A research-based approach to fixed income factor portfolio implementation

By Jay Raol, Ph.D., Amritpal Sidhu, Benton Chambers, Reed McDonnell, Nancy Razzouk and Bin Yang

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Does factor investing work for fixed income? To answer this and other questions, we review motivations for factor investing, describe the implementation of a multi-factor portfolio with turnover and risk constraints, and present a framework for return attribution and monitoring.

In their popular paper on the Norwegian Government Pension Fund Global, Chambers et al. (2012) develop a set of criteria for fund investing, which became known as the Norway Model. These criteria include sufficient diversification and capacity, low-cost implementation, and transparency. But can they be fulfilled by a fixed income factor strategy?

We believe so, provided implementation of the factor strategy is as robust as the factors themselves. But, since the starting point of any factor strategy lies in the factors, we will first discuss the ones we consider most important for fixed income: low volatility, value and carry. Our analysis is based the Bloomberg Barclays US Investment Grade index on US investment grade corporate bonds, with data from January 2002 to December 2021.

For each factor, we divide our investment universe into five factor quintiles, with quintile 1 having the lowest and quintile 5 the highest factor exposure. When regressing the factor exposures on monthly credit returns, we control for spread volatility as measured by duration times spread (DTS) to reduce noise.[1]

Low volatility

The low volatility factor explains the higher risk-adjusted return of low volatility bonds.[2] Table 1 shows the results of our regressions for the five factor quintiles. The intercept, i.e., the excess return of the factor quintile over the investment universe, is statistically significant. It is positive for quintile 5 (highest exposure to low volatility) and decreases continuously to quintile 1 (lowest exposure), where it is strongly negative. Sharpe ratio and information ratio against the capitalization-weighted index are also much better for lower volatility bonds.

Since we control for DTS, the spread volatility is similar in all quintiles. But there are clear differences in the higher moments: Quintile 5 has a significant negative skew – i.e., a median above the mean – which implies many small positive monthly returns. But the kurtosis of quintile 5 is also elevated, indicating a significant left tail and infrequent, but

Table 1
Regression of low volatility on credit returns and other risk summary metrics

Quintile	Intercept	T-Stat	Volatility	Skew	Kurtosis	Sharpe	Information Ratio
1	-7.89	-4.45	143	-1.03	9.55	0.01	-0.28
2	-2.96	-1.71	135	-1.03	9.59	0.03	-0.12
3	0.50	0.32	130	-1.20	10.65	0.06	0.00
4	4.31	3.37	130	-0.65	8.25	0.10	0.19
5	6.73	1.86	161	-2.34	25.22	0.11	0.14

Source: Invesco. Quintile 1: lowest exposure to low volatility; quintile 5: highest exposure to low volatility. Intercepts and spread volatility in bps/month. Monthly data from January 1, 2000 to December 31, 2021.

Table 2
Regression of value on credit returns and other risk summary metrics

Quintile	Intercept	T-Stat	Volatility	Skew	Kurtosis	Sharpe	Information Ratio
1	-9.33	-6.41	132	-1.00	7.95	-0.00	-0.43
2	-4.65	-4.58	131	-1.21	9.90	0.02	-0.31
3	-1.05	-1.36	134	-0.99	9.70	0.05	-0.10
4	3.13	3.27	142	-0.82	9.66	0.08	0.22
5	11.36	6.15	152	-0.76	12.39	0.13	0.39

Source: Invesco. Quintile 1: lowest exposure to value; quintile 5: highest exposure to value. Intercepts and volatility in bps/month. Monthly data from January 1, 2000 to December 31, 2021.

Table 3
Regression of carry on credit returns and other risk summary metrics

Quintile	Intercept	T-Stat	Volatility	Skew	Kurtosis	Sharpe	Information Ratio
1	-7.87	-3.77	114	-1.05	10.86	-0.00	-0.23
2	-3.45	-1.85	129	-1.01	11.58	0.03	-0.13
3	0.58	0.37	135	-1.16	11.00	0.06	0.01
4	4.40	2.56	140	-0.89	9.51	0.09	0.17
5	7.31	1.67	188	-1.95	18.96	0.11	0.13

Source: Invesco. Quintile 1: lowest exposure to carry; quintile 5: highest exposure to carry. Intercepts and volatility in bps/month. Monthly data from January 1, 2000 to December 31, 2021.

large, losses. This return pattern significantly deviates from the other quintiles and cannot be explained by spread volatility. Furthermore, quintile 1 has a statistically significant negative intercept, meaning that removing just the 20% most volatile bonds can result in significantly better portfolio returns.

Value

The value factor explains the higher risk-adjusted return of bonds with spreads above those of other bonds with similar characteristics. We have chosen a simple definition that selects bonds with the highest options-adjusted spread (OAS) within their respective industry and rating groups.

Table 2 summarizes the results. The intercept (i.e., excess return), Sharpe ratio and information ratio all improve with higher factor exposure. Volatility clearly rises with exposure to the value factor, even though all five quintiles have similar DTS. Thus, portfolios with higher value exposure are likely to exhibit higher returns, but also risks not captured by spread volatility.

Carry

The carry factor explains the higher risk-adjusted returns of the bonds with highest option-adjusted spread.

Table 3 summarizes the results. Again, we see a strong relationship between factor exposure and excess return; the intercepts are statistically significant. Sharpe ratio and information ratio both increase with higher carry exposure. Finally, the top quintile portfolio has significantly higher spread volatility, skew and kurtosis. Risk and return also increase with carry exposure. Like low volatility and value, the carry factor is statistically significant for quintile 1. This implies that removing the 20% of the universe with the lowest carry exposure can result in better returns.

The factors are robust to fixed income risk and liquidity

We now control for other characteristics beyond DTS to see whether any hidden loadings on common risk factors can explain excess factor returns. Table 4 shows the intercepts of long-short portfolios formed by taking the top quintile factor portfolios and subtracting the respective bottom quintile factor portfolios. This isolates the return and risk of the respective factor.

As we see, our three factors earn consistent excess return irrespective of sorting controls. Not only do they work across a large part of the corporate universe, but also across sectors, rating classes and maturity buckets. Therefore, we should expect fixed income factors to be as scalable as equity factors.

In addition to traditional factors, we look for liquidity characteristics to understand whether the factors can be traded at costs similar to the overall universe. When controlling for size (amount outstanding), transaction volume in the preceding month and age of the bond, we see that the factors still have positive excess returns.

Factor allocation

To construct targets with multiple factor exposures, we now combine the single factor targets using a simple weighting mechanism. The weights are based on empirical correlations, seeking to provide consistent performance and risk in

When controlling for size (amount outstanding), transaction volume in the preceding month and age of the bond, we see that the factors still have positive excess returns.

Table 4
Intercepts for long/short factor portfolios when controlling for different characteristics

Sort	Carry		Low Volatility		Value	
Sector	13.4	(2.39)	13.1	(2.96)	17.1	(2.97)
DTS	15.2	(2.45)	14.6	(2.91)	20.7	(6.70)
Maturity	12.5	(1.52)	4.9	(2.95)	22.3	(5.24)
Rating	6.8	(0.82)	11.6	(2.14)	15.5	(2.62)
Age	7.7	(0.91)	12.0	(2.36)	13.5	(2.40)
Volume	10.2	(1.41)	10.4	(2.39)	17.6	(3.42)
Size	5.8	(0.69)	12.4	(2.48)	12.6	(2.23)

Source: Invesco. Intercepts for long/short factor portfolios when controlling for different characteristics. Volume is based on TRACE data, size is the amount outstanding. Monthly data from January 1, 2000 to December 31, 2021.

Table 5
Correlation of excess returns

		Carry	Low Volatility	Value
US Investment Grade	Carry	1.000	-0.330	0.754
	Low Volatility	-0.330	1.000	-0.208
	Value	0.754	-0.208	1.000
US High Yield	Carry	1.000	-0.530	0.784
	Low Volatility	-0.530	1.000	-0.399
	Value	0.784	-0.399	1.000

Source: Invesco. Monthly data from January 1, 2000, to December 31, 2021.

different macro environments and roughly equal risk contributions from each factor. Indeed, there is significant diversification potential between low volatility and the more risk loving factors value and carry. Table 5 shows the correlations of factor excess returns for US investment grade and high yield bonds. We seek an asset allocation scheme that allows us to utilize the diversification offered between the various factors to produce a multi-factor target intended to perform well across various market environments.

We have analyzed five different asset allocation methods: equal drawdown allocation, equal standard deviation allocation, the efficient frontier portfolio method, equal contribution to risk (risk parity) and risk targeting:

- **Equal drawdown allocation** measures the drawdown of each factor and allocates based on equal contributions to historical drawdown.
- **Standard deviation allocation** computes standalone factor volatility, allocates based on this metric and does not account for correlations among factor returns.
- The **efficient frontier portfolio (a.k.a. mean-variance optimization)** is the tangency portfolio in the traditional Markowitz model.
- The **risk parity method** computes the covariance of factor returns and allocates weights to achieve equal contributions to risk while also accounting for correlation among the factors.
- **Risk targeting** is the most complicated method, further expanding on the equal contributions achieved using the risk parity approach and further optimizing allocation weights over time such that the final portfolio is DTS-neutral to the broader investment universe.

Table 6 shows the information ratios of the different methods over the full period as well as during times of market stress for our US investment grade universe as well as for a US high yield universe. As the table shows, the various forms of risk parity may add value in times of stress, a result that is confirmed by several studies.[3] Over the full 20-year period, however, classic mean-variance optimization is clearly preferable.

Portfolio optimization

Factor targets have two kinds of active risk: (1) active factor exposures (intentional) and (2) residual risk exposures (unintentional). The unwanted residual risk exposures, which are the consequence of simple factor definitions or construction methodologies, should be minimized so that the major active risk exposures come from factor tilts.[4] Optimization allows us to explicitly set deviation constraints for these residual active risks (such as issuer, sector, OAS, DTS) while still prioritizing bonds with high factor exposures.

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Note: We refer to simulated portfolios as *targets* or *target portfolios*. These are constructed based on the historical holdings of various Bloomberg Barclays indexes, such as the US Investment Grade Corporate Index and US High Yield 2% Issuer Capped Index.

Table 6
Information ratios of five different asset allocation methods

	Macro period	Equal drawdown	Equal standard deviation	Mean variance	Risk parity	Risk targeting
US IG Target (LEH CORP Index)	**Full period**	**0.707**	**0.744**	**0.995**	**0.745**	**0.767**
	Depressed US credit returns	-0.693	0.358	-1.453	0.034	0.537
	Weak USD currency	0.714	0.430	1.505	0.532	0.400
	Depressed SP 500 returns	-0.632	0.164	-0.897	-0.089	0.314
	High VIX Index	-0.244	0.439	-0.297	0.225	0.648
	Average across stress periods	**-0.213**	**0.348**	**-0.286**	**0.176**	**0.475**
US HY Target (LHY2ICAP Index)	**Full period**	**0.179**	**0.185**	**0.252**	**0.180**	**0.179**
	Depressed US credit returns	-0.078	0.106	0.151	0.102	0.236
	Weak USD currency	0.235	0.164	0.261	0.156	0.122
	Depressed SP 500 returns	-0.039	0.121	0.181	0.115	0.229
	High VIX Index	0.094	0.194	0.279	0.187	0.268
	Average across stress periods	**0.053**	**0.146**	**0.218**	**0.140**	**0.214**

Source: Invesco. Information ratio of excess return across various macroeconomic conditions as measured by forming quartiles on the percentage change of the underlying macroeconomic variable. Monthly data from January 1, 2000, to December 31, 2021. Allocations for the multi-factor target are static but periodically reviewed.

Building on the simple multi-factor target based on the allocation framework described above, which constructs a naïve multi-factor target portfolio by blending several single factor target portfolios, we utilize an optimization step to take final risk constrains, portfolio bond count limitations, and turnover into account. This allows us to generate a smaller target portfolio that fulfills certain risk constraints while still having high exposure to multiple factors.

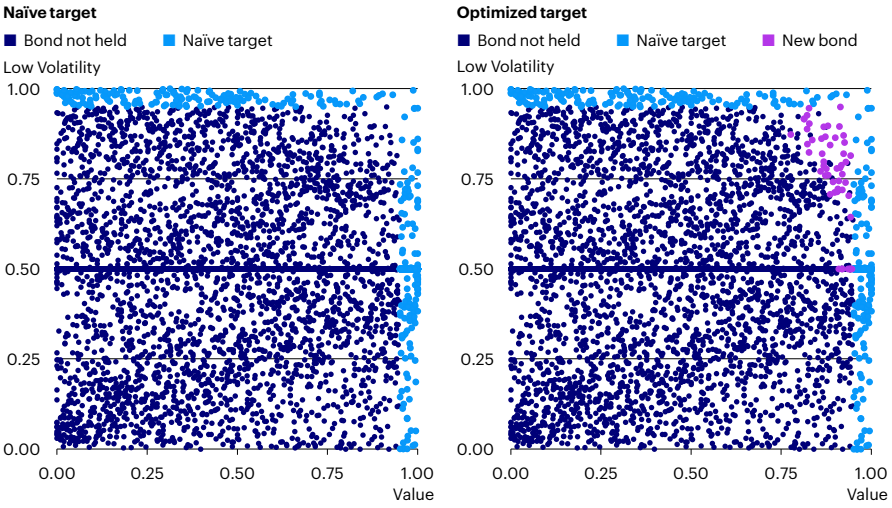
We seek to find an optimized target exhibiting high holdings overlap with the naïve multi-factor target (in terms of positions) and risk characteristics similar to those of our naïve target and benchmark. Figure 1 visualizes the optimization process. Each chart shows a scatter plot of value and low volatility factor scores for the individual bonds from the US investment grade universe on September 30, 2020. The light blue dots represent the bonds included in our naïve multi-factor target, whereas the dark blue dots represent those not included because of low factor scores. The naïve multi-factor target is on the left, the optimized target is on the right.

In a naïve target, by definition, we would simply select bonds in the top-most and right-most rectangles with factor scores higher than 0.95 (for illustrative purpose, we show only two factor dimensions here). The optimized target, on the other hand, also includes bonds from the upper-right corner, which do not fall into our factor rectangles. The optimized target selects them to satisfy the constraints on active risk exposures with respect to countries, sectors, duration etc.[5]

Rebalancing and attribution

Rebalancing can be based on TRACE data, Bloomberg dealer runs, market access data etc. To control turnover whenever trading a factor portfolio, we use a sampling approach: We sample tradable

Figure 1
Scatter plots of hypothetical two-factor portfolios



Source: Invesco. Hypothetical factor portfolio (low volatility and value) with constraints.

Table 7
Return attribution of a hypothetical US investment grade factor portfolio

Factor sleeve	Market value (average)	Portfolio excess return	Portfolio excess return contribution	Index excess return	Active excess return contribution
Full portfolio	100%	7040	7040	2208	4833
Low volatility	45%	2599	1167	2208	174
Value	36%	12574	4567	2208	3772
Carry	9%	13261	1083	2208	885
Tracking error control	10%	2229	223	2208	2

Source: Invesco. Data from January 1, 2000 to December 31, 2021. For illustrative purposes only. Portfolio excess return, portfolio excess return contribution, index excess return and active excess return contribution are stated in basis points

The performance of a multi-factor target portfolio can be cleanly attributed to the various factor sleeves.

bonds from our optimized target and portfolio being traded while controlling for other risk factors such as sector, rating and maturity. The main advantage here is that it allows for explicit security selection while minimizing turnover. From our experience, a classic optimizer-only approach not only produces higher turnover, but also results in portfolios with factor exposures different from those of the target portfolio. The automated rebalancing process can ensure that sampling occurs effectively across any construction dimension, e.g., sector, maturity bucket or rating without having to trade to explicitly match an optimized target holding for holding, all while producing a final entity that has high factor exposures.

Here, ex-post attribution analysis is also helpful to ensure that a portfolio's return is generated by the intended drivers rather than unintended bets. If the attribution approach is flexible and built around a faithful implementation of how the portfolio is constructed and traded, it has great potential to identify shortcomings and improve future portfolio management decisions.

The performance of a multi-factor target portfolio can be cleanly attributed to the various factor sleeves, as in the example in table 7. Over the past 20 years, the index achieved a return of over 200% percentage points. Therefore, as expected, value and carry would have performed well – as they usually do in up markets. Low volatility, on the other hand, may have been the largest allocation, but would have contributed comparatively little to the overall performance, again as expected.

When markets are rising, factors like carry and value should perform well. In our example, they account for 1083 bp and 4567 bp return contribution, i.e., for almost the entire return of the blended-factor target portfolio.

Conclusion

Credit factors have provided statistically significant alpha over credit benchmarks, and properly constructed single and multi-factor factor portfolios that are tradeble and take turnover and bond liquidity into account can achieve their targets in terms of risk controls and factor exposure, in particular when supplemented by optimization and automated trade generation techniques as well as performance attribution.

Notes
1 Technique developed by Fama and French (1993) and further refined by Bai (2018).
2 The low volatility effect has been observed in various asset classes; see Brinson (1986).
3 E.g., Litterman (2015) and Korajczyk (2011).
4 In theory, one should seek to find new factors that are orthogonal to the existing risk factors and thus represent unique risk dimensions. But, in our pure factor construction, not all risks are explicitly controlled.
5 These bonds are not the only possible solution for correcting unwanted active risk biases. Solutions can include combinations of bonds from any part of the factor grid. In this case, we intentionally tilt towards bonds with high factor exposures to raise efficiency.

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Interview with Jay Raol, Amritpal Sidhu, Benton Chambers, Bin Ying, Reed McDonnell and Nancy Razzouk

"Fixed income factors and equity factors share similar foundations"

Risk & Reward spoke to the Invesco Systematic and Factor Investing Group, co-authors of our study on fixed income factor portfolios.

Risk & Reward
How do fixed income factors compare with equity factors? Do they share any underlying economic drivers? Are they just as scalable?

Systematic and Factor Investing Group
Fixed income factors and equity factors share similar foundations. Think of concepts such as risk and return, supply and demand, and performance expectations in up or down markets. Many bond factors have the same economic rationale as their equity counterparts. In bonds – as in equites – value seeks to purchase assets that are cheap relative to their peers, and low volatility seeks less volatile bonds as well as less volatile equities. Fixed income factors are also scalable, and when controlled for size and liquidity metrics they can provide robust risk-adjusted returns in different market environments. Nevertheless, there are some implementation challenges, in particular in long-short portfolios.

Risk & Reward
Can you give an example of a bond factor constructed along similar lines as the corresponding equity factor?

Systematic and Factor Investing Group
Take value, for instance: In equities and in bonds, the value factor often relies on mean reversion. In equities, it identifies stocks that are trading at a price below their fundamental value, such as earnings or book value – the idea being that the price will eventually return to the intrinsic value of the security, generating returns if you purchased them at a discount. In fixed income, the value factor can be constructed by identifying bonds that are trading at a discount. They may have a higher yield or a lower price than other bonds in a similar rating class, maturity segment or industry sector. In both equities and fixed income, the value factor seeks to capture the long-term return premium associated with buying low and selling high.

Risk & Reward
Can you briefly describe the research process? How do you evaluate new ideas?

Systematic and Factor Investing Group
Factor research is open-ended and encourages equal input from all team members. In regular meetings we set goals and evaluate ideas based on their relevance. It's important that a concept works in different markets, for efficiency reasons but also as proof of its economic rationale. We use a variety of data sources and market insights, and we thoroughly assess potential risks and limitations.

Risk & Reward
What is your underlying factor philosophy? How do you deal with complexity, and what do you do to facilitate implementation?

Systematic and Factor Investing Group
Simplicity and an ease of implementation are central to the approach. Complex factors may sometimes appear smart and promising, but in practice they often cause problems. They can require more data and analysis, which leads to higher costs and more uncertain results. More complex factors may also be harder to trade and monitor – so that maintaining a consistent investment strategy over time can become quite a challenge. Ultimately, successful factor investing requires a strategy that is grounded in sound economic principles yet is also straightforward and easy to execute.

Risk & Reward
How do you evaluate the statistical robustness of a factor? And does this offer insight into its scalability and liquidity?

Systematic and Factor Investing Group
We seek factors with similar performance across different asset classes, for example US high yield or European investment grade debt – we think such factors are more robust. We control for credit rating or issue size, and we prefer factors with a robust alpha when controlled for numerous metrics. In addition, we analyze their performance under various market conditions using macroeconomic data. Not only do we aim for high alpha, we also compare the factor performance with our expectations because a factor that should theoretically perform well in an up market shouldn't perform poorly when the index is rising.

Risk & Reward
What risk controls and constraints can be applied, and what is the role of optimization?

Systematic and Factor Investing Group
Multiple risk controls can be applied to ensure that factor portfolios are well-diversified and appropriately balanced. For instance, factors can be ranked across numerous control buckets, with index weights allocated to selected dimensions, like country or maturity. This helps ensure broad diversification over risk factors.

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In equities and in bonds, the value factor often relies on mean reversion.

"

Factor research is open-ended and encourages equal input from all team members.

Portfolio blending means better transparency and interpretability.

Then, a light-touch optimization can help achieve more nuanced controls while reducing the number of bonds in the portfolio. Generally, we think optimizers should be used as little as possible to improve clarity. Indeed, an optimizer can sometimes be a bit of a black box.

Risk & Reward
One final question: I know it is not part of your most recent study, but it's no secret that you prefer portfolio blending to signal blending in multi-sector factor portfolios. Why?

Systematic and Factor Investing Group
Indeed we do – and for various good reasons. First, portfolio blending allows for a more straightforward rebalancing. Each asset class-specific factor portfolio is constructed separately before the individual portfolios are combined. This simplifies rebalancing since we can adjust the individual portfolios' weights without having to modify the signal combination itself. Second, portfolio blending allows use of existing attribution methods such as Brinson to monitor portfolio performance through a factor lens. Portfolio blending means better transparency and interpretability. The individual factor contributions to the overall portfolio are easier to understand.

Risk & Reward
Thank you very much!

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