The TAMING of the *SKEW*

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Executive Summary

Investors are often concerned about the negative skewness, or left-tail asymmetry, of equity returns. In response, they seek risk-mitigating strategies to provide offsetting returns when equity markets fall. Due to their association with positive skewness, trend-following strategies are popular candidates for risk-mitigation or crisis-offset. This paper explores how a trend-following portfolio can achieve positive skewness, and finds that time variation in risk is the primary factor. In fact, any portfolio with a positive Sharpe ratio can achieve positive skewness simply by varying the level of risk taken through time.

To illustrate this point, three different approaches to risk management are applied to trend-following: constant risk targeting (CRT) achieves **zero skewness**, signal risk targeting (SRT) achieves positive **skewness by chance,** and equity risk targeting (ERT) achieves positive **skewness by design**. Each risk targeting approach is studied from 1990 to 2016. The key features are summarized in the table below.

Risk Strategy	Risk Variation	Long-Run Sharpe Ratio	Skewness	Correlation to Equities	Crisis Alpha
Constant Risk Targeting (CRT)	None	Highest	None	Negative, Low	Moderate
Signal Risk Targeting (SRT)	With average trend signal strength	Lowest	Positive, High	Negative, Low	Moderate
Equity Risk Targeting (ERT)	With equity volatility and trend/equity correlation	Moderate	Positive, Moderate	Negative, High	High

Finally, the paper turns to investor objectives and discusses the distinction between a **diversifier** and a **complement**. A diversifier is an investment strategy which has accretive portfolio benefits with the goal to increase the overall *long run* Sharpe ratio of a relatively diversified portfolio. A complement is an investment strategy which is designed to best improve a concentrated portfolio by exploiting conditional correlation. In this study, the CRT was found to have the best stand-alone performance and was therefore the best diversifier. The ERT portfolio provided the best equity protection with the highest risk-adjusted return during crisis periods. The SRT portfolio achieves the highest skewness, but with less crisis alpha than the ERT and a lower Sharpe ratio than the CRT. This highlights the fact that positive skewness alone is not enough for risk mitigation; timing matters.

Skewness is simply an outcome; the ultimate decision of whether or not to vary risk over time depends on the investor’s objective: to diversify or to complement?

Introduction

Many investors are interested in return **skewness**; in fact, certain investors even consider it an explicit objective when selecting an investment. The skewness of a distribution is a measure of asymmetry around the average return. Negatively skewed portfolios usually have most of their returns above the mean, punctuated with fewer, but larger, returns below the mean. [1] In practice, investors often worry about negative skewness in equity markets. In response, they may seek out positively skewed strategies that can mitigate large negative equity movements.[2]

This paper begins by discussing two sources of skewness in portfolio returns: the composition of the underlying assets/strategies (the ingredients) and amount of risk taken (quantity).[3] The paper then turns to trend-following to demonstrate how dynamic risk taking can alter return distributions and create positively skewed outcomes. Two illustrative examples are discussed. The first example uses both a contrived *heads/tails strategy*, as well as a signal risk-targeting strategy, to show how random (or uncontrolled) time-varying risk can lead to portfolio **skewness by chance**. The second example employs an alternative risk targeting approach to explore how a controlled time-varying risk target might be able to tame the skew and create **skewness by design**. Finally, the particular objective of creating positive skewness to complement equity portfolios is discussed.

Portfolio Return Distributions

Portfolio returns depend on two inputs: the composition of assets/strategies and the amount of risk taken. Given these two choices, a stream of portfolio returns r_{Pt} which includes positions in n assets with returns r_{it} $(i = 1..n)$ at each time t can be written as[4]

$$r_{Pt} = \underbrace{\sigma_t}_{\text{Amount of risk}} \overbrace{\sum_{i=1}^{n} w_{it} r_{it}}^{\text{Portfolio ingredients}} \qquad \textit{Equation 1}$$

[1] The converse is true for positively skewed distributions. Skewness is defined as the normalized third central moment of a return distribution. For returns (r_t) with mean ($\bar{r}$), the skewness can be written as

$$\frac{\mathbb{E}[\,(r_t - \bar{r})^3]}{\mathbb{E}[\,(r_t - \bar{r})^2]^{3/2}}$$

[2] For a practical example, several large US pension funds are implementing risk mitigation strategies and crisis mitigating strategies to offset negative skewness in their portfolios. See Diamond (2016)

[3] In this paper, the measured expected volatility of portfolio returns defines the amount of risk.

[4] w_{it} is restricted to satisfy $\sum_i \sum_j w_{it} \Omega_{ij} w_{jt} = 1$, where Ω is an estimate of the covariance matrix of market returns. This gives σ_t the appropriate interpretation as an expected volatility level because $Var(r_{Pt}) = \sigma_t{}^2$. There is no other restriction on the sign or magnitude of w_{it}.

where at time t, σ_t is the risk level for the total portfolio, w_{it} is the weight in market i and r_{it} is the percent return. The set of w_{it} is explicitly constrained such that when σ_t=1, the portfolio takes unit risk. Take as a simple example a long-only equity strategy using the S&P500; this portfolio will have the same distribution as the S&P500, which has historically exhibited negative skew.[5] As additional assets/strategies are added, what happens to the portfolio's return distribution?

At this point, it is necessary to differentiate between the *point-in-time* distribution and the *time-series* distribution. The *point-in-time distribution* is the unobservable distribution of potential return outcomes at any point in time. At a given time *t*, the observed portfolio return will be the weighted sum of observed asset returns (Equation 1), each drawn from potentially time-varying point-in-time distributions of market returns. As the number of markets *n* gets large and these markets are sufficiently independent, the portfolio's point-in-time return distribution will approach a normal distribution.[6]

What return distribution does the investor actually observe? Because an investor has only one realization from each point-in-time distribution, the point-in-time distributional properties cannot be measured. Rather, the investor will aggregate portfolio returns over time, and each of these returns (r_{Pt}) will come from a potentially different point-in-time distribution. As a result, the investor actually measures the average distribution across time, which is called the *time series distribution.*[7]

Time Varying Risk Allocation and Skewness

Since a highly diversified portfolio should approach normality in its point-in-time distribution, if that same portfolio maintains constant volatility through time it will also have a normal time-series distribution, and therefore no skewness.[8] In simple terms, a highly diversified portfolio with constant risk has no skew. The baseline case is a diversified portfolio with a constant volatility target, often termed a **constant risk targeting (CRT)** portfolio. Returning to Equation 1, the expected portfolio risk σ_t is constant:

$$\sigma_t = \sigma_{Target}$$

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[5] In the framework from Equation 1, $n = 1, w_{S\&P500,t} = \sigma^{-1}_{S\&P500,t}, \sigma_t = \sigma_{S\&P500,t}$

[6] This is a consequence of the central limit theorem. In this case, markets are not distinguished from strategies.

[7] Such a distribution is called a mixture distribution. In this case, the mixing distribution is uniform over time:

$$\overline{f_{r_p}}(x) = T^{-1}\int_0^T f_{r_p}(x,t)dt$$

Where f_{r_p} is the point-in-time distribution of portfolio returns at time *t*.

[8] With a constant risk target, the portfolio distribution is approximately time-invariant, so the average distribution equals the point-in-time distribution and the portfolio, if sufficiently diversified, will have no skewness (or any other higher moments). In practice, estimation error of the future asset covariance can cause moderate deviations 0 in measured skewness.

Now, consider the option to change the risk target between high and low risk states. This decision causes the portfolio return's time-series distribution to become a mixture of (approximately) normal distributions with different means and variances. Figure 1 plots a hypothetical positive Sharpe, normally distributed portfolio's point-in time distribution with a high risk target (left) and a low risk target (middle), alongside the time-series distribution (right) which results from switching equally between the two different risk states.

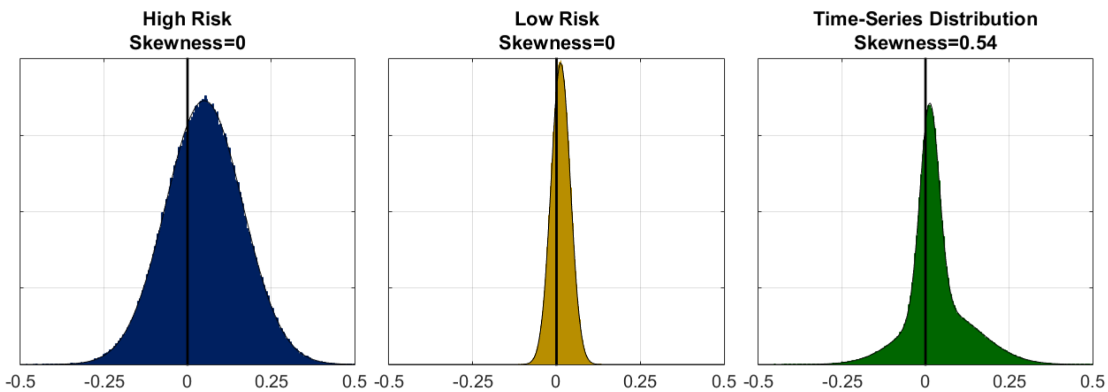


Figure 1 : Hypothetical monthly return distributions for a high and low risk target, as well as the average. Both distributions are chosen to have positive Sharpe ratios (1.5 annualized). The high risk state is normally distributed with 40% annualized volatility; while the low risk state is normally distributed with 10% annualized volatility. ***The skewness of the time-series distribution is 0.54****.*

Figure 1 demonstrates that if the portfolio Sharpe ratio is positive, toggling risk between a high risk target and a low risk target can achieve positive skew through time.[9] Exploration of how skewness arises in real portfolios warrants a practical example.

Trend-following and Skewness

Most investors associate trend-following returns with positive skewness. Historically, monthly trend-following returns have exhibited strong positive skew on a per-market basis. To examine skew in trend-following, a portfolio of 77 futures markets across fixed income, commodities, equity indices, and currencies is constructed with data from January 1990 to May 2016.[10] Trend positions are determined using simple moving averages (SMA) and exponential moving averages (EMA) with both quarterly and yearly lookbacks.[11] Paralleling the previous example

[9] If the Sharpe ratio is negative, the skew will be negative. For practical purposes, a portfolio's skewness will depend on how the Sharpe ratio varies through time and how this aligns with the risk level. See (Campbell & Company, 2015)

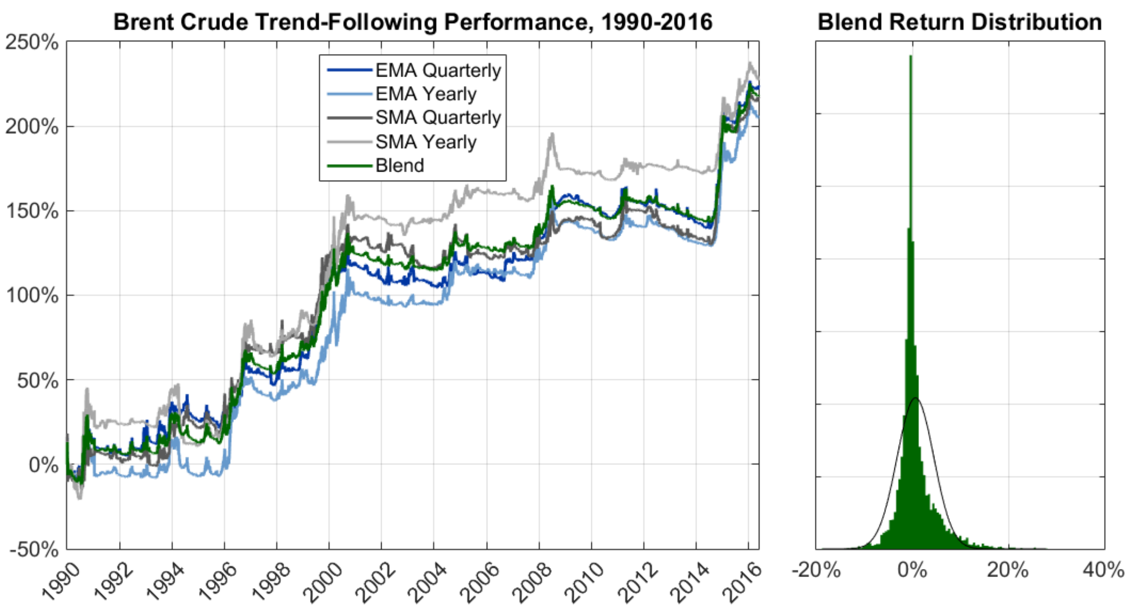
[10] All portfolio returns are from a simplified equal risk allocation trend-following portfolio. The capital is assumed to be small and therefore the portfolio is not bound by many practical constraints, like exchange limits, market liquidity concerns, or transaction costs. For example see Kaminski (2015).

[11] The trend signals S_{it} are computed as rolling weighted sums of de-volatized historical returns. Risk is allocated on an equal volatility basis as $\widetilde{w_{it}} = {S_{it}}/{\sigma_{it}}$, where σ_{it} is the time t volatility estimate for asset i. The final portfolio weights are computed as $w_{it} = {\widetilde{w_{it}}}/{\sqrt{\sum\sum \widetilde{w_{kt}}\Omega_{kj}\widetilde{w_{jt}}}}$. For more details on trend strategies, see (Greyserman & Kaminski, 2014)

with the S&P500, consider the returns to a trend-following strategy local to only one market – for example Brent Crude Oil.

Figure 2 plots the historical performance, time-series return distribution, and corresponding statistics for trend-following on Brent Crude Oil for different signal choices. In this example, a trend-following strategy on Brent Crude Oil has high positive skewness ranging from 1.32 to 1.69 and high kurtosis.

Where does this skewness come from? It is important to note that in a trend-following portfolio, the returns local to crude oil are neither diversified nor constant risk. The skewness can come from both the (unobservable) properties of the point-in-time distribution for the crude oil market or the time-varying risk that trend strategies take.[12]



	EMA Quarterly	EMA Yearly	SMA Quarterly	SMA Yearly	Blend
Sharpe (ann.)	0.55	0.51	0.52	0.54	0.58
Skewness (mo.)	**1.53**	**1.47**	**1.32**	**1.69**	**1.54**
Kurtosis (mo.)	9.3	11.1	8.8	15.3	9.4

Figure 2: (top left) Historical performance for a SMA and EMA trend signal on Brent crude oil from January 1990 to May 2016. Both signals are traded using quarterly and annual lookbacks for comparison. All four strategies are blended to show the average strategy performance. The strategies are simulated on daily data but skewness and kurtosis are calculated based on monthly returns. (top right) Monthly return distribution of the blended trend strategy on Brent crude oil. A normal distribution with the same mean and variance is shown for comparison.

Positive skewness on a per market basis for trend-following is a well-known phenomenon. Things become slightly more subtle at the portfolio level. Figure 3

[12] Trend-following positions tend to be proportional to the trend strength. As a result, for an individual market risk will naturally vary over time.

plots a histogram of the return skewness for each of the individual markets as well as the return distribution for the quarterly EMA portfolio. The time-series skewness across markets is very positive with a mean of 1.8, while the portfolio itself has a skewness of just 0.1. Note that even a portfolio which includes highly skewed ingredients has close to zero skew if there is little time variation in aggregate risk. This supports the conclusion that for a highly diversified portfolio, the main avenue to obtain skew is to allow risk to vary in time.

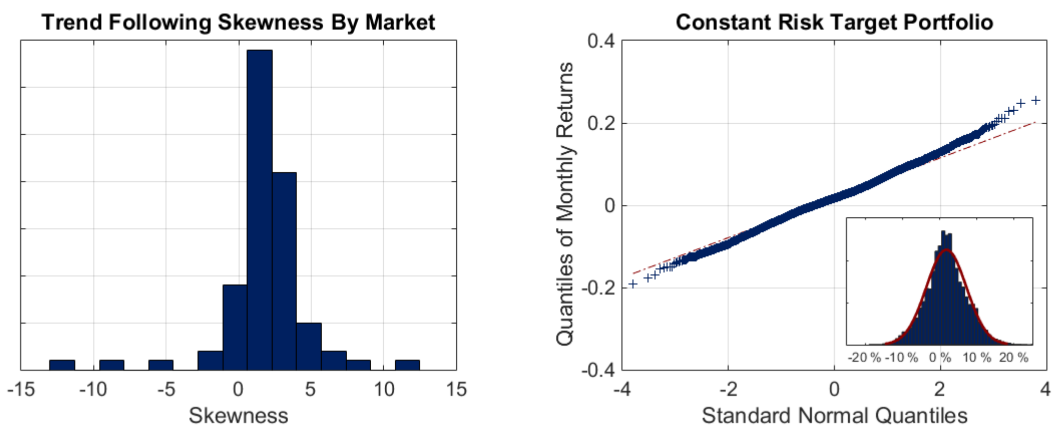


Figure 3 – (left) Histogram of the return skewness by market for a trend-following strategy on 77 individual markets from January 1990 to May 2016. (right) QQ Plot of the monthly returns of the trend-following strategy under constant risk targeting. The distribution is shown in the lower right with a normal distribution in red for reference.

Skewness by Chance

If skewness were an explicit portfolio goal, it would be relatively simple to vary risk in such a way as to increase a portfolio's skew. More generally, any arbitrary time-varying risk target could create skewness with little or no objective value. To demonstrate this, a simple *heads/tails* risk variation strategy can be used. Starting with the CRT portfolio (EMA quarterly described above), each year a coin is tossed. If the coin turns up heads, the risk is increased to twice the CRT target; if it turns up tails, the risk is decreased to half the CRT target. In this case, the decision to change the risk target is clearly uninformed. The risk target for the *heads/tails strategy* can be described as follows

$$\sigma_{HT,t} = \begin{cases} 2\sigma_{Target} & if\ H \\ 0.5\sigma_{Target} & if\ T \end{cases}$$

Figure 4 plots the time series of returns for one realization of the heads/tails strategy compared with the CRT portfolio with $\sigma_{Target} = 15\%$ (per annum). In contrast to the CRT portfolio with a skewness of 0.1, various *heads/tails* realizations have skewness between 0.1 and 1.25 with the average skewness of 0.47.

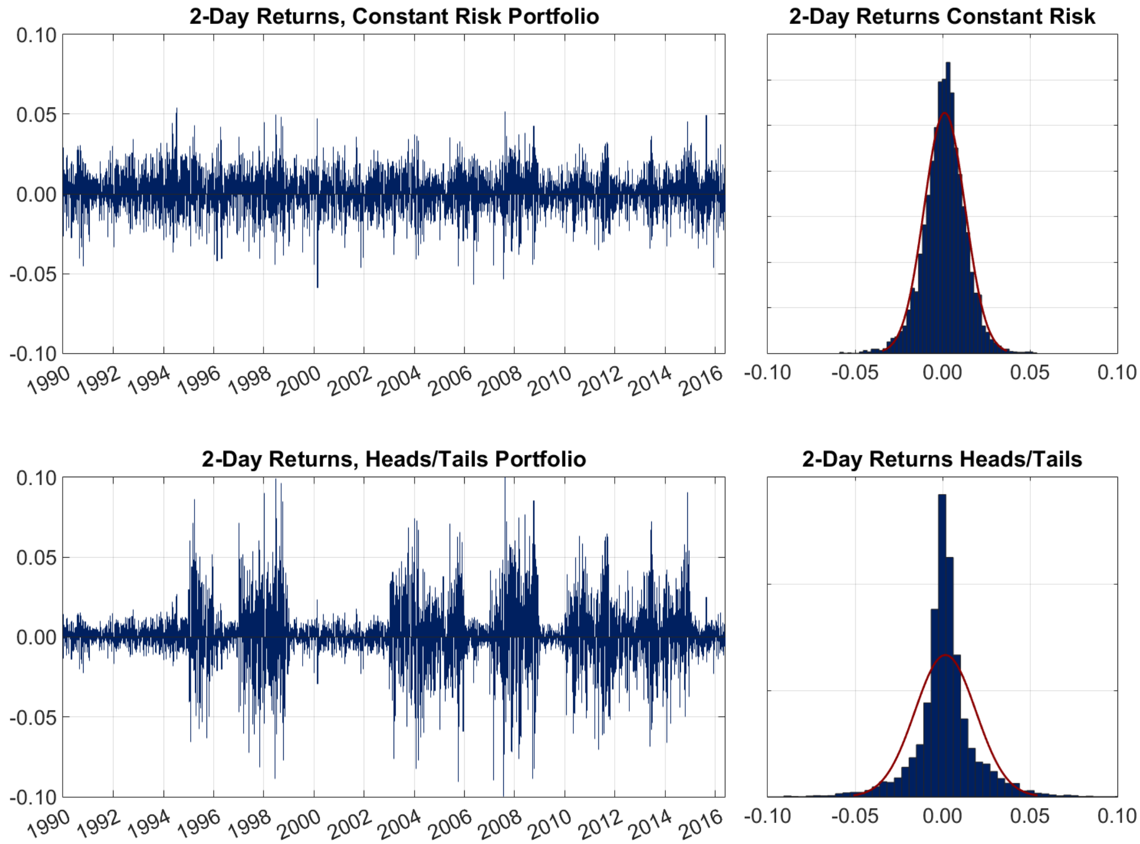


Figure 4: Time series of 2-day returns and histograms of a simulated trend-following strategy with constant risk targeting (top), and one realization of the heads/tails strategy (bottom) from January 1990-May 2016.

To further highlight the differences between heads/tails and the CRT portfolios, Figure 5 plots the expected portfolio risk target and 3 month rolling realized risks for both the CRT and the particular realization of the heads/tails strategy. Realized risks vary substantially but a constant risk targeted approach is much more stable over time. In practice, measurement error in both realized risks and expected risks will create deviations from a risk target.

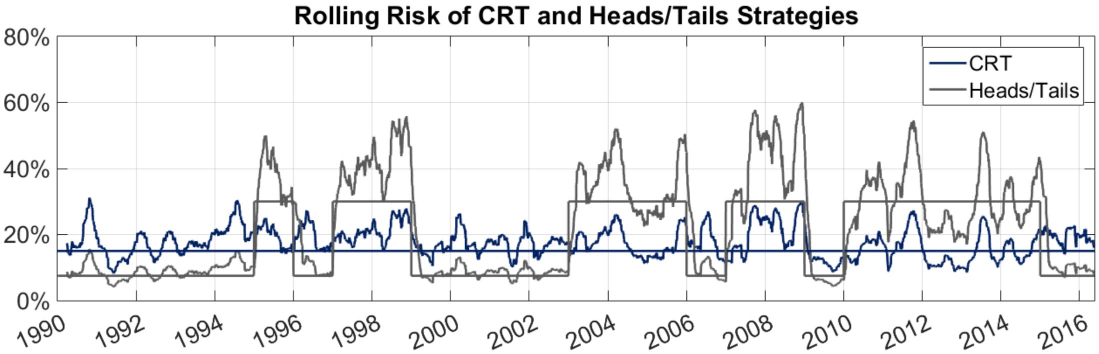


Figure 5: Rolling 3 month annualized standard deviation of returns for a realization of a heads/tails strategy and the CRT portfolio from January 1990-May 2016. The CRT target level of 15% per annum is shown by the horizontal blue line.

In the case of the heads/tails strategy, the risk target decision is clearly uninformative, and employment of such a strategy lowers the expected portfolio Sharpe ratio compared with the CRT portfolio.[13] Despite the reduction in Sharpe, on average the heads/tails strategy exhibits more positive skewness than the CRT portfolio.

Figure 6 plots 150 possible realizations of the *heads/tails* strategy's performance as well as the CRT portfolio. Over a large set of realizations, the differences in Sharpe ratio and skewness are statistically significant. This example demonstrates the possibility that portfolios that exhibit positive skewness may do so purely by chance.

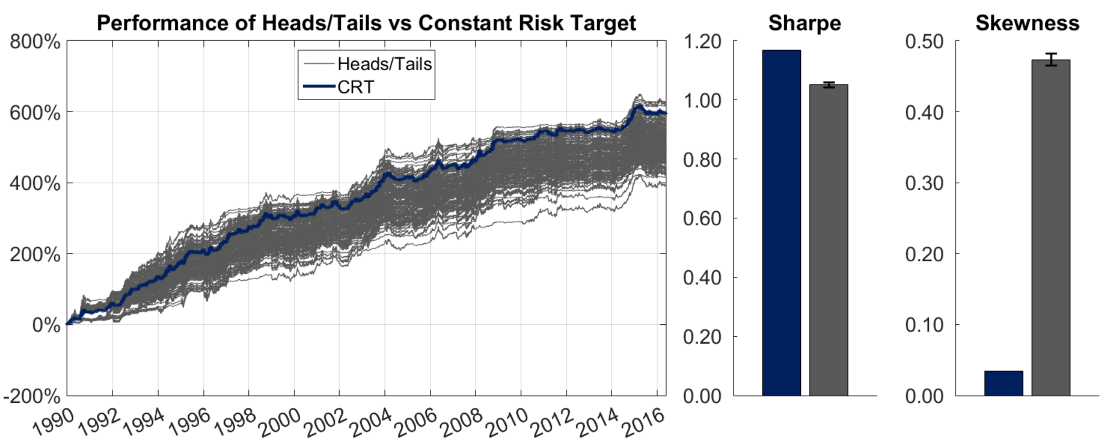


Figure 6: 150 sample performances of the heads/tails strategy are shown in gray, along with the CRT portfolio in blue from January 1990-May 2016. Equity lines have been risk-adjusted for comparison. The average values (and standard errors) of the Sharpe ratios and skewness are shown in the accompanying bar chart. The heads/tails portfolios have a lower average Sharpe but a higher average skewness than the CRT portfolio.

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[13] This is an intuitive result. Random variation in the risk target adds noise to the returns process without a subsequent increase in portfolio return. For the Sharpe ratio to rise there must be a sufficiently large positive correlation between the amount of risk taken and the point-in-time Sharpe ratio. If the point-in-time Sharpe ratio is constant through time, $\mathbb{E}(r_{Pt})/\sigma(r_{Pt}) \approx k$, all variations in risk from a constant target will cause the time-series Sharpe ratio to fall below k.

The heads/tails strategy is clearly nonsensical. What if, rather than constant risk targeting, the portfolio risk is allowed to vary naturally with the average trend signal strength across markets? Such an approach, *signal risk targeting (SRT)*[14] , can be calibrated to take the same amount of risk over longer time horizons but it will vary from the CRT risk target in the short term. Figure 7 plots the distributional characteristics of the SRT portfolio. For the SRT, since the risk varies through time, the portfolio exhibits significant skewness (1.3) but has a lower Sharpe ratio than the CRT portfolio (1.16 vs 0.78). While clearly more sensible than the heads/tails case, the SRT portfolio suffers from a precise lack of control over *when* big returns will occur. More specifically, large returns occur when trend signals are large in aggregate, but they may not align in time with large returns from other allocations (such as equities), which limits their potential impact. Moving from **skewness by chance** to **skewness by design** requires a more directed risk targeting approach.

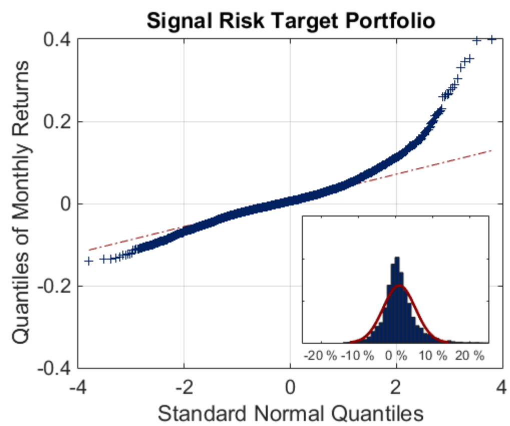

Figure 7: QQ Plot of the monthly returns of the trend-following strategy under signal risk targeting (SRT) from January 1990-May 2016. The distribution is shown in the lower right with a normal distribution in red for reference.

Skewness by Design

The previous sections demonstrated that simply changing the risk target over time can create positive skewness, but the timing of large returns comes by chance. This leads to the next question – if skewness can be obtained by varying a risk target – can a portfolio be designed to capture big moves at the appropriate time? Since most investors are concerned about equity drawdowns, one approach, **equity risk targeting (ERT)**, may provide controlled skewness by co-varying the risk target with equity volatility. Specifically, in equity risk targeting (ERT), the risk target σ_t should depend on the level of equity volatility and the potential for trend-following to offset large negative movements in equity markets. In simple terms, the ERT risk

[14] The expected portfolio risk varies proportionally to the quantity $\sqrt{\boldsymbol{S}_t{}^T \boldsymbol{R} \boldsymbol{S}_t}$, where $\boldsymbol{S}_t$ is a vector of signal strengths and R is the correlation matrix between assets. In an equal-volatility allocation, the portfolio will naturally take more risk when correlations are high (for a given set of trend strengths).

target will be high when equity volatility is high and the portfolio has an expected negative correlation to equities.

To examine the differences between skewness by chance and by design, the CRT, SRT, and ERT risk targeting schemes are applied to the same representative equal risk trend-following strategy on 77 markets. Again, the only difference between strategies is the risk targeting methodology. Figure 8 plots the cumulative risk-adjusted performance and relevant performance statistics including Sharpe ratios, skewness and crisis alpha[15] for the three portfolios, while Figure 9 plots their realized risk variation over time. The CRT portfolio has the most stable risk while the ERT has the highest range in risk. The ERT portfolio risk is highly variable due to the natural fluctuations in equity volatility and equity/trend correlations. Additionally, constant risk targeting provides the highest Sharpe ratio with moderate crisis alpha and almost no skew. Signal risk targeting provides the highest skewness, moderate crisis alpha, and the lowest Sharpe ratio.[16]

Both the SRT and ERT approaches produce positive skewness. For equity risk targeting (ERT), however, positive skewness is the outcome of a portfolio *designed to capture crisis alpha*. This discussion naturally leads to a more pointed discussion of investor objectives.

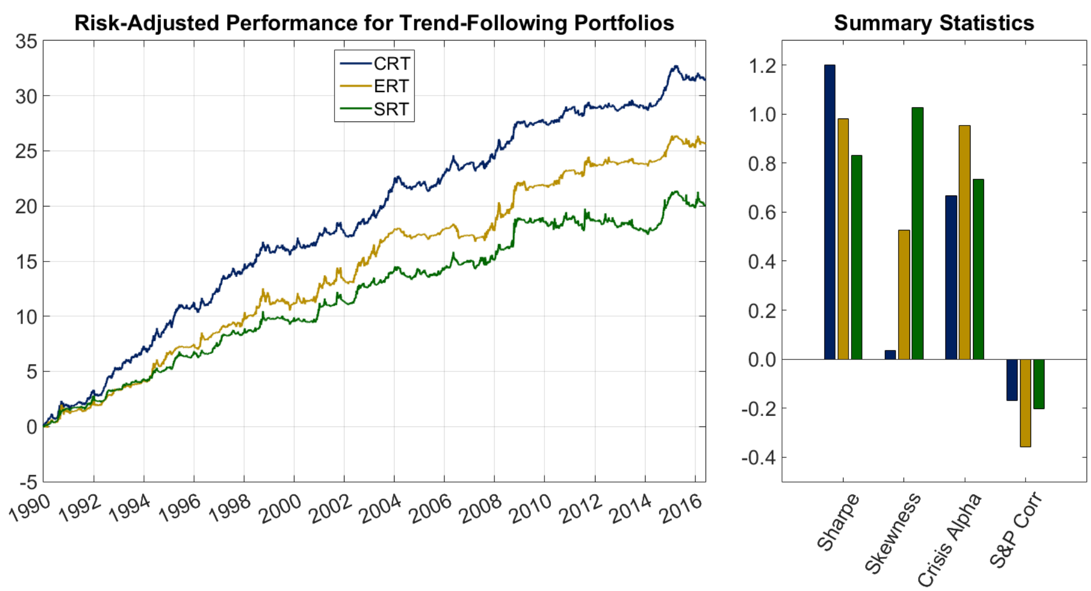

Figure 8: (left) Cumulative performance for a constant risk targeted (CRT), an equity risk targeted (ERT), and a signal risk targeted (SRT) trend-following portfolio scaled by the annual risk taken of the ERT portfolio. The portfolio is a representative equal risk trend-following portfolio of 77 markets from January 1990 to May 2016. (right) Monthly Sharpe, skewness, crisis alpha (monthly alpha per unit monthly risk) and correlation to the S&P 500 for the CRT, ERT, and SRT portfolios.

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[15] Crisis alpha is the conditional performance of a strategy when equities have fallen continuously month/month by 5% or more. This definition is consistent with (Kaminski, In Search of Crisis Alpha: A short guide to investing in Managed Futures, 2011)

[16] As discussed in (Campbell & Company, 2015), there is a tradeoff between skewness and Sharpe ratio for non-informative risk fluctuations. It is somewhat unsurprising that because the SRT realizes a higher skewness, it also realizes a lower Sharpe ratio.

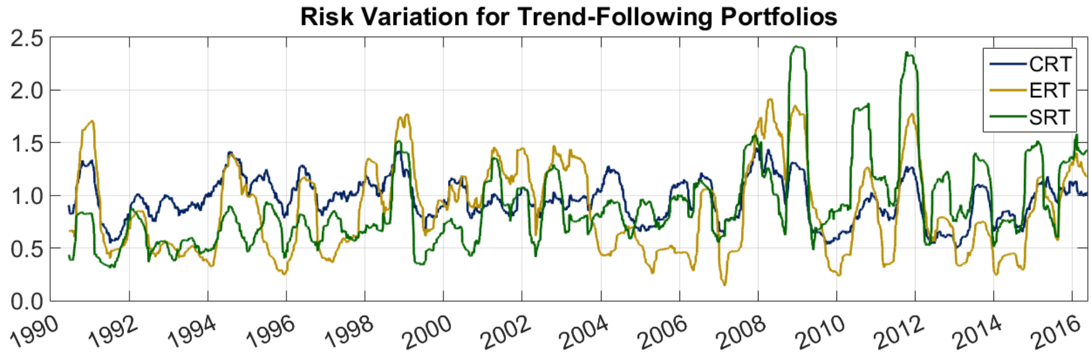

Figure 9: 6 month realized risk variation for CRT, ERT, and SRT portfolios. Each portfolio is a representative trend-following portfolio using 77 markets from January 1990 to May 2016. A value of 1.0 corresponds to the full-sample risk of the ERT portfolio. Values greater(smaller) than 1.0 indicate that over a 6 month period, the portfolio took more(less) risk than the ERT full-sample value.

CTA Investment Objectives

While investment objectives may vary, is it possible to divide CTA investment objectives into two categories: a diversifier or a complement. A **diversifier** is an investment strategy which has accretive portfolio benefits with the goal to increase the overall *long run* Sharpe ratio of a relatively diversified portfolio. A **complement** is an investment strategy which is designed to best improve a concentrated portfolio by exploiting conditional correlation. Given its high risk-adjusted performance relative to the SRT and ERT, the CRT portfolio would be the best choice as a diversifier. For an equity-focused investor who is looking to *complement* an equity tilted portfolio, it is most likely the combined performance of equities with trend-following as well as the absolute level of crisis alpha which is important.

In this case, consider adding trend-following with three different risk targeting approaches (CRT, SRT, and ERT) to an equity portfolio. Figure 10 plots the cumulative return and performance statistics for a portfolio with 80% allocated to the S&P500 and 20% allocated to trend-following with different risk targeting approaches. In this example, when compared with SRT, the combined ERT and the CRT portfolios provide higher risk adjusted performance. To highlight the difference between the ERT and CRT approaches, the combined portfolio's *crisis risk-adjusted return (crisis RaR)* is also shown.[17] Additional statistics are listed in the appendix. Although all three portfolios exhibit low skewness when combined with equities, the conditional performance of the ERT portfolio during equity market crisis periods is more pronounced. For the objective of complementing an equity portfolio, the ERT approach seems to more effectively capture crisis alpha by using an informed risk target, creating skewness by design.

[17] Crisis risk adjusted return (Crisis RaR) is defined as the conditional risk adjusted performance of the combined portfolio when equities have fallen continuously month/month by 5% or more. It is computed as the ratio of the average monthly return to the standard deviation of monthly returns during these periods.

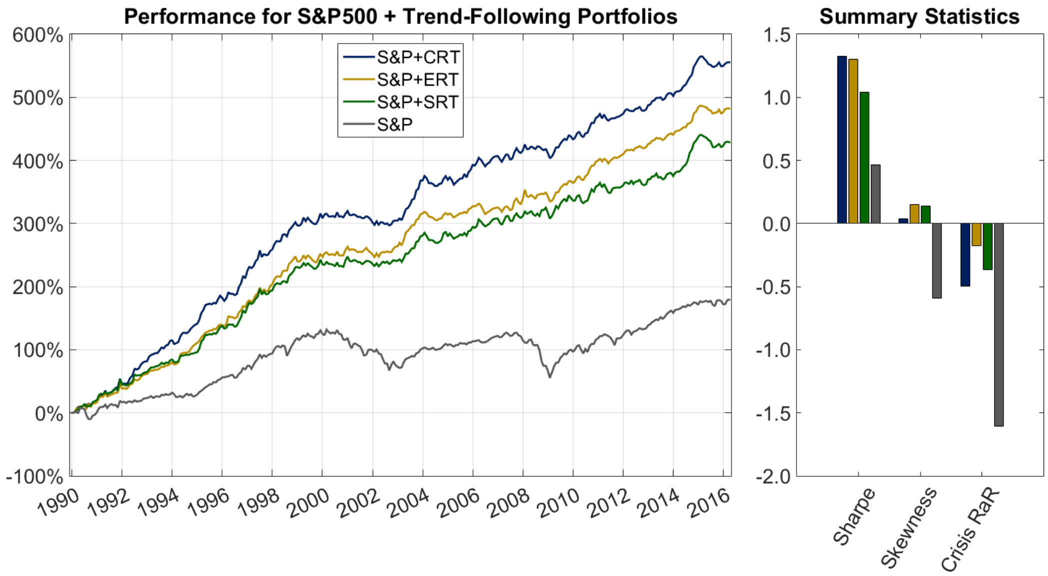

Figure 10: (left) Cumulative performance for an 20% notional allocation to the same CRT, ERT, and a SRT portfolios presented in Figure 8, combined with a 80% allocation to the S&P 500 (without compounding). The S&P 500 total return is shown for reference. (right) Monthly Sharpe ratio, skewness, crisis risk-adjusted return for the combined portfolios and the S&P 500.

Summary

Investors dislike negative skewness and search for positive skewness, particularly if the large returns of a positively skewed investment align with large negative returns in other investments. This paper provides a framework for understanding how risk variation creates skewness in a portfolio. Using trend-following as an example, different approaches to time-varying risk demonstrate the difference between **skewness by chance** and **skewness by design**. Risk variation designed to capture crisis alpha provides both positive skewness and improved risk adjusted performance during equity crisis. Targeting constant risk provides the best overall risk adjusted performance with no skewness. In the end, skewness is simply an outcome; the ultimate decision of whether or not to vary risk over time depends on the investor's objective: to diversify or to complement?

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Appendix: Table of Risk-Adjusted Performance in Crisis Alpha Periods

Crisis Period			Combined Portfolio Return			Stand-Alone Risk-Adj Return		
Start	**End**	**S&P 500**	**S&P 500 + CRT**	**S&P 500 + ERT**	**S&P 500 + SRT**	**CRT**	**ERT**	**SRT**
Sep-08	Nov-08	-30%	-6.4%	1.2%	**5.4%**	2.12	3.19	**3.45**
Apr-02	Jul-02	-21%	-4.4%	**1.6%**	0.5%	1.26	**2.01**	1.84
Jan-09	Feb-09	-18%	-14.8%	**-14.5%**	-17.4%	0.05	**0.07**	-0.15
Feb-01	Mar-01	-16%	-6.7%	**-4.0%**	-7.7%	0.51	**0.74**	0.43
Nov-07	Mar-08	-16%	-1.7%	**3.0%**	-1.1%	0.44	0.28	**0.75**
Aug-90	Sep-90	-15%	1.2%	**2.2%**	-3.1%	1.24	**1.29**	0.82
Aug-98	Aug-98	-15%	-3.5%	**-0.5%**	-2.2%	0.65	**0.87**	0.74
Sep-00	Dec-00	-15%	-2.4%	2.0%	**2.9%**	0.81	1.24	**1.33**
Aug-01	Sep-01	-14%	-2.0%	**2.3%**	-1.2%	0.83	**1.24**	0.88
May-10	Jun-10	-13%	-8.6%	**-6.1%**	-13.3%	0.16	**0.36**	-0.21
Aug-11	Sep-11	-12%	1.0%	5.5%	**8.3%**	0.95	1.41	**1.69**
Sep-02	Sep-02	-11%	-3.5%	**-1.2%**	-4.3%	0.40	**0.58**	0.35
Dec-02	Feb-03	-10%	4.2%	**9.6%**	1.6%	1.14	**1.77**	0.88
Jun-08	Jul-08	-10%	**-4.3%**	-6.4%	-7.8%	**0.23**	0.07	-0.01

Table 1: Crisis periods where the S&P500 dropped 10% or more, alongside the performance of the CRT, ERT, and SRT portfolios combined with equities (compounded monthly). Also shown is the stand-alone performance of the three portfolios (compounded monthly) scaled by the full sample risk of the ERT portfolio from January 1990-May 2016. The bold indicates which portfolio performed best (stand-alone and combined) in the indicated crisis period. The best stand-alone return may not be the same as the best combined return during a period due to the nonlinear effects of compounding and return timing.

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Trading in commodities, futures, options, derivatives and other financial instruments ("Managed Futures"), as discussed in this paper, involves speculation, is subject to a significant amount of market risk and is not appropriate for all investors.

The Risks of Managed Futures

Alternative investments, such as managed futures, are speculative, involve a high degree of risk, have substantial charges and are suitable only for the investment of the risk capital portion of an investor's portfolio.

Some or all managed futures products may not be suitable for certain investors. Some products may have strict eligibility requirements.

Managed Futures are speculative and can be leveraged.

Past results are not indicative of the future performance, and performance of managed futures can be volatile.

Investors can lose all or a substantial amount of their investment.

There can be liquidity restrictions in managed futures products.

Substantial expenses of certain managed futures products must be offset by trading profits and interest income.

Trades executed on foreign exchanges can be risky. No U.S. regulatory authority or exchange has the power to compel the enforcement of the rules of a foreign board of trade or any applicable foreign laws.

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