Academic Research Monitor

Rebalancing Risks

Equities

Global

Quantitative

Rebalancing Risk

What are the effects of a weighting strategy on the performance of a portfolio? At a single stock level the general view is that equal weighting (even after costs) outperforms a cap weight methodology. Why is this the case? And asset allocators tend to run a constant weighting mix (the archetypal 60/40 strategy being a well known example). What is the effect of rebalancing back to this fixed weight benchmark?

Does fixed weight rebalancing benefit from being a 'contrarian'?

The general view is that a fixed weight strategy benefits from being a contrarian – selling winners and buying losers – but we show in our reproductions of one of the reviewed papers that the story is more complex. For example in European equities a fixed weight strategy outperforms even though one month price reversals actually underperforms over the backtest period.

Myths and risks associated with rebalancing approaches

Periodic rebalancing to fixed weights (also known as constant-mix strategies) is often associated with passive investing and is considered the optimal approach to achieving a target return over the long term. There are several myths around this approach, however, and risks associated with "naïve" rebalancing methods are often not given enough attention in the related academic literature. The first two papers discuss these risks and myths aforementioned and offer solutions to overcome these risks when periodic rebalancing is unavoidable.

Improving your rebalancing

Two of the papers we review suggest improvements to the fixed weight rebalancing – either adding an option-writing- or a momentum-overlay.

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Introduction

The possibilities regarding stock selection and portfolio construction methods are endless; from a simple equal-weighting strategy to more esoteric suggestions, the volume of research on this topic is vast. Whilst this breadth of academic research on forming portfolios is advantageous to quants like us, the practical considerations are often given less attention in the academic literature. In this issue of our Academic Research Monitor, we therefore focus our attention on the topic of rebalancing, the decisions involved in rebalancing policies and the implications those decisions have on portfolio performance (see Figure 1).

Many of these papers focus on the idea that a fixed weight strategy has an exposure to a 'contrarian' strategy – selling winners and buying losers, and this is part of the reason that a fixed weight strategy tends to outperform. We discuss this, and analyse some results of our own, in our review of Plyakha et al (2016). We find the conclusion is more complex.

The first two papers we review discuss the myths and risks around fixed-weight rebalancing ("naïve" rebalancing). In a framework where the investor is not constrained to one asset class and bases the portfolio performance on a wide range of summary statistics, i.e. not just on volatility, the authors of both papers deduce that naïve rebalancing strategies result in poor market timing and are not necessarily a means of managing risk and yielding superior returns. The first paper suggests using a momentum overlay to mitigate these risks (more specificially reduce drawdowns) when periodic rebalancing is mandatory. In the second paper, several *naïve* and *intelligent* rebalancing approaches are tested. The authors show that the latter not only outperforms the former from an absolute and risk-adjusted return perspective, and exhibits the highest degree of skill.

Chinco and Fos discuss how rebalancing in one name could lead to a cascade of trades. They illustrate this concept via ETF holdings.

The final paper argues that an option overwriting strategy is an efficient way of implementing rebalancing to fixed weights – using the example of a equity / bond portfolio they argue that if equities outperform bonds one has to sell equities to rebalance back to fixed weights. Selling a call option achieves this and has the advantage of receiving a premium for doing so.

Figure 1: Papers on Rebalancing

"Rebalancing Risk" *Nick Granger, Douglas Greenig, Campbell Harvey, Sandy Rattray & David Zou*	*SSRN working paper, June 2016*
"The Mythology of Rebalancing: A Random Walk Down Performance and Risk Management" *Brian Baker, Michael Dieschbourg, Damian McIntyre & Arun Muralidhar*	*SSRN working paper, Jan 2017*
"The Sound of Many Funds Rebalancing" *Alexander Chinco & Vyacheslav Fos*	*SSRN working paper, Jan 2017*
"Equal or Value Weighting? Implications for Asset-Pricing Tests" *Yuliya Plyakha, Raman Uppal and Grigory Vilkov*	*SSRN working paper, Jan 2016*
"An Alternative Option to Portfolio Rebalancing" *Roni Israelov & Harsha Tummala*	*Journal of Derivatives, Spring 2018*

Source: UBS.

"Rebalancing Risk"

by Nick Granger, Doug Greenig, Campbell R. Harvey, Sandy Rattray and David Zou

Why do investors rebalance at periodic frequencies?

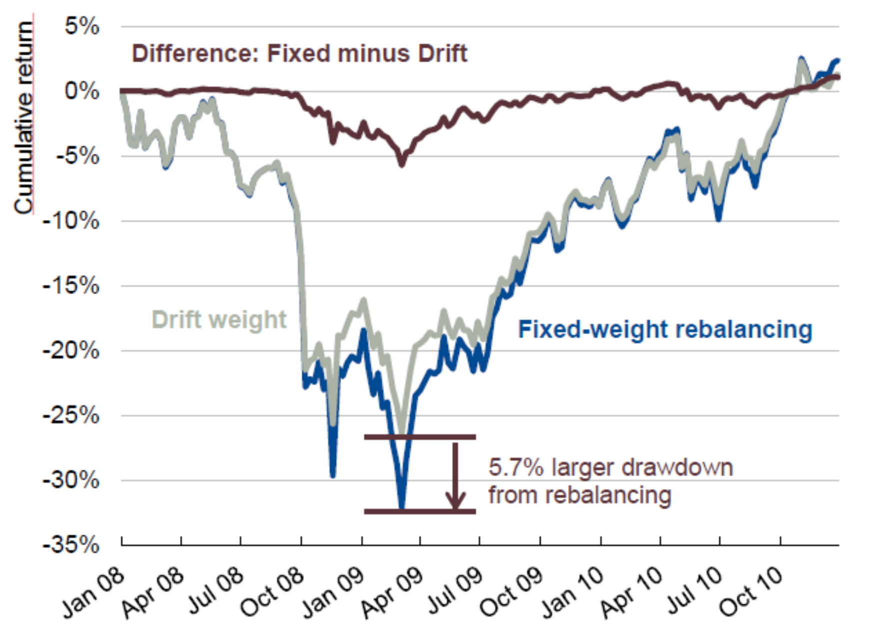
When will a rebalancing premium be realised?

Rebalancing to fixed weights (also known as constant-mix strategies) is done, in practice, for several reasons. Firstly, it systematically maintains the portfolio characteristics set out at the beginning of the strategy formation period. Secondly, it is advocated for avoiding extreme weight drifts which could result in overweighting those assets whose risk profile is relatively high. Related to this, rebalancing can limit the concentration in particular groups of stocks or assets so that an appropriate level of diversification is sustained. In addition, there are circumstances under which rebalancing offers a premium; the so-called "rebalancing premium". This occurs in situations where rebalancing requires buying some of the underperforming assets and selling some of the outperforming assets; a mechanism which offers the investor gains provided mean reversion occurs in relative asset performance.

When is rebalancing not advantageous to the investor?

Despite these justifications, Granger et al. (2014) explain why rebalancing to fixed weights has its drawbacks. Mainly, when relative asset returns are not mean reverting and, instead, diverge strongly over periods of time, rebalancing forces the investor to continue buying underperforming assets.

Figure 2: Magnified drawdowns from rebalancing during the GFC



Source: Figure 1 from "Rebalancing Risk" by Granger et al. Used with permission. The plot shows cumulative returns to buy-and-hold and fixed-weight 60/40 portfolios of the S&P 500 and 10-year US Treasury Bond over the period January 2008- December 2010.

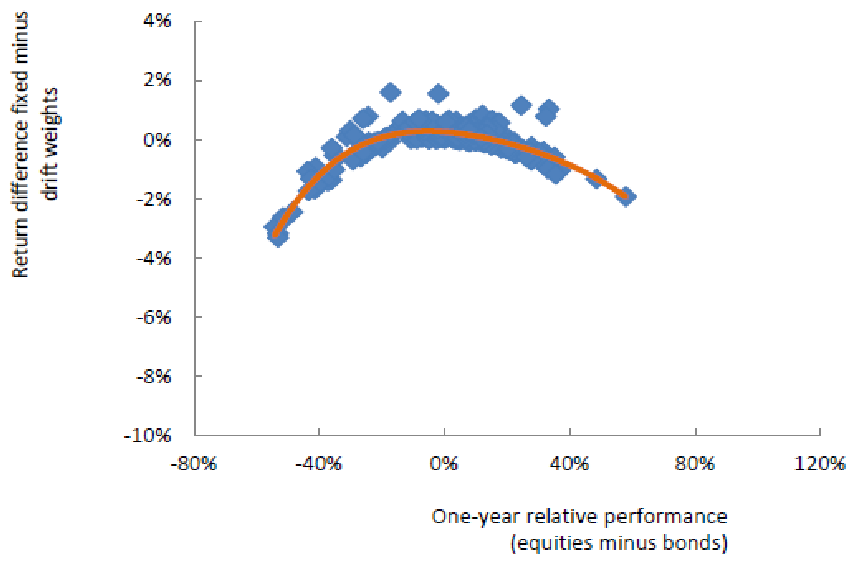
Fixed-weight rebalancing can increase the magnitude of drawdowns

As Figure 2 demonstrates, a fixed-weight 60/40 equity/bond portfolio realised worse drawdowns than the buy-and-hold equivalent portfolio where weights were allowed to drift. In addition, Figure 3 shows that, whilst fixed-weight rebalancing can earn a small rebalancing premium relative to the "drift-weight" case, the negative relative returns are much greater in magnitude.

> *" ...rebalancing is no free lunch but represents an implicit bet against diverging asset performance."*

The definition of "drift weight" is simple – the portfolios are invested at the fixed weights at the start of the period and then allowed to move with the relative performance of the two assets. We note that this introduces a dependence on the choice of starting dates to the results of the backtests reported in the paper.

Figure 3: Fixed vs. drift weights: performance difference over one year



Source: Figure 3A from "Rebalancing Risk" by Granger et al. Used with permission. The plot shows one-year (empirical) returns differences between fixed weights and drift weights as the one-year relative performance between equities and bonds changes.

When rebalancing is required, add a momentum overlay

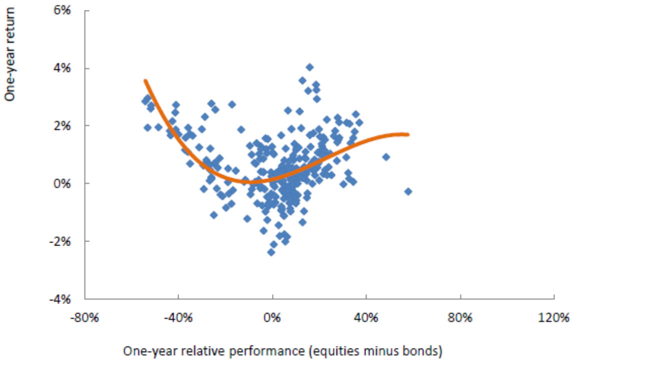
Essentially, large drawdowns from a constant-mix portfolio occur in trending markets. The authors show theoretically[1] that the final payoff of a fixed-weight rebalancing strategy offers worse drawdowns in comparison to a buy-and-hold strategy. However, in practice it is often mandatory to carry out periodic rebalancing.

In this case, Granger et al. suggest adding a momentum overlay for the purpose of improving the risk properties and hedging the elevated drawdown risks mentioned above. This might seem counter-intuitive since momentum strategies are notorious for their large crashes. A momentum strategy, however, gains during those times when the constant-mix strategy suffers losses and, as the authors claim, it "imposes little cost at other times". In other words, the benefits of adding a momentum tilt outweighs the costs.

Figure 4 and Figure 5 below show empirical and simulated one year returns from momentum trading on stocks and bonds for varying divergences between the returns of these two assets. Comparing these with Figure 3 visually suggests how momentum could hedge a fixed weight fixed-weight rebalancing scheme.

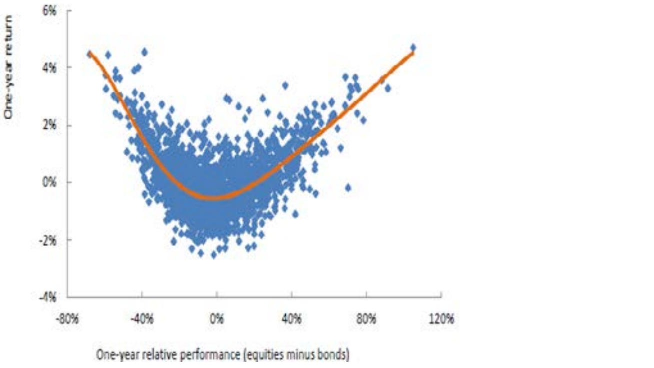
[1] We refer the interested reader to the appendix of the paper for their theoretical workings.

Figure 4: Momentum trading on stocks and bond (empirical)



Source: Figure 5A from "Rebalancing Risk" by Granger et al. Used with permission. The plot shows one-year returns as a function of the return difference between stocks and bonds.

Figure 5: Momentum trading on stocks and bond (simulated)



Source: Figure 5B from "Rebalancing Risk" by Granger et al. Used with permission. The plot shows one-year returns as a function of the return difference between stocks and bonds using simulated data.

The momentum overlay uses a momentum average cross-over model with a target risk of 10% of the fixed-weight portfolio.

According to the authors the choice of momentum strategy is not that important. The primary choice is the degree to which the momentum overlay is applied. The size of the momentum overlay is driven by risk – one can allocate a constant proportion of the fixed-weight portfolio's risk into the momentum strategy.

As Figure 6 shows, whether rebalancing is carried out monthly or quarterly, for greater allocations of momentum, higher returns (absolute and risk-adjusted) are realised. Furthermore, the maximum drawdown is reduced and skewness becomes less negative the higher the amount of momentum overlay is applied.

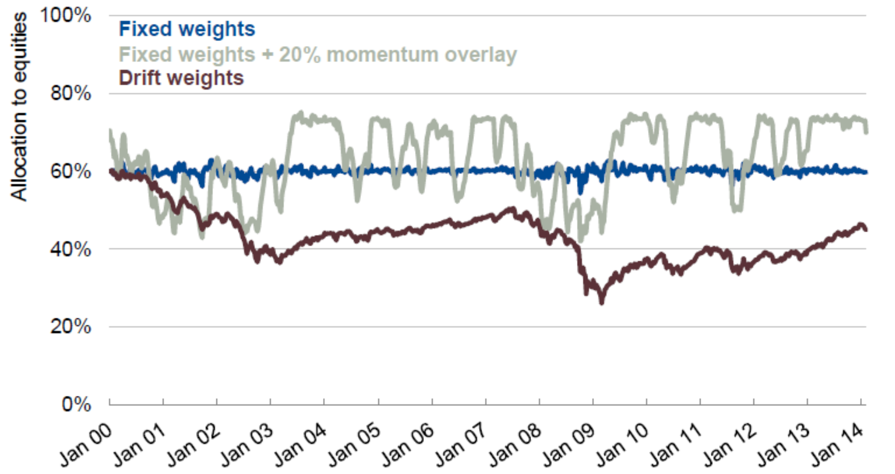
Figure 6: Impact of momentum overlays on constant-mix portfolios

Rebalance frequency	Momentum allocation	Annualised return	Annualised volatility	Sharpe Ratio	Skewness	Correlation to rebalanced portfolio without overlay	Max drawdown depth
Monthly	0%	3.50%	9%	0.4	-0.99	1	-34.40%
	10%	4.20%	9%	0.45	-0.8	1	-31.90%
	20%	4.80%	10%	0.5	-0.62	0.98	-29.60%
	40%	5.80%	10%	0.58	-0.3	0.93	-25.30%
Quarterly	0%	3.70%	9%	0.42	-0.9	1	-33.00%
	10%	4.30%	9%	0.47	-0.72	1	-29.50%
	20%	4.80%	9%	0.52	-0.55	0.98	-27.40%
	40%	5.90%	10%	0.6	-0.26	0.93	-23.60%

Source: Results from Table 1 from "Rebalancing Risk" by Granger et al. Used with permission. The table shows summary statistics to a constant-mix portfolio with varying levels of momentum allocation over the period January 2000 – February 2014.

One might argue that the two components (rebalancing and momentum) should cancel each other out; Figure 3 and Figure 4 might lead us to this conclusion. This is not the case. Figure 7 plots the allocation to equities under fixed-rebalancing with and without a momentum overlay (20% risk allocation); evidently there are key differences in trading from rebalancing and momentum signals.

Figure 7: Allocation to equities.



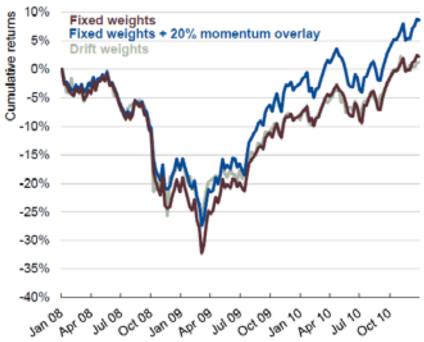
Source: Figure 7 from "Rebalancing Risk" by Granger et al. Used with permission. The plot shows the allocation to equities (starting at 60%) under fixed-weight rebalancing with and without a momentum overlay as well as the weight evolution when the weight is allowed to drift. The period covered is January 2000 – February 2014.

As the authors explain, "the overlay will resist buying too aggressively into equities in times of market stress (easing the psychological pressure on the rebalancer). But, as divergences in asset performance stabilise, the momentum overlay will cutout and allow the full rebalance to occur… the momentum overlay, acting on a shorter time scale, seeks to improve the timing of the rebalance."

Figure 8: Constant-mix + Momentum

Source: Figure 8 from "Rebalancing Risk" with Granger et al. Used by permission. The plot show the cumulative returns over the period Jan 2000 – Feb 2014 to a constant-mix portfolio with and without a momentum overlay.

Figure 9: Impact of adding momentum: 2008 - 2010



Source: Figure 9 from "Rebalancing Risk" with Granger et al. Used by permission. The plot show the cumulative returns over the period Jan 2008 – Dec 2010 to a constant-mix portfolio with and without a momentum overlay.

Figure 10: Impact of adding momentum: 2001 - 2004

Source: Figure 10 from "Rebalancing Risk" with Granger et al. Used by permission. The plot show the cumulative returns over the period Jan 2001 – May 2004 to a constant-mix portfolio with and without a momentum overlay.

Figure 8 shows the returns to example fixed-weight and fixed-weight-plus-momentum strategies, with more detailed analyses of the two market drawdowns in Figure 9 (GFC) and Figure 10 (tech unwind). In both these cases the momentum strategy reduces the drawdowns of the fixed weight strategy.

In conclusion, the authors argue that "rebalancing represents a kind of anti-momentum [strategy]" and hence adding a momentum overlay "reduces drawdowns and improves risk-adjusted performance".

"The Mythology of Rebalancing: A Random Walk Down Performance and Risk Management "

by Brian Baker, Michael Dieschbourg, Damian McIntyre & Arun Muralidhar

There are several misconceptions regarding fixed-weight rebalancing policies such as those employed, for example, in target date funds (TDF)[2] and institutional investing in general. In their recent paper, Baker et al discuss the posited merits of rebalancing which are often given from the perspective of a two-asset investor who measures portfolio performance, solely, according to its volatility. They call this approach "naïve rebalancing" and claim it is often advocated according to bad theory and myths. We state these myths below and briefly review the arguments the authors put forward in their efforts to invalidate them.

In the second part of their paper, the authors test and compare several "naïve" and "intelligent" rebalancing approaches according to multiple performance statistics as well as quantifying the performance driven from skill rather than noise. We summarise their results at the end of this review.

Myth #1: Long term allocations will deliver the target return and that we have the ability to forecast returns, risks and correlations of these major assets.

Rebalancing is the best way of achieving a long-term target return…

… but this assumes we have perfect foresight on the expected returns on the invested assets.

Resetting portfolio allocations over short-term periods for the purpose of achieving a desired long-term target return assumes that the portfolio manager has perfect foresight on the expected returns, volatilities and correlations of the invested assets. Since it is well known that existing forecasting methods and optimization techniques are rarely successful in practise, rebalancing to a target which we have a small chance of forecasting could be regarded as simply noise trading. Furthermore, rebalancing back to a portfolio with specific allocations assumes this is the optimal allocation at all times and under all economic scenarios over the investment horizon.

Myth #2: Rebalancing is good risk management as it brings you back to your target mix.

Rebalancing avoids over-weighting higher risk assets…

…but this assumes risk is defined by volatility. For retirement portfolios, drawdown is of greater concern.

A large proportion of the rebalancing literature claims that rebalancing is simply good risk management practice. However, this assumes that risk is defined by volatility and that the investor seeks this level of volatility at all times. The logic behind this claim is that by allowing weights to drift, the allocation to higher performing assets increases which typically leads to higher volatility in the overall portfolio. Scaling down exposures to these assets, therefore, is seen as a positive thing from a risk perspective.

As Baker et al. argue though, volatility is not necessarily the appropriate measure of risk. For retirement portfolios, for example, the key objective is capital preservation in which case the drawdown is a more suitable measure to use. If the objective is, instead, to minimise drawdowns, rebalancing can actually do more harm than good, particularly during bear markets when rebalancing forces the investor to sell outperforming assets and buy the losing assets. As they describe rebalancing can be considered as starting with a buy-and-hold strategy and then selling a call and put option.

[2] A lifecycle fund whose allocations become more conservative towards a particular date (typically a retirement date).

Myth #3: Rebalancing can add value as it is a mean-reverting trade.

Those that support rebalancing argue that it can add value when assets are mean-reverting. This, as mentioned above, relates to the mechanism whereby an investor buys low and sells high (i.e buys the losing assets and sells the outperforming assets) on the basis that the performance direction will revert back to a long-term trend. As Baker et al. point out, however, there is no sufficient evidence to state over which time periods and at what magnitude mean-reversion occurs for all asset classes. Furthermore, even if all assets are mean-reverting, it should not be assumed that the mean-reversion pattern is the same for all assets and occurs over the same period, therefore trading on this is more complicated than it might seem. The authors suggest, instead, that if an investor wants to exploit mean-reversion then they should do so by buying and selling each asset according to its relative magnitude and time horizon of mean reversion rather than trying to achieve this through naïve rebalancing.

Rebalancing can add value when assets are mean-reverting….

…even if all assets are reverting, however, they do not necessarily mean-revert simultaneously.

Myth #4: Rebalancing is a mechanistic passive activity and hence not a bet. The alternative is "Market Timing"

Periodic rebalancing is typically considered as a passive investing mechanism and is placed at the opposite end of the spectrum to market timing; an endeavour which is normally associated with active investing where a portfolio manager makes conscious decisions regarding which assets to buy/sell and by how much and at what time. This is a misconception since, as Baker et al. point out, all investing is market timing to some extent, "… the only choice is between naïve market timing and intelligent or informed market timing". What they mean here, is that rebalancing is really just naïve market timing where trades are made not necessarily because the market triggers it but rather because of some prescribed trading scheme. In a multi-asset context if one asset needs rebalancing – it has drifted outside of some preset range – then the investor has to decide where the opposing transactions are carried out, leading to a degree of arbitrariness.

Rebalancing is a form of passive investing rather than market timing…

… but all forms of investing are market timing. Even doing nothing is market timing.

Myth #5: Intelligent market timing is difficult or requires incredible skill

Purporting all forms of "intelligent market timing" as difficult renders anything other than naïve rebalancing an impossible task. It assumes that rebalancing is a safer policy than letting a portfolio drift and results in better performance and lower risk. As they demonstrate in their paper, over the period October 1998 – June 2016, global markets were negative around 43-45% of the time, a range similar to that for rebalancing programmes at 48-50% of the time.

Market timing is a very difficult task…

… implies that anything other than naïve rebalancing is a task for a genius.

$$\text{" } \textit{rebalancing excess returns are pretty much a coin toss}$$

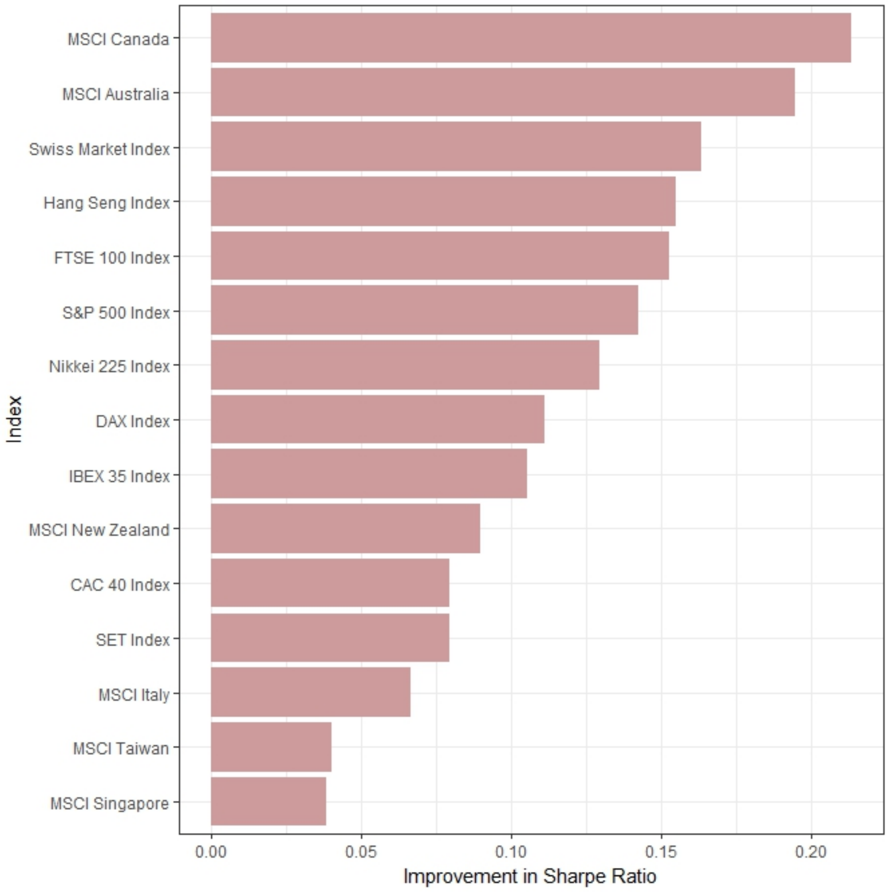
$$(\textit{and possible even a random walk?})\text{"}$$

Myth #6: Missing the best days of market performance can severely deplete performance.

The final myth the authors of this paper refute is the common belief that doing anything tactical can result in missing the best days of market performance. They demonstrate, instead, that intelligent tactical allocation where the intention is to eliminate the performance-harming portion of the returns distribution pays off.

More specifically, Baker et al. show that, whilst missing the best 1% of days leads to a reduction in performance, focusing on missing the worst days instead causes a much greater difference in performance (from a return and risk perspective). With reference to Figure 11, calculating the Sharpe ratio gain of global indices from eliminating the best and worst 1% of days results in a positive improvement universally. The key message here is that, even if it's true that tactical allocation can cause the investor to miss the best performance days (which isn't the case anyway), they can intelligently focus on eliminating exposure to the worst performing days and/or extreme returns in either direction and realise gains from an absolute and risk-adjusted return perspective.

Figure 11: Missing the best and worst days



Source: UBS Quantitative Research: Numbers taken from Table 2 from "The Mythology of Rebalancing…" by Baker et al. Used by permission. The bar chart shows the gain in the return/risk ratio from eliminating the best and worst performing days for global indices.

Naïve and Intelligent rebalancing approaches are tested and compared.

In the latter part of their paper, the authors empirically test a number of naïve rebalancing approaches and two intelligent rebalancing approaches based on an initial allocation to a portfolio of US stocks, international stocks, US bonds, commodities and cash (allocations and transaction costs shown in Figure 12).

Figure 12: Assumed Target Asset Allocation

Asset Class	Target Weight	Benchmark Index	Transaction Costs
US Large Cap Stocks (USLC)	30%	S&P500 Index	10 bps
US Small Cap Stocks (USSC)	10%	Russell 2000 Index	10 bps
International Stocks (INEQ)	15%	MSCI ACWI Ex US	10 bps
US Bonds (USFI)	30%	Barclays Capital US	10 bps
Commodities (GSCI)	10%	GSCI Commodity Index	10 bps
Cash	5%	US T Bills	5 bps

Source: Table 3 from "The Mythology of Rebalancing…" by Baker et al. Used with permission. The table show the target allocation to US and international stocks, US bonds, commodities and cash for their empirical test on naïve rebalancing strategies.

The naive rebalancing options considered include monthly and quarterly rebalancing, rebalancing back to the target based on a 3% and 5% range and rebalancing based on volatility adjusted ranges (bonds and cash with ranges of 3%; equities and commodities with a range of 5%). The buy-and-hold case is also included (i.e. the allocation which is allowed to drift) as well as a naïve target date fund which has a start and end allocation and a glide path which determines how the end weights are arrived at.

Baker et al. include two "Intelligent Rebalancing" approaches; the first makes allocation adjustments based on triggers relating to the factors shown in Figure 13. This table answers the "what to do", "when to do it", "how much to do it" and "why to do it" questions relating to the methodology. Each rule will simply overweight or underweight an asset by 1% when the trigger is executed.

Figure 13: Factor trigger used to tilt various assets

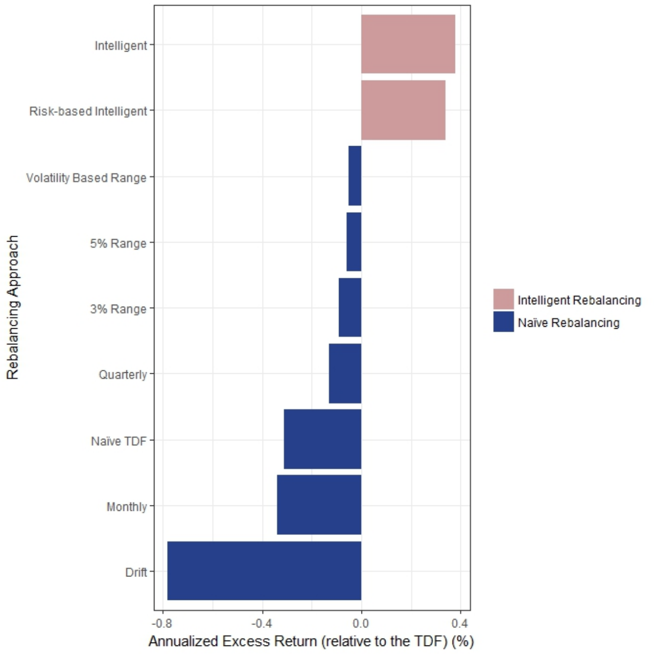
Factor	Asset Pair Applied To	Basic Intuition	Formulation
Seasonality	US Equities and Intl Equities vs Bonds	Stocks do badly in the summer	Underweight stocks in May and overweight in October
Momentum	US Equities and Intl Equities vs Bonds and GSCI vs Cash	Momentum is profitable	Overweight primary asset when 1 month average > 10 month average and underweight otherwise
VIX (Sentiment)	GSCI vs Cash	Sell risky assets when risk aversion rises	Overweight when the 1 month average > 3 month average and vice versa
Baltic Dry Index (Economic)	Intl Equities vs Bonds	Global economic growth is good for equities	Overweight when the 1 month average > 3 month average and vice versa
Fed Model (Valuation)	US LC vs Bonds	Buy the higher yielding asset	Compare earnings yield to the 1 month average of the BAA spread

Source: Table 5 taken from "The Mythology of Rebalancing…" by Baker et al. Used by permission. The table summarise the allocation tilt decisions made according to various factors and the reasons why these adjustments are carries out.

Intelligent rebalancing improves performance statistics which are driven from skill rather than noise trading

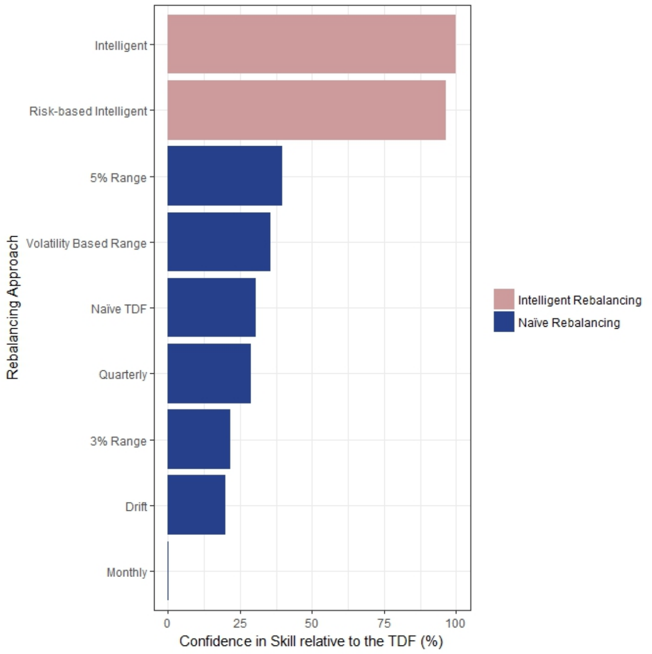
The second ("Risk-based") intelligent approach, just takes four rules: three of which are equity rules based on Momentum and one rule on International Equities based on the Baltic Dry Index. The main takeaway from this analysis is that the "Intelligent" approaches deliver the best performance from an absolute and risk-adjusted perspective over the period Jan 2000 – April 2014 (see Figure 14 for the latter); the risk-based approach also experiences the lowest drawdowns amongst all approaches. Interestingly, when the performance of these approaches was computed relative to the target, none of the naïve rebalancing methods offered a positive annualised return whereas the intelligent approaches did. Furthermore, when they measured the confidence in skill, i.e. the confidence that each approach stemmed from skill rather than noise, then the intelligent approaches were far superior, as shown in Figure 15.

Figure 14: Excess Returns relative to TDF



Source: "The Mythology of Rebalancing…" by Baker et al. Used with permission. The plot shows the excess returns (relative to the target) to each rebalancing strategy. Data taken from Figure 7 in the paper.

Figure 15: Confidence in skill relative to TDF



Source: "The Mythology of Rebalancing…" by Baker et al. Used with permission. The plot shows proportion of return driven from skill rather than noise trading for each rebalancing strategy. Data taken from Figure 7 in the paper.

"The Sound of Many Funds Rebalancing"

by Alex Chinco and Vyacheslav Fos

What causes noise in the markets? Cascades

There is a great deal of noise (share price movements unrelated to fundamental value) in financial markets. Historically, this was explained by individual investors trading on uninformed hunches. However the fraction of the US market owned by individual investors has fallen by more than half since the 80s and there does not appear to have been a corresponding drop in trading noise. This paper illustrates a possible alternative explanation for noise: long rebalancing cascades.

The authors describe how rational trading can be triggered by extremely minor events or even events that are completely unrelated to the future prospects for that company. For example, if a fund holds stocks based on a cross-sectional threshold, e.g. the top third by price momentum, then a miniscule change in the momentum of stock A can tip it over that threshold and trigger a rebalance, requiring the purchase of stock A and sale of stock B. The subsequent price move in stock B may then trigger other funds to rebalance and buy stock C and so on. This cascade means that a shock to stock A can affect stock Z, even if they are not owned by any of the same funds and the shock is not relevant to the fundamental value of stock Z.

Cascades have unpredictable effects

Chinco & Fos illustrate that, even if the rules which trigger rebalances in each individual fund are simple, when there are a large number of densely overlapping funds, it becomes computationally infeasible to predict whether a cascade will have a positive or negative impact on a stock Z. There may be multiple "routes" a cascade can take between stock A and stock Z, some associated with positive returns and others associated with negative returns, so it is difficult to predict what the net result will be.

Greater noise means greater opportunities for skilled investors

However, what *can* be predicted is which stocks are more likely to be affected by these cascades and hence have noisier returns. These are stocks which are owned by a large number of funds. There should be greater opportunities for informed traders in these names. The authors create a model to illustrate these ideas and analyse the properties of connected systems such as funds with overlapping holdings.

Evidence from cascades triggered by M&A announcements

To test how this hypothesis holds up in real life Chinco & Fos examine what happens to stocks owned by ETFs when an unrelated stock in the market becomes the target of an M&A bid. They describe stock Z as unrelated to stock A if it comes from a different industry group and is not held by any ETF which also holds stock A. The authors find that, in the 10 days after an M&A announcement in a stock, the ETF trading volumes in unrelated stocks increases by an average of 14% more for the stocks which are held by an above median number of ETFs than in stocks which are held by fewer ETFs. This implies that ETF rebalancing does cause cascades. They also note that informed traders (those with a 5% or more stake in a company) are slightly more likely to trade in the stocks which are held by many ETFs after M&A announcements - implying that these investors do treat the demand from ETF rebalancing cascades as noise.

"Equal or Value Weighting? Implications for Asset-Pricing Tests"

by Yuliya Plyakha, Raman Uppal and Grigory Vilkov

In their well-known paper, "Optimal Versus Naive Diversification: How Inefficient is the 1/N Portfolio Strategy?", DeMiguel et al run a number of backtests of portfolio construction across seven data sets. They find that of the models they evaluate "none is consistently better than the 1/N rule in terms of Sharpe ratio, certainty-equivalent return, or turnover, which indicates that, out of sample, the gain from optimal diversification is more than offset by estimation error."

Equal- tends to outperform value-weighting …

In this follow-on paper (Uppal being an author of both) the authors investigate three topics in the context of asset pricing tests. The first step is to analyse in detail the difference between the performances of equal- and value-weighted portfolios.

… because of an exposure to a price reversal strategy …

They then go on to identify the source of this difference in performance which is the contrarian strategy of rebalancing back to constant weights: selling the winners and buying the losers.

… and this difference can influence asset pricing tests.

And finally (although of less relevance to the topic of rebalancing in this edition of the ARM) they show that because of this difference in performance "the inferences drawn from tests of asset pricing models are substantially different, depending on whether one performs these tests on equal- or value-weighted test assets".

Hou et al (2017) show the choice of weighting also influences the 'anomaly' literature.

This final point is also investigated in Hou et al (2017) who replicate 447 "anomalies" using a consistent universe and a value-weighting scheme, although their concern with equal-weighting is more the influence of microcap stocks rather than the effect of rebalancing per se.

The starting point for the authors' analysis is the S&P 500 from February 1967 to December 2009. They use resampling to create 1,000 portfolios each containing 100 names[3] which allows them to use the empirical distribution of the metrics to calculate p-values. They create portfolios using three schemes: value-, price- and equal-weighting. We will focus on the first and last of these in this review.

Equal weighting outperforms by 271 basis points on average

The equal weighted (EW) portfolio has a mean annual return of 13.19% compared to 10.48% for the value weighted (VW) portfolio – a difference of 271 basis points (with a p value smaller than 0.01). This difference is also significant if transaction costs of 50 basis points are included. The equal weighted portfolio outperforms the value weighted one in 67.7% of twelve-month periods.

Regressing out the standard four factors (market, size, value and momentum) gives an average alpha for the VW portfolios of 60 basis points and 175 bp for the EW portfolios. Perhaps surprisingly more of the difference in the systematic component of return comes from the EW portfolios having a larger sensitivity to the value factor, not to the size one although both contribute positively to EW beating VW.

[3] For robustness they repeat their analysis with between 30 and 300 stock portfolios and also using the S&P 400 and S&P 600 as the initial universe.

The next step in their analysis is to demonstrate that the source of the extra alpha is the rebalancing each month which is needed to maintain equal weights: a 'contrarian' strategy. To demonstrate this they carry out two experiments: reducing the frequency of rebalancing the equal-weighted portfolio from monthly to 6- and then 12-monthly; and secondly fixing the weights of the value weighted portfolio for a period (so rebalancing the VW portfolio back to constant weights for say 6 months and then adjusting to the true value weights). Reducing the rebalancing of the equal weighted portfolio changes the outperformance frequency from 67.7% to 69.71% (6 months) to 61.43% (12 months).

The alpha comes from a 'contrarian' strategy

The authors go on to discuss how the choice of value- or equal-weighting changes the results from various asset pricing tests. As an example they investigate the influence of weighting choice on measuring the relationship between idiosyncratic volatility and future returns. The low decile – high decile return for equal weighting is a significant 10.51% (a p-value of 0.09), but insignificant at only 4.46% (p-value of 0.50) for the value weighted portfolios. The authors conclude their "work shows that the choice of equal-, value- or price-weighted portfolios is not an innocuous one because it has the potential to influence the inferences one makes based on tests of asset-pricing models."

Value or equal weighting changes the significance of idiosyncratic volatility based returns

Reproducing the results

To reproduce some of the results reported above we use four regions from the MSCI World index between December 2007 and December 2017. The regions are Europe, US, Japan and Asia ex Japan. As in the paper: if a stock drops out of the index it is replaced with another random stock[4].

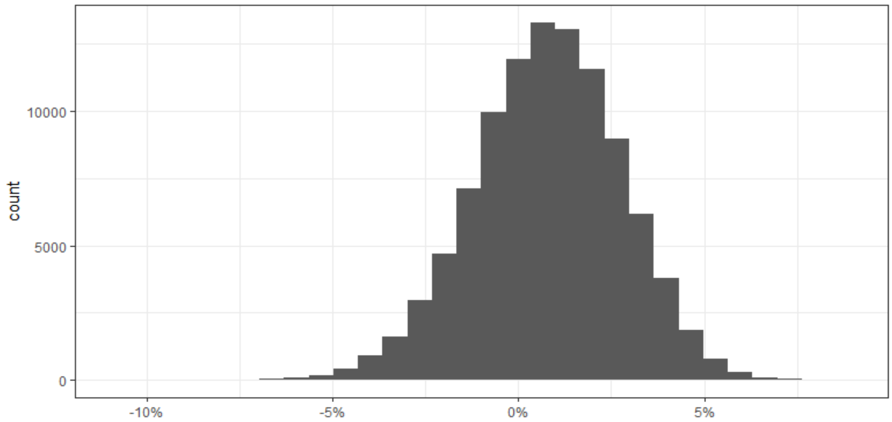
The interpretation of our reproductions is challenging

We randomly select 50 names from each universe and calculate the returns to two portfolios:

- equal weighted, rebalanced monthly, and
- floating weights (i.e. set the weights to the index weights at the start of the period and allow them to change with returns).

We repeat this 100,000 times.

Figure 16: Difference in annualised returns: equal- vs. value-weighting - Europe



Source: UBS. Figure shows the distribution of the difference in annualised returns between equal and value weighted 50 stock portfolios for the MSCI Europe universe, total returns in USD.

[4] The free floating weights are not adjusted.

The chart above shows the distribution of the difference in annualised returns for the MSCI Europe universe. The equal weighted portfolio outperforms 66.2% of the time when the returns are calculated over the whole sample period. This is similar to the 67.7% quoted from the paper. If we take all the calendar year returns then equal weighting outperforms 57.6% of the time.

Equal weighting generally outperforms …

Figure 17 gives the results for the four regions and three rebalancing periods for the equal weighted portfolios: 1, 6 and 12 months. The table shows both the mean outperformance and the proportion of simulations where the equal weighted portfolio outperforms the float weighted portfolio.

… particularly in Japan

Figure 17: Outperformance of equal weighting over floating weights

		Region			
Rebalancing (months)		Europe	US	Japan	Pac Basin ex Japan
1	EW outperform	66.2%	84.7%	99.8%	77.8%
	Mean	0.8%	4.3%	3.4%	1.5%
6	EW outperform	74.2%	83.4%	99.9%	76.1%
	Mean	1.2%	3.5%	3.3%	1.3%
12	EW outperform	81.1%	84.4%	99.9%	76.8%
	Mean	1.6%	2.6%	3.4%	1.4%

Source: UBS

The first observation is regarding Japan: in that market equal weighting almost always outperforms; in the other regions the frequency of outperformance varies from 66.2% in Europe to 84.7% in the US.

We see that the results from the paper are not matched by the global data over the past ten years. In Europe decreasing the rebalancing frequency increases the outperformance; for the US and Pacific Basin ex Japan the amount of outperformance is relatively constant.

To explain this we calculated the returns to four factor portfolios: the market, size (small-big), 1-month reversals (losers-winners) and value. Figure 18 shows the annualised returns and risk adjusted returns to these factor portfolios.

Figure 18: Factor portfolio risk adjusted returns

		Market	Reversals	Size	Value
Europe	Return	2.21%	-1.21%	-0.57%	-4.50%
	Risk Adj. Return	0.11	-0.13	-0.08	-0.33
US	Return	8.47%	0.70%	2.58%	-1.72%
	Risk Adj. Return	0.56	0.06	0.29	-0.17
Japan	Return	3.27%	0.35%	6.10%	3.23%
	Risk Adj. Return	0.21	0.03	0.87	0.32
P Basin ex Japan	Return	3.90%	4.22%	0.24%	1.06%
	Risk Adj. Return	0.18	0.35	0.03	0.11

Source: UBS. The table shows the risk adjusted returns for the market, size, reversals and value portfolios in four regions. All returns are total returns in USD.

We see the best performance for reversals is in the Pacific Basin ex Japan region whereas in Europe reversals actually lost money over the period. Interestingly in Europe both size and value also lost.

In Japan small cap significantly outperformed, and as we see in Figure 19, where we show the average betas of the EW-FW spread to the factor returns, the beta to this factor is large.

In Japan small cap significantly outperformed

Figure 19: Average beta to the factor portfolios.

	Intercept	Market	Reversals	Size	Value
Europe	0.002	0.036	-0.040	0.539	0.153
US	0.010	-0.043	0.060	-0.093	0.630
Japan	0.001	-0.001	-0.021	0.408	-0.032
PBasin ex Japan	0.003	-0.022	0.022	0.120	0.018

Source: UBS

Our conclusion is that although equal weighting tends to outperform, the explanation of a fixed weight strategy having an implicit exposure to price reversals is not enough. There is a complex interplay of exposures to value, size and reversals which need to be understood.

An Alternative Option to Portfolio Rebalancing

by Roni Israelov and Harsha Tummala

In their recent paper, Israelov and Tummala propose a way to improve portfolio rebalancing by systematically selling out-of-the money options. According to their analysis, this short option overlay has two benefits: 1) it helps reduce the unintentional (and uncompensated) momentum bets; and 2) earns the volatility risk premium (VRP), thus adding "alpha" to the portfolio.

Illustrative example:
60%/40% equity-bond portfolio

As an illustrative example to demonstrate the efficacy of an option overlay for portfolio rebalancing, the authors use the classical equity/bond portfolio with strategic weights of 60%/40%. Assuming a notional of \$10B the hypothetical portfolio holds \$6B in stocks (assumed share price \$100, thus holding 60m shares) and \$4B in bonds. The option overlay consists of selling calls and puts (European, physically settled) with strike prices near the current stock price; the technical details on the construction of the portfolio of options, including quantity of options needed at various strikes, are discussed later.

Market up scenario

The first scenario considered is "Market up", where the stock rises by 4% to \$104 and bond prices remain unchanged. The current holdings are therefore \$6.24B in equity and \$4B in bonds, resulting in portfolio weights of 61/39. To get back to the 60/40 strategic allocation one has to sell \$96M of stock (923,077 shares) and buy \$96M of bonds. However, the investor has sold calls, so he is obliged to sell 923,077 shares to the option holders (assumed to exercise their options rationally). The cash from the stock sale and the options premium can be used to buy \$96M of bonds.

Marked down scenario

Similarly, if the price of the shares goes down by 4% to \$96, the resulting portfolio weights will be 59/41, meaning that the investor will have to buy \$96M of stock and sell \$96M of bonds. However, the investor has sold puts, so he is obliged to buy 1M shares from the option holders, which can be funded by selling the bonds together with the options premium.

Number of shares needed to rebalance as a function of share price

Assuming that the portfolio begins at its strategic weights and that the bond returns are small relative to equity, the authors derive the quantity of shares needed to rebalance the stock component as a function of the stock price, which is given in Equation (1).

$$q_t^s - q_{t-1}^s \cong q_{t-1}^s(1-w^s)\left(\frac{p_{t-1}^s}{p_t^s} - 1\right) \quad (1)$$

where p^s is the stock price, q^s is the quantity of stock and w^s is the target allocation to equity.

Number of options to be sold at each strike

The next step is to determine the size of the options overlay so that the correct number of shares is traded at expiration. Since the magnitude of future market moves is not known, the range of strikes at which options are sold is a portfolio construction decision. The number of options that need to be sold at strike price K_i (where $1 \leq i \leq N$) is shown to be:

$$options\ sold_i = Notional_{t-1}^s(1-w^s)\frac{|K_{i-1}-K_i|}{K_iK_{i-1}} \quad (2)$$

where $K_0 = p_t^s$ is the stock price at time t. For the derivation of Equation (1) and (2) is beyond the scope of this review; we refer the interested reader to the Appendix of the paper.

As the stylised example demonstrated, the options overlay can be used to systematically rebalance the portfolio back to its strategic weights. In addition, due to its embedded reversals exposure, the short options overlay also naturally hedges the portfolio's tactical equity exposure between rebalances. In the rest of their paper the authors focus on empirically analysing this effect.

Data

The data used consists of S&P 500 total return index, Barclays US Aggregate Bond Index and 3m LIBOR from Bloomberg as well as options data from Option Metrics IVY for the period between 1996 and 2015. The strategic allocation considered is again 60/40 in equities/bonds and the portfolio is rebalanced monthly on S&P 500 option expiration dates.

Decomposing the monthly rebalanced portfolio

To estimate tactical exposures, the monthly rebalanced portolio is decomposed into three components: 1) daily rebalanced portfolio, 2) tactical equity, and 3) tactical bond positioning:

$$MonathlyRebalanced_t = DailyRebalanced_t + TacticalEquity_t + TacticalBond_t$$

60/40 portfolio decompositions

The pure 60%/40% portfolio had a Sharpe ratio of 0.52 (5.12% excess return and 9.81% volatility). Its tactical equity exposure is on average close to zero (0.02%), however varies substantially over time (between -7.6% and 2.9%). The estimated return and volatility for that component are -8bp and 21bp, respectively. The corresponding values for the tactical bond exposure are -3bp and 6bp. According to the authors there is no economic rationale for negative (or positive) expected returns from the tactical equity exposure; they also note that the returns are not statistically significant.

60/40 + Option overlay portfolio decompositions

As one would expect, the tactical equity exposure for the portfolio with the short option overlay is much smaller, ranging between -1% and 0.9%. Its annualised return was -3bp (+5bp from -8bp) and volatility of 10bp. The overall portfolio achieved an annualised return of 5.23%, which is 11bp higher than the pure 60%/40% portfolio. This outperformance is partly due to the reduced tactical equity exposure, which *happens to be negative* for the sample period under consideration (+5bp). The difference (+6bp, which is statistically strong) arises from the short volatility exposure, which is harvesting the well-documented volatility risk premium. As a result the Sharpe ratio also marginally imporves to 0.53 (from 0.52).

The paper concludes with some practical considerations when implementing a short options overlay, such as: whether options should be physically or cash settled, whether one should use single-stock options, what the strike range and increment should be. Finally, the portfolio turnover and trading costs are analysed and the additional operation complexity of the overlay is assessed. The main conclusion is that although the option overlay approach has similar trading costs as the daily rebalanced portfolio, the alpha generated by the short volatity position is more than sufficient to cover the cost of execution.

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