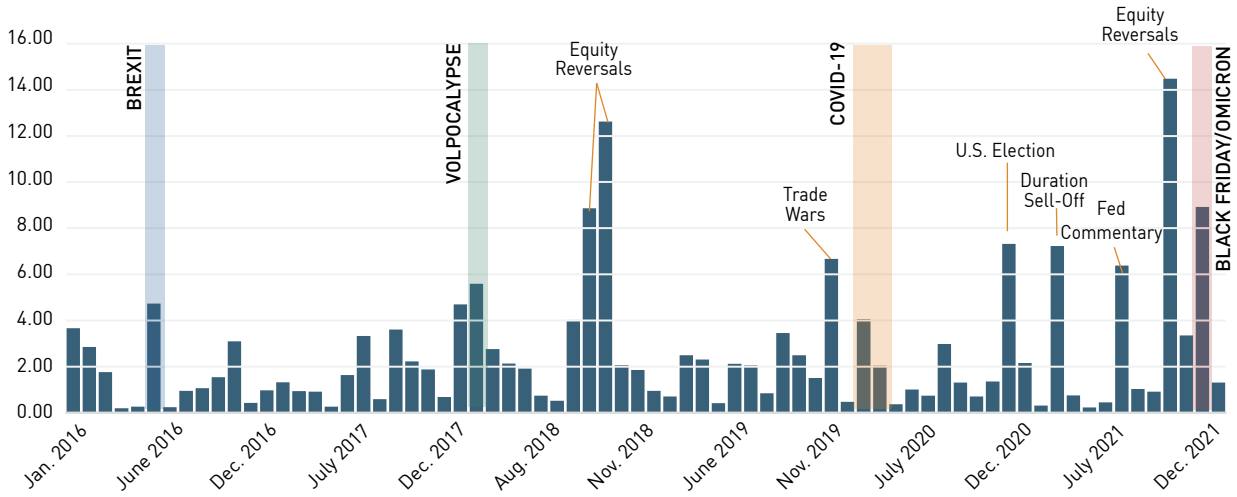
RETURN DISPERSION AND CORRELATION SURPRISE IN MONTHLY RETURNS

The previous sections examined turbulence from a daily perspective. For longer-term investors, turbulence at a slower frequency also can help to give insights into portfolio-level effects and the impact of diversification. To examine

Figure 4

MEASURED TURBULENCE IN TREND FOLLOWING (MONTHLY)

Measured turbulence in trend following on a monthly basis.



Source: Bloomberg, AlphaSimplex.

Table 2

TOP 10 TURBULENT MONTHS FOR TREND FOLLOWING, JANUARY 2016–DECEMBER 2021

Month	Description	Level of Turbulence	Magnitude Surprise (Percentile)	Correlation Surprise (Percentile)	MSCI World Index	JPM Bond Index	GSCI Index	U.S. Dollar Index	SG Trend Index	Average Intramonth Pairwise Correlation
Sep. 2021	Equity Reversal	14.29	63%	93%	−4.2%	−1.2%	6.0%	1.7%	1.8%	63%
Oct. 2018	Equity Reversal	12.46	65%	90%	−7.3%	0.0%	−5.8%	2.1%	−4.3%	81%
Nov. 2021	Black Friday/Omicron	8.80	100%	11%	−2.2%	1.1%	−10.8%	2.0%	−4.7%	87%
Sep. 2018	Equity Reversal	8.75	51%	89%	0.6%	−0.5%	3.9%	0.0%	−1.0%	85%
Nov. 2020	U.S. Election	7.22	79%	72%	12.8%	0.2%	12.0%	−2.3%	1.2%	85%
Feb. 2021	Duration Sell-Off	7.13	77%	73%	2.6%	−2.2%	10.6%	0.3%	3.6%	92%
Dec.2019	Trade Wars	6.58	34%	99%	3.0%	−0.6%	7.0%	−1.9%	−0.6%	75%
June 2021	Fed Commentary	6.30	76%	66%	1.5%	0.6%	4.3%	2.9%	−2.2%	90%
Feb. 2018	Volpocalypse	5.52	99%	6%	−4.1%	0.0%	−3.3%	1.7%	−9.0%	91%
June 2016	Brexit	4.66	83%	56%	−1.1%	2.5%	0.1%	0.3%	5.4%	82%

Top 10 turbulent months for trend following, January 2016–December 2021. For comparison, the returns for equities (MSCI World Index), bonds (JPM Bond Index), currencies (U.S. Dollar Index), and commodities (GSCI Index) are provided along with the SG Trend Index. Average Intramonth Pairwise Correlation refers to the average of the daily return correlations for each pair of managers in a given month.

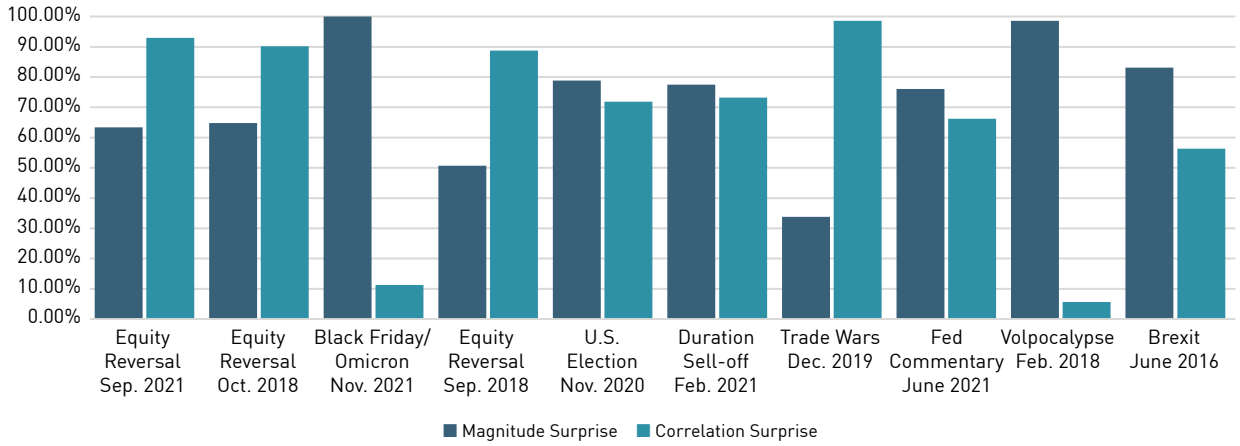
this, we repeat the same study for monthly trend-following data, again using the returns of the five largest '40-Act managed futures mutual funds from January 2015 to December 2021. Figure 4 plots the measured turbulence in monthly trend-following returns from January 2016 to December 2021. From figure 4, we can see that turbulence is also relatively low with the exception of some rare but perhaps less equity-specific events. To examine turbulence in monthly trend-following returns, table 2 lists the top 10 most-turbulent months from January 2016 to December 2021.

Given the high daily turbulence during the COVID-19 market drawdown, shown in figure 1, it is interesting to note that neither February nor March 2020 was a particularly turbulent month for trend following despite the daily moves during this crisis. Instead, certain months, such as September 2021 or October 2018, proved to have the highest trend-following turbulence on a monthly basis. The percentile values for magnitude surprise are lower than correlation surprise during these two high-turbulence months, which suggests that correlations played a bigger role in turbulence at a monthly frequency across different managers. To present this more clearly, figure 5 shows the percentile values for magnitude and correlation surprise during the top 10 turbulent months from January 2016 to December 2021. From figure 5, especially when compared with figure 2, we can see that correlation surprise plays a bigger role on a monthly basis, suggesting that large deviations may be driven more by differences across managers during changing macro environments instead of market shocks. Still, certain periods with magnitude surprise register

Figure 5

MAGNITUDE AND CORRELATION SURPRISE PERCENTILES (MONTHLY)

Percentile values for magnitude and correlation surprise for the top 10 turbulent months for trend following.

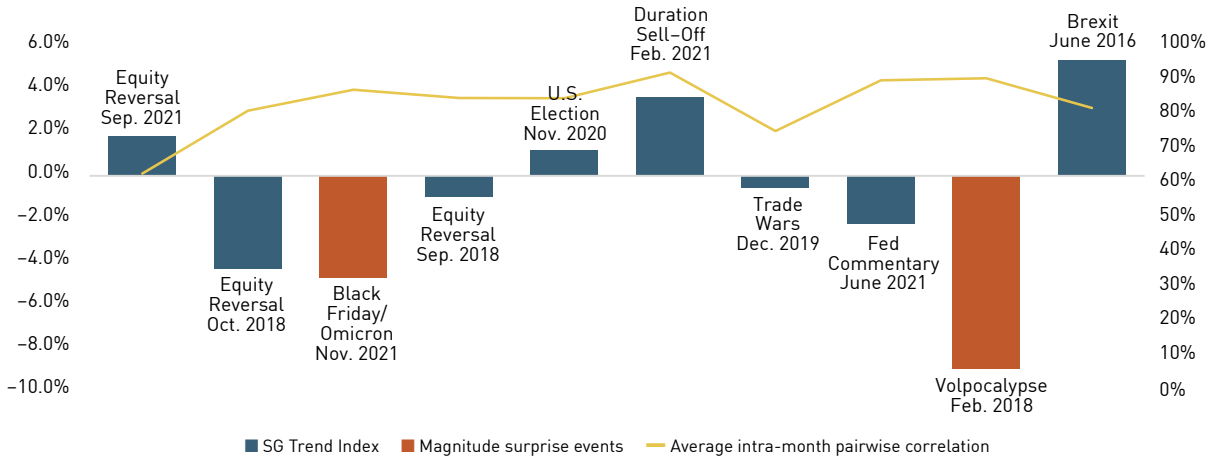


Source: Bloomberg, AlphaSimplex.

Figure 6

TREND PERFORMANCE DURING TURBULENT MONTHS

Trend returns during the top 10 most-turbulent months for trend following versus average intra-month pairwise correlation. Events that have predominantly magnitude surprise are highlighted in orange.



Source: Bloomberg, AlphaSimplex.

high on turbulence. For example, Black Friday and Volpocalypse are both predominately magnitude surprises, but the remaining high turbulence months exhibit substantial correlation surprise. This finding reiterates the importance of portfolio diversification during high return dispersion periods, similar to the findings of Kaminski and Yang (2020).

TURBULENCE AND RETURN DISPERSION

As shown in figure 5, of the 10 months with the most turbulence, two are dominated by magnitude surprise and the other eight more often are dominated by correlation surprise. A simple question could be: How does trend following perform during these high turbulence months? Figure 6 plots the SG Trend returns during the top 10 most-turbulent months where the two magnitude surprise events—Black Friday and Volpocalypse—are shown in orange. Figure 6 also shows the average intra-month pairwise correlation across managers. Figure 5 shows that, just as with daily magnitude surprise, monthly magnitude surprise seems to be difficult for trend performance because periods with high magnitude surprise tend to have negative performance. On the other hand, when turbulence is more concentrated on correlation surprise the results are mixed, with some high turbulent months being very positive, e.g., Brexit (June 2016) and Duration Sell-Off (February 2021). Note that for certain months during this period, average pairwise correlation, which is usually around 90–95 percent, dips as low as 60–80 percent, which demonstrates the

impact of correlation surprise. From the portfolio perspective, these events are periods with higher-than-usual return dispersion, which highlights the importance of diversification across a portfolio of trend-following strategies, especially during periods of return dispersion (see Kaminski and Yang 2020).

TACKLING TURBULENCE IN TREND FOLLOWING

Investments occasionally experience sudden violent or unsteady movements. In this article, we use a quantitative method proposed in Kinlaw and Turkington (2013) that allows us to measure the level of turbulence in returns. This method also allows us to decompose turbulence into two core drivers: magnitude surprise and correlation surprise. Given this approach, we examine turbulence in trend-following returns on both a daily and monthly basis. On a daily basis, we find that there are occasionally extremely turbulent days in trend-following returns and these days often are driven by magnitude surprises. Not only are these extreme days rare but they are also very negative for trend following; however, they do not persist and they often are followed by positive trend-following returns in the following week or month. This highlights the episodic nature of market shocks, which unfortunately plague all investments—equities and trend-following alike. On a positive note, these events are transitory in nature and they tend not to persist. From a monthly perspective, turbulence events dominated by magnitude surprise tend to be extreme and rare; monthly turbulence is often dominated by correlation surprise. On high-turbulence days, when the main driver is correlation surprise, there may be lower average pairwise correlations and mixed returns across managers. These results highlight the importance of occasional periods of return dispersion in trend-following returns despite the high correlations over long periods, as discussed in Kaminski and Yang (2020).

From a portfolio perspective, correlation surprises can lead to dispersion and point to the importance of diversification in the trend-following space.

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ENDNOTES

1. We use a one-year window for estimation.
2. The methodology used for measuring turbulence as well as decomposing turbulence into magnitude and correlation surprise is detailed in the appendix.
3. For comparability, we list percentiles for magnitude and correlation surprise over the entire time horizon. This is necessary because their scales are not directly comparable. The percentile gives a sense of how extreme the value is relative to the overall history of this study.

REFERENCES

Kaminski, Kathryn, and Ying Yang. 2020. Managed Futures Return Dispersion: A Review. *AlphaSimplex Insights*. https://www.alphasimplex.com/insight/managed-futures-return-dispersion-a-review/.

Kinlaw, Will, and David Turkington. 2013. Correlation Surprise. *Journal of Asset Management* 14, 385–399. https://doi.org/10.1057/jam.2013.27.

APPENDIX

Using the method from Kinlaw and Turkington (2013), we measure the level of turbulence decomposed into magnitude surprise and correlation surprise.

Turbulence is defined as Mahalanobis distance divided by the number of assets:

$$Turbulance_t = (r_t - \mu)\ '\Sigma^{-1}(r_t - \mu)/n,$$

where r_t is the vector of asset returns for period t, μ is the sample average vector of historical returns, Σ is the sample covariance matrix of historical returns, and n is the number of assets.

Magnitude surprise is defined as the "correlation-blind" turbulence score. The formula is the same as turbulence's except that all off-diagonal terms in the covariance matrix Σ are set to 0.

Correlation surprise is the ratio of turbulence to magnitude surprise:

$$Correlation\ Surprise_t = \frac{Turbulance_t}{Magnitude\ Surprise_t}$$

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