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INSIGHTS

TREND-FOLLOWING THROUGH THE PRISM OF TACTICAL ASSET ALLOCATION

Quantifying the benefits of constrained and unconstrained trend-following vs a traditional asset allocation: short-selling, leverage, and market diversification.

#15 | 19 SEPTEMBER 2023

Executive summary

Even when investors facing traditional investment portfolio restrictions are long-only, unlevered, and restricted to a narrow investment universe, trend-following for tactical asset allocation can enhance risk-adjusted returns in two ways: by overweighting outperforming and underweighting underperforming assets and by sitting in cash during extended negative periods for some asset classes.

To unleash the full power and potential of trend-following, however, investors need the freedom to go short as well as long, use leverage, and trade a wider range of asset classes and markets. Analysis shows that leverage and a wider investment universe can enhance risk-adjusted returns over a full market cycle, while shorting may produce a smoother and steadier return profile more evenly balanced between bull markets and bear markets.

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ONE OF THE LIMITATIONS OF HYPOTHETICAL PERFORMANCE RESULTS IS THAT THEY ARE GENERALLY PREPARED WITH THE BENEFIT OF HINDSIGHT. IN ADDITION, HYPOTHETICAL TRADING DOES NOT INVOLVE FINANCIAL RISK, AND NO HYPOTHETICAL TRADING RECORD CAN COMPLETELY ACCOUNT FOR THE IMPACT OF FINANCIAL RISK IN ACTUAL TRADING. FOR EXAMPLE, THE ABILITY TO WITHSTAND LOSSES OR ADHERE TO A PARTICULAR TRADING PROGRAM IN SPITE OF TRADING LOSSES ARE MATERIAL POINTS WHICH CAN ALSO ADVERSELY AFFECT ACTUAL TRADING RESULTS. THERE ARE NUMEROUS OTHER FACTORS RELATED TO THE MARKETS IN GENERAL OR TO THE IMPLEMENTATION OF ANY SPECIFIC TRADING PROGRAM WHICH CANNOT BE FULLY ACCOUNTED FOR IN THE PREPARATION OF HYPOTHETICAL PERFORMANCE RESULTS AND ALL OF WHICH CAN ADVERSELY AFFECT ACTUAL TRADING RESULTS.

The performance data shown in this note is gross of fees but net of estimated trading costs. As such, it does not reflect the deduction of fees and expenses which would have lowered performance. Returns contained herein are shown as excess returns (excl. cash income) and include reinvestment of earnings. The estimated trading costs are based on Quantica's proprietary cost models.

Hypothetical results presented in this note are calculated by taking the prevailing market prices available at the relevant point in time. The case studies included in this presentation are for illustrative purposes only. The information is intended to be educational and is not tailored to the investment needs of any specific investor. There are numerous factors related to the markets in general or to the implementation of any specific program that cannot be fully accounted for in the preparation of hypothetical performance results.

Traditional investment portfolio restrictions

The liquid portion of any traditional investment portfolio is usually dominated by a diversified mix of equities and bonds, and sometimes supplemented by other liquid asset classes such as listed real estate equities and commodities. Such a portfolio typically cannot take short positions. It can therefore only profit when markets rise and is naturally exposed to directional equity and interest rate risk. Additionally, the sum of portfolio constituent weights is usually restricted to 100% of the portfolio's net asset value to avoid the use of any financial leverage.

Finally, asset exposures may be fixed and aligned with a strategic asset allocation (SAA) scheme or may allow some latitude for tactical adjustments over time around the longer-term strategic allocation weights. In the latter case, a dedicated investment strategy is required to dynamically adjust weights.

Trend-following for TAA

Systematic medium-to-long-term trend-following is one approach for dynamic tactical asset allocation (TAA). Established trend-following CTAs aim to identify and take advantage of persistent and recurring price trends across a globally diversified investment universe composed of the most liquid exchange-traded futures markets in equities, government bonds, short-term interest rates, currencies, and commodities. By construction, a systematic trend-following approach will have a higher (lower) risk exposure *on a relative basis* to the assets which display the strongest (weakest) trends.

A constrained trend-following approach can operate as a tactical allocation scheme within a SAA framework. Setting long-term SAA strategic risk targets for each asset class can control the relative risk allocations to individual asset classes.

Trend-following TAA benefits for long-only and unlevered investors

We first compare hypothetical return and risk characteristics of a static exposure-based asset allocation benchmark and our in-house generic trend-following model on a long-only, and unlevered basis. We consider a typical SAA benchmark with a balanced risk profile, using 16 of the most liquid Exchange Traded Funds (ETFs) widely used for traditional asset allocation in the US.

Three key freedoms and benefits of unconstrained trend-following

The next step is to relax each of the three major constraints. We quantify the incremental and aggregate impact on performance, risk-adjusted returns and smart diversification of sequentially giving the generic trend-following model three key liberties that distinguish it from traditional static SAA and constrained TAA:

1. Using a risk-based rather than an asset-based investment process that allows to take on leverage in a cash efficient and cost-effective way[1] and potentially invest more in terms of aggregate gross notional exposure than the strategy's net asset value (to achieve a specific volatility target), and
2. use short exposures to individual instruments in the same way as it takes long positions, and thus be agnostic to market direction, and

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[1] Futures are typically traded on margin. Consequently, an investor does not need to pay the full amount of the contract but merely deposits part of it as security, i.e., the margin. Depending on the profit & loss of the position and changes in volatility of the underlying, this margin is increased or decreased.

3. invest in a universe composed of 100 liquid exchange traded futures globally (a typical investment universe for a trend-following CTA), including commodities with inflation hedging properties, and also currencies (which can be hard to integrate into a static asset allocation). Sufficiently liquid ETFs do not exist for many of these markets.

Section 1) Trend-following TAA applied to restricted, long-only, and unlevered portfolios

We first quantify and compare the hypothetical performance and risk characteristics of a generic medium-to-long-term trend-following strategy applied to the same investment universe and subject to the allocation constraints of a

traditional SAA benchmark. We construct this generic benchmark from a US investor perspective, using 16 of the most liquid US listed ETFs, each of which owns a distinct traditional asset class category based on a passive index. Additionally, we opt for a "balanced" risk profile, defined by strategic allocation weights of 45% equities, 45% bonds, 5% commodities, and 5% real estate[2]. Table 1 lists the ETFs and notional weights for each asset class and instrument.

A generic trend-following model

For a representative trend-following strategy, we use a constrained version of the medium-to-long-term generic trend-following model introduced in 2020 for our *Quarterly Insights* publications. This model results in a reasonable and time consistent approximation of the trend-

Table 1: Liquid US Listed ETFs for Strategic Asset Allocation Benchmark from the perspective of a US investor

Asset classes	Sub-categories	Selected ETFs (16)	Strategic allocation weight [% of NAV]
Fixed Income			**45%**
	US Govt/Treasuries	iShares 7-10 Year Treasury Bond ETF	10%
		iShares 20+ Year Treasury Bond ETF	
FI - United States	US Corporate	iShares Core U.S. Aggregate Bond ETF	10%
		iShares iBoxx $ Investment Grade Corporate Bond ETF	
	US Municipal	iShares National Muni Bond ETF	7.5%
	US High Yield	iShares iBoxx $ High Yield Corporate Bond ETF	7.5%
FI - International	EM Bonds	iShares J.P. Morgan USD Emerging Markets Bond ETF	10%
Equities			**45%**
	US Large Cap Growth	iShares Russell 1000 Growth ETF	8%
EQ- United States	US Large Cap Value	iShares Russell 1000 Value ETF	8%
	US Mid Cap	iShares Russell Midcap ETF	7%
	US Small Cap	iShares Russell 2000 ETF	7%
EQ - International	EMEA	iShares MSCI EAFE ETF	8%
EQ - Emerging Markets	EM	iShares MSCI Emerging Markets ETF	7%
Real Estate			**5%**
RE - United States	US Real Estate	Vanguard Real Estate ETF	5%
Commodities			**5%**
CO - Precious Metals	Gold	SPDR Gold Shares	3%
CO - Diversified	Commodity basket	Invesco Optimum Yield Diversified Commodity Strategy No K-1 ETF	2%

Table 1: Representative traditional asset allocation benchmark constructed based on 16 of the most liquid US listed ETFs from the perspective of a US investor, including strategic allocation weights associated with a balanced risk profile. Portfolio and strategic allocation weights provided for illustrative purpose only. Source: Quantica Capital.

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[2] Any such benchmark is usually associated with a risk tolerance level, which is typically defined by a target allocation weight to equities, which may vary between 0% (for a very conservative benchmark) up to 80% (in case of a high-risk benchmark).

following CTA industry's average return characteristics.[3]

Average trend-following exposures versus the SAA benchmark

Unlike a traditional asset allocation benchmark based on notional weights, our generic trend-following strategy's asset allocation is risk-based, i.e., it targets a variable percentage of its total portfolio risk in each instrument and asset class, that is purely a function of their prevailing trend strengths. To fairly compare performance and risk between the benchmark and our constrained generic trend-following strategy, we need to define a strategic risk allocation that results in roughly the same long-term average notional weightings of asset classes. Table 2 lists strategic target risk and notional allocations.

Table 2: Strategic Risk Allocations and Notional Exposures per Asset Class

	Target strategic risk allocation [% of total risk]	Average realized notional exposure [% of NAV]	Target strategic benchmark notional exposure [% of NAV]
Equities	65.0%	32.9%	45.0%
Fixed Income	15.0%	38.8%	45.0%
Commodities	10.0%	7.4%	5.0%
Real Estate	10.0%	4.3%	5.0%
Total	100.0%	83.4%	100.0%

Table 2: Target strategic risk allocations and average realized notional exposures[4] per asset class for a constrained (long-only, unlevered) generic trend-following strategy applied to a universe of 16 US listed ETFs. Period: 2000 – 2023. Source: Quantica Capital.

For instance, allocating 65% of the portfolio risk to equities would have corresponded to average realized notional exposure of 33% over the past 23 years, which comes reasonably close to the 45% equity target benchmark weight. Similarly, allocating 15% of the total portfolio risk to fixed income would have resulted in an average realized notional exposure weight of 39% over the past 23 years, which comes close to the benchmark's 45% fixed income target weight.

Figure 1 highlights how the notional weight allocated to each asset class by the trend strategy varies over time[5].

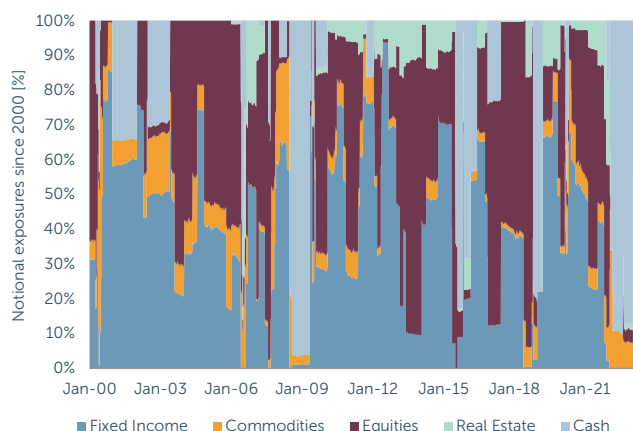**Figure 1: Using Constrained Trend-Following for Dynamic Tactical Asset Allocation**

Figure 1: Simulated notional exposures per asset class (expressed as a fraction of the strategy's net asset value) of a long-only, unlevered generic trend-following strategy applied to a restricted but representative universe of 16 of the most liquid US-listed ETFs and targeting a long-term strategic risk allocation to equities, bonds, commodities, and real estate of 65%, 15%, 10%, and 10%, respectively. Period: 2000 – 2023. Source: Quantica Capital. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

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[3] Quantica Capital's generic trend-following model has been designed to closely track the *SG Trend Index*, an industry benchmark an industry benchmark designed to track the largest trend following CTAs and be representative of the trend followers in the managed futures space. The SG Trend Index is equally weighted, rebalanced and reconstituted annually (Source: Societe Generale). The Index cannot be invested into directly. Quantica's generic trend-following model can be viewed as a realistic approximation of a typical trend-following program. It transforms trend signals with half-lifes of one calendar quarter via a continuous, increasing, and bounded function into target risk allocations. The overall portfolio is scaled to target a long-term volatility of 12% per annum.

[4] The different average asset class notional exposures do not sum up to 100% because in some periods of the past, like 2008 and 2022, only a small fraction of the strategy NAV could be invested because of a lack of positive market trends within the investment universe. As short exposures are forbidden, a negative trend signal translates into an instrument weight of 0%.

[5] The notional weight allocated to each asset class is a function of the magnitude of trend opportunities identified in each asset class.

In the long run however, the average notional weights allocated to each of the four asset classes are close to our benchmark's static asset class weights. The differences are wider than some TAA overlay mandates (indeed, the tracking error between the constrained generic trend-following strategy and the asset allocation benchmark is 9% per annum) but are not a wholesale change to the SAA.

Long-only trend-following can enhance risk-adjusted returns and may reduce drawdowns

Figure 2 outlines and compares the hypothetical historical gross (but net of estimated trading costs) excess (i.e., excluding cash-income) returns and drawdowns of the benchmark[6] and our constrained trend-following strategy since January 2000. Complementarily, the key performance and risk characteristics of both approaches are provided in Table 3.

Figure 2: Static Asset Allocation versus Constrained Trend-Following TAA

Generic trend-following (long-only, no leverage) on ETFs
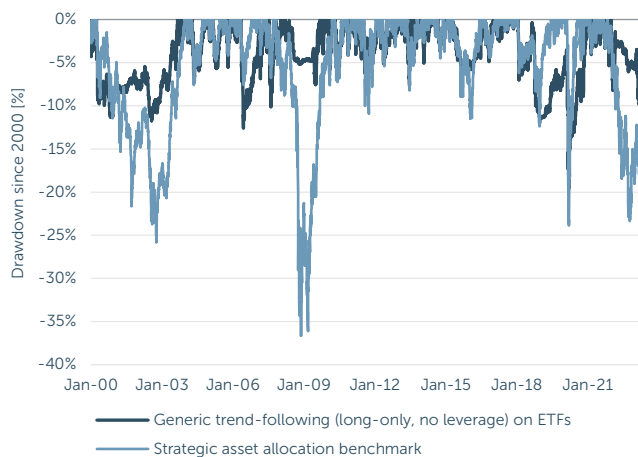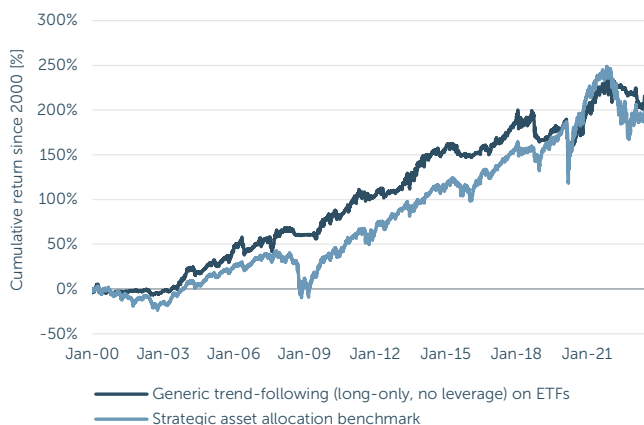Strategic asset allocation benchmark

Figure 2: Cumulative gross excess return and drawdown of a traditional asset allocation benchmark (45% equities, 45% bonds, 5% commodities and 5% real estate) and a constrained long-only, unlevered generic trend-following strategy, both applied to a representative universe of 16 of the most liquid US-listed ETFs. Period: 2000-2023. Source: Quantica Capital. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

The fully constrained trend-following approach would have generated a slightly higher annualized excess gross return of 5%[7] (above the risk-free rate) with annualized volatility of 7.5%, which is lower than the benchmark's 11.2% volatility. Consequently, the generic restricted trend-following strategy has delivered a superior gross Sharpe ratio of 0.67 against 0.43 for the benchmark over the past 23 years. Additionally, the strategy's maximum drawdown is smaller than that of the benchmark (-19.6%, or 2.5 times the volatility, versus -36.6%, or 3.3 times the volatility), reflecting its superior capital preservation characteristics.

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[6] The strategic asset allocation benchmark is a hypothetical, daily rebalanced portfolio based on the strategic instrument weights listed in Table 1.

[7] All reported returns in this note are *excess returns*. For ETFs, such returns are obtained by subtracting a short-term funding rate from their total return to make them comparable to futures returns.

Table 3: Static Asset Allocation versus Constrained Trend-Following TAA

	Generic trend-following (long-only, no leverage) on ETFs	Strategic asset allocation benchmark
Ann. return	5.0%	4.8%
Ann. volatility	7.5%	11.2%
Sharpe ratio	0.67	0.43
Max. drawdown	-19.6%	-36.6%

Table 3: Key excess return and risk characteristics of a traditional asset allocation benchmark (45% equities, 45% bonds, 5% commodities and 5% real estate) and a constrained long-only, unlevered generic trend-following strategy. Both the benchmark and the generic trend-following strategy share the same investment universe, which is restricted to a representative set of 16 of the most liquid US listed ETFs. Period: 2000 – 2023. Source: Quantica Capital. Returns are gross of fees, but net of estimated trading costs. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

This is achieved partly through sitting in cash during some down periods for the asset classes. The risk-based portfolio construction approach of the trend-following strategy leads to more stable and controlled portfolio volatility over time as further outlined by Figure 3.

Figure 3: Realized Volatility for Static Asset Allocation versus Constrained Trend-Following
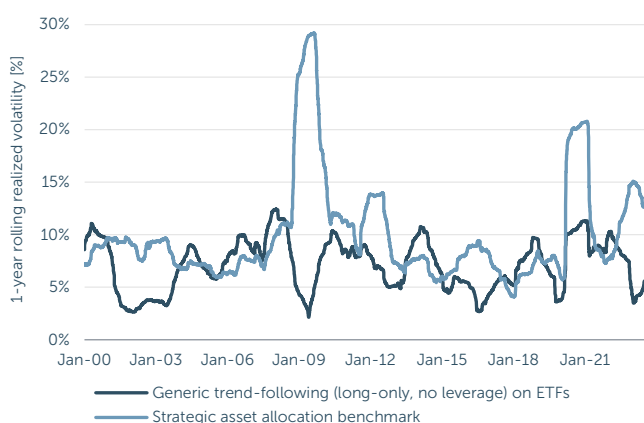

Figure 3: Rolling 12-month realized volatility of a constrained trend-following strategy and corresponding passive asset allocation benchmark with a comparable target risk allocation to equities, bonds, and commodities. Period: 2000 – 2023. Source: Quantica Capital. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

In contrast, passive asset allocation benchmarks, with a fixed allocation weight to equities, can see their risk profile spike up dramatically, doubling, tripling or even quadrupling in equity market crises such as 2008 or 2020.

In short, even when subject to the same constraints as a passive strategic asset allocation benchmark, trend-following offers a compelling systematic rule-based solution to running dynamic asset allocation with superior risk-adjusted return and capital preservation characteristics. It offers more stable risk exposure over time through different market regimes as opposed to a static exposure-based benchmark.

Section 2) The benefits of a risk-based approach to portfolio construction

As a next step, we quantify the risk-adjusted performance impact of eliminating the *no-leverage* constraint by considering a fully risk-based portfolio construction methodology.

Table 3 shows the average realized annualized volatility of the fully constrained generic trend strategy is only 7.5%, far below the target volatility of 12% of the unconstrained trend-following strategy.

Additionally, Figure 1 shows that the strategy is only fully invested (defined as total notional exposure reaching its maximum allowed value of 100%) for 63% of the time. Figure 3 above shows that, even during these fully invested periods, realized volatility has a wide range between 5% and 12% because the absence of leverage will often prevent the strategy from meeting its volatility target. Ruling out leverage is a binding constraint most of the time which results in the strategy undershooting its volatility target. It is also sitting in cash 37% of the time, when it cannot act upon short signals, which we explore in the next section.

Leverage can improve absolute and risk-adjusted returns – across all volatility targets

We now run simulations of the same generic trend-following model (still based on the 16 ETF-universe), but with different portfolio volatility targets, ranging from 1% to 14% per year, but without leverage restrictions.

Figure 4 shows the annualized return of an *unconstrained* generic trend-following is proportional to the target volatility, which translates into an almost constant Sharpe ratio across all vol-targeting levels[8].

Figure 4: Generic Trend-Following With and Without Leverage, at Various Volatility Targets
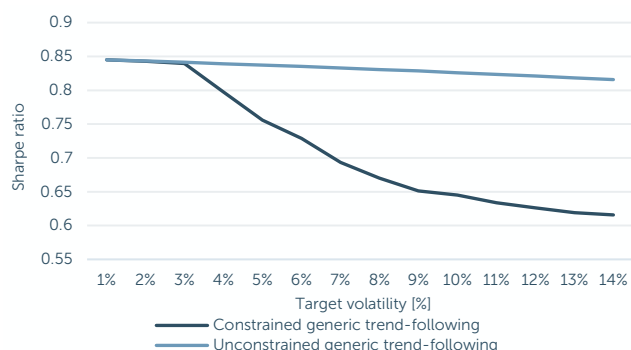

Figure 4: Comparative risk-adjusted excess returns of a generic long-only constrained trend-following strategy, with and without a no-leverage constraint, applied to an investment universe of 16 of the most liquid US listed ETFs for different annualized portfolio volatility targets, from 1% to 14%. Period: 2000 – 2023. Source: Quantica Capital. Returns are gross of fees, but net of estimated trading costs. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

Figure 4 also reveals that a no-leverage constraint reduces the strategy's risk-adjusted returns, lowering its Sharpe ratio by 0.2 from 0.83 to 0.63 for a 12% p.a. target volatility. Ruling out leverage lowers risk-adjusted returns for all volatility targets.

Regardless of the level of risk targeted, the *no-leverage constrained* version of our generic strategy consistently underperforms its *unconstrained* counterpart on a risk-adjusted basis. This is because capping total notional exposure prevents it from deploying its risk budget consistently over time and across asset classes, which ultimately results in a lower Sharpe ratio. A no-leverage constraint implies that low-volatility instruments at times consume a large portion of the available "notional exposure budget" (and thereby reduce the weighting in other asset classes), putting a cap on the portfolio volatility that can be maximally achieved.

Section 3) The benefits of short positions during bear markets

Having eliminated the leverage restriction, we now additionally relax the long-only constraint. We quantify the benefits of a generic trend-following program's ability to take short positions in the same way that it takes long positions. We simulate the generic trend-following model, allowing it to freely scale in and out of short positions in the 16 ETFs[9]. Looking at the whole period since 2000, relaxing the long-only constraint does not improve risk-adjusted returns – as shown in Figure 5: indeed, the Sharpe ratio declines from 0.82 to 0.79. This means that our generic medium-to-long-term trend-following model would have not been able to generate consistent long-term profits by taking on short positions in the underlying ETFs.

However, the ability to selectively short instruments when a negative trend has been identified by the strategy smoothes returns between bull and bear markets, as illustrated by a *smart diversification* analysis, which is essentially

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[8] The slightly decreasing Sharpe ratio from 0.85 to 0.82 is due to the compounding effect of daily fund rebalancing.
[9] For simplicity, we are ignoring any potential additional costs associated with the financing of leveraged long positions or financing of borrowing and short selling of ETFs.

a regime conditional return attribution analysis[10]. This defines three different market regimes – *Bear*, *Normal*, and *Bull* market – for a global equity and a global bond benchmark.

Figure 5 compares trend-following's annualized return attribution, with and without the long-only constraint, across the three regimes for two risk factors (global equities and interest rates), over the 23-year period from 2000 to 2023. This analysis clearly highlights how short selling improves smart diversification characteristics.

Indeed, a generic *unconstrained* trend-following strategy may have generated on average up to an annualized 2.7% and 0.5% in global equity and bond Bear market regimes, respectively, since 2000, compared to -1.6% and -0.8% for the *long-only* trend-following strategy. Freedom to take long and short positions improves the strategy return convexity profile and portfolio diversification benefits in times of declining equity markets and/or rising interest rates.

Figure 5: Long-only and Unconstrained Trend-following in Bull, Normal and Bear Markets
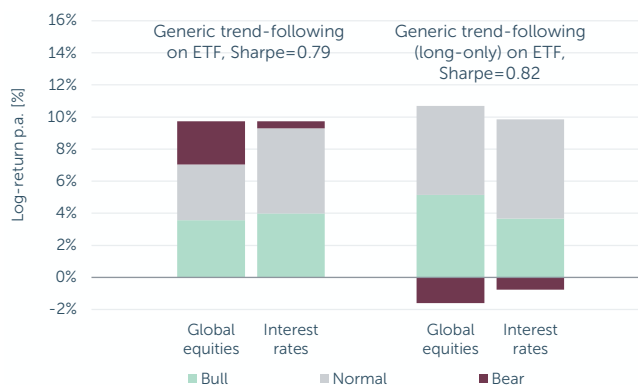

Figure 5: Comparative annualized log-return attribution of a generic trend-following model, with and without a long-only constraint, conditional on three disjointed Bull, Normal and Bear market regimes of two different risk factors: global equities and global interest rates. Period: 2000 – 2023. Source: Quantica Capital. Returns are gross of fees, but net of estimated trading costs. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

Note: Can we use ETFs to mimic the diversification and liquidity of the futures universe?

Given the relatively small size of the ETF universe we used so far, a logical next question is: can we improve the portfolio diversification characteristics (i.e., lower the cross-instrument correlations) of our ETF universe by increasing the number and diversity of its constituents? The interested reader may find an answer to this question in Appendix 1, in which we present the portfolio diversification characteristics of a second, larger ETF-based universe, composed of 100 constituents. This does not come close to the diversification benefits of the futures universe, because most of the other liquid ETFs are in equity or bond markets that are correlated to traditional SAA.

Some investment strategies venture into less liquid markets for perceived diversification benefits, but in this context futures do not in any way compromise liquidity. To the contrary, futures range between massively and substantially more liquid than ETFs in terms of their average daily traded volume. Appendix 2 demonstrates how fixed income futures are over 170 times; equity futures over 25 times; and commodities over 2 times more liquid than comparable ETFs.

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[10] To show the smart diversification benefits, we calculate annualized trend-following returns for different disjointed market regimes. The regimes are inferred from the *calendar quarter returns* of a chosen benchmark (e.g., global equities, global bonds, etc.) and are classified into a *Bull*, *Bear* or *Normal* regimes, according to whether they belong to the top 16%, the bottom 16% or the middle 68% of the benchmark's quarterly returns, respectively.

Section 4) Diversification and liquidity benefits of a wider investment universe: futures compared to ETFs

In this section, we seek to quantify the additional impact of replacing the pure ETF-based investment universe that we have used so far, which is most representative of a traditional asset allocation framework, with a futures-based investment universe, which most trend-following CTAs rely on. We perform this comparison in the absence of constraints on short positions or total gross exposure[11].

This final step expands the opportunity set to asset classes and sub-asset classes which are considered less traditional from a buy-and-hold perspective, including short-term interest rates, currencies, and commodities. Table 6 in Appendix 1 compares the composition by asset class and sub-sector of the universe of 16 ETFs and the generic universe of 100 futures.

Table 4 shows that the (in-sample, hypothetical) Sharpe ratio increases to 1.27 from 0.79 when the fully unconstrained generic trend-following strategy is applied to 100 futures instead of the 16 ETFs.

In a previous Quarterly Insights[12], we have shown that the expected Sharpe ratio of an equal-weighted portfolio associated with a given investment strategy is essentially proportional to the average Sharpe ratio of its constituents, scaled by a diversification multiplier which depends only on the number of instruments and their average correlation. In short, the higher the number of constituents, the lower their average correlation, and the higher their average Sharpe ratio, the more diversified the portfolio and the higher its expected Sharpe ratio.

Lower correlations within the portfolio

Table 4 further provides an overview of these different metrics for the two investment universes. The average correlation between the universe constituents' trend-following return streams is almost 50% lower for the futures universe than the ETF universe! This increases the Diversification Multiplier to 3.7 versus 2.3. Put differently, the futures universe has much stronger diversification characteristics than its ETF counterpart.

Table 4: Unconstrained trend-following applied to ETFs versus Futures

Investment universe	Investment universe size	Avg. corr. of constituent's strategy returns	Diversifica-tion multiplier	Realized strategy Sharpe ratio
Futures	100	0.07	3.7	1.27
ETFs (16)	16	0.14	2.3	0.79

Table 4: Comparative diversification characteristics of three different investment universes (composed of 100 futures and 16 ETFs, respectively) when a fully unconstrained generic trend-following strategy is applied. Diversification Multiplier as defined in "The Value of Diversification in Trend-Following", Quantica Quarterly Insights, December 2021. Period: 2000 – 2023. Source: Quantica Capital. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

Broadening benchmark constraints

In short, a systematic trend-following managed futures strategy lets investors tap into a wider set of liquid investment opportunities, which are not as easy to integrate into a traditional buy-and-hold asset allocation framework based on equity and bond securities. Accessing these additional sources of diversification allows gaining exposure to:

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[11] It is worth highlighting that compared to ETFs, exchange-traded futures let investors build portfolios with a total notional exposure of above 100% without the use of financial leverage in the traditional sense (i.e., no money is borrowed). The *margin to equity* of an unconstrained generic trend-following portfolio with a 12% annualized target volatility is estimated to be anywhere between 10-15% under normal market conditions. This means that only 15% of the portfolio net asset value is utilized to realize the desired risk target.

[12] "The Value of Diversification in Trend-Following", Quantica Quarterly Insights, December 2021

- lower-volatility instruments (short-term interest rates and short-term government bonds), which require the use of some form of leverage
- instruments which are not practical from a buy-and-hold perspective (i.e., currencies), or
- instruments with adverse long-term carry characteristics for a long position holder[13] (i.e., many commodity markets).

Section 5) Summary: the five steps towards tripling the Sharpe ratio

In summary, each constraint (no leverage, long-only, traditional/securitized assets only) is detrimental in its own way to the overall performance and risk characteristics of a systematic dynamic tactical asset allocation approach such as trend-following. In Figure 6, we provide a recap of the incremental Sharpe ratio and smart diversification benefits (against global equities and global interest rates, respectively) of relaxing each of the previous constraints in the following order:

1. Static ETF-based asset allocation ("SAA") benchmark (the most constrained allocation framework)
2. Unlevered and long-only, ETF-based trend-following (akin to a dynamic TAA)
3. Long-only leveraged ETF-based trend-following
4. Unconstrained (leveraged and long/short) ETF-based trend-following
5. Unconstrained futures-based trend-following (the least constrained allocation framework)

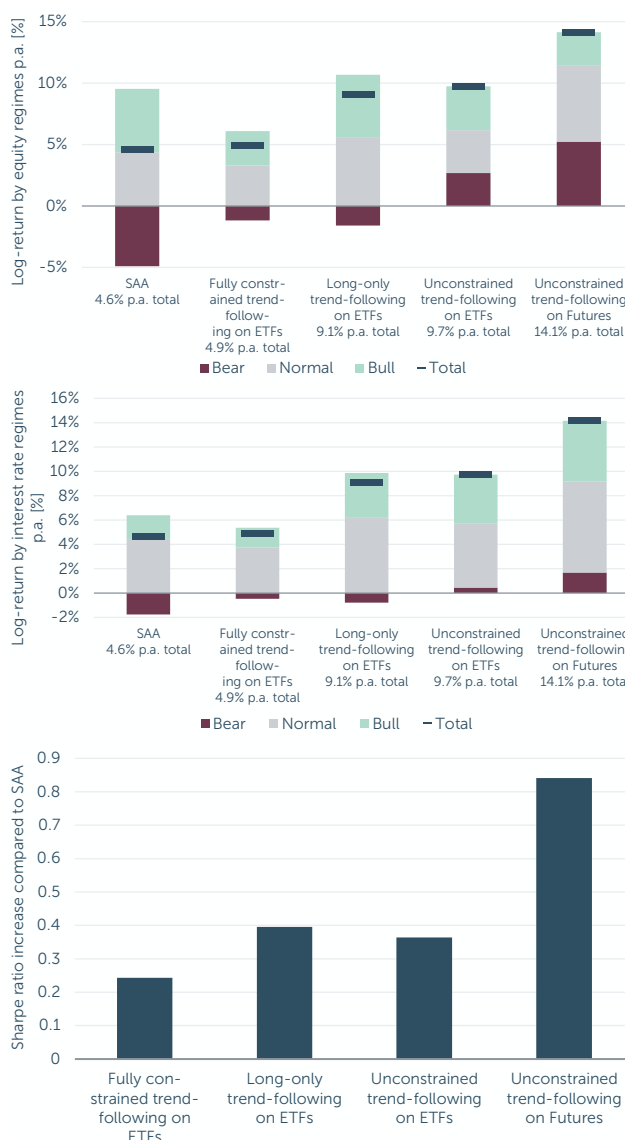### Figure 6: The Five Steps to Tripling the Sharpe Ratio

Figure 6: Incremental Sharpe ratio increase and comparative regime-conditional annualized excess log-return attribution of a generic trend-following strategy, subject to an incremental number of constraints, across three distinct Bull, Normal and Bear regimes for two different risk factors: global equities and global interest rates. Period 2000 – 2023. Source: Quantica Capital. Returns are gross of fees, but net of estimated trading costs. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

Fully unconstrained trend-following would have achieved an in-sample, hypothetical Sharpe ratio since 2000 that is 0.84 points higher than that of

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[13] For more information about the adverse long-term carry characteristics of many commodity markets from a buy-and-hold perspective, please refer to: "Rolling Down the Curve", Quantica Quarterly Insights, September 2021.

a static asset allocation benchmark recorded over that same period.

The smart diversification characteristics against both global equity and interest rate risk factors are significantly improved by the addition of short positions and the expansion of the investment universe to non-traditional assets, which have higher diversification potential. Unlike a static asset allocation benchmark, an unconstrained trend-following approach can generate positive returns during bear markets in stocks and bonds.

Conclusion

Trend-following based Tactical Asset Allocation can enhance risk-adjusted returns even when investors are long-only, unlevered, and restricted to a narrow traditional investment universe.

But an unconstrained approach to medium-to-long-term trend-following is likely to perform much better. The three key freedoms are: a risk-based (as opposed to a notional exposure based) approach to portfolio construction that uses leverage and dynamic risk management in an efficient way; its ability to take long or short positions alike; and relying on a highly diversified investment universe going beyond equities and bonds to include commodity, currency, and a wider variety of short-term bond & interest rates markets, for which sufficiently liquid ETFs do not exist and which are not part of most passive asset allocation benchmarks.

We have shown that prohibiting leverage significantly lowers the absolute and risk-adjusted returns from such a strategy.

This is because capping overall gross notional exposure prevents it from deploying its risk budget consistently over time and across asset classes.

Although prohibiting short positions had no adverse impact on overall hypothetical risk-adjusted returns over the observation period, it does significantly alter and almost eliminates its attractive smart diversification benefits (i.e., any positive absolute performance) in times of equity and/or bond market stress.

Although strong risk-adjusted trend-following returns can be generated within a traditional investment universe of 16 ETFs, the diversification benefits can be increased by an additional 50% by expanding the investment universe to 100 liquid futures markets.

Appendix 1: Expanding the ETF investment universe from 16 to 100 instruments does not improve portfolio diversification characteristics

On top of the initial set of 16 ETFs, we select another 84 distinct[14] US listed ETFs with the highest market capitalization as per June 30, 2023. For reference purpose, Table 6 provides an overview of the asset class and sub-sector composition of this extended ETF universe compared to both its more concentrated version and our generic futures universe. Additionally, the trend-following portfolio diversification characteristics of the extended investment universe are provided in Table 5.

Table 5: Comparative Diversification Characteristics

Investment universe	Investment universe size	Avg. corr. of constituent's strategy returns	Diversification multiplier	Realized strategy Sharpe ratio
Futures	100	0.07	3.7	1.27
ETFs (16)	16	0.14	2.3	0.79
ETFs (100)	100	0.21	2.1	0.85

Table 5: Comparative diversification characteristics of three different investment universes (composed of 100 futures, 16 ETFs, and 100 ETFs, respectively) when a fully unconstrained generic trend-following strategy is applied. Diversification Multiplier as defined in "The Value of Diversification in Trend-Following", Quantica Quarterly Insights, December 2021. Period: 2000 – 2023. Source: Quantica Capital. HYPOTHETICAL RESULTS. PLEASE SEE IMPORTANT DISCLAIMERS ON PAGE 2.

Strikingly, adding another set of 84 instruments does not increase the universe's Diversification Multiplier, which slightly decreases from 2.3 to 2.1., as the average cross-instrument trend-following correlation increases from 13.6% to 21.3%. In summary, the most liquid US ETFs offer far fewer diversification benefits than the most liquid global futures contracts. This is because a large chunk of the markets for which liquid futures exist do not have a corresponding liquid ETF, e.g., short-term interest rates, currencies,

and most commodity markets. These are an important driver of a higher portfolio Diversification Multiplier.

Table 6: Asset Class Constituents' Breakdown

Asset class	Sub Sector	Futures (100)	ETFs (16)	ETFs (100)
Equities	North America	7	4	47
	Europe	8	0	2
	Emerging Markets	2	1	4
	Asia Pacific	10	0	2
	Global	0	1	12
Fixed Income	Government bonds	18	4	9
	Corporate bonds	0	2	9
	MBS	0	0	2
	Total bond market	0	1	6
Short-term interest rates		4	0	2
Currencies		12	0	0
Commodities	Precious metals	4	1	3
	Base metals	6	0	0
	Energy	10	0	0
	Agriculturals	19	0	0
	Aggregate	0	1	1
Real Estate		0	1	1

Table 6: Number of constituents in each asset class and sub-sector for three different investment universes. Source: Quantica Capital.

Appendix 2: Liquidity of the 100 most liquid futures compared to 100 most liquid ETFs

Table 7: Asset Class Trading Volume and Volatility

	Per asset class median of 3-month Median Daily traded Volume [USD mn]		Average asset class 3-month ann. volatility [%]
	Futures (100)	ETF (100)	
Equities	4'120	160	15.0%
Fixed Income	27'356	158	6.5%
Currencies	5'227	N/A	8.0%
Commodities	946	389	25.0%
Real Estate	N/A	361	15.0%

Table 7: Per asset class median of 3-month Median Daily traded Volume for 100 futures universe and 100 ETFs universe as per August 2023. Source: Quantica Capital.

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[14] We filter out any ETF with less than five years of price history. When two ETFs track the same underlying index, we select the one with the highest three-month Median Daily traded Volume.

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