Factor Investing in Fixed Income

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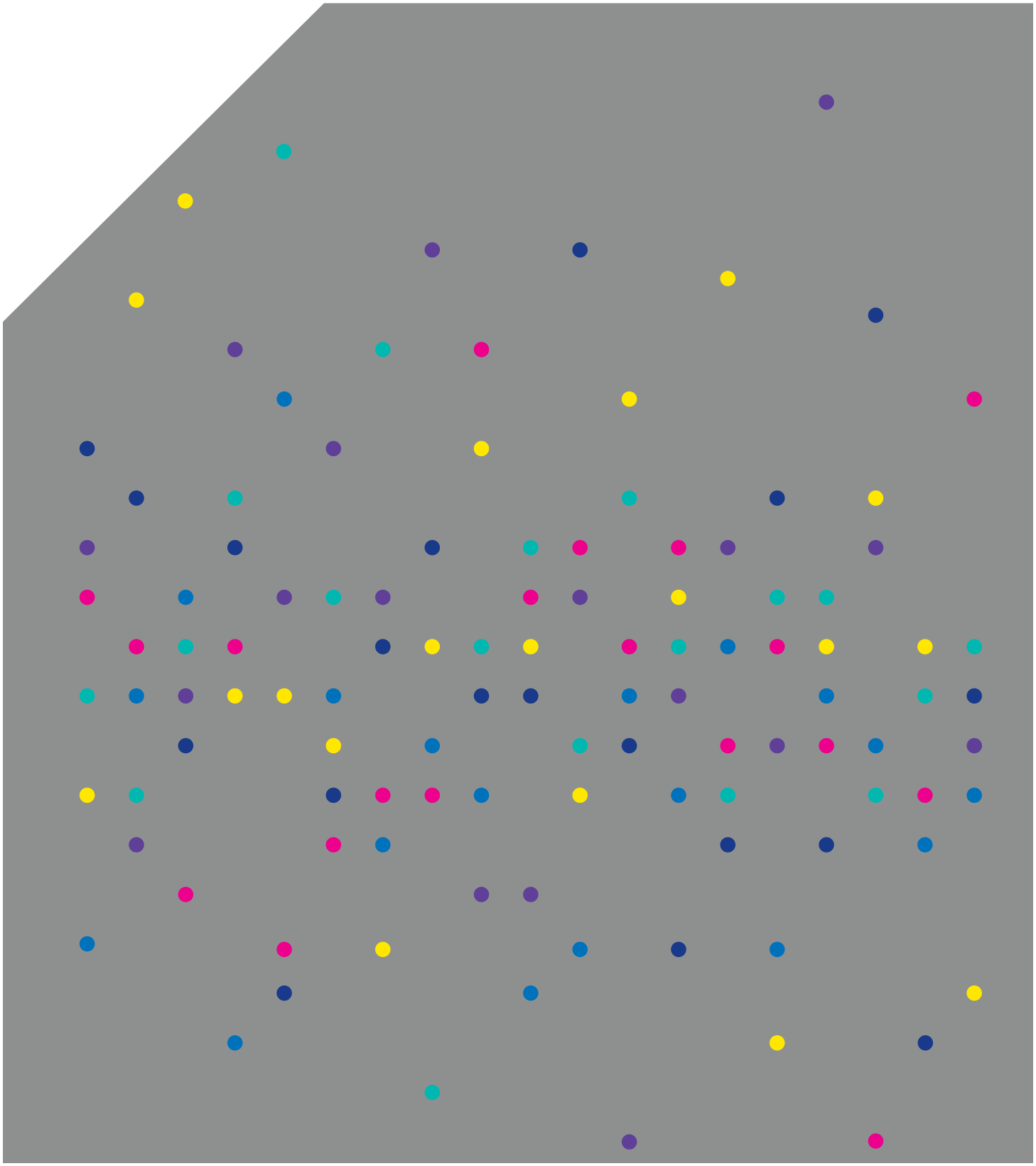

Why should investors consider credit factors in fixed income?

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Introduction to factors
A substantial body of academic research, coupled with a long track record of use in portfolios, has led to a wider acceptance of factor investing within the investment community. Most of the academic research and practical implementation of factors has been done in the equity asset class, where factors have been key characteristics used to explain equity risk and return. In over 50 years of research, three general reasons have been given for why factors earn excess returns. First, factors are by-products of the collective behaviour biases of investors that result in sub-optimal investing. Second, factors can earn higher returns for higher risk. And third, structural differences, such as liquidity differences between securities, can lead to excess returns. Often, a single factor's risk and return encompasses all three explanations.

Factors should exist in all asset classes
While factor investing is quite established in equities, there is much less academic research and a much shorter track record when it comes to fixed income portfolios. However, we believe the underlying reasons for factors are not asset class-specific. Factors simply connect investor behaviour to investment returns. As such, there is no reason to believe they cannot be applied to other asset classes, such as fixed income.

Factors are only recently being harvested in fixed income portfolios. What is the reason for this lag in adoption? First, fixed income is inherently more complex than equities. While equities of one issuer are interchangeable, bonds are typically not. For example, bonds of the same issuer can have different maturities, liquidity, embedded optionality and can sit in different parts of the capital structure. Moreover, bonds have finite lives and usually disappear from the investment universe after five years. This added complexity is one of the reasons that fixed income factor research has been slower to evolve.

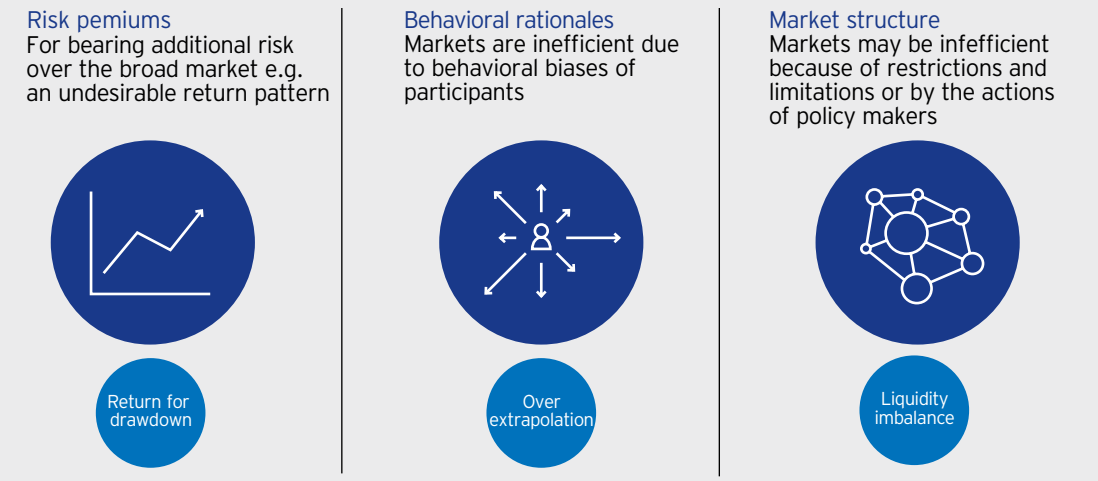
Second, factors help to explain the price changes of assets. When interest rates were high, many investors were content to earn returns from coupons, without much thought of price appreciation. However, as yields have fallen, factors have naturally become viewed as more valuable in helping to generate returns from prices, and not just coupons.

Risk premia definitions of factors provide investors with the most certainty in terms of returns
Many investors have expressed a high degree of uncertainty about using factors in fixed income. We believe choosing the right factor definitions can improve certainty and comfort around the concept of factors. In our view, however risk premia definitions are superior, since they are the most likely to provide certainty of outcomes to investors.

Most importantly, by expecting higher returns for unwanted risk, risk premia-based definitions offer a compelling rationale for returns that fits within an efficient market framework. As a result, they should offer more confidence in their potential risk-reward payoffs. A recent review of the literature confirms this view. Two new studies utilizing robust techniques to guard against data mining, confirm that there are only a few, largely risk premia-based, definitions that have a high likelihood of existence.[1] From another angle, several authors have identified a striking relationship whereby factor strategies with high tail risk have higher Sharpe ratios.[2]

More certainty around risk is another advantage of risk premia definitions. By pre-identifying the risks inherent in strategies, and not mistaking them for pure alpha, investors can better size these factors in portfolios. For a conservative investor, risk premia are likely to have fewer unknowns, or unidentified risks.

Figure 1
Three major reasons for excess returns associated with factors



Source: Invesco. For illustrative purposes only.

Factor definitions in fixed income must be carefully designed to facilitate their practical implementation
There are some major differences between equity and fixed income factor investing. The spread of electronic trading, dedicated pools of factor investors and deeper shorting liquidity are some of the reasons that equity and fixed income factor implementations differ. Fixed income, generally, has higher transaction costs, lower liquidity and lacks a deep short market, aside from a few types of government bonds. Higher transaction costs mean that factor returns need to be heavily scrutinized to ensure that their returns are positive and not just trading frictions.

In addition, lower liquidity at the bond level means that factor definitions must be robustly designed so that their risk and return characteristics are relatively independent of the exact number or types of bonds used. Often, only 60% of the bonds needed for a factor portfolio are available for trading. There needs to be some confidence that factor portfolios can be formed with the available underlying liquidity in the market. Finally, it is generally difficult to short bonds. Therefore, practically speaking, long-only portfolios are the principal way to gain factor exposures in fixed income.

Fixed income investors may wish to consider credit factors first
While we strongly believe that factors can be found in all asset classes, for fixed income investors, we think credit offers the best place to start factor investing. Because corporate bonds offer a larger cross sectional universe from which to build portfolios than government bonds or currencies, investors would likely be better able to form large diversified portfolios that retain mostly factor exposures. Second, given the long-only constraint, we would expect credit beta exposure to be a large driver of returns. Credit beta has one of the most consitent Sharpe ratios among all asset classes, and clear risk-return characteristics, which breed confidence in the likelihood of future excess returns.

Factor-based Investing at Invesco Fixed Income
History of factors at Invesco Fixed Income (IFI)
IFI began developing our factor-based investing framework three years ago - starting with macro factors and expanding to credit factors. The genesis of our work was the adoption of factors as part of our active management process. We believe factor-based investing will likely be the next iteration of active investment management, and we continue to refine our factor-based approach with the goal of being an industry leader.

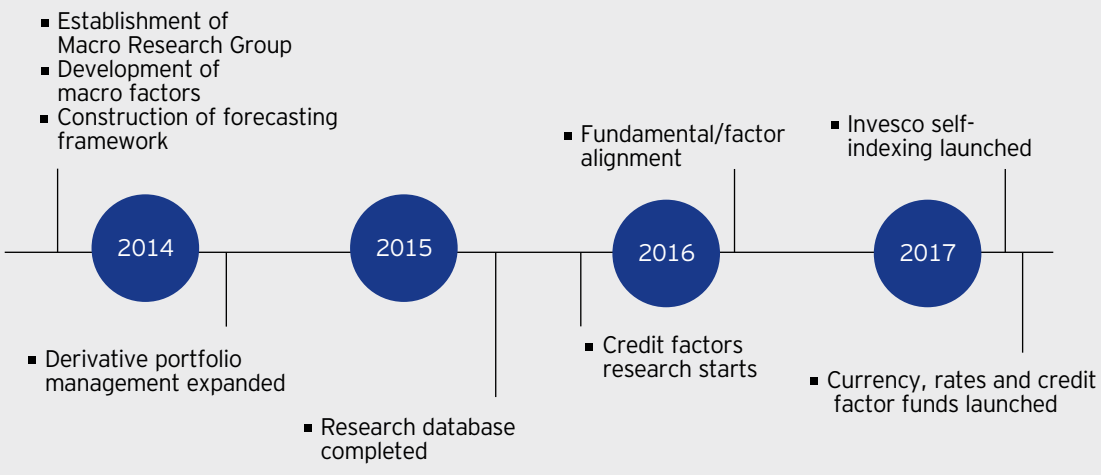
Invesco Fixed Income's factor philosophy
IFI's factor philosophy reflects our goal to provide the best investment performance for our investors. First, we think factors must have a strong fundamental rationale, rooted in economic theory – backtesting is not sufficient to warrant inclusion in our portfolios. We believe that all quantitative processes have embedded assumptions at their core. By acknowledging this, we believe there is less likelihood of perpetuating poor assumptions.

Second, while factors can be used for alpha generation, beta replication and risk hedging, at IFI, we emphasize beta replication and risk hedging. We think the academic literature and investment professionals have been too focused on alpha. We think there are many potential factors that have been under-researched and underutilized because they are more suited for beta replication or hedging, but showed no alpha.

Third, we believe factors should represent a trade-off between risk and return by showing a regime dependency. We believe that factors that offer return for risk are likely to be more consistent over time. In addition, we prefer to identify the risks associated with factor strategies. We believe this allows for more robust ex-post risk assessment by reducing the number of unknowns.

Fourth, we believe factors require continuous research. From definition to implementation, we believe factors can always be improved. In rare cases, risk and reward attitudes in markets can structurally shift, causing material changes in factors'

Figure 2
The timeline of factor research at Invesco Fixed Income



Source: Invesco, 1 June 2013 to 30 June 2017. For illustrative purposes only.

expected risk and return profiles. As investors adopt factor investing, we believe it will be important to constantly monitor and adapt factors.

Finally, we seek factor definitions that are robust to security selection. In other words, we seek factors that are likely to perform equally well whether they represent 100% of a factor portfolio or only a portion. By separating the performance of any one security from the overall factor portfolio, we are better able to implement factor portfolios in relatively illiquid markets. We think this can facilitate the coherent addition of security selection through careful credit analysis to a factor portfolio. Since our portfolios only need a small percentage of the available securities to provide meaningful factor exposure, our team of fundamental credit analysts can select specific bonds to maximize portfolio returns.

Factors in action – liquidity, quality, value, momentum and the multi-factor approach

In credit, our research has focused on adapting key equity factor definitions to corporate bonds. While corporate bonds have traditionally been broken up into maturity, rating and industry buckets, we have created a four-factor model which includes liquidity, quality, value and momentum. We briefly describe those factors below. In keeping with our factor philosophy, we describe the fundamental rationale, regime dependency of the factor and consistency of performance across investment grade, high yield and equities, which we believe indicates robustness. Our definitions build on work in the literature, although some key details differ.[3, 4, 5] Finally, we provide an example of the potential excess return provided by a multi-factor credit model.[6]

Summary of factor risks and returns

Table 1a-b summarizes the risk and return characteristics of the four factors relative to the Bloomberg Barclays US Corporate Investment Grade and High Yield Indices ("IG and HY indices"). All of the Sharpe ratios, except investment grade momentum, exceed those of the market weighted index.

Credit factor descriptions

Liquidity

We start with liquidity and treat it separately because it is somewhat unique to the fixed income space. "Liquidity" is the excess risk and return associated with holding illiquid bonds. In fixed income, illiquid bonds are often not marked to market accurately. As a result, they tend to have a higher yield for a lower beta exposure. From a backtesting perspective, there seems to be a higher Sharpe ratio (Table 1a-b) without any additional drawdown.

Figure 3 shows the return of the liquidity factors for both high yield and investment grade bonds in different risk environments. The average return of the liquidity factor in both high yield and investment grade is plotted for five different VIX scenarios. Bucket one represents the periods with the largest decreases in the VIX and represents periods when risk sentiment was the best. Bucket five represents the largest increases in the VIX and represents periods when risk sentiment was the worst.

The returns are plotted in terms of excess returns (duration-hedged returns) versus the benchmark excess returns. The benchmarks used were the Bloomberg Barclays US Corporate Investment Grade and High Yield Indicies for the investment grade and high yield liquidity factor, respectively.

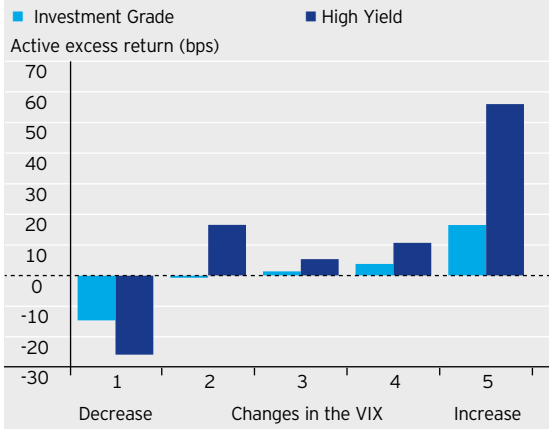
Table 1

a) Investment Grade

	IG Index	Liquidity	Quality	Value	Momentum	Multi-factor
Beta	1	0.82	0.48	1.17	0.67	0.63
Alpha (bps)	0	4.1	2.47	5.96	-0.09	5.02
Turnover (annual %)	19	39	57	269	295	209
Tracking Error (bps)	0	129	244	126	246	188
Sharpe Ratio	0.18	0.31	0.29	0.34	0.14	0.38
Drawdown (%)	24	22	14	24	15	14
Correlation to IG Index	1	0.96	0.89	0.98	0.81	0.93
b) High Yield						
Beta	1	0.8	0.64	1.4	0.68	0.71
Alpha (bps)	-	23.28	11.27	3.51	21.27	8.1
Turnover (annual %)	31.08	85	65	255.12	276.12	192
Tracking Error (bps)	-	296	386	561	433	324
Sharpe Ratio	0.31	0.54	0.51	0.32	0.61	0.72
Drawdown (%)	45	38	34	51	33	33
Correlation to HY Index	1	0.96	0.96	0.95	0.9	0.97

Source: Bloomberg Barclays US Corporate Investment Grade and High Yield indices, Invesco calculations. Summary statistics are shown for investment grade and high yield factors over the period 1 January 1994 to 31 March 2017. "bps" is basis points. The "Market Index" refers to the Bloomberg Barclays US Corporate Investment Grade Index and Bloomberg Barclays US Corporate High Yield Index for the investment grade and high yield benchmarks, respectively. All of the statistics are in excess returns, or duration hedged returns. Turnover is calculated as a half of the percentage of the portfolio buys and sells. The drawdown is calculated from the highest peak to trough over the backtest period.

Figure 3
Credit returns under different VIX scenarios



Source: Bloomberg Barclays US Corporate Investment Grade and High Yield indices, Invesco calculations. The scenerios were during the period 1 January 1994 – 31 March, 2017. The average return of the liquidity factor in both high yield and investment grade is plotted for five different scenerios, or periods, of VIX changes. Bucket one are the periods with the largest quintile of VIX changes and represents periods when risk sentiment was the best. Bucket five are the periods with the smallest quintile of VIX changes and represents the peiods when risk sentiment was the worst. The returns are plotted in excess returns, or duration hedged returns, against the benchmark excess returns. The benchmarks used were the Bloomberg Barclays US Corporate Investment Grade and High Yield Indicies for the investment grade and high yield liquidity factor, respectively. Past simulated performance is not a guide to future returns. An investment cannot be made into an index.

Contrary to the idea of a higher "risk premium" driving higher returns, the liquidity factor outperformed during periods of extreme stress (see bucket 5). Past simulated performance is not a guide to future returns. An investment cannot be made into an index. However, in reality the risk is significant, in that it is extremely likely that selling an illiquid bond during times of stress would result in a significant loss. The scenario analysis returns only accrue to buy-and-hold investors. Therefore, only investors who can hold illiquid bonds through market turmoil would be able to harvest higher Sharpe ratios. The liquidity factor is defined by those older vintage bonds that are small in issue size relative to large, newly issued bonds. This factor definition has been well researched in the literature.[7]

Quality

Quality is the excess risk and return associated with holding low-volatility, or low-beta, bonds.[8] The quality factor is a characteristic of securities that are good stores of value during times of stress, since they have low-volatilities. Figures 4a-c show that the quality factor consistently outperformed during periods of stress across the three asset classes. It underperformed, however, during strong rallies. Table 1 shows that the quality factor earned risk adjusted alpha and had a higher Sharpe ratio than the market index. Since most investors prefer the embedded leverage in high-beta securities, low beta securities must offer a higher Sharpe ratio to compensate. Quality is defined as the return of those bonds that have relatively short maturities and low default risk as measured by their ratings.

Value

Value is the excess return obtained by holding assets that are cheap to their intrinsic long-run estimated prices. Since a bond's price is a function of its default risk, a natural definition is to look for those bonds that are cheap relative to their intrinsic default rate. Table 1a-b shows that the value factor earned risk adjusted alpha and had a higher Sharpe ratio than the market index. Figures 4a-c show that value provided strong Sharpe ratios in compensation for the materially larger tail risk during times of stress. Value is defined as characteristics of those bonds that are trading at a lower price relative to bonds in the same industry with similar default risks and maturities.

Momentum

Momentum is the return of past winners versus past losers. As expected momentum produced the weakest Sharpe ratios in investment grade (Table 1a-b), especially using definitions most consistent with traditional equity momentum. This is partly because bonds can only appreciate by a limited amount , especially in investment grade where prices are close to par. As a result, the time horizon and structure of momentum are different for bonds than equities. More speculative bonds have the strongest Sharpe ratios using the equity-based definition.[9] Our analysis indicates that momentum profits after transactions costs are not necessarily very positive. However, momentum offers strong diversification and manageable trading costs in a multi-factor portfolio.

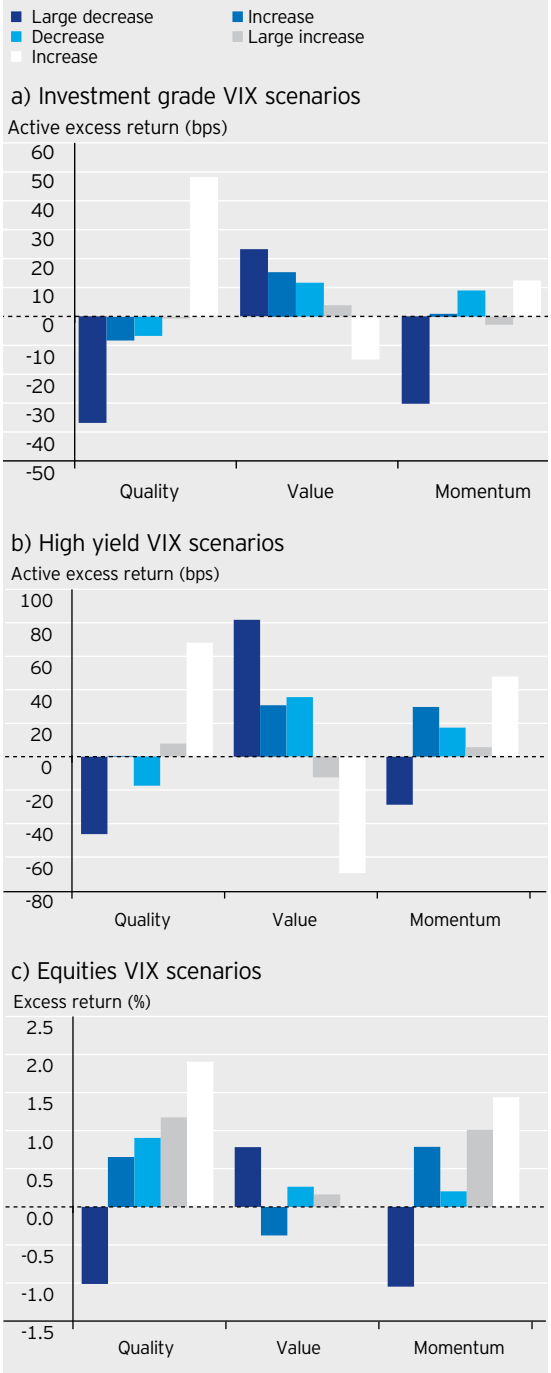
Comparing quality, value and momentum factors in different risk environments

Figures 4a-c show the same five VIX scenarios for high yield, investment grade and equities across quality, value and momentum. There is a striking similarity in conditional correlations, or return patterns, across VIX scenarios for all of the factors across the three asset classes. Quality and momentum were positively correlated, but negatively correlated with risk sentiment. They had the highest return periods when risk sentiment was the lowest. Value was negatively correlated with quality and momentum and was positively correlated with risk sentiment. Value tended to have its highest return periods when the VIX was decreasing the most. We think that this consistency is a sign that our definitions are capturing the common behaviour of investors driving these risk premia in all three asset classes.

Benefits of a multi-factor portfolio

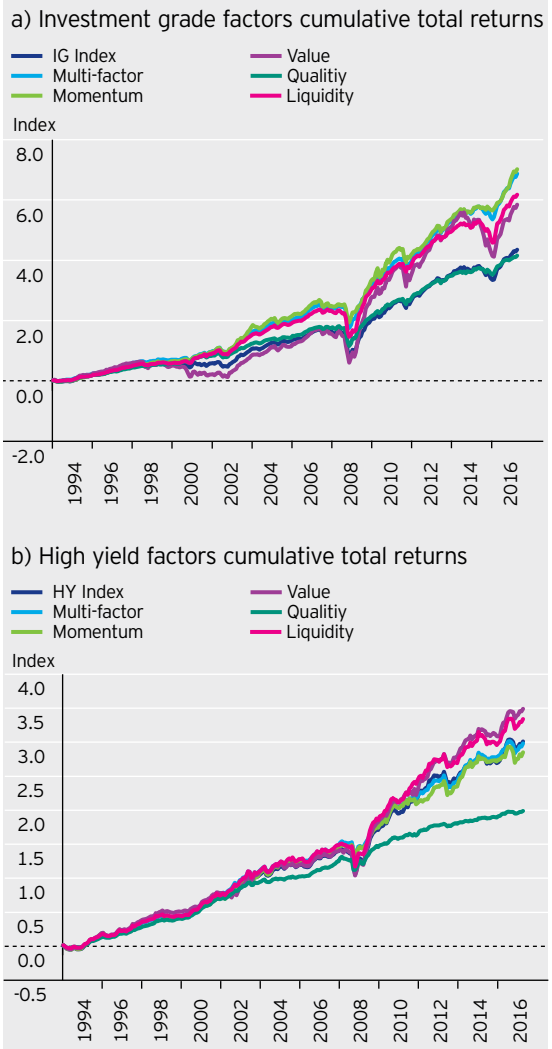
If we examine the correlation of our factors to the IG and HY indices in Table 1a-b, we can see that our factors helped diversify portfolios while generating higher Sharpe ratios over the period shown. However, single factors can experience long periods of under or outperformance. Therefore, we believe it is vital to take a balanced, multifactor approach to ensure consistent outperformance. For simplicity, we show the return profile and attribution of an equally weighted multi-factor portfolio. Table 1a-b shows that, in both high yield and investment grade, the multi-factor portfolio produced higher Sharpe ratios without adding a significant amount of downside risk. Figure 5a-b shows the cumulative returns of the individual factors, the IG and HY indices and the multi-factor portfolios over the period.

Figure 4
Credit returns under different VIX scenarios



Source: Source: Bloomberg Barclays US Corporate Investment Grade and High Yield indices, Invesco calculations. The scenario returns were calculated from 1 January 1994 – 31 March 2017. "bps" is basis points. For the equity factor returns, "Quality" is taken from Frazzini, Andrea and Lasse H Pedersen (2014), "Betting Against Beta", Journal of Financial Economics, 111, 1-25. The value factors was taken from Asness and Frazzini (2013), "The Devis in HML's Details," Journal of Portfolio Management, 29, 29-68. The momentum factor is based on Fama and French (1996), "Multifactor Explanations of Asset Pricing Anomalies," Journal of Finance, 51, 55-84. The returns for the credit factors are expressed in excess return against the Bloomberg Barclays US Corporate High Yield Index and the Bloomberg Barclays US Corporate Investment Grade Index. The darkest bar represents the dates when the VIX decreased the most and, represents, periods of very positive risk sentiment. The lightest bar represents the dates when the VIX increased the most and represents periods of very negative risk sentiment. Past simulated performance is not a guide to future returns. An investment cannot be made into an index.

Figure 5
Cumulative total returns of factors by asset class

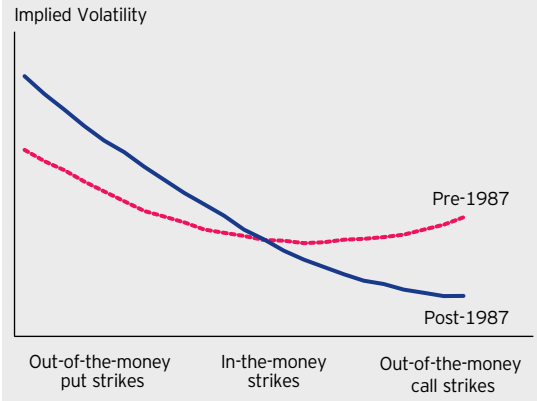


Source: Bloomberg Barclays US Corporate Investment Grade and High Yield indices, Invesco calculations. The returns are calculated for the period 1 January 1994 – 31 March 2017. The cumulative returns for four factors, the multi-factor portfolio and the Bloomberg Barclays US Corporate High Yield Index ("HY Index") are plotted in Figure 5a. Likewise, the cumulative returns for same factors, the multi-factor portfolio and the Bloomberg Barclays US Coporate Investment Grade Index ("IG Index") are plotted in Figure 5b. Past simulated performance is not a guide to future returns. An investment cannot be made into an index.

Summary of results and implications for the future

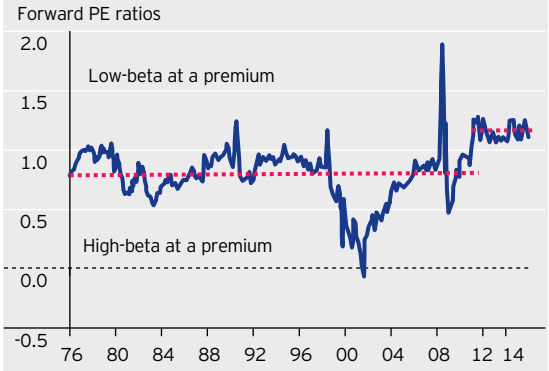
For investors seeking to apply the advantages of equity factor investing to fixed income, we believe our risk premia-based credit factor definitions offer a compelling investment profile. Compared to other definitions, we think risk premia definitions provide investors with more certainty around both risk and return. Since factor-based investing is, necessarily, long-only in fixed income, we think it makes sense to concentrate on applying credit factors on top of the credit risk premium. At IFI, we have narrowed our credit factors to four: liquidity, quality, value and momentum. We believe that each factor offers compelling diversification to benchmarks, higher Sharpe ratios and robustness in its consistency in risk and return across credit assets and compared to their equity counterparts. We believe combining

Figure 6
S&P 500 implied volatility curve, pre-and post-1987



Source: Chicago Board Options Exchange (CBOE), 2010. For illustrative purposes only. "The CBOE Skew Index", illustrates the difference in implied volatilites of options on the S&P 500 Index before and after the stock market crash on 19 October 1987. The permanent change in preference for downside protection after the event caused put options, which protect against large falls in equity prices, to trade at much higher prices than call options.

Figure 7
Low-versus high-beta ratio of forward PE ratios



Source: Goldstein, Price and Zhao (2016), "Low-Beta Strategies: Duck and Cover," Empirical Research Partners, data from 1 January 1976 to 31 May 2016. The figure shows the forward PE ratios of large capitilzation stocks of the lowest versus highest quintiles of beta. A higher ratio indicates that low-beta stocks are expensive relative to high-beta stocks. For illustrative purposes only.

these four factors in a multi-factor investment generates a compelling portfolio.

Factors are always evolving and require continuous research and active management

We end our discussion of factors on a word of caution and the need for continuous research. It is very likely that factor investing will change the landscape of more fundamentally based investment strategies. As more players adapt to factor-based investing, we believe that factor definitions and their risks and rewards must be continuously considered to ensure that they are appropriately used in portfolios. This is because market attitudes toward risk and reward can shift. A striking example of a major shift was the US equity market crash of 1987. Prior to 1987, there was no difference between the volatility implied in a put versus a call, or the "skew" (Figure 6). This meant that investors were indifferent between potential upside participation in the market and downside protection. However, after the 1987 crash, investors seemed to prefer downside protection over upside participation. This structural change resulted in the birth of a risk premium available to those investors willing to take unwanted downside equity risk.

A more recent example is the recent preference for low-beta stocks. Figure 7 shows the forward price-earnings (PE) ratios of low- versus high-beta stocks. The ratio of forward PEs is a proxy for investor attitudes about future expected returns. A higher PE ratio means that a stock is considered expensive and, therefore, likely to offer limited upside. For this reason low-beta stocks would be less likely to outperform high-beta stocks. In the post-crisis period, for example, low-beta stocks have traded at historically rich levels relative to high-beta stocks, as represented by their forward PE ratios.

This is an important shift, similar to the volatility skew described above. Furthermore, both shifts could be permanent. It is, therefore, important to constantly re-evaluate risk premia to detect shifts in investor attitudes toward risk and return and determine their likely staying power. We believe such continuous research and active management are necessary to ensure that investors earn the kind of returns they expect from their factor portfolios.

Conclusion

We believe the adoption of factors in fixed income allows investors to better decide which risks and returns are appropriate for their portfolios. Ultimately, this may lead to smarter decisions by investors and more efficient markets. However, by altering investor behaviour, factors may also alter the risk-return landscape. At IFI, we are constantly adapting our factor framework and evolving our investment processes to stay ahead of these trends to help clients achieve their goals.

Notes

1 Harvey, Liu and Zhu (2015), "... and the Cross-Section of Expected Returns," Working Paper; Harvey and Liu (2016), "Luck Factors," Working Paper
2 Hamdan, Pavlowsky, Roncalli and Zheng (2012), "A Primer on Alternative Risk Premia," Working Paper; Lemperiere, Deremble, Nguyen, Seager, Potter and Bouchaud (2015), "Risk Premia: Asymmetric Tail Risks and Excess Returns," Working Paper
3 Israel, Palhares and Richardson (2016), "Common Factors in Corporate Bond and Bond Fund Returns," Working Paper
4 Houweling and van Zundert (2014), "Factor Investing in the Corporate Bond Market," Working Paper
5 Bai, Bali and Wen (2016), "Common Risk Factors in the Cross-Section of Corporate Bond Returns," Working Paper
6 We constructed factor portfolios by market value weighting the top quintile of sorted portfolios. The constituents of the Bloomberg Barclays US Corporate Investment Grade and High Yield Indices were used in factor construction from the period January 1, 1994 to March 31, 2017. For the construction of factors excluding liquidity, bonds were first screened for liquidity by keeping only the top 60% and 30% in bond size each month for investment grade and high yield, respectively.
7 Bao, Pan. and Wang (2011), ","Liquidity in Corporate Bonds," Journal of Finance, 66, 911-946.
8 Frazzini, Andrea and Pedersen (2014), "Betting Against Beta", Journal of Financial Economics, 111, 1-25
9 Lin, Wu, and Zhou (2016), "Does Momentum Exist in Bonds of Different Ratings?" Working Paper.

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