BLACKROCK®

Fixed Income Smart Beta:
What it is, and why investors should care

MKTG0918A-602539-1872669

Executive Summary

- 2016 saw record inflows into fixed income beta products. Against a changing backdrop of broker behaviour within the over-the-counter corporate bond market[1] , investors are increasingly turning to bond exchange traded funds (ETFs) to take corporate index-like and emerging market index-like exposures.
- In recent years the breadth of fixed income indexing has extended to alternative indexing products, where constituent weights are not primarily driven by their market capitalization. These products include fixed income Smart Beta products that benefit from the application of factor insights. However, traction here has lagged equities due to idiosyncrasies of the fixed income markets.
- This paper presents a framework to understand the burgeoning fixed income Smart Beta investment landscape, outlining the reasons it has lagged equity-equivalents and drivers for change. It defines the principle factors in fixed income, describing those that have historically been rewarded and why. An exposition of these factors is made using simple constructions in case studies, with discussion of further implementation considerations.
- A familiarity with fixed income Smart Beta presents investors with the means for better risk management, a wider breadth of investments to help diversify and enhance portfolios, and empowerment.

While the investment approach described herein seeks to control risk, risk cannot be eliminated. Diversification and asset allocation may not fully protect you from market risk.

[1]In "Capital Commitment and Illiquidity in Corporate Bonds", Henrik Bessembinder, Stacey Jacobsen, William Maxwell, and Kumar Venkataraman, April 2016, a study of FINRA transaction data between 2003 and 2014 lead the authors to conclude that "the role of corporate bond dealers has changed in recent years, as dealers are less inclined to trade on a principal basis, and more inclined to prearrange a customer's trades in a search-and-match brokerage role." It is further noted that measures "of market quality, including turnover, dealers' capital commitment, the likelihood that trades are completed on a principal basis, interdealer trading, and dealers' propensity to hold positions overnight were not only degraded during the financial crisis but failed to return to pre-crisis levels in more recent years."

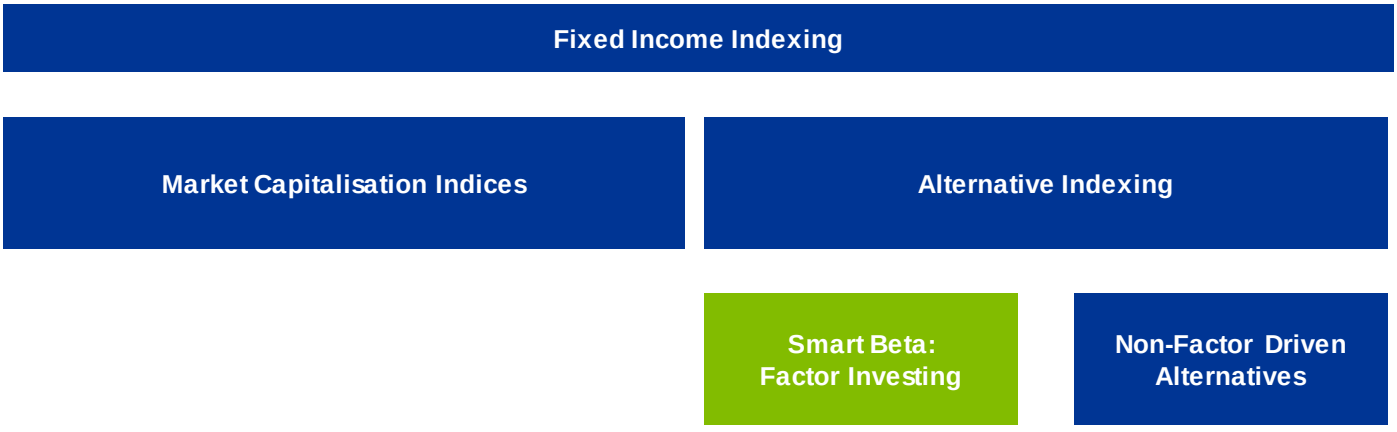
1. Fixed Income Indexing

Historically, the landscape of fixed income indexing products has been dominated by indices[2] where weights are proportional to their constituents' respective market capitalization. Market capitalization indices are popular in fixed income products for similar reasons as they are in equity beta products:

- Rebalancing transaction costs are often minimal as portfolio churn is low. The required weights of constituents move in line with market movements, so existing holdings in a tracking portfolio are designed to largely meet the new targets at month-end, (apart from adjustments for new index entrants and retirees)
- Frequently the primary reference to market capitalization is enhanced with supplemental rules, such as maximum issuer or issue exposure, to help ensure portfolio diversification
- Index investing in general offers a low-management fee means of taking precise market exposures, delivered consistently through time, through the quantification and management of risks and costs
- The price of each bond reflects the forward-looking insights and outlook of the market. (However, the benefit of this is not as strong as within equities, as the market capitalization weight is also determined by the volume of debt issued)

In recent years, the breadth of fixed income indexing has extended to alternative indexing products, where constituent weights are not primarily driven by their market capitalization. There are many forms of non-cap weighted indices – for this piece we shall broadly categorize them into two different groups: "Smart Beta" and "Non-Factor Driven Alternatives":

- **Smart Beta**[3] refers to any systematic investment strategy (a transparent, rules-based process) that seeks to create differentiated investment outcomes (e.g. enhanced level or quality of returns; the avoidance of drawdowns; or targeting other specific requirements) using factor insights.[4] There can be no guarantee that the investment strategy can be successful and the value of investments may go down as well as up.
- **Non-Factor Driven Alternatives** adopt weighting schema that deviate from market capitalization, but are not underpinned by a factor-based investment philosophy (examples include GDP-weighted government bond indices; equally-weighted indices; or volatility parity indices where volatility is determined over asset-class returns, as opposed to factor returns[5])



For illustrative purposes only.

[2] *Indexes are unmanaged and one cannot invest directly in an index.*

[3] *Smart Beta has variously been described as alternative beta, exotic beta, hedge fund beta, systematic beta, and strategic beta. Although the asset management industry has been slow to reach agreement on headline terms, this belies a growing consensus that Smart Beta presents a distinctive investment approach that falls outside of traditional active and passive strategies. In the interest of establishing a common lexicon, we shall adopt Smart Beta and stick to it, while acknowledging that 'a rose by any other name would smell as sweet'.*

[4] *As we think of Smart Beta as the long only and index driven form of factor based investing, the focus here will be on investment approaches that are deliberately constructed based on factor insights.*

[5] *Factor returns would involve the isolation of returns to particular drivers (e.g. rates; credit)*

Although equity-based Smart Beta has gained traction over the last decades, within fixed income these developments have lagged, in part due to surmountable challenges:

- A lack of academic research. Easier availability of equities data over fixed income, and differentiated familiarity with the investment space, has led to comparatively little research in bonds, against stocks
- The concept of fixed income Smart Beta is new to most investors, and they lack a framework for understanding it
- Demand-pull has been muted by the perception that active fixed income managers tend to outperform, (in contrast to active equity managers). However, in a study spanning 121 US Core Plus Fixed Income investment managers, "on average 67% of active risk in these fixed-income strategies can be explained by smart-beta factors. For about 38% of the funds, 90% or more of the active risk can be explained by smart-beta factors. Compared with equities, fixed-income managers appear to derive an even greater proportion of their active risk from static exposures to smart-beta factors."[6]

This paper seeks to help address the gaps above.

[6] *"Smart Beta: The Owner's Manual"; Ronald Kahn and Michael Lemmon; The Journal of Portfolio Management; Winter 2015*

2. Factor Investing

Factor investing is predicated upon the philosophy that within markets, returns generated from asset price movements are largely driven by developments arising in the risks they are exposed to, and that in a well-functioning market, participants are compensated for taking exposure to these investment risks (a **risk premium**).

A simple example of this is to contrast the yield of a corporate bond with the equivalent yield of a government bond with similar attributes (e.g. maturity, duration, denomination) – there is almost always a credit spread, as the yield of the corporate bond is generally higher than that of the equivalent government bond – and this spread is what the market of investors demands in compensation for the additional company-specific risks they are taking exposure to, over those embedded in the government bond.

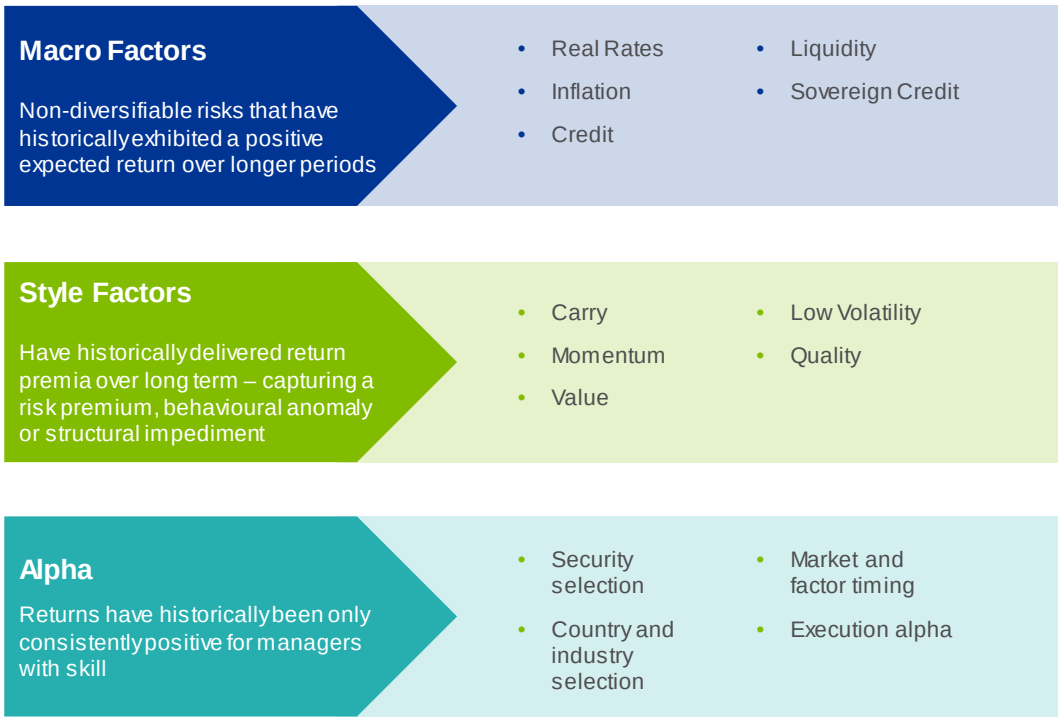
Beyond harvesting risk premia, factor investing also seeks to be rewarded for:

- taking advantage of market imbalances arising from the **structural impediments** that some investors may face relative to others (e.g. leverage constraints; only investment grade corporates)
- opportunities created by investor **behaviour** (e.g. idiosyncratic biases; differentiated appetite for risk)[7]

Factor investing seeks to identify the broad, persistent drivers of return – factors -- that have historically earned positive long-run returns both within and across asset classes[8]. Once these are identified, all investments can be perceived through a factor lens as bundled exposures to these drivers and the degree of sensitivity (or factor loading) of a particular instrument to a factor can be quantified. Continuing with the example above, an investment grade corporate bond would have a lower factor loading to the credit factor than a high yield corporate bond. There is no guarantee that a positive investment outcome will be achieved.

Across multiple assets, the decomposition of asset exposures into factor exposures can improve the understanding of portfolio performance by revealing hidden, outsized risks where concentrations may arise unintentionally within traditional asset-class based allocations. Within portfolio construction, this understanding may lead to better diversification[9], enhanced returns, and/or reduced risks according to investor needs.

Conversely, in performance attribution, a factor framework can help investors disentangle factor driven-returns from pure alpha, helping to improve decision-making in manager-selection.



Macro factors, style factors, and alpha within Fixed Income. There is no guarantee that a positive investment outcome will be achieved.

[7] *More on these later, as we look at style factors in greater detail.*

[8] *"Foundations of Factor Investing"; Jennifer Bender, Remy Briand, Dimitris Melas, and Raman Aylur Subramanian; 2013; MSCI*

[9] *Diversification may not protect against market risk or investment loss.*

Separating the Wheat from the Chaff

There has been a proliferation of proposed factors within academic literature[10], highlighting risks that help explain the variation of returns, but most of these do not satisfy the 4 criteria that we believe identify rewarded factors:

1) Economic Rationale – Is the factor based on economic intuition and academic evidence?
2) Value Creation – Is there empirical evidence of positive returns? Does this persist even after its identification is widely recognised?
3) Diversification – Is the factor distinctive from other factors, and has a low correlation with them?
4) Efficient Implementation – Can the factor be captured and implemented in a transparent, repeatable manner?

The application of these essential criteria presents us with two categories of factors. Firstly, when we filter across asset classes, we identify a set of **Macro Factors** – common systematic risks that cannot be diversified away; over the long run, investors bearing exposure to these factors are expected to be paid a premium. Within Fixed Income instruments, there are 5 principal rewarded macro factors that drive returns[11]:

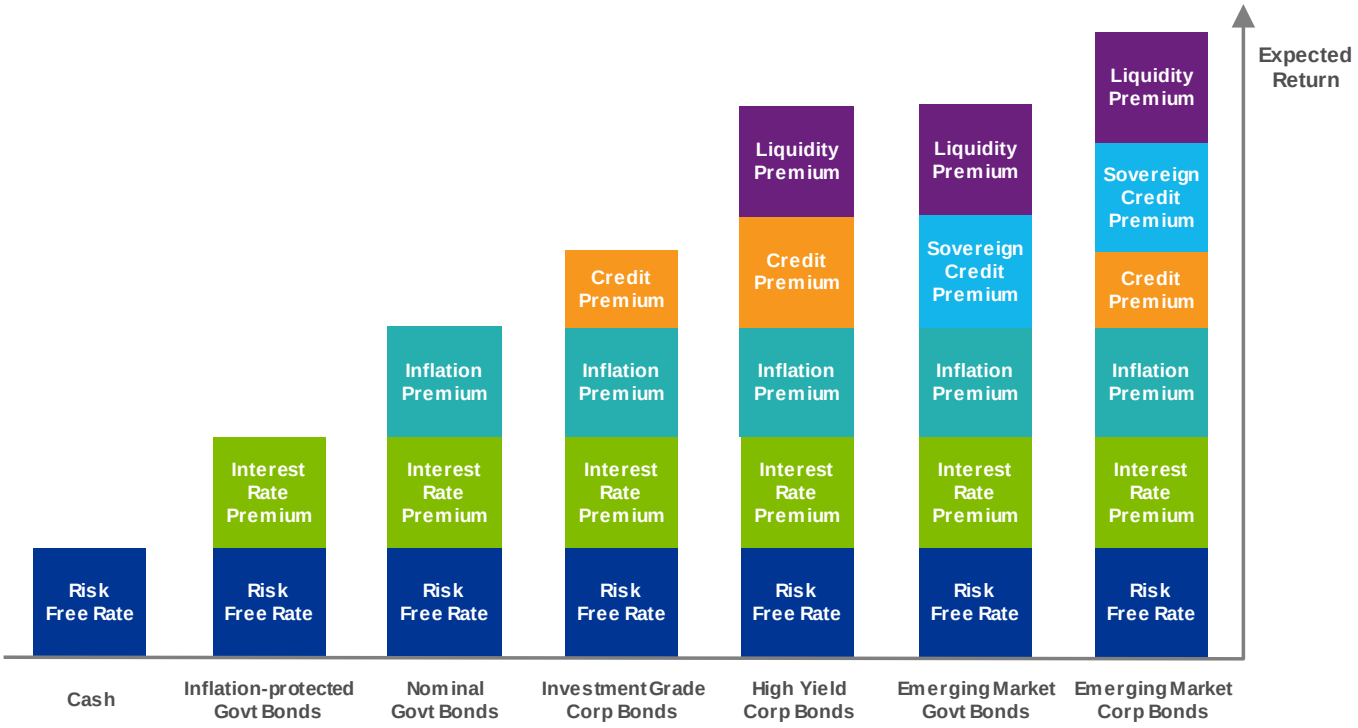
- Real Rates – *The risk of bearing exposure to real interest rate changes. Rising real interest rates decrease the present value of future cash flows, notably the market value of fixed income*
- Inflation – *The risk of bearing exposure to changes in nominal prices and suffering erosion of buying power*
- Credit – *The risk of corporate issuer default or spread widening*
- Sovereign Credit[12] – *The risk of government issuer default or spread widening. The risk that political upheaval may lead a sovereign to change capital market rules or may be unable to service liabilities due to other reasons (e.g. fiscal challenges), impairing the value of future expected cash flows*
- Liquidity – *The risk of bearing exposure to illiquid securities that are hard to trade and experience extreme price losses in crises*

[10] A count of over 300 proposed factors since the 1960s is made in "…and the Cross-Section of Expected Returns" by Campbell Harvey, Yan Liu, Heqing Zhu; 2016; Review of Financial Studies, Vol. 29, No.1 (January); 5-68; with roughly 40 newly 'discovered' factors announced each year

*[11] A sixth macro factor, Economic Growth, is a principal driver of returns outside of Fixed Income, when addressing equities, commodities, and real estate, for instance. See **"What is Factor Investing"** for a wider, multi-asset view on factor investing. The authors are employees of BlackRock.*

*[12] The Sovereign factor pertains to the credit risk associated with sovereign issuers while the Credit factor applies to the credit risk associated with corporates. Sovereign differs from Credit in several ways, not least because the sovereign issuer can choose to default when it doesn't have to, introducing a "Willingness To Pay" risk aspect, and continues to exist after insolvency. See **"Introducing the BlackRock Sovereign Risk Index"** for more detail on this. The authors are employees of BlackRock.*

A factor decomposition of typical fixed income instruments held in investor portfolios, (below), illustrates how these macro factors are the building blocks for asset classes. Factor investing across macro factors is simply replacing the traditional organization of portfolio along the silos of asset classes (the verticals), in favour of organizing exposures with reference to factors (the horizontals).



Factor decomposition of selected Fixed Income asset classes

For illustrative purposes only.

This approach presents an enhanced means of managing portfolio risk, by looking through instruments to the fundamental drivers of returns. While unbundled, standalone exposures to factors are rare within most assets, they provide the means to adopt targeted portfolio factor exposures in combination with one another.

Returning to the earlier example, a long position in a liquid corporate bond alongside a short position in its nearest government bond equivalent would present a long exposure to the Credit factor differential between them. Similarly, within the chart above, a long nominal government bond position coupled with a short inflation-protected government bond would isolate the inflation factor exposure. There is no guarantee that a positive investment outcome will be achieved.

These bond-level macro factor returns can be aggregated across targeted universes, and scaled against analytic risk metrics (e.g. Duration; Spread Duration; Duration Times Spread ["DTS"][13]) or returns-based risk metrics (e.g. total return volatility, excess return volatility) to derive representative macro returns series per unit of risk.

For example, filtering across investment grade corporates for liquid bonds (with reference to float size and time-since-issue, for example), a calculation of their excess returns over government-equivalents, per unit of DTS, can be aggregated as a clean measure of Credit. This return series can be used as a yardstick for portfolio forensics purposes or against similar measures for other factors (e.g. Real Rates, Inflation) in determining optimal portfolio construction. Diversification and asset allocation may not fully protect you from market risk.

[13] *"DTS (Duration Times Spread)"; Arik Ben Dor, Lev Dynkin, Jay Hyman, Patrick Houweling; Erik van Leeuwen; and Olaf Penninga; The Journal of Portfolio Management; Winter 2007.*

The second category of factors arises when we apply our criteria within the cross-section of each fixed income asset class, identifying **Style Factors** that have been historically persistently rewarded over the long run. Within fixed income instruments, there are 5 principal rewarded style factors that drive returns:

- Carry – *Bonds with higher yields have tended to outperform bonds with lower yields*
- Value – *Cheap bonds (relative to fundamentals) have tended to outperform expensive bonds*
- Momentum – *Bonds with strong recent performance have tended to maintain higher returns*
- Low Volatility – *Structural demand for higher yielding bonds means stable bonds can potentially outperform more volatile bonds on a risk-adjusted basis*
- Quality – *Bonds with stronger fundamentals can potentially outperform bonds with weaker fundamentals on a risk-adjusted basis*

There can be no guarantee that the investment strategy can be successful and the value of investments may go down as well as up.

We shall look at each of these in closer detail, in the following section.

3. Style Factors

Carry

Simply put, the return arising from an asset can be decomposed into two components:

- performance attributable to a change in price (the present value of future cash flows), as markets incorporate new information
- the mark-to-market of the asset that arises, assuming nothing changes in the market, except for the passage of time[14]

While the first component is an uncertain variable, the latter component – which is known as Carry – is deterministic. Within Fixed Income instruments Carry's magnitude is thus well-defined at the outset.

Carry is a function of the shape of the yield curve.[15] When the spot curve slopes upwards (longer dated yields are higher than shorter dated yields), then the market expects yields to rise in the future. If forward yields are not realised, then Carry will result and is comprised of two components: coupon income (net of the cost of financing the bond) and roll-down (the mark-to-market effect of rolling down the spot yield curve). Carry measures are quantified on this basis, assuming that nothing changes in the market except the passage of time (an unchanged spot yield curve).

The case for using Carry measures to gauge future returns is often made on grounds that in efficiently functioning markets, current prices reflect all available information and expectations and are the best approximation of an asset's intrinsic value. Price movements are thus random-walk-like. If the best forecast of future price is the current price, expected returns from the changes in price component tend to zero, leaving the Carry component as the best forecast of overall return. There is no guarantee that a positive investment outcome will be achieved.

This argument faces challenge on two fronts:

- Dogmatic adherents to William Sharpe's efficient market hypothesis would attest that if markets reflect all available information and expectations, then the price change component of return consists of an uncertain random walk *and a deterministic component that equals the negative magnitude of the Carry component, offsetting it*
- The assumption of a static spot curve assumes the market is consistently wrong about the future. If spot yields actually follow projected forward yields, then Carry will be zero……the closer that market fundamentals move towards the shape implied by forward yields, the *more distant* that realised returns will be from the expected returns arising from the Carry component.

Addressing the latter argument first, there is considerable academic literature, across multiple asset classes, finding Carry measures to be useful for forecasting returns at short horizons, as opposed to forecasting fundamentals.[16]

---

[14] The total return, R, of any asset between time t and t+1 can be decomposed into a 'Price Change' component and a 'Carry' component:

$$R_{t,\,t+1} = \text{Price Change}_{t,\,t+1} + \text{Carry}_{t,\,t+1}$$

[15] Yield is appropriate when referring to aggregate Carry. Alternative curves may apply when referring to subsets of this. For instance, in the case of a corporate bond, its rates-related carry is a function of the government yield curve, and its credit-related carry is a function of its spread curve.

[16] An illustrative summary is:

- *Treasuries: A rising yield curve signals better 1-year returns for long-term bonds, not higher future interest rates. Fed fund futures signal returns, not changes in the funds rate. [Fama and Bliss (1987), Campbell and Shiller (1991), Piazzesi and Swanson (2008)]*
- *Corporate Bonds: Much variation in credit spreads over time and across firms or categories signals returns, not default probabilities [Fama (1986), Duffie and Berndt (2011)]*
- *Foreign Exchange: International interest rate spreads signal returns not exchange rate depreciation [Hansen and Hodrick (1980), Fama (1984)]; contrary to the theory of Uncovered Interest Parity that postulates that any initial interest rate advantage one country has over another will be offset by future exchange rate depreciation*
- *Equities: Dividend yields forecast returns, not dividend growth [Cochrane (2006)]*

Summary is drawn from Presidential Address: Discount Rates; by John H. Cochrane; The Journal of Finance; Vol. LXVI, No. 4; August 2011; pg 1051 [ttps://faculty.chicagobooth.edu/john.cochrane/research/papers/discount_rates_jf.pdf]

Portfolios constructed to harvest the Carry style factor, tilting towards constituents with higher Carry components and away from constituents with lower Carry components, have tended to generate positive excess returns over non-tilt portfolios with similar macro exposure profiles. Empirics suggest the use of Carry measures to gauge expected returns is reasonable, but leave us cold as to the reason why.

Proponents of the former argument would ascribe these empirics as a behavioural anomaly. Risk-neutral rational agents should price assets in equilibrium, predicting that price changes exactly offset initial Carry advantages and that all assets have the same expected return as the risk free asset. Most investors would probably agree that markets are not perfectly efficient, but the enduring nature of Carry performance despite clear arbitrage opportunities suggests more is at play here than a simple lack of attention on the part of market participants.

The philosophy of factor investing fills this gap, while providing a rationale to explain why Carry measures are better indicators of future returns than they are of future market fundamentals. A central plank of factor investing is that investors are compensated for taking exposure to risks. Harnessing Carry is thought to be a reliable source of returns because of the ***risk premium*** embedded in asset prices to entice potential investors to take risk. While the investment approach described herein seeks to control risk, risk cannot be eliminated.

For example, a 5 year government bond yield is a function of the expected path of the future short-rate in the country as well as a risk premium component. The risk premium is the extra return required by an investor given the uncertainty in the path of the short-rate and the volatility in the asset's price --effectively, the investor is provided a "discount" for the willingness to take on risk. The risk premium tends to be greater in instances where a country or asset's vulnerability generates more uncertainty in the future payoff to the investor, with worries ranging from covenant-specific idiosyncrasies, to the risk of supply/demand shocks, or any number of potential tail-risks. As the distant future is less certain than the near future, this usually results in a term premium for longer dated issues, as a borrower's ability to repay becomes more uncertain over longer horizons.[17]

If the current spot yield curve incorporates a risk premium, then the forward curve may not be a particularly good predictor of the actual future curve, yet Carry metrics bear resemblance to realised returns – this resonates with empirical findings. If the nature of the return is compensatory for risks assumed, and not risk-less, then it shall not be arbitraged away (as this would result in uncompensated exposure to risks) this explains the nature of Carry's historical outperformance[18].

As with all Style Factors, there is no absolute recipe that defines Carry returns, as this varies by investment universe, product goals and constraints. Cross-sectional Carry strategies have a commonality in tilting towards constituents with attractive Carry features, relative to constituents with unattractive features, in the scenario where nothing changes in the market except the passage of time. This deterministic Carry component is often scaled by a suitable risk denominator (e.g. trailing total return volatility or duration[19] for government bonds; trailing excess return volatility, spread duration[20] or DTS[21]), particularly within investment vehicles that can use leverage, to take larger positions in constituents that have attractive Carry per unit of risk, but low volatility, duration, DTS, etc as the case may be. The broadening of the opportunity set using leverage can potentially improve performance[22], while intuitively, the normalization of each asset's Carry by its risk helps avoid discontinuity of volatility-profile in the cross-section of holdings, reducing the risk of outsized adverse price moves offsetting carry returns. There is no guarantee that a positive investment outcome will be achieved.

Rationales for investors to be interested in Carry style factor exposures range from strategic (Carry returns can potentially enhance and diversify returns accruing to macro factor exposures) to tactical (against a backdrop of accommodative central bank policy that globally supports asset price inflation, gainsaid by expensive valuations and below-trend growth, large price moves in either direction are constrained leaving the Carry component as a significant driver of returns for many asset classes).

[17] *It is worth recognising that the additional uncertainty in this example is at least partly attributable to greater macroeconomic uncertainty at longer horizons relative to shorter horizons. Poor style factor construction in the cross-section can result in inadvertent macro factor loading. Section 5 expands on these considerations in implementation*

[18] *The Carry style factor across FX has been likened to 'picking up pennies in front of a steamroller' for this reason. However Koijen et al show that the skewness of Treasury Carry and Credit Carry returns are positive, unlike the negative skew and elevated tail risk of FX. ["Carry"; Ralph Koijen, Tobias Moskowitz, Lasse Heje Pedersen, and Evert Vrugt; August 2013]*

[19] *"Understanding Duration and Volatility", Robert W. Kopprasch, Salomon Brothers Inc; September 1985.*

[20] *"A Look at a Variety of Duration Measures"; Robert W. Kopprasch; Citi; July 2004.*

[21] *"DTS (Duration Times Spread)"; Arik Ben Dor, Lev Dynkin, Jay Hyman, Patrick Houweling; Erik van Leeuwen; and Olaf Penninga; The Journal of Portfolio Management; Winter 2007.*

[22] *"The Road to Profitability is Paved with Volatility-Adjusted Carry"; G. Ooman and M. Chang; Credit Suisse Fixed Income Research; April 2011.*

Value

A long-standing insight, the Value style factor has been discussed since the 1930s, when Benjamin Graham first published on the risk-adjusted outperformance of 'value stocks'. Within Fixed Income, the Value style factor tilts towards bonds that are inexpensive relative to the 'fair value' implied by their fundamentals, and away from bonds that are expensive relative to fundamentals, as the former have tended to outperform the latter.

Macroeconomic expectations of real growth and inflation are typical fundamentals used to assess the attractiveness of nominal government bond yields, with inflation projections dropped when assessing the attractiveness of inflation-linked bonds. Additional components, such as sovereign CDS, may be added to the fold where significant, such as within Emerging Markets issuance.

Within corporate bonds, fundamental expectations of default and recovery rates are used to assess the attractiveness of credit spreads against default breakeven projections. Default rate expectations may be based on accounting fundamentals (e.g. leverage, interest coverage), rating agency assessments (e.g. the long-run default incidence of the credit rating at hand, or Markov chains built on ratings transitions matrices), or a combination of fundamental and market data (e.g. Merton-like models). Similarly, recovery rate expectations typically arise from fundamental analysis, bond-specific covenants and seniority, and the prevailing default environment.

A likely explanation for the outperformance of Value is that it arises from a **risk premium** for taking exposure to distressed names. Within value strategies, investors are generally taking longer positions in company or country debt facing difficult times, which are already unfavoured by the market. As the utility function of most investors is asymmetrically risk averse (e.g. most behavioural studies show investors feel greater pain at a loss than joy at an equivalent gain), a 'distress premium' is required for exposure to potential loss. There is no guarantee that a positive investment outcome will be achieved. While the investment approach described herein seeks to control risk, risk cannot be eliminated.

Another explanation posited is **behavioural**, that investors tend to over-extrapolate recent performance and tilt portfolios towards recent winners, and away from recent losers, beyond fundamental justification (to be expanded upon within the Momentum section). While Momentum dominates at shorter investment horizons, eventually its impetus fades, and relative mean reversion to fundamentals tends to dominate with Value outperforming.

Further support for Value can arise from **structural impediments** faced by some market participants. For instance, when investment grade corporate bonds are downgraded to speculative grade, the resultant forced-selling of these names within investment-grade-only mutual funds swamps the disproportionately smaller high yield market, resulting in prices undershooting fundamentals. Subsequently, the impact of this market segmentation dissipates and these "Fallen Angels" may outperform as prices revert to fundamentals, (as within other Value opportunities).

Momentum

On a relative basis, many assets have tended to exhibit return trend (autocorrelation) over certain horizons. That is to say, across a universe of government bonds, outperformers have continued to win, and underperformers have continued to lose. Since its 'discovery' over 20 years ago[23] it has been documented to outperform across multiple markets, across multiple asset classes, over multiple decades.[24] There is no guarantee that a positive investment outcome will be achieved.

Most explanations for Momentum are ***behavioural:***

- Differentiated access to market information may lead some investors to react to news more slowly than others, but in the same direction. The time taken for information to be disseminated and digested by all market participants can lead to autocorrelation of returns as a result
- Differences in the utility function of investors may result in some investors reacting more slowly to information than others, even when the information is assimilated uniformly. For instance, risk averse investors may require more confirmation in macroeconomic releases heralding the "green shoots" of a post-recession recovery before joining the rally arising from less risk averse investors tilting into risky assets, also leading to returns autocorrelation in the relative performance of cross-sectionally risky versus defensive corporate bonds
- Investors may over-react to information, pushing prices beyond fundamentals, particularly if something is "hot". This herding behaviour may be ad hoc, or may be driven by investors employing Momentum style factor strategies, for a positive feedback loop
- Investors may pull funds from funds that are exposed to "losers". This divestiture results in a lagged effect of forced selling on the very same areas
- Risk management techniques such as stop-loss thresholds may add to the momentum effect by cutting out losers while letting winning trades run

While Value factor strategies position for reduced dispersion (a cross-sectional relative mean reversion trade), Momentum can lead a portfolio to take positions anticipating expensive assets to become more expensive, and cheaper assets to become cheaper, resulting in the attractive feature of low-to-negative correlation between these style factors' returns. Nevertheless, both can potentially present positive performance, as they tend to operate on different investment horizons. There is no guarantee that a positive investment outcome will be achieved.

Within corporate bonds, there is academic support for a momentum factor at play within high yield credit, but within investment grade credit evidence of performance differentiation using trailing returns is weak[25]. The relative inconsistency of momentum performance, compared to firmer evidence in adjacent equity markets, may be attributable to key differences between fixed income and equities:

Fixed Income instruments present a more asymmetric return profile than equities, with upside capped at the full return of interest and principal. Equity investors are more likely to perpetuate momentum trades where the potential upside to increasingly expensive securities are unbounded, while Fixed Income investors may be more inclined to sell strong recent performers, (accentuated in short-maturity securities priced at, or in the proximity of, a premium-to-par)

Just as the negative feedback loop of bounded performance differentiates momentum performance between equities and corporate bonds, the proximity-to-par of bond prices may lead to the momentum performance differentiation between high yield and investment grade bonds. The behaviour of investors with respect to momentum is likely to be more equity-like, the more distant that par is from current prices, as with large discounts the upper bound has lower materiality.

It should be noted that this does not necessarily preclude the harvesting of Momentum within this space. A growing literature on lags in price discovery between related markets highlights that equity price momentum, for example, can be used as an exogenous substitute to trailing corporate bond returns, where equity markets may react more quickly to news than credit markets.[26]

---

[23] "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency"; Narasimhan Jegadeesh and Sheridan Titman; The Journal of Finance, Volume XLVIII, No 1; March 1993.

[24] A good summary of multiple markets is within "Value and Momentum Everywhere"; Clifford Asness, Tobias Moskowitz, and Lasse Pederson; The Journal of Finance, 2013. More widely, momentum has been documented for international equities (Rouwenhorst 1998, Chan, Hameed, and Tong 2000, Liew and Vassalou 2000), currencies (Okunev and White 2003),commodities (Miffre and Rallis 2007, Gorton, Hayashi, and Rouwenhorst 2008), international government bonds (Asness, Moskowitz, and Pedersen 2013), and residential real estate (Beracha and Skiba 2010)

[25] Jostova, Nikolova, Philipov and Stahel (2013) find evidence of significant momentum in noninvestment grade bonds. However, earlier Gebhardt, Hvidkjaer and Swaminathan (2005b) find no momentum in investment-grade bond returns.

[26] See "Successful factors to select outperforming corporate bonds" by Hottinga, J., E. van Leeuwen and J. van Ijserloo; 2001, Journal of Portfolio Management, Fall 2001, 88-101; "Value of security selection versus asset allocation in credit markets " by Dynkin, L., P. Ferket, J. Hyman, E. van

Low Volatility

Assets with high beta should earn higher rates of return than assets with low beta as compensation for bearing additional risk[27] , but empirically low beta securities have seemed to outperform high beta securities on a risk-adjusted basis, and often in absolute terms as well[28]. As a result, this empirical finding is often referred to as the 'low beta anomaly' or the "low volatility anomaly".[29]

Much research relates to the low beta anomaly, mostly in equities, though spanning other asset classes. In a high-breadth paper, Frazzini and Pederson found consistent empirical evidence within each major asset class: higher risk adjusted returns in low (versus high) beta stocks in 19 markets, higher risk-adjusted return in higher-rated versus lower-rated, riskier corporate bonds, and similarly so within lower risk (short-maturity) versus riskier (long-maturity) US treasuries.[30]

Although the use of rating and maturity are effectively proxies for volatility within these studies, they are reasonable -- bond return volatility has generally increased monotonically with increasing maturity, and with decreasing credit rating. The short-maturity effect has been documented by Ilmanen [2004], Pilotte [2006], Derwall [2009], Palhares [2013] and Binsbergen [2015] while the high-rating effect has also found coverage in Kozhemiakin [2007] and Houweling [2015].

The historical outperformance of low beta can be attributed to a **structural impediment** that constrains the behaviour of some market participants. The theory of leverage aversion[31] contends that some investors would prefer to purchase higher yielding assets than leverage lower yielding equivalents. These investors buy high beta securities instead of leveraging, reducing the required rate of return on elevated beta instruments relative to low beta securities, a demand mismatch that flattens the security market line more than CAPM would project. Higher risk adjusted returns at the low volatility end results, and vice versa.

This is not an unrealistic assumption – obtaining leverage requires getting financing, using derivatives and establishing counterparty relations. Managing leverage requires adjusting margin accounts and dynamic portfolio management. Many investors will not have the means to execute these, and may be constrained by regulation – many mutual funds and pension funds are not allowed to borrow or face leverage caps.

There is no guarantee that a positive investment outcome will be achieved.

Leeuwen and W. Wu; 1999, Journal of Portfolio Management, Summer 1999, 11-27; " A bond-picking model for corporate bond allocation" by L'Hoir, M., and M. Boulhabel (2010):, Journal of Portfolio Management, Spring 2010, 131-139.

[27] According to the Capital Asset Pricing Model (CAPM).

[28] Black (1972) and Haugen and Heins (1972) were early authors to note the existence of the anomaly within equities.

[29] Although 'beta' relates to systematic risk, the construction of the cross-sectional low volatility style factors can made with reference to total risk or idiosyncratic risk in place of systematic risk. Ang [2006] found that equities with high idiosyncratic risk have below average returns. Having sorted equities by their idiosyncratic volatility and establishing quintile portfolios, the portfolios are shown to have statistically significant return profiles. The authors posit that high idiosyncratic risk is associated with high exposure to aggregate volatility, which lowers returns. ["The Cross-Section of Volatility and Expected Returns"; Andrew Ang, Robert Hodrick, Yuhang Xing, Xiaoyan Zhang; The Journal of Finance, January 2006.Ang (2006)] Andrew Ang is an employee of BlackRock.

[30] "Betting Against Beta", Andrea Frazzini and Lasse Pederson, 2010.

[31] "Leverage Aversion and Risk Parity", Clifford Asness, Andrea Frazzini, and Lasse Pedersen; Financial Analysts Journal; Volume 68, Number 1; 2012.

Leverage aversion is not the only proposed explanation for the low beta anomaly: [32]

- Structural demand by liability-driven investors seeking long-horizon immunization can complement the performance of tilts that favour short duration over long duration equivalents
- Sefton [2011] proposes that the time varying dispersion of betas in equities is market direction-specific, with dispersion rising in falling markets, augmenting the outperformance of low beta constituents, and beta dispersion contracting in bull markets, muting the outperformance of high beta constituents at these times
- Scherer [2011] attributes the outperformance of low risk securities to mismeasurement due to missing factors within the (single) market factor CAPM. In this vein, Fishwick [2016][33] augments the CAPM with an explicit term for interest rate changes to analyse the returns of low beta and high beta equity portfolios in different interest rate environments, and finds that the low beta anomaly in equities is *conditioned* by the interest rate environment (e.g. whether the risk free rate is rising or falling). Historically, the return on low beta portfolios increases whenever the interest rate decreases, and high beta portfolios have an increase in their return whenever interest rates rise; however, under this framework the low beta anomaly remains intact
- Along similar lines, the outperformance of equity low beta portfolios has been attributed to persistent industry tilts that can arise, although this has been refuted by the construction of intra-industry portfolios[34]

Although well-established within most asset classes (including government bonds), a consensus on the existence of a credit Low Volatility style factor is, as yet, mixed. In contrast with papers cited earlier:

- Soe [2016] [35] found little evidence of a low beta anomaly within US investment grade credit, in contrast with papers cited earlier
- Ambiguously, similar research by Ng and Phelps[2016] sorting investment grade corporates by DTS (a metric closely associated with credit excess return volatility) found no statistically significant evidence of a low volatility anomaly amidst excess returns…but gave limited support when risk is measured using idiosyncratic volatility[36]
- Contrary to the above, Bai [2016] found evidence of a *positive* relationship between credit excess returns and idiosyncratic risk, and no relationship with systematic risk[37]
- In contrast, Carvalho [2014] found "*duration-times-yield (DTY) is a particularly efficient measure to screen bonds and form portfolios exposed to the [low-risk] anomaly*"[38]
- While the establishment of style factors within some asset classes does not necessarily imply they must occur in all (particularly if potentially market-specific structural impediments are driving performance), the mixed picture of research highlights that the low risk anomaly in corporate bonds is sensitive to the selected measure of risk.

[32] Several of these rationales are drawn from a list compiled within "The Low Beta Anomaly and Interest Rates" by Ed Fishwick and Steve Satchell, Risk-Based and Factor Investing, 2015. Ed Fishwick is an employee of BlackRock.

[33] "Dynamic CAPM Geometry"; Ed Fishwick, Cherry Muijsson and Steve Satchell; 2016. Ed Fishwick is an employee of BlackRock.

[34] "Low-Risk Investing without Industry Bets"; Clifford Asness, Andrea Frazzini, and Lasse Pedersen; Financial Analysts Journal; 2014.

[35] "Factor-Based Investing in Fixed Income: A Case Study of the US Investment Grade Corporate Bond Market"; Aye Soe, Hong Zie; S&P Global; January 2016.

[36] "Low-Risk Anomaly Investing in Corporates : DTS or Beta?"; Kwok Yuen Ng and Bruce Phelps; Barclays; January 2015.

[37] "Do the Distributional Characteristics of Corporate Bonds Predict Their Future Returns?"; Jennie Bai, Turan Bali, Quan Wen; August 2016.

[38] "Low-Risk Anomalies in Global Fixed Income: Evidence from Major Broad Markets"; by Raul Leote de Carvalho, Patrick Dugnolle, Xiao Lu, and Pierre, Moulin; The Journal of Fixed Income; Spring 2014.

Quality

Amidst academic literature, Quality is sometimes bundled together with Low Volatility, collectively as a "defensive" style factor. This is understandable - corporate credit ratings have been used as a close proxy for volatility in studies investigating the low volatility anomaly, for example, and both style factors are expected to outperform in flight-to-quality events, so can fill a similar role in portfolio construction endeavours to address drawdowns.

However, in equities the underlying rationale for Quality outperformance is distinctive from Low Volatility. While the latter is likely to arise from a structural impediment amidst market participants, within equities Quality outperformance can arise for **behavioural** reasons – with investors overpaying for "growth and lottery" stocks with exciting investment stories but weak proven accounting fundamentals, whilst shirking more established, profitable-yet-boring firms. A related insight is that investors do not properly separate earnings and cash flows, leading them to overpay for stocks whose earnings are driven by high accruals that will reverse in the future.[39]

So much for equities, but how does this relate to corporate debt? While equities present unbounded upside to "growth and lottery" success stories, the upside to corporate bondholders is limited so the impact of useful Quality metrics in equities need not apply in the adjacent corporate market. Also, the corporate bond market is largely comprised of institutional investors compared to a higher proportion of non-institutional investors within equities, which may lead to behavioural differences. On the other hand, Gebhardt [2005] and Kwan [1996] present evidence that equity momentum impacts corporate bond markets by showing that trailing equity returns predict future corporate bond returns from the same issuer, even when controlling for issuer-specific corporate bond momentum.

At present, a consensus is still developing on the relationship between equity characteristics and corporate bond returns. Chordia [2016][40] find profitability and asset growth do predict bond returns, but other Quality measures like accruals do not. Bektic [2016][41] find profitability to be "economically and statistically significant" in the US high yield market, but the strong positive relationship does not extend to investment grade corporate bonds in the US and Europe. Choi [2014] conclude that profitability and equity net issuance anomalies do not exist in corporate bond markets.[42]

Turning to the relationship between corporate bond characteristics and corporate bond returns, the picture is more promising. BlackRock research[43] suggests that many fixed income investors reach for yield, driving up the prices of riskier bonds. Investor demand for higher yielding bonds may result in a mispricing of credit risk, whereby bonds issued by corporations with higher probabilities of default[44] are often overpriced relative to less risky bonds with similar ratings. Portfolios that avoid bonds issued by the riskiest issuers have produced higher risk-adjusted returns than portfolios of bonds with the riskiest, highest yielding, bonds.[45]

It should be noted that while Quality is derived *cross-sectionally* within credit, it arguably bears close similarity to the Credit macro factor, where investors are compensated for taking exposure to aggregate market credit risk (similarly, Quality filters over government bonds bear similarity to the Sovereign macro factor). The cross-sectional dispersion of credit (and sovereign) spreads are correlated with the movement of the market itself, so this factor is less orthogonal to long-only macro exposures than other style factors are. However, as the stance is defensive this greater correlation should be negative in market shocks, diversifying long-only macro exposures when needed most.

---

[39] *A good summary of the literature on Quality investing in equities is "Quality Investing" by Robert Novy-Marx.* ***Link***

[40] *"Are Capital Market Anomalies Common to Equity and Corporate Bond Markets"; Tarun Chordia, Amit Goyal, Yoshio Nozawa, Avanidhar Subramanyam, Qing Tong; Emory University; May 2016.*

[41] *"Extending Fama-French Factors to Corporate Bond Markets"; Demir Bektic, Josef-Stefan Wenzler, Michael Wegener, Dirk Schiereck, and Timo Spielman; April 2016.*

[42] *"Anomalies and Market (Dis)Integration"; Jaewon Choi and Yongjun Kim; August 2014.*

[43] *See "Reach For Safety" by Johnny Kang, Tom Parker, Scott Radell, and Ralph Smith; September 2017. The authors are employees of BlackRock.*

[44] *The distinction between using issuer-specific default likelihood insights here, as opposed to the Value examples earlier, is that in the latter these insights are used in conjunction with market spreads to determine attractiveness, while within the Quality style factor the cross-section is derived from the default breakeven requirement of each issuer alone.*

[45] *See "Factor Investing in the Corporate Bond Market"; Patrick Houweling and Jeroen van Zundert; Financial Analysts Journal; 2017*

4. Exposition of Style Factors

The following case studies illustrate the properties of style factors, established across corporate bonds as an example asset class. In the interest of transparency, these recipes for factor construction are kept simple, while demonstrating cross-sectional return patterns that are analogous to those we observe in more complex versions. *They do not represent BlackRock's best insights into factor construction and should not be construed as such.*

Part of this exposition involves the performance assessment of 5 subportfolios (quintiles) within the cross-section of the corporate universe, stratified by the style factor at hand – it should be noted that these assessments are pre-transaction costs as the introduction of quintile thresholds artificially elevates portfolio churn relative to a full cross-section of the universe. As a result, the performance metrics of each subportfolio are of interest in comparison to one-another, but should not be considered representative of post-transaction portfolios.

Case Study: Carry in Corporate Bonds

For the Carry style factor, we take the US Investment Grade Corporate and High Yield bond universes[46] since 2006. This window covers a full economic cycle, including the Global Financial Crisis, (and precursory period when the credit bubble was still inflating), without giving too much weight to empirics in a pre-ZIRP[47] environment.

Bank of America Merrill Lynch (BAML) produce fitted spread curves by credit rating across the investment universe. At the end of each month, these reference curves are used to calculate spread-based carry projections over the subsequent month for every bond in the study. For example, the credit-driven carry of a bond[48] with a maturity of 5 years and rating of single-A, is the sum of:

- Its monthly spread-return; the bond's option-adjusted spread (OAS) divided by 12
- The return attributable to roll-down if the spread curve does not move (the difference between the spline-fitted curve spread for single-A US corporates at the maturities of 5 years and 4.92 years, multiplied by the spread duration of the bond)

The carry projection for each bond is ranked cross-sectionally against its peers. This ranking is used to stratify the corporate bond universe into 5 subportfolios that have an equal number of bonds, that we call quintile portfolios; within each quintile portfolio, all bonds are market-value-weighted. The performance of these quintile portfolios are assessed over the subsequent month – using each bond's excess returns over the risk free rate.

In line with academic convention, returns derived from the net positions of the extreme quintile portfolios (e.g. Q5 and Q1) are assessed, isolating the credit Carry factor, both through simple netting (e.g. equally weighting Q5 and Q1 and taking the difference, called unhedged) and when hedged (e.g. scaling the Q5 and Q1 legs to balance their weight in terms of a risk metric[49]).

---

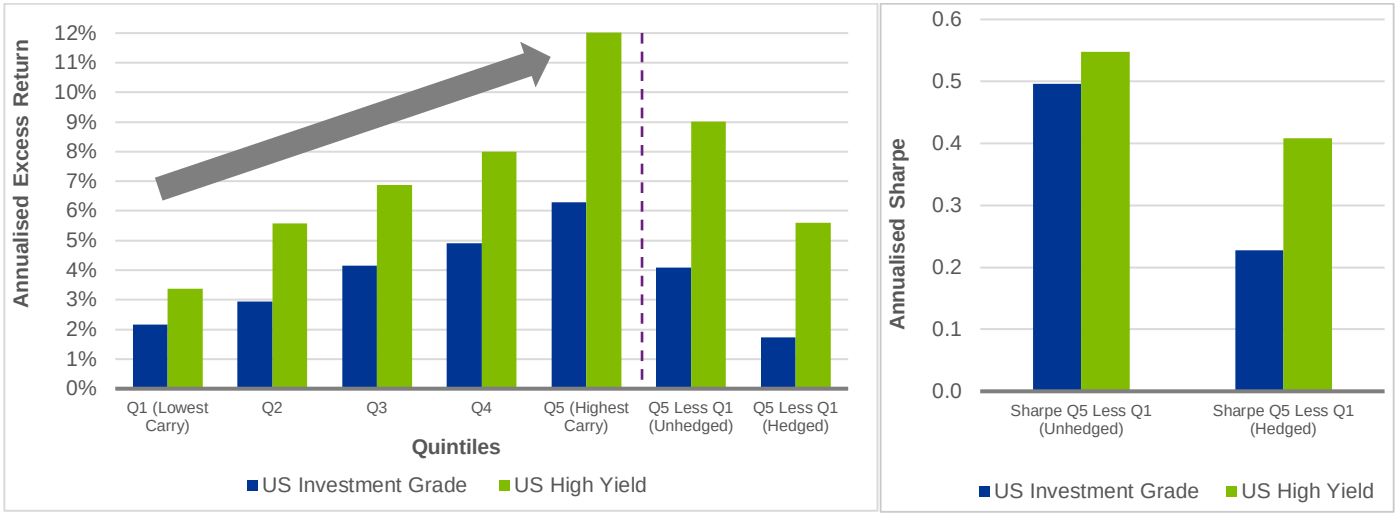
[46] *Within this report, the constituents of the Bank of America Merrill Lynch (BAML) US Corporate Index (C0A0) and US Cash Pay High Yield Index (J0A0) are used to represent the US Investment Grade and US High Yield corporate universes respectively. These indices present a comprehensive picture of US investment grade corporates, (spanning over 7,200 bonds) and US high yield corporates (spanning over 1,900 bonds) respectively*

[47] *Zero Interest Rate Policy; a macroeconomic concept describing conditions with a low nominal interest rate, when exceptional actions have been taken by central banks (e.g. quantitative easing, Operation Twist)*

[48] *Similar calculations could be made for the rates-driven carry of each bond using the US government yield curve, but for simplicity this example considers the perspective of an investor who is happy to take credit tilts, but not inclined to take key-rate duration exposures in light of rates-driven carry opportunities.*

[49] *Hedging within this report refers to Duration-Times-Yield (DTY). DTY is one of many potential risk metrics that could be used to represent risk; selected here and in subsequent examples, as it incorporates both rates and credit factors.*

The empirics support the posit that Carry projections stratify subsequent investment grade and high yield returns.



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses.

Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

Case Study: Value in Corporate Bonds

Value is showcased through several metrics. Within investment grade credit, the observed OAS for each bond is compared to a spread curve fitted through similarly-rated corporate bonds against effective duration. The degree to which each bond is cheap (wider spread) or expensive (tighter spread) is noted versus the curve at the point of its duration.

For example, a single-A rated bond with Subordinated seniority and duration of 3 years is cheaper than the 3Y point on the single-A spread curve against duration by 15 basis points.

This presents a naïve relative value premia for the corporate bond. To make this metric more relevant, it is compared against the average naïve premia of peer groups defined within the corporate universe. Two peer groups are defined:

- Group 1: All US corporates within similar rating, seniority, and level-4 granularity industry classification[50]
- Group 2: All US corporates within similar rating, seniority, and level-3 granularity industry classification

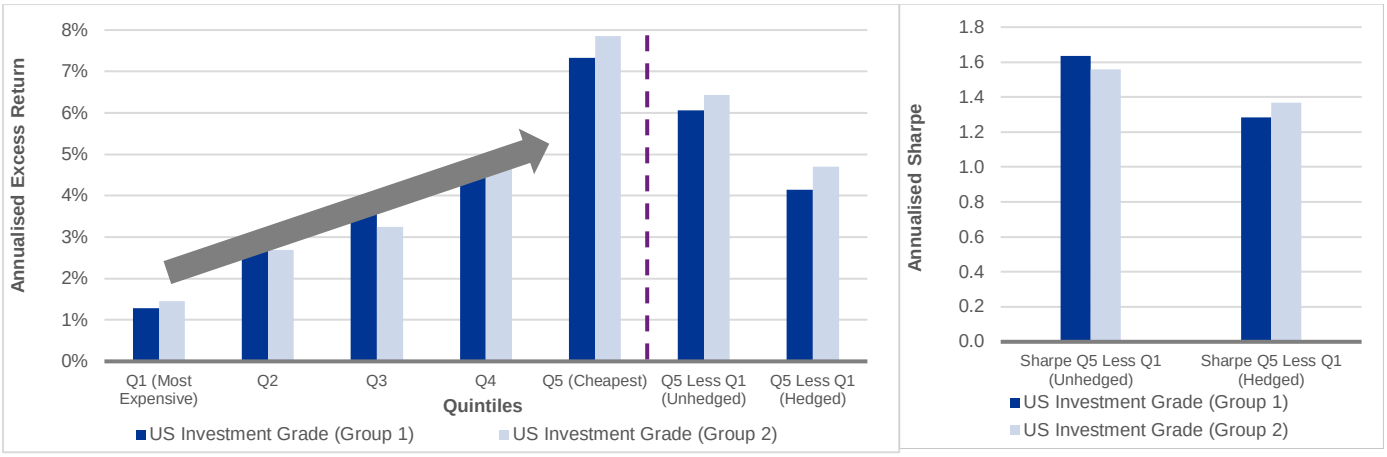
Continuing with the example above, assume the bond has a level-4 industry classification of Gas Distribution, and a level-3 industry classification of Energy. If the peer group of single-A rated, Subordinated, Gas Distribution corporates has an average premium of 6 basis points using spread curve against duration, the bond at hand is 9 basis points cheap by duration. Turning to the second peer group, if single-A rated, Subordinated, Energy corporates have an average premium of 2 basis points against duration, the example bond is 13 basis points cheap against duration.

With a threshold requirement of at least 2 comparator bonds to establish a meaningful set, Group 1 and Group 2 provide relative value coverage of over 80% and 91% of the US investment grade corporate universe, respectively. Relative value measures are stratified cross-sectionally based on attractiveness, and divided into quintile-portfolios within which all bonds are equally float value weighted. All corporates missing a relative value metric are assumed for the purpose of this exposition to be at fair value. The quintile-portfolios arising from this cross-section are assessed against excess returns (over the risk free rate) for the subsequent month.

The empirics (overleaf) support the posit that value assessments using fitted spread curves and considered peer groups stratify subsequent investment grade corporate returns. Positive Sharpe ratios are observable from both DTY-hedged and unhedged netted returns arising from the two extreme quintile sub-portfolios.

There is no guarantee that a positive investment outcome will be achieved.

[50] *Using the BAML index industry classification tree. Within this classification tree, BAML identify the sector and industy of the issuer of each bond – there are 4 levels of increasing granularity within this structure*



Source: BAML, BlackRock; data as of end-December 2016.

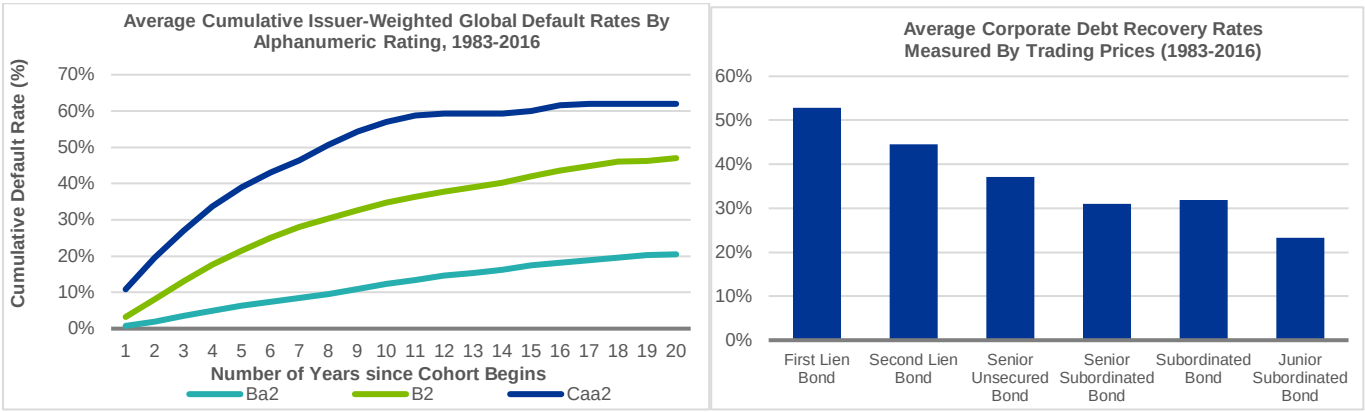
Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses.

Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

Returning to the US high yield corporate universe, an alternative relative value metric is used, establishing a credit premium of observed spreads over a *fundamentally-defined breakeven curve*. Although the relative value metrics presented within investment grade perform well in this space[51], the higher incidence of defaults in lower-grade credits means that supplementing the signal with insights into these fundamentals can potentially enhance performance.

Since 2006, Moodys have annually published cumulative issuer-weighted global default rates for alphanumeric ratings, based on cohort analyses dating back to 1983 – detailing the average path of default incidence through multiple economic cycles based on initial credit rating. Other aggregate information includes the average recovery rate of bonds that have defaulted, partitioned by bond seniority.



Source: Moody's Annual Default Study 2016; note cumulative default curves exist for every alphanumeric rating - a subset is displayed above left

These are used together to calculate a projected path of losses over the next 20 years, based on the preceding historical norm (e.g. no lookahead on default incidence). These are discounted back by the concurrent yield curve to give a breakeven curve by alphanumeric rating; the observed OAS for each High Yield bond is compared to this breakeven curve to give a naïve relative value premium for the corporate bond. As previously within investment grade value, this metric is compared against the average naïve premium in each of two peer groups, based on rating, seniority, and granular industry classification[52].

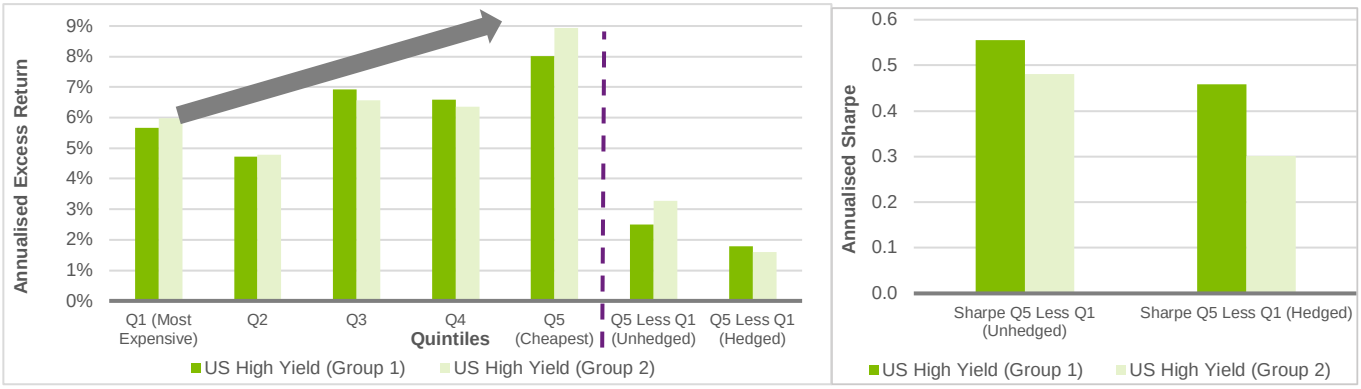
In keeping with the earlier methodology, the universe is stratified cross-sectionally into quintile-portfolios, with float value weighting to bonds in each portfolio; bonds without valuation insight are arbitrarily assigned fair value and given a percentile of 50%. The quintile-portfolios arising from this cross-section are assessed against excess returns (over the risk free rate) for the subsequent month.

---

[51] *See Appendix for supporting evidence – a performance assessment of the High Yield universe using the fitted curve value approach in place of the fundamentally-defined breakeven curve.*

[52] *As previously the peer groups use Level 4 and Level 3 of the BAML index industry classification tree. Discarding peer groups that have fewer than 2 comparators, the Level 4 and Level 3 peer groups have valuation coverage over 73% and 90% of the High Yield bond universe, respectively*

The empirics support the posit that value assessments using historically derived breakeven curves and considered peer groups stratify subsequent High Yield corporate returns -- as previously, both DTY-hedged and unhedged portfolio returns arising from the extreme quintile subportfolios present positive Sharpe ratios.



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses.

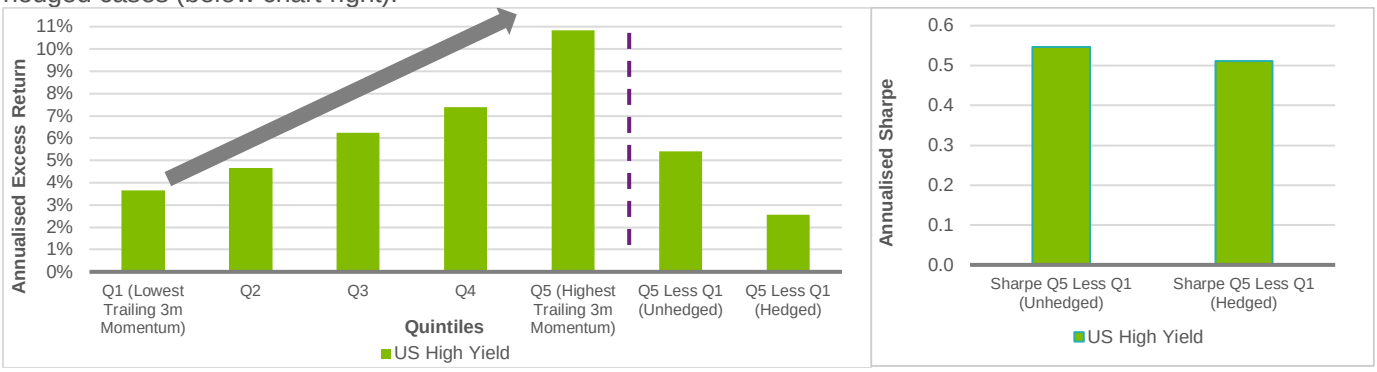
Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

Case Study: Momentum in Corporate Bonds

Continuing with the High Yield universe, in this case study the bonds are cross-sectionally stratified based on their 3-month trailing total returns. As previously, bonds within each of these subportfolios are market value weighted, and quintile-portfolio performance is assessed against excess returns (over the risk free rate) in the subsequent month.

The cross-section of returns by quintile presents elevated performance in bonds where recent returns have been strong relative to bonds where recent returns have been weak. Similar patterns are observable using alternative trailing horizons[53]. The empirics support the posit that High Yield excess returns are robustly stratified by the momentum of trailing returns at the 3-month, with the netted quintiles indicating outperformance in both the unhedged and DTY-hedged cases (below chart right).



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses.

Past performance is not a reliable indicator of current or future results.

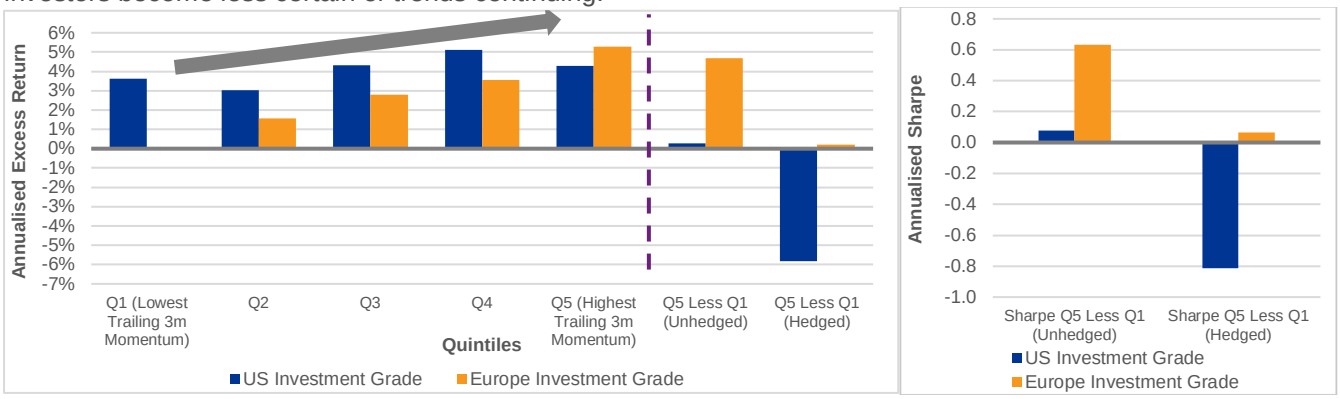
Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

As mentioned earlier, empirical support for a momentum factor driven by trailing endogenous returns in investment grade credit is thin; a similar pattern to high yield is evident in European investment grade credit[54] but not US. In the US universe, the bottom quintile has a greater propensity for reversals than in High Yield, as markets mean-revert from

[53] *See Appendix for similar analyses based on alternative trailing windows (6 months, 9, months, and 12 months)*

[54] *Within this report, the constituents of the Bank of America Merrill Lynch (BAML) Euro Corporate Index (ER00) is used to represent the Euro-denominated corporate universe. This European corporate index is deep, spanning over 2,400 bonds*

overshooting in sell-offs (value opportunities) or laggards catch-up with the rest of the market in rallies. At the other extreme, the top US quintile is characterized by lower returns and lower return quality than the 4th quintile, (the Sharpe ratios of these subportfolios are 0.63 and 0.98 respectively) -- with the standard deviation of returns increasing as investors become less certain of trends continuing.



Source: BAML, BlackRock; data as of end-December 2016.

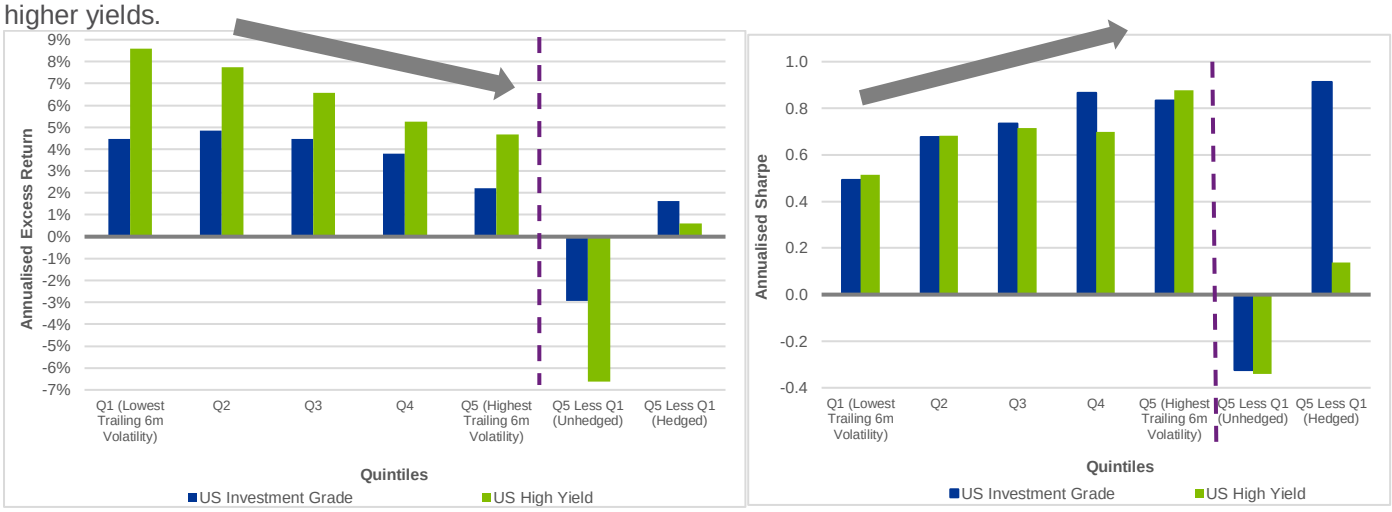
Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses**.**

Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

Case Study: Low Volatility in Corporate Bonds

The tendency for investors to reach-for-yield, (particularly if they are leverage-averse or constrained), may result in structurally higher demand for high yielding securities - that usually tend to also have higher volatility. This bias leads to a phenomenon in credit, as witnessed in other asset classes, where relatively unfavoured lower volatility securities (high percentile groups below) have outperformed on a risk-adjusted basis but exhibit lower yields, while higher volatility securities (low percentile groups below) with a more crowded bid have underperformed in risk adjusted terms but exhibit higher yields.



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses**.**

Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

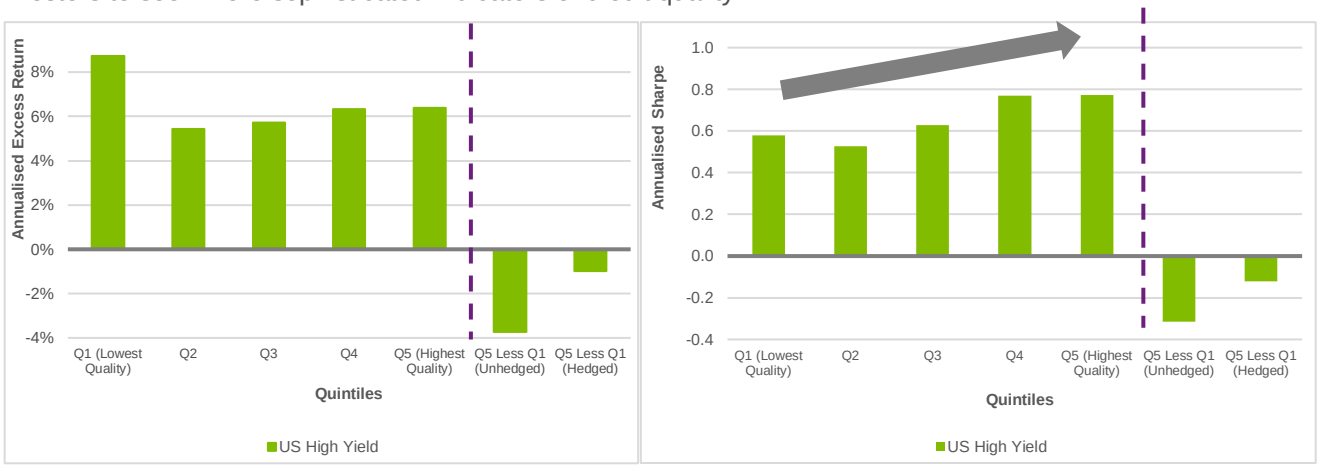
Investors with limited leverage constraints can potentially benefit from the cross-sectional improvement in quality-of-returns within higher percentile securities by scaling up these holdings and reducing positions in lower percentile securities. In the absence of being able to take leverage, a cross-sectional bias to the Low Volatility factor presents a structural drag on returns, but can still enhance the portfolios on merit of diversification. There can be no guarantee that the investment strategy can be successful and the value of investments may go down as well as up.

Case Study: Quality in Corporate Bonds

The rating tiers posted by ratings agencies such as Moody's, Standard and Poor, and Fitch are investors' usual first port-of-call for a fundamental assessment of a bond's credit quality, with the greatest differentials in default incidence arising between high yield tiers.

Focusing on the cross section of the US high yield universe, a pattern of improving quality of returns is observable as the quintiles increase in quality (as within the Low Volatility factor above). However in this case, the DTY-hedged portfolio does not present a positive Sharpe (when the Quality style factor is isolated).

This may be the result of unintended exposures, (as shall be explored in greater detail in the next section), or require investors to seek more sophisticated indicators of credit quality.[55]



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses.

Past performance is not a reliable indicator of current or future results.

Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

[55] *See Appendix.*

5. Considerations in Implementation

As mentioned earlier, the style factor examples in the last section are intended to showcase their general properties rather than represent a best-of-breed implementation. In truth, there are many ways of incorporating a factor insight into a portfolio, and the implementation can depend heavily on the goals of the product and the constraints of the investor. Typical considerations include:

Neutralisation

Tilting the portfolio in line with a given style factor may inadvertently change its exposures to other dimensions of risk. As factor investing seeks to tilt exposures only to rewarded risks it is better to neutralise unintended bets – this can be done by firstly partitioning the investment space by groups defined within the dimension that is to be neutralised, and then cross-sectionally using the style factor within each of these groups.

For instance, if investors wanted exposure to corporate bond momentum, but did not want the portfolio to make tilts into particular sectors, a neutralisation of the sector exposure could be achieved by tilting towards the strongest performing corporate bonds and away from the weakest performing corporate bonds within each sector.

The impact of neutralisation on each of the style factors showcased earlier are presented below. The "No Neutralisation" case shows the Sharpe arising from the hedged Q5-Q1 portfolio as discussed earlier, as a base case. Then the process is repeated, firstly within each partition by credit rating, and finally segmenting the universe by credit rating as well as sectors[56]. The one exception to this is US HY Quality, where in the earlier example credit ratings were used to cross-sectionally stratify the universe, so cannot be neutralised; in this case the neutralisation is of maturity bucket (5Y increments of years-to-worst[57]) and sector instead.

Corporate Universe, Style Factor, Neutralisation	Sharpe of Hedged Q5-Q1
US IG Carry, No Neutralisation	0.2
US IG Carry; Ratings Neutralised	0.3
US IG Carry; Ratings & Sector Neutralised	0.6
US HY Carry; No Neutralisation	0.4
US HY Carry; Ratings Neutralised	0.3
US HY Carry; Ratings & Sector Neutralised	0.6
US IG Value (Group 1); No Neutralisation	1.3
US IG Value (Group 1); Ratings Neutralised	1.3
US IG Value (Group 1); Ratings & Sector Neutralised	1.1
US IG Value (Group 2); No Neutralisation	1.4
US IG Value (Group 2); Ratings Neutralised	1.3
US IG Value (Group 2); Ratings & Sector Neutralised	1.1
US HY Value (Group 1); No Neutralisation	0.5
US HY Value (Group 1); Ratings Neutralised	0.7
US HY Value (Group 1); Ratings & Sector Neutralised	0.7
US HY Value (Group 2); No Neutralisation	0.3
US HY Value (Group 2); Ratings Neutralised	0.6
US HY Value (Group 2); Ratings & Sector Neutralised	0.6

Corporate Universe, Style Factor, Neutralisation	Sharpe of Hedged Q5-Q1
US HY Momentum; No Neutralisation	0.5
US HY Momentum; Ratings Neutralised	0.2
US HY Momentum; Ratings & Sector Neutralised	-0.6
US IG Momentum; No Neutralisation	-0.8
US IG Momentum; Ratings Neutralised	-1.0
US IG Momentum; Ratings & Sector Neutralised	-1.5
Europe IG Momentum; No Neutralisation	0.1
Europe IG Momentum; Ratings Neutralised	-0.1
Europe IG Momentum; Ratings & Sector Neutralised	-0.5
US IG Low Volatility; No Neutralisation	0.9
US IG Low Volatility; Ratings Neutralised	0.9
US IG Low Volatility; Ratings & Sector Neutralised	0.9
US HY Low Volatility; No Neutralisation	0.1
US HY Low Volatility; Ratings Neutralised	0.4
US HY Low Volatility; Ratings & Sector Neutralised	0.6
US HY Quality; No Neutralisation	-0.1
US HY Quality; Maturity Neutralised	0.0
US HY Quality; Maturity & Sector Neutralised	0.2

Source: BAML, BlackRock; data as of end-December 2016.

IG and HY denote investment grade and high yield corporate bonds, respectively Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses**.**

Past performance is not a reliable indicator of current or future results.

Case studies shown for illustrative purposes only and do not represent actual portfolios or investment strategies.

Colour coding highlights the strongest (green), weakest (red) and middle (yellow) quality of returns for each factor, out of the 'No Neutralisation' factor and versions of the factor with neutralisation applied.

[56] *Alphanumeric credit rating (e.g. AAA, AA1, AA2, AA3…) composites drawn from rating agency views. Sectors are drawn from the Level 3 granularity industry classification using the BAML index industry classification tree.*

[57] *There are 4 maturity buckets: 0-5Y, 5-10Y,10-15Y, 15Y+*

On the positive side, neutralisation:

- gives comfort that the portfolio hasn't unintentionally taken on concentrated exposures
- can align the hedging scalar between netted quintiles closer to 1, as the barbell is more cleanly aligned with the style factor and incidental macro factor tilts are reduced
- reduces mutual exposures between style factors, improving their diversification properties
- may improve the quality of returns – the negative Sharpe within the US High Quality case study improves from -0.1 to 0.2 once maturity and sector tilts are removed

On the negative side, neutralisation may remove an attractive aspect of a style factor. The detrimental impact on momentum in the case studies above suggests that within credit this depends marginally on autocorrelations in relative ratings returns and significantly on autocorrelations of relative sector returns, while idiosyncratic momentum outside of these drivers is less prevalent. Neutralisation should be particularly considered when it results in unintended *long-standing or static tilts.*

There can be no guarantee that the investment strategy can be successful and the value of investments may go down as well as up.

Importance of the tails

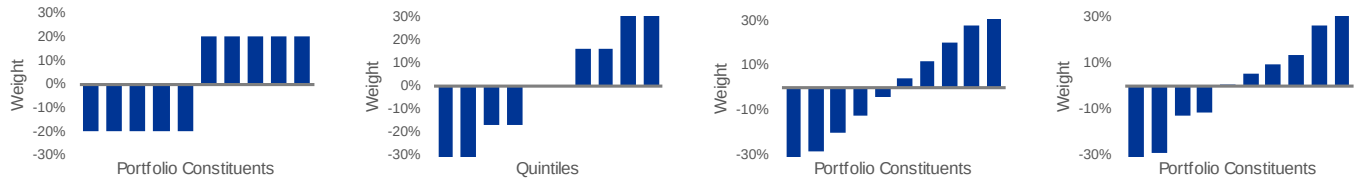
The Sharpe and return profile of the quintiles should be examined to assess where outperformance is coming from. If there is a monotonic improvement across the subportfolios then it may make sense to take active tilts across the full investment space. Alternatively, the performance profile is particularly tail-specific, it may make more sense to implement the style factor tilt as a simple filter (e.g. reduce exposures to the weakest first quintile).

Cross-sectional construction and weighting schema

The academic convention assumed earlier, of dividing the investment space into quintiles and netting the extreme quintiles, is expedient in demonstrating the properties of the cross-section, but impractical. 60% of the investible universe – that may be useful for effecting neutralisation through diversified constituents – is cast-aside, and churn may be increased for constituents near the quintile thresholds.

Within the earlier examples, the constituent weighting within each quintile is market-value weighted. This is an attractive option for long-only investors considering products with factor tilts away from a market-weighted benchmark index, as it results in a better fit for implementing the short-leg against the zero-weight lower bound. However, for less constrained investors, there may be upside to incorporating more information from the style factor signal, mapping weights to the magnitude of the signal, either directly or based on ranks arising from the signal.

Example alternative constructions across the full cross-section are highlighted below, by increasing complexity:



Equal Weight	Quintile Portfolios	Ranks	MV Optimization
Pros: • Simple and transparent • Incorporates the **sign** of the insight	Pros: • Relatively simple • Incorporates the **sign** of the insight, and some information from its **magnitude**	Pros: • Relatively simple • Incorporates the **sign** of the insight, and some information from its **magnitude** • Uses the full cross-sectional dispersion of the insight	Pros: • Theoretically optimal • Incorporates the **sign** and **magnitude** of the insight • Optimally trades off return per unit **risk**
Cons: • Does not consider **risk** • Does not incorporate the **magnitude** of the insight	Cons: • Does not consider **risk** • Does not consider the full cross-sectional dispersion of the insight	Cons: • Does not consider **risk**	Cons: • More complex to implement

Weighting schema pictured are for illustrative purposes only.

Hedging

Netting the extreme quintiles and scaling with reference to DTY is just one metric that may be considered to reduce exposure to macro factors within the cross-section of holdings. Duration may suffice for an investor constructing a style factor across DM government bonds, for instance, where rates risk is the primary concern; alternatively, a corporate bond investor who can hedge rates risk through treasury future overlays may focus on credit risk alone, using excess returns and scaling with reference to DTS.

Given that analytic metrics can misrepresent macroeconomic sensitivity[58], investors may use adjusted duration or eschew analytic for market-based metrics altogether and be based on the trailing volatility or beta of the long and short legs.

Optimization

When more than one risk needs to be managed, a one-dimensional hedging scalar will not suffice. An optimization approach[59] provides the means to satisfy multiple constraints, while optimally maximising expected returns based on the style factor insight, with penalties to systematic risks, residual risks and transaction cost drag[60].

A distinction between using an optimization to hedge out unintended factor exposures, and the neutralisation route covered earlier, is that neutralisation occurs within the calculation of a style factor cross-sectional signal, while an optimization provides a solution of optimal weights for an overall portfolio (that may be for a product that intends to combine several style factors). In cases where a risk needs to be managed for some style factors but not others, neutralisation provides a more tailored route, idiosyncratically controlling for the risk only where needed.

Risk Model

If taking the path of using an optimization seeking to maximise style factor returns per unit of ex ante risk, a risk model needs to be determined. The breadth of most fixed income universes, as well as the changing risk profile of finite

---

[58] For instance, bonds trading on a cash basis due to junk-status have tended to exhibit lower correlation to changes in interest rates than more highly rated spread-priced bonds; and bonds that are shortly to be redeemed exhibit a 'pull to par' near redemption that has tended to supersede rates sensitivity

[59] For an extensive discussion on factor-mimicking portfolio construction using optimization approaches, see "Efficient Replication of Factor Returns"; by Dimitris Melas, Raghu Suryanarayanan, and Stefano Cavaglia; MSCI Barra Research Insights; June 2009.

[60] Depending on the case at hand, these may be standalone portfolio risks or active risks established by deviations from a benchmark index.

constituents when at different maturities, favours structural (factor) risk models over bond-level risk models (which have a dimensionality equal to the number of constituents)[61].

In the context of style factors, a selection of macro factors complemented by sectors/industries would provide a useful covariance matrix of systematic risks, while helping to avoid a misalignment with the style factors themselves.[62]

Feasibility constraints

Other constraints may be applied to constituent weights with the optimization to ensure their feasibility on implementation, or curtail a tendency of optimisers to favour allocations to illiquid and/or mispriced issues.

For instance, some fixed income benchmark indices include constituents that are altogether difficult to obtain, due to liquidity constraints (particularly if the issue float size was small and time-since-issue is large). As a result, within corporate bond and emerging market debt products, full replication portfolios are rarer than within equity products – there is no passive replication in the strictest sense, but rather degrees of semi-active to active positioning. Considering this, maximum deviations from benchmark index weights may be established with reference to float (as a proxy of bond availability and liquidity).

In summary, while there are optimal factor-mimicking portfolios, (and on the flip-side there are certainly many dubiously constructed style factor portfolios), there is no absolute instantiation of a style factor portfolio that is better than all others – the appropriate manner of its implementation should be in light of these considerations, in the context of other factors also used within the financial product at hand, and in the context of and investor's goals and constraints.

---

[61] "Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk" by Richard Grinold and Ronald Kahn; Chapter 3; covers the merits of structural risk models over elementary risk models, as well as favouring a considered selection of factors over statistically-derived principal components. Richard Grinold is a former employee of BlackRock. Ronald Kahn is an employee of BlackRock.

[62] The inclusion of style factors within the risk model can lead to suboptimal performance, when they are the insight (alpha) driving tilts in the portfolio. See "Do Risk Factors Eat Alphas?" by Jyh-Huei Lee and Dan Stefek; April 2008; MSCI Barra Research Insights, and "Are Your Factors Aligned? A Practical Process for Identifying and Addressing Misalignment" by Leon Roisenberg, Mehmet Bayraktar, and Dimitris Melas; March 2016; MSCI Barra Research Insight.

6. Distinguishing Factors from Alpha

Stepping back from the minutiae of factor construction, it is worth reviewing the commonalities of the principal Macro and Style factors within Fixed Income, and considering how this distinguishes them from Alpha insights. As outlined in the descriptions earlier, the enduring positive performance from these factors can be attributed to:

- *Risk Premia*, compensating investors for exposure to risk
- *Structural Impediments* upon some market participants relative to others
- *Behavioural* characteristics amidst investors

Aside from the historically longstanding track record of factor returns, why might we believe these three driving rationales will persist going forwards? The answer to this is that each arises from the heterogeneity of market participants.

To illustrate this heterogeneity – in terms of objectives, constraints, and behaviour, investors:

- Purchase fixed income products for a wide-range of reasons – for income; to diversify multi-asset portfolios; to reduce portfolio volatility; to capture flight-to-quality upside when risky assets are in shock; to hedge risky assets with a positive carry portfolio; to speculate on the direction of rates, growth, and the economy; to match liability streams (in pensions or insurance for instance); to leverage high risk-adjusted returns for equity-like payoffs; or in the case of central banks, perhaps to provide liquidity to the economy they oversee
- Are differentiated by access to leverage, transaction or refinancing costs[63], regulatory, political and institutional constraints
- Are characterised by different levels of risk aversion to different types of risk, behavioural biases (e.g. domestic bias, confirmation bias), and investment horizons

Protagonists with different utility profiles leads to the persistence of net-positive utility (rather than zero-sum) transactions -- willing buyers and willing sellers. Or put another way, the unwillingness of certain investors to continue taking certain risks (sellers) providing compensation for those willing to take on these risks (buyers) in the form of a risk premium.

Whilst the market remains heterogenous, so too shall they endure.

By contrast, alpha insights are more transient in nature, arising from a differential advantage between market protagonists relating *to assessing likely outcomes in the future and acting upon this information.* These returns streams can be zero-sum, as the gains of those with a superior investment process are matched by the losses of their lagging competition; in time, they are likely to erode, unless the investors at hand can persistently keep an edge of insight over most other market participants.

Diversification and asset allocation may not fully protect you from market risk. There can be no guarantee that the investment strategy can be successful and the value of investments may go down as well as up.

[63] *Within "Failure to refinance" by Benjamin Keys, Devin Pope, and Daren Pope; Journal of Financial Economics; 2016; the authors investigate why so many US households fail to refinance their mortgage when more attractive terms arise: "A household can very sensibly not refinance their house for many reasons, even when it apparently could save money by doing so. Perhaps the most obvious reason—and one that is especially important after the recent housing bust—is that it is unable to qualify for a new loan due to bad credit or because of decreasing housing values [leading to high loan-to-value (LTV) ratios]. Another reason is if a household plans to move in the near future. Further, some households might not have the cash-on-hand liquidity to pay the up-front refinancing fees. For these reasons, it would be naïve to argue that any household that appears as if it could save money by refinancing is acting suboptimally when it fails to do so."*

In short, even though style factors are sometimes referenced as 'generic alpha', (as they have been used within hedge funds for decades), there are clear differences between these insights and 'non-generic alpha':

- Factor performance arises from a market's structural heterogeneity and need not be zero-sum in nature. Alpha performance arises from a superior investment process incorporating information that is not yet priced into the market and acting on likely future developments. Alpha seeks to capture the time-varying return profile, and results in zero-sum pay-offs
- Factors are generally transparent and rule-based while alpha may be idiosyncratic and discretionary
- Implementing time-varying exposures to macro and style factors is alpha. Factor investing within Smart Beta products is typically more strategic in nature, seeking higher quality returns through enhanced diversification rather than tactical shifts
- Forecasting returns is an alpha endeavour, while factor investing makes allocations based on risk where the autocorrelation of driving metrics (volatility, covariance) are more stable
- Alpha is not easily replicated and may be executional, arising from good market access, or a trading platform that aids favourable trade execution
- Alpha commands higher fees
- Factors are higher-capacity while alpha insights are typically more capacity constrained, (arbitrage opportunities or new issue premia, for instance)

7. Potential Opportunities for Fixed Income Investors

Gradual traction, not a revolution

Despite the potentially attractive features of factor-based investing in Fixed Income, there are good reasons to expect the continuing extension of the product landscape will be gradual. Idiosyncratic properties of Fixed Income present additional challenges to the issues of coverage mentioned earlier:

- While Fixed Income and Equity returns alike are principally macro-factor driven, the opportunity set of style premia tends to be wider in the latter. Idiosyncratic volatility within Fixed Income is typically lower than in other assets classes – so style factor premia arising from the cross-section within asset classes is also smaller and less attractive, particularly for leverage constrained investors. Moreover, as we have seen in Quality earlier, the equity Smart Beta framework doesn't just map over to Fixed Income in exactly the same way, but looks and feels different, so even investors who embrace equity Smart Beta are often slow to embrace Fixed Income Smart Beta.
- The harvestable cross-sectional style factor premium is even more muted for long-only investors
- Fixed Income asset classes where idiosyncratic volatility present more enticing premia face other challenges. For example, in high yield credit indices a large proportion of issuers are private companies, so forward-looking earnings estimates, and accounting data can be difficult to source for fundamental-metric driven style factors; and high yield credit is characterised by high transaction costs that mute standalone style factor performance
- Other investor constraints can impinge upon the opportunity set – narrow rating agency bands can limit the potential performance arising from the cross-section of Quality, for instance
- There is a continued, strongly held belief in active management in Fixed Income. The adoption of Smart Beta in equities came about partly because active performance was poor, which led investors to question their investment decision. Fixed Income investors have only begun to question active management – which has led to an increased adoption of indexing. As this trend accelerates it opens the door for Fixed Income Smart Beta developments

The changing Fixed Income landscape presents opportunities for investors

As familiarity with Fixed Income Smart Beta grows, investors may seek to use it to enhance their existing broad–market portfolios, to diversify existing macro factor exposures with style factor positioning. For example, in a low-to-negative yield environment, Carry strategies can improve the return proposition, while Momentum and Value insights provide additional return sources that are orthogonal to macro factors, and enjoy a low-to-negative correlation with one another.

Alternatively, in index products where investors have trepidation over drawdowns, perhaps due to an anticipated turn in Central Bank policy or an upswing in corporate defaults, exposure to the Low Volatility and Quality style factors may help mute drawdowns when the turn (eventually) occurs, allowing investors to rest easier holding onto positions and accrue returns in the meantime. Alternatively, they may opt to seek a better balance of macro factor exposures themselves.

Depending on investor demand, products that bundle together or provide isolated exposure to macro and style factors can be developed, with a goal of providing investment instruments with return profiles that best complement one another or existing portfolios, targeting investor needs.

Familiarity with a Fixed Income Smart Beta framework presents investors with the means to understand and decompose the types of directional and cross-sectional risk exposures their active managers are taking, with insights to better assess their performance, and gauge their ability to deliver pure alpha as opposed to persistent style bets.

In summary, Fixed Income Smart Beta may present investors with the means for better risk management, a wider breadth of investments to diversify and enhance portfolios, and empowerment.

References

"*A Bond-Picking Model for Corporate Bond Allocation*"; L'Hoir, M., and M. Boulhabel, Journal of Portfolio Management, Spring 2010, 131-139, 2010

"*A New Look at Minimum Variance Investing*"; Bernd Scherer; EDHEC Business School; 2010

"*Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk*"; Richard Grinold and Ronald Kahn; Chapter 3; 1999

"*Are Your Factors Aligned? A Practical Process for Identifying and Addressing Misalignment*"; Leon Roisenberg, Mehmet Bayraktar, and Dimitris Melas; MSCI Barra Research Insight; March 2016

"*Can book-to-market, size, and momentum be risk factors that predict economic growth?*"; Jimmy Liew and Maria Vassalou, Journal of Financial Economics, Vol 57, Issue 2, pg 221-245, 2000

"*Capital Commitment and Illiquidity in Corporate Bonds*"; Henrik Bessembinder, Stacey Jacobsen, William Maxwell, and Kumar Venkataraman, April 2016

"*Do Momentum-Based Strategies Still Work in Foreign Currency Markets?*"; John Okunev and Derek White; Journal of Financial and Quantitative Analysis; Vol 38, No 2; June 2003

"*Do Risk Factors Eat Alphas?*"; Jyh-Huei Lee and Dan Stefek; MSCI Barra Research Insights; April 2008

"*DTS (Duration Times Spread)*"; Arik Ben Dor, Lev Dynkin, Jay Hyman, Patrick Houweling; Erik van Leeuwen; and Olaf Penninga; Journal of Portfolio Management; Winter 2007

"*Efficient Replication of Factor Returns*"; Dimitris Melas, Raghu Suryanarayanan, and Stefano Cavaglia; MSCI Barra Research Insights; June 2009

"*Factor Investing in the Corporate Bond Market*"; Patrick Houweling and Jeroen van Zundert; Financial Analysts Journal; 2017

"*Failure to refinance*"; Benjamin Keys, Devin Pope, and Daren Pope; Journal of Financial Economics; 2016

"*Firm-specific information and the correlation between individual stocks and bonds*"; Simon H. Kwan; Journal of Financial Economics, 40, pg 63-80; 1996

"*Forward and Spot Exchange Rates*"; Eugene F. Fama; Journal of Monetary Economics, 14, pg 319-338; 1984

"*Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis*"; Lars Peter Hansen and Robert J. Hodrick; Journal of Political Economy, Vol 88, No 5, pg 829-853, 1980

"*Futures prices as risk-adjusted forecasts of monetary policy*"; Monika Piazzesi and Eric T. Swanson, Journal of Monetary Economics; 55; pg 677-691, 2008

"*International Momentum Strategies*"; Geert Rouwenhorst; Journal of Finance, 53, pg 267-284, 1998

"*Introducing the BlackRock Sovereign Risk Index*"; Benjamin Brodsky, Garth Flannery and Sami Mesrour; BlackRock Investment Institute; June 2011

"*Momentum in Corporate Bond Returns*"; Gergana Jostova, Stanislava Nikolova, Alexander Philipov, and Christof W. Stahel; FDIC Center for Financial Research Working Paper No. 2010-04; 2010

"*Momentum in Residential Real Estate*"; Eli Beracha and Hilla Skiba; Journal of Real Estate and Finance and Economics, Vol 43, pg 299–320, October 2011

"*Momentum Strategies in Commodity Futures Markets*"; Joëlle Miffre and Georgios Rallis; Journal of Banking and Finance, 31, pg 1863-1886; 2007

"*On the Evidence Supporting the Existence of Risk Premiums in the Capital Market*"; Robert A. Haugen and A. James Heins; Working Paper, 1972. A later version entitled "*Risk and the Rate of Return on Financial Assets: Some Old Wine in New Bottles*" was published in the Journal of Financial and Quantitative Analysis, 1975.

"*Presidential Address: Discount Rates*"; John H. Cochrane; Journal of Finance; Vol. LXVI, No. 4; pg 1051; August 2011

"*Profitability of Momentum Strategies in the International Equity Markets*"; Kalok Chan, Allaudeen Hameed, and Wilson Tong; Journal of Financial and Quantitative Analysis; Vol 35, No 2, pg 153-172, 2000

"*Reach For Safety*"; Johnny Kang, Tom Parker, Scott Radell, and Ralph Smith; BlackRock; Working paper; September 2017; [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3037745]

"*Sharpe and Treynor Ratios on Treasury Bonds*"; E. A. Pilotte; University of Wyoming Economics and Finance Faculty Publications; 2006

"*Stock and Bond Market Interaction: Does Momentum Spill Over?*"; William R. Gebhardt, Soeren Hvidkjaer, and Bhaskaran Swaminathan, Journal of Financial Economics 75, 651–690, 2005

"*Successful factors to select outperforming corporate bonds*"; Hottinga, J., E. van Leeuwen and J. van Ijserloo; 2001, Journal of Portfolio Management, Fall 2001, 88-101

"*Term Premiums and Default Premiums in Money Markets*"; Eugene F. Fama, Journal of Financial Economics, 17, pg 175-196; September 1986

"*The Dog That Did Not Bark: A Defense of Return Predictability*"; John H. Cochrane; Review of Financial Studies, Vol 21, issue 4, pg 153-1575, 2008

"*The Information in Long-Maturity Forward Rates*"; Eugene F. Fama and Robert R. Bliss; The American Economic Review; Vol. 77, No 4, pg 680-692, September 1987

"*The Risk Premium of Corporate Bonds*"; Alexander V. Kozhemiakin; Journal of Portfolio Management; Vol. 33, No. 2, pg 101-109; Winter 2007

"*The Short-Term Corporate Bond Anomaly*"; Jeroen Derwall, Joop Huij, and Gerben J. de Zwart; Working Paper, Erasmus University, 2009

"*The Term Structure of Returns: Facts and Theory*"; Jules H. van Binsbergen and Ralph S.J. Koijen; NBER Working Paper No. 21234; June 2015

"*Value of security selection versus asset allocation in credit markets*"; Dynkin, L., P. Ferket, J. Hyman, E. van Leeuwen and W. Wu; 1999, Journal of Portfolio Management, 11-27, Summer 1999

"*Which Risks Have Been Best Rewarded?*"; Antti Ilmanen, Rory Byrne, Heinz Gunasekara, and Robert Minikin; Journal of Portfolio Management; Vol 30, No. 2, pg 53-57; Winter 2004

"*Why is low-risk investing successful?*" J. Sefton, D. Jessop, G. De Rossi, C. Jones, and H. Zhang; UBS Investment Research Q-Series, September 2011

"*Yield spreads and interest rate movements: a bird's eye view*"; Campbell, John Y., and Robert J. Shiller; The Econometrics of Financial Markets, Review of Economic Studies 58, no. 3: pg 495-514, 1991

"*…and the Cross-Section of Expected Returns*"; Campbell Harvey, Yan Liu, Heqing Zhu; Review of Financial Studies, Vol. 29, No.1 (January); pg 5-68, 2016

"*A Look at a Variety of Duration Measures*"; Robert W. Kopprasch; Citi; July 2004

"*Anomalies and Market (Dis)Integration*"; Jaewon Choi and Yongjun Kim; August 2014

"*Are Capital Market Anomalies Common to Equity and Corporate Bond Markets*"; Tarun Chordia, Amit Goyal, Yoshio Nozawa, Avanidhar Subramanyam, Qing Tong; Emory University; May 2016

"*Betting Against Beta*", Andrea Frazzini and Lasse Pederson, 2010

"*Carry*"; Ralph Koijen, Tobias Moskowitz, Lasse Heje Pedersen, and Evert Vrugt; Journal of Financial Economics, 127(2), 2018, p.197-225

"*Cash-Flow Maturity and Risk Premia in CDS Markets*"; Diogo Palhares; University of Chicago; 2013

"*Do the Distributional Characteristics of Corporate Bonds Predict Their Future Returns?*"; Jennie Bai, Turan Bali, Quan Wen; August 2016

"*DTS (Duration Times Spread)*"; Arik Ben Dor, Lev Dynkin, Jay Hyman, Patrick Houweling; Erik van Leeuwen; and Olaf Penninga; Journal of Portfolio Management; Winter 2007

"*Dynamic CAPM Geometry*"; Ed Fishwick, Cherry Muijsson and Steve Satchell; 2016

"*Extending Fama-French Factors to Corporate Bond Markets*"; Demir Bektic, Josef-Stefan Wenzler, Michael Wegener, Dirk Schiereck, and Timo Spielman; April 2016

"*Factor-Based Investing in Fixed Income: A Case Study of the US Investment Grade Corporate Bond Market*"; Aye Soe, Hong Zie; S&P Global; January 2016

"*Foundations of Factor Investing*"; Jennifer Bender, Remy Briand, Dimitris Melas, and Raman Aylur Subramanian; MSCI; 2013

"*Leverage Aversion and Risk Parity*"; Clifford Asness, Andrea Frazzini, and Lasse Pedersen; Financial Analysts Journal; Volume 68, Number 1; 2012

"*Low-Risk Anomalies in Global Fixed Income: Evidence from Major Broad Markets*"; Raul Leote de Carvalho, Patrick Dugnolle, Xiao Lu, and Pierre, Moulin; Journal of Fixed Income; Spring 2014

"*Low-Risk Anomaly Investing in Corporates : DTS or Beta?*"; Kwok Yuen Ng and Bruce Phelps; Barclays; January 2015

"*Low-Risk Investing without Industry Bets*"; Clifford Asness, Andrea Frazzini, and Lasse Pedersen; Financial Analysts Journal; 2014

"*Measuring Default Risk Premia from Default Swap Rates and EDFs*"; Berndt, A., R. Douglas, D. Duffie, M. Ferguson, and D. Schranz, Working paper, Stanford University, 2005

"*Quality Investing*" by Robert Novy-Marx; Working Paper; 2014

"*Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency*"; Narasimhan Jegadeesh and Sheridan Titman; Journal of Finance, Volume XLVIII, No 1; March 1993

"*Smart Beta: The Owner's Manual*"; Ronald Kahn and Michael Lemmon; Journal of Portfolio Management; Winter 2015

"*The Capital Asset Pricing Model: Some Empirical Tests*"; Michael C. Jensen, Fischer Black, and Scholes, Myron S. Scholes; Studies in the theory of Capital Markets; Praeger Publishers Inc, 1972

"*The Cross-Section of Volatility and Expected Returns*"; Andrew Ang, Robert Hodrick, Yuhang Xing, Xiaoyan Zhang; Journal of Finance, January 2006

"*The Fundamentals of Commodity Futures Returns*"; Gary Gorton, Fumio Hayashi and Geert Rouwenhorst; National Bureau of Economic Research Working Paper No. 13249; 2007

"*The Low Beta Anomaly and Interest Rates*"; Ed Fishwick and Steve Satchell, Risk-Based and Factor Investing, 2015

"*The Road to Profitability is Paved with Volatility-Adjusted Carry*"; G. Ooman and M. Chang; Credit Suisse Fixed Income Research; April 2011

"*Understanding Duration and Volatility*"; Robert W. Kopprasch, Salomon Brothers Inc; September 1985

"*Value and Momentum Everywhere*"; Clifford Asness, Tobias Moskowitz, and Lasse Pederson; Journal of Finance, 2013

Appendix

Variations of Style Factors

Within the exposition of style factors, it was stated that the High Yield value signals would fare well with reference to the fitted spread curve (as within investment grade) – but breakeven curves are used within the example as they perform better still. For completeness, the performance of High Yield using the fitted spread curves are presented below.[64]

Similarly, the robustness of the High Yield momentum signals was asserted using alternative trailing windows of returns than the 3m window used within the example. Additional outputs using trailing windows of 6, 9, and 12 months are presented to illustrate this.

Corporate Universe, Style Factor	Annualised Returns Q1	Annualised Returns Q2	Annualised Returns Q3	Annualised Returns Q4	Annualised Returns Q5	Annualised Returns Q5-Q1 (Unhedged)	Annualised Returns Q5-Q1 (Hedged)
US HY Value (Group 1); Value using Fitted Spread Curve vs Duration	4.5%	5.7%	6.8%	6.7%	8.3%	4.1%	**2.4%**
US HY Value (Group 2); Value using Fitted Spread Curve vs Duration	5.5%	4.8%	7.2%	6.4%	8.4%	3.3%	**0.5%**
US HY Momentum Trailing 12M Returns	6.9%	6.2%	5.7%	6.4%	8.5%	-1.2%	**1.5%**
US HY Momentum; Trailing 9M Returns	6.2%	6.4%	6.2%	6.5%	8.7%	-0.3%	**1.4%**
US HY Momentum; Trailing 6M Returns	4.2%	6.3%	6.2%	7.0%	9.2%	2.8%	**2.4%**
US HY Momentum; Trailing 3M Returns	3.7%	4.7%	6.3%	7.4%	10.8%	5.4%	**2.6%**

Corporate Universe, Style Factor	Sharpe Q1	Sharpe Q2	Sharpe Q3	Sharpe Q4	Sharpe Q5	Sharpe Q5-Q1 (Unhedged)	Sharpe Q5-Q1 (Hedged)
US HY Value (Group 1); Value using Fitted Spread Curve vs Duration	0.55	0.63	0.77	0.68	0.65	0.75	**0.89**
US HY Value (Group 2); Value using Fitted Spread Curve vs Duration	0.62	0.62	0.75	0.68	0.60	0.46	**0.13**
US HY Momentum Trailing 12M Returns	0.43	0.53	0.66	0.83	0.99	0.00	**0.29**
US HY Momentum; Trailing 9M Returns	0.40	0.55	0.69	0.85	0.96	0.06	**0.27**
US HY Momentum; Trailing 6M Returns	0.31	0.57	0.73	0.88	0.91	0.28	**0.46**
US HY Momentum; Trailing 3M Returns	0.29	0.49	0.70	0.89	0.98	0.55	**0.51**

IG and HY denote investment grade and high yield corporate bonds, respectively Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses. Past performance does not guarantee future results. Case studies shown for illustrative purposes only and do not represent actual portfolios or investment strategies.

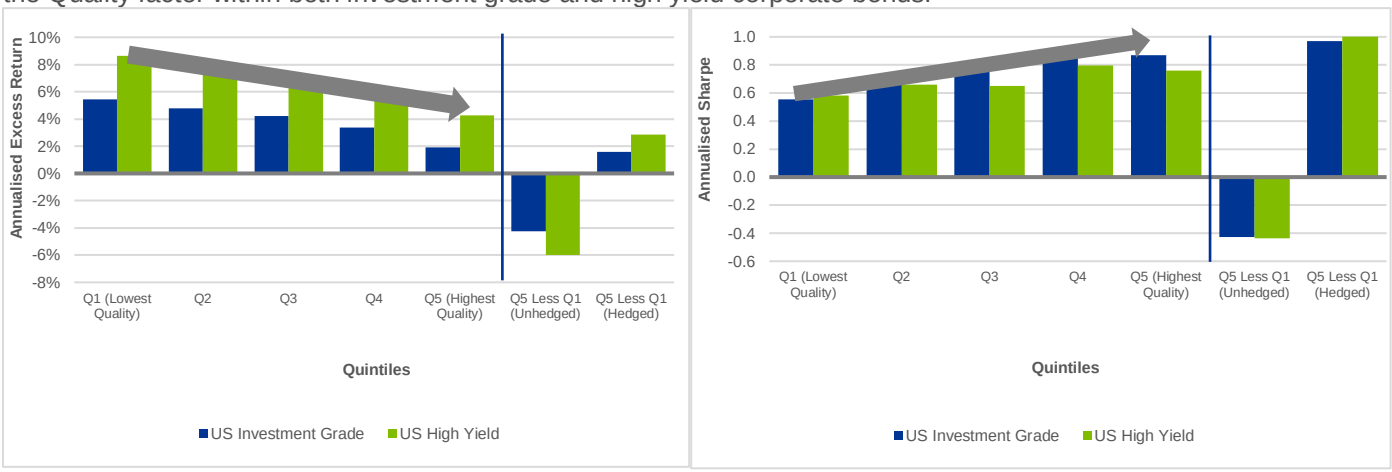
Past performance is not a reliable indicator of current or future results.

Case studies shown for illustrative purposes only and do not represent actual portfolios or investment strategies.

Within the exposition of the Quality factor, a stratification of the US High Yield corporate universe was made with reference to the average bond rating from the principal ratings agencies. Neutralisation by sector and maturity subsequently suggested an improvement in the performance between the extreme quintiles.

[64] *The BAML corporate index constituents used within Section 4 and 5 are used within these Appendix case studies. The risk metric used in the hedged calculation is DTY, as within the earlier sections.*

However even with this enhancement a challenge may be that the higher quality names (e.g. BB1) may outperform as they have a better balance of credit versus rates risk (that negatively correlate in risk off periods), and are more likely to benefit from the Fallen Angels value premium than B1 or lower-rated constituents. An alternative approach that would allay this critique is to neutralize by rating, and approach the cross-section *within each rating group* using an alternative metric of Quality. Stratifying by DTY (Duration-Times-Yield) within each alphanumeric tier produces empirics that affirm the Quality factor within both investment grade and high yield corporate bonds.



Source: BAML, BlackRock; data as of end-December 2016.

Returns are in excess of the risk-free rate, calculated between January 2006 and December 2016. Bond returns drawn from the BAML corporate indices are for illustrative purposes only. Bond returns do not reflect any management fees, transaction costs, or expenses. Past performance does not guarantee future results. Case study shown for illustrative purposes only and does not represent actual portfolios or investment strategies.

Past performance is not a reliable indicator of current or future results.

Case studies shown for illustrative purposes only and do not represent actual portfolios or investment strategies.

FOR INSTITUTIONAL, ACCREDITED, PROFESSIONAL AND WHOLESALE INVESTORS AND PROFESSIONAL INTERMEDIARIES ONLY – NOT FOR PUBLIC DISTRIBUTION (PLEASE READ IMPORTANT DISCLOSURES)

Important notes

This material is prepared by BlackRock and is not intended to be relied upon as a forecast, research or investment advice, and is not a recommendation, offer or solicitation to buy or sell any securities or to adopt any investment strategy. The opinions expressed are as of February 2018 and may change as subsequent conditions vary. The information and opinions contained in this material are derived from proprietary and non-proprietary sources deemed by BlackRock to be reliable, are not necessarily all inclusive and are not guaranteed as to accuracy. As such, no warranty of accuracy or reliability is given and no responsibility arising in any other way for errors and omissions (including responsibility to any person by reason of negligence) is accepted by BlackRock, its officers, employees or agents. This material may contain 'forward-looking' information that is not purely historical in nature. Such information may include, among other things, projections and forecasts. There is no guarantee that any forecasts made will come to pass. Reliance upon information in this material is at the sole discretion of the reader.

In Hong Kong, this material is issued by BlackRock Asset Management North Asia Limited and has not been reviewed by the Securities and Futures Commission of Hong Kong. This material is for distribution to "Professional Investors" (as defined in the Securities and Futures Ordinance (Cap.571 of the laws of Hong Kong) and any rules made under that ordinance.) and should not be relied upon by any other persons or redistributed to retail clients in Hong Kong.
Many thanks,

In Singapore, this is issued by BlackRock (Singapore) Limited (Co. registration no. 200010143N) for use with institutional investors/accredited investors as defined in Section 4A of the Securities and Futures Act, Chapter 289 of Singapore.

In Korea, this information is issued by BlackRock Investment (Korea) Limited. This material is for distribution to the Qualified Professional Investors (as defined in the Financial Investment Services and Capital Market Act and its sub-regulations) and for information or educational purposes only, and does not constitute investment advice or an offer or solicitation to purchase or sells in any securities or any investment strategies.

In Taiwan, Independently operated by BlackRock Investment Management (Taiwan) Limited. Address: 28F., No. 100, Songren Rd., Xinyi Dist., Taipei City 110, Taiwan. Tel: (02)23261600.

In China, this material may not be distributed to individuals resident in the People's Republic of China ("PRC", for such purposes, excluding Hong Kong, Macau and Taiwan) or entities registered in the PRC unless such parties have received all the required PRC government approvals to participate in any investment or receive any investment advisory or investment management services.

Issued in Australia and New Zealand by BlackRock Investment Management (Australia) Limited ABN 13 006 165 975 AFSL 230 523 (BIMAL) for the exclusive use of the recipient who warrants by receipt of this material that they are a wholesale client and not a retail client as those terms are defined under the Australian Corporations Act 2001 (Cth) and the New Zealand Financial Advisers Act 2008 respectively. BIMAL is the issuer of financial products and acts as an investment manager in Australia. BIMAL does not offer financial products to persons in New Zealand who are retail investors (as that term is defined in the Financial Markets Conduct Act 2013 (FMCA)). This material does not constitute or relate to such an offer. To the extent that this material does constitute or relate to such an offer of financial products, the offer is only made to, and capable of acceptance by, persons in New Zealand who are wholesale investors (as that term is defined in the FMCA). This material has not been prepared specifically for Australian or New Zealand investors and may contain references to dollar amounts which are not Australian or New Zealand dollars and financial information which are not prepared in accordance with Australian or New Zealand law or practices.

For Other Countries in APAC, this material is issued for Institutional Investors only (or professional/sophisticated/qualified investors, as such term may apply in local jurisdictions) and does not constitute investment advice or an offer or solicitation to purchase or sell in any securities, BlackRock funds or any investment strategy nor shall any securities be offered or sold to any person in any jurisdiction in which an offer, solicitation, purchase or sale would be unlawful under the securities laws of such jurisdiction.

The information provided here is neither tax nor legal advice. Investors should speak to their tax professional for specific information regarding their tax situation. Investment involves risk including possible loss of principal. International investing involves risks, including risks related to foreign currency, limited liquidity, less government regulation, and the possibility of substantial volatility due to adverse political, economic or other developments. These risks are often heightened for investments in emerging/developing markets or smaller capital markets.

FOR INSTITUTIONAL, ACCREDITED, PROFESSIONAL AND WHOLESALE INVESTORS AND PROFESSIONAL INTERMEDIARIES ONLY – NOT FOR PUBLIC DISTRIBUTION (PLEASE READ IMPORTANT DISCLOSURES)