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Should risk controlled equity be seen as a smart beta?

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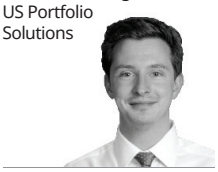


According to the *Financial Times* lexicon, "Smart beta strategies attempt to deliver a better risk and return trade off than traditional market cap weighted indices."[1] In this paper we take the evaluation criteria used by Ashley Lester and Fred Dopfel in their paper *Improving investment outcomes with advanced beta: moving beyond elementary smart beta*[2] and explore whether risk controlled equities meet the same objective criteria that are often applied to smart beta. Our findings suggest that these risk controlled betas may offer a new and different set of portfolio building blocks relative to existing US equity, smart beta, bond, and cash components within a portfolio.

Executive summary

In their paper Dopfel and Lester proposed that to qualify as an "advanced beta", a fund needs to meet:

- a "value add" condition, i.e. provide something better than is already available; and
- a "portfolio demand" condition, i.e. help the investor attain a desired outcome.

We first remind ourselves of the techniques that can be used to create a risk controlled equity strategy.[3] We then investigate our four candidate risk controlled equity betas – an equity collar, a volatility cap, a volatility target, and a variable volatility cap. These are investigated in the context of a set of broadly adopted smart betas from the S&P family of indices.[4] For the analysis we also add the Bloomberg Barclays US Aggregate Index (US Bonds), as well as USD cash.

We start by getting to know the available assets. We then see whether we can build risk controlled betas using our extended universe of assets. We go on to look at whether risk controlled betas offer better outcomes.

To test the "portfolio demand" condition, we build an efficient frontier for the universe of assets with and without the risk controlled equity betas.

From this we compare risk versus return using Sharpe ratios and tail risk using conditional value at risk (CVaR).[5] The conclusions from this work are:

1. Risk controlled equity betas cannot be replicated using a combination of standard and smart betas.
2. Although risk controlled equity betas do not tend to add excess return relative to equities, they do offer a better Sharpe ratio and lower risk of capital loss.[6]

These two findings indicate that risk controlled equity betas satisfy the value add criteria and thus can bring beneficial characteristics when considered in a total portfolio context. **This suggests to us that risk controlled betas could be considered as a new set of portfolio building blocks that offer something different than existing equity, smart beta, bond, and cash components of a portfolio.**

If we build portfolios that take the universe of assets and seek to maximize return for a given level of risk we find the risk controlled betas improve the return and therefore the Sharpe ratio. This indicates that the **risk controlled betas satisfy the portfolio demand criteria.**

We also show that the addition of risk controlled equities to a portfolio offers an opportunity to recycle risk (i.e. increase returns for a given level of risk) or to minimize the reduction in expected returns as a portfolio is de-risked.

The implication of this analysis is far greater than extending the definition of smart betas. It shows that **the inclusion of risk controlled equities** in all but the most risk seeking of portfolios can not only **improve returns** for a given level of risk but also reduce drawdowns. Therefore these techniques

1 http://lexicon.ft.com/Term?term=smart-beta.
2 See www.schroders.com/en/pensions.
3 These were examined in greater detail in *Managing investment outcomes with volatility control*, Mike Hodgson and Andy Connell, Schroders July 2016.
4 To be clear, we are not making any statements as to whether large cap, small cap, value, momentum and minimum volatility are truly "smart", other than noting their widespread usage and therefore whether the risk management techniques meet the Lester and Dopfel criteria. For reference herein, we will refer to and describe these smart betas as "Small cap", "Momentum", "Value" and "Min vol", as well as "US Bonds" and "Cash".
5 Throughout the document we use the average loss beyond the 95th percentile for the CVaR measure.
6 A capital loss that is less than the underlying equity benchmark occurs even though this may not be the primary aim of the risk control strategy.

should **be considered an important long-term strategic element in many portfolios** and be seen as much more than a short-term tool to protect against equity shocks.

Risk controlled equity – the techniques

All risk controlled equity strategies aim to alter an outcome for an investor, either by managing the volatility of the investment or through the use of options.

The volatility target

This technique aims to manage the volatility of a portfolio so that it remains at a constant level over time. This is achieved by monitoring portfolio volatility over an appropriate period and adjusting the exposure to equities to maintain a constant level of volatility. For example, if an equity portfolio is managed to a volatility target of 10%, then the process is as set out below.

Tomorrow's exposure to equities = 10% (i.e. the volatility target)/today's volatility. To illustrate this:

1. If the target is 10% and today's volatility is 15%, then the allocation to equities is 10%/15%, i.e. 67%.
2. If the target is 10% and today's volatility is 8%, then the allocation to equities is 10%/8%, i.e. 125%.[7]

For this paper we apply a volatility target ("VT") of 15%.

The volatility cap

The volatility cap aims to modify an investor's experience by measuring the daily volatility of equities across an appropriate period and reducing the exposure if the volatility exceeds a pre-defined (i.e. cap) level. The process used to achieve this is relatively straightforward and is set out below.

Tomorrow's exposure to equities = the lower of:

1. a 100% allocation to equities; or
2. the volatility cap level/today's portfolio volatility.

To illustrate this process if we have an equity portfolio with a volatility cap of 15% and:

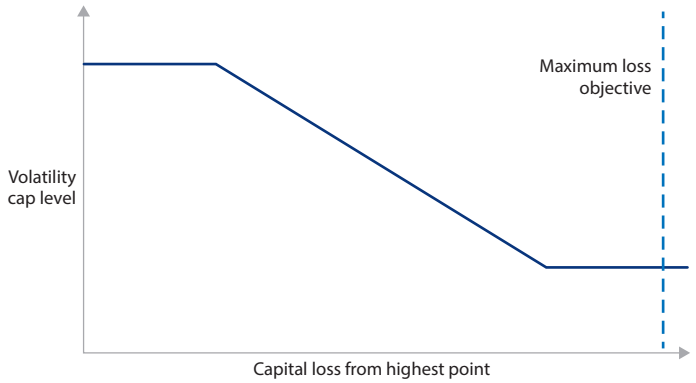
1. today's volatility is 8%, then, as this is below the cap, tomorrow's portfolio will be a 100% allocation to equities
2. today's portfolio volatility is 20% then as this is above the cap level, tomorrow's allocation to equities will be 15% (the cap level)/20% (today's volatility), i.e. 75%.

For this paper we apply a volatility cap ("VC") of 20%.

The variable volatility cap

A variable volatility cap aims to limit the risk of loss below a specific level. Figure 1 below gives an overview of how a variable cap works. Essentially, the implementation formula is the same for the volatility cap except that the level of the volatility cap is variable. The volatility cap depends on the level of loss that the strategy has incurred from the high watermark. As losses increase the volatility cap falls. This aims to reduce the risk taken in falling markets and so limit the losses incurred by the strategy.

Figure 1: Simply capping losses



By way of example:

1. If the capital loss since the highest point is 7%, the cap level that corresponds to this is 10%. If equity volatility is 12%, then the allocation to equities will be 10%/12% = 83%.
2. As the amount of loss increases the volatility cap level also falls to a minimum level. So, for example, if the loss level is 12% (i.e. the strategy is only worth 88% of its maximum value), the volatility cap is reduced to 5%. If equity volatility remains at 12%, then the allocation to the equities becomes 5%/12% = 42%.

For this paper we apply a variable volatility cap ("VVC") that aims to limit losses on a rolling 12-month basis to 20%.

The option collar

The option collar (or "collar") strategy aims to limit equity losses by purchasing put options on the equity exposure. To pay for the cost of this downside insurance, some of the upside equity participation is sold. This is achieved through the sale of equity call options.

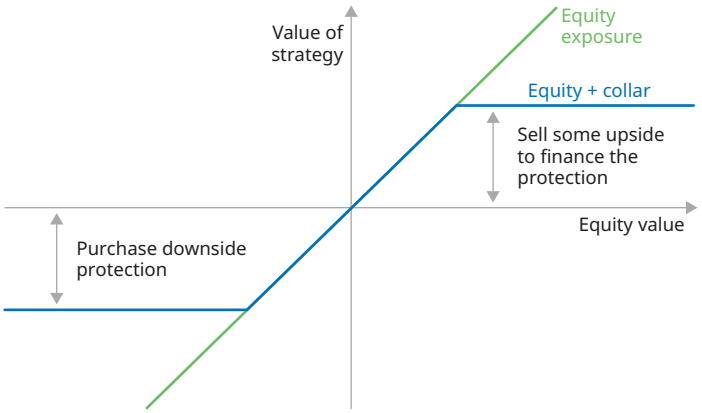
For the purposes of this paper, we have used a rolling collar, whereby 12-month put options are purchased monthly covering 1/12th of the equity risk, with a one-month call being sold to offset this cost. In this way the collar becomes evergreen and self refreshing, as each month one put option expires and is replaced by another 12-month put, with a one-month call sold to offset the cost. We have used a collar protecting against annual equity losses of more than 10% (90% put strikes).

Each of these techniques is appropriate for investors seeking specific outcomes or facing specific constraints. They are explored in much more detail in a previous paper.[8]

7 To achieve levels of exposure in excess of 100%, derivatives are often introduced into the portfolio. However, volatility target portfolios are often constrained to a maximum level of exposure, e.g. 150%.

8 *Managing investment outcomes with volatility control,* Connell and Hodgson, as above.

Figure 2: Capping losses cheaply



Source: Schroders. Figures 1 and 2 are for illustrative purposes only. Protection herein refers to the level at which the use of derivatives would limit capital drawdown.

Can we build risk controlled equity returns using other asset classes?

The previous review of risk controlled equity techniques shows how each one aims to change the outcomes from an underlying equity investment in a way that is distinct from smart betas. However, to identify whether risk controlled equities actually deliver new types of equity betas, we need to examine the techniques in the context of our investment universe.

Test 1: How strong is the relationship between risk controlled equity and the other asset classes?

To understand the relationship between risk controlled equity beta and smart betas, we look at the correlations of their excess returns relative to other US equities.

Specifically, as shown in Figure 3, we see:

a. Relatively strong correlations between the various types of risk controlled equities, and them and US Bonds

b. A moderate correlation between each of the risk controlled equities and Min Vol

c. A generally low, and even negative, correlation between each of the risk controlled equities and Momentum, Small cap and Value, respectively.

At first sight this could suggest that the risk controlled betas might fail the value add criteria as they may in fact be a blend of S&P 500, Min Vol and US Bonds. Intuitively this could suggest that risk control creates an equity-like beta that starts with the characteristics of S&P 500 and then is modified to include a combination of Min Vol and bond-like characteristics.

Test 2: Can we rebuild risk controlled equity betas out of a combination of smart betas, bonds, and cash?

To further test our tentative conclusion above, i.e. that the returns of risk controlled equity betas can be adequately explained using a combination of the available assets,[9] we have performed regressions on each of the risk controlled equities. These explain risk controlled equities in terms of cash returns, equity returns in excess of cash, and other assets in excess of equities. Constraints ensured that the weights of the independent variables were positive and summed to 100%. The results are set out in Figure 4 on the next page. At first sight they appear to indicate that many of the risk controlled betas are actually reconstituted equities plus Momentum, Value and US Bonds. Each column heading shows the risk controlled equities we are trying to explain using the explanatory variables in the first column. The squares highlighted in green indicate the explanatory variables that were statistically significant.[10] By implication, only the variables with a positive weight and highlighted in green are effective at explaining the returns of the risk controlled equities.

Figure 3: Correlations of returns in excess of the S&P equity index

	S&P Small Cap	S&P 500 Value	S&P 500 Momentum	S&P 500 Min Vol	S&P 20% VVC	S&P 15% VT	S&P 20% VC	S&P 90% Collar	US Bonds
S&P Small Cap	1	0.36	-0.04	-0.18	-0.22	-0.20	-0.26	-0.26	-0.33
S&P 500 Value	0.36	1	-0.51	-0.03	-0.23	-0.27	-0.30	-0.29	-0.27
S&P 500 Momentum	-0.04	-0.51	1	0.11	0.24	0.29	0.32	0.28	0.14
S&P 500 Min Vol	-0.18	-0.03	0.11	1	0.43	0.35	0.37	0.52	0.66
S&P 20% VVC	-0.22	-0.23	0.24	0.43	1	0.90	0.91	0.89	0.67
S&P 15% VT	-0.20	-0.27	0.29	0.35	0.90	1	0.89	0.77	0.50
S&P 20% VC	-0.26	-0.30	0.32	0.37	0.91	0.89	1	0.86	0.59
S&P 90% Collar	-0.26	-0.29	0.28	0.52	0.89	0.77	0.86	1	0.82
US Bonds	-0.33	-0.27	0.14	0.66	0.67	0.50	0.59	0.82	1

Source: Morningstar, Schroders, for period between December 2002 through November 2017. Correlations are based on past performance which is no guarantee of future results. Volatility control, volatility cap, variable volatility cap, and option collar strategies are based on back-tested performance calculated by Schroders and do not reflect any actual portfolio performance. Each of the S&P and the Bloomberg Barclays indices reflect widely used, unmanaged proxies for their respective asset class. Investors cannot invest directly in any index.

9 The available assets in the regression aim to make is as easy as possible to recreate the returns of risk controlled strategies. They are therefore the separate elements of the total return of each asset and are cash, excess returns of S&P 500 vs. cash and then the differential excess returns of the smart betas and bonds relative to the excess returns of S&P 500.

10 These were obtained using only the variables with a non-zero weight in an unconstrained regression. The test was to a 95% confidence interval with the degrees of freedom determined by the number of explanatory variables.

Figure 4: Explaining risk controlled equity returns using other asset classes

	S&P 20% VVC	S&P 15% VT	S&P 20% VC	S&P 90% Collar
US Bonds	0%	0%	0%	0%
Min Vol	0%	0%	0%	0%
Momentum	14%	18%	14%	15%
Value	2%	0%	0%	0%
Small cap	0%	0%	0%	0%
Cash	25%	6%	6%	32%
S&P 500	60%	75%	79%	53%
Intercept	2.2%	2.6%	2.1%	1.7%
Sum of weights	100%	100%	100%	100%

Source: Bloomberg, Schroders. Regression coefficients based on monthly returns, December 2002 to November 2017, except for the intercepts, which have been annualized. Green coefficients reflect statistically significant data.

The results indicate that:

a. Only the S&P 500 has significant exposures across all of the risk controlled betas: statistical significance is far greater for this variable than for the others

b. For the 15% Volatility Target, 20% Volatility Cap and 90% Collar, Momentum are also significant

c. All the other variables with a non-zero weight are not statistically significant at the tested confidence level

d. The intercepts of the regression are sizeable. This shows that a large proportion of risk controlled equity returns are not explained by the universe of assets. Academic research[11] finds that this extra return generated by risk controlled techniques is statistically significant.

These findings indicate that risk controlled equities appear to offer something different from the pre-existing assets. **Risk controlled equities cannot be recreated from a combination of other asset classes' returns.** However, this in itself doesn't mean that they add value relative to the other asset classes, which is why we now explore this question a bit further.

Do risk controlled equity betas add value when compared to US equities?

Figure 5 ranks the Sharpe ratios, excess returns and drawdowns of the asset classes that have been examined. It shows that, if we rank the betas by Sharpe ratio (second column with green being the highest and red the lowest), a majority of the asset classes perform better than US equities. However, if we rank the betas by returns (green for highest and red for lowest), only two of the four risk controlled betas outperform the underlying equity benchmark.

The fourth column shows the size of the largest drawdowns from peak to trough experienced by each of the asset classes (red for largest loss, green for smallest). It shows that risk controlled equities appear to be effective at mitigating losses. The table confirms two fundamental aspects of risk controlled betas – that risk management is not costless in terms of performance, but is beneficial when considered in the context of Sharpe ratios (see Connell and Hodgson, July 2016).[12] This leaves us to consider the second of the Dopfel and Lester tests: whether risk controlled equities help investors attain their desired outcomes.

Figure 5: The relative performance of the asset classes

Asset class	Sharpe	Returns	Drawdown	Volatility
S&P 90% collar	85%	8.4%	20%	8%
S&P 20% VC	80%	10.6%	37%	11%
S&P 20% VVC	80%	9.3%	23%	9%
S&P 15% VT	80%	10.7%	30%	11%
S&P 500 Min Vol	78%	10.2%	50%	11%
US Bonds	72%	4.1%	5%	3%
S&P 500	61%	9.8%	55%	13%
S&P Small Cap 600	60%	12.3%	58%	18%
S&P 500 Momentum	58%	9.7%	48%	14%
S&P 500 Value	52%	9.3%	61%	14%
Cash	n/a	1.7%	n/a	n/a

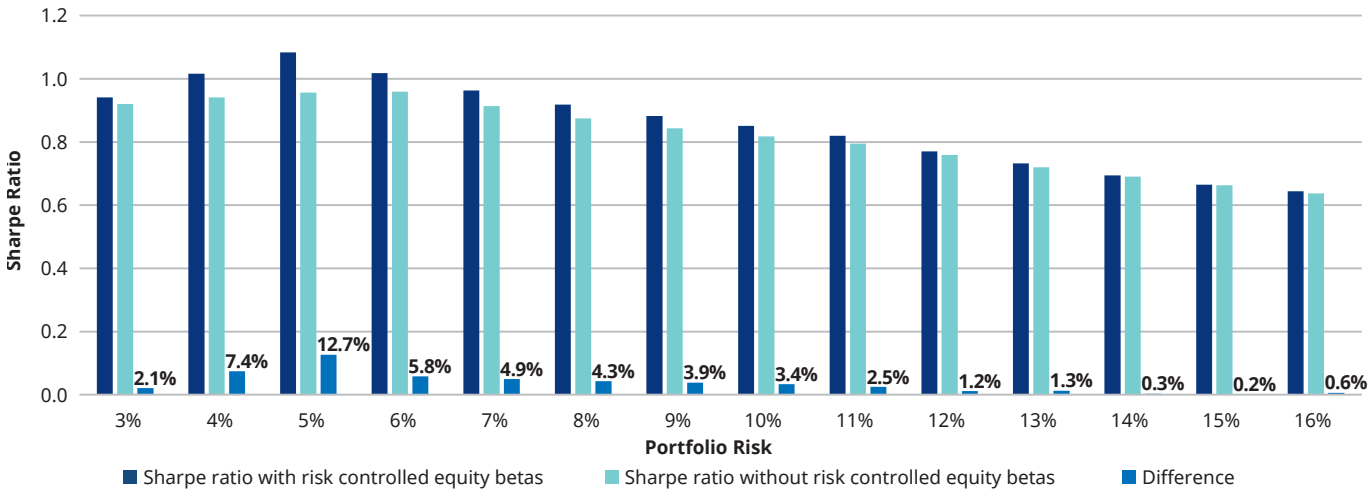
Source: Bloomberg, Schroders. Monthly returns between December 2002 and November 2017. The Sharpe ratios are measured as the excess returns over the volatility of total returns. The returns are total annualized over the period. The drawdown is the largest peak to trough loss in total return for the strategy. The drawdowns are calculated using daily data. Past performance is no guarantee of future results.

Do risk controlled equity betas meet the portfolio demand criterion?

Using the same universe of assets, we can build a set of portfolios that are efficient in terms of risk and return. The portfolios seek the maximum return for a given level of risk. **This will naturally improve the Sharpe ratio, as risk controlled equities offer a better trade off between return and risk than many of the existing asset classes.** Volatility is generally between that of US bonds and equities, while returns are not much less than equities. We can further show how risk controlled equities can improve a portfolio's attractiveness if we extend the measures of risk to include conditional value at risk (CVaR). This is the value that a portfolio may be expected to fall by in a month if a downside market event occurs that is at least as bad as a 95th percentile scenario. The results are set out in Figures 6 to 8 on the next page.

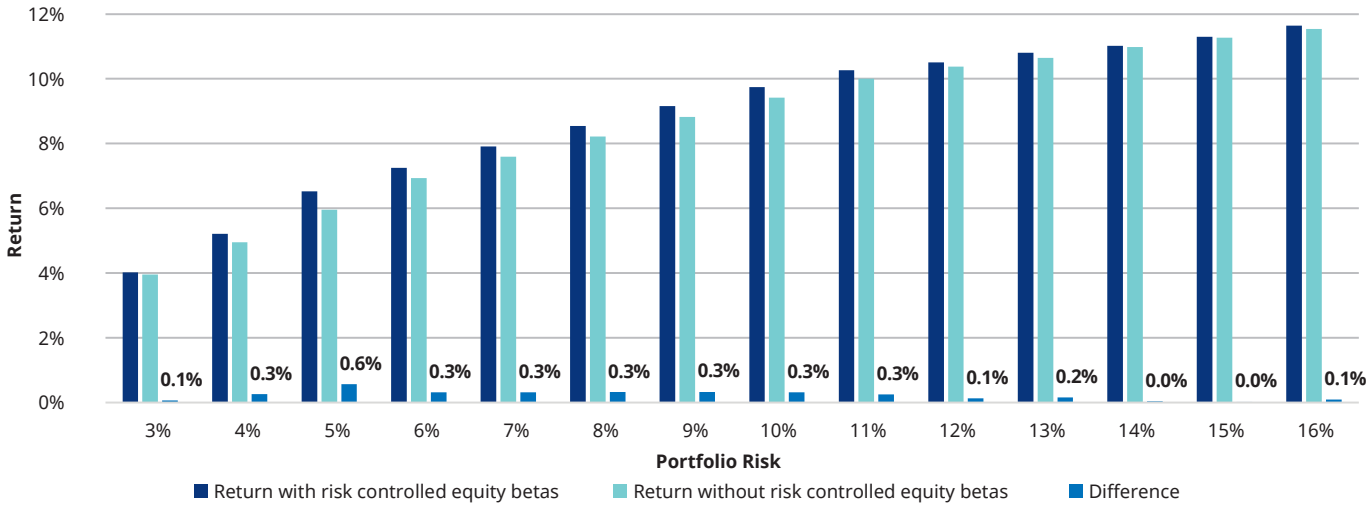
11 *Volatility managed portfolios*, by Alan Moreira and Tyler Muir, The Journal of Finance, 6 April 2016. https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.12513.
12 See footnote 10

Figure 6: Improving the characteristics of equity and bond portfolios using risk controlled equities - the effects on Sharpe ratio



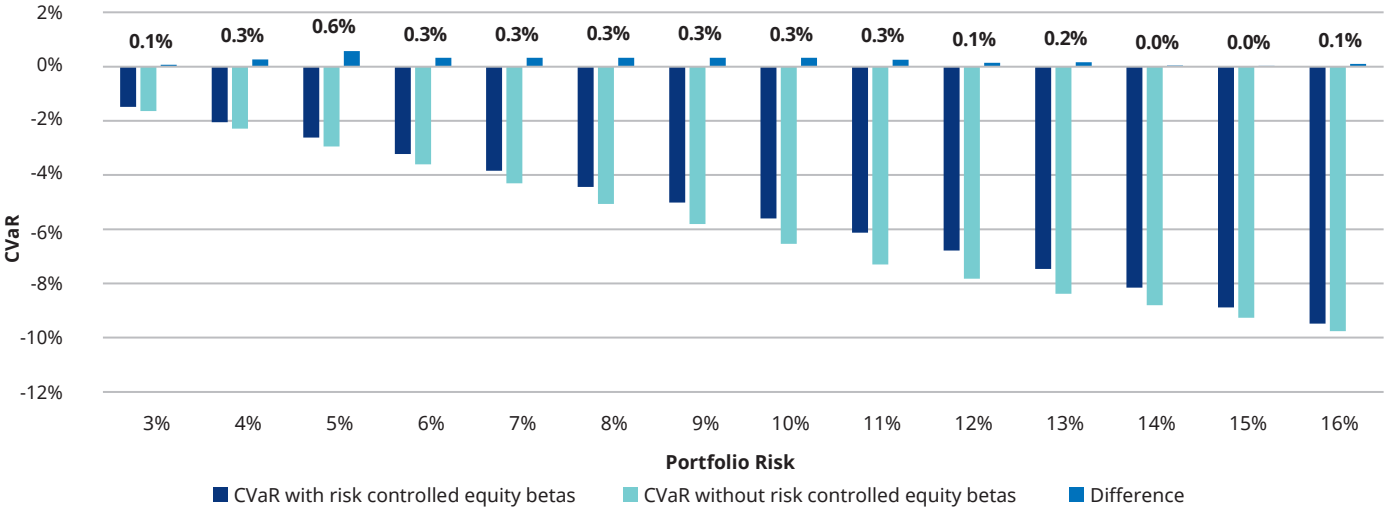
Source: Schroders, S&P, Bloomberg. Monthly returns Dec 2002 to November 2017. For illustrative purposes only. Actual results would vary. Past performance is no guarantee of future results. The Sharpe ratios are measured as the excess returns over the volatility of total returns.

Figure 7: The effect on returns



Source: Schroders, S&P, Bloomberg. Monthly returns December 2002 to November 2017. For illustrative purposes only. Actual results would vary. Past performance is no guarantee of future results.

Figure 8: The effect on tail risk CVaR[13]



Source: Schroders, S&P and Bloomberg. Monthly returns December 2002 to November 2017. For illustrative purposes only. Actual tail risk events may be greater or less than those shown above. Past performance is no guarantee of future results. The drawdown is the largest peak to trough loss in total return, calculated using daily data.

13 For the purpose of the CVaR calculation, the losses are total returns calculated monthly.

These results indicate that the **risk controlled betas may satisfy the portfolio demand criterion because they can help investors achieve an outcome that is not addressed by existing assets.** However, we also need to recognize that the results of a portfolio optimization will be driven by the combination of the assets' Sharpe ratios and their correlations. Also, depending on their circumstances and given human heuristic nature, each investor will naturally gravitate to a single equity risk management technique, rather than build a portfolio of different strategies. In reality an investor will already have a portfolio and a more constrained approach to asset allocation.

Adding risk controlled equities to an existing portfolio

Set out below we show the potential benefits an investor can obtain by adding a single risk managed equity allocation to their portfolio, whereby an investor **can use risk controlled equities to either:**

- **reduce risk without foregoing as much return as with bonds**
- **and/or "recycle" risk so that the portfolio has a higher level of return for the same level of risk**

Figure 9 shows how a hypothetical balanced mandate (portfolio 1) split 60% US Equities (S&P 500) and 40% US Bonds (US Aggregate) can be de-risked by selling 20% of the equity exposures into bonds (portfolio 2). This is an effective reduction of the portfolio's risk but is also costly in terms of returns. However, an alternative approach is to keep the allocation to bonds constant but convert the equity exposures into risk controlled equity (portfolio 3). This shows how the portfolio can benefit from an equity-to-bond level of risk reduction with only a smaller reduction in overall expected return.

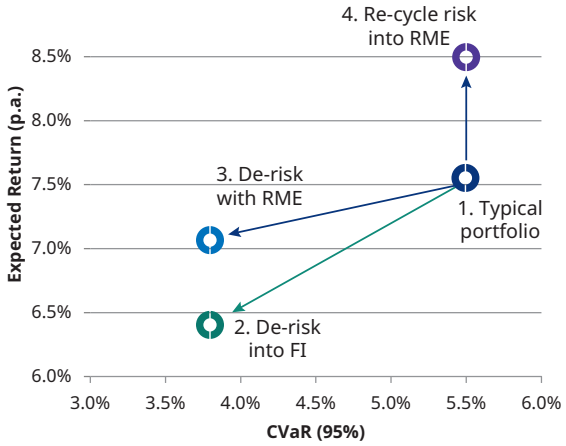
The inclusion of risk managed equities offers yet another outcome – that the risk of the portfolio is recycled to increase the expected return without increasing the risk (portfolio 4).

Figure 9: Improving return potential and/or minimizing tail risk

Potential portfolios

	1. Typical Client Portfolio	2. De-risk (via Fixed Income)	3. De-risk with Risk-Managed Equity	4. Re-cycle risk into Risk-Managed Equity
US Equity	60%	40%	25%	35%
US Risk Controlled Equity*	–	–	**35%**	**55%**
US Fixed Income	40%	60%	40%	10%
Return (1 yr)	7.6%	6.4%	7.1%	8.5%
CVaR (95%)	5.5%	3.8%	3.8%	5.5%

Risk/return



Source: Schroders, Bloomberg, S&P, monthly returns December 2002 to November 2017. *90% collar. Past performance is no guarantee of future results. For illustrative purposes only. Actual results would vary. Please refer to the back of this report for important information on backtested results.

Conclusion

The analysis shows that the inclusion of risk controlled equities in the investment universe can potentially improve returns for a given level of risk and/or reduce risk for a given level of return. Thus, risk controlled equities bring beneficial characteristics when considered in a total portfolio context. Our findings suggest that risk controlled equity betas could be considered as a new set of portfolio building blocks that offer something different from the existing equity, smart beta, bond and cash components. These techniques should be considered much more than short-term tools used to protect against equity shocks – they can be important long-term strategic holdings in many portfolios.

A word about backtested returns

Any hypothetical/simulated results shown must be considered as no more than an approximate representation of a portfolio's performance, not as indicative of how it would have performed in the past. Simulated returns are the result of statistical modeling, with the benefit of hindsight, based on a number of assumptions and there are a number of material limitations on the retrospective reconstruction of any performance results from performance records. For example, it may not take into account any dealing costs or liquidity issues which would have affected a strategy's performance. There can be no assurance that this performance could actually have been achieved using tools and data available at the time. No representation is made that the particular combination of investments would have been selected at the commencement date, held for the period shown, or the performance achieved. This data is provided to you for information purposes only as of the dates of this material and should not be relied on to predict possible future performance.

All investments, domestic and foreign, involve risks including the risk of possible loss of principal. No investment strategy or technique can guarantee future results.

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