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RESEARCH
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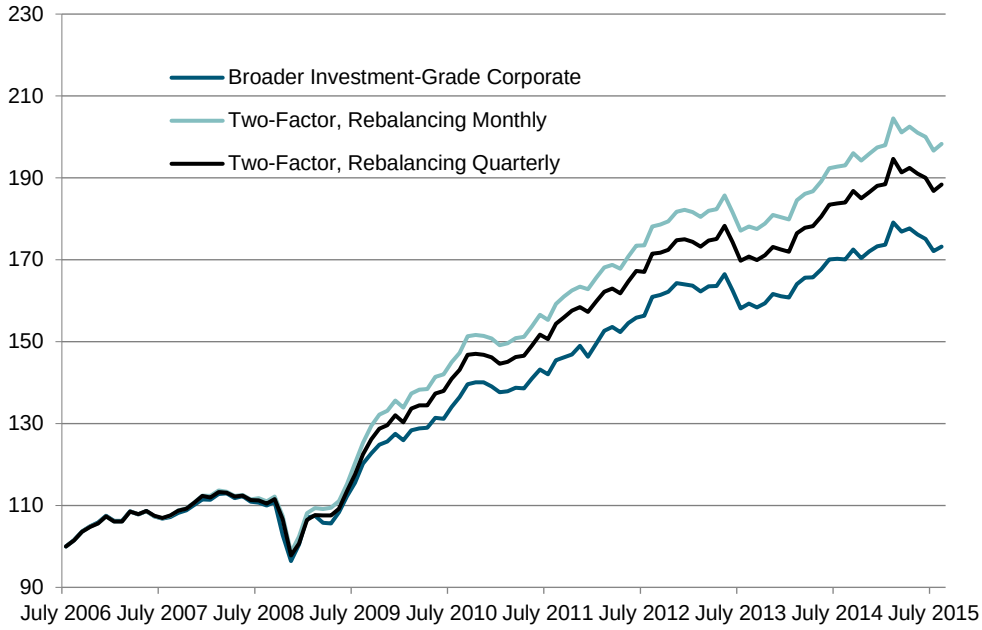
Factor-Based Investing in Fixed Income: A Case Study of the U.S. Investment-Grade Corporate Bond Market

Factor-based investing is a well-established concept in equities that has been supported by over four decades of research, testing, and documentation. However, factor-based investing in fixed income remains in its nascent stages. Recent studies have shown that the majority of fixed income active managers' risk can be explained by systematic risk factors. Our analysis finds that factor-based fixed income strategies implemented in a rules-based, transparent index can represent an alternative tool for fixed income portfolios. S&P DJI has examined a theoretical stylized example of a multi-factor index portfolio. This theoretical index portfolio attempted to reflect value and low-volatility factors existent in the U.S. investment-grade corporate bond universe.

EXECUTIVE SUMMARY

- As an increasing number of investors adopt risk-factor-based asset allocation, interest in smart beta fixed income strategies may be poised to grow.
- Factors may be even more important in fixed income, as systematic risk constitutes a significant proportion of bond total risk.
- Exposures to factors have long been utilized by active fixed income managers to achieve targeted risk/return characteristics. The majority of fixed income managers' risk can be explained by exposures to factors.
- Factors can be systematically reflected in a rules-based, transparent manner.
- We seek to identify value and low-volatility factors in the U.S. investment-grade corporate bond universe.
- Higher exposure to the value factor may be used to seek enhanced returns, while lower exposure to the low-volatility factor may be used to mitigate risk.
- Back-tested results show that a multi-factor Index could maintain a target risk profile (ratings and duration) in line with the broad-based benchmark, while having the potential to provide higher risk-adjusted return.
- High portfolio turnover remains a potential significant implementation challenge.

Exhibit 1: Two-Factor Model Results in Higher Index Performance



Source: S&P Dow Jones Indices LLC. Back-tested data from July 2006 to August 2015. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Factor-based investing is well established in equities, with growing recognition since the 2008 financial crisis.

INTRODUCTION

In the wake of the 2008 global financial crisis, two secular trends emerged in the investment industry that laid the groundwork for the rise of factor-based strategies across asset classes.

1) Investors started to evaluate and implement portfolio diversification in terms of underlying systematic risk factors (i.e., drivers behind asset-class returns) given the failure of active management to provide adequate downside protection.
2) Investors have sought lower-cost alternative investment vehicles that can capture most or part of active managers' excess returns.

Even though factor-based investing gained widespread recognition and adoption after 2008, it has been around for several decades. It is a well-established approach in equities in which common risk factors such as value, volatility, momentum, quality, and size have been used to explain differences in stock returns. Moreover, it has been widely documented that these factors have been shown to potentially add higher risk-adjusted returns than the broad market over a long-term investment horizon (Kang 2012).

As a result, risk factors have been utilized as the basis of strategic and tactical asset allocation frameworks in the investment process. For decades, factors have been incorporated as part of the stock selection and portfolio construction processes by active managers. In recent years, there

has been an increase in new launches of passively managed funds that seek to capture the same risk premia in rules-based, systematic, and transparent ways.

Growing Interest in Fixed Income Factor Investing

As factor-based investing and risk factor diversification gained momentum in equities following the financial crisis, interest has been extended to risk premia in the fixed income markets as well. While the financial crisis served as a broad-based catalyst, interest in fixed income factor investing has also been driven by the structural reality of low interest rates and the challenge for bond portfolio outperformance in the context of portfolio allocation within an environment of rising rates.

Idiosyncratic Risk and the Importance of Performance Factors

Factors are even more important in fixed income, as systematic risk constitutes a significant portion of bond total risk.

Given the fundamental difference in risk/return profiles between fixed income and equity markets, some market participants may question whether factor investing is as relevant in fixed income markets. In considering this question, we note that equity investors often seek to benefit from the potential upside of future cash flows of a given company, while fixed income investors may simply seek timely payments of principal and interest. This fundamental difference between equity and fixed income investments highlights the critical difference in the role idiosyncratic risk plays in the equity and fixed income markets.

Compared with the equity market where idiosyncratic risk constitutes a significant proportion of a stock's total risk, fixed income market returns are affected predominantly by systematic risk. Interest rate risk and credit risk together account for nearly 90% of cross-sectional differences in bond returns. Idiosyncratic risk as a proportion of total risk tends to increase as investors move down the credit spectrum from Treasuries, to agencies, to investment-grade corporate bonds, to high-yields corporates. However, the systematic risk, with duration effect in particular, continues to dominate.[1]

As a result, fixed income markets are, by nature, more reliant on systematic drivers than equity markets. Studies have shown that, on average, 67% of fixed income managers' active returns can be explained by exposures to systematic risk factors.[2] As a result, a growing number of studies on fixed income risk factors have begun to emerge, as academics and practitioners alike explore ways to capture risk premia.

[1] Litterman and Scheinkman 1991; Ang 2014.

[2] Khan and Lemmon 2015.

Risk Factors and Fixed Income Investing

Despite the importance of factors, factor-based investing in fixed income has been slow to develop and remains a nascent area of study. This is driven in part by the lack of data, relatively opaque pricing, and a relative lack of transparency in the asset class. However, many active fixed income managers have long been utilizing risk factors as part or all of their strategies by overweighting and underweighting their factor exposures relative to the benchmarks. Hence, it is possible to reflect fixed income factor exposures in a rules-based, systematic manner by categorically isolating each factor and using proxy measures to represent each premium.

Factor-based fixed income strategies can be implemented in a rules-based, transparent manner, and can be considered as building blocks for strategic asset allocation.

Much like their equity counterparts, smart beta fixed income strategies seek to capture alternative sources of returns. In doing so, these strategies aim to enhance return and/or reduce risk compared with a broad-based benchmark. Given that most fixed income portfolios are managed fundamentally, quantitative fixed income or factor-based fixed income strategies (implemented in a rules-based, transparent approach) represent an alternative tool for fixed income portfolios, in the same way that factor-based equity strategies have come to be considered as alternative tools for strategic and tactical asset allocations.

Defining Fixed Income Risk Factors

When evaluating risk factor considerations, the different structure and nature of fixed income markets compared with equity markets necessitates adaptations. The fragmentation across fixed income markets (e.g., government bonds, corporate bonds, securitized products, leveraged loans and structured products) further complicates the risk factor transference from equities to bonds, making it difficult to take a one-size-fits-all approach when considering risk factor definitions. As such, significant differences can exist in factor definitions as well as in measures used to identify factor returns. Exhibit 2 highlights the well-accepted risk factors, their definitions, and commonly used measures to represent them in both asset classes.

Exhibit 2: Risk Factors in the Equity and Fixed Income Markets

FACTORS	FACTOR DEFINITION/ASSUMPTIONS	COMMONLY USED MEASURES–EQUITY	COMMONLY USED MEASURES–FIXED INCOME
Value	Securities with market values that are lower than their intrinsic values earn, on average, higher returns than those with higher market values than intrinsic values	P/E, P/B, P/CF, P/Sales	Relative value measures: Yield–to-maturity, yield-to-worst, option-adjusted spread (OAS), Z-Spread
Size	Small-cap securities earn, on average, higher returns than large-cap securities	Market cap	Total issuer debt outstanding, individual bond size (proxy for liquidity)
Momentum	Securities with high historical returns earn, on average, higher returns than those with low historical returns	Price change (3-month, 6-month, 12-month, typically with 1-month lag to capture reversals)	Price change (3-month, 6-month, 12-month, typically with 1-month lag to capture reversals)
Volatility	Low-volatility securities earn, on average, higher risk-adjusted returns than high-volatility securities	Beta, standard deviation	OAS volatility, yield volatility, duration times spread (DTS), modified duration times yield (DTY)
Quality	Higher-quality securities earn, on average, higher returns than lower-quality securities Lower-quality bonds, on average, carry higher yield than higher-quality bonds	ROE, earnings accruals, financial leverage, gross profit margin	Financial leverage, debt servicing capacity, free cash flow, earnings capacity, capitalization, credit ratings, quantitative probability of default (PD) and loss given default (LGD) calculations
Interest Rate	High-duration bonds earn, on average, higher returns than shorter-duration bonds	N/A	Level, slope, and twist changes in yield
Liquidity	Bonds with high liquidity earn, on average, higher returns than those with lower liquidity over the long term	N/A	Total issuer debt outstanding, individual bond size, bid-ask spread, trading volume

Source: S&P Dow Jones Indices, LLC. Table is provided for illustrative purposes.

There is not a one-size-fits-all translation of equity risk factors to fixed income.

LITERATURE REVIEW

Duration and Credit as Traditional Return Drivers for Fixed Income

A substantial amount of literature exists on equity risk factors such as value, size, momentum, quality, and volatility. However, there appears to have been little research done on fixed income factors. Duration and credit are widely viewed as the two major performance drivers behind the cross-sectional differences in bond returns.[3] Empirical and academic research studies have shown that over a long investment horizon, longer-term bonds, on average, earn higher returns than shorter-term bonds, while low-quality bonds, on average, earn higher returns than high-quality bonds.

Research on Factors in Fixed Income

While momentum has been studied in the sovereign and corporate bond markets,[4] studies on other remaining factors, such as value and low

[3] Litterman and Scheinkman 1991; Fama and French 1992.

[4] Asness, Moskowitz, and Pedersen 2013; Pospisil and Zhang 2010.

volatility, remain scarce. The momentum effect has been documented as particularly effective in the sovereign bond market, but it has had mixed results in corporate bond markets.

Houweling and Zundert (2014) extensively studied the size, low-volatility, value, and momentum factors in the U.S. corporate bond market, and they noted that the factors delivered statistically significant premiums over the market. The authors noted investing in multi-factor portfolios appeared to be advantageous over single-factor portfolios. Similar to factor investing in equities, multi-factor portfolios tend to be better diversified and able to withstand prolonged underperformance that may be experienced by one or more factors in the corporate bond market.

Carvalho, Dugnolle, Lu, and Moulin (2015) studied sovereign, quasi sovereign, securitized, collateralized, investment-grade, high-yield corporate, and emerging market bonds in four major currencies. The authors noted the presence of the low-volatility factor across major developed fixed income markets, with lower-volatility bonds generating higher risk-adjusted returns.

Research on fixed income factors is starting to grow but remains scarce compared with research on equity factors.

Ng and Phelps (2015) showed that depending on the risk measures being used, the low volatility anomaly can be largely absent in the U.S investment-grade corporate universe when using the Sharpe ratio to measure the factor effectiveness.

Alternative Weighting for Balanced Risk Contribution

In addition to stand-alone risk factors, alternative weightings of securities and key risk factors in the portfolio construction process have also been studied. The underlying catalyst behind alternatively weighted fixed income portfolios stems from the notion that the traditional market capitalization method rewards more indebted issuers or countries, thereby resulting in potentially riskier portfolios.

Staal, Corsi, Shores, and Woida (2015) formed a risk contribution balanced portfolio in which the contribution to total portfolio risk from rates and credit factors is equal. The equal-risk contribution portfolio proved a better risk-diversified profile and had market-like returns with lower volatility when compared with the broader Barclays U.S. Aggregate Index.

FACTOR IDENTIFICATION AND INVESTMENT PHILOSOPHY

Moving From Theory to Stylized Framework

S&P DJI has outlined a broad summary and framework for factor investing in fixed income, highlighting the similarities and differences between equity and fixed income markets and factors. There are many avenues to pursue in peeling the layers of factor investing within fixed income, reflecting the diversity, complexity, and nuances across segments of this market.

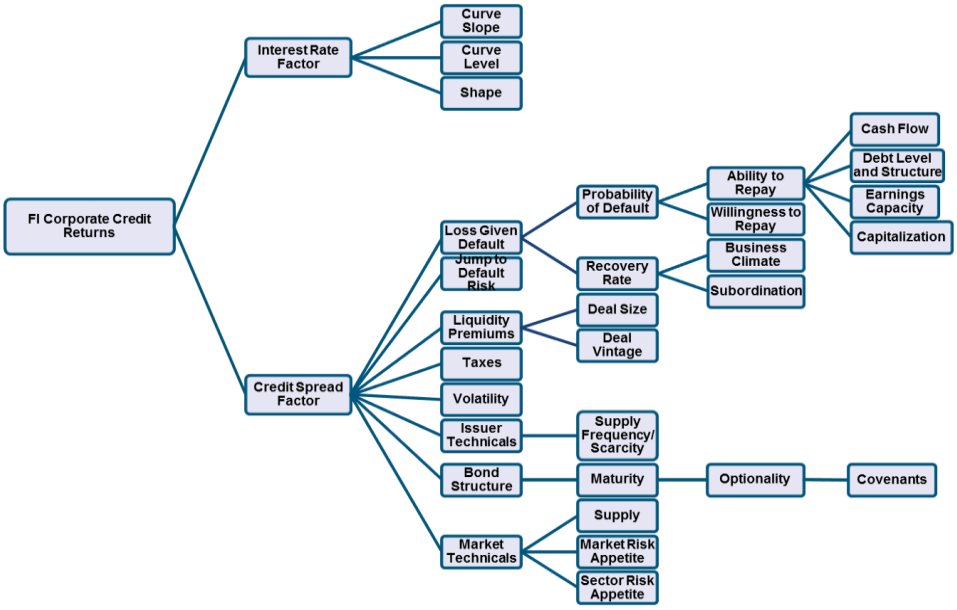
For the balance of this report, we turn from a theoretical discussion about fixed income factor investing to providing a stylized framework that can be used for representing risk premia in the U.S. investment-grade corporate bond universe through factor portfolios. We have chosen this specific market segment due to the breadth and depth of the opportunity set and the fact that the corporate bond market is affected by factors that have an impact on risk-free bonds and credit risk.

Our analysis of factors and the framework we present in this paper is meant to serve as the foundation for further exploration of fixed income smart beta topics. Therefore, the list of factors we have defined and presented in our work is not exhaustive.

We begin with the value factor, which is defined as the difference in yields between corporate bonds and comparable maturity yield curve and is often used to measure credit risk. While spreads over risk-free rates are often associated with default risk, the value factor, in practice, provides more than just default risk information and includes additional risk considerations such as liquidity and volatility (see Exhibit 3).

S&P DJI has chosen the U.S. investment-grade corporate bond universe as the basis of our stylized example, due to the breadth and depth of the opportunity set.

Exhibit 3: Risk Factors in the Credit Fixed Income Markets



Source: S&P Dow Jones Indices, LLC. Chart is provided for illustrative purposes.

Our analysis uses the LIBOR OAS credit spread measure to approximate return attributable to the value factor and the yield volatility measure for return attributable to the low-volatility factor. While the value factor alone has historically earned higher returns, reflecting in part higher credit risk or liquidity considerations, it has done so with much higher volatility. On the other hand, the low-volatility factor delivers a somewhat lower return, albeit with significantly lower volatility. Much like in equities, combining uncorrelated or low-correlated fixed income risk factors potentially allows

for smooth return patterns and may offer portfolio diversification benefits over market cycles.

Back-tested performance results find that over a long-term investment horizon, both single- and multi-factor portfolios earn higher risk-adjusted returns than the broad-based corporate bond universe. However, we do acknowledge that challenges exist in the practical implementation of the multi-factor portfolio. In particular, high turnover of the strategy and transaction costs are a significant consideration.

Most corporate bond managers focus on credit returns, specializing in expressing views on the direction of credit spreads and security selection. The two-factor model we examined is meant to reflect the portion of active return coming from security selection by identifying relative value opportunity in credit returns, while keeping portfolio duration and credit duration neutral to the underlying universe.

To achieve our intended approach, we chose two factors that have empirically demonstrated a strong relationship between factor exposure and performance statistics and have long been incorporated in the investment process by corporate bond portfolio managers.

Factor Definition

We have defined volatility as the standard deviation of bond yield changes for the trailing six-month period.

In this section, we present our definitions of risk factors for a corporate bond strategy and the investment rationale behind the selection of each factor. As previously noted, it is important to define fixed income factors using applicable bond characteristics rather than simply borrowing from the equity market.

The fixed income investment community has long used volatility as an important factor in analyzing bond valuations and identifying investment opportunities. The definition of volatility, however, can vary greatly, based on our survey of literature review. The definition ranges from credit ratings to measures such as modified duration times yield (DTY), duration times spread (DTS), the Libor option-adjusted spread (OAS), and OAS volatility. We have defined volatility as the standard deviation of daily changes in bond yield for the trailing six-month period. All else being equal, the more volatile the bond yield is, the higher the yield needs to be in order to compensate for the volatility risk.

For the value factor, we consider the Libor OAS, which represents the yield compensation for taking credit risk and is a common measure of valuation for investment-grade corporate bonds. By limiting the bond selection to those with an OAS greater than the median level within each group by duration and credit rating, we identify the universe with better spread-tightening potential to which a volatility factor can be applied.

Robustness of the Value and the Low-Volatility Factors

To understand the strength of the relationship between each factor and bond portfolio returns and risk, we compute the performance statistics of the quintile portfolios ranked by each factor.

To form quintile portfolios, we first rank bonds within the investable sub-universe by each factor (value and low volatility) and divide the universe into five groups, with higher values ranking better for value and lower values ranking better for low volatility (see Exhibit 4). It should be noted that these two single-factor portfolios do not control for either duration or credit rating.

Exhibit 4 confirms a positive relationship between the value factor, portfolio return, and return volatility. The higher the value exposure, i.e., the wider the spread, the higher the return and return volatility (Quintile 1). However, on a risk-adjusted basis, Quintile 1 is not the most efficient, as its return/risk ratio (1.04) is lower than that of Quintile 5 (1.10).

Ranked-order quintile value portfolios confirm a positive relationship between spread, return, and return volatility.

Exhibit 4: Performance Statistics of Ranked Quintile Portfolios by Each Factor

QUINTILE PORTFOLIO	OAS (RANKED HIGH TO LOW)			YIELD VOLATILITY (RANKED LOW TO HIGH)			YIELD VOLATILITY WITHIN EACH DURATION AND RATING GROUPING (RANKED LOW TO HIGH)		
	ANNUALIZED RETURNS (%)	REALIZED VOLATILITY	RETURN/ VOLATILITY	ANNUALIZED RETURNS (%)	REALIZED VOLATILITY	RETURN/ VOLATILITY	ANNUAL-IZED RETURNS (%)	REALIZED VOLATILITY	RETURN/ VOLATILITY
1	9.47	9.12	1.04	3.90	6.96	0.56	5.39	5.21	1.04
2	7.34	7.39	0.99	5.71	6.44	0.89	5.63	5.41	1.04
3	6.32	6.20	1.02	6.61	5.80	1.14	6.07	5.63	1.08
4	5.18	5.10	1.02	6.67	5.47	1.22	5.92	5.84	1.01
5	3.62	3.29	1.10	7.59	6.21	1.22	7.12	6.88	1.03

Source: S&P Dow Jones Indices LLC. Back-tested data from June 30, 2006, to Aug. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Contrary to the value factor, we can observe a non-linear relationship between risk and return for the low-volatility factor. The Quintile 1 portfolio, which contains the least-volatile bonds, demonstrates the lowest return and the highest level of realized portfolio volatility. On a risk-adjusted basis, Quintile 1 portfolio has a return/risk ratio (0.56) that is less than one-half of Quintile 5's (1.22).

Exhibit 4 also includes performance statistics for quintile portfolios formed by ranking the low-volatility factor within each duration and rating grouping. Unlike their unconstrained counterparts, these modified quintile portfolios display a generally linear relationship between the low-volatility factor, its returns, and volatility. The Quintile 1 portfolio results in the lowest return but has the least amount of volatility whereas the Quintile 5 portfolio demonstrates the highest return with the highest volatility.

The data demonstrates that applying the low-volatility factor without taking duration and quality into consideration does not result in portfolios with desirable risk/return characteristics. This is because simply ranking bonds by yield volatility across the universe can potentially result in highly concentrated portfolios in duration or quality, which, in turn, may cause greater portfolio volatility. This can be particularly exacerbated when long-duration bonds exhibit lower yield volatility than short-duration bonds, when markets are typically calm.

The findings confirm that value and low-volatility factors can effectively explain portfolio return and volatility, and they also highlight the importance of applying factors within duration and quality constraints. Next, we detail the methodology behind our two-factor model, which seeks to capture the security selection of active corporate bond managers in a quantitative and rule-based format.

Quintile portfolios arranged by low volatility factor within a grouping display a positive relationship between the low volatility factor, return, and volatility.

DATA AND METHODOLOGY

The underlying universe for our study is the S&P U.S Issued Investment Grade Corporate Bond Index (U.S. issuers). The index is designed to measure the performance of investment-grade corporate bonds issued by U.S.-domiciled corporations and is denominated in U.S. dollars. Based on the availability of constituent data and yield curve, the period covered in the study is June 30, 2006, through Aug. 31, 2015.

Creating the Investable Sub-Universe

To enhance the liquidity profile and tradability of the index portfolio, we derive an investable sub-universe with a three-step process.

1. First, we include only recently issued bonds when available due to the fact that newly issued bonds tend to enjoy better market liquidity in secondary trading. For each issuer and each benchmark issuance tenor, bonds issued within the last 30 months of the rebalance date are considered. If an issuer has no recent issuance in the previous 30 months, all outstanding bonds of the issuer are considered.
2. Second, only bonds that have existed for at least six months are included. This step is necessary to allow screening through the volatility factor, which is defined as the standard deviation of yield changes during the trailing six-month period.
3. Third, for each issuer in each duration grouping, only the bond issue with the largest outstanding amount is included.

After creating this more liquid sub-universe, the bonds are then divided into groups based upon their effective duration and credit rating.

Portfolio Construction Using Two Factors

Bonds are selected from the investable sub-universe to form the model portfolio following these steps.

1. First, in each group of effective duration and credit rating, bonds with Libor OAS wider than the median level of the group are selected.
2. Second, bonds are ranked by yield volatility for the trailing six-month period. The 20% of bonds with the lowest volatility are then selected from each group.

Portfolio Weighting Scheme

The weighting scheme for the two-factor portfolio is done in a two-step approach.

1. First, we match the weights for each grouping to that of the underlying base universe.
2. Second, within each grouping, individual bonds are equally weighted.

Low volatility is a key factor to identify bonds that offer higher credit spreads than justified by their trading volatility.

In order to assess the impact of rebalancing frequency on the risk/return characteristics, the portfolio is rebalanced on two frequencies—monthly and quarterly. The rebalancing reference dates for the quarterly portfolios are the last trading day of March, June, September, and December.

Key Considerations Behind the Application of the Low-Volatility Factor

Utilizing a volatility factor is a key step in the index component selection process. Without the overlay of the factor, one is simply picking the cheapest bonds with the widest OAS and, therefore, most likely piling on credit risk. Screening first by OAS results in a pool of bonds that have better potential for spread tightening and better carry. The subsequent low-volatility screening is designed so that bonds with less risk, as demonstrated by their trading pattern, are selected, while duration and credit rating are held equal. One can intuitively think of our selection process as identifying the cheapest bonds with wide credit spreads that are not justified by their historical trading volatility in their respective duration and credit groups.

In forming our factor index portfolios, each portfolio's exposure to duration and credit quality is held in line with those of the underlying universe. This targeted approach to factor exposure is taken in an attempt to ensure that any positive or negative excess returns earned by the factor portfolio relative to the underlying universe is attributable to the aforementioned factor return and not due to excessive loading on duration risk or credit risk.

PERFORMANCE OF TWO-FACTOR AND SINGLE-FACTOR PORTFOLIOS

In this section, we present the risk/return characteristics of the individual factor as well as the two-factor portfolios relative to the broader investment-grade corporate bond universe.

The two-factor portfolios, rebalanced monthly or quarterly, achieve higher Sharpe ratios than the broader market and the investable sub-universe (see Exhibit 5). Not surprisingly, the monthly rebalanced two-factor portfolio has the highest Sharpe ratio (1.15) among all the portfolios. When viewed within the active risk/return framework, the two-factor portfolios significantly reduce the tracking error relative to the broader market and improve the information ratio to 0.82 (monthly) and 0.53 (quarterly).

The two-factor model achieves a higher Sharpe ratio than the base universe.

One of the main drivers of widespread adoption of factor-based allocation in equities has been that by diversifying across various low-correlated factors, the resulting portfolio appeared to be more capable of withstanding market downturns and experienced lower drawdowns. We see that advantage in our two-factor fixed income portfolio as well. While, the low-volatility factor portfolio has the lowest drawdown, 11.86%, the value factor portfolio has the worst drawdown, at 16.86%. In contrast, the two-factor portfolios improve the drawdown level to 13.32% (monthly) and 13.66 (quarterly), which are lower than the broader market (14.66%).

This demonstrates that the volatility factor may effectively act as a risk control mechanism. The two-factor portfolio represents the spread-tightening opportunity offered by a wider spread than historical volatility may justify, but potentially not at the expense of excessively loading on risk.

Exhibit 5: Two-Factor Model Results in Higher Risk-Adjusted Return and Experiences Less Drawdown

RISK/RETURN PROFILES (ANNUAL-IZED, %)	LOW-VOLATILITY FACTOR	VALUE FACTOR	TWO-FACTOR, REBALANCED MONTHLY	TWO-FACTOR, REBALANCED QUARTERLY	INVESTABLE INVESTMENT-GRADE SUB-UNIVERSE	BROADER INVESTMENT-GRADE CORPORATE
Return	5.73	9.20	7.70	7.10	6.08	6.11
Volatility	5.24	7.40	5.89	5.82	5.63	6.00
Return/Volatility Ratio	1.09	1.24	1.31	1.22	1.08	1.02
Sharpe Ratio	0.91	1.12	1.15	1.06	0.91	0.86
Active Return	-0.40	2.98	1.49	0.92	-0.05	0.00
Tracking Error	2.39	3.17	1.80	1.72	0.84	0.00
Information Ratio	-0.17	0.94	0.82	0.53	-0.07	0.00
Maximum Drawdown (Not Annualized)	-11.86	-16.86	-13.32	-13.66	-13.10	-14.66

Source: S&P Dow Jones Indices LLC. Back-tested data from June 30, 2006, to Aug. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 6: Performance of Two-Factor Strategy Remained Stable Through Market Cycles

PERIOD	LOW-VOLATILITY FACTOR	VALUE FACTOR	TWO-FACTOR, REBALANCED MONTHLY	TWO-FACTOR, REBALANCED QUARTERLY	INVESTABLE INVESTMENT-GRADE SUB-UNIVERSE
HIT RATE–PERCENT OF MONTHS WITH OUTPERFORMANCE					
All Periods	48	72	65	64	47
Up Months	44	73	63	60	32
Down Months	57	70	70	70	78
AVERAGE MONTHLY EXCESS RETURNS (%)					
All Periods	-0.03	0.25	0.12	0.08	0.00
Up Months	-0.18	0.37	0.08	0.03	-0.05
Down Months	0.25	0.01	0.22	0.17	0.09

Source: S&P Dow Jones Indices LLC. Back-tested data from June 30, 2006, to Aug. 31, 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

One property of the low-volatility strategy in the equity market is its asymmetric upside and downside capture abilities. A low-volatility strategy tends to outperform more frequently in down markets than in up markets.[5] Similarly, in fixed income, the low-volatility portfolio tends to outperform the market more frequently when the market is falling than when the market is rising, therefore possibly providing less upside participation in exchange for better downside protection. The two-factor portfolios also experienced a higher participation rate and higher outperformance in down markets than in up markets, thus confirming the central role of the volatility factor in portfolio construction.

CHARACTERISTICS AND PERFORMANCE ATTRIBUTION

The two-factor model exhibits a similar yield and duration profile to the base universe, and therefore is market neutral.

Our two-factor portfolios are constructed in a way intended to keep exposures to overall and credit spread duration in line with those of the underlying universe, while also constraining the number of bonds in the portfolios to a small percentage of the universe (11% as of July 31, 2015). This process seeks to ensure that the portfolio efficiently provides beta exposure to the broader investment-grade corporate bond market, thereby controlling portfolio tracking error, while delivering possible incremental returns over the benchmark.

Exhibit 7 provides the portfolio characteristics of the two-factor portfolios. The portfolios exhibit slightly higher yield than the broad universe, which is not surprising, as the constituents are selected from bonds with a greater-than-median level of Libor OAS spread in each duration and quality group. We also note that the yield pickup of the two-factor portfolios is modest at 0.17% (monthly rebalancing) and 0.13% (quarterly rebalancing), confirming

[5] Soe 2012.

that the portfolios are not simply picking the highest-yielding bonds with the most risky credit profile. Exhibit 7 also confirms that there are minimal differences in duration exposure between the two-factor portfolios and the broader market.

Exhibit 7: Two-Factor Portfolios Closely Match the Broad Market in Yield and Duration Profile

PORTFOLIO CHARACTERISTICS	TWO-FACTOR (MONTHLY REBALANCING)	TWO-FACTOR (QUARTERLY REBALANCING)	BROAD CORPORATE BOND MARKET
Number of Bonds	533	533	4,666
Average Yield-to-Worst	3.45	3.41	3.28
Portfolio Effective Duration	7.1	7.0	7.0
AAA	6.8	6.6	6.9
AA	7.7	7.4	7.6
A	7.0	6.9	6.9
BBB+	7.4	7.3	7.3
BBB	7.2	7.2	7.1
BBB-	6.3	6.2	6.2

Source: S&P Dow Jones LLC. Data as of July 31, 2015. Table is provided for illustrative purposes. Past performance is no guarantee of future results.

Performance attribution analysis confirms that the two-factor model is effective in identifying relative value opportunity.

In order to further decompose the sources of excess return of the two-factor portfolios relative to the underlying broad based benchmark, we conduct a performance attribution analysis (Exhibit 8). The data shows that a significant portion of the portfolio excess return is contributed by the credit spread tightening of specific names. Because we have matched the duration and credit allocation of the two-factor portfolio to that of the underlying broad-based USD corporate bond benchmark, the excess returns figures show that these two factors combined can help identify relative value opportunity for corporate bonds.

Exhibit 8: Credit Spread Tightening Drove the Bulk of the Outperformance of the Two-Factor Portfolio

RATING	PORTFOLIO AVERAGE WEIGHT (%)	RETURN ATTRIBUTION (PER YEAR, BPS)		
		CARRY	DURATION	CREDIT SPREAD
AAA	2	4	4	12
AA	9	4	3	5
A	43	8	6	96
BBB+	14	7	3	21
BBB	19	9	5	33
BBB-	13	10	4	39
Total	100	43	24	206

Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Aug. 31, 2015. Per year performance attribution figures are calculated from cumulative attribution report. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

COMPARISON VERSUS ACTIVE BOND FUNDS

Some believe that fixed income strategies may be best accessed via actively managed investment vehicles because passively managed funds have structural shortcomings (liquidity, OTC trading) that limit their ability to react to market events. Therefore, in theory, passively constructed, factor-based fixed income strategies should earn lower risk-adjusted returns as well as have lower information ratios (IR) when compared with actively managed fixed income funds.

In Exhibit 9, we compare the performance of the two-factor corporate bond index portfolio with that of actively managed U.S. investment-grade corporate bond funds. Using the Morningstar database, we obtain performance statistics of the fixed income funds whose stated benchmark from the prospectus is either the Barclays U.S. Credit Index or the Barclays U.S. Investment Grade Corporate Index. The data shows that the two-factor portfolio that is rebalanced monthly has a higher Sharpe ratio as well as a higher IR than those of the top three highest IR bond funds, while the quarterly rebalanced portfolio has a higher Sharpe ratio but a lower IR.

Selecting bonds from the investable sub-universe improves the liquidity and tradability of the two-factor portfolios.

Exhibit 9: Comparison of Two-Factor Index Portfolios and Actively Managed Fixed Income Funds

CATEGORY	FUND SIZE (IN USD BILLIONS)	ACTIVE RETURN	TRACKING ERROR	SHARPE RATIO	INFORMATION RATIO	MAXIMUM DRAWDOWN
MUTUAL FUNDS						
Minimum	0.019	-5.1	1.5	-0.03	-0.67	-43.6
Maximum	6.573	2.2	8.6	1.32	1.04	-4.1
Average	1.185	-0.3	3.3	0.80	0.02	-16.6
Average of Top 3 Funds by IR	2.697	1.5	2.1	1.01	0.69	-13.7
PORTFOLIOS						
Two-Factor, Rebalanced Monthly	-	1.5	1.8	1.15	0.82	-13.3
Two-Factor, Rebalanced Quarterly	-	0.9	1.7	1.06	0.53	-13.7
Base Universe	-	-	-	0.86	-	-14.7

Source: S&P Dow Jones Indices LLC, Morningstar. Back-tested data from July 2006 to August 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The IR measures active return per unit of risk relative to a benchmark. In our sample universe of corporate bond managers, the distribution of IR ranges from 1.04 to -0.67, with most of the observations (59%) falling in the negative territory, indicating that most investors may not be adequately compensated per unit of active risk taken by their managers.

The results are not surprising, given the recent study by Khan and Lemmon (2015) that showed that a significant portion (67%) of fixed income managers' active risk comes from exposure to systematic risk factors. The authors concluded that fixed income investors involved in active strategies are overpaying for their risk exposures.

KEY CONSIDERATIONS IN IMPLEMENTING FACTOR PORTFOLIOS IN CORPORATE BONDS

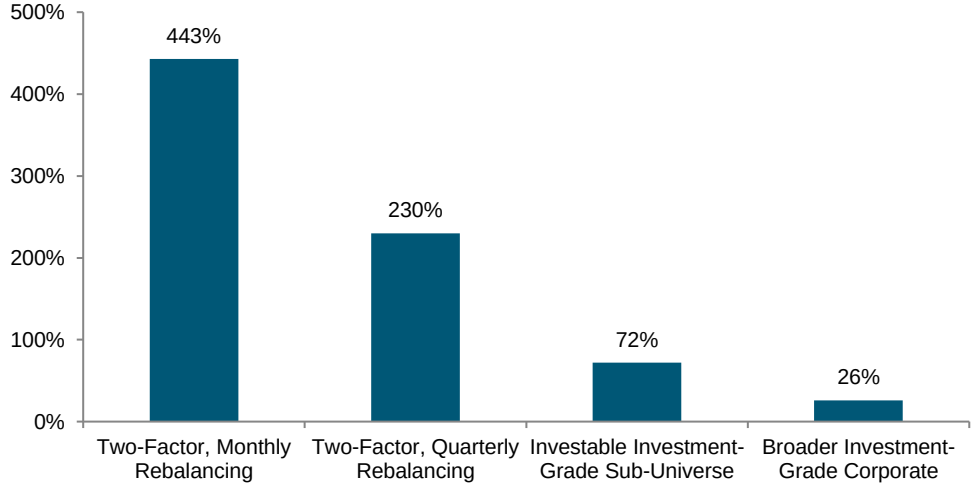
When evaluating and selecting factor-based fixed income portfolios, there are several important portfolio-management considerations that investors may want to take into account. In particular, liquidity, tracking error, turnover, and transaction costs may want to be factored as part of the portfolio construction.

In our construction of a two-factor portfolio, liquidity and tracking error are incorporated into the construction process. The investable sub-universe is created to narrow down bond issues with a large outstanding amount and recent issues. Because large and recently issued bonds tend to have better liquidity in the secondary market, the process of selecting from the investable sub-universe may help improve the liquidity and tradability of the two-factor portfolios and reduce overall transaction cost.

Reducing the rebalancing frequency to quarterly nearly halves the turnover ratio.

Turnover of smart beta strategies generally tends to be higher than that of market-cap-weighted, broad-based indices. With turnover being a function of rebalancing frequency, we find that the monthly portfolio results in higher turnover than the quarterly one, displaying an average annual turnover in excess of 400%. Changing the rebalance frequency to quarterly reduces the turnover by nearly half, to 239%, a figure that is higher than broad market indices but comparable to that of actively managed bond funds.

Exhibit 10: Average Annual Turnover of Strategies



Source: S&P Dow Jones LLC. Back-tested data from July 2006 to August 2015. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosures at the end of the document for more information regarding the inherent limitations associated with back-tested performance.

For potential licensees of the multi-factor stylized index concept, we have included additional calculations to estimate the impact of turnover on index performance. We have re-calculated index performance after subtracting for hypothetical transaction costs associated with removing and adding index components at rebalance, assuming a bid-ask spread of 30 bps for each transaction (see Exhibit 11).

Our use of a 30 bps bid-ask spread to calculate hypothetical transaction costs is based on the assumption that the component would be a liquid investment-grade corporate bond at normal market duration, as the index universe considered is based on the investable universe. However, there is no guarantee that a 30 bps bid-ask spread would apply to the purchase or sale of any of the index components. Similar research by S&P DJI also found that, on average, dealer-to-dealer transaction costs in the U.S.-issued, investment-grade corporate bond space ranged from 85 bps for the broad market to 34 bps for the AAA segment in 2015.[6]

As expected, the monthly rebalanced two-factor portfolio incurs the highest hypothetical transaction costs, coming in at 1.33% per year. Rebalancing the portfolio on a quarterly basis would theoretically reduce the transaction costs approximately by half.

After accounting for transaction costs, the quarterly rebalanced two-factor portfolio shows an excess return of 16 bps per year, compared with -8 bps for the broader universe. The quarterly rebalanced two-factor index portfolio also produced a higher return/volatility ratio (1.10) than the monthly rebalanced one (1.08) and the broad-based benchmark (1.01).[7]

Outperformance over the benchmark persists in the two-factor model with transaction costs accounted for.

Exhibit 11: Estimated Annualized Index Performance Statistics With Hypothetical Transaction Costs

STATISTIC	TWO-FACTOR, REBALANCED MONTHLY	TWO-FACTOR, REBALANCED QUARTERLY	INVESTABLE INVESTMENT-GRADE SUB-UNIVERSE	BROADER INVESTMENT-GRADE CORPORATE
Turnover (%)	443	230	72	26
Number of Bonds as of July 31, 2015	533	533	2,566	4,666
Transaction Cost	1.33	0.69	0.22	0.08
Return Ex-Transaction Cost (Annualized, %)	6.4	6.4	5.9	6.0
Excess Return Versus Broader Investment-Grade Corporate Benchmark Ex-Transaction Cost	0.16	0.23	-0.27	-0.08
Return/Volatility	1.08	1.10	1.04	1.01

Source: S&P Dow Jones LLC. Data from July 2006 to August 2015. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

[6] Rieger. Unveiling the Hidden Cost of Retail Bond Buying & Selling. January 2016.

[7] Similar to our findings, Houweling and Zundert (2014) showed that it may still be possible to preserve higher the Sharpe ratios of single-factor and multi-factor portfolios than the market portfolio, even after taking high turnover and transaction costs into account. In their analysis, the after-cost Sharpe ratio of the multi-factor, investment-grade portfolio remained 0.26, versus 0.10 for the market.

CONCLUSION

In recent years, an increasing number of investors have adopted factor-based investing framework in their equity allocation, judging by the record amount of flows into strategies (passive and active) that aim to provide exposure to equity risk factors. Interest in applying a similar framework to fixed income is gaining momentum. As a result, factor-based investing in fixed income has started to receive the attention of practitioners.

Against that backdrop, our paper aims to contribute to the growing body of literature about factor-based investing. We test to understand whether factor analysis can be applied to the U.S. investment-grade corporate bond universe. Our analysis indeed confirms that over the back-tested investment horizon, both value and low-volatility factor portfolios have higher Sharpe ratios than the broad market. When evaluated in a two factor framework, the two-factor portfolio exhibits similar risk-efficient characteristics, even after accounting for hypothetical transaction costs.

GLOSSARY

Yield-to-maturity: The annual rate of return expected on a bond based on its current price and the assumption that it will be held to maturity.

Yield-to-worst: The lowest yield generated, given the potential stated options prior to maturity.

Option-adjusted spread: The average spread over the benchmark curve, based on potential paths that can be realized in the future for interest rates. The potential paths of the cash flows are adjusted to reflect the options embedded in the bond.

OAS volatility: The standard deviation of OAS.

Yield volatility: For this paper, it is defined as the standard deviation of the daily change of yield-to-worst for a trailing six-month period.

Duration times spread (DTS): The multiplication of duration and OAS.

Modified duration times yield (DTY): The multiplication of modified duration and yield-to-worst.

Level: The yield level of a yield curve.

Slope: The slope of a yield curve, most commonly expressed by the yield difference between 10-year and 2-year points.

Twist changes in yield: The change in the slope of yield curve.

Probability of default (PD): The likelihood that a debt instrument will default within a stated timeframe.

Loss given default (LGD): The amount of loss on a credit instrument after the borrower has defaulted. It is typically stated as a percentage of the debt's par value (one minus the recovery rate). Also known as "loss in the event of default."

Recovery rate: The amount that a creditor receives in final satisfaction of the claims on a defaulted credit. The recovery rate is generally stated as a percentage of the debt's par value. Also known as "expected recovery given default."

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The S&P U.S. Investment Grade Corporate Bond Index was launched on April 9, 2013. All information presented prior to an index's Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. Complete index methodology details are available at www.spdji.com.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live: index values provided for any date or time period prior to the index's Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company's public website or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed "Date of introduction") is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index's public release date.

Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

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