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# The Realities of Realizing Risk

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## Introduction

Quantitative investing starts and ends with risk. We measure it, we study it, we forecast it, we monitor it, and we use highly technical tools to manage it. Risk can be defined as a situation where things do not end up as you expect. In practice, risk is not constant. It varies over time as things change and it contains a component of uncertainty (or things that are unknown to us). For example, few investors could have known prior to February 2020 that the COVID-19 crisis would occur (an unknown unknown). On the other hand, volatility and correlations are much more consistent and somewhat predictable over time.

## Post-COVID-19: Realizing Less, Wanting More

Looking back during the first half of 2021, we began to notice some interesting patterns in realized risk over recent periods. Since June 2020, realized risk has been much lower than might have been expected given the volatility in March and April 2020. In this note, we consider a simple representative trend-following system that takes time-varying positions across four asset classes (equity index futures, fixed income futures, currency futures and forward contracts, and commodity futures). For simplicity, we target this strategy at 10% volatility using a 3-month estimation window for volatility and correlation.

Figure 1 plots targeted volatility (also called *ex ante volatility*) and realized volatility (*ex post volatility*) for this simple 10% volatility (annualized) trend-following strategy from January 2020 to June 2021. For perspective, Figure 1 also includes the realized risk for a 60/40 portfolio<sup>1</sup> (in orange) to demonstrate the magnitude of this volatility. Overall, realized risk was persistently lower and more consistent for trend following than for a traditional 60/40 portfolio. There were certain months (like March 2020, April 2020, and September 2020) where realized risk was drastically lower for the trend-following strategy; conversely, in August 2020 and June 2021, realized risk for the traditional portfolio was lower than the realized risk in trend following. The traditional 60/40 portfolio had large swings in realized volatility over this period, from 5% (December 2020) to 43% (March 2020). The trend-following strategy had a range of volatility much closer to its target (from 4% to 16%); its volatility has been consistently lower than its target since the volatility spike in March 2020.

We began to wonder what was driving this difference. To examine this further, we go back to basics in this note and decompose realized risk into several key components based on market relationships such as volatility and correlation as well as trading effects from a dynamic time-varying strategy.

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<sup>1</sup> In this example, the 60/40 portfolio is a notionally-funded portfolio that is rebalanced quarterly without explicit risk targeting. This is included to provide a benchmark for the magnitude of relative changes in risk during the same period.

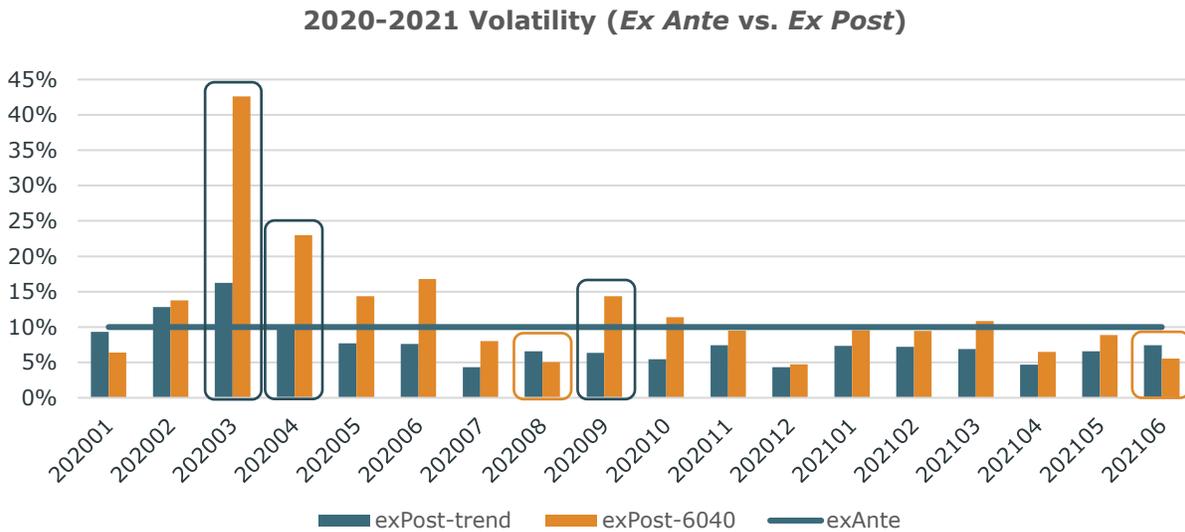


Figure 1: Realized risk (*ex post*) for a 60/40 portfolio and a simple representative trend-following strategy with a 10% volatility target (*ex ante* risk) from January 2020 to June 2021. Source: AlphaSimplex, Bloomberg.

## The Realities of Realized Risk

Let's consider two time periods:  $t_0$  and  $t_1$ , where  $t_0$  is the beginning of a month and  $t_1$  is the end of a month. For a dynamic strategy like trend following, we expect the weights, volatility, and correlation between assets to change from month start to month end. Targeted risk is the amount of risk measured at the beginning of a month with the initial weights, initial correlation, and initial volatility estimation. Realized risk for each month is the amount of realized volatility measured at the end of each month. By decoupling the impact of each of these changing factors we can decompose the difference between targeted risk and realized risk into four key components: (1) volatility surprise; (2) correlation surprise; (3) interaction effects between correlation and volatility;<sup>2</sup> and (4) trading effects based on changing assets weights.

<sup>2</sup> For clarification, interaction effects take into account the non-linear relationship between correlation and volatility. These effects do not have an intuitive meaning but they are second order and must be included to decompose the total impact of changing correlations, volatility, and portfolio weights. In general these effects are small in magnitude and are thus left out of the discussion in this paper.

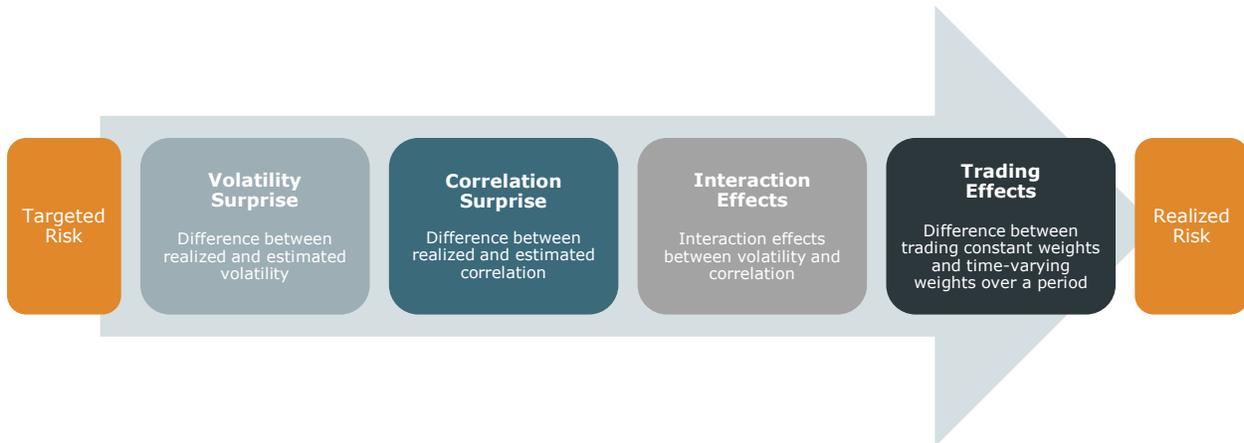


Figure 2: A schematic description of the difference between targeted risk and realized risk based on volatility surprise, correlation surprise, interaction effects, and trading effects.

To demonstrate these effects we can plot them graphically using a waterfall chart.<sup>3</sup> We consider some key months in recent history to visualize this decomposition. Figure 3 plots this decomposition during the start of the COVID-19 Crisis (March 2020) and after the U.S. election and positive vaccine news (December 2020). For further examples, Figure 4 plots a very low-volatility month for trend following (April 2021) and the most recent month in this analysis (June 2021).



Figure 3: Realized risk decomposition for a simple trend-following strategy with a 10% volatility target for March 2020 and December 2020. Source: AlphaSimplex, Bloomberg.

In Figure 3, we examine the start of the COVID-19 crisis (March 2020) and a month that had very low realized risk (December 2020). In March 2020, we can see that for trend following the volatility surprise was large, but the correlation surprise over the month was negative.

<sup>3</sup> Steiner (2013) presents the decomposition with more detail on the mathematical specification for this analysis.

The negative correlation surprise reduced the effects of the volatility surprise; the interaction between the two also dampened the overall realized risk. Consistent with a medium-term strategy, we can see that trading effects (the changing portfolio weights) had little impact on the overall realized volatility. In December 2020, we can see a month where both volatility and correlation surprises were negative, resulting in lower realized risk. These two months represent very different risk environments, with the COVID-19 crisis in March 2020 compared to the relatively calm period in December 2020, after positive vaccine news and the U.S. election.

Shifting to 2021, April 2021 was also a month with very low realized volatility for trend following. We can see that both volatility and correlation surprises were negative again, which were the main drivers of such a low realized volatility—just half of the risk target. In June of this year, the impact of both the correlation and volatility surprises decreased significantly in comparison to previous months.

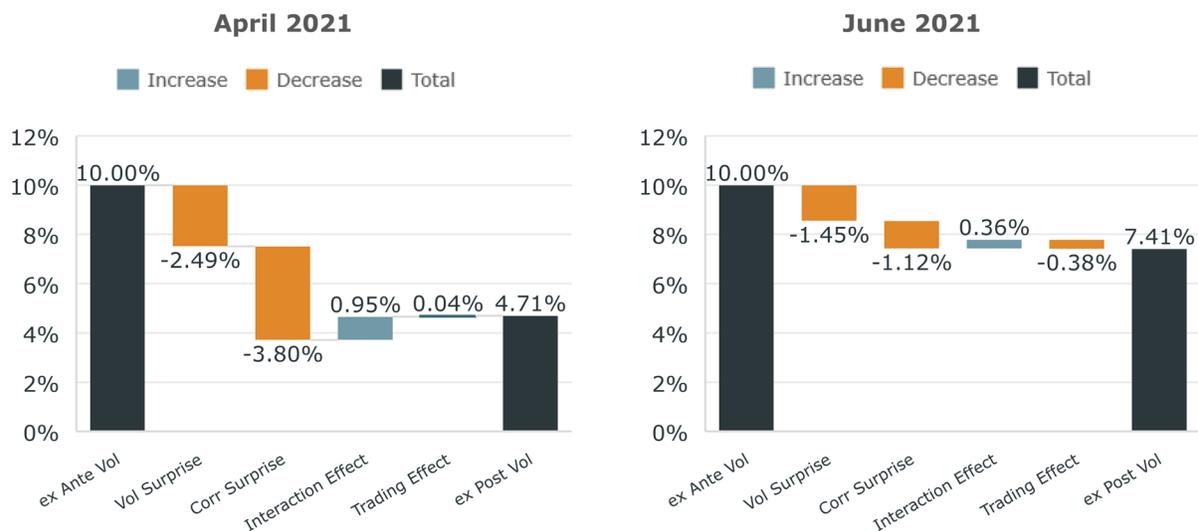


Figure 4: Realized risk decomposition for a simple trend-following strategy with a 10% volatility target for April 2021 and June 2021. Source: AlphaSimplex, Bloomberg.

## Putting recent realized risk into longer term perspective

Given the very different realized risk profiles outlined in Figure 3 and Figure 4 (from 2020 and 2021), it is interesting to put these results into perspective. Thus, in this section, we review a few longer-term trends in volatility surprise, correlation effects, and trading effects to explain how these recent values fit into a longer-term narrative.

### Don't be surprised by volatility after crisis

Volatility surprise is "not surprisingly" the most impactful during and immediately after crisis events. What is more interesting is when volatility surprise is negative for prolonged periods

after a crisis. Figure 5 plots the volatility surprise for risk-targeted trend-following strategies since 2000. We can see that a few events were more surprising than others for trend strategies: the Lehman Crisis (Great Financial Crisis or GFC), the Flash Crash, the European Banking Crisis, the Taper Tantrum, the Swiss Franc Event, Volpocalypse, and of course the COVID-19 Crisis. For the more pronounced crisis events like COVID-19 or the Lehman Crisis, we can see a pronounced persistent negative volatility surprise period after the event. This is interesting because it is consistent with behavioral effects like the snake-bite effect,<sup>4</sup> indicating that risk taking may be lower after a crisis due to changing risk preferences of investors.

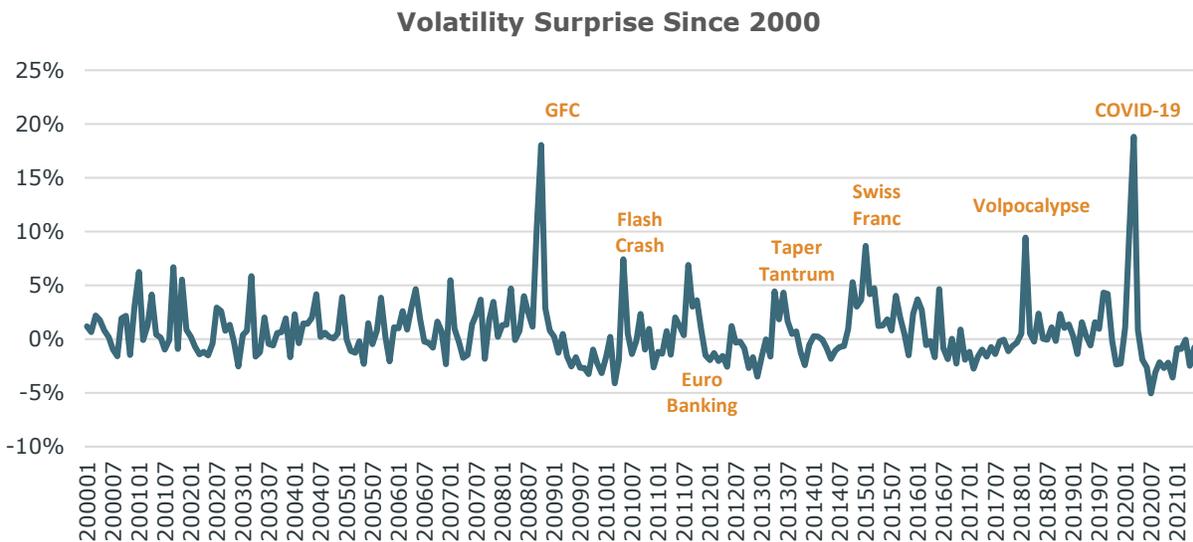


Figure 5: Volatility surprise in trend-following strategies since 2000. Key volatility surprise events post 2008 are labeled. Source: AlphaSimplex, Bloomberg.

Using this time horizon, there seem to be two key periods: Post-GFC and pre-GFC for volatility surprise in risk targeting. To demonstrate this further, Figure 6 plots a histogram for volatility surprise during these two periods. From Figure 6, we can see that the distribution of volatility surprise has become more fat-tailed with more events both on the lower and higher end. This means that more extreme realized risk values have occurred post-GFC than prior. There is one bucket on the right: a 20% volatility surprise during the GFC and during the beginning of the COVID-19 Crisis in March 2020.

<sup>4</sup> In behavioral finance, the snake-bite effect refers to lackluster performance after a crisis or bubble event as investors are reluctant to re-enter an asset class that has recently experienced significant losses.

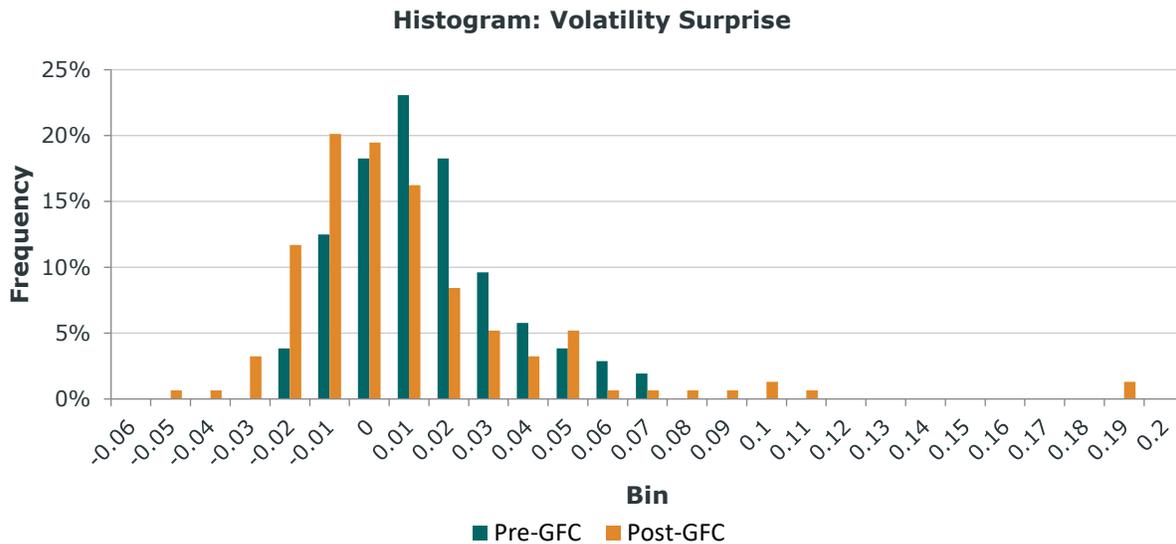


Figure 6: Historical distributions for volatility surprise pre-Great Financial Crisis (GFC) and post-GFC. The volatility surprise is calculated using the metrics described prior and it applies to the measured volatility surprise in risk targeting for a simple trend-following strategy with a 10% risk target. Source: AlphaSimplex, Bloomberg.

### Correlation Surprise Over time

Correlation is a measure of asset class relationships, which can change over time. In practice it takes time to measure these changes. When we see changes in asset class relationships, we can see that correlation surprise can have a bigger impact on realized risk. Figure 7 plots correlation surprise for trend following since 2000. From this graph, we can see that correlation surprise is relatively stable, with some positive and some negative surprises. During both the GFC and the COVID-19 Crisis, we can see that correlation surprise had a dampening effect on risk in contrast with volatility surprise, as we saw in the previous section. During the recent period, correlation surprise has been somewhat negative. To examine this further, Figure 8 plots correlation surprise for a simple trend-following strategy against a stock/bond correlation for the recent period of January 2019 to June 2021. From Figure 8 we can see that in the recent period asset class relationships have been changing from a classic low-inflation defensive relationship between stocks and bonds to a pro-inflation relationship with positive stock/bond correlation. During periods where correlations change, real correlations can be underestimated. Depending on how trends relate to that change a portfolio can experience either negative or positive correlation surprise. For example, parts of 2018 saw a positive surprise, while the GFC and the COVID-19 Crisis saw negative surprises. As trends developed and strengthened in 2021, it took time to capture the new correlations, which may have led to underestimating risk and causing some negative correlation surprise.

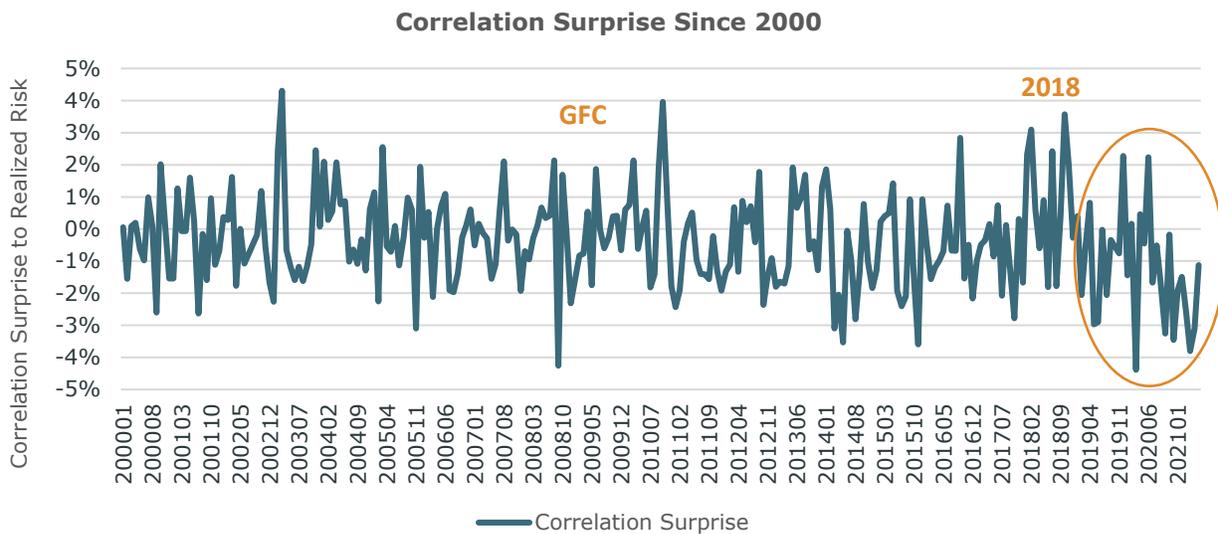


Figure 7: Correlation surprise for a 10% risk-targeted trend-following strategy since 2000. Source: AlphaSimplex, Bloomberg.

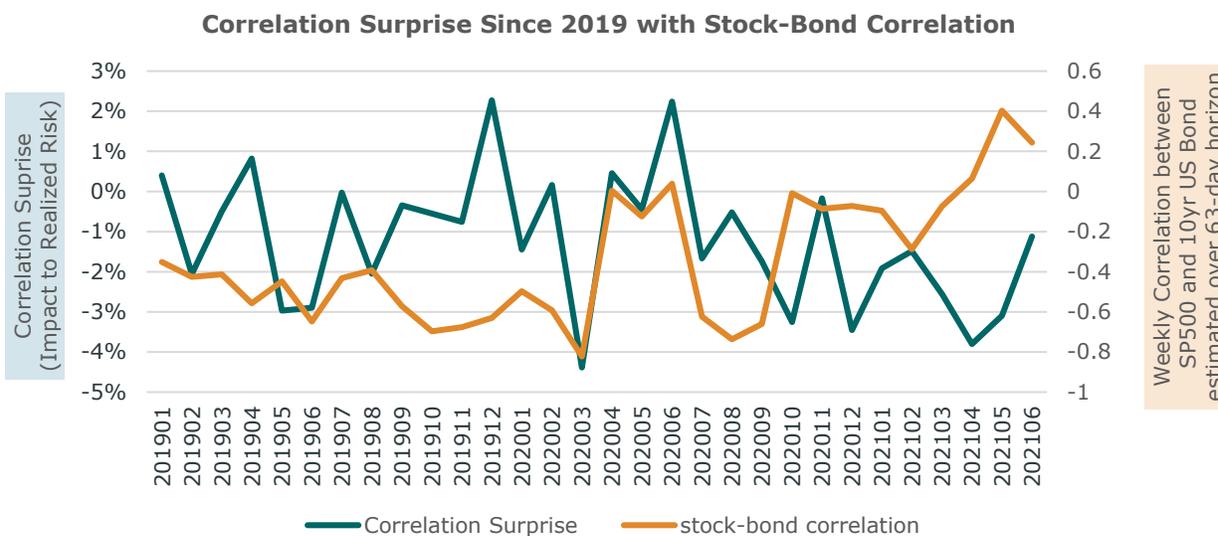


Figure 8: Correlation surprise for a 10% risk-targeted trend-following strategy since 2019 (left axis) and the correlation estimated between S&P 500 and U.S. 10-Year Notes at a weekly frequency over 63-day horizon. Source: AlphaSimplex, Bloomberg.

### Trading Effects

Dynamic strategies like trend following still tend to be rather smooth over time in how they change positions. This is by design, as trading costs and excessive trading of portfolios can incur undesired effects. The trading effects in realized volatility are defined as the impact of changing portfolio weights during a specific month on the portfolio’s overall risk. Figure 9 plots the trading effect on realized risk for a simple 10% risk-targeted trend-following strategy.

From this graph, we can see that, in general, changing portfolio weights over any individual month has very limited impact on the portfolio's realized risk. There are a few events which stick out: the GFC, 2018, and the start of the COVID-19 Crisis. For the GFC, changing weights seemed to increase the realized volatility of the strategy during September 2008 and subsequently decreased the realized risk in October 2008. This is not surprising because as markets moved drastically, trend-following strategies aggressively repositioned into new trends during this period. The same situation was true for the onset of the COVID-19 Crisis; the changes in portfolio positions over the month of February seemed to actively reduce the realized risk for the strategy. We also note that 2018 was a challenging year for trend following due to some large volatility events. During this year changes in positions due to these events had the impact of reducing realized risk for trend-following strategies. Figure 9 is interesting because it highlights a key feature of trend-following strategies: in general, the month-to-month changes in positioning have little impact on realized risk, yet during extreme events the strategy can change with changing market conditions, more often choosing portfolio changes that reduce realized risk.

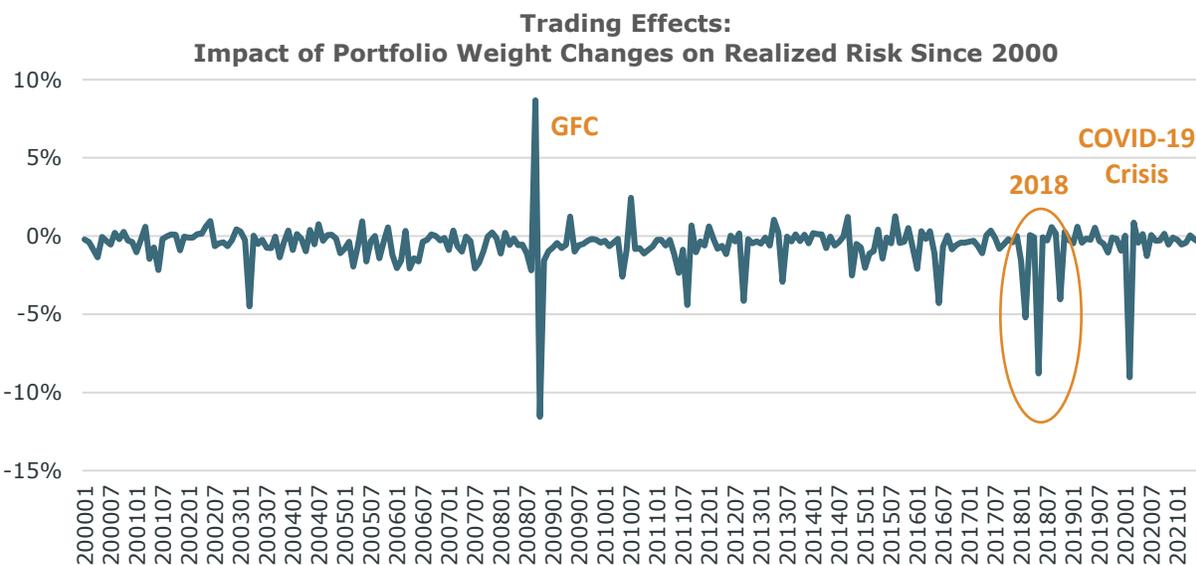


Figure 9: Trading effects for a simple 10% volatility-targeted trend-following strategy since 2000. Source: AlphaSimplex, Bloomberg.

### Does Targeting Risk Faster Hit the Target?

One potential criticism for this analysis is that we have used 3-month windows to target risk in the simple trend-following strategy. A simple question could be how consistent these results are with different speeds of measurement. Put simply, if you measure and target risk faster, could you pick up these changes in market risk faster or are they more a function of a changing risk preference and asset class correlation environment? Figure 10 plots realized risk for the

current 3-month approach versus 1-month measurement.<sup>5</sup> From this graph, we see improvements for a faster measurement period, with the caveat that a shorter time horizon is often less desirable because it induces bigger trading effects and more position movements over time. This demonstrates how there is still a big component of both volatility and correlation surprise, which impacts realized risk despite different tools for measuring and managing it.

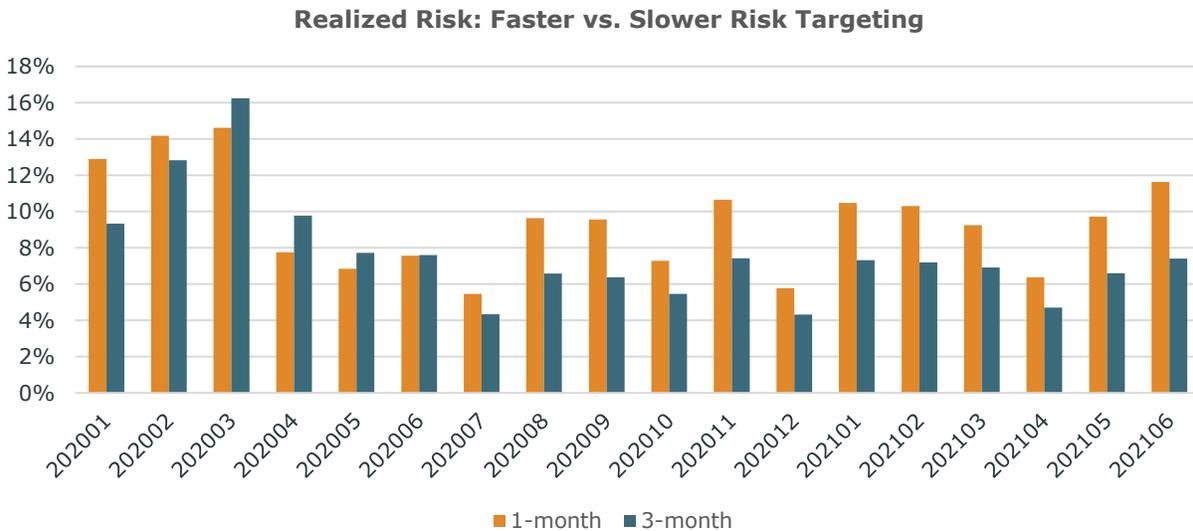


Figure 10: Realized risk for faster vs. slower trend system targeting 10% volatility. The faster measurement system tends to be closer to the targeted volatility during the period. Source: AlphaSimplex, Bloomberg.

## Realizing Risk into 2021 and Beyond

In this note, we reviewed the realities of realized risk by examining volatility surprise, correlation surprise, and trading effects, and their role in realizing risk for trend-following strategies. We examined how volatility surprise has been a bit more fat-tailed post-GFC and how correlation surprise has the ability to dampen realized risk in certain extreme scenarios. We also demonstrated how trading effects or portfolio positioning changes more often than not are relatively mundane in terms of realized risk, except during extreme events where portfolio changes have tended to help reduce realized risk.

When we take our findings from this paper to the current environment, there were a few things that stuck out. First, time-varying behavioral preferences for risk and volatility have persisted into 2021, and we can certainly expect more time variation with potential for lower realized risk should these preferences persist. Second, asset class correlations have changed

<sup>5</sup> In practice even a 3-month estimation period for risk targeting is somewhat choppy over time. Often more smooth multi-horizon measures of volatility and correlation can be used to further dampen the effects of estimation noise. We choose to use a 3-month horizon in this paper to allow the system to be reactive to recent events and avoid the potential bias induced by longer estimation periods, which may include spikes in volatility such as the COVID-19 crisis.

drastically as the inflation theme has entered the markets, resulting in negative correlation surprise on realized risk. The impact of these new relationships between asset classes will continue to filter into portfolios and change realized volatility should the world continue to shift into that direction.

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