Research

FTSE Fixed Income Factor Research Series – The Value Effect

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FTSE Fixed Income Factor Research Series – The Value Effect

Executive summary: Discover the value embedded in bonds and start the journey of fixed income factor investing

A factor index is designed with the intention of capturing the return premium associated with exposure to a particular factor or set of factors in a transparent, rules-based and replicable format. Factor indexes can be used both as benchmarks for the performance of actively managed funds and as the reference or benchmark for an index-replicating product.

As we have discussed previously [1,2], the rise of factor investing has been a notable trend over recent history. Now in its fifth year, the FTSE Russell global institutional smart beta survey provides a clear insight into major trends at work in recent years in awareness, popularity and use of smart beta index-based strategies among global institutional asset owners. The observable prominence of smart beta strategies within equity investing leads to the question of whether similar smart beta strategies can be employed in other asset classes. We argue that for the underlying reasons factors are not asset class-specific, and that there is no reason to believe they cannot be applied to fixed income.

As we will discuss, factor-driven smart beta strategies are arguably more straightforward to define for equities than fixed income. While equities of one issuer are interchangeable, bonds are typically not, and possess additional properties that make comparison more cumbersome, not least the fact that bonds have finite lives and so disappear from the investment universe over the medium term. Despite the challenges, we will show that fixed income factors can be well defined - and employed by investors to potentially extract excess returns and better understand the risks and returns appropriate for their portfolios.

The paper will cover the following sections:

- **The value concept**. While there have been a variety of successful approaches of value in equities, the factor does not have a widely accepted definition in fixed income. However, previous work and our research all point to focusing on the measure of spread.
- **The cross-sectional approach.** We will introduce in detail our approach to value, the cross-sectional model and the deciling and reweighting mechanism. The parsimonious model incorporates various credit risk drivers that are critical to determine credit spreads.
- **The empirical study.** The same definition and methodology will be employed to analyze the behavior and effectiveness of value in various global corporate bond markets. The analysis of the US investment-grade corporate itself will be covered in detail to showcase the steps of the study.

This paper on the Value Factor for Fixed Income represents the first in a series of Fixed Income Factor Research exploring in detail how factor based approaches can be applied to fixed income investing. Additional discussions on other factors including carry, quality, momentum and volatility will follow.

[1] Trends and outlook for smart beta http://www.ftserussell.com/files/research/trends-and-outlook-smart-beta
[2] The rise of factor investing http://www.ftserussell.com/sites/default/files/the_rise_of_factor_investing_final.pdf

Value Factor: The relative cheapness compared to the fundamental riskiness

Introduction to Value for Stocks and Corporate Bonds

The value effect is one of the most well studied and evidenced market factors within equity investing. The value factor, or value premium, refers to the tendency for mean-reversion in valuations, with ‘cheap’ stocks outperforming ‘expensive’ stocks in the long run. The premium has been observed across many different markets, regions and sample periods.

The early groundwork was set by Graham and Dodd in their seminal Security Analysis (1934), and the foundational work within modern portfolio theory that followed. [3] The value factor gained its popularity after Fama and French’s paper in 1992, and the parallel academic research published by Chan, Hamao and Lakonishok (1991), Lakonishok, Shleifer and Vishny (1994), alongside others around the same period. Over the past two decades, our understanding of value factor within equities has been further deepened by studies from academia and industry alike, including of course FTSE Russell’s own exploration of the value factor across global markets.[4]

In equities, value factors can be defined and captured using a variety of different metrics for ‘cheapness’. The aforementioned FTSE Russell paper considers forecast measures of Earnings Yield, Book to Price, Cash Flow Yield, Sales to Price and Dividend Yield, for example. The philosophy here is to compare the stock prices or the total market capitalization with the companies’ underlying fundamentals to identify the relatively undervalued stocks.

However, within corporate bonds there has not been nearly such a widely accepted definition of value. Fama and French’s follow up paper (1993) included a model based on two common return factors for bonds – related to duration and credit risk - but did not seek to extend the premise behind an equity-like value factor to the bonds universe. There are several possible reasons for this:

- The direct extension of the equity definition doesn’t apply. The equity value factor is defined as price to certain fundamental attributes, or in short form P/x. Replacing the equity price ‘P’ with bond price, results, in aggregate, in the total market capitalization of the company’s outstanding issues, or total debt. As such, the ratios become total debt-to-earnings, or total debt-to-book-value – which look much more like quality metrics than value metrics. Whilst such assessments of the capability of an issuer to pay back its debt and attempt to screen low-quality issues / issuers certainly has merit, this will be covered in a separate topic.
- Different from the payoff structure of equity instruments, the upside of bond prices is capped by the coupon and yield embedded in the bond characteristics. Certain issuers can have extremely strong fundamentals; however, as a reasonable consequence, they will also be highly-rated and only required to offer low coupon payments.

In short, the value factor in fixed income cannot directly borrow the definition from equity and cannot be purely fundamental driven. Nonetheless it can take the same philosophy from the equity value factor - that is to identify the relatively undervalued securities, or more specifically to evaluate the relative cheapness compared to some measure of inherent or structural risk.

[3] For portfolio theory, see Markowitz (1959); for the capital asset pricing model (CAPM) see Treynor (1962), Sharpe (1964), Lintner (1965), and Mossin (1966)

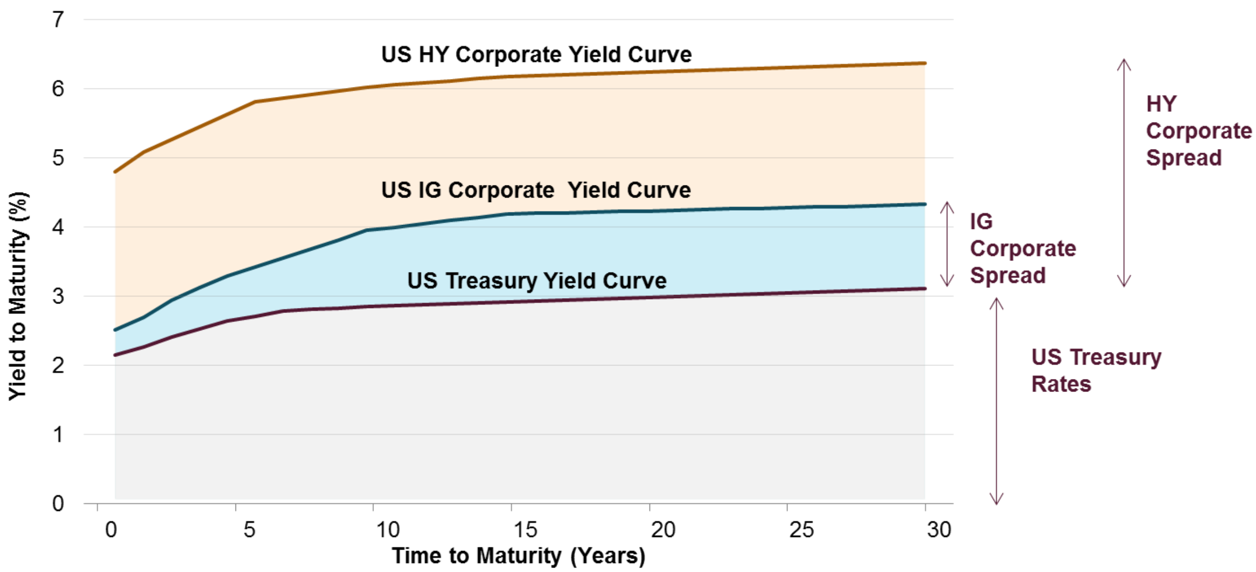
[4] For details, see http://www.ftserussell.com/files/research/factor-exposure-indexes-value-factor.

Past Approaches to Value within Credit Markets

The value of individual bonds is determined by comparing a market measure that is observable, and derived from the market traded price, with a model-implied "intrinsic" measure - which approximates the value implied by the bonds key risk features, and is unobservable.

One could take a variety of market measures of value, depending on the purpose – price, yield, spread etc. Previous work on value has focused on measures of spread since the goal is to measure the market's required compensation for the bond's credit riskiness. A natural approach is to focus on the payoff structure of bonds, and observe their coupon rates. Since the coupon rate is a comparison against par, one can combine the coupon and principal payments and compare against the latest bond price, which gives the measure of yield. From yield, if one subtracts the corresponding treasury rate that is extraneous and irrelevant to the company's creditworthiness, it results in the choice of spread.

Exhibit 1: US Investment-Grade and High-Yield Corporate Bond Spread



Source: FTSE Russell

Indeed, of the previous work on value within corporate bond markets, L'Hoir & Boulhabel (2010), Correia, Richardson & Tuna (2012), Houweling & Zundert (2017) and Israel, Palhares & Richardson (2018) all opted for a spread measure as a proxy for the market measure of value. This approach has the benefit of removing the impact of treasury rate risk on bond price movements and targeting only the market's best estimate of the bonds credit (and liquidity) risk.

To construct a model-implied value, there are broadly two approaches one can adopt; utilizing either bond characteristics, such as rating, maturity and credit spread, or accounting based metrics, such as cash-flows, profitability or leverage. As noted, value within equities is classically measured using fundamental accounting-based metrics of a company's future cash-flow generating potential, utilized as a kind of proxy for intrinsic value.

Such an approach has been adopted within corporate bonds, too. L'Hoir & Boulhabel utilize a range of accounting-based metrics, including profitability (ROA) and cash-flow revisions estimates (alongside a lagged one-month equity return). They show that each of these metrics have explanatory power for excess bond returns over varying time horizons, with fundamentals having greater impact in the medium to long term.

Similarly, Correia et al utilize a variety of models of default prediction - each of which rely on a variety of accounting metrics - to explain cross-sectional variation in credit spreads across corporate bond and CDS data. They find default forecasts combining market and accounting based information can forecast changes in credit spreads, with the best default models able to explain up to 42 percent of the cross-sectional variation in corporate bond spreads. Israel et al also utilize fundamental accounting-based metrics to compute default-probabilities implied by a structural model of credit risk, and regress against credit spread changes.

Whilst adding explanatory power to a particular estimate of intrinsic risk for bonds, the use of accounting data has its drawbacks in the context of a value definition. Firstly, the fair value of bonds remains static between financial reporting cycles when purely determined by accounting metrics. It doesn't reflect the latest bond price movements and market conditions hence deviates from the philosophy of measuring the relative cheapness. While fundamental strength could impact future bond performance, it may however be more relevant to a quality type of factor. Secondly, credit ratings would normally incorporate many of the accounting measures already and this creates the issue of duplicating the inputs and their impact. Finally, different from equities, the fundamental data is not always readily available for an entire universe of bond issuers and can be particularly problematic to source for private issuers. Perhaps for these reasons, Houweling & Zundert opt to limit their model-implied value by using only readily available market measures of value, opting for maturity, rating, and the 3-month change in the bond's credit spread.

Relative value for corporate bonds: The cross-sectional comparison

A Model to Measure Fixed Income Value

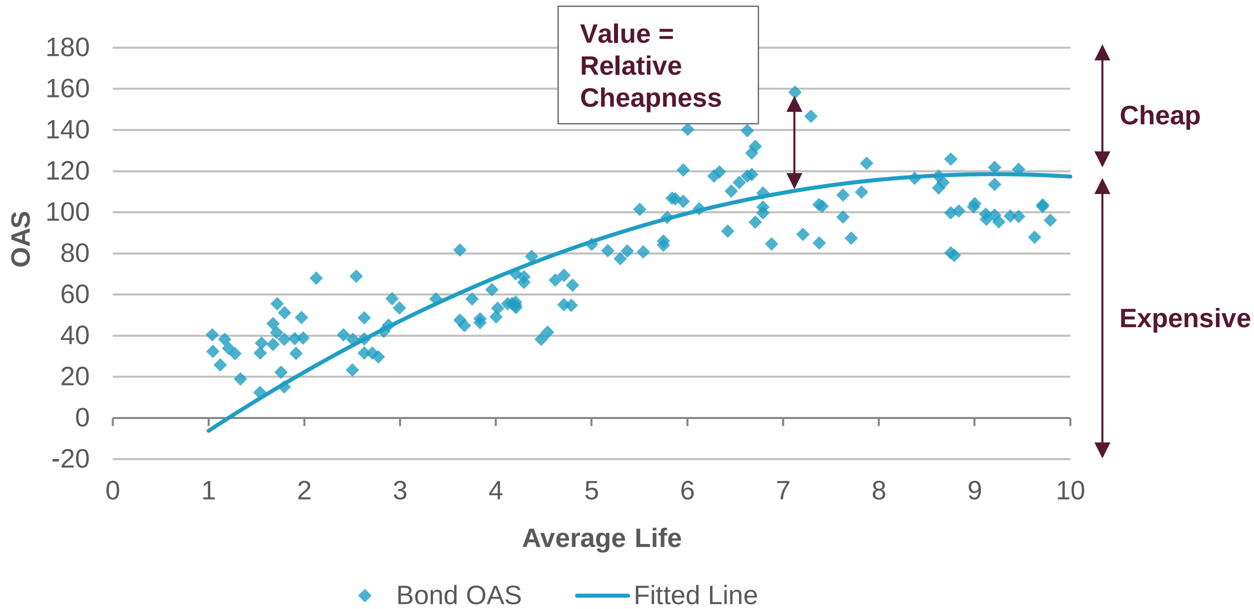
Our approach is similar to Houweling and van Zunderf (2017) and Israel, Palhares and Richardson (2018). Here we define value as the relative difference between the option-adjusted-spread (OAS) observed in the market and a model-based estimated OAS of individual bonds. If the model implied OAS is lower than the market observed OAS, the bond is considered "cheap", as the market's required compensation is high relative to the model-implied riskiness.

In order to build our model-implied intrinsic measure of OAS a parsimonious cross-sectional regression model is applied to incorporate the various credit risk drivers that are critical to determine credit spreads. While the more detailed mathematical definition of the model is shown in the Appendix, conceptually the key drivers of the OAS regression model include 1) credit rating, 2) time to maturity and 3) industry:

- **Credit rating** is the most direct assessment of the underlying default risk of bond issuers. Lower rated bonds post higher probability of issuers' inability to pay back the coupon and principal thus required to offer a higher spread to treasury yields.
- **Time to maturity** is correlated with interest rate risk, liquidity risk and reinvestment risk. It also helps to depict the term structure of credit spread.
- The level and term structure of credit spread is **industry**-specific. Comparing spreads across different industries can be misleading and result in constantly overweighing a particular industry over another, or a biased preference of short term bonds of one sector and long term bonds of another.

The goal of the regression is to make a relevant comparison between bonds with similar but not identical characteristics. It is an assessment of average market required compensation for the bond's fundamental risk levels. Individual bond value is then measured as the deviation of the OAS from its fitted value from the model. Bonds with high positive deviations are deemed to be cheap versus those with similar characteristics. Conversely, bonds with high negative deviations are deemed to be expensive.

Exhibit 2: US Investment-Grade Corporate Bond OAS Regression Example



Source: FTSE Russell. For illustrative purposes only. Please see the end for important legal disclosures.

Characteristics and Behavior of the Fixed Income Value Effect

Note that bonds which appear to be cheap in one credit rating may be regarded as expensive in a lower rating. One reason behind the constant existence of bond OAS deviating from the average is the market's speculation of potential future rating changes. Many credit analysts claim that price appreciation and depreciation can start much earlier than the actual upgrades and downgrades. This view that credit ratings changes could lag the market was also expressed by Norden and Weber (2004) and by Norden (2014), whose results demonstrated that credit spreads start moving multiple months prior to a rating change. However, our analysis and the empirical results of the value factor will also show that reverting to the norm has been the more probable case, especially for investment-grade bonds. The resulting spread from the rating change speculations in the market is the premium that the value strategy targets to extract.

There were certain stressed periods where the value factor performed less impressively. For instance, during the great financial crisis the rating agencies were not able to timely reflect the deterioration of certain issuers' fundamentals in their ratings, which caused larger pull back in the value factor's performance. The shortfall was quickly covered and reversed as the value factor has performed significantly better during recovery and expansionary phases. This cyclical behavior is also consistent with the value factor of equities.

In addition, as Ang (2013) noted, the outperformance of the value stocks can be attributed to risk premium and behavioral bias. These are also likely to be the reasons behind the effectiveness of the fixed income value factor, plus the unique structure of corporate bond markets. Due to the factor's cyclicality, the fixed income value factor tends to show higher volatility than the base universe. This observation is in line with findings on the equity side - for example FTSE Russell's own analysis showed that equity value indexes exhibited higher volatility than the underlying reference index. However, as we will show, the premium doesn't come purely as a reward to the heightened risk.

On the other hand, overreaction is the other explanation of the fixed income value premium, which is a behavioral bias augmented by the market structure. It is most prominent among the investment-grade corporates, as the majority of the companies are regarded as remote from default and small disruptions in the fundamentals should have limited impact on their solvency. However, as fixed income asset owners tend to be more buy-and-hold investors, the lack of active counterparties could potentially amplify the disruptions and lead to the bonds' price moving away from their fair values.

Deciling and Reweighting

To evaluate the effectiveness of the value factor, we apply our standard decile testing framework to analyze the factor. Here are the steps of the analysis in detail:

- **Define a liquid bond universe**

  Our smart beta research usually starts from defining a liquid universe, as alternative weighting puts a higher requirement on bond liquidity. Typically, higher bond outstanding amount thresholds are used, to reduce unnecessary liquidity premium whilst maintaining market representation and preserving a reasonable amount of bonds in each industry for regression. While this approach leads to a lower number of bonds, it maintains the majority of market cap coverage using bonds with higher liquidity qualities.

- **Divide the universe into credit rating x maturity x industry buckets**

  Greater granularity is used when bucketing than in the regression, as there will not be sophisticated modeling within each bucket, but ranking and dividing only. Having more granular buckets helps maintain the allocation of various credit ratings, maturity and industries, and hence reduces unnecessary tracking error.

- **Within each bucket, rank all bonds in descending order based on their value implied by the regression model; divide each bucket into 10 equally weighted deciles**

  The 1st decile of each of the credit x maturity x industry buckets is combined to form the 1st value decile of the universe. In a similar fashion, we can create the 2nd to the 10th value decile of the base universe that consist of the 2nd to the 10th decile of each individual bucket. Now the 10 value deciles represent the top 10% to the bottom 10% of bonds, respectively, of the entire universe based on their value readings within their bucket.

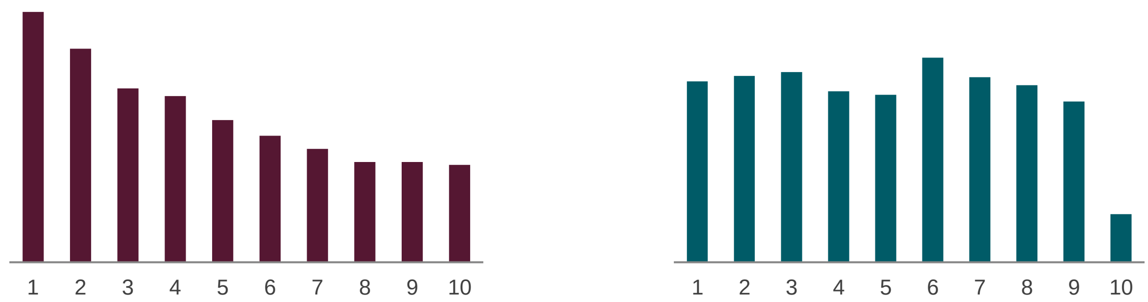
- **Repeat the bucketing and deciling process monthly to create the historical value deciles**

  The historical time series of the value deciles can be created by repeating the bucketing and deciling process monthly over the designated testing period. Each of the deciles is updated monthly to include the corresponding bonds based on their latest values. The monthly returns of individual bonds are aggregated to compose the monthly returns of the value deciles.

- **Evaluate the effectiveness and robustness of the value factor through analyzing the performance statistics of the deciles**

  The ideal performance distribution is in declining order from the top to the bottom decile. A distribution where the bottom single or multiple deciles perform particularly poorly is also statistically indicative of a possible robust indicator. Both distribution patterns indicate a satisfactory and conclusive factor that could be used, for example, to potentially enhance the performance of the portfolio by screening away the lower value scoring bonds/issuers captured in such bottom decile(s).

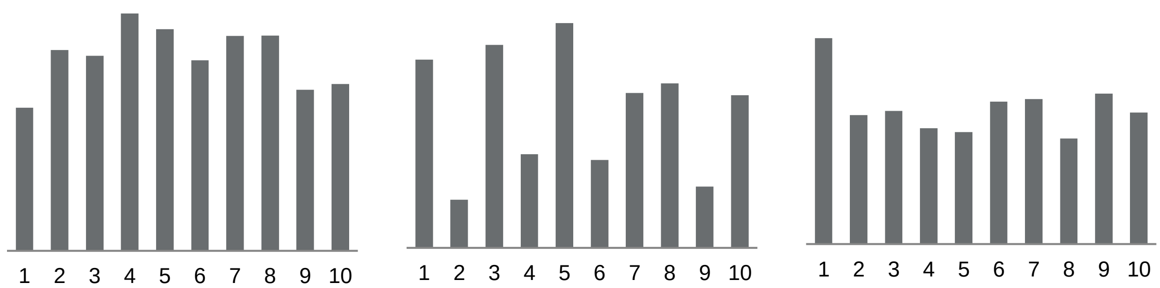
Exhibit 3: Examples of Conclusive Factor Decile Distribution



Source: FTSE Russell.

In contrast, if deciles are showing similar performances, or the average returns are up and down across deciles without a clear pattern, it indicates ineffectiveness of the factor. It is neither ideal to have a single decile that has superior performance while other deciles perform similarly - the capacity of this factor is limited and its robustness and consistency are doubtful.

Exhibit 4: Examples of Inconclusive Factor Decile Distribution



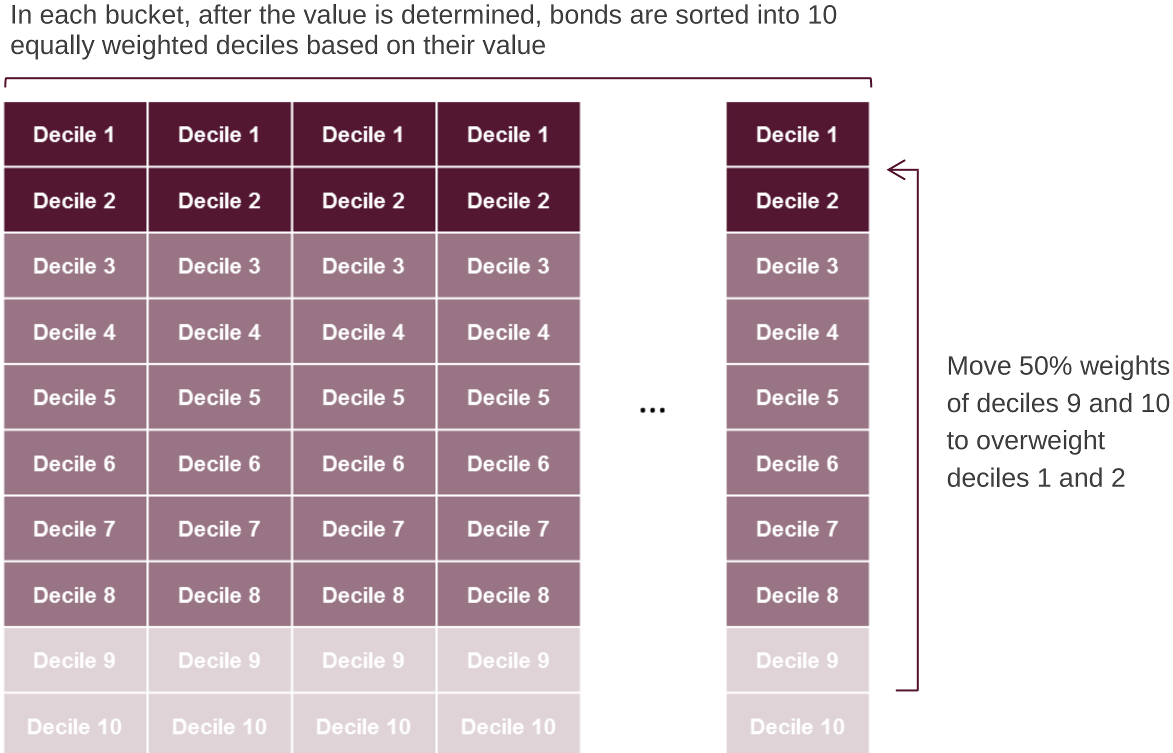
Source: FTSE Russell.

- **Reweight the deciles to create value-based portfolio**

  Once the effectiveness and robustness of the factor is confirmed, there are a variety of ways to reweight the bonds based on the factor. The methodology can be dependent on the objectives of the investor and the characteristics of the factor. For example, bottom screening would be well suited to a bond quality factor. When the factor shows declining scale returns across the deciles, the investor could choose an alternative weighting approach based on factor-driven tilting similar to what FTSE Russell uses for some of its equity smart beta indexes.

  In this study, to avoid adding further complexity and new parameters to consider to the analysis, we chose to apply a straightforward 50% weight rotation from the bottom 2 deciles to the top 2 deciles to create a new portfolio and test the impact of the value factor on the portfolio returns. Weights of the bonds within deciles 9 and 10 are reduced by 50% to increase the weights of the bonds in deciles 1 and 2. All other deciles remain unchanged. Such reweighting has the added benefit that leads to reasonably low tracking error compared to the original universe as the sector allocation is preserved, which avoids introducing additional noise from sector bias.

Exhibit 5: Illustration of Deciling and Reweighting



Source: FTSE Russell.

In the next section we will go through the global corporate bond markets individually to test the value factor across different sectors and regions by applying the methodology specified above. The analysis of the US investment-grade corporate universe will be covered in detail to showcase the steps of the study.

Empirical study of the value effect in various global corporate bond markets

US Investment-Grade Corporate

The FTSE US Broad Investment-Grade Corporate Index (USBIG® Corporate Index) tracks the performance of US Dollar-denominated investment-grade corporate debt. Introduced in 1985, the index provides a broad representation of the US investment-grade corporate bond market. The USBIG Corporate Index includes US and non-US corporate securities issued in registered form and bonds issued under Rule 144A with registration rights.

Exhibit 6: US Investment-Grade Corporate Liquid Universe

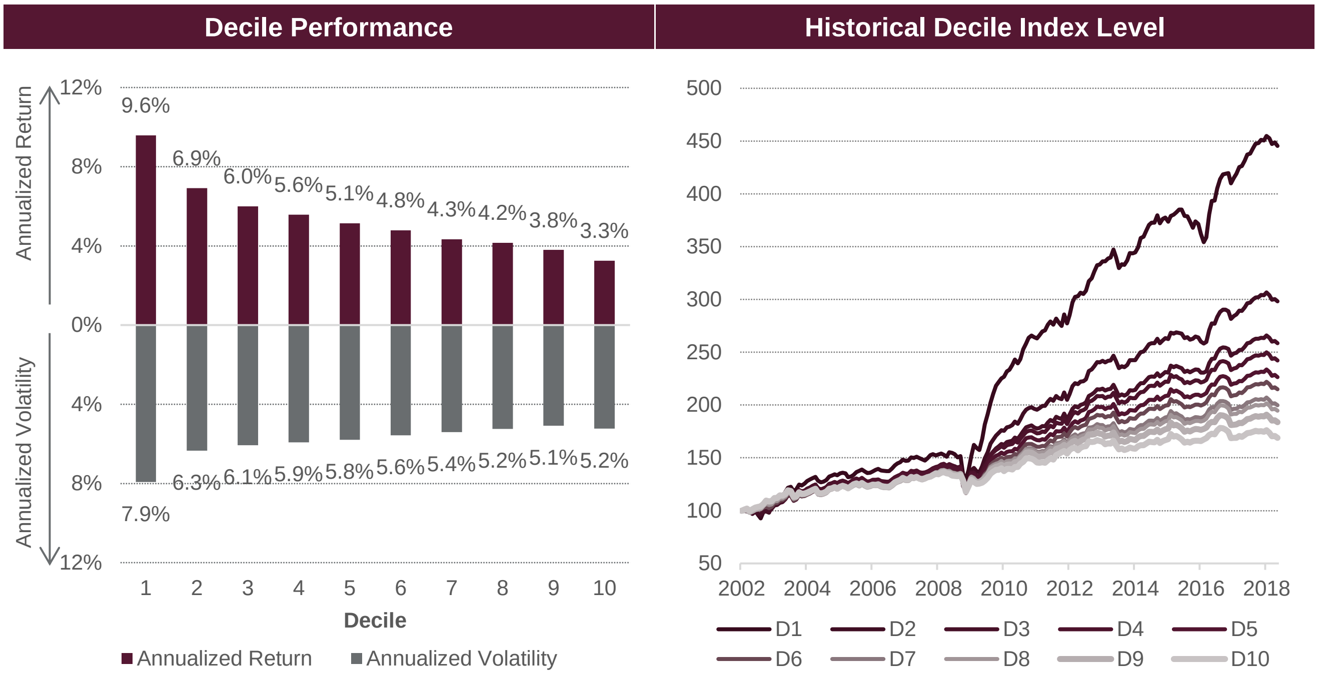
Base Index	US Broad Investment-Grade Corporate Index
Minimum Issue Size	USD 500 million*
Minimum Credit Quality	BBB-

* Higher than the base index, otherwise same as the base index

As introduced in the previous section, the analysis starts from the definition of the liquid universe. Within the US investment-grade corporate market, we increased the minimum issue size requirement to 500 million from the 250 million cutoff defined in the original USBIG Index. Such universe definition aims to select bonds with higher liquidity characteristics while i) maintaining good market representation, ii) preserving a reasonable amount of bonds in each industry for regression and in the majority of the buckets for deciling.

The second step is bucketing and deciling. The liquid universe is divided into credit rating x maturity x industry buckets. Within each bucket, bonds are ranked by their latest value and further divided into 10 deciles. Individual deciles of various buckets are combined to form the deciles of the index. The process is repeated monthly to create the time series of the deciles.

Exhibit 7: US Investment-Grade Corporate Value Portfolio Decile Ranking and Performance



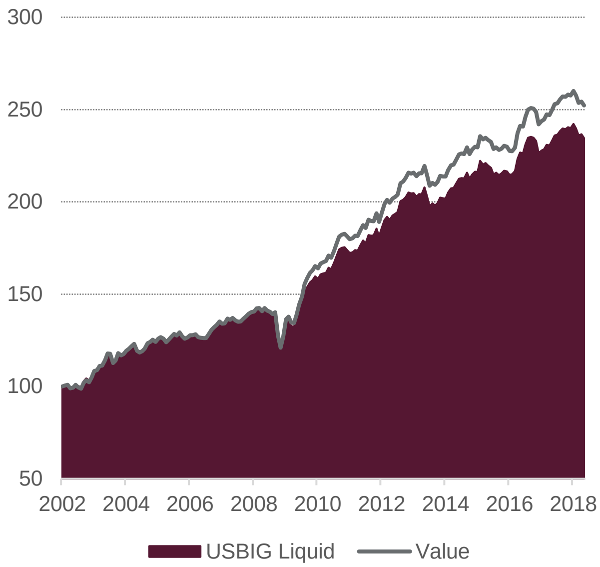
Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

The left chart presents the annualized return and volatility of each decile, with the positive direction of the vertical axis showing the returns and negative direction showing the volatilities. The right chart displays the time series performance of individual deciles.

Among US investment-grade corporates, the value factor demonstrates a clearly declining scale in annualized returns from decile 1 to 10. This is the desired pattern and it represents the effectiveness and consistency of the value factor. Ideally comparable levels of volatility across all the deciles would also be seen. In the case of US investment-grade corporates, volatilities are higher in the higher deciles; however, those higher deciles demonstrated noticeable additional returns. As discussed earlier, the value factor is a cyclical factor and we can expect higher value deciles to be accompanied by higher volatilities. Again, this pattern is not unique to fixed income. Zhang (2005) applied a similar deciling approach to equities and the results showed that the higher value deciles exhibited higher volatilities. Further discussion on the topic of risk characteristics can be found below.

Exhibit 8: US Investment-Grade Corporate Value Portfolio Historical Performance

Historical Index Level



Performance Statistics

	US BIG Liquid	Value
Annualized Return	5.35%	5.82%*
Annualized Volatility	5.60%	5.79%
Rtn/Vol Ratio	0.96	1.01
% Positive Months	65.82%	65.82%
Best Monthly Return	7.33% (Dec-08)	7.70% (Dec-08)
Worst Monthly Return	-8.37% (Sep-08)	-9.10% (Sep-08)
Max Drawdown	-14.91%	-15.03%
Drawdown Start date	02/29/2008	04/30/2008
Drawdown End Date	10/31/2008	10/31/2008
Recovery End date	06/30/2009	05/31/2009

* In this paper transaction costs are not excluded from the annualized returns. If we assume 30 bps of bid-ask spread for the US investment-grade corporate bonds, the excess return will be reduced by approximately 23 bps due to the extra turnover.
Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

The last step is to reweight the deciles by the 50% weight rotation from the bottom 2 deciles to the top 2 deciles to create the value portfolio. A simulated index constructed by compounding the monthly returns of such portfolio over a multi-year historical backtest period is generated. In the table and graph shown in Exhibit 8 we label such simulated index as the “Value” index. In order to quantify the added benefit of rotating the portfolio from the bottom value bonds to the higher value ones, we compare the performance and risk characteristics of the value index to the equivalent measures of the initial liquid universe.

The decile performance analysis from Exhibit 7 previously showed that higher deciles have higher returns and volatilities. This is reflected in the reweighted value index. Over the simulation period from 2002, the value index of the USBIG Corporate Index improved the return by 47 bps annually at the cost of 19 bps higher volatility. In combination the return over volatility ratio increased from 0.96 to 1.01.

In addition, it is also worth noting that, although the value index had a slightly larger drawdown due to its higher volatility and cyclicality, its drawdown started later and recovered earlier in 2008. As mentioned, the value factor is a cyclical factor and typically performs better during recovery and expansions.

Besides the deciling, reweighting and performance analyses that will be repeated for other global markets, the discussion of the US investment-grade corporate bond market includes the following analyses to further explore the robustness of the value factor.

Risk and Return Characteristics

As is shown above, whilst the value factor exhibited higher returns at higher deciles, these were accompanied by gradually increasing volatility as one moves through the deciles. Consequently, one could ask whether the extra returns are simply compensation for this extra risk.

The below table includes the return, volatility and return over volatility ratio of individual deciles, alongside the base liquid universe. The table highlights that, whilst higher deciles exhibited both higher volatilities and returns, the returns per unit of volatility increased as one moves up the deciles - from 10 to 1.

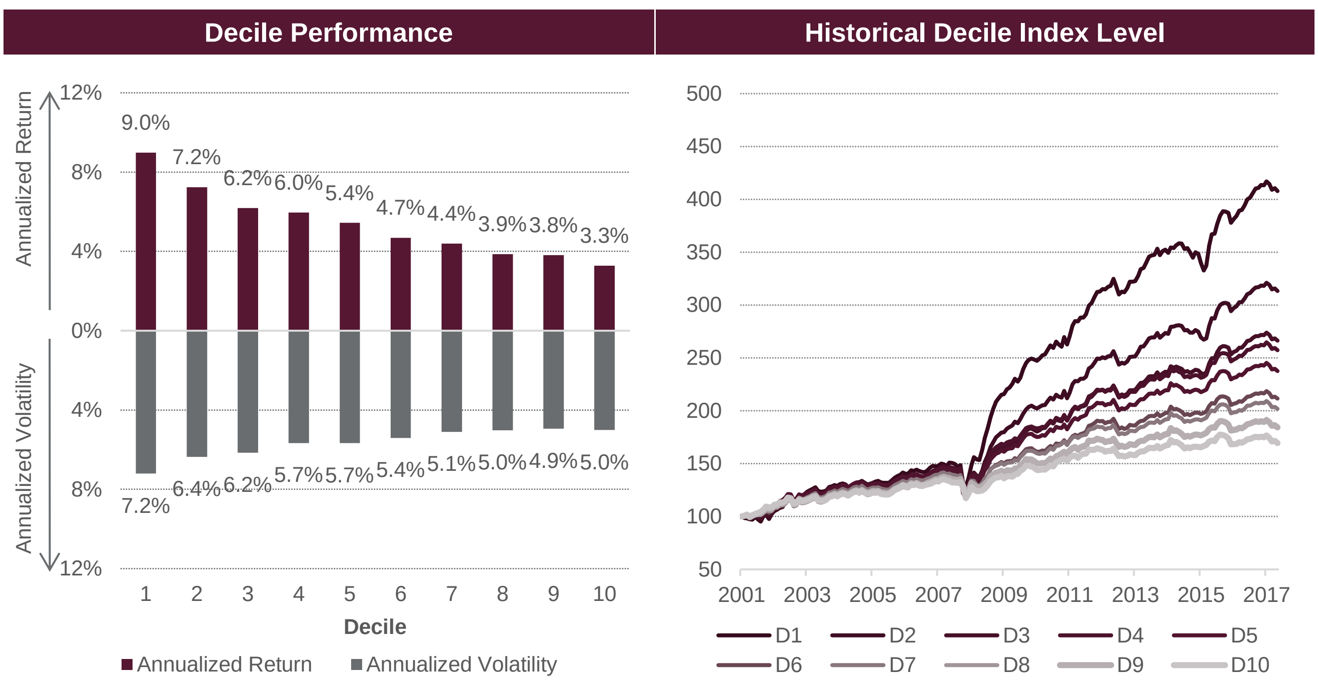
Exhibit 9: US Investment-Grade Corporate Decile Value Portfolio Risk and Return Profile

Decile	1	2	3	4	5	6	7	8	9	10	Base
Return (%)	9.6	6.9	6.0	5.6	5.1	4.8	4.3	4.2	3.8	3.3	5.36
Volatility (%)	7.9	6.3	6.1	5.9	5.8	5.6	5.4	5.2	5.1	5.2	5.59
Ret/Vol	1.2	1.1	1.0	0.9	0.9	0.9	0.8	0.8	0.7	0.6	0.96

Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

To explore this, firstly we consider the impact of adjusting our value ranking to account for trailing OAS volatility. To do so, we adjusted the current value score by the past 12-month OAS volatilities of individual bonds to effectively normalize the figure by units of historical realized volatility.

Exhibit 10: Value Portfolio Decile Ranking and Performance after Ex-ante Volatility Adjustment



Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

Exhibit 11: Value Portfolio Decile Risk and Return Profile after Ex-ante Volatility Adjustment

Decile	1	2	3	4	5	6	7	8	9	10	Base
Return (%)	9.0	7.2	6.2	6.0	5.4	4.7	4.4	3.9	3.8	3.3	5.36
Volatility (%)	7.2	6.4	6.2	5.7	5.7	5.4	5.1	5.0	4.9	5.0	5.59
Ret/Vol	1.2	1.1	1.0	1.1	1.0	0.9	0.9	0.8	0.8	0.7	0.96

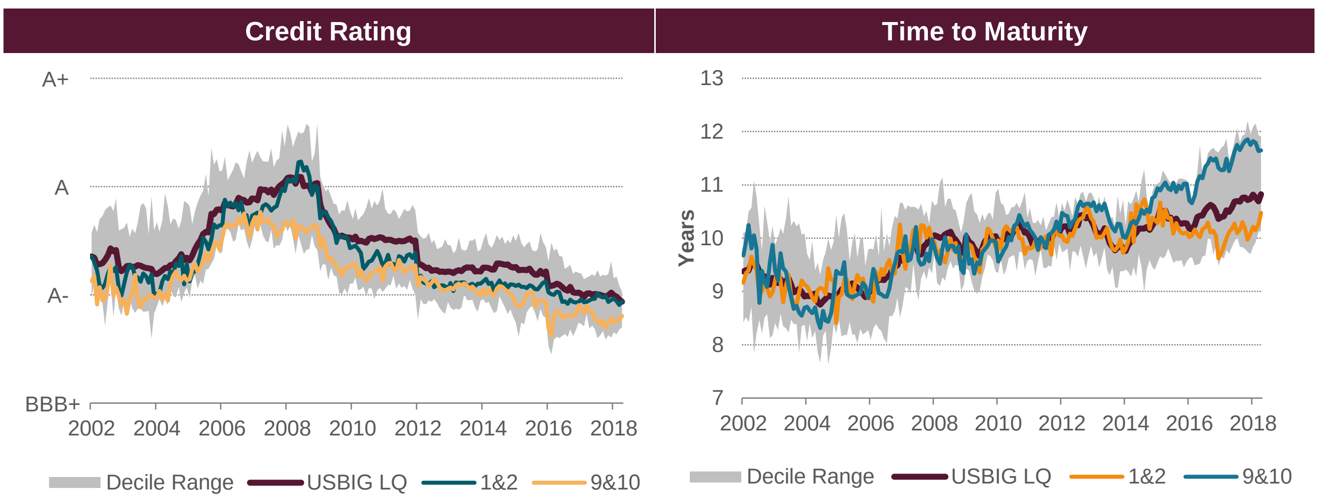
Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

As highlighted in the above table and chart, whilst outperformance is consistent after controlling for historical OAS-volatility, so too is the higher ex-post volatility associated with the higher deciles. However, the difference between the higher and lower deciles shrank slightly. This suggests that the higher returns and volatilities of the higher deciles can only be marginally attributed to the past volatility.

Moreover, the higher deciles exhibited greater returns per unit of volatility and the ratios for each decile remained similar before and after the adjustment for ex-ante volatility. [5] Clearly these return-to-volatility ratios are not driven by the historical spread volatility and one can wonder about the source behind this differentiation.

The second source of risk we want to exclude is the traditional credit risk – proxied here by credit rating, time to maturity and industry. Through the design of the bucketing and deciling approach all value deciles should have similar risk profiles as the base universe. The below explores whether this was indeed the case.

Exhibit 12: Risk Characteristics of the Value Deciles by Credit Rating and Time to Maturity

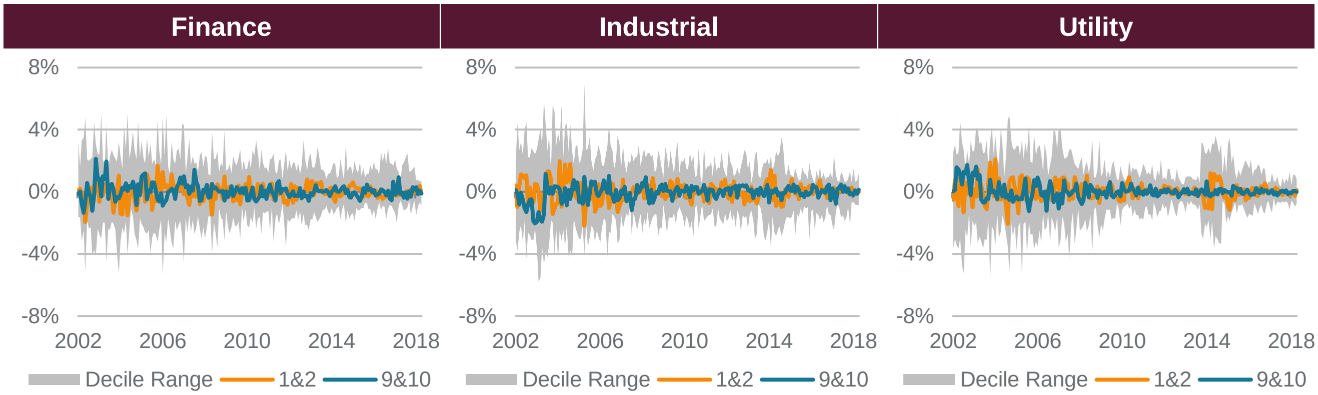


Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

As represented by the grey bands in Exhibit 12, the average credit rating and time to maturity of the various deciles remained close to the base universe: less than half a notch away in rating and less than half a year longer or shorter in average tenor. Moreover, the “preferred” decile 1&2 and the “unwanted” decile 9&10 were not extreme cases; except for a few periods when the underweighted decile 9&10 had the lowest ratings and/or longest maturity. This illustrates that the value strategy was not gaining extra return and volatility through reducing the credit quality or extending the duration.

[5] There might be interest in applying the volatility adjusted spread deviation as an alternative value approach, in this paper we stick to the original definition of the factor.

Exhibit 13: Industry Overweight in the Value Deciles

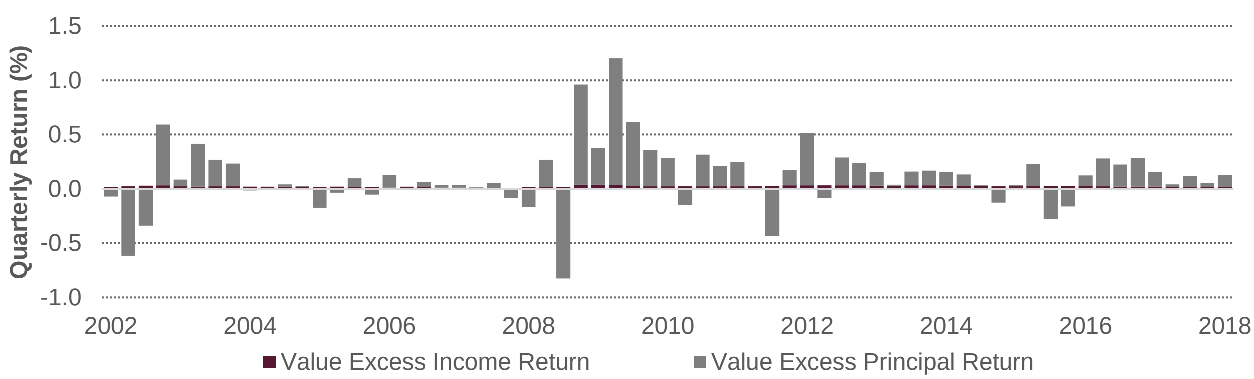


Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

In a similar fashion we want to ensure that the value index avoids industry bias which can lead to additional risk and sector misalignment compared to the base index. Exhibit 13 compares the individual industry weights in various value deciles with those of the base universe. The majority of the differences were less than 2%. The top and the bottom deciles were even closer to the base universe with less than 1% deviation in the industry weightings. This shows that the deciles' industry allocations were comparable to that of the base universe and that sector exposure was not the source of the additional risk or return in the value index, either.

To better understand the characteristics of the value factor, we provide a more detailed attribution of the excess return of the value index over the base universe.

Exhibit 14: Attribution of the Excess Return of the Value Index

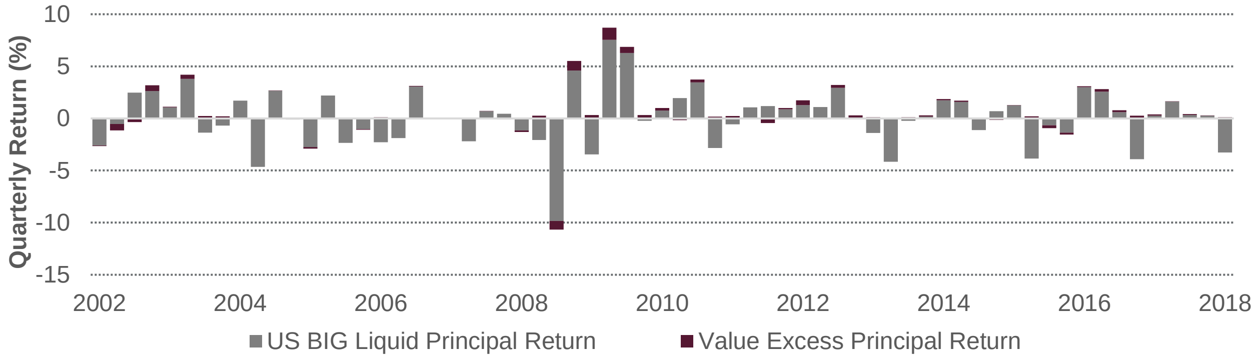


Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

As the value index overweights bonds selling cheap and offering higher spreads, the income return of the value index should be higher than the base universe by design. As shown in Exhibit 14, the excess income returns were small but consistently positive. It demonstrates that the value index tends to outperform the base index even when bond prices remained static.

However, analysis of the excess price/principal returns shed more light on the outperformance of the value factor. Whilst having mostly positive readings after the great financial crisis, the excess principal returns show swings of a much larger scale. On quarterly average, 2.3 bps of the total excess return were from the higher income, whilst 9.1 bps came from price movements. Clearly, spread reversion to the mean is a dominating source of excess return of the value factor; and the uncertainty of this reversion adds volatility.

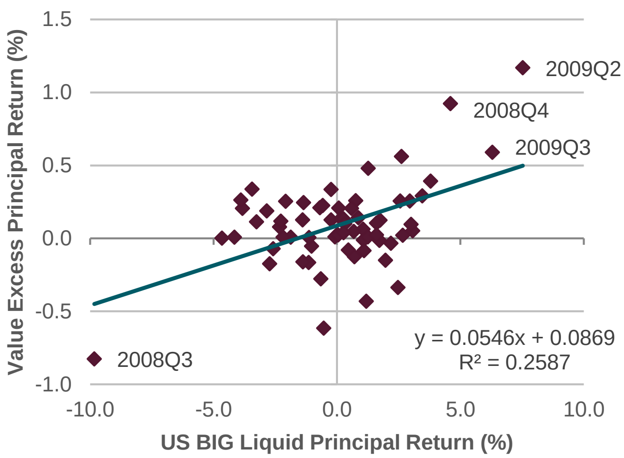
Exhibit 15: Principal Return of the Base Universe and the Value Index



Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

To further evaluate the behavior of this excess price return, Exhibit 15 shows a comparison of the principal return of the USBIG liquid index and the excess principal return of the value index. [6] One can observe an apparent relationship, with excess principal returns from the value factor seemingly in the same direction and very much correlated with principal returns in the base index.

Exhibit 16: Linear Regression of Value Excess Principal Return on USBIG Liquid Principal Return



Regression Statistics of Quarterly Returns			
Observations			65
R square			25.87%
Adjusted R square			23.48%
Correlation			50.86%
	Coeff	*Std Error*	*t Stat*
Intercept	0.0869	0.0314	2.77
BIG Prin Ret	0.0546	0.0116	4.69

Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

Indeed, this observation is substantiated further upon a more direct evaluation of the relationship, through a scatter plot and a linear regression. The quarterly data in the left chart of Exhibit 16 clearly shows a positive correlation, with the quarterly excess principal return of the value index 51% correlated to the principal return of the base universe. The bottom left observation took place during the financial crisis and the quarters in the top right of the chart were the strong rebounds right after. This provides further evidence for the cyclicality of the value factor, and thus the observed increase in volatility of the value index.

Most interestingly, the dots in the scatter above are biased to the positive direction of the y axis, and the linear regression yielded a positive and statistically significant intercept. This positive intercept suggests that the value index is not just a linear extension of the base universe in return and risk, but rather the value factor has captured a real and persistent source of excess return.

[6] Note that the grey bar in Exhibit 14 is the red bar in Exhibit 15. The scales of the two charts differ.

Exhibit 17: Panel Regression Statistics

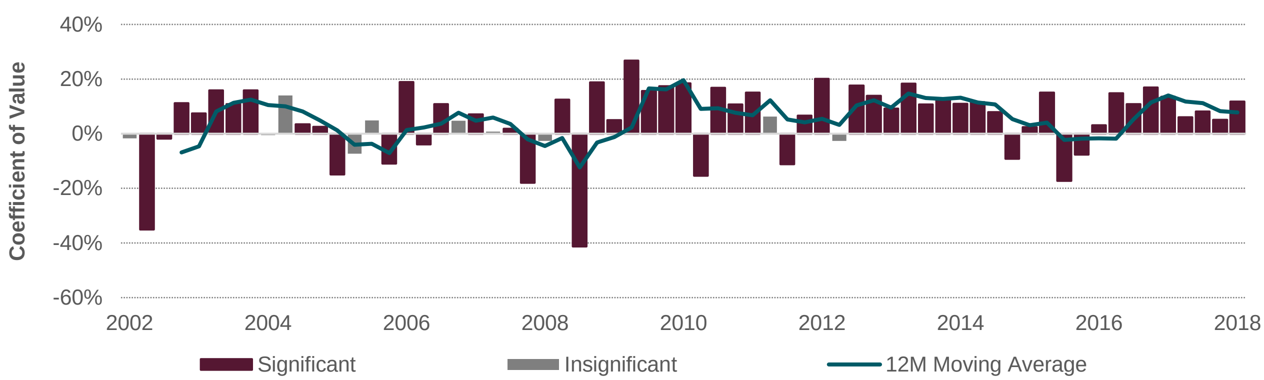
Regression Statistics			Coefficients	Standard Error	t stat	P-value
Observations	415,069	Intercept	0.00098	0.00089	1.11	26.8%
Adjusted R square	4.9%	Value	0.14001	0.00095	147.00	0.0%

Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

As a final test, we ran a regression of individual bond's future excess return on their beginning-of-period value figures to assess the factor's prediction power. The excess returns over the base universe are normalized by the bonds' duration to remove its amplification impact. The panel regression in Exhibit 17 pools all bonds' monthly returns together from 2002 to 2018 - over 400,000 observations. Here are several interesting takeaways from the regression shown in Exhibit 17:

- According to the adjusted R-square 4.9% of the variance in the normalized excess return was explained by the value factor.
- The coefficient of value is 0.14 with a stunning 147 t-stat. Note that we measure value by the relative difference in spread from the model-based estimate therefore 14% of that spread difference was realized in the following month's return.
- It is intuitive that the intercept of the regression is close to zero and statistically insignificant as we are regressing the excess returns.

Exhibit 18: The Quarterly Average Coefficients of Value in the Monthly Regressions

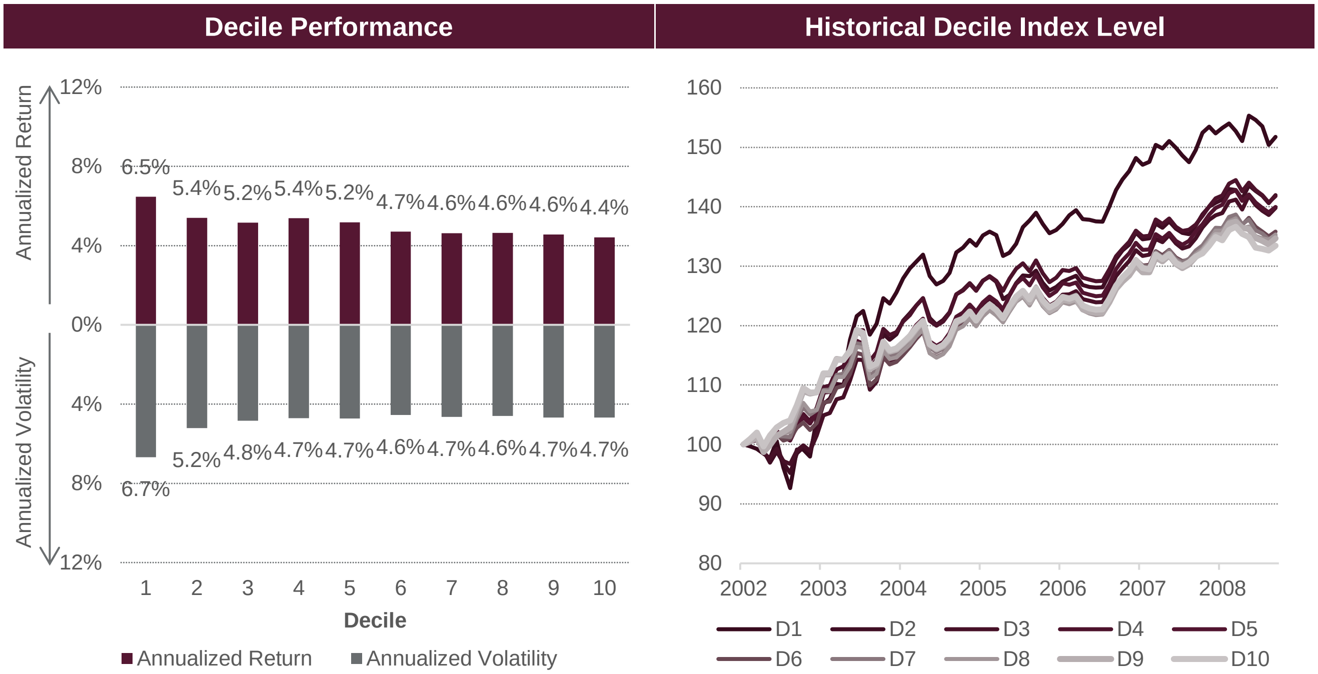


Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

In order to evaluate the prediction power and consistency of the value factor over time, we analyzed the value scores and returns by individual months from January 2002 to April 2018. Exhibit 18 presents the quarterly average coefficients of value in the monthly regressions. The red bars, being the majority of the cases, are statistically significant; and the direction of the coefficients is in line with that of the value excess principal returns in Exhibit 15. Most of the coefficients remained above 10% after the great financial crisis, indicating the factor's increased prediction power and consistency over the recent periods.

Based on this time-series analysis, and the fact that the decile index levels in Exhibit 7 seem to be clustered together before the 2008 crisis, one might question the effectiveness of the value factor between 2002 and 2008. Here is a zoomed analysis into this period.

Exhibit 19: Value Portfolio Decile Ranking and Performance Prior to the Great Financial Crisis



Source: FTSE Russell. Data from Jan 2002 to Aug 2008. Return and risk in USD with currency unhedged. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

The value deciles still managed to differentiate themselves prior to September 2008, with a similar pattern of declining return and risk as in Exhibit 7 where the value effect was tested over a longer horizon spanning the pre and post 2008 crisis periods. However, there was a noticeable reduction in the difference between the higher and lower deciles. Similar to the case for equities, the value effect shows dependency on regime cycles and performs differently under different market conditions and macro regimes.

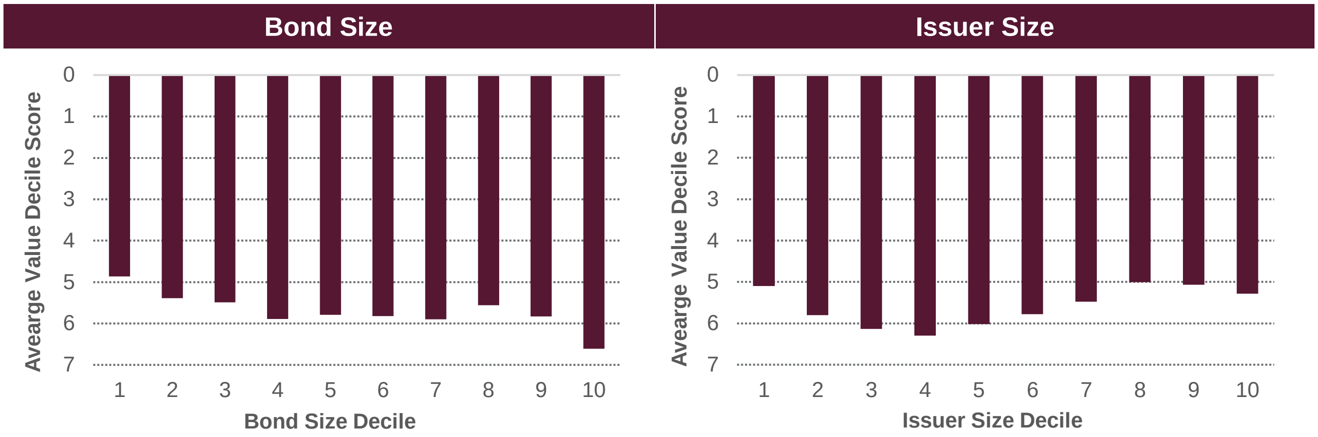
Implementation Considerations

A second set of considerations worth exploring relate to the implementation of the value factor. Aspects such as bond liquidity, transaction costs and portfolio turnover are important to consider with any investment strategy, as these can impact whether the observed excess return is effectively achievable in the market.

As previously noted, the deciling-reweighting process begins by defining a liquid universe, as alternative weighting puts a higher requirement on bond liquidity. To proxy liquidity, higher outstanding amount thresholds are used for universe inclusion, in order to maintain the majority of market cap coverage using bonds with greater liquidity.

Within this more liquid universe, we still need to consider whether the value premium is partially correlated to bond illiquidity or is simply an illiquidity premium. If this were the case, one would expect the less liquid bonds within the universe to receive better value scores. To assess, again we rank and divide the universe into deciles; this time based on bond/issuers' outstanding amount as a straightforward proxy of bond liquidity. Within each decile, we take the weighted average of bond/issuers' value deciles as the score of that liquidity decile.

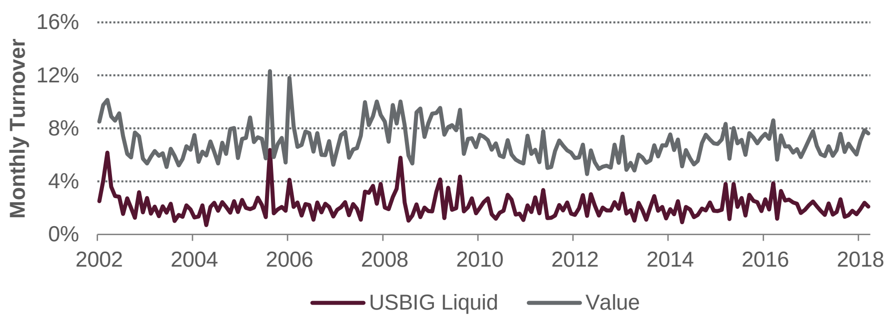
Exhibit 20: Average Value Decile Scores across Different Bond and Issuer Sizes[7]



Source: FTSE Russell. Data from Jan 2002 to Apr 2018.

The results in Exhibit 20 suggest liquidity has little impact on bond and issuer value scores. It's interesting to note that the largest bonds according to the left chart were to some extent under-bought. Most of the value decile scores stayed close to the average and remained between 5 and 6. Overall there was no clear pattern in the charts between liquidity and value.

Exhibit 21: Monthly Turnover of the Value Index and the Base Universe



Average Turnover Statistics		
	Monthly	Annual
USBIG	2.2%	25.9%
Value	6.9%	82.7%

Source: FTSE Russell. Data from Jan 2002 to Apr 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

On the other hand, even amongst the liquid corporate bonds, transactions create added cost, which can reduce or even wipe out a strategy's excess return. In this paper, transaction costs are not excluded from the annualized returns; however, Exhibit 21 details the turnover comparison between the value index and the base universe. Within the testing period the value index required 57% of additional annual turnover, and we calculate that, if one assumes 30 bps of bid-ask spread for the US investment-grade corporate bonds, the excess return will be reduced by approximately 17 bps due to this extra turnover. As the value index provides 47 bps of excess return, the theoretical breakeven transaction cost is 81 bps. Any investor who receives more favorable bid-ask spread from their brokers can benefit from implementing the value strategy.

Moreover, the value factor demonstrates a degree of persistency, which helps to naturally limit transaction costs, and could allow for the factor to be implemented at a lower rebalancing frequency than monthly. To observe this, recall that the weighting approach adopted here is to rotate 50% weight of the bottom 2 deciles to the top 2 deciles based on their value ranking. Therefore the value index is essentially manipulating about

[7] Note that in Exhibit 20 a larger value decile score indicates that the majority of bond/issuers come from lower value deciles therefore the scores are shown in reverse order.

10% weight of the base universe (50%*20%). If the 10% is always different month-to-month, it should require 120% (10%*12) of additional annual turnover. Instead it added 57% of turnover, which indicates that more than half of the bonds remained in the top or bottom 2 deciles and their OAS deviations from the implied levels decayed gradually.

Results across Regions and Markets

We apply the same value definition, deciling and reweighting methodology across the various regions and markets globally. This is to examine the behavior of value in different markets, as well as to run a completely out-of-sample validation test of the factor.

From each market Exhibit 22 includes the return, volatility and return over volatility ratio of individual deciles, the base liquid universe, and the middle decile(s). The inclusion of the middle decile is to proxy the performance of the fitted value curve which can serve as an alternative reference to the base liquid universe to measure the outperformance of the value strategy.

For consistency, here we mark the positive (desired outcomes) figures in red and negative (undesired outcomes) figures in grey with darker colors representing more extreme numbers. In other words, returns and return over volatility ratios are red if they are higher while volatilities are red if they are lower.

At a high level the table shows that the value strategy tends to lead to more desirable return outcomes than those of the base liquid index or the middle decile that proxies the fitted value curve. On occasions, additional desirable results in the form of lowered volatility and higher return to volatility ratios can also be observed.

Exhibit 22: Performance Summary of Various Value Portfolios on Different Fixed Income Sectors

1. US Broad Investment-Grade Corporate Sector (USD, Jan 2002 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	9.6	6.9	6.0	5.6	5.1	4.8	4.3	4.2	3.8	3.3	5.36	**5.83**	5.35
Volatility (%)	7.9	6.3	6.1	5.9	5.8	5.6	5.4	5.2	5.1	5.2	5.59	**5.78**	5.84
Ret/Vol	1.2	1.1	1.0	0.9	0.9	0.9	0.8	0.8	0.7	0.6	0.96	**1.01**	0.92

2. US High Yield Market Sector (USD, Jan 2002 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	8.9	7.9	7.7	5.2	6.6	6.1	6.1	5.0	5.3	4.3	6.37	**6.76**	6.35
Volatility (%)	18.9	13.2	11.3	12.8	9.3	8.5	8.6	8.2	7.2	7.2	9.88	**10.7**	8.76
Ret/Vol	0.5	0.6	0.7	0.4	0.7	0.7	0.7	0.6	0.7	0.6	0.64	**0.63**	0.73

3. EURO Broad Investment-Grade Corporate Sector (EUR, Aug 2008 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	7.7	6.6	5.5	5.3	4.9	4.9	4.7	4.1	3.8	3.0	5.05	**5.42**	5.10
Volatility (%)	6.2	4.4	3.9	3.7	3.3	3.0	2.9	2.9	2.8	2.8	3.42	**3.66**	3.47
Ret/Vol	1.2	1.5	1.4	1.4	1.5	1.6	1.6	1.4	1.4	1.1	1.48	**1.48**	1.47

4. European High Yield Market Sector (EUR, Jan 2013 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	9.2	9.6	8.2	6.5	5.5	5.7	5.1	4.3	4.5	3.0	6.15	**6.72**	6.00
Volatility (%)	8.6	5.8	5.3	4.3	4.3	4.1	3.6	3.7	3.2	2.7	4.33	**4.72**	4.23
Ret/Vol	1.1	1.7	1.5	1.5	1.3	1.4	1.4	1.2	1.4	1.1	1.42	**1.42**	1.42

5. Asian Investment-Grade Corporate (USD, Sep 2009 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	8.3	7.1	6.5	5.7	4.9	4.6	4.9	4.0	3.5	2.5	5.11	**5.61**	4.99
Volatility (%)	3.9	3.9	3.7	3.7	3.4	3.4	3.5	3.1	3.2	2.8	3.25	**3.34**	3.37
Ret/Vol	2.1	1.8	1.8	1.6	1.4	1.3	1.4	1.3	1.1	0.9	1.57	**1.68**	1.48

6. Asian Investment-Grade and High Yield Corporate Sector (USD, Sep 2009 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	9.5	7.2	7.6	6.8	5.4	4.9	5.6	3.8	4.6	3.0	5.72	**6.19**	5.58
Volatility (%)	6.2	5.7	4.9	5.3	4.8	4.5	4.4	4.1	4.2	3.7	4.54	**4.75**	4.72
Ret/Vol	1.5	1.3	1.6	1.3	1.1	1.1	1.3	0.9	1.1	0.8	1.26	**1.30**	1.18

7. EM Investment-Grade Corporate Sector (USD, Jan 2013 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	8.9	5.7	4.0	3.9	3.3	2.0	1.8	1.2	1.6	0.1	3.23	**3.87**	3.04
Volatility (%)	6.5	5.5	4.9	4.8	4.2	4.4	4.2	4.2	3.9	4.4	4.48	**4.64**	4.40
Ret/Vol	1.4	1.0	0.8	0.8	0.8	0.5	0.4	0.3	0.4	0.0	0.72	**0.84**	0.69

8. EM Investment-Grade and High Yield Corporate Sector (USD, Jan 2013 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	7.0	6.1	5.6	4.5	4.2	3.2	2.5	2.8	2.5	1.7	4.01	**4.46**	3.97
Volatility (%)	7.2	5.3	4.9	4.6	4.3	4.1	3.9	3.8	3.8	3.7	4.38	**4.61**	4.30
Ret/Vol	1.0	1.1	1.1	1.0	1.0	0.8	0.6	0.7	0.7	0.5	0.92	**0.97**	0.92

9. Chinese Onshore Corporate Sector (CNY, Jan 2014 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	7.7	6.7	6.7	6.4	6.2	6.3	5.8	5.1	4.9	4.0	5.99	**6.26**	6.30
Volatility (%)	2.9	2.8	2.9	2.9	2.8	2.8	2.7	2.8	2.7	2.7	2.72	**2.73**	2.82
Ret/Vol	2.7	2.4	2.3	2.2	2.2	2.2	2.1	1.9	1.8	1.5	2.20	**2.29**	2.24

10. Australian Broad Investment-Grade Corporate (AUD, Jun 2004 – Apr 2018)

Decile	1	2	3	4	5	6	7	8	9	10	Base	Val	Mid
Return (%)	8.8	7.2	6.5	6.4	6.6	6.4	6.1	6.1	5.9	5.5	6.56	**6.79**	6.52
Volatility (%)	5.4	2.9	2.8	2.6	2.4	2.3	2.1	2.1	2.3	2.2	2.31	**2.48**	2.40
Ret/Vol	1.6	2.5	2.3	2.5	2.8	2.8	2.9	2.9	2.6	2.4	2.84	**2.74**	2.72

Source: FTSE Russell. Data from Jan 2002 to April 2018. Past performance is no guarantee of future results. Data shown reflects hypothetical, historical performance. Please see the end for important legal disclosures.

The value factor generally works better in investment-grade than high yield, as the overreaction and mean-reverting patterns aforementioned are more prominent among investment-grade bonds. Disruptions to high yield corporates however could imply fundamental changes to their solvency. Normally it takes prolonged periods to fully reflect the impact of such disruptions. This creates room for further improvement of the value factor in high yield markets by the addition of a momentum factor.

Among the various global corporate markets, the value factor provided most value add to the emerging markets, as well as the Asian and Chinese onshore corporates that are highly overlapped with EM. According to the results these markets are relatively less sophisticated and the value premium is under-exploited.

Lastly, the only market that doesn't seem to be improved by the value factor is the Australian investment-grade corporates. Different from its government bonds that are frequently traded by international investors for the currency carry trade, the Australian corporate bonds are mostly owned by the domestic investors following a buy-and-hold strategy. Introducing the value factor breaks the tranquility and added more volatility than return proportionally.

Conclusion

There are multiple approaches to capturing the value effect in fixed income. As highlighted at the opening of the paper, various academic research has defined the value factor in a number of ways. Depending on the proposed definition, one might look at such factor as the representation of a real risk premium or as a strategy to capture relative value. In this paper, we have put forward our first analysis of value in fixed income and outlined an approach to the factor by utilizing a model-implied OAS framework to identify under and over-valued securities.

In our approach we employed a highly controlled deciling and reweighting mechanism to best preserve the credit rating, maturity and industry allocations and reduce the tracking error from unwanted sources. The simulation results across various global corporate bond markets showed that the value factor could unlock additional returns, though mostly accompanied by higher volatilities due to cyclicality.

Similar to the value effect for equities and considering that bond spreads are cyclical, the fixed income value factor value performs differently under different macro regimes, and typically does better in recovery and expansionary phases. As illustrated in Exhibit 7 for the entire period and Exhibit 19 for the period prior to the great financial crisis, the value portfolio may deliver similar distributions of results under different market conditions albeit with different magnitudes of returns. With expected interest rate hikes potentially paving the way to a different macro environment, it will be interesting to observe the proposed factor under that regime shift.

From an implementation perspective, besides the decile weight rotation method chosen for the purpose of this study, there are a number of ways to execute the value factor in the design of an actual portfolio and benchmark:

- Screening: rank bonds according to the factor score, select a given portion (e.g. the top 50%) of the universe, and weigh the selected bonds according to their market value.
- Tilting [8]: rescale and truncate factor values into standardized factor scores (or "Z-scores"), tilt the bond weights according to the S-shaped cumulative normal function of the Z-scores.
- Optimization: transform the factor scores into an objective function to maximize subject to certain constraints on country, sector and risk exposures.

Exhibit 23: FTSE Fixed Income Factor Series

Factor	General Concept and Description
Value	Bonds that appear cheap tend to perform better than bonds that appear expensive
Carry	Bonds with higher rolling yield returns tend to perform better than bonds with lower yields
Quality	Bonds issued by lower quality companies tend to underperform and bear more risk
Momentum	High yield corporate bond performance tends to persist, either continuing to rise or fall
Volatility	High yield corporate bonds that exhibit low volatility tend to suffer less in performance
Size	Bonds issued by smaller issuers tend to outperform but with difficulties to liquidate

Source: FTSE Russell.

This paper is the first of the FTSE Fixed Income Factor Research Series and our exploration of fixed income factor investing will continue. Additional discussions will follow on other factors that are applicable to fixed income including carry, quality, momentum and volatility as previewed in Exhibit 23.

[8] Similar to the weighting scheme adopted by the equity factor indices in the FTSE Global Factor Index Series.
For details, see http://www.ftserussell.com/files/research/factor-exposure-indexes-index-construction-methodology.

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Appendix: The Cross-Sectional Regression Model

The cross-sectional regression estimates individual bond OAS by its credit rating, time to maturity and industry. In technical terms, we model OAS through the monthly industry-specific regressions on credit dummy variables and a quadratic fitting of time to maturity:

$$OAS_{i,j} = \sum_{k=1}^{n} \beta_{k,j} u_{i,k} + \gamma_{1,j} T_i + \gamma_{2,j} T_i^2 + \varepsilon_i$$

$where$

$j \in \{Industries\}$

$u_{i,k}: dummy\ variables\ for\ credit\ ratings$

$k \in \{Credit\ ratings\}$

$T_i: Time\ to\ maturity$

$\varepsilon_i: Error\ term, essentially\ the\ value\ embedded\ in\ individual\ bonds$

If we take a closer look at the explanatory variables of the regression individually:

- The credit rating dummy variables reflect the different average spread levels required by different credit ratings. Graphically the model would show parallel horizontal lines in Exhibit 2 if it starts with these dummy variables only.
- The linear term of time to maturity reflect the different credit spreads between bonds with different maturities. As longer tenor bonds generally require higher credit spreads, adding the linear time to maturity will change the model to parallel upward sloping lines.
- The quadratic term of time to maturity adds a bit of curvature to the model. Usually the difference between short-term bonds and the medium term bonds are different from the difference between the medium term and long term. Adding the quadratic term will reflect that difference and change the model to parallel parabolic curves.
- The level-slope-curvature framework is consistent with the common treasury yield curve models. Adding a cubic term is less theoretically intuitive and was not statistically supported.
- As it is an industry-specific regression, all parameters in the model are different across different industries to be tailored to industry-specific differences across various ratings and maturities.

An alternative to our approach is to run credit x industry-specific regressions, or maturity x industry-specific regressions. However the historical data didn’t provide the luxury to entertain the more granular regressions. There were certain buckets with too few bonds remaining; and the lack of degree of freedom will lead to over-fitted results. As previously mentioned, the essence of the model is not to predict, but to provide a relevant norm/average for individual bonds to compare.

For more information about our indexes, please visit ftserussell.com.

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