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QIS Insights

Practical Perspectives for the Creation of Alternative Risk Premia Portfolios

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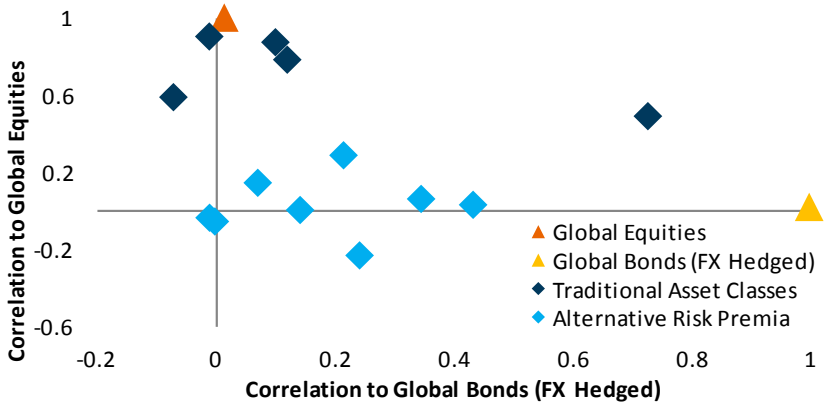
In an environment of both high equity valuations, particularly in the US, and low bond yields, following a global rally of historic length, investors continue to search for alternative exposures. Alternative risk premia (**ARP**) are one of the most widely advocated solutions for this investor need, especially in the space of liquid investments. In this paper we demonstrate that ARP portfolios can be designed in such a way as to suit this investor need for alternative exposure. We go on to discuss some of the key characteristics that investors may want to consider when forming ARP portfolios:

- **Strategy selection** – we consider various inputs to choosing a mix of complementary strategies that might be appropriate given certain investment objectives and also provide a framework for such a process
- **Portfolio construction** – given a selection of strategies, we outline an appropriate way to blend a set of ARP into a diversified investment. In doing so, we take into account the characteristics of the strategies and briefly discuss the pros and cons of different portfolio construction methods
- **Timing of risk premia** – we showcase tools to consider timing of alternative risk premia and also look at the attractiveness of ARP currently

Figure 1: Alternative Risk Premia offer diversification, that is uncorrelated to equities or bonds



Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays. The eight ARP strategies shown are those selected within the example ARP Balanced Portfolio. Global Equities represent the MSCI World Net TR USD Index and Global Bonds (FX Hedged) represent the Bloomberg Barclays Global-Aggregate TR Hedged USD Index.

Executive Summary

The following list highlights some of the key insights that are presented in the paper. For more details, please refer to the respective sections.

Strategy selection:

1. Selection is key: we highlight the importance of Factor/ARP purity and academic/economic rationale, while we prefer to avoid signal based strategies, in most cases
2. Creating a well rounded portfolio: in order to understand the properties of strategies selected we use a macro factor framework to build robust portfolios with the desired properties
3. Backtest versus live performance: we show that returns are roughly 25-50% lower out-of-sample and therefore we put a strong emphasis on strategies with longer live performance
4. ARP offer a second layer of diversification: we highlight that ARP drawdowns tend to occur at different times compared to both each other and traditional assets
5. Excess diversification: adding too many ARP strategies to a portfolio is costly, for each additional strategy the marginal benefit decreases, while the cost-to-volatility ratio increases

Portfolio construction:

1. Choosing an appropriate weighting scheme may be important: evidence suggests that equal (or inverse) volatility may be hard to beat
2. Avoiding high turnover: careful selection of rebalancing frequency and volatility estimation may result in lower rebalancing costs and better risk-adjusted performance
3. Practical implementations: we may be able to overcome the main shortcomings of a volatility-based allocation by using features such as using a fixed volatility (based on long-term volatility) for certain strategies and also by implementing allocation caps and floors at both portfolio and strategy level

Timing of risk premia:

1. Timing risk premia is difficult: we discuss the tool developed at Barclays, ARP Scores, to help investors monitor ARP attractiveness through time
2. Tactical allocation of ARP: risk premia "cheapness" or "costliness" is easier to measure in carry-like strategies and may provide a tool to perform tactical allocation
3. Risk premia outlook: at a portfolio level, according to our analysis, there is no evidence of a significant reduction of the amount of risk premia to capture, in recent years

Introduction

Investors have sought to gain systematic exposure to enhanced returns since the 1930s, firstly by picking undervalued stocks as identified by Graham and Dodd, and then later by branching out into more sophisticated strategies. As time has passed, the range of identified factors underlying these approaches has proliferated, based largely on research by academics such as Fama and French.[1] These factors started as enhancements to traditional beta exposure, now commonly known as smart beta. More recently, the concept of factor investing has broadened to include ARP, where the idea is to enable investors to isolate and access specific risk premia alone, without taking exposure to market beta. A US equity value ARP strategy, for example, extracts the equity value risk premium by buying undervalued US stocks, as measured by a particular value metric, and hedging out the market risk by shorting the US market (or indeed expensive stocks) with an appropriate beta weighting. The resulting value ARP strategy would allow investors to take a view on a very specific type of premium or return source.

As the sophistication of investors has increased and the interest of the financial community has shifted towards this space, it has became more and more clear that certain hedge funds were, to some extent, providing exposures similar to these ARP, as discussed in the seminal report by Ang et al. for the Norwegian Government Pension Fund.[2] This realisation has led to the view that such exposures could also be accessed via systematic strategies, designed to give the pure ARP exposures with more transparency and greater liquidity, as can be seen in Figure 3 below. The advantages of such ARP strategies are that they are widely backed by many leading academics, they have a clear rationale as to why they exist, and they are somewhat orthogonal to most other asset classes of investor portfolios (see Figure 1 above). As such, adding these ARP to client portfolios, even if the expected Sharpe Ratios might be only modest, could be expected to enhance the risk-adjusted returns.

Figure 2: Glossary of Key Terms (Barclays' Definitions)

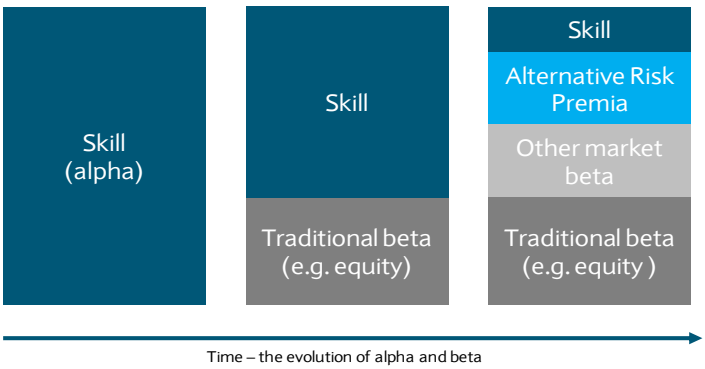
Key Term	Barclays' Definition
Quantitative Investment Strategies (QIS)	QIS are systematic, non-discretionary trading strategies, the performance of which is generally measured by indices. QIS encompass Smart Beta Strategies, Alternative Risk Premia Strategies, Trading Strategies and Risk Management Strategies
Smart Beta Strategies	Strategies that provide access to traditional long-only asset classes, aiming to provide improved risk-adjusted returns versus traditional benchmarks
Alternative Risk Premia (ARP) Strategies	Strategies that provide access to non-traditional risk premia exposures, often involving long-short or market-neutral implementations
Trading Strategies	Strategies that provide enhanced access to traditional and/or non-traditional risk premia exposures via a signal-based implementation
Risk Management Strategies	Strategies that aim to tailor the return profile of investments either by using uncorrelated exposures or by reducing risk
Style	A particular investment strategy approach, applicable across markets and asset classes, based on academic insight and economic intuition, which has historically generated outperformance versus traditional long-only exposures
Factor	An identified attribute of a set of securities from a particular investment universe which may be isolated to produce a return stream with a particular risk and return profile

Source: Barclays

[1] Security Analysis was a book written by Professor Benjamin Graham and David Dodd of Columbia Business School, which laid the intellectual foundation for what would later be called value investing.
E. Fama, and K. French, "The cross-section of expected stock returns", Journal of Finance, pp. 427-465, 1992.

[2] A. Ang, W. Goetzmann, and S. Schaefer, "Evaluation of Active Management of the Norwegian Government Pension Fund – Global", report to the Norwegian Ministry of Finance, 2009.

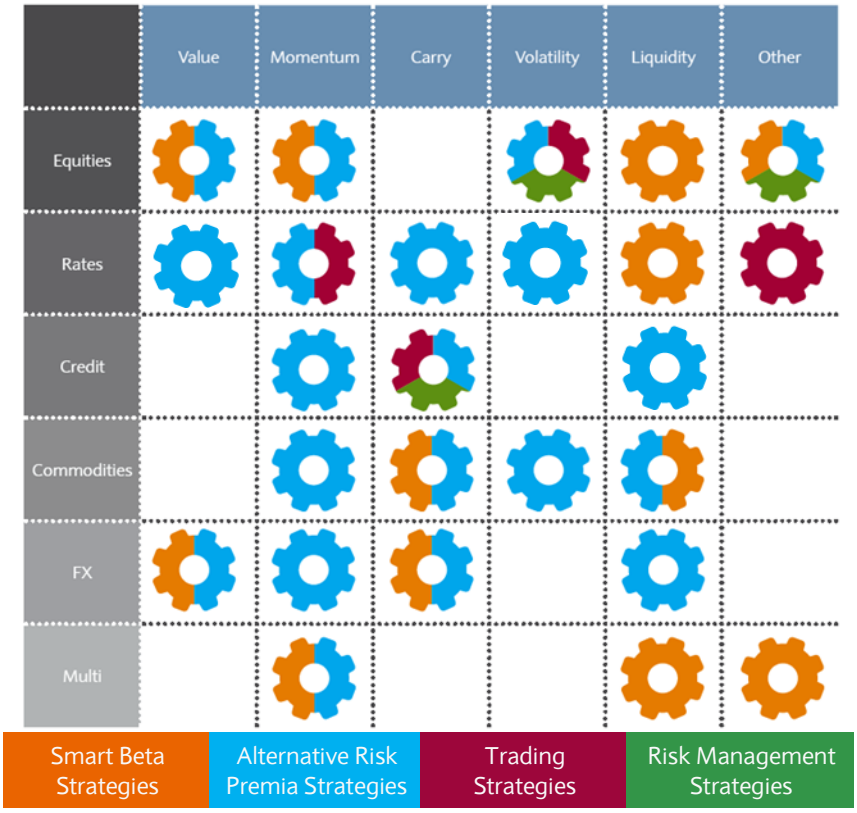
Figure 3: The evolution of the attribution of returns through time



Source: Barclays

In the last 10 years there has been an exponential growth in the number of proposed ARP and smart beta strategies, across asset classes and styles. Many product providers, including Barclays, have produced the now-ubiquitous "grid" of Quantitative Investment Strategies by style and asset class (Figure 4 below). The Barclays range of Quantitative Investment Strategies also has further dimensions beyond asset class and style, namely the type of strategy (while the majority are ARP, there are also Smart Beta, Trading Strategies and Risk Management Strategies) and also the geography (which may be particular relevant for some of the strategies, e.g. equity factors).

Figure 4: Example of Quantitative Investment Strategies across asset classes and styles

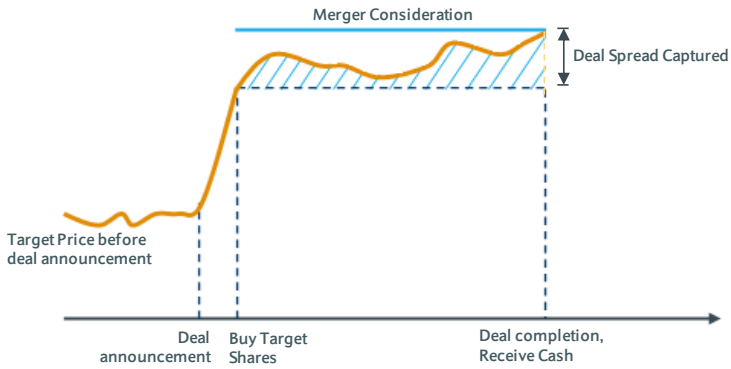


Source: Barclays.

The basic idea behind risk premia investing is that an investor should receive a return for taking on an identified risk of an investment. A simple example is merger arbitrage, where an investor in the deal, post announcement, can earn the difference between the price and the terms of the merger, as shown in Figure 5 below. It is important to note that the deal typically trades at a discount to the terms of the merger. The investor in such a merger deal can then potentially receive this – generally limited – upside, but is exposed to a larger downside risk if, for example, a merger is terminated and the stock returns to its pre-announcement price. The key in designing a merger arbitrage strategy is

therefore to give exposure to a diversified set of deals with some upside (if they complete), combined with an appropriate weighting scheme, such that a single deal termination does not significantly impact the investor's overall portfolio of merger arbitrage deals.

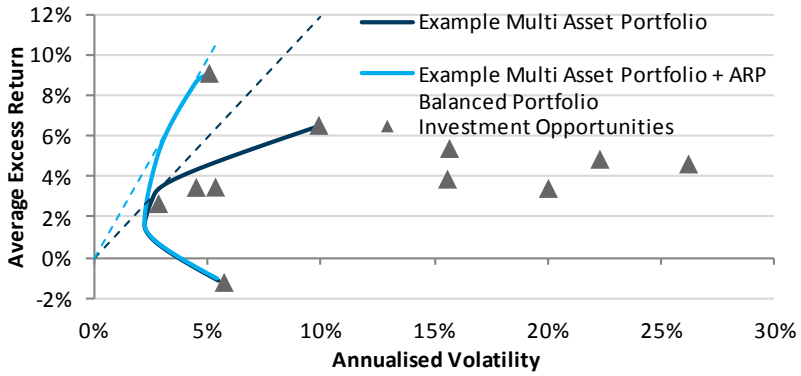
Figure 5: Illustrative example of a Merger Arbitrage deal



Source: Barclays

ARP are generally risk premia which do not share the same source of returns as "traditional" risk premia, such as those coming from bonds or equities. Given that ARP are generally not correlated to the major asset classes in most investors' portfolios, they present some very interesting diversification opportunities and may enhance the efficient frontier, as shown in Figure 6 below. We show below that, after the inclusion of an exposure to the ARP Balanced Portfolio among the investible assets, the investment opportunity set increases and the efficient frontier moves up and to the left, i.e. it may be possible to achieve both higher returns and lower volatility.

Figure 6: Enhancement of the potential efficient frontier with the addition of the ARP Balanced Portfolio



Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays.

As the range of ARP strategies has increased, it has produced a corresponding difficultly for investors trying to assemble portfolios of such strategies, in terms of:

(i) Navigating and understanding the different premia available;
(ii) Choosing the best implementation representing each premium; and
(iii) Deciding on the number of premia and their characteristics in order to create a portfolio according to the investor's objectives.

Given the above, Barclays has launched, over the course of 2018, a family of three example ARP Portfolios. These strategies aim to give some examples to investors on how they might assemble portfolios of such exposures across Barclays' range of ARP or Quantitative Investment Strategies, given different objectives:

- **Barclays Alternative Risk Premia Balanced Portfolio**: aims to provide returns, from a set of ARP across asset classes and styles, that aim to be uncorrelated to equity and bond markets.
- **Barclays Alternative Risk Premia Defensive Portfolio**: aims to provide returns, from a set of ARP across asset classes and styles, that are positive even during stressed market periods when equities and/or bonds decline.
- **Barclays Alternative Risk Premia Carry Portfolio:** aims to provide returns, from a set of ARP across asset classes and styles, with carry-like characteristics, that are somewhat de-correlated from equity and bond market returns.

We hope to see investors use these example portfolios as a starting point to enable them to design their own ARP portfolios, given their own unique investment objectives. In constructing these ARP portfolios, Barclays has incorporated a number of insights from third party academic research, as well as from the experience gained by Barclays over the last 12 years in implementing ARP and putting together portfolios of such strategies, since the launch of Barclays' first ARP indices in 2006. Regarding the design of ARP portfolios, there has been a number of hotly debated topics. In this paper, we aim to provide some commentary and analysis on some of the key aspects around the portfolios and how they have been constructed as illustrations of perspectives on creation of ARP portfolios generally. For more information on the portfolio composition of the three ARP Portfolios, please see the Appendix.

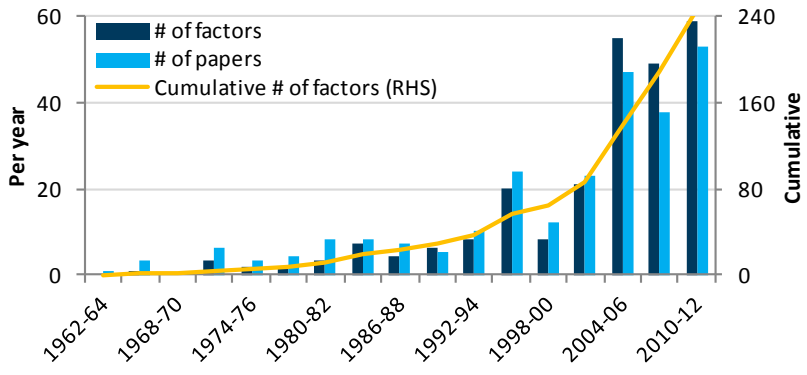
Strategy Selection

Strategy selection is probably the most profound and important aspect of assembling a portfolio of ARP. Even the most sophisticated portfolio construction techniques may not entirely make up for either poor strategy design or an unbalanced strategy selection. As the quantitative investment strategy business has grown in scale, the number of premia that indices claim to capture has increased, the implementation of the premia has been refined and the range of instruments traded has expanded. In discussions with investors and other practitioners, Barclays has identified a number of key topics around strategy selection:

(i) Quantifying a Strategy Universe to select from

Factor purity and academic rationale have become increasingly important. Investors have naturally become cautious around any new or more esoteric risk premia, given the number of factors now available and accusations of data mining. A recent survey counted well over 200 factors in various academic papers, with their number increasing exponentially over time, as shown in Figure 7 (Harvey et al., 2016).

Figure 7: Number of risk premia factors and papers, year-by-year



Source: Harvey (2014), Barclays.

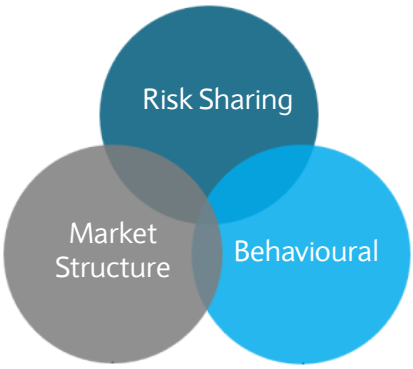
In terms of risk premia and where they come from, Barclays sees three distinct sources of ARP, namely Risk Sharing, Market Structure and Behavioural, as can be seen in Figure 8 below. We can debate, at length, the validity of each of these three types of premia, but we feel they serve as a good basis to understand why each of the individual risk premia exist.

- **Risk sharing:** risk sharing is the transfer of risk from one market participant, that does not want exposure to that particular risk, to another market participant, who does. An example is the volatility risk premium. In option markets, implied volatility generally trades at a premium over subsequent realised volatility. This premium is due to the fact that many market participants wish to hedge equity exposure and are willing to pay an insurance premium to protect their equity portfolios by somewhat overpaying for options, thereby over-pricing implied volatility. Investors who are happy to bear this insurance risk can sell volatility and thereby capture attractive risk-adjusted returns. These returns come at the cost of suffering losses at a potentially inopportune time i.e. when equity markets sell off.

- **Market structure**: a market structure based risk premium is an effect caused by a significant group of participants, in a particular market, which creates a certain distortion in that market. An example of such a premium could be the fact that low volatility stocks tend to outperform high volatility stocks. The reason for their outperformance is that low volatility stocks have been systematically under-priced, as many fund managers are unwilling to take significant exposure to them. Holding a significant amount of low volatility stocks may cause a fund manager (absent the ability to use leverage) to have a large tracking error to their benchmark and also a resultant low beta in their portfolio, leading to underperformance in rising markets.[3]

- **Behavioural:** certain risk premia are caused by longstanding behavioural effects of participants in a given market. The leading example of a behavioural risk premium is momentum or trend investing. There is evidence of momentum working in the US market since 1801.[4] Momentum is the tendency for past winners to continue to outperform, and is explained by the propensity of investors to want to be associated with winning stocks and also investors' slow reaction to emerging news.

Figure 8: Sources of risk premia



Source: Barclays.

An ARP investor should also note that there is a wide variation in the volume of academic research carried out across the different types of ARP. Equity factors are undoubtedly the most well-researched risk premia and are now very widely accepted. Outside of equities, it is our belief that there are a number of very interesting risk premia to be harvested, which have a clear rationale, may have some academic backing and are based on one of the three widely-accepted sources of risk premia, as shown in Figure 8. Markets outside of equities are worthy of consideration for investors in risk premia, as they may have different market participants and unique characteristics in the trading in those markets, which may lend themselves to create rich sources of ARP strategies.

Given the above, we would argue that, just because extensive academic work has not been done on individual risk premia, it does not mean there should be a barrier to including them. The key points are that the fundamental rationale for such premia existing is clear and that the creation of the indices and any parameters used is done in a thoughtful and robust way.

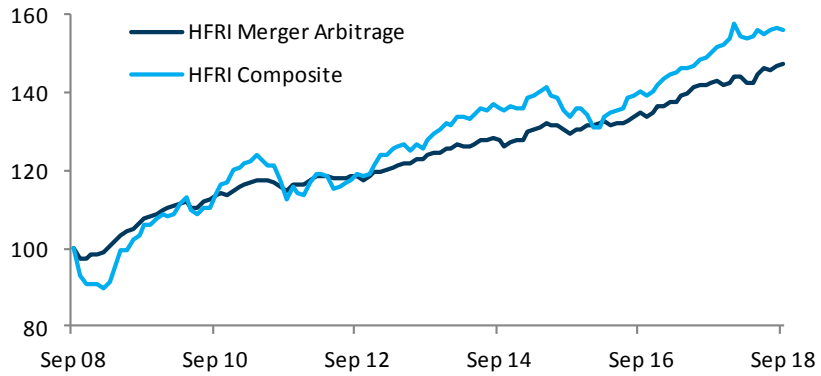
[3] A. Frazzini, L.H. Pedersen, "Betting against beta", Journal of Financial Economics, 111.1:1-25, 2014.
[4] C. Geczy, and M. Samonov, "Two Centuries of Price Return Momentum", Financial Analysts Journal, 72.5: 35-56, 2016.

One example would be liquidity strategies in commodities, which have been thoroughly analysed in a previous Barclays QIS Insights article on commodity congestion.[5] Within commodity markets, one of the most well-known risk premia is the liquidity or congestion risk premium. The commodity liquidity or congestion premium arises as commodity beta strategies generally roll systematically from a closer-to-expiry future to a further-to-expiry future, at a given time in a month. There is therefore the possibility for liquidity strategies to provide liquidity to these beta investors and for the ARP investors to be compensated for doing so.

Commodity markets are quite different to equity markets by their very nature. Commodity markets have different major players, e.g. producers and consumers of each commodity, whose activities are key to the dynamics of each market. In commodity markets investors are a much less important part of the market, compared to equity markets. Individual commodity groups have much lower levels of pairwise correlation with one another than, for example, the stocks within the S&P 500, and they are each a distinct market. There is also a unique structure to each of the commodity futures markets, with a particular term structure shaped by supply and demand and seasonal effects. Although there has been some interesting research work done [Miffre, (2016) for example], it still remains a relatively less-well understood asset class for ARP.

Another example, included in the ARP Balanced Portfolio, is Merger Arbitrage. It is a "classic" hedge fund strategy which has been around at least since the 1990s, and is in fact one of the best performing HF strategies over recent years, as can be seen in Figure 9. Merger Arbitrage is a very difficult strategy to backtest, with significant market data issues around getting point-in-time deal data. The strategy also requires expertise in the specifics of sizing each merger arbitrage deal which requires considerable knowledge. Given these points this premia has been less researched by academics, although there are at least a couple of papers providing valuable insights around the characteristics of the strategy.[6]

Figure 9: Historical performance of Merger Arbitrage strategies



	HFRI Merger Arbitrage	HFRI Composite
Annualised Excess Return	3.2%	4.2%
Annualised Volatility	2.4%	5.5%
Sharpe Ratio	1.3	0.8

Determined using monthly data from Sep 2008 to Sep 2018. Source: Bloomberg, HFRI, Barclays.

It is our belief that when looking at strategies built around both academic and non-academic factors, an additional consideration must be made on whether the strategy is signal-based or aims to achieve a pure exposure to the risk premium. The "use of signals" is a hotly debated topic in the implementation of ARP strategies. In the early years of Quantitative Investment Strategies, prior to the financial crisis, many providers proposed indices or strategies with one or more signals aiming to create a "45-degree line" strategy which was "all-weather" by going long and short one or more premia. Given the infrequency of risk-off events, it was very difficult to calibrate these "on-off" signals and, as a result, many strategies disappointed, mainly due to signals

[5] J. Horrex, "Commodity Congestion Study", Barclays QIS Insights, 2018.
[6] M. Baker, S. Savasolgu, "Limited arbitrage in mergers and acquisitions", Journal of Financial Economics, 2001
M. Mitchell, and T. Pulvino, "Characteristics of Risk and Return in Risk Arbitrage", 2001

which did not anticipate the financial crisis in 2008. Post-crisis, these signal-based strategies were calibrated to a "2008-style event", and did poorly in smaller sell-offs and the "buy the dips" market that we have witnessed in the following decade. After these bad experiences, providers and their clients pushed for more "purity" in their approach. They started to understand that risk premia involve downside risk by their very name and nature and so, if the risk they were taking crystallised, then there were would be a corresponding period of weak returns.

These days, the most popular approach to ARP is to build "pure", well-constructed and carefully designed risk premia strategies and then work to offset their negative aspects in the combination and portfolio construction stages.[7] In some strategies the methodology is, by its nature, signal-dependent, such as CTAs or trend-followers where the whole strategy is built upon anticipating upwards and downwards trends in multiple instruments across different asset classes. In the case of forming a defensive risk premia portfolio, there may be different considerations in deciding on whether to use signals or not.

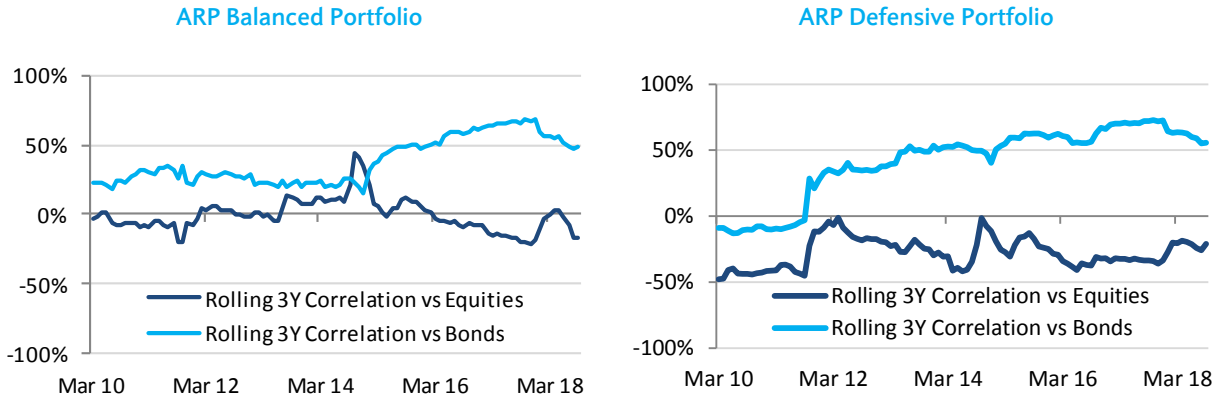
(ii) Understanding the properties of strategies selected

Barclays has done significant work analysing the characteristics of different types of risk premia strategies, as described in the Barclays QIS pieces on Risk Factor Analysis and Macro Factor Analysis. Strategies may exhibit quite different characteristics dependent on their construction. A short volatility strategy, which is a carry strategy by its very nature, will likely exhibit, at least in certain periods, equity-like downside. On the other hand, a fixed income carry strategy is also a carry strategy, but may exhibit attractive returns in a risk-off environment for equities. Across carry-type strategies, an investor has to be diligent in understanding the characteristics of each of those strategies as they are quite different. Analysis needs to be undertaken, strategy by strategy, to understand their characteristics and how these dovetail with other selected strategies, and also may help to meet the overall portfolio objective. Finally, designing a portfolio of defensive strategies may require additional considerations versus a portfolio of carry or balanced strategies.

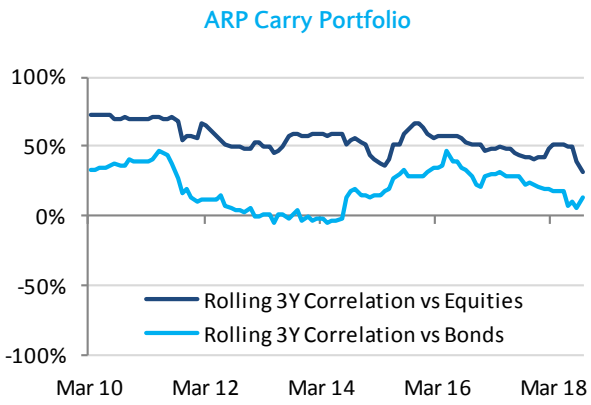
Correlation Profile

In the case of the ARP Carry Portfolio, the idea is to have an "equity replacement"-like profile. It may be appropriate to have strategies which are correlated to equities in this portfolio as opposed to the ARP Balanced Portfolio, which is meant to be more uncorrelated to equities and have a performance regardless of broad market conditions. We plot 3-year rolling correlation versus equities and bonds of the Balanced and Carry ARP Portfolios in Figure 10 below.

Figure 10: Rolling 3-year correlation versus equities and bonds



[7] F. Li, and S.Sheperd, "Craftsmanship in Smart Beta", 2018.



Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays. Equities represent the MSCI World Net TR USD Index and Bonds represent the Bloomberg Barclays Global-Aggregate TR Hedged USD Index.

Figure 11 shows the correlation for the eight strategies selected in the example ARP Balanced Portfolio. By design, the correlation with global equities is low and the correlation amongst the strategies is also low, with an average full sample pairwise correlation of 11%.

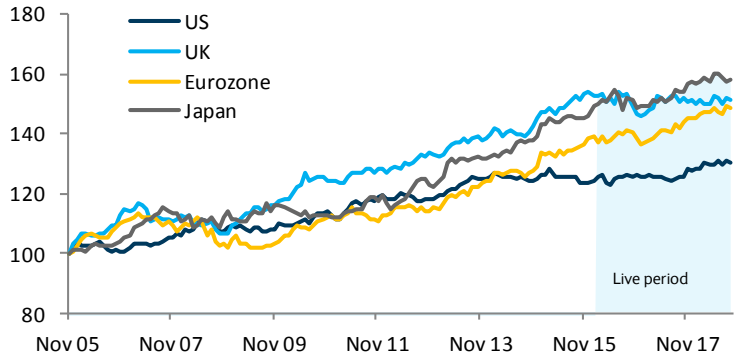
Figure 11: Correlation among example ARP Balanced Portfolio components

	MSCI World ER	ARP Balanced Portfolio	Equity Multi-Factor MH	Rates Multi-Factor	Commodity Carry	Commodity Liquidity	FX Carry	FX Liquidity	Cross-Asset Trend	Merger Arbitrage
MSCI World ER	100%									
ARP Balanced Portfolio	-1%	100%								
Equity Multi-Factor MH	5%	62%	100%							
Rates Multi-Factor	1%	40%	21%	100%						
Commodity Carry	12%	39%	11%	6%	100%					
Commodity Liquidity	-1%	40%	1%	16%	29%	100%				
FX Carry	29%	13%	-1%	9%	-9%	-1%	100%			
FX Liquidity	-5%	27%	-8%	7%	7%	3%	-7%	100%		
Cross-Asset Trend	-25%	50%	5%	14%	17%	12%	-17%	19%	100%	
Merger Arbitrage	-7%	42%	15%	2%	3%	6%	-9%	-1%	23%	100%

Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays.

There is potentially a lot to be gained by asset class and geographical diversification for ARP strategies (noting the following discussion on over-diversification). Not only does one benefit from the potential improved risk-adjusted returns, but there is also the possibility of testing a given strategy in multiple markets. An ARP strategy designer can gain significant comfort from showing that a single approach to building an equity multi-factor works equally well in US, Eurozone, UK and Japan and reduces the potential for backtest over-fitting. In Figure 12 we show the pairwise correlation for the Equity Multi-Factor MH Strategy in four different regions. The correlation between the different regions is low for the exact same implementation and we see the implementation is effective across all four regions.

Figure 12: Equity Multi-Factor MH Strategies Performance and Correlation across Regions



	US	UK	Eurozone	Japan
US	100%			
UK	17%	100%		
Eurozone	29%	40%	100%	
Japan	24%	13%	16%	100%

Determined using monthly data from Nov 2005 to Sep 2018. Source: Bloomberg, Barclays.

In Figure 13 we show the benefit of asset class diversification for a trend-following strategy. We show the correlations across components of our CTA strategy, Cross-Asset Trend, which follows a similar trend following strategy in six separate asset classes.[8] Again, there is a good degree of comfort from the performance in each of the asset classes, given the same methodology for signal construction and sub-portfolio construction.

We note that in the case of our ARP Balanced Portfolio, for which we choose eight strategies, we are in fact choosing certain strategies, e.g. Equity Multi-Factor MH and Cross-Asset Trend, which already themselves benefit from diversification by being implemented across asset class, style and/or geography.

Figure 13: Correlation among asset class CTAs – Cross-Asset Trend Single Asset Class Strategies

	Equity	DM FX	EM FX	Commodity	Bonds	Money Market
Equity	100%					
DM FX	17%	100%				
EM FX	25%	57%	100%			
Commodity	20%	38%	31%	100%		
Bonds	10%	19%	17%	9%	100%	
Money Market	14%	13%	10%	13%	77%	100%

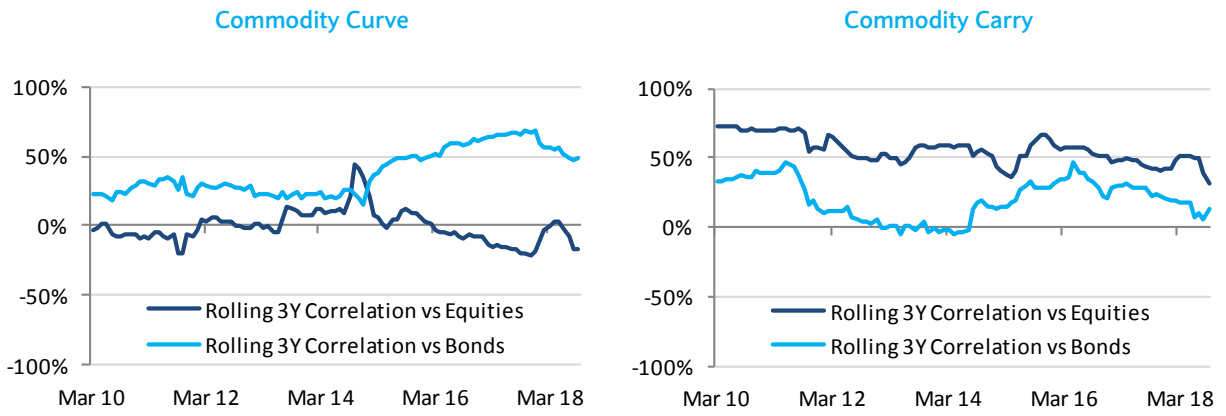
Determined using monthly data from Feb 2002 to Sep 2018. Source: Bloomberg, Barclays.

In essence, we think that it is important to harness the following characteristics of the ARP Strategy Universe:

a. **Cross–asset**: investors may wish to take a cross-asset approach. Commodities have many good examples of ARP which are not correlated to macro moves of equities and bonds. A Commodity Curve or Carry strategy is not influenced as much by a sell-off in equity markets as some other ARP strategies, such as Equity Short Vol or Credit or FX Carry. Commodity markets have more idiosyncratic risks, which is a potential positive for their inclusion in ARP portfolios.

[8] K. Ghia, "The Trend-Cycle Strikes Back", Barclays IPRS, 2015.
K. Ghia, A. Staal, and C. Fattouche, "Diversified Trend Following", Barclays IPRS, 2014.

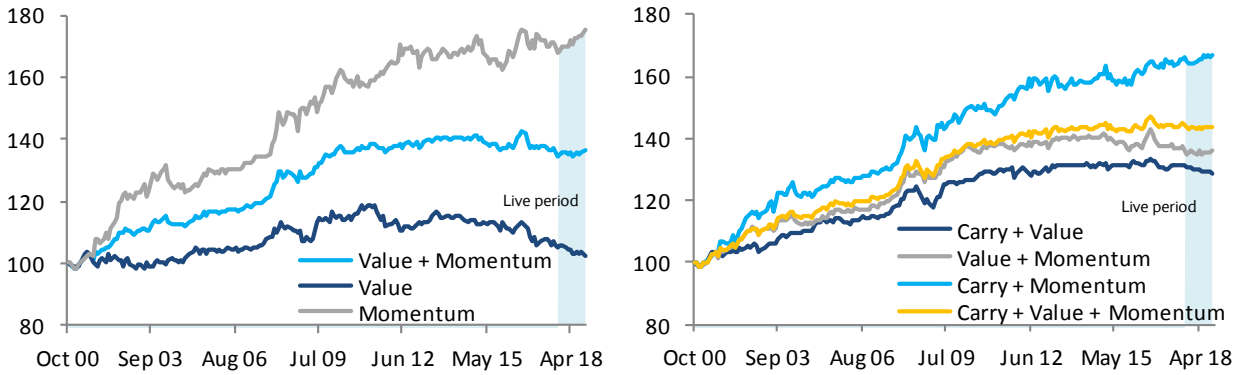
Figure 14: Commodity strategies' rolling 3-year correlation versus equities and bonds



Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays. Equities represent the MSCI World Net TR USD Index and Bonds represent the Bloomberg Barclays Global-Aggregate TR Hedged USD Index.

b. **Cross-style**: For many strategies, there may be advantages to mixing different styles. A good example of this is in Rates Factors, where the Value and Momentum styles tend to be uncorrelated and work well in a multi-factor approach.

Figure 15: Historical simulated performance and correlation of Rates Single Factor and Multi-Factor Strategies



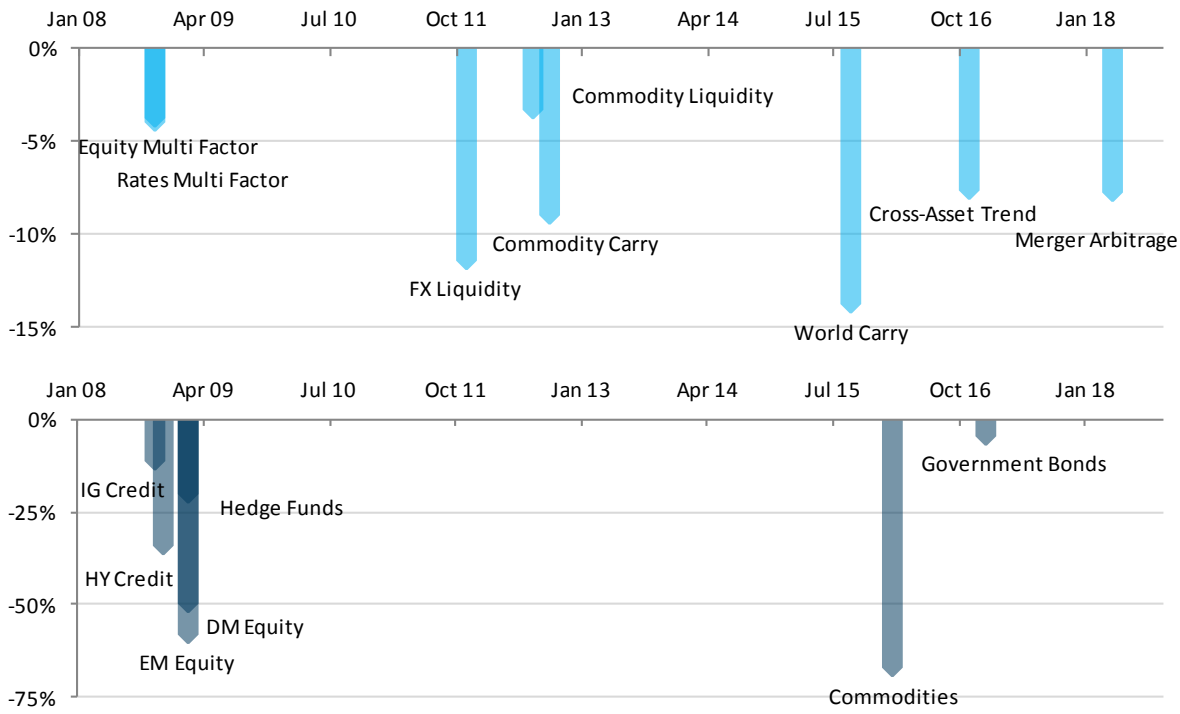
	MSCI World	Global Agg	Carry	Value	Momentum
MSCI World	100%				
Global Agg	24%	100%			
Carry	-3%	25%	100%		
Value	24%	-8%	-12%	100%	
Momentum	-15%	21%	40%	-17%	100%

Determined using monthly data from Oct 2000 to Sep 2018. Source: Bloomberg, Barclays. Please note that Carry + Value + Momentum coincides with the Rates Multi-Factor Strategy.

Downside Diversification

Analysing correlation among portfolio components is important during the portfolio construction process. In fact, it is common knowledge that building a portfolio including uncorrelated assets/strategies will lower portfolio volatility, and therefore enhance risk diversification. In addition, we consider it important to take into account a second dimension of diversification, i.e. whether risk premia have historically crystallised losses at the same time. Figure 16 shows that the strategies within the ARP Balanced Portfolio have tended to have drawdowns at different times. This again reinforces the previous point around potential portfolio diversification and confirms that the selected strategies are indeed harnessing different types of premia.

Figure 16: Historical max drawdown of ARP Balanced Portfolio components compared to traditional asset classes

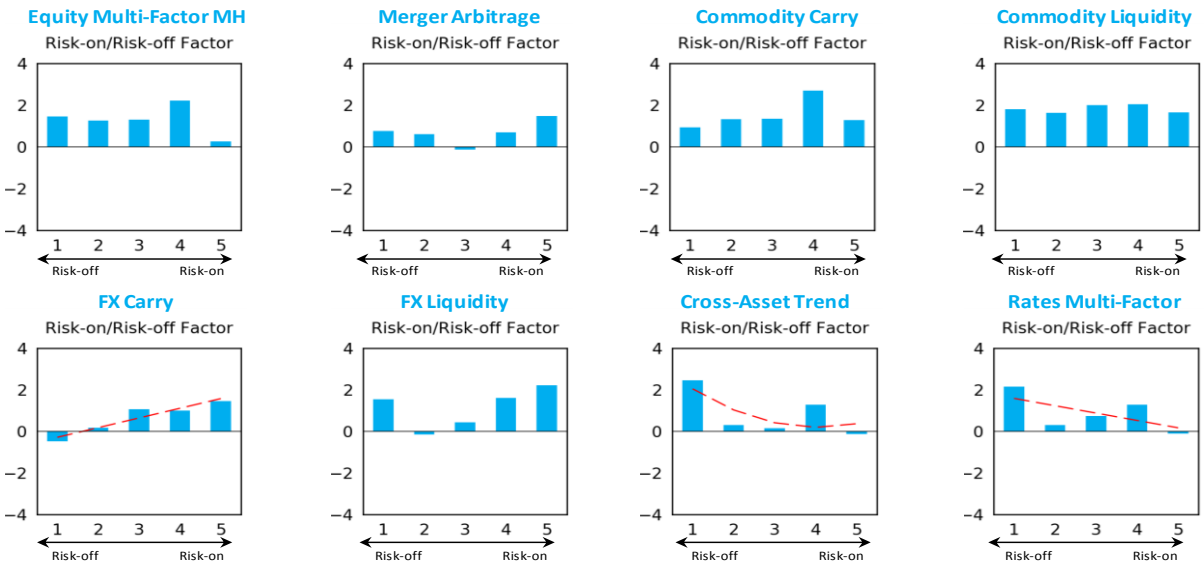


Determined using monthly data from Mar 2007 to Sep 2018. Source: Bloomberg, Barclays.

Macro Factor Analysis

After considering cross-asset, geographical, and drawdown diversification, it is important to understand how ARP strategies would fit into an existing portfolio in order not to increase exposure to more common risk factors. Leveraging on its industry expertise and on continuous feedback from clients, Barclays has developed a Macro Factor framework as a tool for investors to better understand the exposure of ARP strategies to those factors, either macroeconomic or market related, that have historically tended to drive the performance of traditional asset classes. In Figure 17 below we show the Macro Factor analysis on the eight strategies selected in the ARP Balanced Portfolio. We note that there is one "risk-on" strategy which is significant at the 5% level and there are two "risk-off" strategies significant at the 5% level, along with five strategies that have no significant positive or negative loading to the risk-on, risk-off factor.

Figure 17: Risk-on/risk-off profile of ARP Balanced Portfolio components

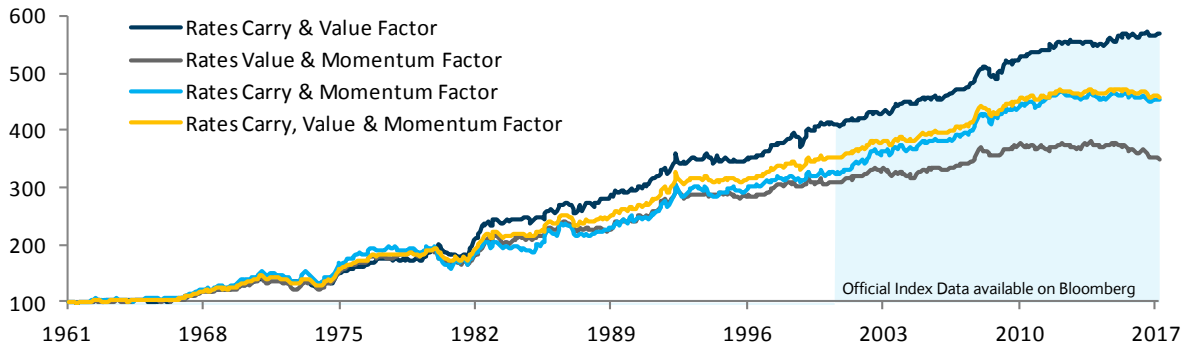


Determined using monthly data from Jan 2000 to Jun 2018. Source: Bloomberg, Barclays. The graphs above show the conditional Sharpe ratios depending on the risk-on/risk-off quintiles. Dotted red lines are inserted only when a linear (alternatively, a convex) relationship is observed with a p-value ≤ 5%.

(iii) Areas for further consideration

Adjusting for short backtests /recent live dates: Length of backtest can be an issue for risk premia investors. It is important to understand the potential performance of each strategy in various types of macro environment, some of which we have not witnessed in the last 10 or 15 years, e.g. increasing inflation or rates. In many cases, there are various dilemmas for risk premia strategy providers to address when creating indices or strategies. A key constraint is that good quality data is not necessarily available going back through time. Researchers may be able to produce backtests to the 1970s and before, but for many producers of indices the need for consistent, high quality data throughout the published time series means that many indices have only a 10 or 15 year "official" history. Barclays has tried to help investors by, in certain cases, publishing a longer "non-official" and "for research purposes" time series, shown in Figure 18. In the case of creating risk premia and the selection of specific premia in a portfolio, data scarcity obviously creates a bias as researchers and product providers will naturally gravitate towards researching and developing better-performing premia. Given the short time history available, this may translate into a bias towards strategies performing in a market environment similar to the one we have experienced recently e.g. falling rates and low inflation.

Figure 18: Rates Multi-Factor Long Sample Backtest

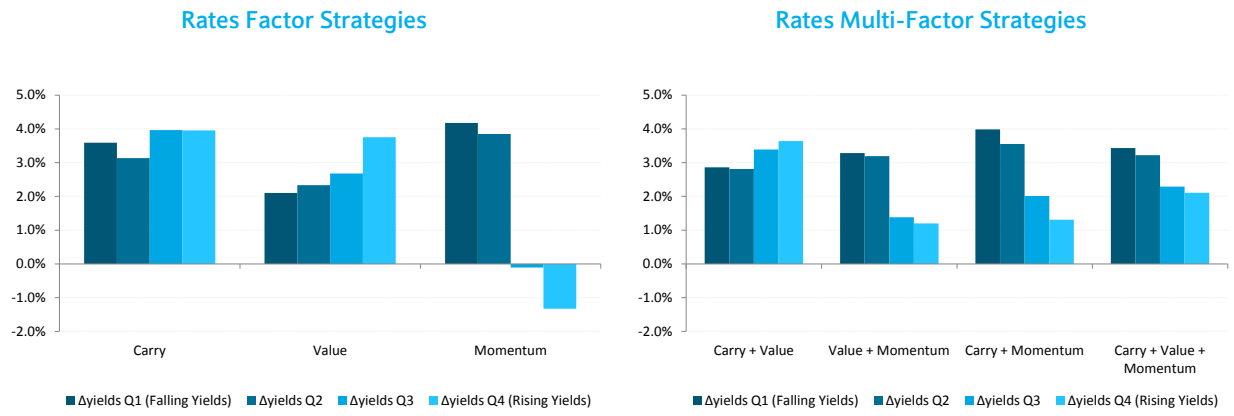


Determined using monthly data from Apr 1961 to Jun 2017. Source: Bloomberg, Barclays. Please note that Rates Carry, Value & Momentum coincides with the Rates Multi-Factor Strategy.

Figure 18 shows the long sample backtest of the Rates Multi-Factor strategies. In order to avoid biases associated with the long recent period of falling yields, and in particular to cover the period of rising yields in the 1960s, 1970s and early 1980s, we extended the data before bond futures data were available. To do this we used proxies calculated from the corresponding government bonds, as explained in more detail in the Barclays QIS Insights article Style Investing in Rates Markets.[9] We can then go on to test whether a multi-factor combination of Value, Carry and Momentum, applied to government bonds futures, is indeed as effective in rising yield environments as it is in falling yield environments. The result, shown in the paper, confirms that this is indeed broadly true.

[9] C. Fattouche, "Style Investing in Rates Markets", Barclays QIS Insights, 2018.

Figure 19: Annualised monthly returns (annualised) of rates factors conditional on global yield environments sorted by quartiles



Determined using monthly data from Feb 1962 to Jun 2017. Source: Bloomberg, Barclays. Please note that Carry + Value + Momentum coincides with the Rates Multi-Factor Strategy.
Δ yields Q1 to Q4 represent monthly changes in treasury yields sorted by quartiles, where treasury yields means the Bloomberg Barclays Global Treasury Yield to Worst (BTSYYW Index) from Jan 1987 onwards, and US Generic Government 10Y Yield (USGG10YR Index) before that.

Another example of a potential issue with shorter backtests is the case of equity low volatility strategies. For low volatility stocks, Barclays has a global time series, which is market neutral, only since 2005. Since 2005, 10 year US government bond yields declined from 4.5% (reaching as high as 5.3% in June 2007) to a low of 1.35% in July 2016 and subsequently recovered to around 3.15% as of the end of October 2018. Barclays has analysed the impact of interest rates on equity low volatility strategies in three reports namely the Barclays QIS Insights pieces on equity multi-factor approaches, ARP performance in rising yield environment and the research piece of August 2014 titled "Low Volatility Equity Strategies: Anomaly or Capital Structure Effect". It is clear that many strategies, such as low volatility, have biases to certain market conditions, such as declining rates, which were prevalent over the relatively short backtesting period for those strategies.[10] Given such examples, care should be taken to avoid selecting strategies solely based on recent performance. It may be prudent also to consider selecting strategies that have performed less well over the last 15 years, as they may exhibit more robust future performance.

At Barclays, we also have a strong preference for out-of-sample performance of ARP and ideally want significant live track records before including ARP in a portfolio. Our approach to strategy design has been to do the "homework upfront" when it comes to strategy design and, as such, try to avoid multiple subsequent variants of strategies. Nonetheless, there may be instances when investing in a newer strategy make sense, e.g. where there are new capabilities to enhance a strategy, such as shorting acquirer stocks to create a "purer" merger arbitrage strategy or intraday hedging for a short volatility strategy, or indeed where a simple variant of an existing strategy is made in order to increase capacity by, for example, rolling into new positions on a different day.

The widespread market knowledge of the risk premia eroding returns: One additional potential disadvantage of using very "academic" or "mainstream" ARP with commonly-agreed implementations is that those exact premia may be arbitraged away.[11]

[10] F. Jivraj, D. Haefliger, Z. Khan, B. Redmond, "Equity Multi-Factor Approaches: Sum of Factors vs. Multi-Factor Ranking", Barclays QIS Insights, 2016.
C. Fattouche, "Alternative Risk Premia in a Rising Yield Enviroment", Barclays QIS Insights, 2017.
C. Karyda, A. Staal, and C. Ural "Low Volatility Equity Strategies Anomaly or Capital Structure Effect", IPRS Quantitative Investment Strategies, 2014.
[11] C. Asness, "How Can a Strategy Everyone Knows About Still Work?" 2015.

Figure 20: Annualised results before and after strategy launch or factor publication versus Barclays Equity Factors

Panel A: Smart Beta Strategies

Jan 1967-Aug 2016	Fundamental Index	Equal Weight	Low-Vol Index	FTSE RAFI Index	Quality Index	Dividend Index	Risk Efficient	Maximum Diversification	Average
Launch	Nov-05	Jan-03	Feb-11	Apr-13	Dec-12	Nov-03	Jan-10	Nov-11	
Before	2.0%	1.3%	1.2%	2.2%	0.4%	2.9%	2.7%	1.6%	1.8%
After	0.5%	2.3%	2.1%	0.1%	0.1%	1.3%	0.9%	4.1%	1.4%
Difference	-1.5%	1.0%	0.9%	-2.1%	-0.4%	-1.6%	-1.9%	2.5%	-0.4%

Panel B: Factors

Jan 1967-Aug 2016	Value (Blend)	Value (B/P)	Momentum	Size	Illiquidity	Low Beta	Profitability	Investment	Average
Publication	1977	1977	1993	1981	2002	1975	2013	2004	
Before	9.8%	9.1%	5.4%	7.0%	2.5%	7.4%	1.2%	3.2%	5.8%
After	2.3%	1.4%	3.7%	0.8%	5.0%	2.1%	5.0%	-1.0%	2.4%
Difference	-7.5%	-7.8%	-1.8%	-6.2%	2.5%	-5.4%	3.8%	-4.5%	-3.3%

Panel C: Barclays Equity Factor Strategies

Nov 2005-Nov 2018	Global Momentum	Global Quality	Global Low Vol	Global Value	US Multi-Factor	Eurozone Multi-Factor	UK Multi-Factor	Japan Multi-Factor	Average
Live*	Jul-14	Sep-14	Oct-13	Sep-14	Sep-14	Sep-14	Sep-14	Sep-14	
Before	0.7%	3.9%	4.4%	3.8%	3.8%	2.8%	3.9%	3.7%	3.4%
After	2.3%	4.3%	3.1%	0.1%	0.9%	3.6%	1.8%	3.8%	2.5%
Difference	1.6%	0.4%	-1.3%	-3.6%	-2.9%	0.8%	-2.1%	0.1%	-0.9%

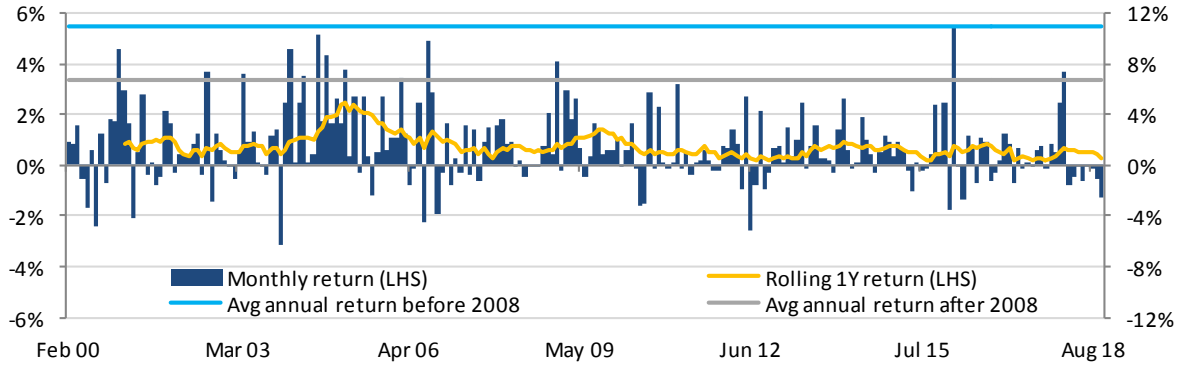
* Please consider that some of the underlying strategies have different live dates.
Source: Research Affiliates LLC using CRSP/Compustat and Worldscope/Datastream data, Barclays. For more information please see https://www.researchaffiliates.com/en_us/publications/articles/541_timing_smart_beta_strategies_of_course_buy_low_sell_high.html.

There is good evidence in size, value and momentum strategies that post-launch performance, as shown in Figure 20, was weaker than over the backtested period. This may be an effect of the premia being arbitraged away or trading costs for such a strategy not having been taken into account, particularly for momentum, where transaction costs may be significant versus the potential returns. There can also be issues with finding reliable shorting data, concerning both the cost of short and the availability of the short, which can have a significant difference on the performance of the short side. This is examined in more detail in the Barclays QIS Insights article on the short side of equity factors, where we show that whilst implementing a "pure" long-short factor is appealing from a theoretical perspective, the practical realities are often different and should be thoroughly analysed.[12]

Another example of ARP return erosion is when the mainstream investors in a particularly market become aware of investors "harvesting" a premium from them and therefore adapt their behaviour. In Commodity Liquidity Strategies, for instance, once it became known that simply rolling prior to the main commodity benchmarks produced outsized returns, the market changed and the effect was diminished by sophisticated investors creating "pre-roll" strategies and arbitraging it away. Additionally, the commodity beta investors switched to enhanced strategies in order not to pay away this liquidity premium to the more sophisticated investors. This change in behaviour is discussed in the QIS Commodity Congestion Study and is shown in Figure 21 below, where the returns of the Commodity Congestion or Liquidity Strategy have diminished through time, predominantly due to the challenged performance of the Commodity Curve component of those returns post 2009.

[12] QIS Insights, "The Short Side of Equity Factors: Single Stocks vs. Market Hedge", 2017.

Figure 21: Nearby Liquidity before and after 2008



Determined using monthly data from Feb 2000 to Aug 2018. Source: Bloomberg, Barclays.

Number of strategies selected: It is tempting for any practitioner or investor in ARP to aim for as much diversification as possible when putting together a portfolio of risk premia. The idea of diversification being a "free lunch" in investing was popularised by Nobel prize-winning economist Harry Markowitz. However, we would be careful making such a statement with regards to ARP. In assembling such portfolios, caution needs to be applied when selecting the number of strategies. We note the following points in terms of our thoughts around the number of strategies selected:

a. There is only a finite number of strategies that can be selected from. Despite the proliferation of ARP and the population of grids by asset class and style, there cannot be an infinite number of "best ideas" with regards to risk premia and investors should concentrate on those in which they have the highest conviction or which are most strongly backed by the underlying research and rationale for the premia.

b. Risk premia strategies, in general, may have high turnover and thereby trading costs per unit of vol or expected return. The S&P 500 has, for instance, a 10-year monthly volatility of 15% and turnover of less than 5% whereas many ARP strategies have volatility considerably less than 5% and turnover considerably above 100%.[13] Given this, the trading costs to volatility ratio is much higher for ARP. The increase in this ratio is not surprising, given that risk premia strategy often use relative value positions, which suppress their volatility, and trade more often than market cap weighted equity strategies to gain exposure to the factor they are aiming to capture. Given that the strategies are in themselves not correlated as seen in Figure 11, then real care needs to be taken in not being over-diversified and investing in too many strategies within an ARP allocation.

c. Ongoing monitoring and understanding of risk premia is time consuming and therefore Barclays is of the opinion that time is better spent focussing on a smaller number of strategies and working to understand the characteristics of those premia and selecting the best implementation.

[McKay, Shapiro and Thomas (2018)] aim to provide a framework to help investors work out how much to pay in terms of "Management Fee for Active Risk" (FAR) to understand if investors are paying an appropriate price for active managers. In terms of deciding how many ARP strategies to allocate to, the framework can be taken and amended to decide on how many strategies to select and how to avoid excess diversification.

Research on excess diversification, focusing on the fund of hedge fund space, showed that:

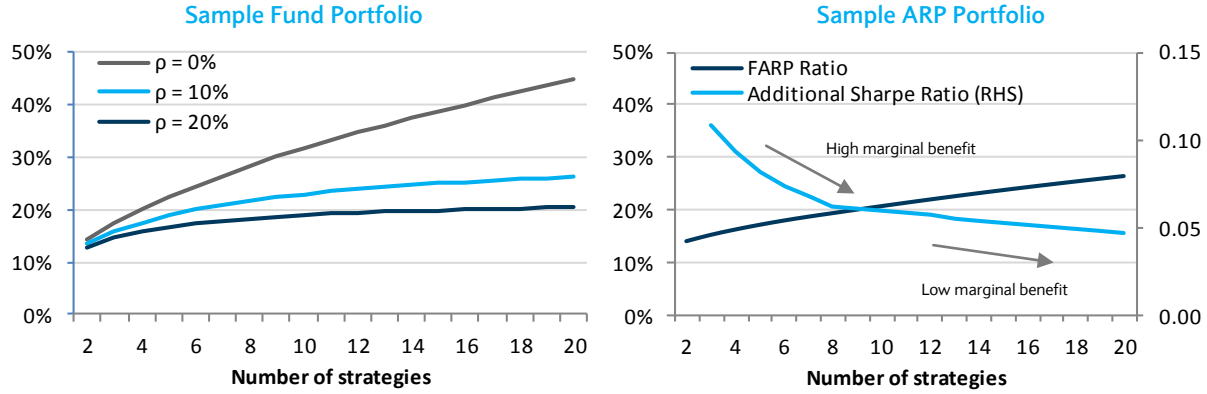
- Operational costs of due diligence may become prohibitive after 10-20 funds, leading to lower quality due diligence and enhanced tail risk in individual hedge funds;
- The overall level of active risk declines beyond a point which hinders the likelihood of achieving expected target returns;
- Falling active risk translates into higher fees per unit of active risk, hence raising the implicit costs of plan oversight;

[13] https://us.spindices.com/indices/equity/sp-500

- The aggregation of funds with individually high active risk increases the exposure to common risk factors.

We show the effect presented by McKay et al in Figure 22, plotting the estimated ratio between fees and active risk assuming different levels of correlations among portfolio components. Additionally, we replicate the analysis in the ARP universe by considering the strategies included in the ARP Balanced Portfolio. In order to do so, we look at returns and volatilities of ARP portfolios built using different combination of ARP strategies in order to study how these change when we increase the number of strategies in the portfolio.

Figure 22: The impact of adding additional strategies to a risk premia portfolio



Determined using monthly data from Mar 2007 to Jun 2018. Source: Bloomberg, Barclays.

The fee to active risk ratio increases with the number of strategies included in a portfolio, in a non-linear manner. The effect is larger if the strategies are not highly correlated or when the fee is significant. As we have seen earlier in Figure 11, in general the universe of strategies considered in the ARP Balanced Portfolio have a very low average pairwise correlation, therefore according to this framework one should take extra care when deciding how many ARP strategies to include in a portfolio. The analysis above indicates that within our ARP Balanced Portfolio the trade-off between higher fee to ARP ratio ('FARP Ratio') and higher Sharpe ratio worsens quickly when adding more strategies. The marginal Sharpe ratio benefit from including an additional strategy decreases significantly after the selection of eight or so strategies.

Being cognizant of capacity constraints: It is important to understand carefully the capacity available in different strategies and accordingly to understand what size is tradeable for a given risk premia portfolio. Clearly, steps can be taken to mitigate the impact of trading large size in strategies. Ways to mitigate capacity constraints that Barclays have used include:

i. Using a liquid starting point for the universe of instruments within a strategy e.g. having specific market capitalisation and liquidity criteria for a single stock to be included within an equity factor portfolio;
ii. Taking steps to reduce the amount of turnover within a strategy or portfolio of strategies;
iii. Rebalancing over multiple days e.g. Barclays' Merger Arbitrage strategies allow for the potential to trade into a deal over up to 10 days using a volume-weighted average price;
iv. Launching alternative roll versions of existing indices when the capacity is close to being reached.

(iv) **For the selection of appropriate Defensive Strategies do I need to do something different?**

Designing a Defensive Portfolio may require additional considerations versus a Carry or Balanced ARP portfolio. For the selection of defensive or tail-risk hedging strategies, we consider our full range of Quantitative Investment Strategies, including those that we define as ARP as well as Trading Strategies and Risk Management Strategies, as we acknowledge that not all the strategies within the range of interesting defensive or tail-risk hedging strategies are "pure" risk premia. There are several ways to choose defensive strategies and different ways to look at their effectiveness. We try to analyze defensive strategies on the basis of "Crisis Alpha", assessing them on an equal level of volatility. We use such a technique to allow us to differentiate between performance in market sell-offs versus performance in more benign market conditions. We will discuss all of the above in more detail in a later QIS Insights Paper.

A key aspect of the portfolio design is the determination of what type of defensive or tail-risk strategies a portfolio should include that could be considered as delivering "Crisis Alpha", namely strategies that generate positive returns in periods of high financial stress. We broadly split the universe of defensive / tail-risk strategies into four groups:

i. "Broadly Defensive strategies" such as Equity Quality or CTA-style (cross-asset trend) strategies, which historically have done well in risk-off environments;

ii. "Signal-based hedging strategies" such as the Barclays Dynamic Convexity Strategy (a signal-based allocation to a long VIX or VSTOXX future whose equity beta is hedged by taking a long equity position), which have the ability to provide downside protection if the signal is triggered, but would not provide any hedge in the case when there is no signal;

iii. "Always-on hedges" such as rolling calendar collar strategies, which have the ability to provide downside protection in most market environments via the purchase of overlapping puts, but also have some element of financing added to fund the hedge, e.g. selling upside calls; and

iv. "Pure hedges" such as rolling put spreads which will invariably work in market sell-offs, but may exhibit a large cost of carry thereby reducing their attractiveness.

The characteristics of these four groups of strategies are somewhat difficult to assess, so practitioners and investors need to consider carefully their strategy selection. It is important to understand the differences between strategies, specifically their performance in different market environments and their "level of guarantee" of a payoff during an equity market sell-off. In many cases, these strategies may not be classified as classic ARP but rather as trading strategies. In fact, the purchase of puts is taking the other side of the "risk premia trade". In most cases investors are looking for strategies that provide the potential for returns during stressed market conditions whilst limiting the cost of carry, thus implying the focus on the first three groups of strategies. However, all of these strategies come with benefits as well as considerations and might deliver Crisis Alpha at different times. We advocate a portfolio approach as possibly providing benefits when looking for a defensive investment, for example in terms of diversifying signal risk for strategies in group (ii) above.

In the case of the creation of the Barclays ARP Defensive Portfolio, we have considered strategies mainly in group (i) and Dynamic Convexity from group (ii) above as we are not aiming for a tail-risk portfolio and we also aim to concentrate mainly on ARP strategies in the defensive portfolio.

Portfolio Construction

A key consideration for investors once they have selected their ARP components is how to combine them into an appropriate portfolio given the characteristics of their selected strategies.

(i) Dynamically rebalanced portfolio allocation method

There are many competing views on how to assemble portfolios of risk premia, including such allocation methods as equal weight, equal volatility, minimum variance, minimum tail risk, maximum diversification and risk parity (equal risk contribution) amongst others. This topic has been extensively covered by Barclays Research in different reports over the last decade. One of the key pieces was the Research Report "Portfolios of Strategies – Does anything beat equal volatility weighting" by Anuj Kumar, Graham Rennison and Arne Staal (June 2010) which analyses different portfolio allocation techniques. In this paper the key takeaways are that:

a. Equal-volatility weighting in the absence of strong views on the predictability of returns, correlations and tail risk of strategies may be hard to beat;

b. As we will discuss later in this paper, the timing of risk premia is difficult and therefore any kind of estimates of potential forward looking returns is similarly very difficult and may lead to much higher levels of turnover, more concentrated exposure and greater variability in performance of the portfolio;

c. Tail-risk minimization requires estimates of the joint behaviour of the likelihood of negative outcomes of the individual strategies.

Other notable papers include:

- July 2012 – Barclays Research Report "Investing with Risk Premia Factors – Return Sources, portfolio construction and tail risk management" by Radu Gabudean, Arne Staal and Anthony Lazanas
- January 2018 – Barclays QIS – "Alternative Risk Premia Portfolio Design – An Academic Risk Factor Framework"

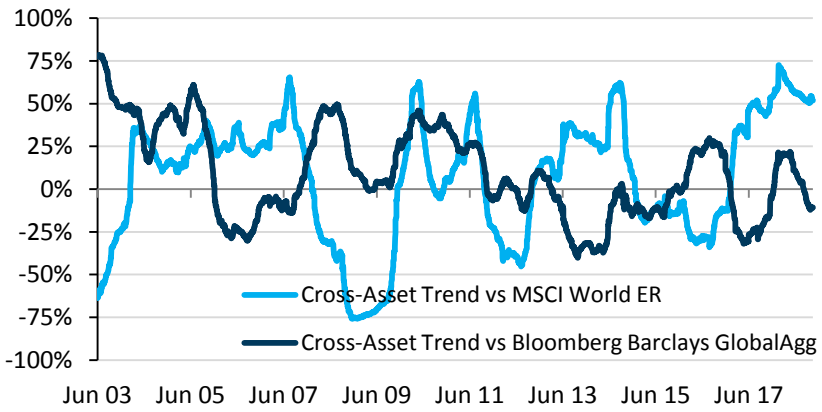
With all this taken into consideration, Barclays has implemented an equal (or inverse) volatility weighting methodology to construct the ARP Portfolios. In this approach, each component strategy is assigned an allocation that is inversely proportional to its estimated volatility, such that a higher/lower volatility strategy receives a lower/higher weighting. In this case we use historical volatility as the estimated volatility metric. In essence this approach makes the ex-ante assumption that the Sharpe ratios for strategies are equal over the rebalancing horizon.

Below we discuss the key merits of the equal volatility weighting approach whilst also noting some important considerations that have to be taken into account when using this method:

a. Simple to calculate and understand: inverse volatility is not a complicated approach. Although it is not an estimation-free model, as one needs to estimate future realised volatility, the persistence of volatility allows it to be estimated better than many other measures. Furthermore, to calculate realised volatility you only need the time series for each of the individual portfolio components.

b. Predictability of volatility: historical volatility is a superior predictor of future volatility, compared to correlations or returns. Expected returns are very hard to forecast and past returns are not a good forecast for future returns. In general, strategies based on projections of returns tend to be very sensitive to the quality of the model for return projection. Correlations are difficult to forecast and using past correlations as a quantitative input may lead to unstable allocations due to unstable forecasts. Additionally, for strategies that may take long-short exposures or significantly change their outright exposure e.g. a CTA-type trend following strategy, the long exposure in the underlying instruments can be changed to an outright short exposure, thus completely changing the correlation profile of the strategy with respect to equities, bonds or other ARP.

Figure 23: Historical simulated 1-year rolling correlation of the Barclays Cross-Asset Trend Strategy vs. Equities and Bonds



Determined using monthly data from Jun 2002 to Oct 2018. Source: Bloomberg, Barclays.

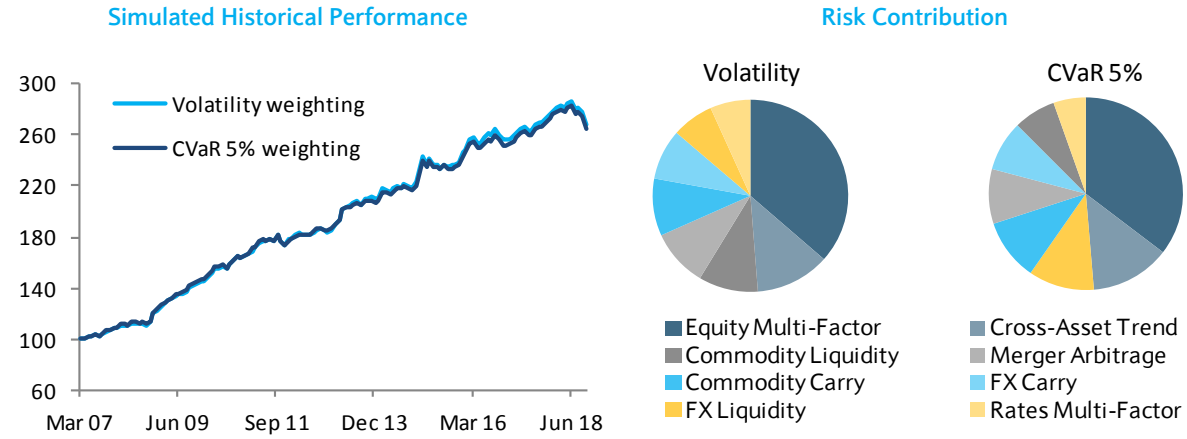
c. Tail-risk / downside estimation allocation techniques: we acknowledge that many practitioners use tail-risk or downside estimation allocation techniques, e.g. Value-at-Risk (VaR) and Conditional-VaR (CVaR). We do not question the validity of this approach, but we feel that using volatility is not inferior and see no

reason to add the additional complexity of a CVaR approach in our systematic strategies. After returns, many investors are most focused on the level of volatility of their portfolio. Our concern with a CVaR is approach is that it makes it harder for a portfolio of risk premia to achieve realised volatility close to the target and also it may lead to exposure being de-levered when an ARP has a high volatility sell-off, which is often the worst time to sell. In fact, our approach only loosely targets a specific level of volatility in order to avoid crystallizing losses in higher volatility regimes.

The use of CVaR instead of volatility in portfolio construction looks very appealing, as it helps overcome some key shortcomings related to ARP return profiles. In fact, ARP exhibit larger skewness risk compared to traditional asset classes, which is especially true for carry-type strategies.[14] Whilst we agree on the shortcomings of using volatility as a risk measure, we argue that using CVaR may not be feasible in practice without making strong assumptions and that it would be optimal to introduce non-linearities and asymmetrical considerations by implementing a two step process in portfolio construction, as discussed in the Barclays Research Report on portfolio construction.[15] Moreover, in many cases the ARP strategies have relatively short backtests and so it is very difficult to get a proper understanding of their tail risk. For instance, if we look at Value or Low Volatility Equity Factor strategies we know that they would have exhibited significant drawdowns in the US over the period between 1998 and 2000, but that would be missed since the overall portfolio only considers returns for calculation of the weighting scheme since 2004, when all component time series are available. It therefore becomes necessary to fit the return distribution to obtain robust estimates for CVaR or VaR measures. However, in order to do so without making restrictive assumptions, it may be necessary to use regime models or a mixture of distributions that significantly increase the complexity of the exercise, without necessarily improving portfolio performance.[16] As an example, we show how the ARP Balanced Portfolio would have behaved historically using CVaR 5% instead of realised volatility to determine the allocations.

As we can see from Figure 24, the return profile is very similar using the two approaches and the portfolio is similarly well diversified in terms of risk contribution of each individual component.

Figure 24: Using different risk measures to build the ARP Balanced Portfolio



Determined using monthly data from Mar 2007 to Oct 2018. Source: Bloomberg, Barclays.

d. Another implicit assumption that is made when using the inverse volatility allocation method is that the correlations among component strategies are either low or constant across strategies. The correlation profile of component strategies has therefore to be analysed before using this allocation method. One of the key features of ARP strategies is that they are uncorrelated to equities, bonds and other broad market benchmarks whilst offering fairly orthogonal returns amongst themselves. As can be seen in Figure 11 and Figure 25, the component strategies of the ARP Balanced Portfolio exhibit low correlations to each other over the period since 2007, therefore inverse volatility weighting might be appropriate. However, analyzing

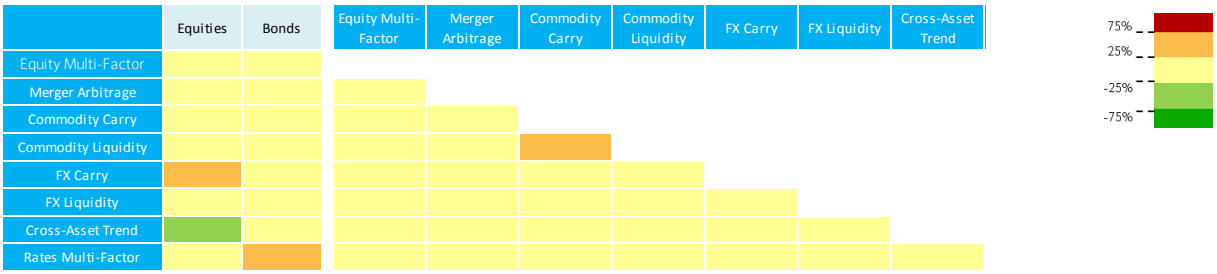
[14] R. Hamdan, F. Pavlowsky, T. Roncalli, B. Zheng, "A primer on alternative risk premia", 2016.

[15] R. Gabudean, A. Staal, and A. Lazanas, "Investing with Risk Premia Factors – Return Sources, portfolio construction and tail risk management", Barclays IPRS Report, 2012.

[16] E. Lezmi, H. Malongo, T. Roncalli, R. Sobotka, "Portfolio Allocation with Skewness Risk: A Practical Guide", 2018.

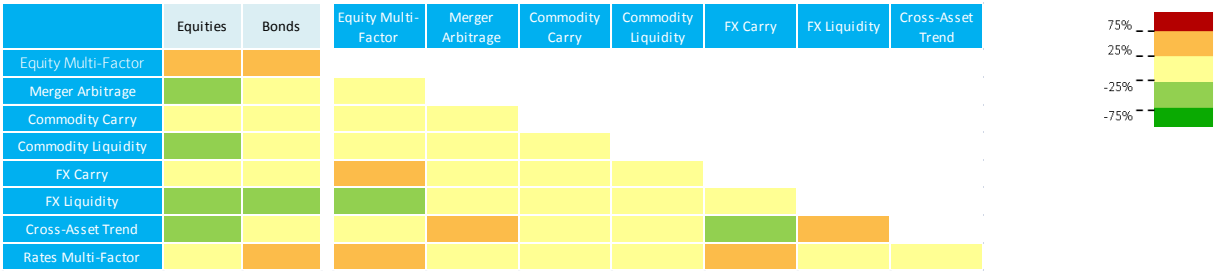
just the long-term correlations might not be sufficient. One of the problems that investors faced during the different financial crisis periods over the last decade was the "correlation breakdown", whereby otherwise uncorrelated assets suddenly started moving (down) in tandem during periods when diversification was needed the most. We assess the different component strategy correlations in stressed market conditions to ensure that correlation properties remain comparable during both benign and difficult market conditions (see Figure 26 below).

Figure 25: Correlation profile among ARP Balanced Portfolio Components over the Full Sample



Determined using monthly data from Mar 2007 to Oct 2018. Source: Bloomberg, Barclays.

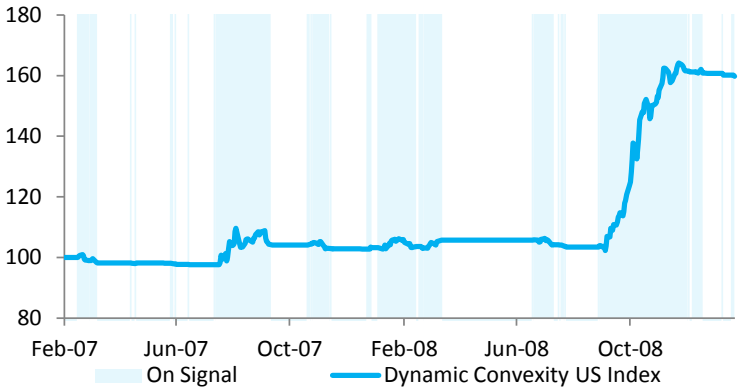
Figure 26: Correlation profile among ARP Balanced Portfolio Components conditional on Equity Sell-Off



Determined using monthly data from Mar 2007 to Oct 2018. Source: Bloomberg, Barclays.

e. We would also add that, for certain strategies, the investor may need to be quite careful on using past volatility as an estimate. For this reason, for certain strategies Barclays has taken the approach of fixing the assumed volatility level instead of measuring it on an on-going basis. Example are: (i) FX Liquidity strategies where positions are taken over only one day per month, therefore using volatility with so few observations would lead to a very significant chance of estimation errors; and (ii) for strategies with very dynamic risk profiles e.g. Dynamic Convexity that has a signal-based exposure to a long convexity position. These types of strategies may experience periods of very low volatility due to the fact that they have no position as the signal is not "on", which can then be followed by a sudden increase of volatility.

Figure 27: Dynamic Convexity US Strategy Signal and Performance History in 2007-2008



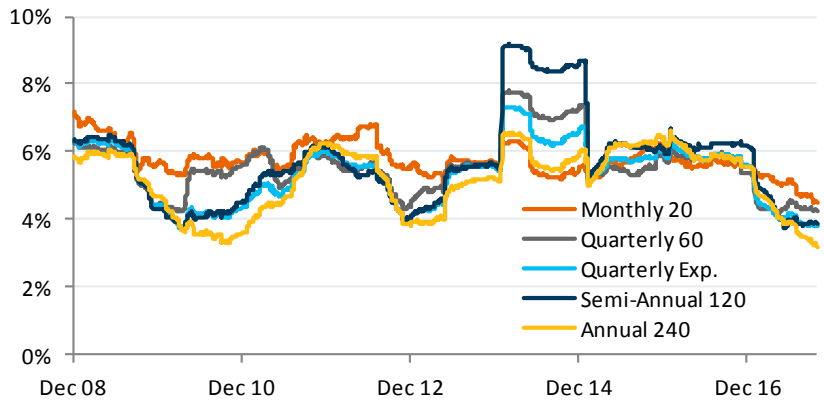
Determined using daily data from Feb 2007 to Feb 2009. Source: Bloomberg, Barclays.

(ii) Avoiding high turnover in the portfolio context

a. When using a quantitative dynamic rebalancing approach, the choice of rebalancing frequency and the volatility window used to measure realised volatility has an impact on the trade-off between performance, closeness to the volatility target and turnover. During the construction of the ARP Balanced Portfolio, different rebalancing frequencies and volatility windows were assessed to quantify this trade-off. We display some of the findings that were observed during the process in Figure 28. As can be seen in the table, low frequency rebalancing can be associated with low turnover when using a rolling volatility window, however at the cost of lower risk-adjusted performance. The graph showing the historical volatility profile of the overall portfolio also highlights that different rebalancing frequencies and volatility windows may be susceptible to one-off short-term events in individual risk premia. In the below example quarterly rebalancing tends to deliver good risk-adjusted historical performance but with fairly high turnover. The relatively high turnover can be mitigated by using an exponentially weighted window to estimate realised volatility. As can be seen, the average annual turnover is halved whilst preserving the risk-adjusted returns. In addition, the portfolio displays a more stable volatility profile that is less susceptible to isolated volatility spikes in individual strategies, as was observed in February 2014 when commodity strategies experienced a short period of higher volatility.

b. There are a couple of reasons why an investor would aim to minimise the turnover of the portfolio. The first reason is that going in and out of the component strategies has an associated cost and may weigh on the returns over the long term. Another very important reason, which we have alluded to previously, is that it might not be the best time to sell the strategies when volatility has increased as generally this might mean crystallizing losses in sell-offs of individual ARP.

Figure 28: Historical 1-year volatility of an ARP Balanced Portfolio dependent on different volatility window inputs



Rebalancing	Monthly	Quarterly	Semi-Annual	Annual	Quarterly
Vol Estimation	20bd Rolling	60bd Rolling	120bd Rolling	240bd Rolling	1Y Exponential 60bd half-life
Sharpe Ratio	1.64	1.81	1.65	1.60	1.84
Avg Ann Turnover	1567%	414%	222%	140%	195%

Determined using daily data from Dec 2007 to Dec 2017. Source: Bloomberg, Barclays.

(iii) Investability considerations

We also have a number of investability considerations that are worth taking into account, namely:

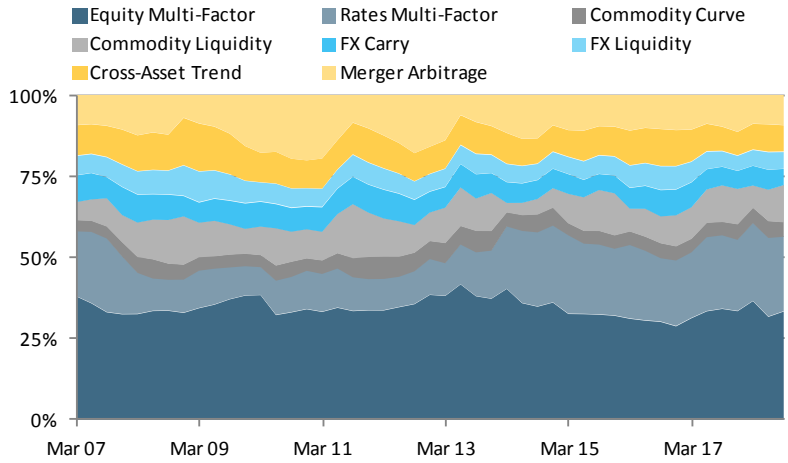
a. Capping the allocation to each component strategy of the portfolio: we do this to deal with unforeseen issues of having a period of exceptionally low volatility, for a particular strategy, which would require significant leveraged exposure to that strategy;

b. Capping the overall portfolio leverage: this is done to ensure that even in the case of exceptionally low market-wide volatility the portfolio does not increase its leverage to a level that may not be appropriate; and

c. Flooring the overall portfolio leverage: the overall allocation is floored to ensure that we do not suffer from a situation where the allocation is reduced significantly due to period of market-wide high volatility.

Having taken all of the above into consideration when building ARP portfolios, we show in Figure 29 the historical allocation of the ARP Balanced Portfolio to the component ARP strategies, scaled to 100%. This process has resulted in a relatively stable weight profile with diversified exposure to different asset classes and risk premia styles. While looking at the chart below one might think that the portfolio has large exposures to Equity and Rates Multi-Factor strategies. It is worth considering that these components are a combination of multiple strategies themselves (16 underlying strategies for Equity Multi-Factor MH and three underlying strategies for Rates Multi-Factor). We also allocate a double risk weight to equity factors as they are an integral part of any ARP portfolio and that strategy is itself very diversified.

Figure 29: ARP Balanced portfolio historical allocations



Determined using daily data from Mar 2007 to Oct 2018. Source: Bloomberg, Barclays.

Timing of Risk Premia

The possibility of timing of risk premia has been hotly debated amongst practitioners and academics in ARP for some time now. Cliff Asness of AQR Capital Management and Rob Arnott of Research Affiliates debated this topic in 2016 and 2017.[17] The debate has concerned mainly equity factors such as value, momentum, growth and low volatility. While some, like Arnott, believe that factors can become expensive (and that much of the recent performance of equity factors is down to an increase in the relative valuation of the stocks chosen by the major factors) and that investors should time their exposures to buy low and sell high, others, like Asness, argue that diversification, not timing, is the best way to achieve returns through factor exposures. At Barclays, we have aimed to tackle the question of whether one can time risk premia in a cross-asset framework, as we actually think that the concept of a factor being cheap or expensive may be somewhat easier to measure outside of equity factors and particularly in more "carry-like" strategies. Our research across asset classes has indicated that timing equity factor strategies may indeed be more difficult than some of the other ARP e.g. Merger Arbitrage or FX Carry.

In our work in this space we have noted that concept of the ARP "cheapness" or "costliness" tends to work best when there is a clear measure of expected return of a factor. For example, in the Merger Arbitrage strategy one can measure the attractiveness of the risk premium, or the ARP "score", by measuring the return of the strategy in the case that all

[17] C. Asness, "Factor Timing is Hard", Working Paper, 2017.
C. Asness, "Lies, Damned Lies, and Data Mining", Working Paper, 2017.
R. Arnott, N. Beck, V. Kalesnik, J. West, "How Can "Smart Beta" Go Horribly Wrong?", Working Paper, 2016.
R. Arnott, N. Beck, V. Kalesnik, "To Win with "Smart Beta" Ask if the Price is Right", Working Paper, 2016.
R. Arnott, N. Beck, V. Kalesnik, "Timing "Smart Beta" Strategies? Of Course! Buy Low, Sell High!", Working Paper, 2016.

the deals close immediately i.e. the target share (of the announced merger deal) price moves exactly to the current terms on offer from the acquirer (in the deal). This ARP Score is of course dependent on a number of factors, for example, the number of announced liquid deals in the US, the weight of those deals within the strategy and then also the spread available, which will be a function of the wider market uncertainty and of the nuances and risks of the individual deals.

In the case of FX Carry, to measure the attractiveness of the risk premium Barclays calculates an expected return assuming the currencies' spot prices do not move over the next month. This assumes an investor in FX Carry can realize purely the interest rate differential between the high yielding and low yielding currencies. We note that our scores are calculated over relatively short periods (i.e. only since 2006 due to data availability) and also use in-sample data and therefore have embedded look-ahead bias.

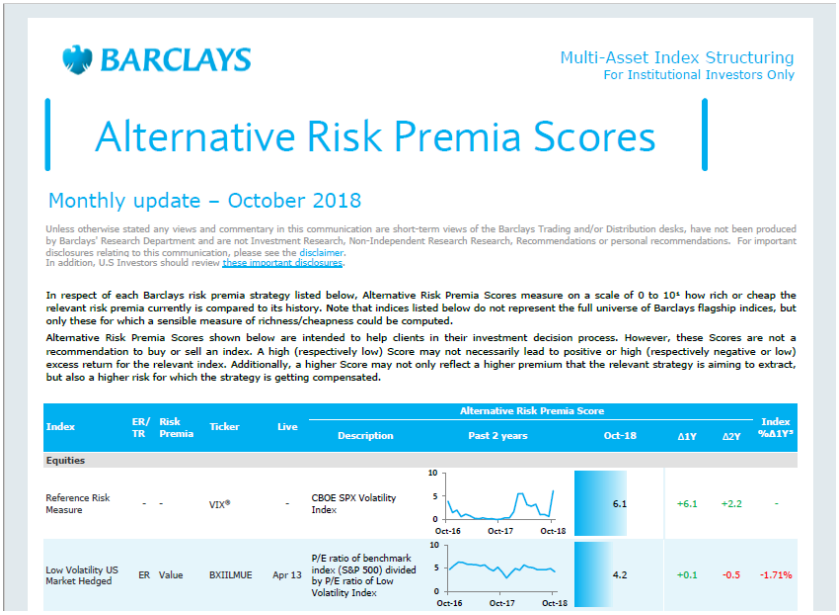
As an example, the Barclays work so far on ARP Scores to date includes:

a. Making available a monthly update of ARP Scores (as shown in Figure 30);

b. A document entitled "FAQ – Alternative Risk Premia Scores". The aim of the document is to answer the key questions around the ARP Scores and provide more details around the framework for calculating them; and

c. A detailed research presentation on the Alternative Risk Premia Scores outlining how the ARP Scores may be useful for timing of risk premia – "QIS Insights Piece Tactical and Strategic Allocation to Alternative Risk Premia, August 2016."

Figure 30: Alternative Risk Premia Scores – Monthly Update


BARCLAYS

Multi-Asset Index Structuring
For Institutional Investors Only

Alternative Risk Premia Scores

Monthly update – October 2018

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In addition, U.S Investors should review these important disclosures.

In respect of each Barclays risk premia strategy listed below, Alternative Risk Premia Scores measure on a scale of 0 to 10[1] how rich or cheap the relevant risk premia currently is compared to its history. Note that indices listed below do not represent the full universe of Barclays flagship indices, but only these for which a sensible measure of richness/cheapness could be computed.

Alternative Risk Premia Scores shown below are intended to help clients in their investment decision process. However, these Scores are not a recommendation to buy or sell an index. A high (respectively low) Score may not necessarily lead to positive or high (respectively negative or low) excess return for the relevant index. Additionally, a higher Score may not only reflect a higher premium that the relevant strategy is aiming to extract, but also a higher risk for which the strategy is getting compensated.

Index	ER/ TR	Risk Premia	Ticker	Live	Alternative Risk Premia Score: Description	Past 2 years	Oct-18	Δ1Y	Δ2Y	Index %Δ1Y[2]
Equities										
Reference Risk Measure	-	-	VIX®	-	CBOE SPX Volatility Index	10 / 5 / 0 Oct-16 Oct-17 Oct-18	6.1	+6.1	+2.2	-
Low Volatility US Market Hedged	ER	Value	BXIILMUE	Apr 13	P/E ratio of benchmark index (S&P 500) divided by P/E ratio of Low Volatility Index	10 / 5 / 0 Oct-16 Oct-17 Oct-18	4.2	+0.1	-0.5	-1.71%

Source: Barclays

In the Barclays ARP Scores, calculated on a monthly basis, the scores are measured on a scale of 0 to 10 with 10 indicating the relevant risk premia is attractive versus its own history and a score of 0 indicating it is not. A high (respectively low) ARP Score may not necessarily lead to a positive or high (respectively negative or low) excess return for that ARP. Additionally, we note that a higher ARP Score may not only reflect a higher premium that the relevant strategy is aiming to extract, but also a higher risk for which the strategy is getting compensated. The scores are measured over a full cycle which we consider as being the period from 2006 to 2014, which is the period for which we have data for a wide range of ARP strategies (it also means that post 2014 the scores are point-in-time and no longer have look-ahead bias).

We have reached the conclusion, after the research over the last two years, that factor timing is indeed difficult across most asset classes and styles and that caution should be exercised on relying on this as a key tool for enhancing returns from an ARP portfolio. We also see factor timing as an issue across not just ARP but also across most asset

classes or strategies, whether they be mainstream assets classes such as equities (using our old friend the CAPE Ratio for instance) or bonds, or within different types of ARP strategies.

We believe the work done around the topic of ARP Scores is useful in a number of different ways:

a. Investors, by viewing the ARP Scores, may understand whether a strategy has indeed a potentially large or small amount of risk premium to capture at any point;

b. Investors have a way to justify keeping an exposure to a specific premium in the case of weak performance and to understand whether that weak performance was driven by an increase in the potential future attractiveness of the risk premium sought by a given strategy;

c. We have also, to some extent, used the ARP Scores as input to strategy design: there are two examples of when looking at the ARP Scores that could shape the design of strategies, particularly related to the universe of investable instruments used for such a strategy. In the first notable example, a Money Market Curve Carry Strategy, due to the flatness of the Japanese interest rates curve over a number of years (given that rates are close to zero), there has been very little carry available to extract, post costs, and therefore implementing such a strategy in Japan may not be efficient. Another example concerns FX Carry Strategies. The effect of the Global Financial Crisis was to reduce G10 interest rates to very low levels across countries, and hence one could question whether an FX Carry strategy predicated on the Interest Rate differential between countries would work in a multi-country zero interest rate environment. Given these considerations, Barclays would generally make the case to prefer an implementation for FX Carry strategies which included both G10 and Emerging Markets currencies.

Having noted all of this, we would still propose that ARP investors occasionally consider tactical timing of ARP in very specific circumstances. In the QIS Spotlight piece of 28 March 2018 around the Barclays Merger Arbitrage US Index, we highlighted one such opportunity. Merger Arbitrage, at that point, allowed investors to take a position on the more specific risk coming from wide merger spreads (as opposed to the more macro risk of many ARP) which could be considered attractive at the time, especially given the muted risk premia available across most asset classes.

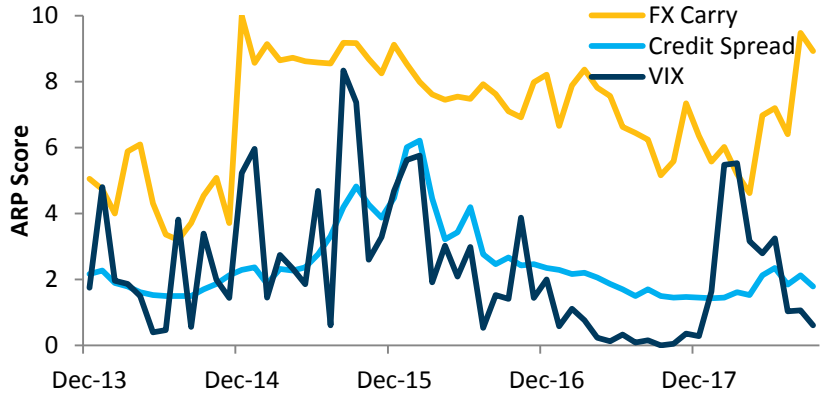
We noted that the spreads in merger arbitrage deals were comparatively higher due to two reasons quite specific to merger arbitrage; (i) the trade dispute between US and China increased deal spreads on cross-border transactions reliant on US or Chinese regulatory approvals; and (ii) there were also concerns regarding the US Department of Justice treatment of a number of vertical mergers that the strategy was exposed to.

In this case, the ARP Scores allowed a screening of the entire ARP universe in a simple way and highlighted the merger arbitrage spread as standing out and worthy of further attention and understanding. In the months after March 2018 the approval of a number of the deals with wide spreads caused the strategy to outperform. We note this one single successful example is not an indicator that such a tactical use of the scores may work in the future.

In terms of the use of the ARP Scores within an investment process, we caution that they are not a panacea for strategy selection of ARP strategies. One of the key aims of calculating the ARP Scores was in some ways to curb some "sub-optimal behaviour" of ARP investors, as in our experience of being ARP strategy providers we often see investors concentrating their interest in strategies that have performed well recently.

A recent example of an insight gained from ARP Scores would be FX Carry. Barclays' implementation of this strategy is to take positions in five unique FX pairs according to their risk-adjusted carry. In recent times, we have seen a stronger dollar and a corresponding sell-off in Emerging Markets currencies. The FX Carry Strategy has therefore suffered weaker performance. The ARP Score for FX Carry has increased significantly and it has done so long before movements in average credit spread and equity volatility (as measured by VIX) that we have seen since the sell-off witnessed in September and October 2018.

Figure 31: ARP Scores of FX Carry, Credit Spread and VIX over the last 5 years (2013 – 2018)



Determined using monthly data from Dec 2013 to Sep 2018. Source: Barclays.

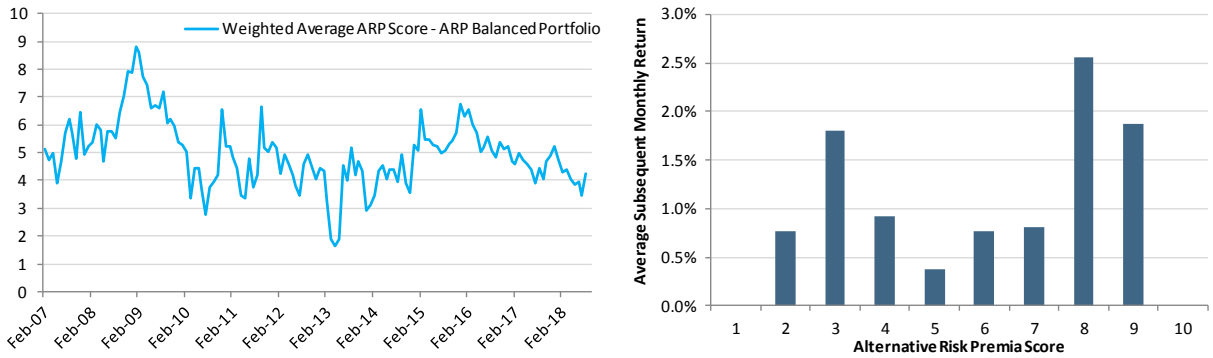
In Barclays' approach to designing the ARP portfolios we have not used the ARP Scores as an input in our systematic allocation, as in this case we are only considering a fully systematic and rules-based solution. We unfortunately have not been able to show systematically enhanced returns using ARP Scores with any great conviction, but we leave them as a potential input for a discretionary manager or allocator to ARP.

Use of the ARP Scores at the portfolio level – Are ARP expensive?

In understanding whether to invest in an ARP portfolio, investors have had more and more questions, especially in 2018, concerning the attractiveness of ARP as a set of strategies and repeated fears about whether the strategies are over-crowded or expensive given the proliferation of products. With this in mind, we have done further work to understand the scoring of ARP at a portfolio level. In all of this analysis, we note that it is not possible to create signals for all risk premia e.g. CTA strategies where there is no clear measure of "attractiveness" of the premia and therefore we think it would make most sense to look at the ARP Scores across a Balanced and a Carry Portfolio and not for a Defensive Portfolio for instance.

We have looked at the ARP Scores across the ARP Balanced and Carry Portfolios. For the ARP Balanced Portfolio we see that there is limited evidence of predictive power and the ARP Score for the portfolio is currently in the middle of the range.

Figure 32: ARP Scores of ARP Balanced and Average Subsequent Monthly Returns vs ARP Score

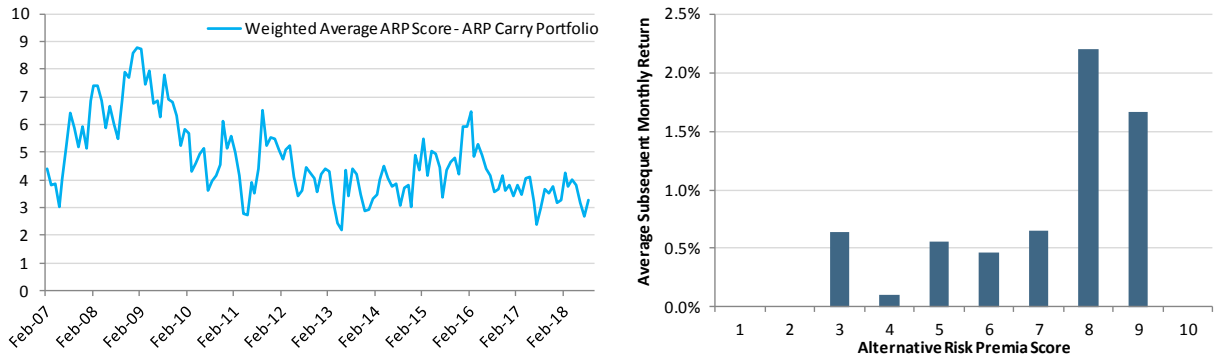


Determined using monthly data from Feb 2007 to Oct 2018. Source: Bloomberg, Barclays

For the ARP Carry portfolio we can see that, historically, future 1-month performance has shown some improvement when the ARP Scores are higher i.e. that when premia to capture are high, returns tend to be high. We can also see that current premia across the ARP Carry portfolio are somewhat lower than average. We note that the result does

not necessarily indicate that ARP are crowded, but perhaps also that risk premia are in general not high across most asset classes, as can be measured by the level of VIX or credit spreads this year.

Figure 33: ARP Scores of ARP Carry and Average Subsequent Monthly Returns vs ARP Score



Determined using monthly data from Feb 2007 to Oct 2018. Source: Bloomberg, Barclays

In summary, we think that the valuation of different ARP is an interesting area for investors to note when investing in ARP. We conclude that the use of ARP Scores is not a panacea, either for strategy selection or to time a general risk premia investment, but we feel that ARP Scores can be a useful enhancement to the toolbox available to ARP investors. We do draw some comfort that the scores at the ARP portfolio level do not indicate a significant reduction, in recent years, of the amount of risk premia to capture.

Conclusion

In this paper we have shown how one might create portfolios of ARP with different characteristics. We acknowledge that not all risk premia are created equally, and that the universe of ARP is a wide-ranging set of strategies with which to work. The range of ARP strategies comprises different asset classes and investment styles, as shown in Figure 4, with specialised and sophisticated index designs in many cases. We can thus see that the resultant three portfolios, created with very different objective in mind, have contrasting beta and correlations to equities and bonds, and we would expect them to perform at different times and their success (or not) to be measured differently.

We discussed in the paper what we view as some of the key pitfalls we have witnessed from researchers, product providers and investors in risk premia, and also some potential ways to minimize the impact of such aspects of ARP portfolio construction. We highlight the following in particular:

i. Over-diversification: we have seen many instances where investors have too much diversification. As we have shown earlier in this paper, ARP portfolio creators and investors have to be disciplined in keeping to a smaller number of ARP e.g. around 6-10 (some of which may be multi-factor or multi-regions themselves) in order to avoid overly increasing the impact of trading costs on portfolios returns;

ii. Momentum bias: we have observed a selection bias when building ARP portfolios, favouring ARP strategies with a strong recent performance. We aim to reduce this impact by including in our strategy selections risk premia that have performed less well of late, as long as their premise and rationale remains strong;

iii. Creating unbalanced portfolios: in our experience, we have seen many ARP portfolios showing a different correlation and beta profile ex-post compared to the ex-ante expectation. In this paper we have shown that two elements are required to avoid this: firstly, clear objectives around the creation of the ARP portfolio; and secondly, a clear understanding of the characteristics of the underlying strategies, with detailed analysis of the strategy design and also the risk-return characteristics of the strategies using a number of tools including Macro-Factor Analysis.

We acknowledge some of the negativity around the whole quantitative investment strategy endeavour and the ability of investable performance to match backtest performance. We note the much-quoted criticism of quant strategies, that "I have never seen a bad backtest". When putting together portfolios of ARP, there are two obvious challenges

when trying to create a portfolio with potential for an attractive future level of return. Firstly, there is backtest bias within the individual strategies i.e. there is always the temptation to optimize the parameters within a particular strategy e.g. the length of the trend window within a trend or CTA strategy or the definition of the value metric within a value strategy (Figure 20 shows evidence of the weakening of post-publication returns for a number of smart beta and factor strategies). Secondly, there is also a strong selection bias in the chosen ARP within a portfolio. To mitigate this as much as possible, Barclays advocates focussing on a two key aspects: firstly, to try to select strategies with a longer "live" track record and also to select strategies that make parsimonious use of signals; and secondly, to try to take a balanced approach to strategy selection and avoid as much as possible a backtest optimisation exercise which focuses too much on strategies with strong recent performance. In the portfolios created, we therefore have a mix of both strongly performing strategies and weaker ones, and hope to avoid in the strategy selection some of the more expensive or crowded strategies by being mixed across very well known strategies as well as other strategies with still strong fundamental rationales that are perhaps a little less well–researched by academics and less widely-used in allocations to ARP strategies.

Looking to the future of ARP, there have been some question marks around future returns, given recent performance which has disappointed some investors in the space. In the same way a bond portfolio will not earn high returns if the initial yield levels at which the bonds were bought were low, a risk premia portfolio will struggle to earn returns if risk is cheaply priced. Recently risk premia, in general, have not been high, as credit spreads have narrowed and volatility remains low. In many of the more carry-like strategies, a low level of risk premia means returns can generally only be earned in the most benign of outcomes e.g. years like 2017 when strategies such as equity volatility selling did well. The strategies performed despite the level of implied volatilities being low as the subsequent realised volatilities were even lower leading to positive returns and exceptionally strong risk-adjusted returns. We are of the view that patience is required, the three portfolios we have discussed in this piece are performing within the range of what might be expected and the case for ARP portfolio investment remains strong in our opinion.

Appendix

Figure A1: Example ARP Balanced Portfolio Composition

Component Name	Short Description
Equity Multi-Factor MH	Market neutral investment in strategies providing exposure to Value, Momentum, Quality and Low Volatility equity factors in US, Eurozone, UK and Japan.
Rates Multi-Factor	Aims to capture Value, Momentum and Carry factors in rates space across G6 market bond futures.
Commodity Carry	Designed to offer investors a market neutral strategy that tracks the performance of a basket of long and short single commodity strategies.
Commodity Liquidity	Aims to provide broad, diversified exposure to commodity congestion at the nearby curve point.
FX Carry	Aims to profit from the interest differential between high yielding and low yielding currencies by looking at Risk-Adjusted Carry.
FX Liquidity	Aims to capture moves in G10 FX Spot rates caused by the month-end FX hedge rebalancing activity of global equity and bond portfolios.
Cross-Asset Trend	Aims to profit from trend phenomena across asset classes to generate absolute returns in both rising and falling markets, in a systematic and transparent way.
Merger Arbitrage	Aims to provide exposure to merger arbitrage, offering enhanced transparency and liquidity vs. typical event-driven HFs. The strategy is market hedged.

Source: Bloomberg, Barclays.

Figure A2: Example ARP Defensive Portfolio Composition

Component Name	Short Description
Atlantic Equity Quality MH	Designed to provide exposure to US and Eurozone stocks that are selected based on their earnings variability, return on assets and accruals ratio.
Volatility Term Structure	Aims to go long convexity in VIX and VSTOXX futures only when the futures carry is positive.
Rates Multi-Factor	Aims to capture Value, Momentum and Carry factors in rates space across G6 market bond futures.
Commodity Curve	Seeks to extract commodity curve alpha from a broad universe of commodities by dynamically allocating each month to a basket of eight commodity spreads.
FX Liquidity	Aims to capture moves in G10 FX Spot rates caused by the month-end FX hedge rebalancing activity of global equity and bond portfolios.
Cross-Asset Trend Ex-Vol	Aims to profit from trend phenomena across asset classes to generate absolute returns in both rising and falling markets, in a systematic and transparent way.

Source: Bloomberg, Barclays.

Figure A3: Example ARP Carry Portfolio Composition

Component Name	Short Description
Equity Value MH	Designed to provide exposure to US, Eurozone, UK and Japan stocks which have been chosen using two metrics to identify a value stock: the price-to-earnings ratio and total yield.
Short Volatility	Aims to capture implied vs. realised volatility premium on S&P 500 and Euro STOXX 50 Indices.
Merger Arbitrage	Aims to provide exposure to merger arbitrage, offering enhanced transparency and liquidity vs. typical event-driven HFs.
Rates Carry	Aims to capture carry returns from government bond futures markets. The strategy takes long exposure to government bond futures with highest carry and short exposure to those with lowest carry.
Credit Carry	Seeks to extract value from the differential in risk premia between High Yield (HY) and Investment Grade (IG) credits. It offers diversified exposure across US and Europe.
Commodity Carry	Designed to offer investors a market neutral strategy that tracks the performance of a basket of long and short single commodity strategies.
Commodity Curve	Seeks to extract commodity curve alpha from a broad universe of commodities by dynamically allocating each month to a basket of eight commodity spreads.
FX Carry	Aims to profit from the interest differential between high yielding and low yielding currencies by looking at Risk-Adjusted Carry.

Source: Bloomberg, Barclays.

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