Quantitative Monographs

Systematic Strategies for Single-Stock Futures

Equities

Global
Quantitative

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Trading single stocks in futures markets

The advent of single stock futures (SSF) has significantly expanded the investable universe that is available for constructing unfunded long-short systematic strategies. We investigate the profitability of trend-following strategies using SSFs and explore their value-add when included in a multi-asset trend-following strategy across commodities, FX, government bonds and currencies. We conduct our analysis using the largest 50 stocks within each sector in MSCI Developed World index, and approximate SSF returns by assuming a flat financing cost of 40 basis points per annum in excess of the risk-free rate, across stocks and across time.

Profiting from trend-following across single stocks

Following our work on trend-following (see "Trend-following meets Risk-parity"), we evaluate the profitability of a trend-following strategy that is constructed using single stocks, accessed via SSFs. Over a 15-year period (November 2001 to April 2016), a volatility-targeted trend-following strategy across SSFs generates a Sharpe ratio of 0.74 and strongly outperforms an equally weighted long-only allocation (see Figure 1).

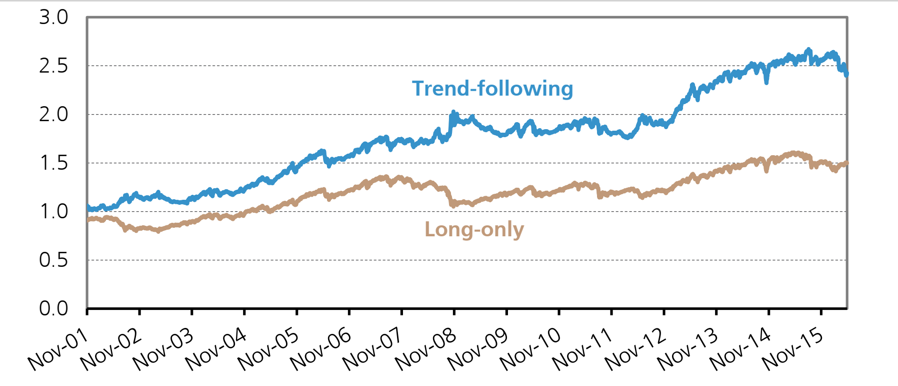
Improving the performance of a multi-asset trend-following strategy

Trend-following strategies have been traditionally constructed using futures contracts across commodities, FX, government bonds and equity indices. Adding SSF as an additional asset class can improve the performance of the overall portfolio, especially during the most recent period; the Sharpe ratio of the strategy post-2010 increases from 0.88 up to 1.01 after the inclusion of the SSF trend-following strategy. This result remains robust to a number of methodological alterations.

What is the sensitivity in the financing costs of SSFs?

The SSF financing costs can certainly hurt the performance of the respective trend-following strategy. By performing a sensitivity analysis, we find that the marginal benefit from the inclusion of SSFs in a multi-asset trend-following strategy is eliminated for relatively larger financings spreads that exceed 230 basis points per annum.

Figure 1: Trend-following versus Long-only using single-stock futures



Source: UBS Quantitative Research. The figure presents the cumulative returns of a 12-month trend-following strategy applied across a universe of single stock futures. For comparison, a long-only equal weighted portfolio is also presented. **Both portfolios target a volatility of 7%**. Sample period: Nov. 2001 – Apr 2016.

Introduction

Single-stock Futures

In the realm of futures, single-stock futures (henceforth, SSF) are relatively new instruments. Following the Commodities Futures Modernization Act of 2000 lifting the ban on trading SSFs in the US, they are proving more appealing as a new ingredient to unfunded systematic long-short strategies.

In this monograph, we first explore the profitability of a trend-following strategy using single stocks that are traded via SSFs; this topic has only recently received some publicity following an article at the CTA Intelligence magazine, by Matt Smith.[1] Then, we investigate the diversification benefits of adding this strategy to a typical multi-asset trend-following strategy that includes commodities, FX rates, government bonds and equity indices.

What is an SSF?

A typical futures contract on a stock requires the buyer to pay a price, agreed at the outset, for a standardised quantity of shares (typically 100) at a pre-defined future date; cash settlement instead of physical delivery is also possible, depending on the contract specifications. Provided that the underlying stock is liquid enough and a financing market exists, a SSF can always be synthesised. That is, the liquidity of an SSF depends on how liquid the underlying stock is as well as the borrowing capability for short positions. As a relatively new class of instruments, they offer investors the ability to trade on a conviction about a particular entity rather than a whole asset class.

Why trade SSFs?

Trading a single stock via a SSF, as opposed to engaging in a cash transaction, comes with a number of advantages, apart from the typical textbook benefits of owning a futures contract (hedging, leverage and speculation). It allows the construction of a strategy on an unfunded basis (subject to margin requirements), it makes the shorting of a stock much easier and straightforward (see Danielsen, Van Ness and Warr, 2009) and additionally, it can prove to be tax-efficient, particularly in the US, given the higher tax rate on dividend income.[2] Additionally, one can use SSFs to gain exposure to interest rates or dividends without necessarily having a directional view on the underlying stock.

The landscape of SSF trading

SSFs are nowadays traded on Eurex or ICE for European equities and on OneChicago for US equities with features similar to those of equity index futures[3] and are typically settled in cash. Most SSFs are total return futures in that they adjust for the dividend on the ex-dividend date, and this is the approach that we take in this monograph.

Whilst the work we present here does not extend to post-implementation effects of carrying out our strategy, it is worth noting that there has been a lot of media coverage following the flash-crash of August 2015 relating to the effect that risk-based investing and trend-following has on the stability of financial markets. For the interested reader, we wrote a report on this in September 2015; *"Why blame Risk-parity and CTAs?"*.

[1] See the CTA Intelligence (March 2014) article "*Stock in Trade*" by Matt Smith.
[2] See the Forbes (2010) article *"How to profit from Single-Stock Futures"* by William Baldwin.
[3] It's important to note that whilst, in theory, SSFs should be easy to trade, volumes so far have been relatively thin and an investor will find it difficult to source a contract with a longer-term maturity. The other issue is the challenge of finding a retail broker to take the trade. These issues, however, should fade in time as more investors seek to exploit the potential of trading SSFs.

Paper structure

After a brief overview of the literature in the next page, we provide a short introduction on trend-following on page 4 and then give an overview of our dataset as well as our methodology in estimating SSF returns using spot return data in pages 5-6. The core of our analysis is contained in pages 7-11, where we present the performance of trend-following strategies using SSFs as well as the performance of multi-asset trend-following strategies before and after the inclusion of the SSF component. Finally, pages 12-16 contain a number of robustness checks and alternative specifications for our empirical analysis.

Literature

Investing in SSFs

Busby (2002) is probably the first paper to provide an overview on the subject of investing in SSFs. More recently, the majority of academic papers on SSFs focus on the improvement of the price discovery mechanism and market efficiency following the introduction of SSFs; see Ang and Cheng (2005), Fung and Tse (2008), Shastri, Thirumalai, Zutter (2008), Mutlu and Arik (2015) and Malik and Shah (2016). However, there is hardly any work done in the space of using SSFs in the construction of systematic equity strategies; we aim to start filling this gap.

Cross-sectional momentum

As far as momentum is concerned, there are two, yet distinct, types of price momentum in the financial economics literature. The more traditional form of momentum studies the (cross-sectional) return differential between recent winners and recent losers and has been heavily studied across single stocks since the works of Jegadeesh and Titman (1993, 2001). Cross-sectional momentum has only recently been studied across non-equity asset classes in Asness, Moskowitz and Pedersen (2013).

Time-series momentum, aka trend-following

The other side of momentum that looks at the serial correlation of returns has been known as trend-following and has only recently been studied in the academic literature by Moskowitz, Ooi and Pedersen (2012), Hurst, Ooi and Pedersen (2012, 2013) and Baltas and Kosowski (2013). Contrary to cross-sectional momentum, trend-following has been primarily studied using a diversified universe of futures contracts across asset classes, but there is hardly any evidence on trend-following using single stocks. Wilcox and Crittenden (2005) are the first to look into the profitability of trend-following strategies using single stocks, but only focus on the long side of the strategy; they do not employ short positions, as they highlight the various implications of shorting using spot cash transactions. With the use of SSFs we can certainly address this issue, as taking a short position becomes practically as easy as taking a long position.

More recently, Goyal and Jegadeesh (2015) compare the cross-sectional and time-series implementations of momentum using spot cash transactions across single stocks (as opposed to SSFs), as well as across various other asset classes (commodities, FX, government bonds and equity indices). Finally, Gulen and Petkova (2015) focus on single stocks, assuming again spot cash transactions, and explore various facets of cross-sectional and time-series natures of momentum.

Following the above and to the best of our knowledge, our paper constitutes a unique contribution to the trend-following literature, being the first to focus on the profitability of trend-following strategies that make use of SSFs.

Trend-following

Trend-following (henceforth TF) is the systematic momentum trading strategy that generates positive returns when there are persistent return continuation patterns either on the upside or the downside. The methodology we use in this note builds on our research on TF strategies; *"Trend-following meets Risk-parity"* (Dec 2013).[4]

"Buy High; Sell Low"

A basic TF strategy involves taking long or short positions on assets with a positive or negative, respectively, past 12-month return.

In what follows we first apply this framework across a universe of single stocks using SSFs, and subsequently explore the value-add of this strategy when included as a new "asset class" to a classic multi-asset trend-following portfolio across commodities, FX, government bonds and equity indices.

Equal weights for SSFs

For the single-stock trend-following strategy, we employ an equal-gross weighting scheme[5] and therefore the return series of the SSF trend-following strategy becomes (N_t denotes the number of available assets at time t):

$$r_{t,t+1}^{TF,SSF} = \sum_{i=1}^{N_t} sign\left(r_{t-12,t}^{i}\right) \cdot \frac{1}{N_t} \cdot r_{t,t+1}^{i} \tag{1}$$

Inverse-volatility weights for the other asset classes

For the remaining asset classes (commodities, FX, government bonds and equity indices), we will follow our existing work in this space and use an inverse-volatility (IV) weighting scheme (in our publications we also refer to this scheme as "volatility-parity") for the gross exposures:

$$r_{t,t+1}^{TF,IV} = \sum_{i=1}^{N_t} sign\left(r_{t-12,t}^{i}\right) \cdot \frac{1/\sigma_t^i}{\sum_{j=1}^{N_t} 1/\sigma_t^j} \cdot r_{t,t+1}^{i} \tag{2}$$

The asset-class specific portfolios are then combined using a risk-parity scheme in order to give rise to the multi-asset risk-parity trend-following portfolio. The benefits of using a risk-parity allocation at the multi-asset level have been highlighted in our *"Trend-following meets Risk-parity"*, (Dec. 2013) note.

Volatility-targeting

In our analysis, we typically present constant-volatility (henceforth CV) versions[6] of the strategies, so to facilitate the visual comparison across various methodologies. The CV overlay introduces leverage, which is equal to the ratio of the chosen target volatility σ_{TGT} and the running realised volatility σ_t of the unlevered strategy of interest. Overall, the CV formulation of any strategy is given by:

$$r_{t,t+1}^{CV} = \underbrace{\frac{\sigma_{TGT}}{\sigma_t}}_{Leverage} \cdot r_{t,t+1} \tag{3}$$

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[4] For further details on the dynamics of trend-following strategies, see Moskowitz, Ooi and Pedersen (2012), Hurst, Ooi and Pedersen (2012, 2013) and Baltas and Kosowski (2013).
[5] As volatilities amongst stocks are typically tightly distributed within a large-cap universe like the one that we use in this note (see next page), an inverse-volatility weighting scheme will be numerically very similar to an equal notional allocation.
[6] We have published extensively on the concept of volatility targeting; see *"Understanding Volatility Targeting Strategies"* (Oct. 2011), *"Beyond Volatility Targeting"* (June 2012), and *"Extending Volatility Targeting"* (Sept. 2013).

Data Description

Single stocks

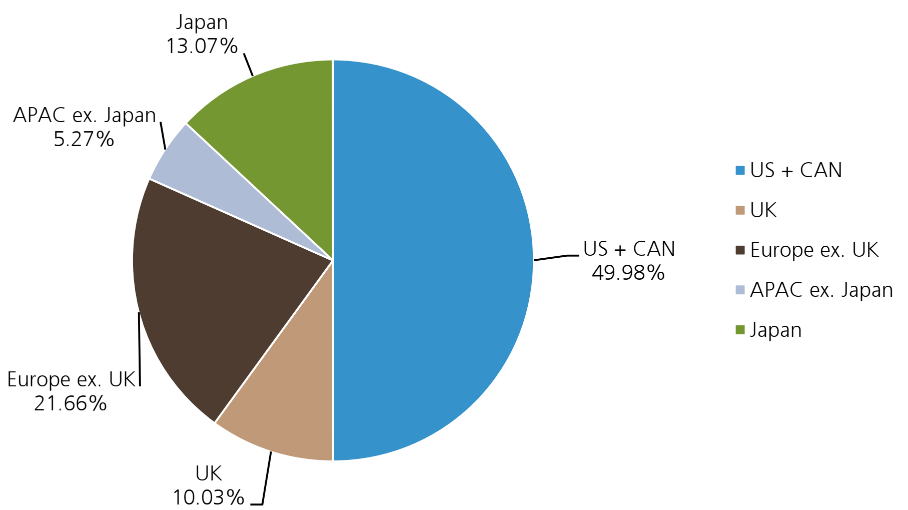
For our analysis, we consider a universe that contains the top 50 stocks by market cap within each sector from the MSCI Developed World Index at the end of each month (there are 10 sectors based on the GICS classification system, so in total we have 500 stocks at each point in time[7]). Our conclusions remain qualitatively the same for other similar universes like the top 500 stocks by market cap or the top 50% by cumulative market cap from the MSCI Developed Index.

Spot versus Futures

In the absence of historical data on futures prices for our universe of single stocks, we have decided to make use of spot prices and convert the respective spot returns into futures returns; we explain this shortly. Local spot prices for all stocks are sourced from I/B/E/S and the period over which we take prices is January 2000 to April 2016.

Figure 2 presents the average historical breakdown of gross weights across the various global regions (24 countries are represented in our universe). Country weights are fairly stable over time; for US, the most dominant country throughout, weights range between approximately 38% and 48%.

Figure 2: Average Gross Weights per Region for Single Stocks



Source: UBS Quantitative Research. The figure presents the average gross weights per region for the SSF trend-following strategy. Sample period: Nov. 2001 – Apr 2016.

In what follows, we assume that single-stock futures are total return futures that adjust for the dividend on the ex-dividend date. Therefore, a single-stock futures price is simply the sum of its cash spot price and the financing cost (basis)[8]:

$$futures = spot + financing\ cost \tag{4}$$

In practice, financing costs differ (across stocks and over time) as a function of a number of factors such as: type of security, loan size, loan duration, liquidity of the stock, collateral required.

[7] As of September 2016, Real Estate, previously under Financials, is classified as a sector in its own right under the GICS classification so there are now 11 sectors in total.
[8] Conversely, for a price return future, we would have to subtract income from the cash amount and financing cost.

General Collateral vs. Special

Stocks are typically categorised as either General Collateral (GC) or "Special"; this categorisation determines effectively the level of the financing costs (risk-free rate and the financing spread). GC stocks are usually more liquid and come with low spread (20-60bps per annum as a ballpark figure), as opposed to Special, which are much harder to borrow and the financing spread can reach levels of several hundreds of basis points per annum.

Due to a lack of reliable and historical information on the financing costs of our universe of stocks, we will assume that for the purpose of our analysis, all stocks are GC with a spread of 40bps per annum. Given that our universe contains the largest (by market cap) stocks of each sector from a global developed index at the end of each month, we think this assumption is not unrealistic. For robustness purposes, we provide some analysis on the sensitivity of our results on this assumption at a later stage in this note.

Estimating SSF returns for long and short positions

Let r_t^i denote the spot total return at the end of month t. In order to estimate the SSF return for our TF strategies, we need to identify the cash-flows that each position entails:

- **Long:** an investor with a long SSF position earns the spot return r_t^i, but pays the prevailing risk-free rate, r_t^{rf}, and the financing spread:

$$r_t^{SSF,Long} = +r_t^i - r_t^{rf} - spread \qquad (5)$$

- **Short:** an investor with a short SSF position earns the negative of the spot return, and also earns the prevailing risk-free rate minus the financing spread:

$$r_t^{SSF,Short} = -r_t^i + r_t^{rf} - spread \qquad (6)$$

For the risk-free rate we use the 3-month Libor rate of the country that each stock in our universe belongs to. As already mentioned above, the financing spread is set equal to 40bps per annum, constant for each stock and across time.

Multi-asset universe

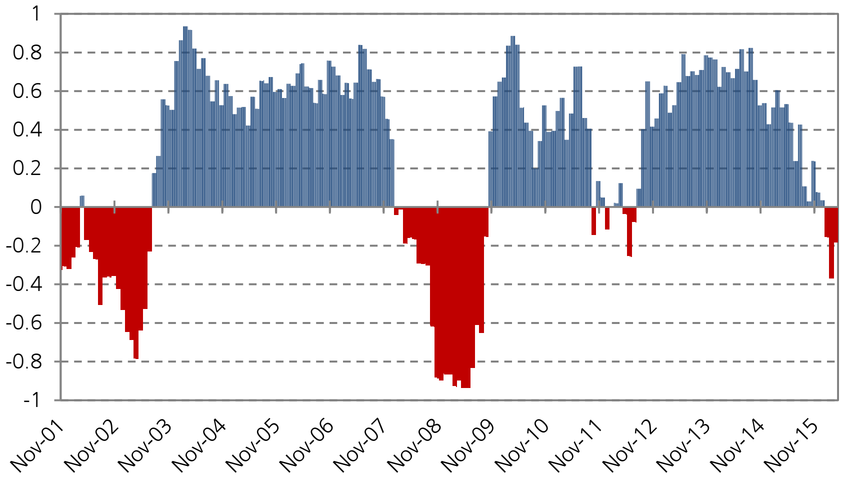
Our multi-asset universe consists of 48 assets across all asset classes: 19 commodities, 9 FX rates, 7 ten-year government bonds, and 13 equity country indices; see the Appendix (Figure 22) for the entire cross-section. In order to construct the various TF strategies we use roll-adjusted front futures contracts; the data are collected from Bloomberg.

As mentioned above, the period over which our chosen dataset of stock prices covers is January 2000 – April 2016. For the trend-following signals, we require an initial training period of 12 months. For the risk-parity allocation across various asset class portfolios we use a trailing 90-day covariance matrix. Finally, when a constant-volatility overlay is employed, we use an additional 90-day trailing volatility estimate. Taken all together, our main results start no earlier than November 2001.

Trend-Following using Single Stocks

We start our empirical analysis by first constructing a trend-following portfolio across single stocks based on equation (1). Figure 3 presents the net exposure for the SSF universe at each rebalance date, and Figure 4 presents the cumulative returns of the strategy.

Figure 3: Trend-Following on SSFs: Net Exposures

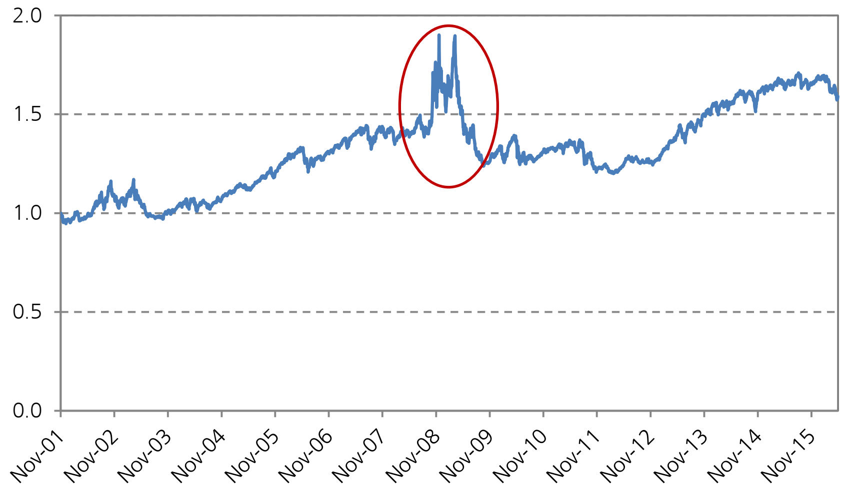


Source: UBS Quantitative Research. The figure presents the net exposure of a 12-month trend-following strategy applied across a global universe of single stock futures. Sample period: Nov. 2001 – Apr. 2016.

Trend and market timing

The market timing nature of the momentum signal is evident: the strategy is net long during market rallies and net short during market downturns, such as during the burst of the dot-com bubble, the recent financial crisis (reaching approximately 100% net short) and less aggressively so, during the Eurozone debt crisis. These conditional shifts in the net exposure offers an attractive return-profile to the SSF TF strategy that benefits across both up and down market regimes as documented in the cumulative returns chart.

Figure 4: Trend-Following using SSFs



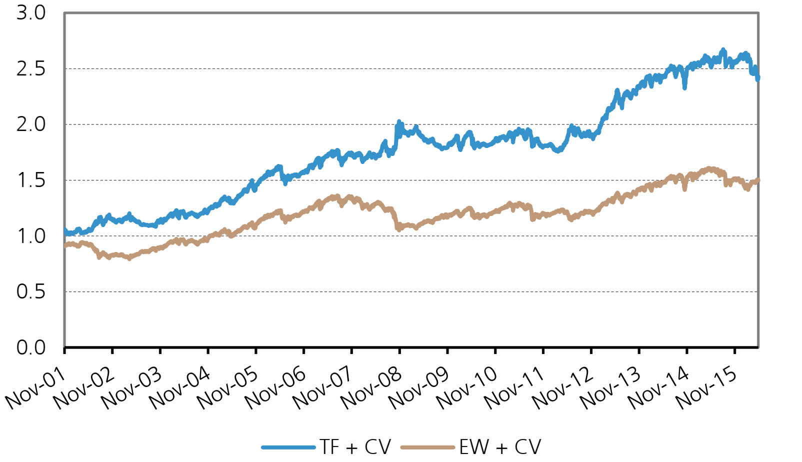
Source: UBS Quantitative Research. The figure presents the cumulative returns of a 12-month trend-following strategy applied across a universe of single stock futures. Sample period: Nov. 2001 – Apr. 2016.

The unlevered TF strategy suffers an aggressive correction during 1H2009, when the traditional cross-sectional momentum strategy suffered huge losses. One way to hedge against such momentum crashes is to employ a constant volatility overlay; see Barroso and Santa-Clara (2015), Daniel and Moskowitz (2016) as well as our review of working versions of these papers in our July 2013 ARM.

Hedging against aggressive momentum corrections

Employing a CV overlay (7% target volatility) significantly improves the performance, on an absolute basis, on a risk-adjusted basis and most importantly when compared against a benchmark long-only equally weighted (EW) portfolio; see Figures 5 and 6 below.

Figure 5: Trend-Following using SSFs with a 7% volatility target



Source: UBS Quantitative Research. The figure presents the cumulative returns of a 12-month trend-following strategy applied across a universe of single stock futures; the portfolio volatility is targeted at 7%. For comparison, a long-only equal weighted (EW) portfolio is also presented. Sample period: Nov. 2001 – Apr. 2016.

Figure 6: Performance Statistics

	TF	TF + CV	EW + CV
Geometric Mean	3.10%	5.62%	3.43%
Arithmetic Mean	3.60%	5.76%	3.66%
t-statistic (NW)	1.31	2.71	1.77
Volatility (%)	10.43%	7.81%	7.63%
Skewness	-0.03	-0.37	-0.42
Kurtosis	18.03	6.78	7.59
Max Drawdown	36.90%	13.47%	22.89%
Sharpe Ratio	0.34	0.74	0.48
Sortino Ratio	0.49	1.04	0.66

Source: UBS Quantitative Research. The figure presents various performance statistics for a trend-following strategy across single stocks before and after applying a 7% volatility target. For comparison, the respective statistics for a long-only equal weighted (EW) portfolio are also presented. Sample period: Nov. 2001 – Apr. 2016.

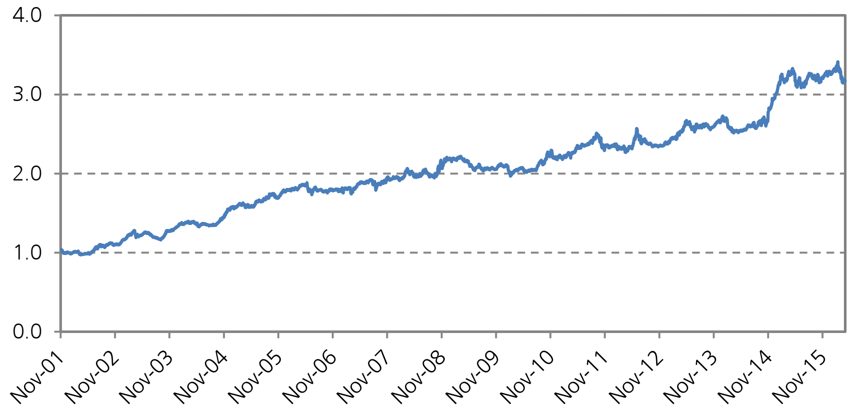
The Sharpe ratio of the SSF TF strategy more than doubles – from 0.34 to 0.74 – after employing constant volatility. A long-only equally-weighted portfolio of all SSFs (which can be thought of as a basic benchmark) only manages to achieve a Sharpe ratio of 0.48 in its constant-volatility form. This constitutes evidence that return serial correlation is strong as the stock level and a trend-following strategy outperforms a simple passive long-only allocation across the SSFs.

Adding SSFs in a multi-asset TF strategy

Given the risk-return profile of the TF strategy using SSFs, we now ask whether it is worth including it as an additional "asset class" in a typical multi-asset TF portfolio across commodities, equity indices, government bonds and currencies.

Figure 7 presents the cumulative returns of the multi-asset TF portfolio of the four asset classes, formed as the risk-parity (RP) combination of the respective asset-class-specific TF portfolios. The strategy additionally employs a CV overlay with 7% target volatility. Additionally, Figure 8 reports various performance statistics.

Figure 7: Trend-Following across four asset classes (using Risk-Parity and CV)



Source: UBS Quantitative Research. The figure presents the cumulative returns of a trend-following strategy across a universe of commodities, government bonds, FX and equity indices. The four asset class portfolios are combined using risk-parity and the portfolio volatility is targeted at 7%. Sample period: Nov. 2001 – Apr. 2016.

Figure 8: Performance Statistics

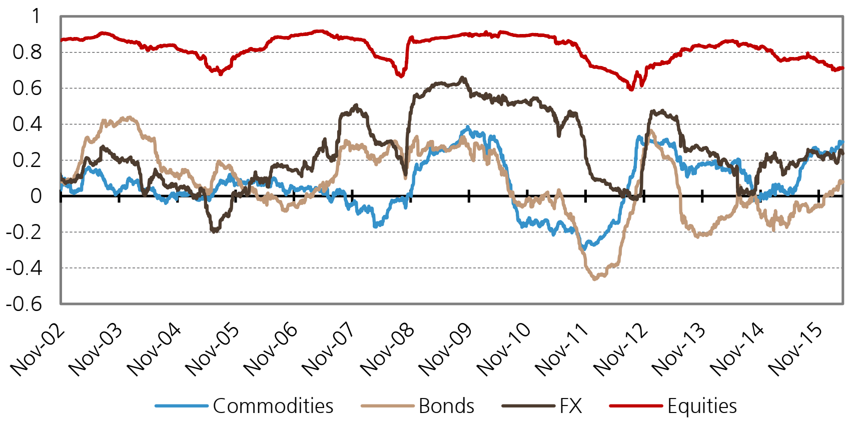
	TF across 4 asset classes
Geometric Mean	7.83%
Arithmetic Mean	7.82%
t-statistic (Newey-West)	3.77
Volatility (%)	7.51%
Skewness	-0.18
Kurtosis	5.89
Maximum Drawdown	11.32%
Sharpe Ratio	1.04
Sortino Ratio	1.51

Source: UBS Quantitative Research. The figure presents performance statistics for the strategy appearing in Figure 7.

As it has been highlighted in our "*Trend-following meets Risk-parity*", (Dec. 2013) note, the RP combination of asset-class specific TF portfolios improves substantially the performance in the post-2009 period that has been characterised by significant correlation shifts across the various asset classes.

Our objective is to evaluate the benefits of including the SSF universe in this multi-asset TF strategy. For this reason, we first investigate the pairwise correlations between the SSF TF strategy and the TF strategies across the various asset classes; 252-day rolling correlation estimates are presented in Figure 9 below.

Figure 9: Rolling 252-day correlations between SSF TF and other asset classes



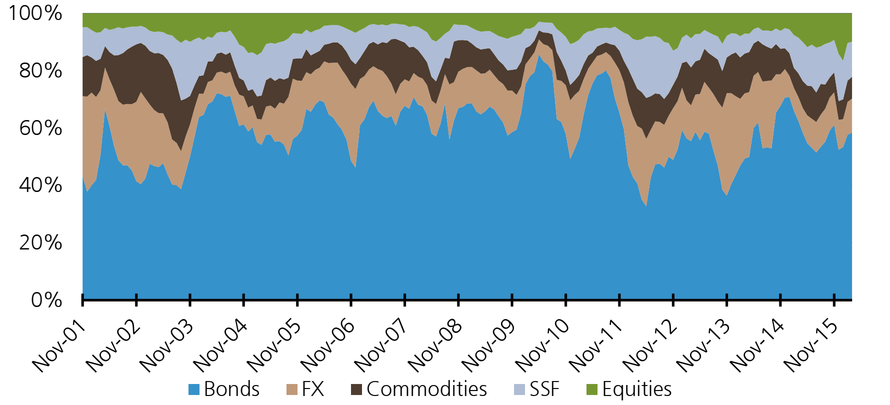
Source: UBS Quantitative Research. The figure presents rolling 252-day correlations between a TF strategy within the SSF universe and the TF strategies across commodities, government bonds, FX rates and equity indices. The sample period is November 2001 (so first estimates become available in November 2002) to April 2016.

As one would expect, the rolling correlation between SSF TF and the TF strategy across equity indices is typically high and consistently positive, around 0.8 over the entire sample period; we will try to address this issue at a later stage in this paper. However, the correlations against the other asset classes vary throughout the sample period, taking both positive and negative values. Collectively, this evidence constitutes some first visual justification for the inclusion of SSFs within our multi-asset TF strategy as we can see the potential for further diversification.

High correlations between TF strategies within SSFs and equity indices

We employ a risk-parity allocation across the five asset classes that is estimated at the end of each month using a window of the past 90 days. Figure 10 presents the evolution of the unlevered risk-parity weights for each asset class. As expected, we are consistently allocating more weight to (low-volatility) government bonds.

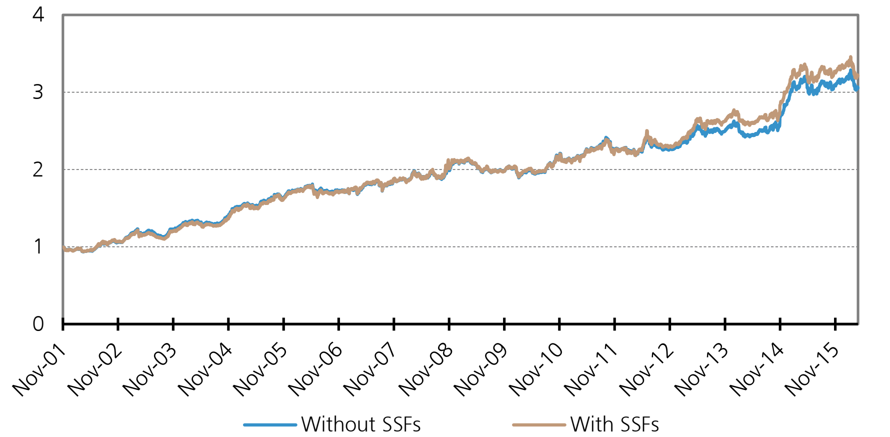
Figure 10: Evolution of RP Weights



Source: UBS Quantitative Research. The figure presents the risk-parity weights across five TF portfolios.

Figure 11 compares the performance of the multi-asset TF strategy before and after including the SSF TF component; Figure 12 presents the respective performance statistics.

Figure 11: Multi-Asset TF with and without SSFs (using Risk-Parity and CV)



Source: UBS Quantitative Research. The figure presents the cumulative returns of a multi-asset trend-following strategy before and after including the SSF trend-following component. Both portfolios target a volatility of 7%. Sample period: Nov. 2001 – Apr. 2016.

Figure 12: Performance Statistics

	w/o SSFs	with SSFs
Geometric Mean	7.83%	8.17%
Arithmetic Mean	7.82%	8.14%
t-statistic (Newey-West)	3.77	3.82
Volatility (%)	7.51%	7.55%
Skewness	-0.18	-0.26
Kurtosis	5.89	6.00
Maximum Drawdown	11.32%	11.44%
Sharpe Ratio	1.04	1.08
Sortino Ratio	1.51	1.56

Source: UBS Quantitative Research. The figure presents performance statistics for the strategies appearing in Figure 7.

There appears to be limited upside to including SSFs before 2011. After 2011, there is some benefit, albeit small, which leads to a small increase in the Sharpe ratio of the strategy over the entire sample (from 1.04 to 1.08). Figure 13 presents a sub-sample analysis; the inclusion of the SSF TF strategy increases the Sharpe ratio from 0.88 to 1.01 in the second half of the sample period.

The benefit of the SSF inclusion becomes apparent in the most recent five years

Figure 13: Subsample Analysis

	Nov. 2001 – Dec. 2010		Jan. 2011 – Apr. 2016	
	without SSFs	with SSFs	without SSFs	with SSFs
Geometric Mean	8.46%	8.40%	6.74%	7.78%
Arithmetic Mean	8.40%	8.35%	6.82%	7.79%
t-statistic (Newey-West)	3.28	3.16	1.90	2.11
Volatility (%)	7.38%	7.47%	7.76%	7.68%
Skewness	-0.15%	-0.29	-0.22	-0.31
Kurtosis	5.09	5.55	7.02	6.69
Maximum Drawdown	11.32%	11.44%	9.72%	8.76%
Sharpe Ratio	1.13	1.12	0.88	1.01
Sortino Ratio	1.66	1.62	1.27	1.43

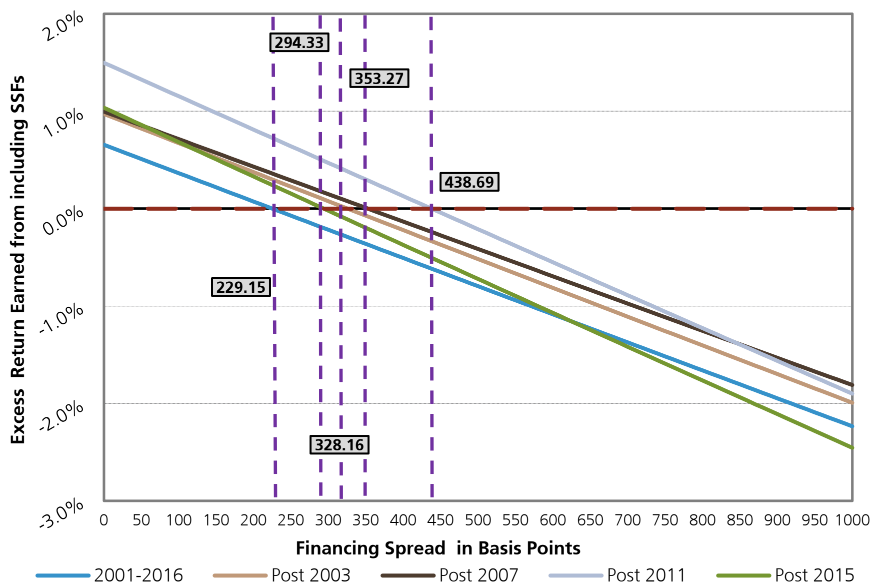
Source: UBS Quantitative Research. The figure presents performance statistics for a multi-asset trend-following strategy before and after including the SSF trend-following component across two sub-periods: November 2001 to December 2010 and January 2011 to April 2016.

What is the sensitivity to the level of financing costs?

For the analysis so far, we have assumed that all stocks were GC and imposed a fixed financing spread of 40bps (annualised) so to compute the respective futures returns, as the full time-series of actual financing costs for single stocks are not readily available. One can therefore wonder how sensitive our findings are on this assumption.

In Figure 14 we plot the excess return from various periods earned from the TF strategy after including SSFs for a wide range financing spreads. The aim is to identify the break-even point at which the inclusion of the SSF TF strategy is no longer justified.

Figure 14: Sensitivity Analysis for the Level of Financing Spread



Source: UBS Quantitative Research. The figure presents the excess return earned after including the SSF TF component in a multi-asset TF strategy for different levels of the financing spread between 0 bps and 1000 bps.

Break-even financing spread threshold: c. 230 bps p.a.

Interestingly, the most conservative break-even point in Figure 14, approximately 230 bps p.a., is associated with the excess return for the entire sample period. What this tells us is that it takes a rather unrealistic increase in the financing spread to completely wipe out the return benefit that comes from the SSF strategy.

Alternative Specifications

In order to provide additional robustness to our findings, we have conducted some additional analysis that addresses two points:

1. Using an alternative trend signal, as opposed to (just) the sign of the past return over the most recent 12-month period.

2. Reducing the effect of the high correlation between the TF strategies across SSFs and equity indices.

Alternative trend signals

One of the main advantages of our trend-following strategy is the simplicity underpinning how we compute the trading signal. However, one could argue that computing weights by (just) mapping past returns to one of two numbers (-1 or 1) could result in allocating too high a weight to those stocks whose returns are highly volatile and hence relatively more risky on a cross-sectional basis.

In this section, we suggest using an alternative trading signal which also accounts for the volatility at which the past 12-month price return has been realised. The ratio of realised excess price return over volatility trivially defines the realised Sharpe ratio.

$$Sharpe\ Ratio = \frac{\mu_{12month}}{\sigma_{12month}} \tag{7}$$

Dividing this estimate with the number of observations, N, (12 if using monthly data, 52 for weekly and 252 for daily) results in the **t-statistic of the average realised return**:

$$\tau = \frac{\mu_{12month}}{\sigma_{12month}/\sqrt{N}} \tag{8}$$

Following the above rationale, we amend the trading signal and map the past 12-month asset performance to trading signals that lie in the range [-1, 1]. We decide to use +2 and -2 as thresholds beyond which the signal is equal to +1 and -1; for the remaining values of the t-statistic we simply scale it by a factor of 2 in order to construct a continuous response function:

$$r^i_{(t-12,t)} : \rightarrow signal^i_{(t-12,t)} = \begin{cases} -1, & if\ \tau \leq -2 \\ \frac{\tau}{2}, & if\ |\tau| < +2 \\ +1, & if\ \tau \geq +2 \end{cases} \tag{9}$$

Using this signal, we systematically reduce the weights of the stocks whose realised Sharpe ratio has been relatively low in the cross-section. One could think of this as a risk-adjusted strategy overlay. In order to satisfy the fully-invested constraint, we rescale the signals in order to compute the final net weights:

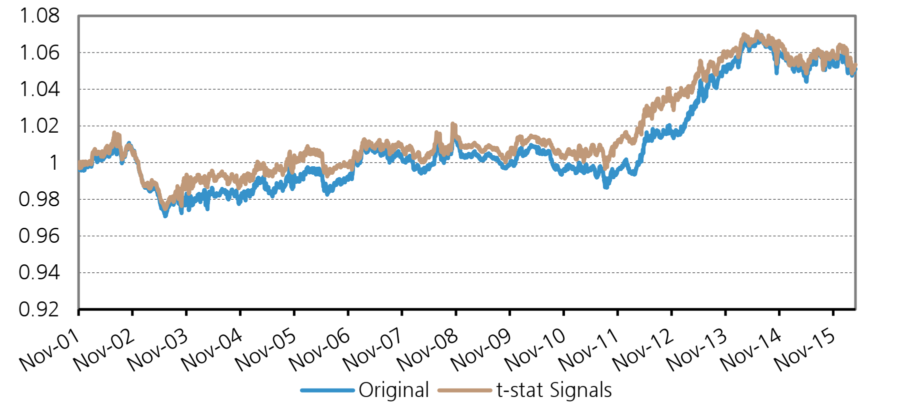
$$w_t^{Net,i} = \frac{signal^i_{(t-12,t)}}{\left|\sum_{i=1}^{N} signal^i_{(t-12,t)}\right|} \tag{10}$$

Hence, the TF strategy becomes:

$$r_{t,t+1}^{TF} = \sum_{i=1}^{N_t} w_t^{Net,i} \cdot r_{t,t+1}^{i} \qquad (11)$$

Figure 15 presents relative returns associated with the strategy generated using the t-statistic adjusted signals - with vs. without the SSF component - as well as the equivalent relative returns of the original strategy (that uses the sign of the past return as the trading signal). Figure 16 presents the respective performance statistics.

Figure 15: Multi-Asset Trend-Following using t-statistic adjusted trading signals



Source: UBS Quantitative Research. The figure presents relative returns (with SSFs vs. without SSFs) of a multi-asset trend-following strategy before and after employing a t-statistic adjusted signal. All portfolios target a volatility of 7%. Sample period: Nov. 2001 – Apr. 2016.

Figure 16: Original TF Signals versus t-stat Adjusted Signals

	Original Signals		t-stat Adjusted Signals	
	no SSFs	with SSFs	no SSFs	with SSFs
Geometric Mean	7.83%	8.17%	8.97%	9.30%
Arithmetic Mean	7.82%	8.14%	8.87%	9.17%
t-statistic (Newey-West)	3.77	3.82	4.25	4.28
Volatility (%)	7.51%	7.55%	7.46%	7.49%
Skewness	-0.18	-0.26	-0.22	-0.27
Kurtosis	5.89	6.00	5.30	5.37
Maximum Drawdown	11.32%	11.44%	9.81%	10.02%
Sharpe Ratio	1.04	1.08	1.19	1.22
Sortino Ratio	1.51	1.56	1.73	1.78

Source: UBS Quantitative Research. The figure presents performance statistics for the strategies of Figure 15.

The main message here is that the t-statistic adjusted signals improve the performance of the strategy overall (with or without the SSF component) both in absolute and risk-adjusted terms. Importantly enough, there is a substantial reduction in the maximum drawdown, which constitutes empirical evidence that the t-statistic adjusted signal reduces the downside risk of the strategy as it allocates more gross exposure to assets with more statistically strong trend. Finally, commenting on the value-add of the SSF TF component to the overall multi-asset strategy, this is still limited, yet positive.

Alternative portfolio methodologies

In our current setup, the multi-asset TF portfolio has been constructed using risk-parity principles; that is, each one of the five asset class TF portfolios (commodities, FX, bonds, equity indices and SSF) contributes the same amount of risk (volatility) to the overall portfolio (so, 20% each). As documented in Figure 9, the SSF and equity index TF components of the multi-asset strategy exhibit relatively high and persistent positive correlation over time. This means that the amount of risk that comes from the equity-related components of the overall strategy is proportionally higher when compared to the remaining asset classes. Additionally, the high level of correlation could explain the limited value-add of the SSF TF component in the overall multi-asset TF portfolio.

The "same-asset" problem

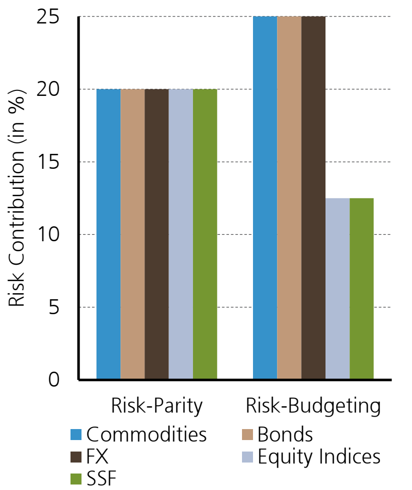
When two assets are highly correlated then a risk-parity portfolio faces the so-called "same-asset" problem, which broadly describes the inability of the portfolio construction methodology to deal with this high level of correlation and actively reduce the collective exposure to the correlated assets; the result is that the overall portfolio diversification is impacted.

In order to alleviate this "same-asset" effect in the risk-parity combination of the various TF portfolios, we explore a number of alternatives from a portfolio construction viewpoint.

Risk-Budgeting

One way to address the issue is by amending the risk allocation in a way that the SSF and equity index TF portfolios contribute *collectively* the same amount of risk that the remaining asset classes are contributing. This amounts to a contribution of 12.5% for the SSF and the equity index TF components and 25% for each one of the remaining three asset classes; Figure 18 illustrates this. The amended allocation no longer satisfies the principle of *parity* in the allocation of risk and we therefore call is risk-budgeting.

Figure 17: Risk Parity vs. Budgeting



Source: UBS Quantitative Research.

Figure 18 presents the performance statistics when we substitute risk-parity with the suggested risk-budgeting framework. Switching from risk-parity to risk-budgeting does not offer any material difference in the performance of the strategy.

Figure 18: Risk-Parity versus Risk-Budgeting

	Risk-Parity	Risk-Budgeting
Geometric Mean	8.17%	7.96%
Arithmetic Mean	8.14%	7.94%
t-statistic (Newey-West)	3.82	3.80
Volatility (%)	7.55%	7.50%
Skewness	-0.26	-0.21
Kurtosis	6.00	5.88
Maximum Drawdown	11.44%	11.31%
Sharpe Ratio	1.08	1.06
Sortino Ratio	1.56	1.53

Source: UBS Quantitative Research. The figure presents the performance statistics for two multi-asset trend-following portfolios; one that uses risk-parity weights and one that uses risk-budgeting weights in a way that the equity index and SSF components contribute jointly the same amount of portfolio volatility as commodities, FX and government bonds do. Both portfolios target a volatility of 7%. Sample period: Nov. 2001 – Apr. 2016.

Maximum Diversification

Another alternative is to depart from a risk-parity framework and employ maximum diversification (MD henceforth), introduced by Choueifaty and Coignard (2008). MD maximises the diversification potential from a given universe of assets and therefore penalises the high correlated pairs of assets; it can therefore address the "same asset" problem that we have identified.

Figure 19 presents the performance statistics when we substitute risk-parity with maximum diversification. We find that the performance improvement is not substantial.

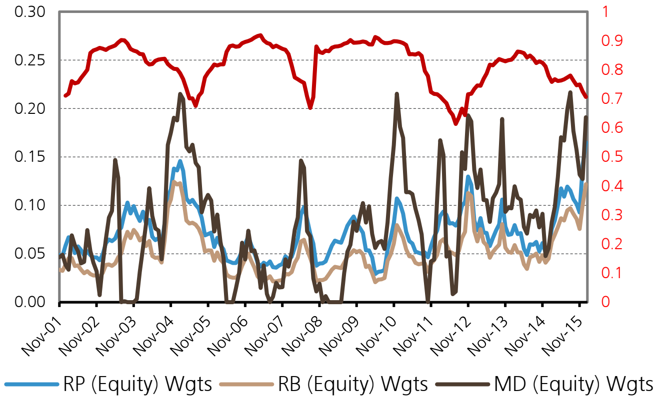
Figure 19: Risk-Parity versus Maximum Diversification

	Risk-Parity	Maximum Diversification
Geometric Mean	8.17%	8.19%
Arithmetic Mean	8.14%	8.15%
t-statistic (Newey-West)	3.82	3.90
Volatility (%)	7.55%	7.35%
Skewness	-0.26	-0.18
Kurtosis	6.00	4.61
Maximum Drawdown	11.44%	11.20%
Sharpe Ratio	1.08	1.11
Sortino Ratio	1.56	1.62

Source: UBS Quantitative Research. The figure presents the performance statistics for two multi-asset trend-following portfolios; one that uses risk-parity weights and one that uses maximum diversification weights. Both portfolios target a volatility of 7%. Sample period: Nov. 2001 – Apr. 2016.

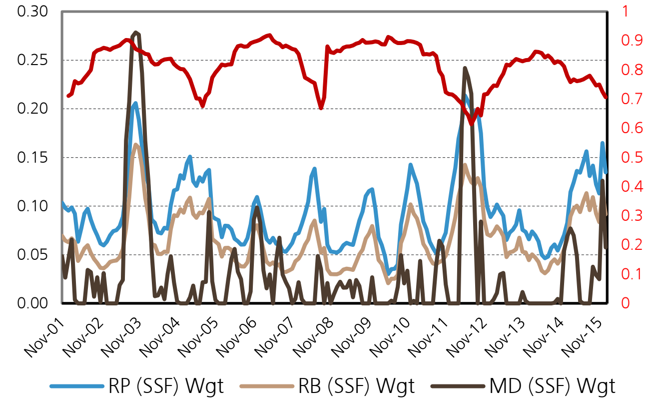
It is evident that the alternative risk-related weighting methodologies that we presented above yield minor differences in the overall performance of the multi-asset TF strategy. It is, however, worth comparing the allocations to equity index and SSF TF components, under the different methodologies that we employed. Figure 20 presents the allocation to the TF strategy of equity indices and Figure 21 presents the allocation to the TF strategy of SSFs. Both figures additionally present the 252-day rolling pairwise correlation between the TF strategies across equity indices and SSFs (red line, measured on the right-hand side).

Figure 20: Equity Index TF allocation



Source: UBS Quantitative Research. The figure presents the allocation to the equity index TF strategy under three different allocation frameworks: risk-parity (RP), risk-budgeting (RB), and maximum diversification (MD). The red line illustrates the correlation between the equity index and the SSF TF strategies on a 252-day rolling basis (measured on the right-hand side).

Figure 21: SSF TF allocation



Source: UBS Quantitative Research. The figure presents the allocation to the SSF TF strategy under three different allocation frameworks: risk-parity (RP), risk-budgeting (RB), and maximum diversification (MD). The red line illustrates the correlation between the equity index and the SSF TF strategies on a 252-day rolling basis (measured on the right-hand side).

Broadly speaking, all weighting schemes respond to correlation changes and generally increase the allocation to both equity indices and SSFs when correlation between the two falls (there are obviously other dynamics that control the allocations, that are not depicted in the figures; these are the correlations with all the remaining TF portfolios across commodities, FX and government bonds).

The risk-parity and risk-budgeting weights are approximately parallel throughout; as expected risk-budgeting consistently allocates less weight to both equities and SSFs, because they should jointly contribute 25% of total portfolio risk (as opposed to 20%+20%=40% for the risk-parity case).

Finally, the maximum diversification allocations are significantly more time-varying, as they are by construction much more responsive to correlation changes (which obviously comes at a higher turnover, as opposed to risk-parity that acts like a shrinkage technique to the covariance matrix[9]). Importantly enough, in order to alleviate the "same asset" problem, maximum diversification allows for zero weights, as it is obvious from the figures above, as opposed to the other risk-based schemes that do now allow, by definition, zero weights.

Avoiding Double Country Bets

In our final attempt to reduce the effect of the "same asset" problem, we suggest "switching off" constituents in our SSF TF portfolio, when their respective position (long or short) aligns with the position in the underlying equity index, which is anyhow part of our equity index TF portfolio. This theoretically removes any duplicate country bets and should therefore increase the breadth of the universe as we are only left with the SSFs with an opposing position to their respective local equity market.

Across time and across countries, the above methodology switches off about 70% of the SSF positions. The resulting SSF TF portfolio is left with few stocks and fails to improve the performance of the multi-asset TF portfolio. We therefore do not present any further results in this paper.

Future Research

This paper constitutes the first effort in understanding the added benefits of using single stock futures for the implementation of systematic strategies. This research can be extended across various directions:

- Looking at conventional equity factor long-short premia (momentum, value, quality, low-risk) and investigate whether the practical implications relating to shorting of the bottom-ranked basket of stocks can be mitigated by the use of SSFs.
- Exploring trade-off between increasing the breadth of the SSF strategies by broadening the equity universe and the higher financing costs that are associated with less liquid stocks.

[9] See our work on this topic in our "*Understanding Risk-Parity*" (Feb. 2013) note.

Appendix

Figure 22: Multi-Asset Universe

Commodities	FX	Government Bonds	Equity Indices
Natural Gas	EUR	US T-Note	US - S&P500
Heating Oil	JPY	Australian GB	Canada - S&P TSX 60
Gas Oil	GBP	Canadian GB	Germany - DAX
Light Crude	AUD	German Bund	UK - FTSE 100
Brent Crude	CAD	Japanese GB	Korea - Kospi 200
Sugar #11	CHF	UK Gilt	Japan - Nikkei 225
Live Cattle	NZD	Swiss GB	Australia - ASX 200
Cocoa	SEK		HK - Hang Seng
Coffee "C"	NOK		Spain - IBEX 35
Cotton #2			Switzerland - SMI
Soybeans			France - CAC 40
Corn			Norway - OBX
Wheat			Netherlands - AEX 25
Copper			
Aluminium			
Nickel			
Zinc			
Gold (100 oz.)			
Silver			

Source: UBS Quantitative Research.

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