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# Quantifying Turbulence in Trend Following

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## Introduction

Trend following is one of the most well-known dynamic investment strategies. Despite its critics, it still remains a popular method for following changing trends in global asset classes, particularly during times of stress. For the typical trend-following investor, events like Black Friday (11/26/2021) remind us how from time to time, just like with equity markets, we can experience more extreme events. The magnitude of this day inspired us to consider a quantitative method for measuring the amount of turbulence an investor may experience with trend following. We examine how often turbulence is high on both a daily and monthly basis and use a novel method to classify what forces are driving turbulence: magnitude surprises or correlation surprises.

## Defining Turbulence

**Turbulence** is defined as *violent or unsteady movement*. From an investment perspective, turbulence is a moment where similar assets are behaving somewhat out of the ordinary. To define turbulence in trend following returns more explicitly, we utilize 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: correlation surprise and magnitude surprise. Correlation surprise is how much the move was out of the ordinary relative to current prevailing correlations; magnitude surprise is how much the overall magnitude of the surprise was out of the ordinary. Intuitively, magnitude surprise is similar to a large shock pushing returns in extreme directions. Correlation surprise is driven more by changing cross-asset relationships. For trend-following strategies, a magnitude surprise is an event that results in large magnitude of 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 these two forces, 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,<sup>1</sup> we measure the level of turbulence decomposed into magnitude surprise and correlation surprise using the method from Kinlaw and Turkington described above.<sup>2</sup> 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 not surprisingly a few rare extreme

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<sup>1</sup> We use a one-year window for estimation.

<sup>2</sup> The methodology utilized for measuring turbulence as well as decomposing turbulence into magnitude and correlation surprise is detailed in the Appendix.

dates stick out: 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, the table also includes a description, the level of turbulence, the percentile for magnitude surprise, the percentile for correlation surprise<sup>3</sup> as well as the corresponding global multi-asset market returns, and the return of the SG Trend Index. Focusing in on the largest 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 see 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 whereas correlation surprise was very low, at the 3rd percentile. This suggests that this event was more of a shock or large magnitude shift across all managers. On the other hand, if we examine an event like the COVID-19 Relief Concerns (6/11/2020), we see turbulence was relatively high, while correlation surprise was in the 94th percentile and magnitude surprise was only in the 79th percentile. This daily event would be characterized by unexpected dispersion across managers with a moderate shock in returns.

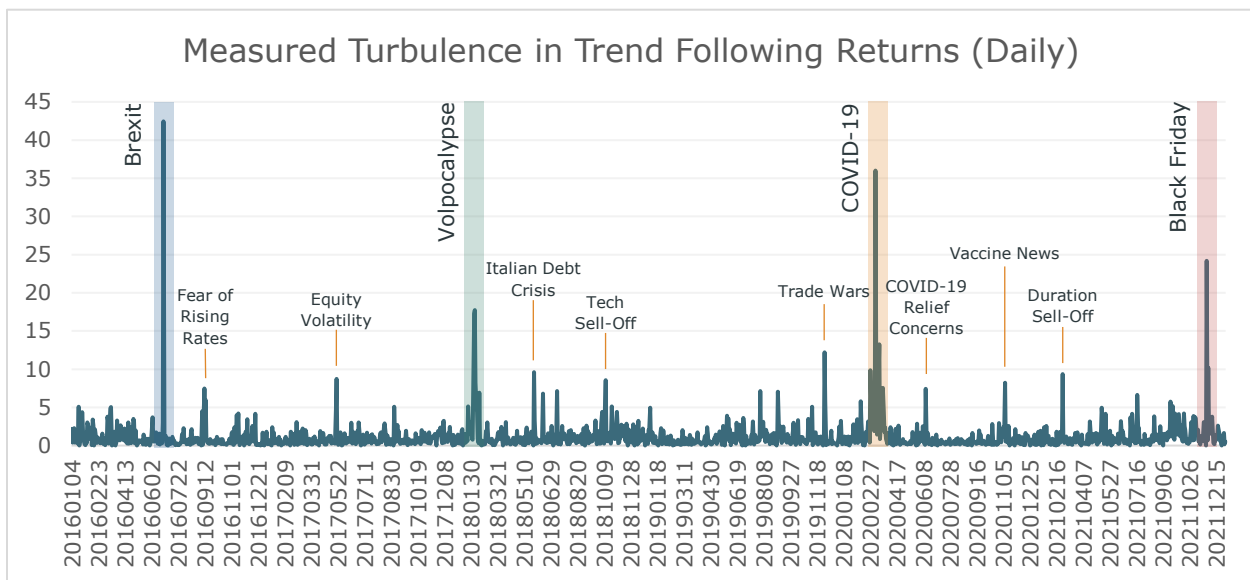


Figure 1: Daily values for turbulence in trend following returns from January 2016 to December 2021. To proxy trend-following investors, a set of the five largest Managed Futures '40-Act Mutual Funds with daily data are used to quantify the level of turbulence across these managers. Source: Bloomberg, AlphaSimplex.

<sup>3</sup> For comparability, we list percentiles for magnitude and correlation surprise over the entire time horizon. This is necessary since 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.

Date	Event	Turbulence	Magnitude Surprise (Percentile)	Correlation Surprise (Percentile)	MSCI World Index	JPM Bond Index	GSCI Index	U.S. Dollar Index	SG Trend Index
20160624	Brexit	42.4	100%	52%	-4.9%	0.9%	-3.0%	2.1%	2.9%
20200309	COVID-19 Pandemic	36.0	100%	32%	-7.2%	0.8%	-11.7%	-1.1%	0.7%
20211126	Black Friday / Omicron	24.2	100%	3%	-2.2%	0.8%	-7.1%	-0.7%	-4.4%
20180206	Volpocalypse	17.8	95%	89%	-0.2%	0.2%	-0.9%	0.0%	-1.8%
20180205	Volpocalypse	17.3	100%	4%	-3.1%	0.1%	-1.1%	0.4%	-4.1%
20200316	COVID-19 Pandemic	13.2	99%	41%	-9.5%	0.2%	-6.5%	-0.7%	0.8%
20191202	Trade Wars	12.2	99%	47%	-0.7%	-0.5%	0.4%	-0.4%	-2.2%
20200312	COVID-19 Pandemic	11.4	96%	64%	-9.9%	-0.7%	-4.4%	1.0%	-0.8%
20211130	Omicron Outbreak	10.2	99%	39%	-1.7%	0.4%	-3.7%	-0.4%	-2.1%
20200227	COVID-19 Pandemic	9.9	98%	51%	-3.6%	0.1%	-2.2%	-0.5%	-1.8%
20180529	Italian Debt Crisis	9.6	97%	51%	-1.1%	0.3%	-1.0%	0.4%	-2.1%
20210226	Duration Sell-off	9.4	100%	20%	-1.2%	0.3%	-2.4%	0.8%	-2.6%
20200313	COVID-19 Pandemic	9.2	97%	54%	5.9%	-0.9%	-0.7%	1.3%	-0.9%
20170518	Equity Volatility	8.7	90%	79%	-0.1%	0.1%	-0.1%	0.3%	-0.5%
20181011	Tech Sell-off	8.6	100%	11%	-2.1%	0.3%	-1.9%	-0.5%	-3.7%
20180207	Volpocalypse	8.2	98%	43%	0.1%	-0.2%	-1.7%	0.7%	-1.4%
20201109	Vaccine News	8.2	99%	19%	1.3%	-0.7%	3.1%	0.5%	-2.7%
20200323	COVID-19 Pandemic	7.6	97%	47%	-3.0%	0.8%	0.8%	-0.3%	0.7%
20160909	Fear of Rising Rates	7.5	99%	22%	-2.1%	-0.5%	-2.1%	0.3%	-3.0%
20200611	COVID-19 Relief Concerns	7.4	79%	94%	-5.0%	0.6%	-4.0%	0.8%	0.3%

Table 1: Top 20 most turbulent days for trend following from January 2016 to 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.

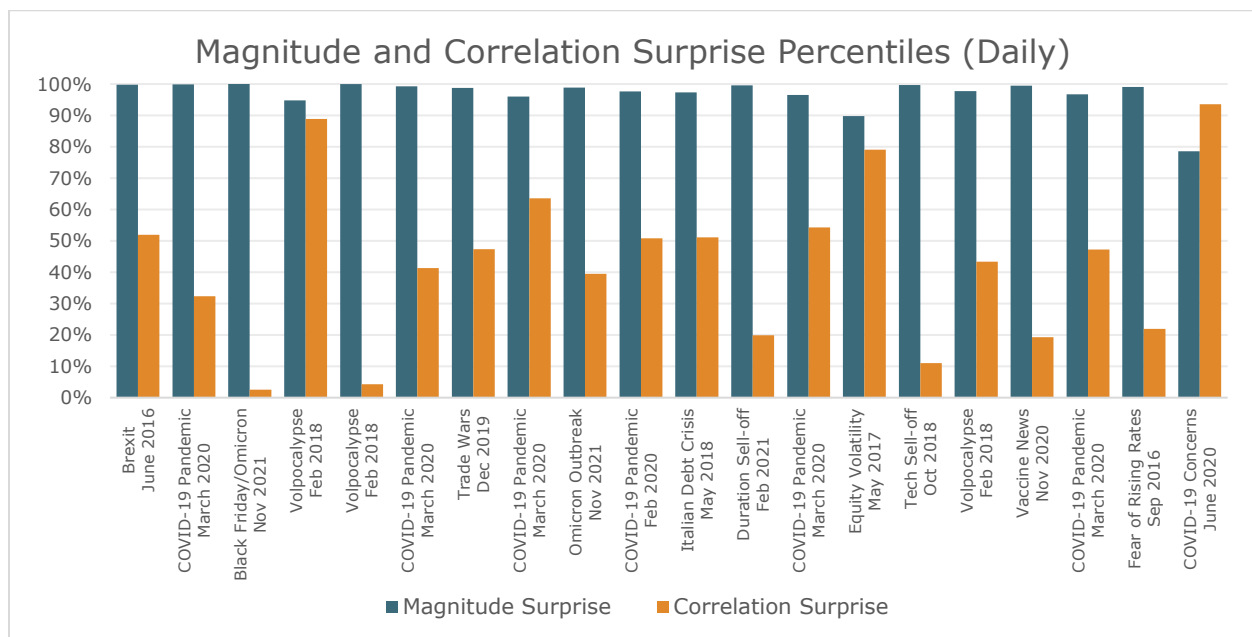


Figure 2: Percentile values for magnitude and correlation surprise during top 20 most turbulent days for trend following from January 2016 to December 2021. Source: Bloomberg, AlphaSimplex.

## 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 do not generally 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 (2/5/2018, 2/6/2018, 2/7/2018). From Table 1, most turbulent days are 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 on non-turbulence days. Figure 3b plots the average returns of the following week and the following month. From Figure 3a we can see that turbulent days, although rare, are difficult for trend following returns, whereas returns on non-turbulent days have been positive on average. From Figure 3b we can see 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 the consecutive performance has tended to be positive after extreme events.

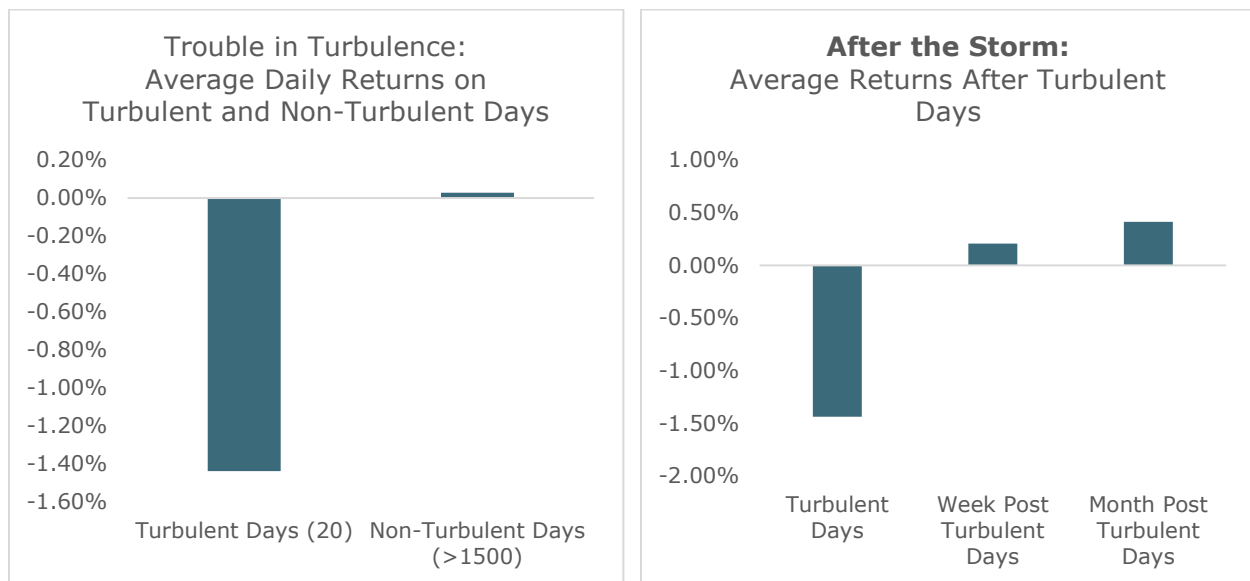


Figure 3a: Average return for trend following on the 20 most turbulent days and on non-turbulent days (i.e., excluding the 20 most turbulent days). Source: Bloomberg, AlphaSimplex.

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

## 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 can also help to give insights into portfolio level effects and the impact of diversification. To examine 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 this figure, 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 ten most turbulent months from January 2016 to December 2021.

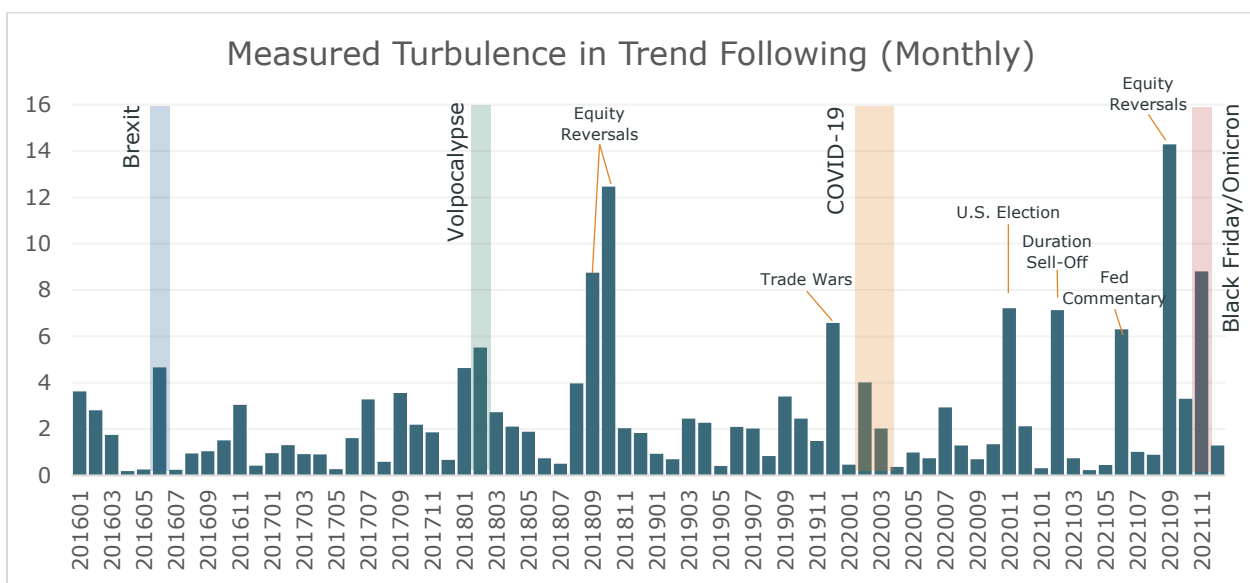


Figure 4: Measured turbulence in trend following on a monthly basis. Source: Bloomberg, AlphaSimplex.

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%

Table 2: Top ten turbulent months for trend following from January 2016 to 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.

Given the high daily turbulence during the COVID-19 market drawdown seen in Figure 1, it is interesting to note that neither February nor March of 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 correlation surprise are higher than magnitude 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 plots the percentile values for correlation and magnitude surprise during the top ten turbulent months from January 2016 to December 2021. From this figure, especially when compared with Figure 2, we can see that correlation surprise plays a bigger role on the monthly basis and periods where we see large deviations may be more driven by differences across managers during changing macro environments instead of market shocks. Still certain periods with magnitude surprise register high on turbulence. For example, Black Friday and Volpocalypse are both predominately magnitude surprises, while the remaining other high turbulence months exhibit substantial correlation surprise. This finding reiterates the importance of diversification from a portfolio perspective during high return dispersion periods, similar to the findings of Kaminski and Yang (2020).

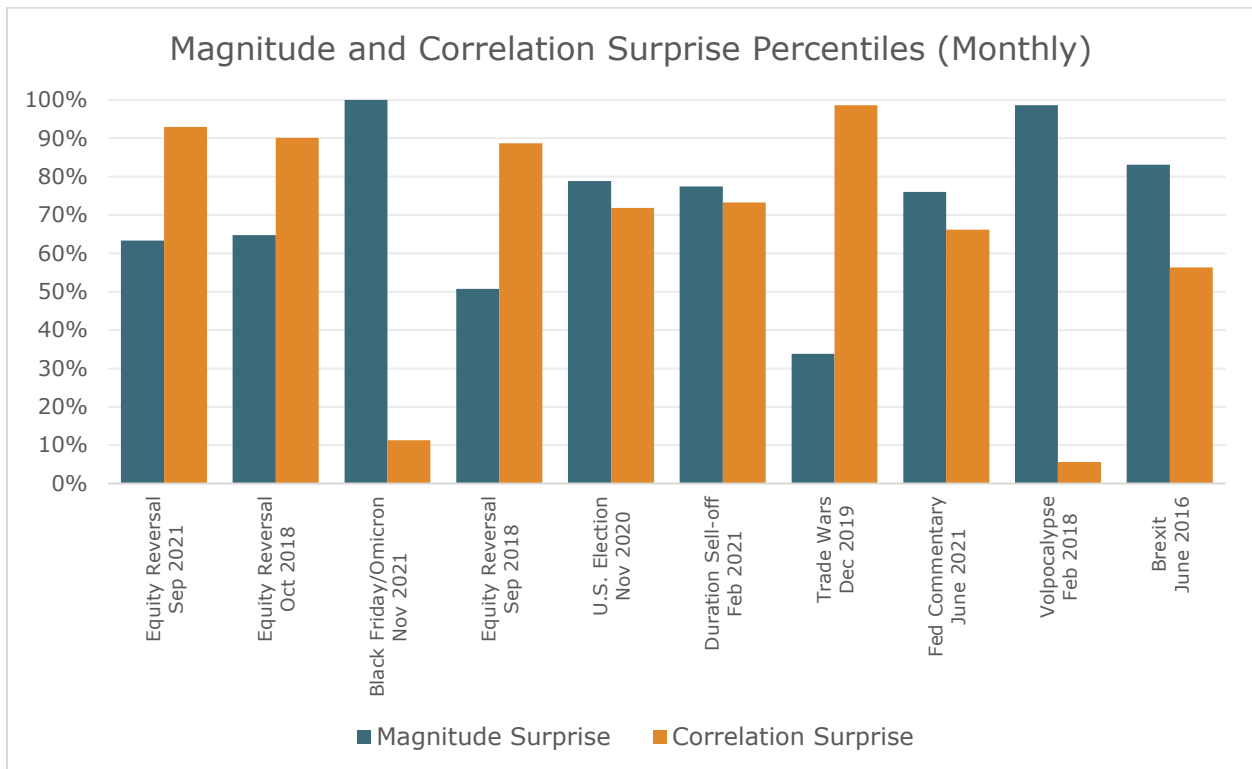


Figure 5: Percentile values for magnitude and correlation surprise for the top ten turbulent months for trend following. Source: Bloomberg, AlphaSimplex.

## Turbulence and Return Dispersion

From Figure 5, of the ten biggest turbulence months, two are dominated by magnitude surprise while the other eight are more often 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 ten most turbulent months where the two magnitude surprise events are highlighted in blue (Black Friday and Volpocalypse) compared with the average intra-month pairwise correlation across managers. From this graph, just as with daily magnitude surprise, even on a monthly basis magnitude surprise seems to be difficult for trend 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 (Brexit 6/2016, Duration Sell-off 2/2021). Note that for certain months during this period average pairwise correlation, which is usually around 90-95%, dips as low as 60-80%, 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.<sup>4</sup>

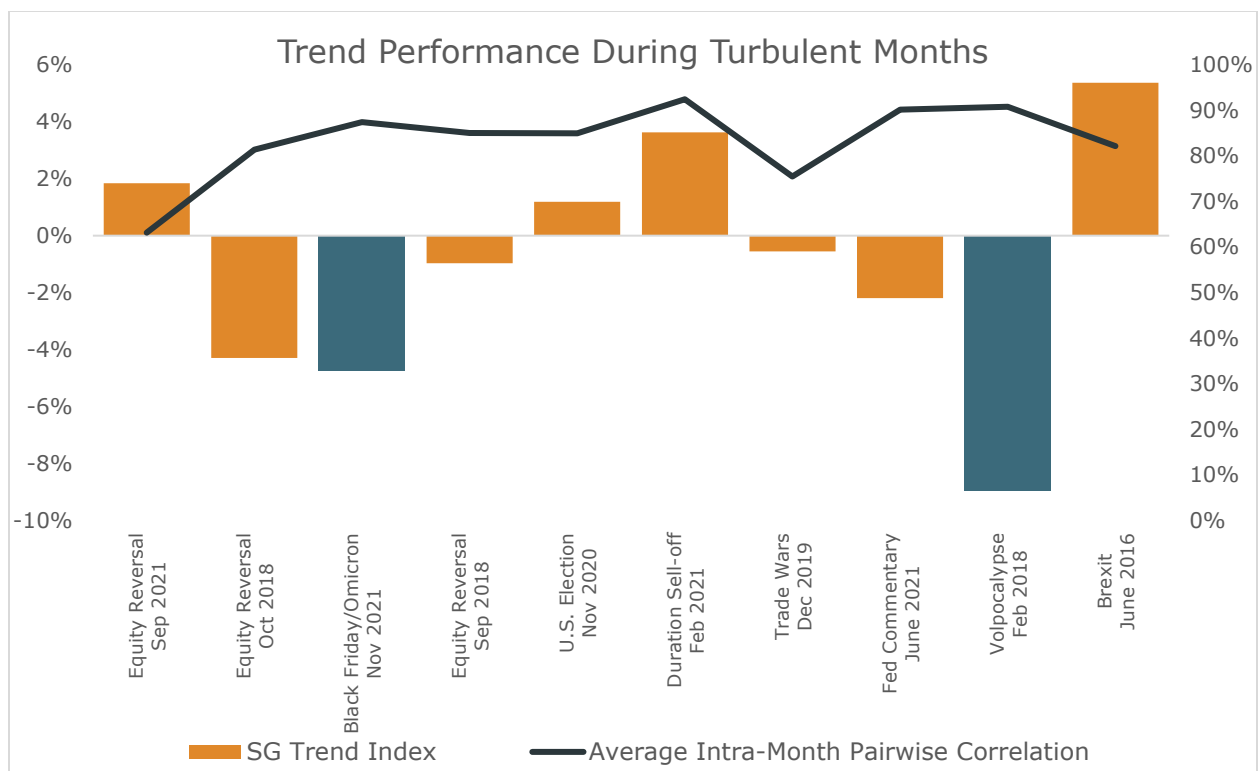


Figure 6: Trend returns during the top ten most turbulent months for trend following versus average intra-month pairwise correlation. Events that have predominantly magnitude surprise are highlighted in blue. Source: Bloomberg, AlphaSimplex.

<sup>4</sup> See Kaminski and Yang (2020).



## Tackling Turbulence in Trend Following

Investments occasionally experience sudden violent or unsteady movements. In this paper, 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 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 are often 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 are often 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 the positive note, these events are transitory in nature and they tend not to persist. From a monthly perspective, turbulence is often dominated by correlation surprise with the exception of highly extreme magnitude surprises. 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.

## 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:

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

where  $r_t$  is the vector of asset returns for period  $t$ ,  $\mu$  is the sample average vector of historical returns,  $\Sigma$  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  $\Sigma$  are set to 0.

Correlation surprise is the ratio of turbulence to magnitude surprise:

$$Correlation Surprise_t = \frac{Turbulence_t}{Magnitude Surprise_t}.$$

### 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>.

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