Bloomberg Professional Services

Systematic Strategies

Performance of Style Portfolios in Credit Markets

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Summary and Outline

Factor investing has been well studied and documented by academics and practitioners in equity markets. Investment strategies which harvest well-defined premia such as value, momentum, size and quality have grown in popularity as more investors became familiar with their properties. Investing in factor strategies has, since, extended to other asset classes such as FX or Commodities but not necessarily to credit markets. Our research provides strong evidence that the concept and benefits of factor investing extend to corporate bond markets. Although our research on credit style investing is guided by common equity styles, we make the necessary adjustments to account for important differences between the two markets particularly with regard to the portfolio implementation and the liquidity constraints of corporate bonds.

This note focuses on the performance of tradable style portfolios in US and European Investment Grade markets and High yields markets. It summarizes the economic intuition behind each premium, the portfolio implementation assumptions, its turnover and assumed historical transaction costs. It compares the factor portfolio's historical performance to relevant benchmark indices on an annual basis and summarizes the performance net of transaction costs in the last section.

The outline of the paper is as follows:

Description of the Data Universe

We use monthly constituent data of the Bloomberg Barclays U.S. Credit Corporate Investment Grade Index (USIG), the U.S. High Yield Index (USHY) and the EU Credit Corporate Investment Grade Index (EUIG). Our data covers the period from January 1996 to June 2018 in the US and from January 2001 to June 2018 in European markets (after the introduction of the Euro currency).
This long back-test period covers three major distress episodes in credit markets: the 2002 global recession, the 2008 financial crisis and 2011 sovereign crisis in Europe. For each bond and each month, we rely on index computed analytics, characteristics and returns. The data are free from survivorship bias: if an issuer defaults, we compute the returns of its bonds from the end of month prices, which reflect the expected recovery rates.

For the purpose of our analysis, we base our research on the excess returns of corporate bonds over duration-matched Treasuries in order to isolate the credit premium. The duration premium, which is directly linked to changes in interest rates, can be efficiently harvested using treasury bonds or futures. Portfolio managers can closely replicate the excess return outperformance by using Treasury bond futures to hedge out their interest rate exposure.

All of our credit factors are constructed using only Fixed-income bond characteristics and do not rely on any accounting data or equity market information. This approach allows us to include all bonds in our analysis and not just the bonds issued by public companies. Furthermore, these definitions facilitate the transparency and actual implementation of the factor portfolios. While we recognize that information from the underlying equity might enhance our style factors definition and results, we feel that the current factors definitions already show very strong outperformance with respect to the market weight benchmarks over the past two decades.

Bond Level Transaction Cost Assessment

An important consideration in our factor implementation is the diversity of bonds liquidity profiles. Corporate bonds differ greatly in their liquidity, which affects both their transactions cost levels and immediacy of trade execution. The proper assessment of transaction costs also helps determine the outperformance of the style portfolios net of trading costs accurately.

From this perspective, we developed a conservative and realistic framework to estimate bid-offer spreads of all bonds in the three investment universes historically (USIG, USHY and EUIG). This framework relies on institutional size executed trades between dealers and clients obtained from trade transparency platforms (such as TRACE in the US) expressed as a percentage of the bond's price. Bid-ask costs for bonds which have not traded actively in a given month are the result of a cross sectional regression based on bond level characteristics such as DTS, age, amount outstanding and subordination type. These costs are then adjusted upward using a multiplier[1] to account for fact that "non-traded" bonds are intrinsically more expensive to trade than actively traded bonds with similar characteristics[2].

[1] The adjustment coefficients depends on the market macro level bid-ask dispersion and the number of months the bond has "not-traded"
[2] Transaction cost are backfilled prior to 2007 used bond-level characteristics

US Investment Grade

Low-Risk Portfolio

Defining the Factor

The Low-Risk factor, defined as a combination of the bond's historical and idiosyncratic excess return volatilities over the previous year, captures the Low-Risk anomaly in Credit markets: Low volatility securities have better risk-adjusted return than high volatility securities.

Portfolios constructed using bonds which rank low on our risk metric have averaged higher excess returns than the IG market with much lower volatilities over the past 20 years. They have also suffered much smaller losses in periods of market distress like 2008 and 2011.

Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the Low-Risk characteristic defined in the previous section. In order to limit the turnover, the low-risk portfolio buys bonds in the 9th decile, holds them as they possibly migrate to the 10th/8th deciles and sells them if they ever drop past the 8th decile. The Low-risk portfolio, under this implementation, averaged 56% annual turnover over the 1997-2018 back-testing period.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[3] profile of the Low-risk portfolio in its tradable format.

The results section, additionally, provides the portfolio's average analytics and highlights some of its liquidity characteristics. It is important to understand how much of an illiquidity premium is associated with a given factor. From that perspective, we highlight the portfolio's average monthly traded[4] volume and average percentage of "actively traded"[5] bonds it contains.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the benchmark index excess return.

	Low-Risk	US IG
Return	0.80	0.60
Volatility	1.83	4.51
SR	0.44	0.13
Alpha	0.58	
Drawdown	-5.0	-8.4
OAS	93	153
OASD	2.7	6.3
Volume in MM	47	71
% Traded Bonds	50%	52%
T-Cost (bps)	41	63
Turnover	56%	26%

The Low-risk portfolio has a Sharpe Ratio of 0.44 which is more than three times the USIG index SR of 0.13. The portfolio has 60 bps annualized alpha to the market.

As a result of the portfolio's lower spread and spread duration, it has averaged a much lower round trip transaction cost from 1997 to 2018 (41 bps).

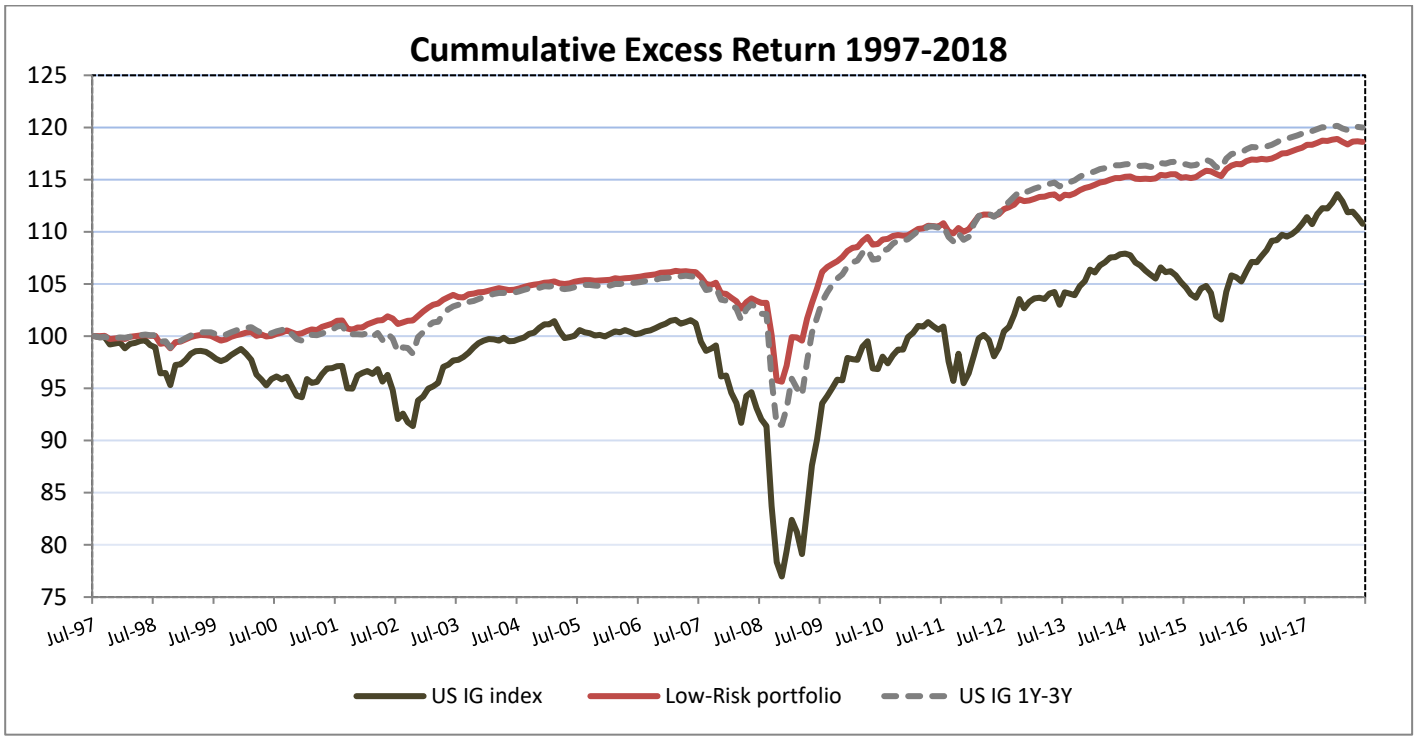
The Low-risk factor has a significant positive net-alpha in both total returns and excess returns.

3 Returns, Volatilities and alphas are annualized

4 Traded Dealer-Client Volume (From TRACE starting in 2007)

5 "Actively traded bonds" are defined as corporate bonds with at least three days of two way trading between dealers and clients and at least 20 Million dollars of total volume for the month

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Low-Risk portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the short duration IG index (1Y to 3Y duration). The Low-risk portfolio had significantly lower drawdowns in market distress episodes than both the USIG and USIG1Y3Y indices (like the dot-com/telecom crisis in early 2000s and the financial crisis of 2008).

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0.1%	0.6%	1.5%	1.8%	0.9%	0.2%	0.7%	-1.9%	-6.6%	11.3%	1.4%	0.5%	2.5%	1.2%	0.6%	0.6%	1.1%	1.5%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USIG index **Low-Risk**

The table above shows the monthly-compounded annual excess returns of the USIG universe (in blue) and the Low-risk portfolio. The Low-risk factor has a much lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It has significantly outperformed the market in 2000,2002,2007,2008 and 2011.

Results after Transactions Costs

The Low-risk factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Low-Risk	0.56%	1.81%	0.38%	4.26%	2.45%	2.06%

US Investment Grade

Momentum Portfolio

Defining the Factor

The momentum factor is based on the behavioral bias where past winners (losers) tend to continue to outperform (underperform). Momentum needs divergent levels of performance between bonds to be an effective selection variable in IG markets. In order to create a disperse momentum signal, we define our momentum ranking measure as the cumulative past 6 months residualized[6] excess returns.

Portfolios constructed using bonds with high momentum exposures have averaged much higher excess returns to the market with lower levels of volatilities.

Momentum Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the momentum characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their momentum signal deteriorates significantly.

Additionally, while rebalancing, the momentum portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[7] profile of the Momentum portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Momentum	US IG
Return	1.09	0.60
Volatility	3.23	4.51
SR	0.38	0.13
Alpha	0.72	
Drawdown	-6.1	-8.4
OAS	161	153
OASD	5.1	6.3
Volume in MM	64	71
% Traded Bonds	54%	52%
T-Cost (bps)	55	63
Turnover	208%	26%

The Momentum portfolio has a Sharpe Ratio of 0.38 which is about three times the USIG index SR of 0.13. The portfolio has 72 bps annualized alpha to the market.

The Momentum portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[8] are comparable to the USIG market averages.

Under our current implementation, the momentum portfolio still has a very high annual turnover at 208%.

The momentum signal in investment grade markets tend to vary significantly over time and deteriorate quickly. Investors face the practical choice of holding bonds with a weakened signal and potentially poorer performance prospects or incurring high transaction costs which could significantly reduce returns. The momentum portfolio, as defined in section 2, has a positive net alpha in total return space[9].

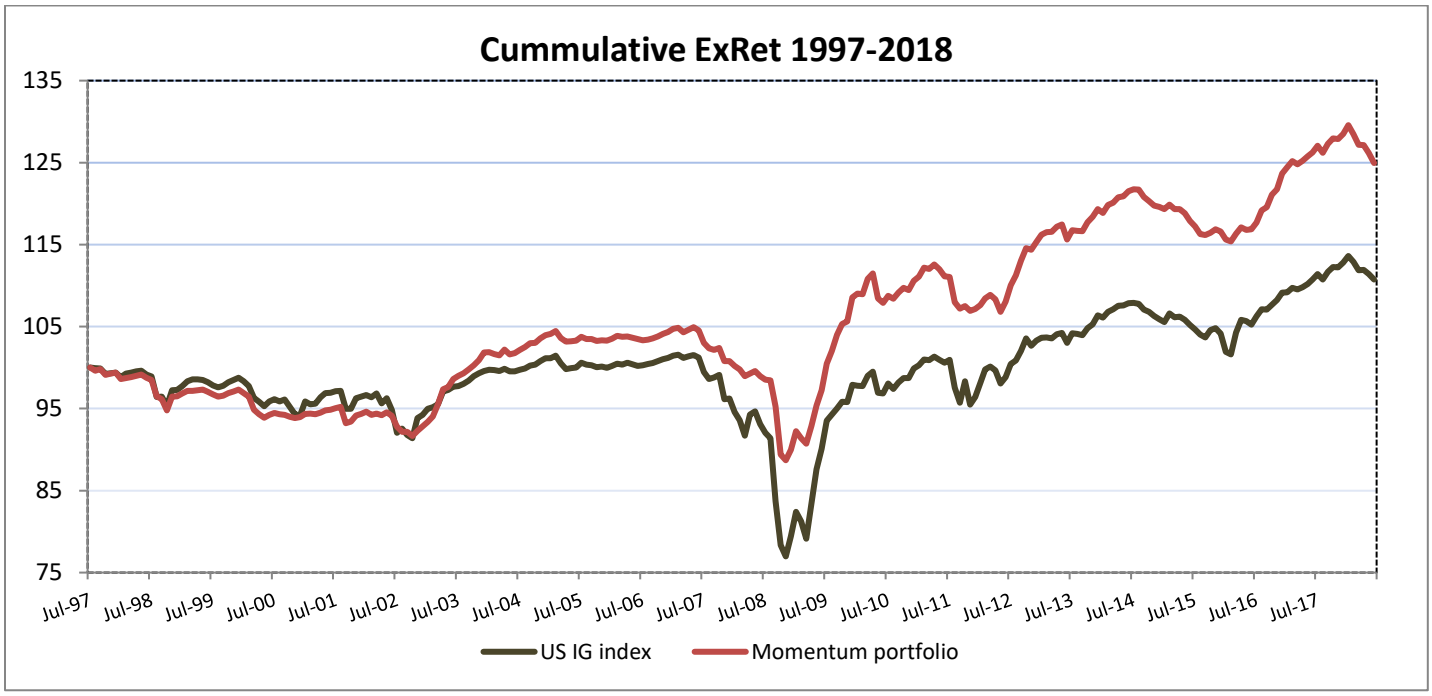
6 Our 'residualization' technique isolates the bond's momentum that can be attributed to the security-specific component and eliminates its systematic component part

7 Returns, Volatilities and alphas are annualized

8 "Actively traded bonds" are defined as corporate bonds with at least three days of two way trading between dealers and clients and at least 20 Million dollars of total volume for the month

9 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Momentum portfolio and how it compares to the US IG index (in black). The momentum portfolio has a lower drawdown in the 2008 financial crisis (-6.1% vs -8.4%) and has historically outperformed the IG index in bull markets.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-3.4%	0.4%	-1.6%	9.7%	2.1%	-0.6%	1.0%	-3.4%	-10.7%	20.6%	1.9%	-3.1%	7.6%	3.5%	0.2%	-2.5%	6.0%	3.9%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USIG index | Momentum

The table above shows the monthly-compounded excess returns of the USIG universe (in blue) and the Momentum portfolio on an annual basis. As noted earlier, the momentum factor tends to outperform in Credit bull markets like 2003-2004 and 2012-2013. It has suffered smaller losses in episodes of market distress like 2002, 2008 and 2011.

Results after Transactions Costs

As a result of its high-turnover, the momentum factor portfolio has a positive net-alpha in total returns but a negative net-alpha in excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Momentum	0.03%	3.20%	-0.31%	4.27%	4.13%	0.44%

US Investment Grade

Value Portfolio

Defining the Factor

The value factor assumes a homogenous market where a bond's spread can be implied from its peer group. A given peer group is defined as the set of bonds with similar duration/Industry/rating and subordination type characteristics.

Credit spreads, however, typically spike/drop months before the rating-agencies downgrades/upgrades. We incorporate this information by manually updating the bond's rating if its spread significantly spiked or dropped without a corresponding rating adjustment from the rating-agencies.

The Value factor exploits the mean-reversion of bonds' spreads to the "fair" values derived from their peers.

The average excess return of the value ranked decile portfolios is monotonically increasing. Portfolios containing bonds with high value exposure have averaged significantly higher excess returns than the USIG index with comparable levels of volatilities.

Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the value characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th deciles and sells them once their value signal deteriorates significantly.

Additionally, while rebalancing, the value portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[10] profile of the Value portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Value	US IG
Return	1.70	0.60
Volatility	4.81	4.51
SR	0.36	0.13
Alpha	1.10	
Drawdown	-9.0	-8.4
OAS	188	153
OASD	5.3	6.3
Volume in MM	82	71
% Traded Bonds	55%	52%
T-Cost (bps)	61	63
Turnover	152%	26%

The Value portfolio has a much higher average return than the market (1.7% vs. 0.6%) and a comparable level of volatility (4.8% vs 4.5%) and, as a result, a substantial 1.1% annualized alpha.

The Value portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[11] are comparable to the USIG market averages.

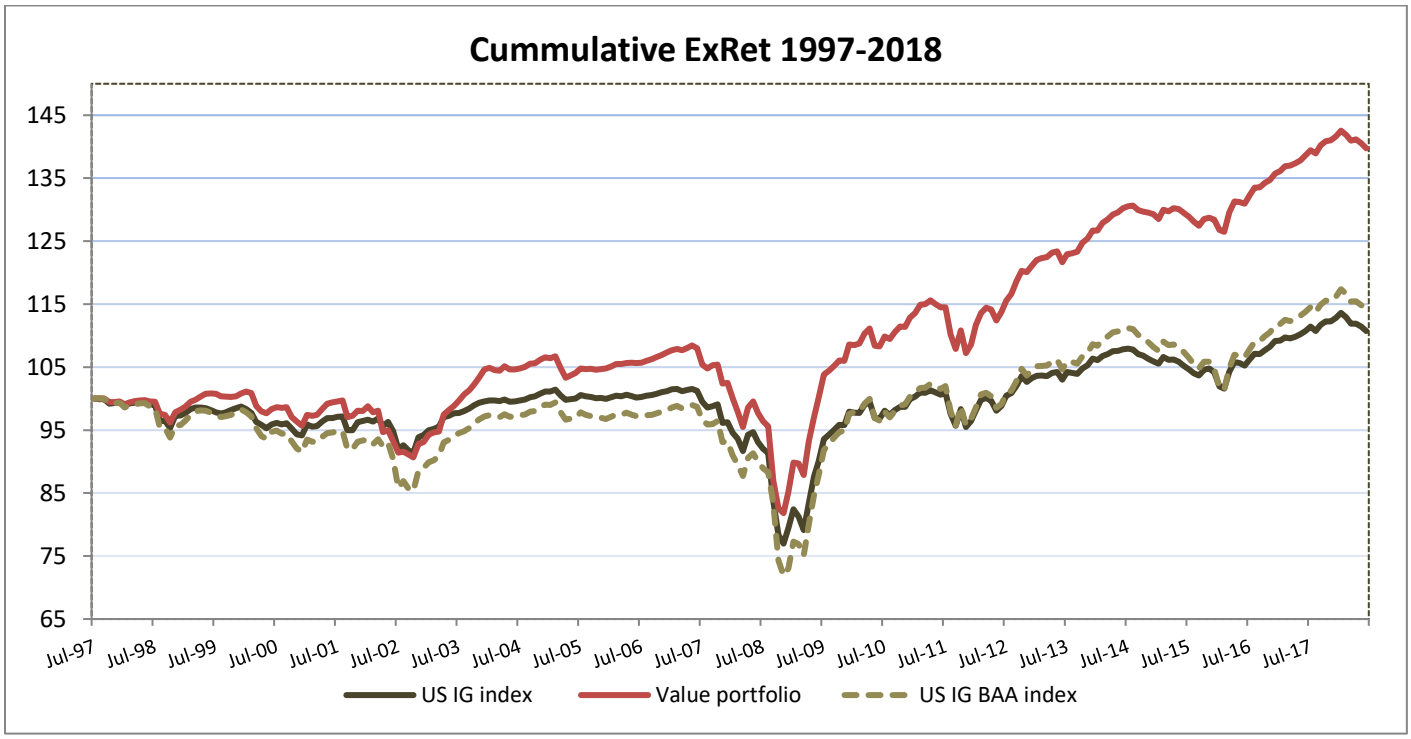
The Value portfolio averaged a higher spread than the USIG index and lower spread duration over the 1997-2018 back testing period.

Despite its high turnover, the value has positive alpha in both total returns and excess returns.

10 Returns, Volatilities and alphas are annualized

11 "Actively traded bonds" are defined as corporate bonds with at least three days of two way trading between dealers and clients and at least 20 Million dollars of total volume for the month

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Value portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the IG BAA rated index which has averaged similar spread levels to the value portfolio. The value factor has a higher spread than the index and, as a result, tends to outperform (underperform) the market index when spreads tighten (widen).

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-5.1%	2.4%	-5.1%	12.4%	1.8%	-1.7%	2.5%	-4.5%	-16.9%	27.5%	3.9%	-3.8%	11.5%	4.6%	2.0%	-0.7%	5.7%	4.3%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USIG Index	Value

The table above shows the monthly-compounded annual excess returns of the Value portfolio and the USIG universe (in blue). As noted earlier, the Value factor has typically a higher spread than the index and, as a result, tends to outperform in periods when spreads tighten like 2003, 2009, and 2012-2016. It has outperformed the IG index in 9 of the past 10 years.

Results after Transactions Costs

The Value portfolio still has a positive net-alpha in both total returns and excess returns using conservative historical transactions costs.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Value	0.68%	4.81%	0.15%	5.44%	5.04%	0.39%

US Investment Grade

Size Portfolio

Defining the Factor

Size refers to the extra premium that can be achieved by investing in bonds of small companies. The size factor exploits the fact that small companies are under-researched and often neglected by fundamental shops and ETFs which usually track liquid benchmarks. Our definition for size uses the total size of a given company's public debt as a ranking measure[12].

Small size portfolios have averaged much higher excess returns to the market with comparable levels of volatilities.

While we recognize that size captures an illiquidity effect, we argue that the premium it offers still holds after accounting for the higher transactions costs small cap bonds incur.

Size Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the size characteristic defined in the previous section. Contrary to the other factors, we assume the bonds in each decile portfolio are equally weighted. Size is a stable signal thru time and the factor portfolio, therefore, constantly tracks bonds in the top decile D10.

The size portfolio, under this implementation, averaged 86% annual turnover over the 1997-2018 back-testing period.

Portfolio Performance and Characteristics

The next table shows equal weighted risk-return[13] profile of the size portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Size	US IG
Return	1.87	0.60
Volatility	4.31	4.51
SR	0.43	0.13
Alpha	1.40	
Drawdown	-8.2	-8.4
OAS	219	153
OASD	6.3	6.3
Volume in MM	8	71
% Traded Bonds	5%	52%
T-Cost (bps)	81	63
Turnover	86%	26%

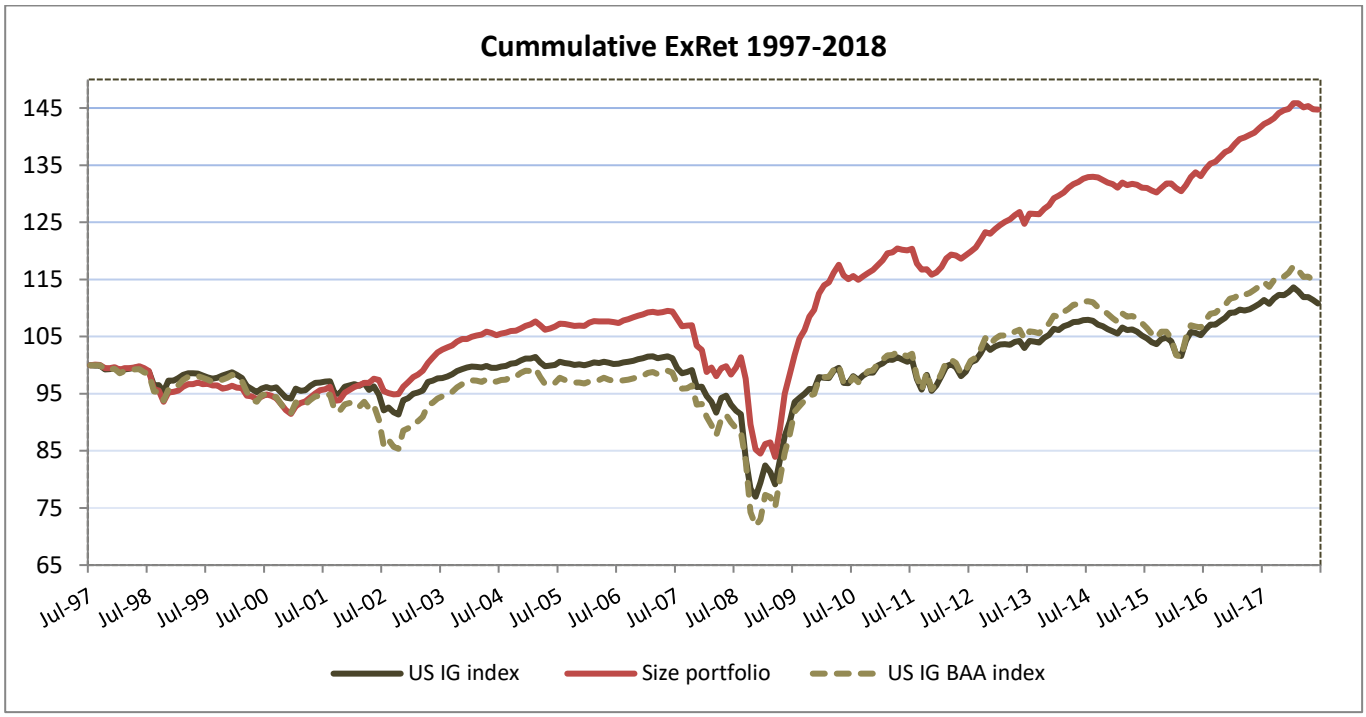
The size portfolio has a much higher average return than the market (1.9% vs. 0.6%) with lower volatility (4.3% vs 4.5%). This results in a substantial annualized alpha of 1.4%.

As expected, the size factor captures a significant illiquidity premium. Bonds in the style portfolio have only averaged 7.6 million dollars monthly in traded volume which amounts to about a 1/10th of the market average (71 MM). In addition to that, only a fraction of the portfolio composition (about 5%) has been actively traded (much lower than the market average of 52%). The portfolio has also averaged a much higher trading cost 81 bps vs. 63 bps.

Despite its high trading cost the portfolio incur, the size factor has a significant positive net-alpha in both total returns and excess returns.

[12] Similar to Houweling and Van Zundert (2018)
[13] Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the size portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the short duration IG BAA index which has averaged comparable high spread levels. The size factor, which consists of bonds issued by small companies, has historically outperformed the index in periods when spreads tighten.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-5.1%	4.6%	1.4%	7.8%	2.2%	0.0%	1.9%	-5.7%	-17.7%	33.1%	4.4%	-1.1%	6.5%	4.3%	1.9%	0.1%	4.5%	5.2%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USIG index	Size

The table above shows the monthly-compounded annual excess returns of the size portfolio and the USIG universe (in blue). The size factor has significantly outperformed in Credit bull markets like 2003-2004 and the credit market rally of 2009. It can however suffer large drawdowns in periods of market distress like the financial crisis (-17.7% in 2008). It has outperformed the market index in 7 of the last 10 years.

Results after Transaction Costs

The Size factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Size	1.40%	4..32%	1.04%	6.55%	5.10%	1.90%

US Investment Grade

Momentum/Value Portfolio

Defining the Factor

As a result of the low/negative active[14] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification across factors (Style Blending)[15].
While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Value integrated factor. Each bond's Value and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Value integrated factor.

The resulting portfolio has even higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Value factors.

Momentum/Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the Momentum/Value composite signal defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.
Additionally, while rebalancing, the portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.
By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

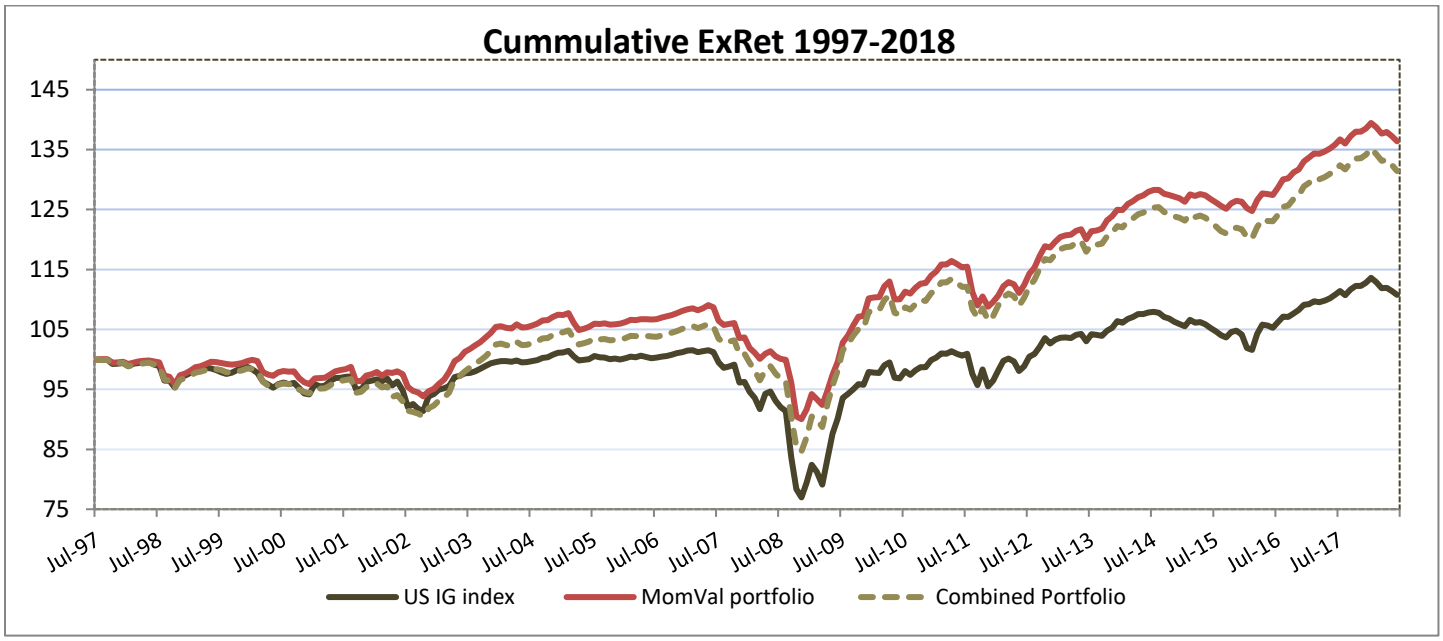
The next table shows the market-value weighted risk-return[16] profile of the Momentum/Value portfolio as well as its other characteristics.
The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Mom/Val	US IG
Return	1.55	0.60
Volatility	3.45	4.51
SR	0.45	0.13
Alpha	1.13	
Drawdown	-5.8	-8.4
OAS	171	153
OASD	5.1	6.3
Volume in MM	68	71
% Traded Bonds	55%	52%
T-Cost (bps)	57	63
Turnover	108%	26%

The Momentum/Value portfolio has a much higher average return than the market (1.55% vs. 0.6%) and a significantly lower level of volatility (3.5% vs 4.5%) resulting in a substantial annualized alpha of 1.1%.
The Momentum/Value integrated portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[17] are comparable to the USIG market averages.
The Momentum/Value portfolio averaged higher excess returns than either the Momentum or Value portfolios in their standalone format. It has a significant alpha in both total returns and excess returns after accounting for transaction costs

14 Active returns are defined as the difference of the portfolio and market returns
15 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio
16 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the momentum-value integrated portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the equally weighted momentum and value portfolios described previously. The integrated momentum value portfolio has outperformed both the USIG index and the combined portfolio of the two standalone styles over our back-testing period.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-3.9%	1.7%	-2.5%	10.9%	1.9%	-1.4%	2.0%	-4.1%	-11.6%	20.2%	3.4%	-3.8%	9.2%	4.5%	1.5%	-0.5%	5.4%	4.1%
-4.3%	1.2%	-3.3%	11.1%	1.9%	-1.2%	1.7%	-4.0%	-13.8%	24.1%	2.9%	-3.4%	9.6%	4.0%	1.1%	-1.6%	5.9%	4.1%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Mom/Value | USIG index | Combined

The table above shows the annualized returns of the Momentum-Value integrated portfolio and the USIG universe (in blue) and over the past 18 years. The table also highlights the annual performance of the equally weighted combination of Value and Momentum portfolios (portfolio mix). The integrated portfolio has outperformed the market in 13 of the past 18 years (6 out the last 6 years).

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Momentum/Value	0.81%	3.42%	0.46%	5.47%	4.02%	1.50%

US Investment Grade

Momentum/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[18] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[19].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Low-Risk integrated factor. Each bond's Low-Risk and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Low-Risk integrated factor.

The resulting portfolio has even higher risk-adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Low-Risk factors.

Momentum/Low-Risk Factor Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the Momentum/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the integrated portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the factor portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[20] profile of the Momentum/Low-Risk portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Mom/LowRisk	US IG
Return	1.23	0.60
Volatility	1.93	4.51
SR	0.64	0.13
Alpha	1.02	
Drawdown	-4.5	-8.4
OAS	103	153
OASD	2.5	6.3
Volume in MM	45	71
% Traded Bonds	50%	52%
T-Cost (bps)	42	63
Turnover	114%	26%

The Momentum/Low-risk portfolio has a much higher average return than the market (1.2% vs. 0.6%) and less than half of its volatility (1.9% vs 4.5%) resulting in a significant 1% annualized alpha.

The integrated portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[21] are comparable to the USIG market averages.

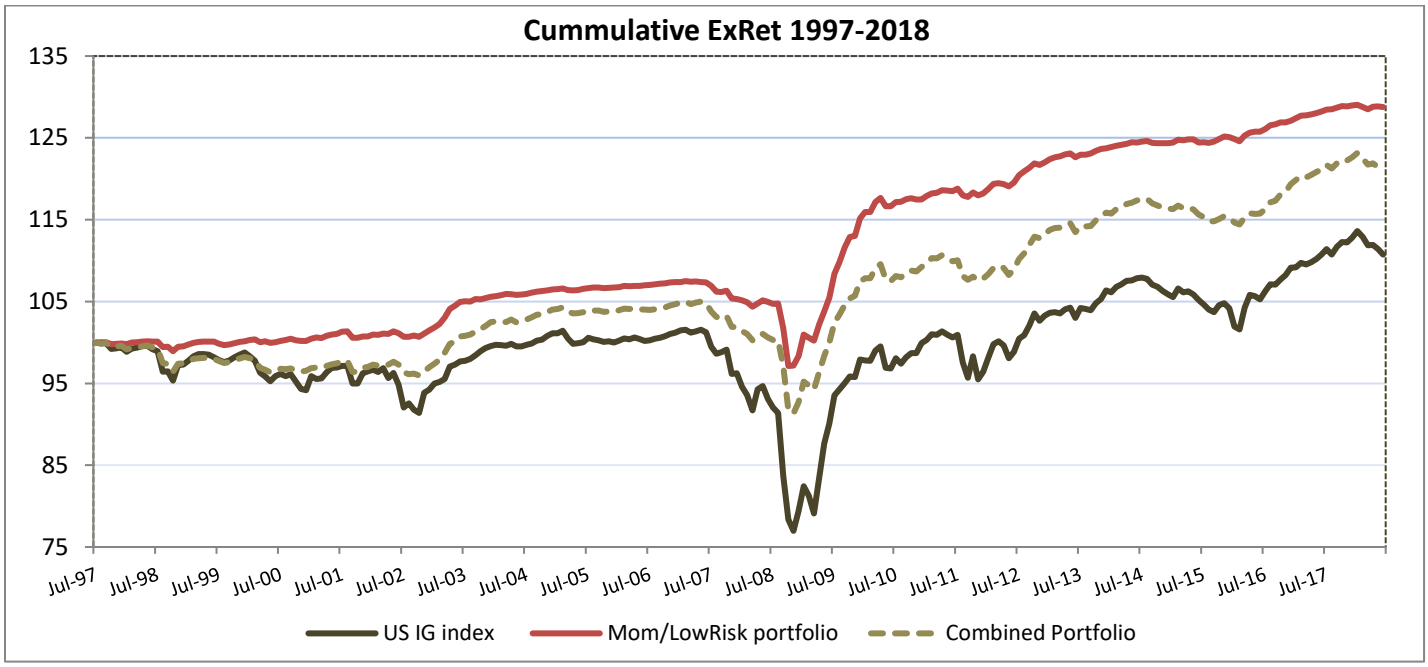
The Momentum/Low-Risk portfolio has averaged a much lower transaction cost (42 bps) and has a significant alpha in both total returns and excess returns after accounting for transaction costs

18 Active returns are defined as the difference of the portfolio and market returns

19 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

20 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the momentum/low-risk integrated portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Momentum and Low-Risk individual portfolios described previously. The integrated portfolio has outperformed both the USIG index and the combined portfolio of the two standalone styles.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0.0%	0.6%	0.7%	4.1%	0.9%	0.2%	0.6%	-1.9%	-6.6%	17.1%	2.0%	0.6%	3.2%	1.4%	0.5%	0.6%	1.6%	1.5%
-1.7%	0.5%	-0.1%	5.7%	1.5%	-0.2%	0.9%	-2.7%	-9.0%	15.9%	1.6%	-1.3%	5.0%	2.3%	0.4%	-0.9%	3.5%	2.7%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Mom/LowRisk | USIG index | Combined

The table above shows the annualized returns of the integrated portfolio, the USIG universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has a much lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Momentum factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Momentum/LowRisk	0.68%	1.92%	0.51%	4.22%	2.36%	2.20%

US Investment Grade

Value/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[22] correlations between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[23].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Value/Low-Risk integrated factor. Each bond's Low-Risk and Value scores are blended into one average composite measure. This composite score is then used to rank bonds in the Value/Low-Risk integrated factor. The resulting portfolio has even higher risk adjusted returns because it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both factors.

Value/Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the Value/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the factor portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[24] profile of the Value/Low-risk portfolio as well as its other characteristics.

	Value/LowRisk	US IG
Return	1.29	0.60
Volatility	2.10	4.51
SR	0.61	0.13
Alpha	1.03	
Drawdown	-4.4	-8.4
OAS	120	153
OASD	3.5	6.3
Volume in MM	46	71
% Traded Bonds	46%	52%
T-Cost (bps)	47	63
Turnover	89%	26%

The Value/Low-risk portfolio has a much higher average return than the market (1.2% vs. 0.6%) and less than half of its volatility (1.9% vs 4.5%) resulting in a significant 1% annualized alpha.

The Value/Low-risk signal integration is an interesting blend since the low-risk factor emphasizes bonds with low spreads whereas the value factor does the opposite. The resulting portfolio seems to keep its excess returns outperformance while its volatility decreases. The integrated portfolio has averaged a lower spread than the USIG index. Additionally, the portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[25] are comparable to the USIG market averages.

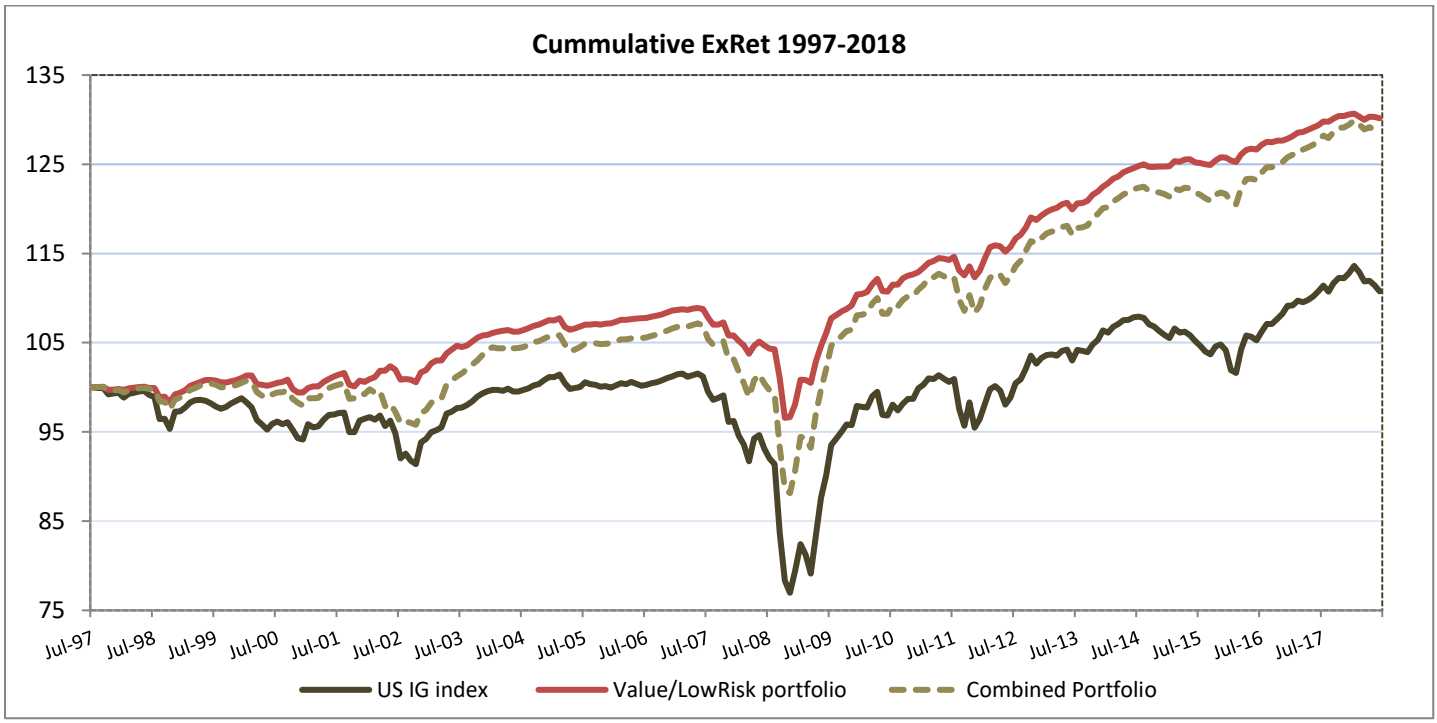
The style portfolio has a significant net-alpha in both total returns and excess returns.

22 Active returns are defined as the difference of the portfolio and market returns

23 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio.

24 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the Value/Low-Risk integrated portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Value and Low-Risk individual portfolios described previously. The integrated portfolio has outperformed both the market index and the combined portfolio of the two standalone styles. It had much lower drawdowns in 2008 and 2002.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-1.6%	1.2%	1.3%	3.9%	1.5%	-0.3%	1.3%	-2.6%	-7.3%	12.5%	2.3%	0.1%	5.5%	2.7%	1.8%	0.8%	1.7%	2.1%
-2.5%	1.3%	-1.8%	7.0%	1.3%	-0.7%	1.6%	-3.2%	-12.1%	19.2%	2.6%	-1.6%	6.9%	2.9%	1.3%	0.0%	3.4%	2.9%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Value/Low-Risk | USIG index | Combined

The table above shows the annualized returns of the Value/Low-Risk integrated portfolio, the USIG universe (in blue) and the along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Value factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Value/LowRisk	0.86%	2.11%	0.64%	4.91%	2.89%	2.16%

US Investment Grade

Multi-Style Portfolio

Defining the Factor

As a result of the low/negative active[26] between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[27].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Multi-Style Portfolio. Each bond's Low-Risk, Momentum and Value scores are blended into one average composite measure. This composite score is then used to rank bonds the Multi-Style integrated factor.

The resulting portfolio has much higher risk adjusted returns because as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to the three factors.

Multi-Style Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US IG universe on the three style composite signal defined in the previous section. In order to limit the turnover, the multi-style portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their composite signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[28] profile of the integrated portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USIG benchmark index excess return.

	Multi-Style	US IG
Return	1.85	0.60
Volatility	2.29	4.51
SR	0.81	0.13
Alpha	1.58	
Drawdown	-4.6	-8.4
OAS	131	153
OASD	3.5	6.3
Volume in MM	51	71
% Traded Bonds	49%	52%
T-Cost (bps)	48	63
Turnover	99%	26%

The Multi-Style portfolio has averaged a higher return than any of the previously defined factors. It also has a volatility of 2.3% over the 1997-2018 back-testing period resulting in a significant 1.6% annualized alpha.

The multi-style portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[29] are comparable to the USIG market averages.

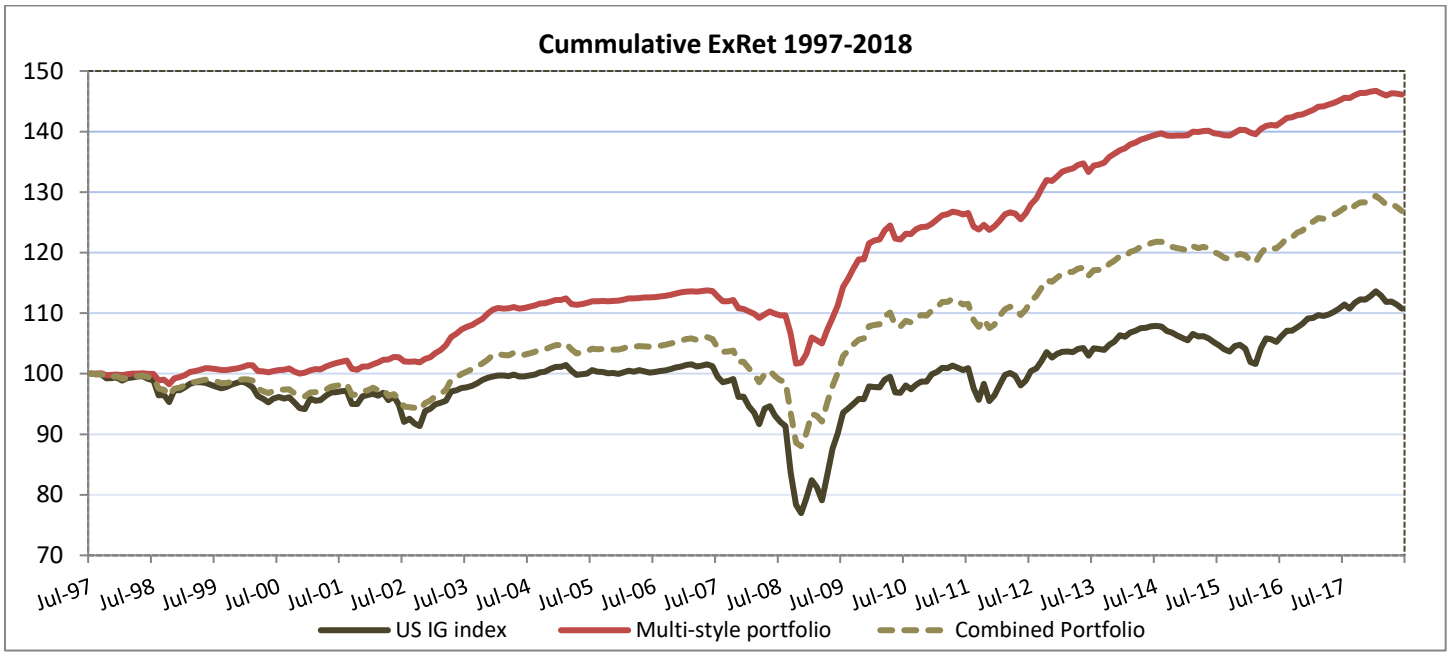
The Multi-Style portfolio exhibits a rather stable performance over the past two decades has a significant net-alpha in both total returns and excess returns.

26 Active returns are defined as the difference of the portfolio and market returns

27 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

28 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the multi-style portfolio and how it compares to the US IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the momentum, value and low-risk standalone portfolios described previously. The Multi-Style portfolio has largely outperformed both the USIG index and the mix portfolio over the 1997-2018 back-testing period.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-0.9%	1.0%	1.5%	7.7%	1.4%	-0.1%	1.2%	-2.4%	-6.8%	17.7%	2.7%	-0.3%	6.6%	3.3%	1.8%	0.6%	2.1%	2.3%
-2.8%	1.0%	-1.7%	7.9%	1.6%	-0.7%	1.4%	-3.3%	-11.6%	19.7%	2.4%	-2.1%	7.2%	3.1%	1.0%	-0.8%	4.3%	3.3%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Multi-Style	USIG index	Combined

The table above shows the annualized returns of the Multi-Style portfolio, the USIG universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). In our back-test, The Multi-Style portfolio has realized comparable returns to the USIG index in credit bull markets with a significant downside protection in periods of market distress like 2000, 2002, 2007, 2008, 2011, 2014 and 2015.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US IG index	0.52%	4.51%		5.55%	5.25%	
Multi-Style	1.31%	2.24%	1.08%	5.36%	2.99%	2.58%

US High-Yield

Low-Risk Portfolio

Defining the Factor

The Low-Risk factor, defined as a combination of the bond's historical and idiosyncratic excess return volatilities over the previous year, captures the Low-Risk anomaly in high-yield Credit markets: Low volatility securities have better risk-adjusted return than high volatility securities.

Portfolios constructed using bonds which rank low on our risk metric have averaged similar excess returns to the US HY index with much lower volatilities over the past 20 years.

Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the Low-Risk characteristic defined in the previous section. In order to limit the turnover, the low-risk portfolio buys bonds in the 9th decile, holds them as they possibly migrate to the 10th/8th deciles and sells them if they ever drop past the 8th decile. The Low-risk portfolio, under this implementation, averaged 90% annual turnover over the 1997-2018 back-testing period.

Additionally, while rebalancing, the portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[30] profile of the Low-risk factor portfolio in its tradable format.

The results section, additionally, provides the portfolio's average analytics and highlights some of its liquidity characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Low-Risk	US HY
Return	2.45	2.39
Volatility	5.23	10.37
SR	0.47	0.23
Alpha	1.36	
Drawdown	-12.5	-16.5
OAS	324	543
OASD	2.8	4.4
Volume in MM	42	63
% Traded Bonds	38%	42%
T-Cost (bps)	88	115
Turnover	90%	40%

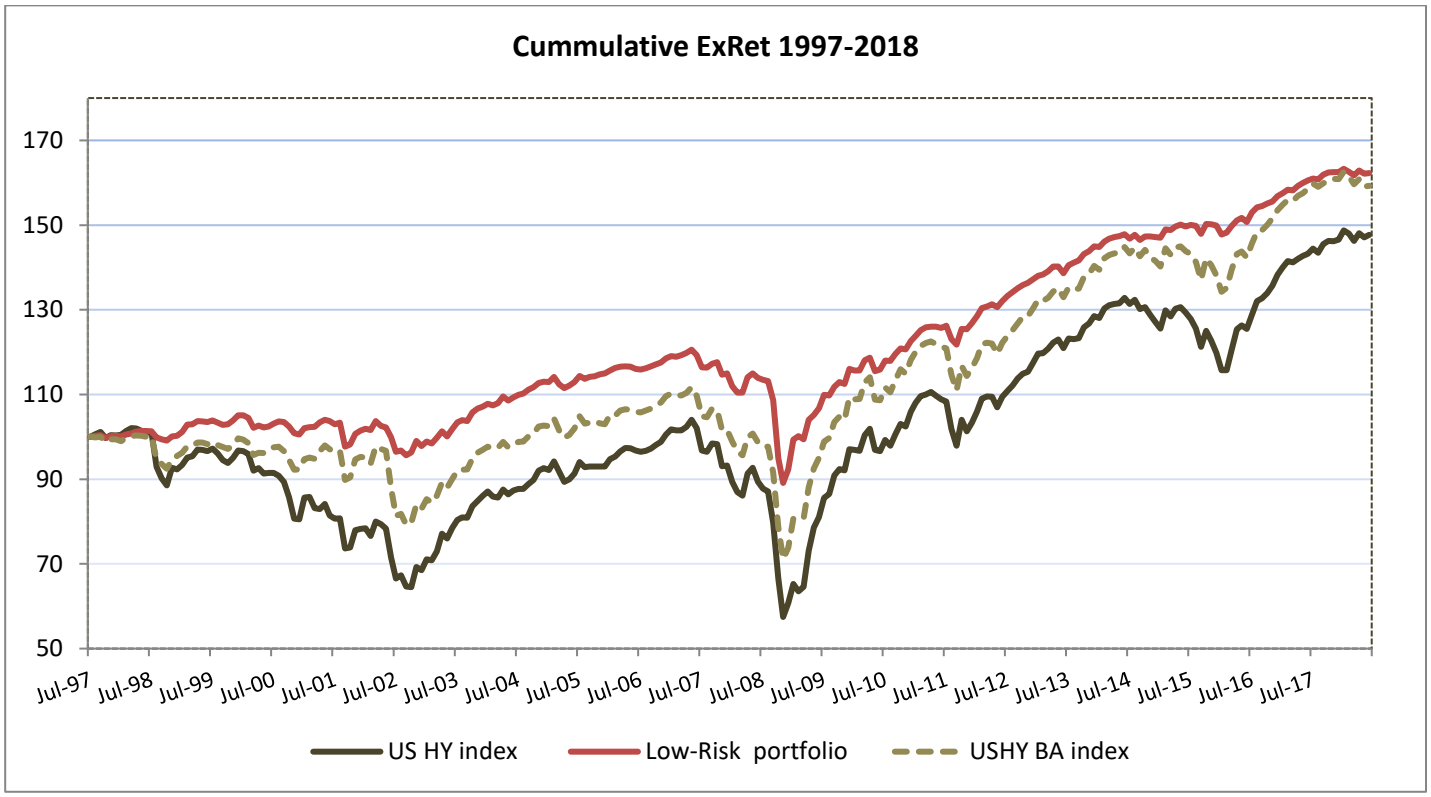
The Low-risk portfolio has a Sharpe Ratio of 0.47 which is almost double the USHY index SR of 0.23. The portfolio has 1.4% bps annualized alpha to the market. As a result of the portfolio's lower spread and spread duration, it has averaged a much lower round trip transaction cost from 1997 to 2018 (88 bps vs 115 bps). The factor portfolio averaged lower trading volume than the USHY average.

The Low-risk factor has a significant positive net-alpha in both total returns and excess returns[31].

30 Returns, Volatilities and alphas are annualized

31 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Low-Risk portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the short duration HY BA rated index which can also be seen as a "low-risk" product in HY markets. The Low-risk portfolio had significantly lower drawdowns in episodes of market distress than both the USHY and USHY BA indices (The dot-com/telecom crisis in early 2000s and the financial crisis of 2008).

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-4.3%	0.9%	-3.6%	9.5%	5.5%	1.7%	3.1%	-3.0%	-19.7%	25.7%	5.6%	3.5%	8.2%	5.7%	1.5%	1.8%	4.6%	3.6%
-16.8%	-2.8%	-12.4%	25.5%	7.7%	0.4%	8.1%	-7.3%	-34.8%	59.8%	9.1%	-2.4%	13.6%	9.4%	-1.1%	-7.4%	10.1%	6.0%

USHY index **Low-Risk**

The table above shows the monthly-compounded annual excess returns of the USHY universe (in blue) and the Low-risk portfolio. The Low-risk factor has a much lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten).

Results after Transactions Costs

The Low-risk factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Low-Risk	1.69%	5.23%	0.69%	5.61%	4.35%	2.81%

US High-Yield

Momentum Portfolio

Defining the Factor

The momentum factor is based on the behavioral bias where past winners (losers) tend to continue to outperform (underperform). The Momentum effect is prevalent in HY markets. In order to create a disperse momentum signal, we define our momentum ranking measure as the cumulative past 6 months residualized[32] excess returns.

Portfolios constructed using bonds with high momentum exposure have averaged much higher excess returns to the market with lower levels of volatilities. On the other hand, portfolios with low momentum exposure have averaged negative returns and much higher levels of volatility over our 1997-2018 back-testing period.

Momentum Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full USHY universe on the momentum characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their momentum signal deteriorates significantly.

Additionally, while rebalancing, the momentum portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[33] profile of the Momentum portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Momentum	US HY
Return	5.83	2.39
Volatility	8.93	10.37
SR	0.65	0.23
Alpha	3.98	
Drawdown	-16.3	-16.5
OAS	545	543
OASD	3.6	4.4
Volume in MM	84	63
% Traded Bonds	50%	42%
T-Cost (bps)	104	115
Turnover	261%	40%

The Momentum portfolio has a much higher average return than the market (5.8% vs. 2.4%) and a Sharpe Ratio of 0.65 which is about three times the USHY index SR of 0.23. The portfolio has a substantial 4% annualized alpha to the market.

The Momentum portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[34] are higher than the USHY market averages.

The Momentum factor has a significant positive net-alpha in both total returns and excess returns[35].

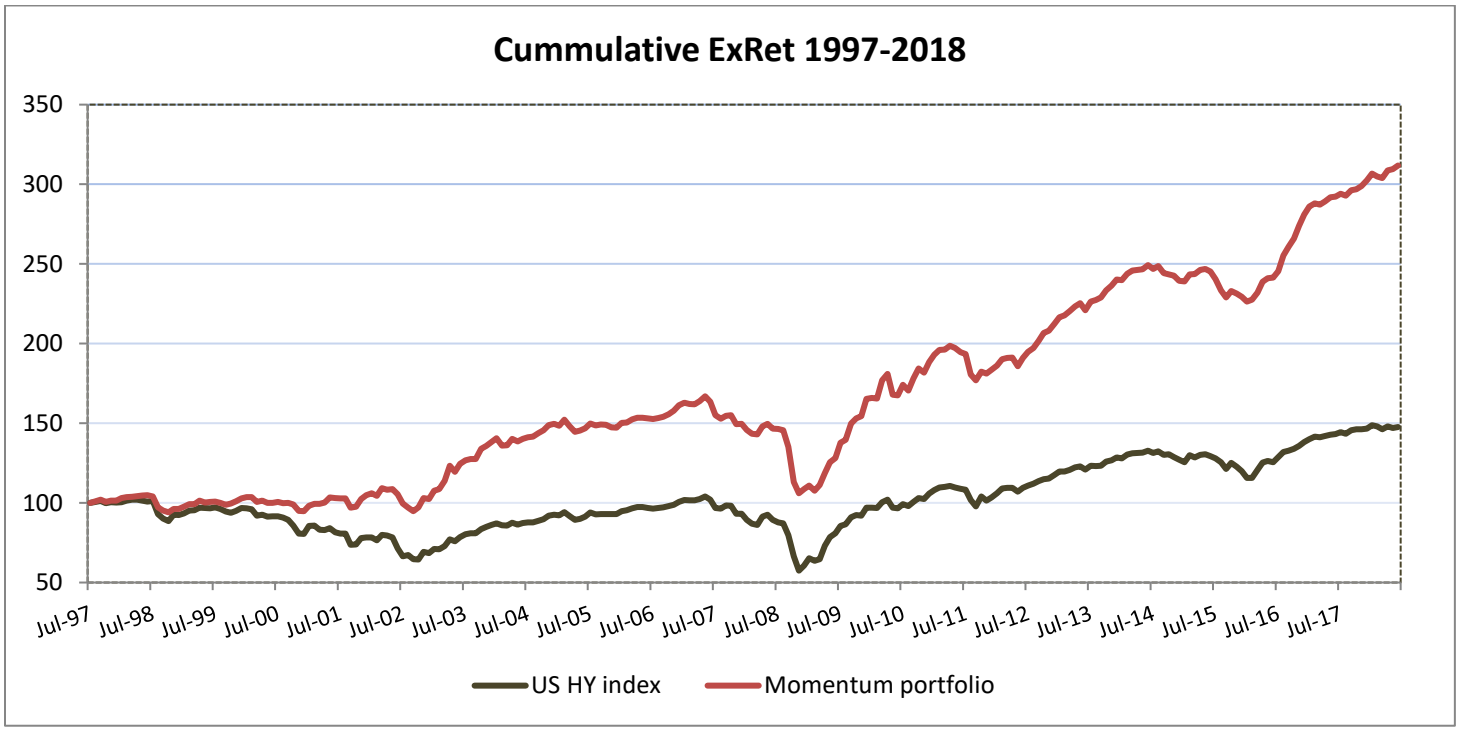
32 Our 'residualization' technique isolates the bond's momentum that can be attributed to the security-specific component and eliminates its systematic component part

33 Returns, Volatilities and alphas are annualized

34 "Actively traded bonds" are defined as corporate bonds with at least three days of two way trading between dealers and clients and at least 20 Million dollars of total volume for the month

35 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Momentum portfolio and how it compares to the US HY index (in black). The momentum portfolio has historically outperformed the HY index in bull markets. It can, however, suffer significant losses in bear markets like 2008 financial crisis and the 2015 energy crisis.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-3.4%	0.4%	-1.6%	9.7%	2.1%	-0.6%	1.0%	-3.4%	-10.7%	20.6%	1.9%	-3.1%	7.6%	3.5%	0.2%	-2.5%	6.0%	3.9%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USHY index | **Momentum**

The table above shows the monthly-compounded excess returns of the USHY universe (in blue) and the Momentum portfolio on an annual basis. As noted earlier, the momentum factor tends to outperform in Credit bull markets like 2003-2004 and 2012-2014. It has suffered smaller annual losses in episodes of market distress like 2002, 2008 and 2011.

Results after Transactions Costs

The momentum factor portfolio has a positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Momentum	3.28%	8.97%	1.56%	7.43%	7.89%	2.65%

US High-Yield

Value Portfolio

Defining the Factor

The value factor assumes a homogenous market where a bond's spread can be implied from its peer group. A given peer group is defined as the set of bonds with similar duration/Industry/rating and subordination type characteristics.

Credit spreads, however, typically spike/drop months before the rating-agencies downgrades/upgrades. We incorporate this information by manually updating the bond's rating if its spread significantly spiked or dropped without a corresponding rating adjustment from the rating agencies.

Because of the prevalence of private companies in the USHY market, we add public-private company flag to our peer group definition.

The Value factor exploits the mean-reversion of bonds' spreads to the "fair" values derived from their peers.

The average excess return of the value ranked decile portfolios is monotonically increasing. Portfolios which contain bonds with high value exposure have averaged significantly higher excess returns than the USHY index with slightly higher levels of volatilities.

Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full USHY universe on the value characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th deciles and sells them once their value signal deteriorates significantly.

Additionally, while rebalancing, the value portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[36] profile of the Value portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Value	US HY
Return	5.02	2.39
Volatility	11.99	10.37
SR	0.42	0.23
Alpha	2.38	
Drawdown	-18.7	-16.5
OAS	570	543
OASD	5.0	4.4
Volume in MM	91	63
% Traded Bonds	49%	42%
T-Cost (bps)	118	115
Turnover	192%	40%

The Value portfolio has a much higher average return than the market (5% vs. 2.4%) and a comparable level of volatility (12% vs 10.4%) resulting in a substantial 2.4% annualized alpha.

The Value portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[37] are higher than the USHY market averages.

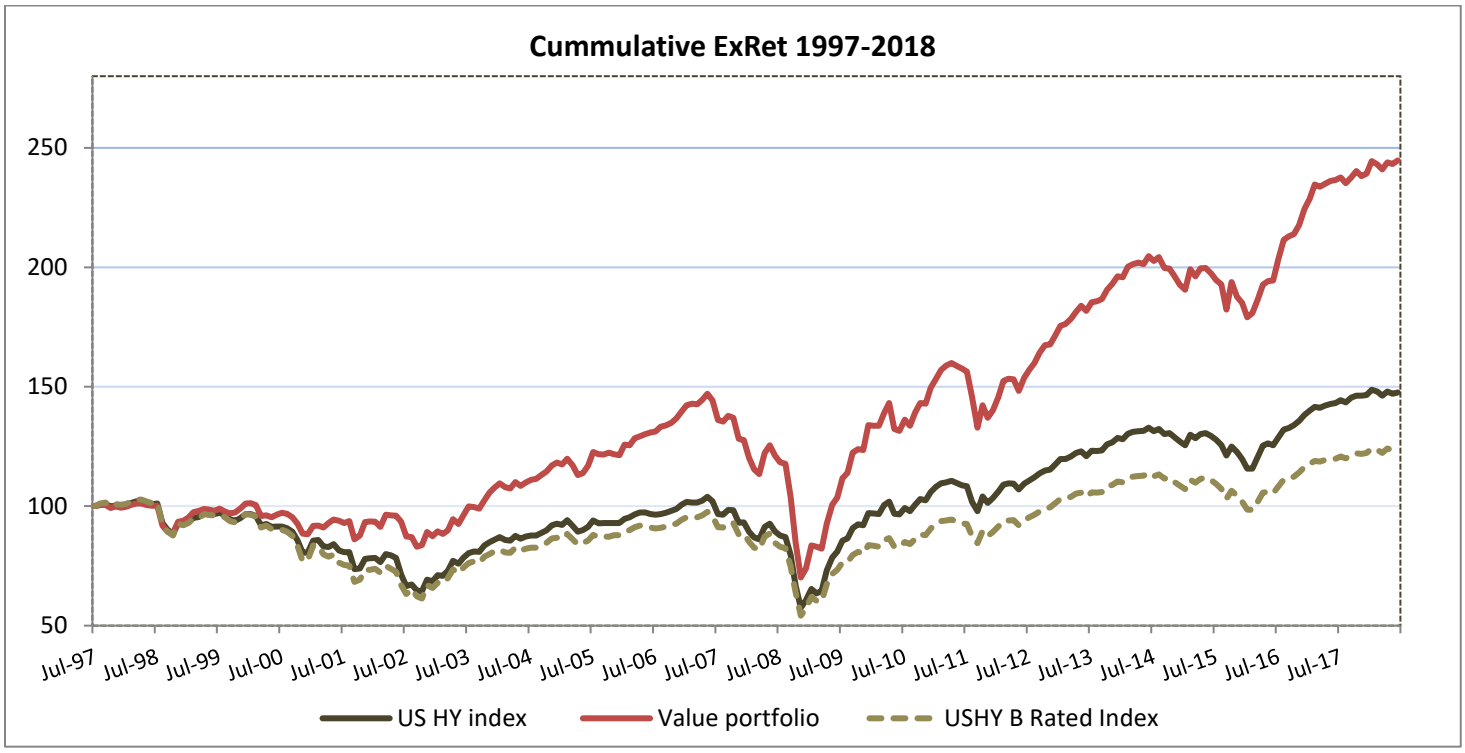
The Value portfolio averaged a higher spread and spread duration than the USHY index over the 1997-2018 back testing period.

Despite its high turnover, the value has positive alpha in both total returns and excess returns.

[36] Returns, Volatilities and alphas are annualized

[37] "Actively traded bonds" are defined as corporate bonds with at least three days of two way trading between dealers and clients and at least 20 Million dollars of total volume for the month

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Value portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the short duration HY B rated index which has averaged similar spread levels to the value portfolio. The value factor has a higher spread than the index and tends to outperform (underperform) the index in periods when spreads tighten (widen). It can, however, suffer significant losses in bear markets like 2008 financial crisis and the 2011 European sovereign crisis.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-5.1%	2.4%	-5.1%	12.4%	1.8%	-1.7%	2.5%	-4.5%	-16.9%	27.5%	3.9%	-3.8%	11.5%	4.6%	2.0%	-0.7%	5.7%	4.3%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USHY Index	Value

The table above shows the monthly-compounded annual excess returns of the Value portfolio and the USHY universe (in blue). As noted earlier, the Value factor has typically a higher spread than the index and, as a result, tends to outperform (underperform) in periods when spreads tighten (widen). It has outperformed the HY index in 11 of the past 12 years.

Results after Transactions Costs

The Value portfolio still has a positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Value	3.01%	12.02%	0.64%	7.94%	10.33%	0.71%

US High-Yield

Size Portfolio

Defining the Factor

Size refers to the extra premium that can be achieved by investing in bonds of small companies. The size factor exploits the fact that small companies are under-researched and often neglected by fundamental shops and ETFs which usually track liquid benchmarks. Our definition for size uses the total size of a given company's public debt as a ranking measure[38].

Portfolios formed using bonds from small issuers have averaged much higher excess returns to the market with comparable levels of volatilities.

While we recognize that size captures an illiquidity effect, we argue that the premium it offers still holds after accounting for the higher transactions cost small cap bonds incur.

Size Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the size characteristic defined in the previous section. Each decile portfolio has an equal market value in that point in time. Contrary to the other factors, we assume the bonds in each decile portfolio are equally weighted. Size is a stable signal over time and the factor portfolio, therefore, constantly tracks bonds in the top decile D10.

The factor portfolio, under this implementation, averaged 72% annual turnover over the 1997-2018 back-testing period.

Portfolio Performance and Characteristics

The next table shows equal weighted risk-return[39] profile of the size portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Size	US HY
Return	8.40	2.39
Volatility	14.42	10.37
SR	0.58	0.23
Alpha	5.98	
Drawdown	-19.3	-16.5
OAS	1092	543
OASD	3.7	4.4
Volume in MM	11	63
% Traded Bonds	8%	42%
T-Cost (bps)	194	115
Turnover	72%	40%

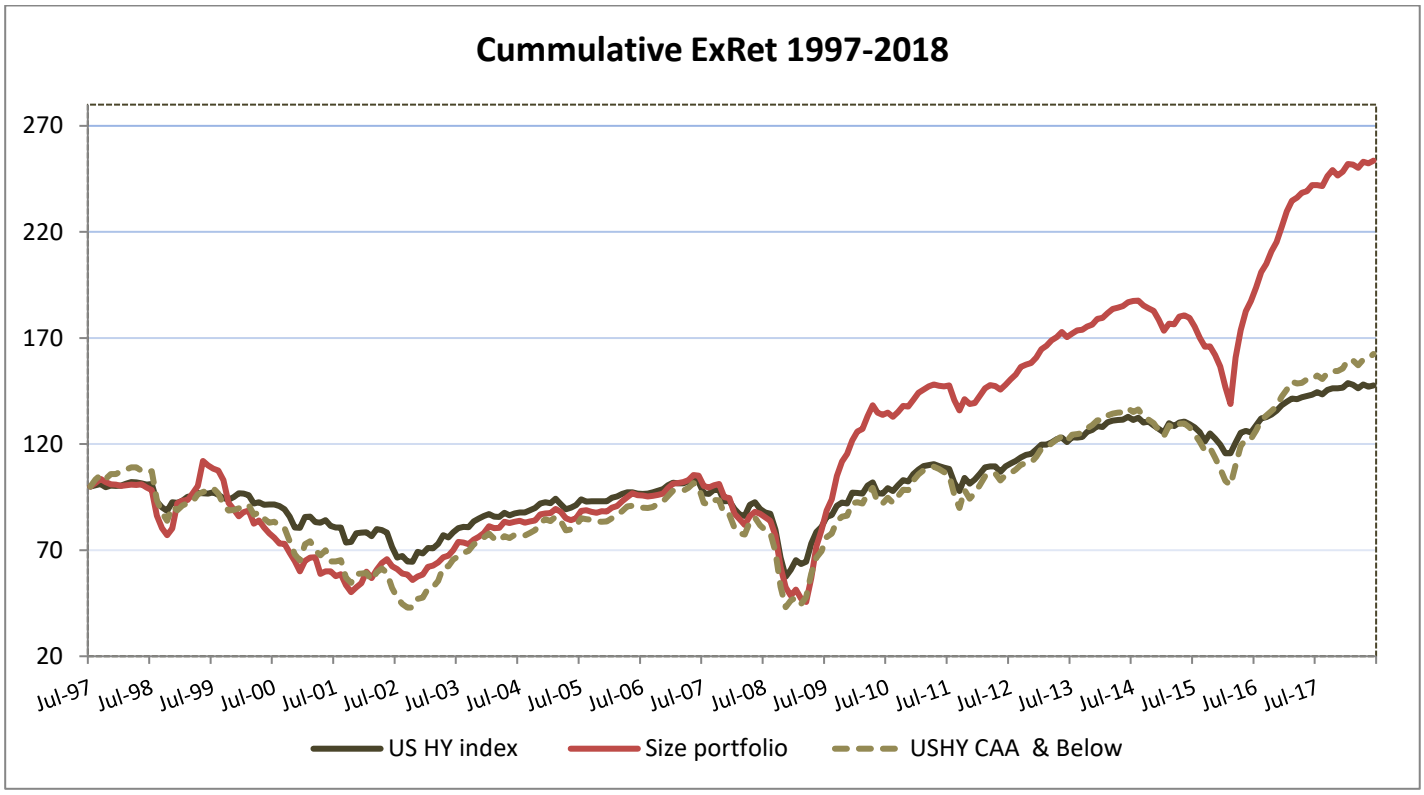
The size portfolio has a much higher average return than the HY market (8.4% vs. 2.4%) and a higher volatility (14.4% vs 10.4%). The factor portfolio has significant annualized alpha of 6%.

As expected, the size factor captures a significant illiquidity premium. Bonds in the style portfolio have only averaged 11 million dollars monthly in traded volume which amounts to about a 1/5h of the market average (63 MM). In addition to that, only a fraction of the portfolio composition (about 8%) has been actively traded (much lower than the market average of 42%). Please note that the portfolio has also averaged a much higher trading cost than the market 194 bps vs. 115 bps.

Despite its high trading cost the portfolio incur, the size factor has a significant positive net-alpha in both total returns and excess returns.

38 Similar to Houweling and Van Zundert (2018)
39 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the size portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the HY CAA rated and below index which has averaged comparable higher levels of spread. The size factor, which consists of bonds issued by small companies, has historically outperformed the index in periods when spreads tighten. It has also suffered significant losses in bear markets like 2008 financial crisis and the 2015 energy crisis

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-5.1%	4.6%	1.4%	7.8%	2.2%	0.0%	1.9%	-5.7%	-17.7%	33.1%	4.4%	-1.1%	6.5%	4.3%	1.9%	0.1%	4.5%	5.2%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

USHY index	Size

The table above shows the monthly-compounded annual excess returns of the size portfolio and the USHY universe (in blue). The size factor has significantly outperformed in credit bull markets like 2003-2004 and the credit market rally of 2009. It can however suffer big losses in periods of market distress the financial crisis.

Results after Transaction Costs

The Size factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Size	7.41%	14.36%	5.25%	11.73%	13.28%	5.14%

US High-Yield

Momentum/Value Portfolio

Defining the Factor

As a result of the low/negative active[40] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[41].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Value integrated factor. Each bond's Value and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Value integrated factor.

The resulting portfolio has even higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Value factors.

Momentum/Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the Momentum/Value composite signal defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[42] profile of the Momentum/Value portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Mom/Value	US HY
Return	5.91	2.39
Volatility	9.28	10.37
SR	0.64	0.23
Alpha	3.97	
Drawdown	-17.4	-16.5
OAS	559	543
OASD	4.1	4.4
Volume in MM	84	63
% Traded Bonds	50%	42%
T-Cost (bps)	108	115
Turnover	215%	40%

The Momentum/Value portfolio has a much higher average return than the HY market (5.9% vs. 2.4%) and a lower volatility (9.3% vs 10.4%) resulting in a substantial annualized alpha of 4%.

The Momentum/Value integrated portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[43] are much higher than the USHY market averages.

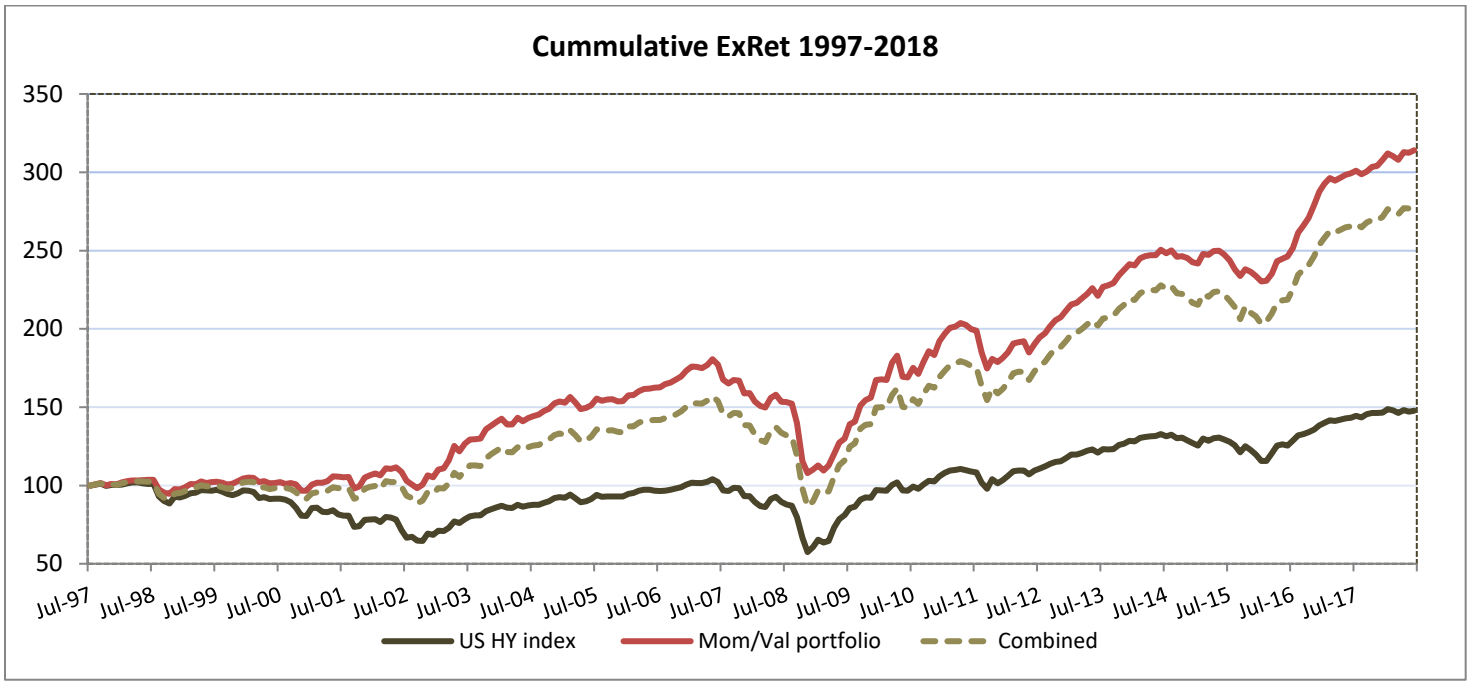
The Momentum/Value portfolio averaged higher excess returns than either the Momentum or Value portfolios in their standalone format. It has a significant alpha in both total returns and excess returns after accounting for transaction costs

[40] Active returns are defined as the difference of the portfolio and market returns

[41] Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

[42] Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the Momentum-Value integrated portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the equally weighted momentum and value portfolios described previously. The integrated momentum value portfolio has outperformed both the USHY index and the combined portfolio of the two standalone styles.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-3.9%	1.7%	-2.5%	10.9%	1.9%	-1.4%	2.0%	-4.1%	-11.6%	20.2%	3.4%	-3.8%	9.2%	4.5%	1.5%	-0.5%	5.4%	4.1%
-4.3%	1.2%	-3.3%	11.1%	1.9%	-1.2%	1.7%	-4.0%	-13.8%	24.1%	2.9%	-3.4%	9.6%	4.0%	1.1%	-1.6%	5.9%	4.1%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Mom/Value | USHY index | Combined

The table above shows the annualized returns of the Momentum-Value integrated portfolio and the USHY universe (in blue) and over the past 18 years. The table also highlights the annual performance of the equally weighted combination of Value and Momentum portfolios (portfolio mix). The integrated portfolio has outperformed the market in 13 of the past 18 years (10 out the last 12 years).

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Momentum/Value	3.51%	9.35%	1.76%	7.91%	8.24%	2.51%

US High-Yield

Momentum/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[44] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[45].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Low-Risk integrated factor. Each bond's Low-Risk and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Low-Risk integrated factor.

The resulting portfolio has even higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Low-Risk factors.

Momentum/Low-Risk Factor Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the Momentum/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the integrated portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the factor portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[46] profile of the Momentum/Low-Risk portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Mom/Low-Risk	US HY
Return	5.81	2.39
Volatility	7.04	10.37
SR	0.83	0.23
Alpha	4.38	
Drawdown	-13.6	-16.5
OAS	491	543
OASD	3.0	4.4
Volume in MM	63	63
% Traded Bonds	43%	42%
T-Cost (bps)	99	115
Turnover	256%	40%

The Momentum/Low-risk portfolio has a much higher average return than the market (5.8% vs. 2.4%) and 70% of the market volatility (7% vs 10.4%) resulting in a significant 4.4% annualized alpha.

The two styles integrated portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[47] are comparable to the USHY market averages.

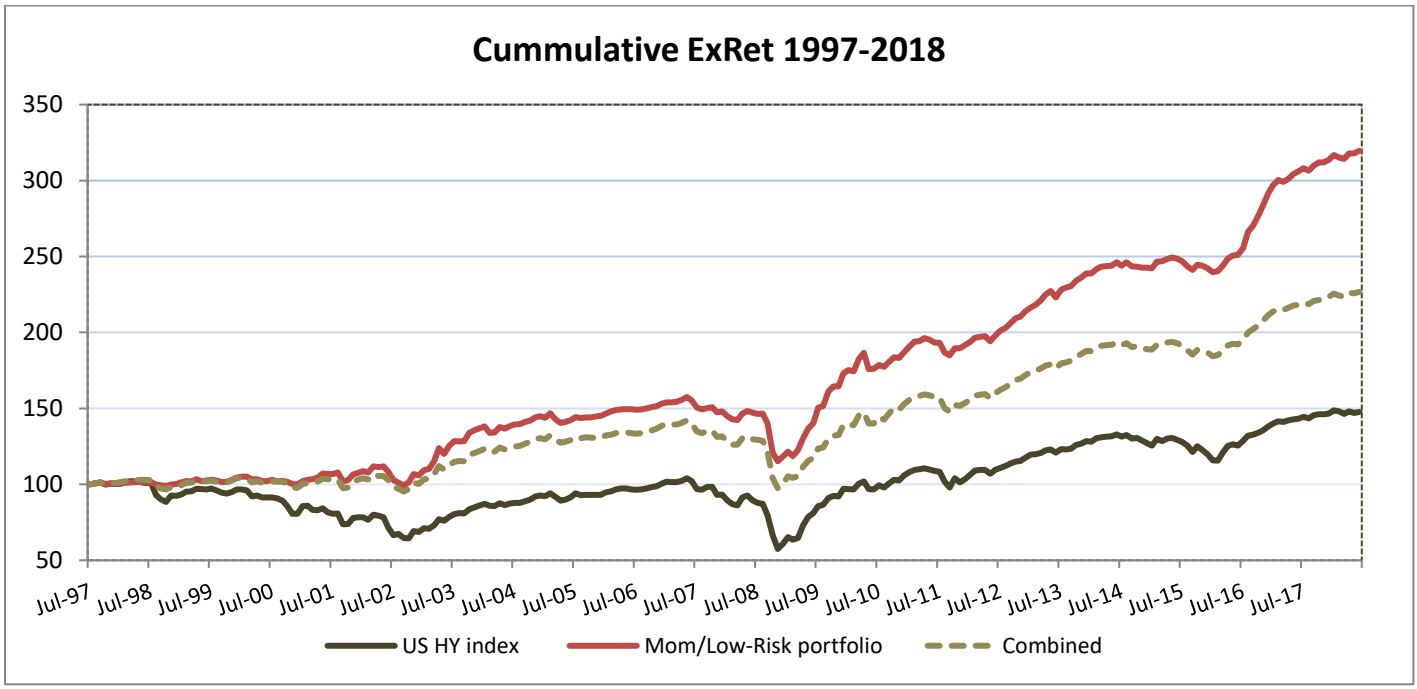
The Momentum/Low-Risk portfolio has averaged a much lower transaction cost (99 bps) and has a significant alpha in both total returns and excess returns after accounting for transaction costs over our back-testing period.

44 Active returns are defined as the difference of the portfolio and market returns

45 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

46 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the momentum/low-risk integrated portfolio and how it compares to the USHY index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Momentum and Low-Risk individual portfolios described previously. The integrated portfolio has outperformed both the USHY index and the combined portfolio of the two standalone styles.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0.0%	0.6%	0.7%	4.1%	0.9%	0.2%	0.6%	-1.9%	-6.6%	17.1%	2.0%	0.6%	3.2%	1.4%	0.5%	0.6%	1.6%	1.5%
-1.7%	0.5%	-0.1%	5.7%	1.5%	-0.2%	0.9%	-2.7%	-9.0%	15.9%	1.6%	-1.3%	5.0%	2.3%	0.4%	-0.9%	3.5%	2.7%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Mom/Low-Risk	USHY index	Combined

The table above shows the annualized returns of the integrated portfolio, the USHY universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Momentum factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Momentum/Low-Risk	3.20%	7.04%	1.92%	7.16%	6.16%	3.27%

US High-Yield

Value/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[48] correlations between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[49].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Value/Low-Risk integrated factor. Each bond's Low-Risk and Value scores are blended into one average composite measure. This composite score is then used to rank bonds in the Value/Low-Risk integrated factor.

The resulting portfolio has even higher risk adjusted returns because it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both factors.

Value/Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the Value/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the factor portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[50] profile of the Value/Low-risk portfolio as well as its other characteristics.

	Value/Low-Risk	US HY
Return	3.59	2.39
Volatility	6.25	10.37
SR	0.58	0.23
Alpha	2.29	
Drawdown	-13.8	-16.5
OAS	397	543
OASD	3.5	4.4
Volume in MM	51	63
% Traded Bonds	39%	42%
T-Cost (bps)	98	115
Turnover	142%	40%

The Value/Low-risk portfolio has a much higher average return than the market (3.6% vs. 2.4%) and almost half of its volatility (6.3% vs 10.4%) resulting in a significant 2.3% annualized alpha.

The Value/Low-risk signal integration is an interesting blend since the low-risk factor emphasizes bonds with low spreads whereas the value factor does the opposite. The resulting portfolio seems to keep its excess returns outperformance while its volatility decreases. The integrated portfolio has averaged a lower spread than the USHY index.

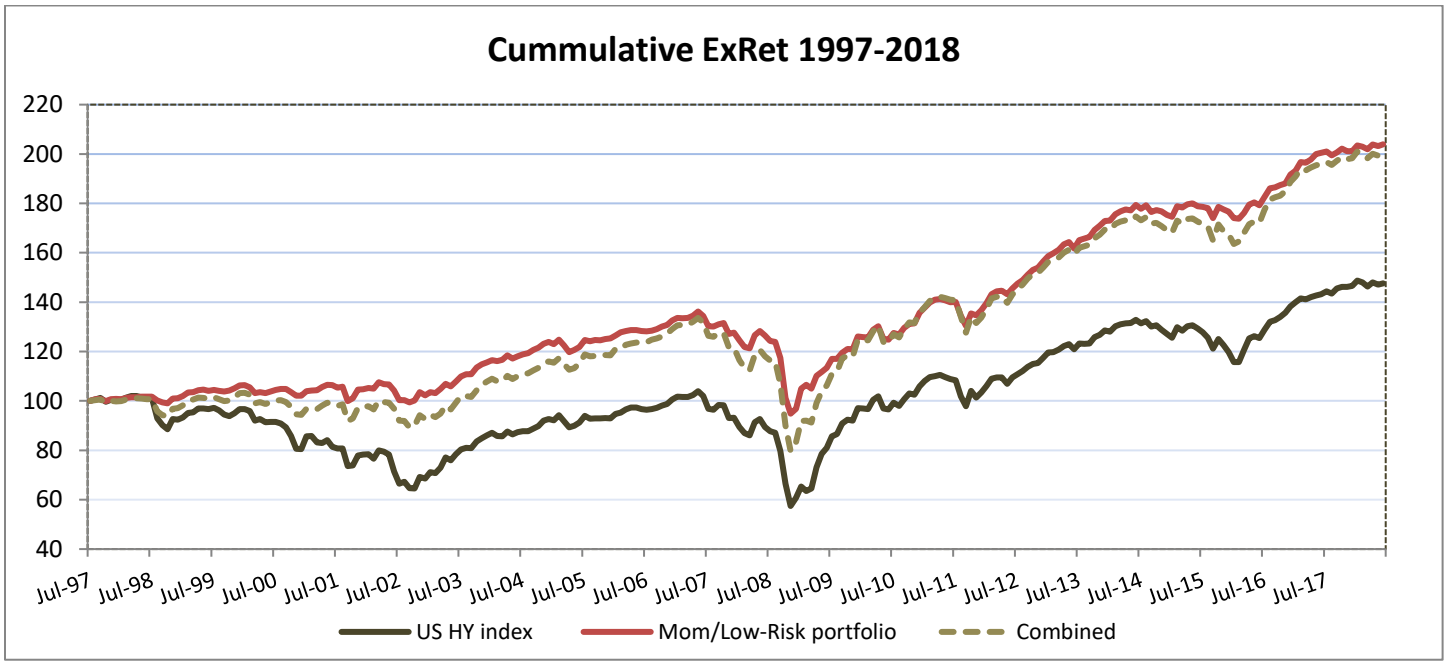
The Value/Low-Risk portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[51] are comparable to the USHY index averages.

48 Active returns are defined as the difference of the portfolio and market returns

49 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio.

50 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the Value/Low-Risk integrated portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Value and Low-Risk individual portfolios described previously. The integrated portfolio has outperformed the market index. It had much lower drawdowns in 2008, 2002 and 2015 than the USHY index and portfolio mix.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-1.6%	1.2%	1.3%	3.9%	1.5%	-0.3%	1.3%	-2.6%	-7.3%	12.5%	2.3%	0.1%	5.5%	2.7%	1.8%	0.8%	1.7%	2.1%
-2.5%	1.3%	-1.8%	7.0%	1.3%	-0.7%	1.6%	-3.2%	-12.1%	19.2%	2.6%	-1.6%	6.9%	2.9%	1.3%	0.0%	3.4%	2.9%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Value/Low-Risk | USHY index | Combined

The table above shows the annualized returns of the Value/Low-Risk integrated portfolio, the USHY universe (in blue) and the along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Value factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Value/Low-Risk	3.20%	7.04%	1.92%	7.16%	6.16%	3.27%

US High-Yield

Multi-Style Portfolio

Defining the Factor

As a result of the low/negative active[52] between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[53].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Multi-Style Portfolio. Each bond's Low-Risk, Momentum and Value scores are blended into one average composite measure. This composite score is then used to rank bonds the Multi-Style integrated factor.

The resulting portfolio has much higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to the three factors.

Multi-Style Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full US HY universe on the three style composite signal defined in the previous section. In order to limit the turnover, the multi-style portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their composite signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[54] profile of the integrated portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the USHY benchmark index excess return.

	Multi-Style	US HY
Return	6.25	2.39
Volatility	7.49	10.37
SR	0.84	0.23
Alpha	4.71	
Drawdown	-14.1	-16.5
OAS	516	543
OASD	3.5	4.4
Volume in MM	65	63
% Traded Bonds	43%	42%
T-Cost (bps)	106	115
Turnover	221%	40%

The Multi-Style portfolio has averaged a higher return than any of the previously defined factors. It also has a volatility of 7.5% over the 1997-2018 back-testing period resulting in a significant 4.7% annualized alpha.

The multi-style portfolio does not seem to capture an illiquidity premium as its average traded volume and percentage of actively traded bonds[55] are comparable to the USHY market averages.

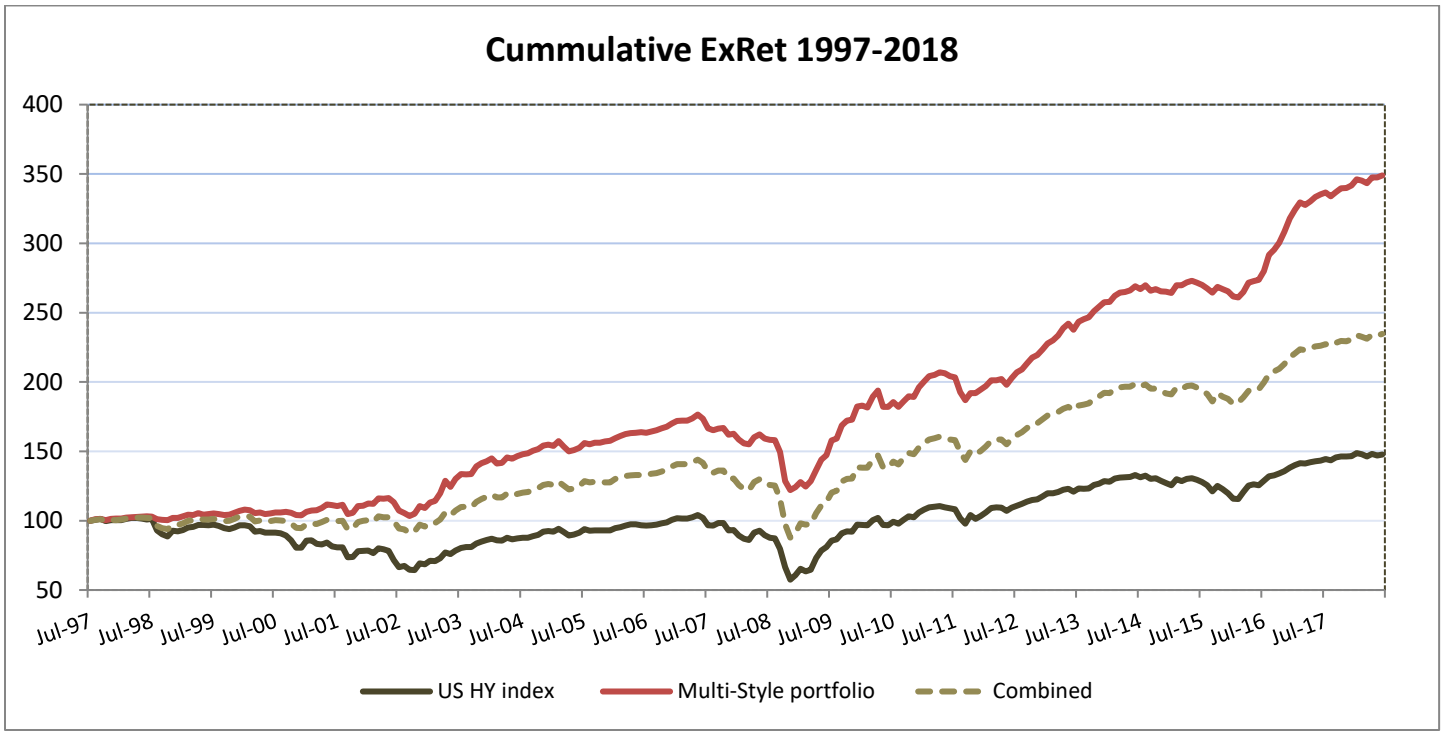
The Multi-Style portfolio exhibits a rather stable performance over the past two decades has a significant net-alpha in both total returns and excess returns.

52 Active returns are defined as the difference of the portfolio and market returns

53 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

54 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the Multi-style portfolio and how it compares to the US HY index (in black). The plot also shows the cumulative excess return of the equally weighted average of the momentum, value and low-risk individual portfolios in their standalone formats. The Multi-Style portfolio has largely outperformed both the USHY index and the mix portfolio over the 1997-2018 back-testing period.

Annual Breakdown of the Style Portfolio Performance

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
-0.9%	1.0%	1.5%	7.7%	1.4%	-0.1%	1.2%	-2.4%	-6.8%	17.7%	2.7%	-0.3%	6.6%	3.3%	1.8%	0.6%	2.1%	2.3%
-2.8%	1.0%	-1.7%	7.9%	1.6%	-0.7%	1.4%	-3.3%	-11.6%	19.7%	2.4%	-2.1%	7.2%	3.1%	1.0%	-0.8%	4.3%	3.3%
-4.7%	2.5%	-2.3%	5.7%	1.6%	-1.1%	1.2%	-4.9%	-17.5%	23.3%	2.0%	-3.5%	7.1%	3.0%	-0.5%	-1.6%	4.8%	3.4%

Multi-Style	USHY index	Combined

The table above shows the annualized returns of the Multi-Style portfolio, the USHY universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). In our back-test, the multi-style portfolio has realized similar returns to the USHY index in credit bull markets with a significant downside protection in periods of market distress like 2002, 2007, 2008, 2011 and 2015.

Results after Transactions Costs

The Multi-Style factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
US HY index	2.14%	10.36%		6.69%	8.96%	
Multi-Style	3.20%	7.04%	1.92%	7.16%	6.16%	3.27%

EU Investment Grade

Low-Risk Portfolio

Defining the Factor

The Low-Risk factor, defined as a combination of the bond's historical and idiosyncratic excess return volatilities over the previous year, captures the Low-Risk anomaly in European credit markets: Low volatility securities have better risk-adjusted return than high volatility securities.

Portfolios constructed using bonds which rank low on our risk metric have averaged similar excess returns to the IG market with much lower volatilities over the past 15 years. They have also suffered much smaller losses in periods of market distress like 2008 and 2011.

Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the Low-Risk characteristic defined in the previous section. In order to limit the turnover, the low-risk portfolio buys bonds in the 9th decile, holds them as they possibly migrate to the 10th/8th deciles and sells them if they ever drop past the 8th decile. The Low-risk portfolio, under this implementation, averaged 66% annual turnover over the 1997-2018 back-testing period.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[56] profile of the Low-risk portfolio in its tradable format.

The results section, additionally, provides the portfolio's average analytics and highlights some of its characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Low-Risk	EU IG
Return	0.64	0.83
Volatility	0.90	3.34
SR	0.71	0.25
Alpha	0.55	
Drawdown	-1.9	-5.5
OAS	74	135
OASD	2.5	4.7
T-Cost (bps)	27	46
Turnover	66%	27%

The Low-risk portfolio has a Sharpe Ratio of 0.71 which is almost three times the EUIG index SR of 0.25. The portfolio has 55 bps annualized alpha to the market. The portfolio has annualized volatility of 0.9% over the 2002-2018 back-testing period.

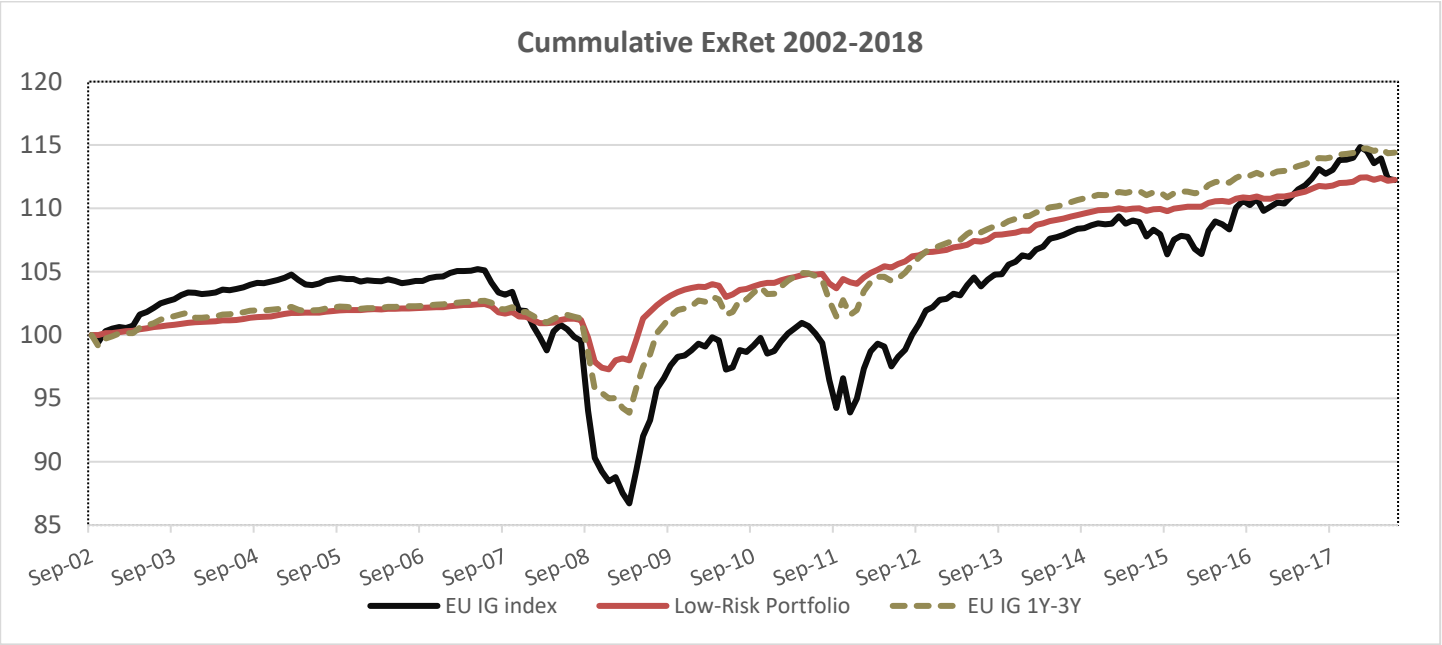
As a result of the portfolio's lower spread and spread duration, it has averaged a much lower round trip transaction cost (27 bps vs. 46 bps for EUIG).

The Low-risk factor has a significant positive net-alpha in both total returns and excess returns[57].

56 Returns, Volatilities and alphas are annualized

57 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Low-Risk portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the short duration IG index (1Y to 3Y duration). The Low-risk portfolio had significantly lower drawdowns in episodes of markets distress than both the EUIG and EUIG1Y3Y indices (The financial crisis of 2008 and the sovereign crisis of 2011).

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0.9%	0.5%	0.4%	0.2%	-0.8%	-4.1%	6.6%	0.4%	-0.1%	2.5%	1.5%	1.5%	0.2%	0.6%	1.2%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	0.0%	1.7%	3.5%

EUIG index **Low-Risk**

The table above shows the monthly-compounded annual excess returns of the EUIG universe (in blue) and the Low-risk portfolio. The Low-risk factor has a much lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten).

Results after Transactions Costs

The Low-risk factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Low-Risk	0.46%	0.91%	0.35%	2.96%	1.49%	1.72%

EU Investment Grade

Momentum Portfolio

Defining the Factor

The momentum factor is based on the behavioral bias where past winners (losers) tend to continue to outperform (underperform). Momentum needs divergent levels of performance between bonds to be an effective selection variable in IG markets. In order to create a disperse momentum signal, we define our momentum ranking measure as the cumulative past 6 months residualized[58] excess returns.

Portfolios containing bonds with high momentum exposure have averaged much higher excess returns to the market with lower levels of volatilities.

Momentum Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the momentum characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their momentum signal deteriorates significantly.

Additionally, while rebalancing, the momentum portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[59] profile of the Momentum portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Momentum	EU IG
Return	1.18	0.83
Volatility	2.72	3.34
SR	0.43	0.25
Alpha	0.61	
Drawdown	-4.7	-5.5
OAS	137	135
OASD	3.8	4.7
T-Cost (bps)	38	46
Turnover	195%	27%

The Momentum portfolio has a Sharpe Ratio of 0.43 which is much higher than the market SR of 0.25. The portfolio has 61 bps annualized alpha to the market.

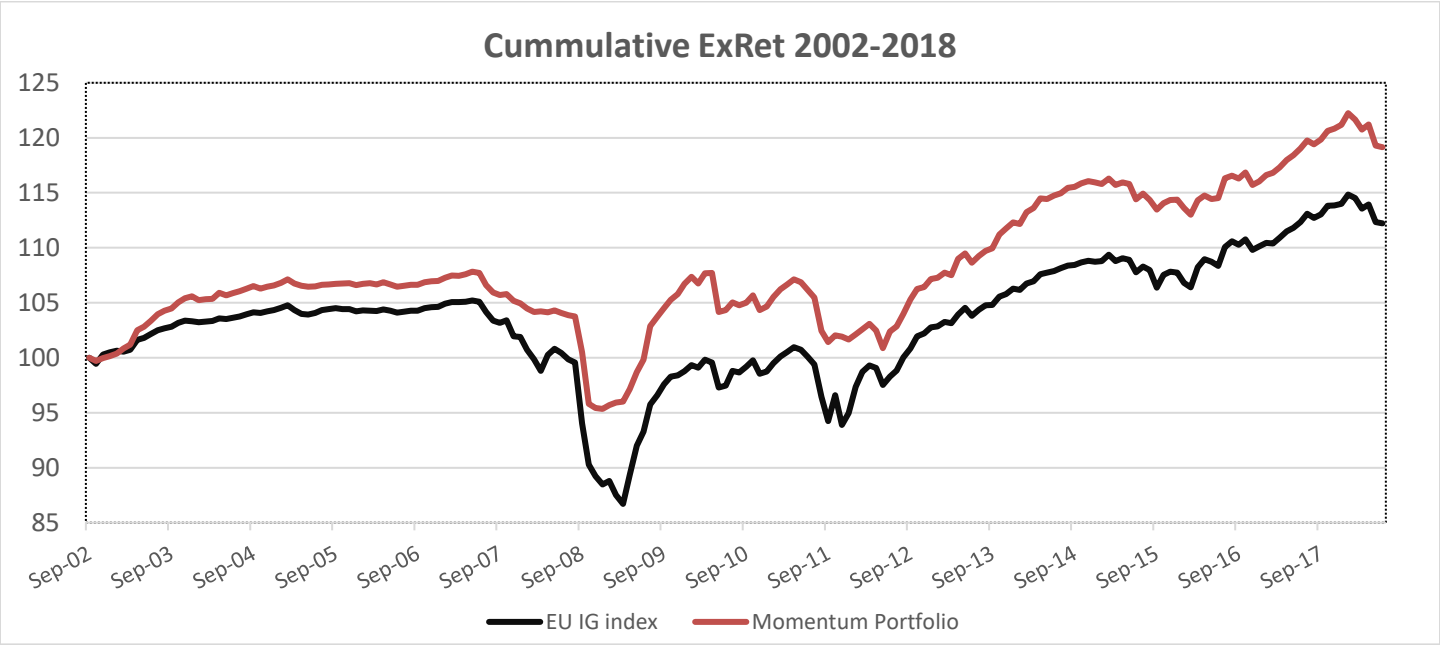
Under our current implementation, the momentum portfolio still has a very high annual turnover at 195%. The momentum signal in investment grade markets tend to vary significantly over time and deteriorate quickly. Investors face the practical choice of holding bonds with a weakened signal and potentially poorer performance prospects or incurring high transaction costs which could significantly reduce returns. The momentum portfolio, as defined in section 2, has a positive net alpha in total return space[60].

58 Our 'residualization' technique isolates the bond's momentum that can be attributed to the security-specific component and eliminates its systematic component part

59 Returns, Volatilities and alphas are annualized

60 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics prior to 2007

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the momentum portfolio and how it compares to the EU IG index (in black). The momentum portfolio has a lower drawdown in the 2008 financial crisis (-4.7% vs -5.5%) and has historically outperformed the IG index in bull markets.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5.4%	0.9%	0.0%	0.4%	-1.9%	-9.1%	11.9%	-1.9%	-2.9%	5.4%	4.8%	3.2%	-1.4%	1.5%	4.4%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	0.0%	1.7%	3.5%

EUIG index | Momentum

The table above shows the monthly-compounded excess returns of the EUIG universe (in blue) and the momentum portfolio on an annual basis. As noted earlier, the momentum factor tends to outperform in Credit bull markets like 2003, 2009 and 2012-2013. It has suffered smaller losses in episodes of market distress like 2008 and 2011.

Results after Transactions Costs

As a result of its high-turnover, the momentum factor portfolio has a positive net-alpha in total returns but a negative net-alpha in excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Momentum	0.42%	2.74%	-0.11%	3.46%	2.77%	0.63%

EU Investment Grade

Value Portfolio

Defining the Factor

The value factor assumes a homogenous market where a bond's spread can be implied from its peer group. A given peer group is defined as the set of bonds with similar duration/Industry/country of issuance/rating and subordination type characteristics.

Credit spreads, however, typically spike/drop months before the rating agencies downgrades/upgrades. We incorporate this information by manually updating the bond's rating if its spread significantly spiked or dropped without a corresponding rating adjustment from the rating agencies.

The Value factor exploits the mean-reversion of bonds' spreads to the "fair" values derived from their peers.

The average excess return of the value ranked decile portfolios is monotonically increasing. Portfolios which contain bonds with high value exposure have averaged significantly higher excess returns than the EUIG index with comparable levels of volatilities.

Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the value characteristic defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th deciles and sells them once their value signal deteriorates significantly.

Additionally, while rebalancing, the value portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[61] profile of the Value portfolio well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Value	EU IG
Return	1.44	0.83
Volatility	2.05	3.34
SR	0.70	0.25
Alpha	0.98	
Drawdown	-2.6	-5.5
OAS	103	135
OASD	4.2	4.7
T-Cost (bps)	36	46
Turnover	136%	27%

The Value portfolio has a much higher average return than the market (1.4% vs. 0.8%) and a lower level of volatility (2.1% vs 3.3%) resulting in a substantial 1% annualized alpha.

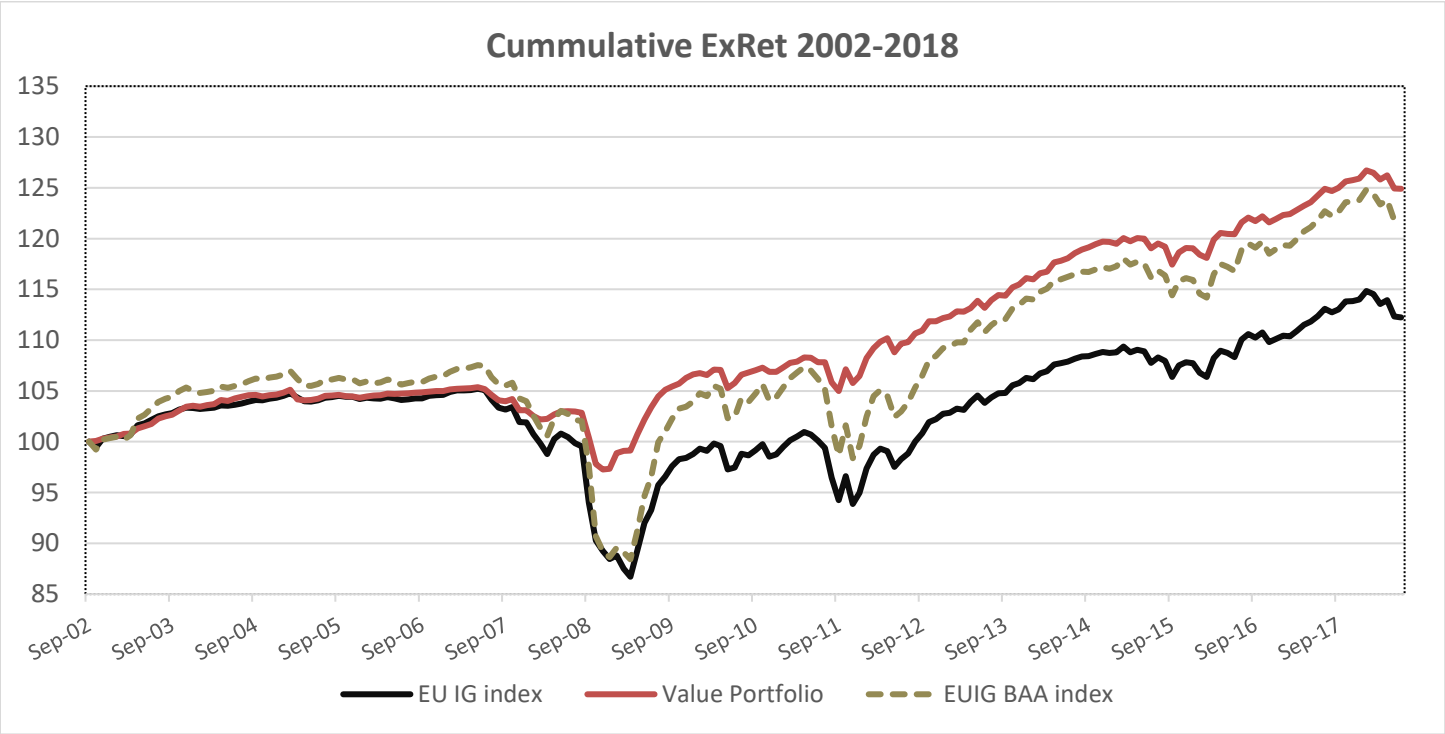
The Value portfolio averaged a lower spread and spread duration than the EUIG index over the 2002-2018 back testing period.

Despite its high turnover, the value has positive alpha in both total returns and excess returns[62].

61 Returns, Volatilities and alphas are annualized

62 Using Conservative historical transaction cost estimated using Dealer-Client institutional size trades and backfilled using bond characteristics prior to 2007

Historical Performance of the Style Portfolio



The plot above highlights the historical performance of the Value portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the short duration IG BAA index which has averaged higher spread levels than the value portfolio. The value portfolio has a lower drawdown in the 2008 financial crisis and the 2011 sovereign crisis.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
3.1%	1.1%	-0.3%	0.6%	-1.8%	-5.6%	9.5%	0.3%	-0.4%	5.4%	3.5%	3.1%	-0.5%	2.4%	3.3%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	0.0%	1.7%	3.5%

EUIG Index	Value

The table above shows the monthly-compounded annual excess returns of the Value portfolio and the EUIG universe (in blue). As noted earlier, the Value factor has typically a lower spread than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten).

Results after Transactions Costs

The Value portfolio still has a positive net-alpha in both total returns and excess returns using conservative historical transactions costs.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Value	1.00%	2.05%	0.58%	4.61%	2.72%	1.76%

EU Investment Grade

Momentum/Value Portfolio

Defining the Factor

As a result of the low/negative active[63] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[64].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Value integrated factor. Each bond's Value and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Value integrated factor.

The resulting portfolio has even higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Value factors.

Momentum/Value Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the Momentum/Value composite signal defined in the previous section. In order to limit the turnover, the momentum portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[65] profile of the Momentum/Value portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Mom/Value	EU IG
Return	1.54	0.83
Volatility	2.06	3.34
SR	0.75	0.25
Alpha	1.10	
Drawdown	-3.3	-5.5
OAS	111	135
OASD	3.9	4.7
T-Cost (bps)	35	46
Turnover	108%	27%

The Momentum/Value portfolio has a much higher average return than the market (1.5% vs. 0.8%) and a significantly lower level of volatility (2.1% vs 3.3%) resulting in a substantial annualized alpha of 1.1%.

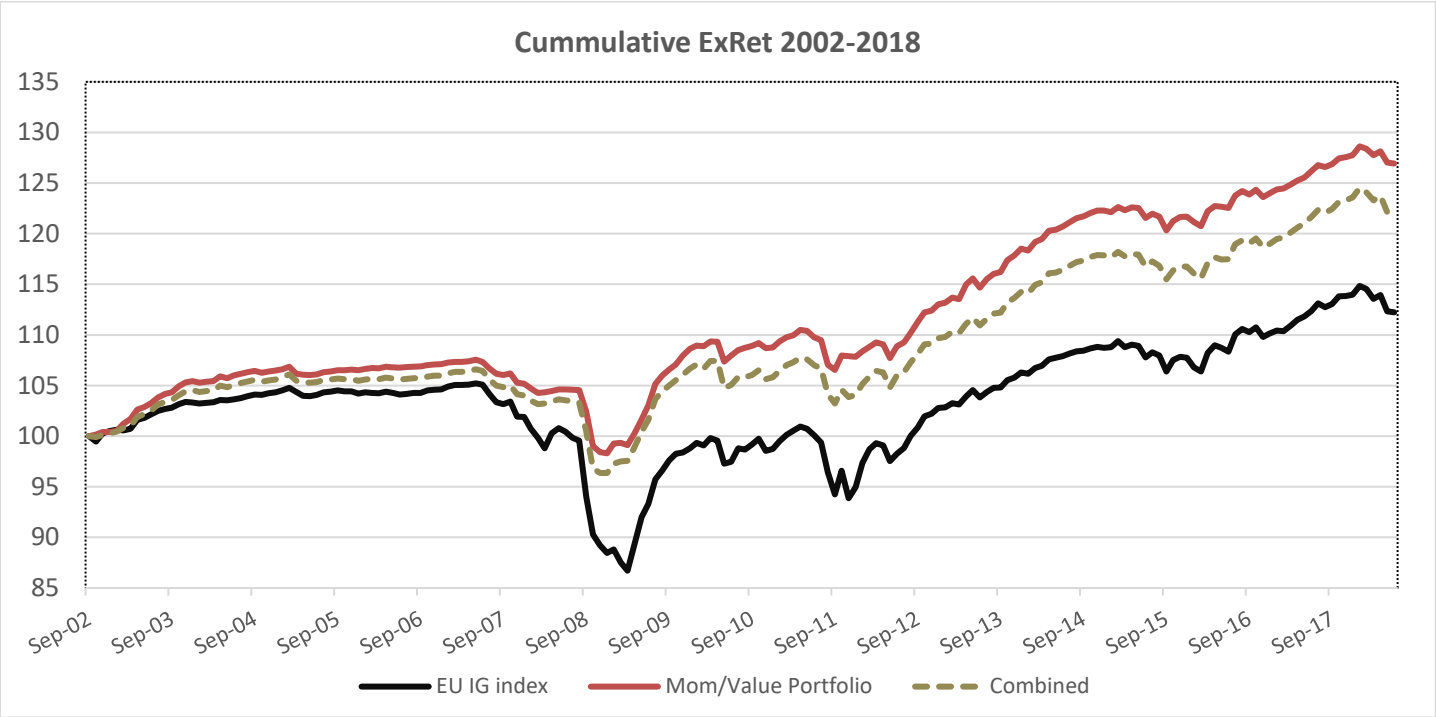
The Momentum/Value portfolio averaged higher excess returns than either the Momentum or Value portfolios in their standalone format. It has a significant alpha in both total returns and excess returns after accounting for transaction costs

63 Active returns are defined as the difference of the portfolio and market returns

64 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

65 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the momentum-value integrated portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the equally weighted momentum and value portfolios described previously. The integrated momentum value portfolio has outperformed both the EUIG index and the combined portfolio of the two standalone styles.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5.0%	1.0%	0.0%	0.6%	-1.8%	-6.5%	10.5%	0.1%	-0.8%	4.8%	4.9%	3.2%	-0.5%	1.9%	3.0%
4.3%	1.0%	-0.1%	0.5%	-1.9%	-7.4%	10.7%	-0.8%	-1.6%	5.4%	4.2%	3.2%	-0.9%	1.9%	3.8%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	-0.9%	2.2%	3.5%

Mom/Value | EUIG index | Combined

The table above shows the annualized returns of the Momentum-Value integrated portfolio and the EUIG universe (in blue) and over the past 15 years. The table also highlights the annual performance of the equally weighted combination of Value and Momentum portfolios (portfolio mix).

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Momentum/Value	1.16%	2.05%	0.76%	4.50%	2.49%	1.96%

EU Investment Grade

Momentum/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[66] correlations between the different credit factors, combining multiple style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[67].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Momentum/Low-Risk integrated factor. Each bond's Low-Risk and Momentum scores are blended into one average composite measure. This composite score is then used to rank bonds in the Momentum/Low-Risk integrated factor.

The resulting portfolio has even higher risk adjusted returns as it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both the Momentum and Low-Risk factors.

Momentum/Low-Risk Factor Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the Momentum/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the integrated portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the factor portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[68] profile of the Momentum/Low-Risk portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Mom/Low-Risk	EU IG
Return	1.25	0.83
Volatility	1.28	3.34
SR	0.98	0.25
Alpha	1.00	
Drawdown	-2.2	-5.5
OAS	92	135
OASD	2.4	4.7
T-Cost (bps)	31	46
Turnover	148%	27%

The Momentum/Low-risk portfolio has a much higher average return than the market (1.3% vs. 0.8%) and almost a third of its volatility (1.3% vs 3.3%) resulting in a significant 1% annualized alpha.

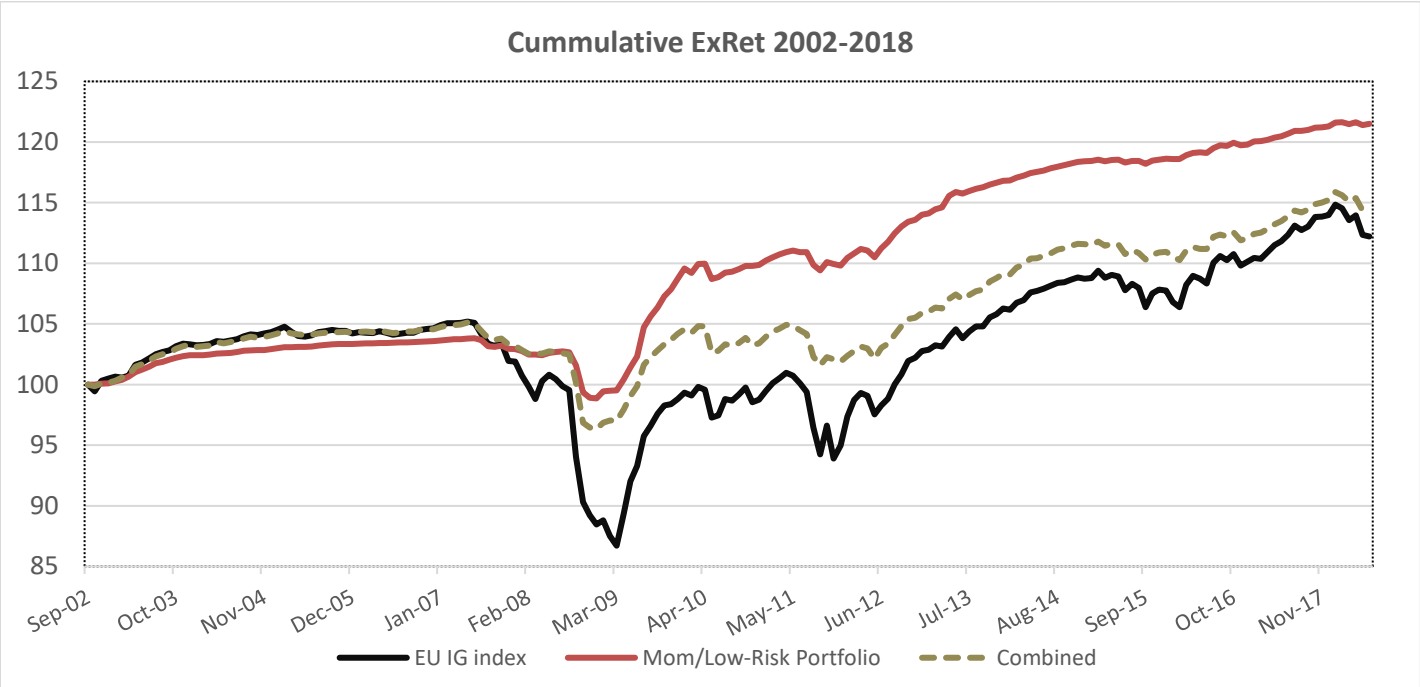
The Momentum/Low-Risk portfolio has averaged a much lower transaction cost (31 bps) and has a significant alpha in both total returns and excess returns after accounting for transaction costs

66 Active returns are defined as the difference of the portfolio and market returns

67 Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

68 Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the momentum/low-risk integrated portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Momentum and Low-Risk individual portfolios described previously. The integrated portfolio has outperformed both the EUIG index and the combined portfolio of the two standalone styles.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.3%	0.5%	0.4%	0.2%	-0.6%	-4.0%	10.0%	1.0%	0.0%	3.8%	2.5%	1.4%	0.2%	1.0%	1.3%
3.1%	0.7%	0.2%	0.3%	-1.3%	-6.6%	8.2%	-0.8%	-1.5%	4.0%	3.0%	2.2%	-0.6%	1.0%	2.8%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	-0.9%	2.2%	3.5%

Mom/Low-Risk	EUIG index	Combined

The table above shows the annualized returns of the integrated portfolio, the EUIG universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has a much lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Momentum factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Momentum/Low-Risk	0.77%	1.24%	0.54%	3.17%	1.60%	1.82%

EU Investment Grade

Value/Low-Risk Portfolio

Defining the Factor

As a result of the low/negative active[69] correlations between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[70].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Value/Low-Risk integrated factor. Each bond's Low-Risk and Value scores are blended into one average composite measure. This composite score is then used to rank bonds in the Value/Low-Risk integrated factor.

The resulting portfolio has much higher risk adjusted returns because it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to both factors.

Value/Low-Risk Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the Value/Low-Risk composite signal defined in the previous section. In order to limit the turnover, the factor portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[71] profile of the Value/Low-risk portfolio as well as its other characteristics.

	Value/Low-Risk	EU IG
Return	0.86	0.83
Volatility	1.14	3.34
SR	0.75	0.25
Alpha	0.61	
Drawdown	-2.0	-5.5
OAS	77	135
OASD	3.2	4.7
T-Cost (bps)	29	46
Turnover	82%	27%

The Value/Low-risk portfolio has comparable average returns to the EUIG market but a lot lower volatility resulting in a 0.6% annualized alpha.

The Value/Low-risk signal integration is an interesting blend since the low-risk factor emphasizes bonds with low spreads whereas the value factor does the opposite. The resulting portfolio seems to keep its excess returns outperformance while it volatility decreases. It has averaged a lower spread than the EUIG index.

The two styles integrated portfolio does not seem to capture an illiquidity premiums as its average traded volume and percentage of actively traded bonds[72] is comparable to the USIG market averages.

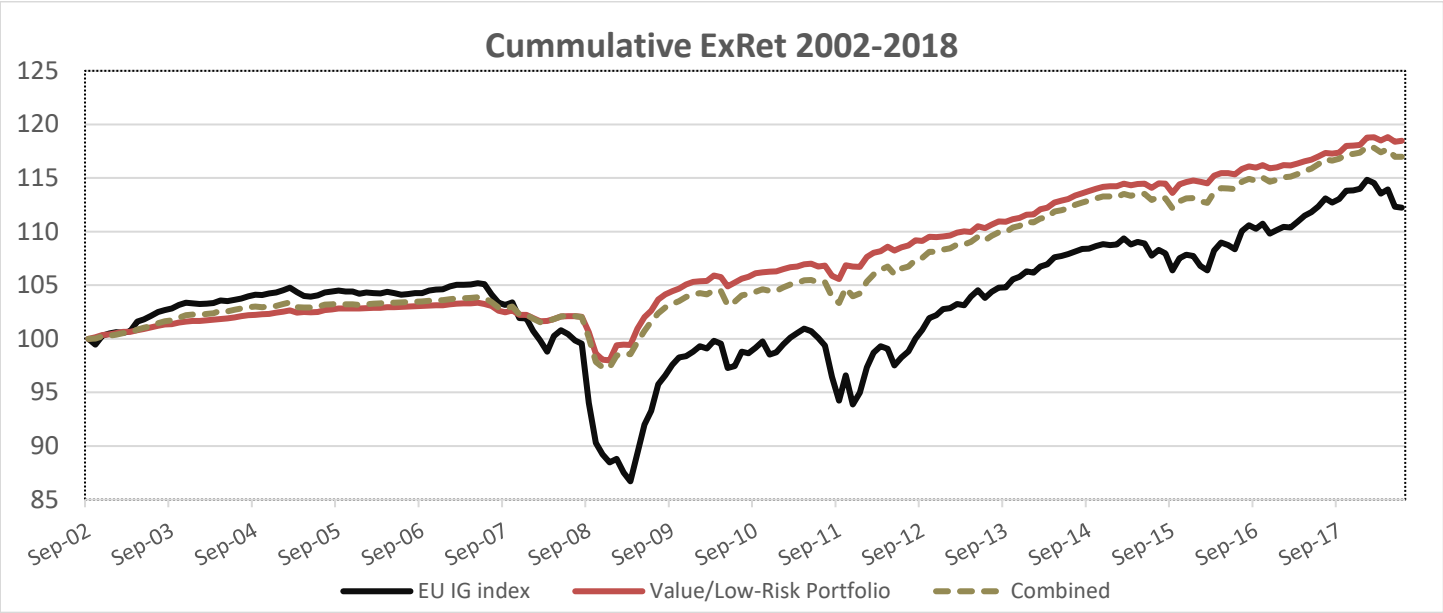
The integrated portfolio has a significant net-alpha in both total returns and excess returns.

[69] Active returns are defined as the difference of the portfolio and market returns

[70] Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio.

[71] Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the Value/Low-Risk integrated portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the Value and Low-Risk individual portfolios described previously. The integrated portfolio has largely the market index. It had much smaller losses in 2008 and 2011 European sovereign crisis.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.2%	0.8%	0.4%	0.3%	-0.9%	-4.2%	7.5%	0.9%	0.4%	2.7%	1.9%	2.4%	0.5%	1.1%	1.8%
2.0%	0.8%	0.1%	0.4%	-1.3%	-4.8%	7.0%	0.3%	-0.2%	3.9%	2.4%	2.1%	-0.1%	1.5%	2.2%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	-0.9%	2.2%	3.5%

Value/LowRisk | EUIG index | Combined

The table above shows the annualized returns of the Value/Low-Risk integrated portfolio, the EUIG universe (in blue) and the along with of the equally weighted combination of the standalone portfolios (purple). The integrated factor portfolio has lower spread and spread duration than the index and, as a result, tends to outperform (underperform) in periods when spreads widen (tighten). It retains some of the outperformance from the Value factor and the tail-events protection from Low-Risk.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Value/Low-Risk	0.63%	1.14%	0.41%	3.56%	1.87%	1.92%

EU Investment Grade

Multi-Style Portfolio

Defining the Factor

As a result of the low/negative active[73] between the different credit factors, combining the style portfolios into a single investment strategy may yield better risk-adjusted returns thanks to the diversification benefits (Style Blending)[74].

While this portfolio construction approach has its merits, we highlight an alternative construction methodology to build the Multi-Style Portfolio. Each bond's Low-Risk, Momentum and Value scores are blended into one average composite measure. This composite score is then used to rank bonds the Multi-Style integrated factor.

The resulting portfolio has even higher risk adjusted returns because it avoids securities with offsetting factor exposures while emphasizing securities with balanced positive exposures to the three factors.

Multi-Style Portfolio Implementation

At the beginning of each month, we construct decile portfolios by sorting the full EU IG universe on the three style composite signal defined in the previous section. In order to limit the turnover, the multi-style portfolio buys bonds in the top decile (D10), holds them as they possibly migrate to the 9th/8Th/7th deciles and sells them once their style signal deteriorates significantly.

Additionally, while rebalancing, the integrated portfolio does not trade any bonds which are in the bottom decile of transactions costs at that point in time. Bonds with high transaction costs are not only expensive to trade, their probabilities of immediate trade execution are also very low.

By directly embedding liquidity considerations into the portfolio construction process we can reduce costs and facilitate a timely execution of trades.

Portfolio Performance and Characteristics

The next table shows the market-value weighted risk-return[75] profile of the integrated portfolio as well as its other characteristics.

The portfolio's alpha is defined as the intercept of the time series regression of its excess return on the EUIG benchmark index excess return.

	Multi-Style	EU IG
Return	1.24	0.83
Volatility	1.29	3.34
SR	0.96	0.25
Alpha	0.96	
Drawdown	-1.9	-5.5
OAS	86	135
OASD	3.2	4.7
T-Cost (bps)	31	46
Turnover	101%	27%

The Multi-Style portfolio has averaged a higher return than any of the previously defined factors. It also has a volatility of 1.3% over the 2002-2018 back-testing period resulting in a significant 1% annualized alpha.

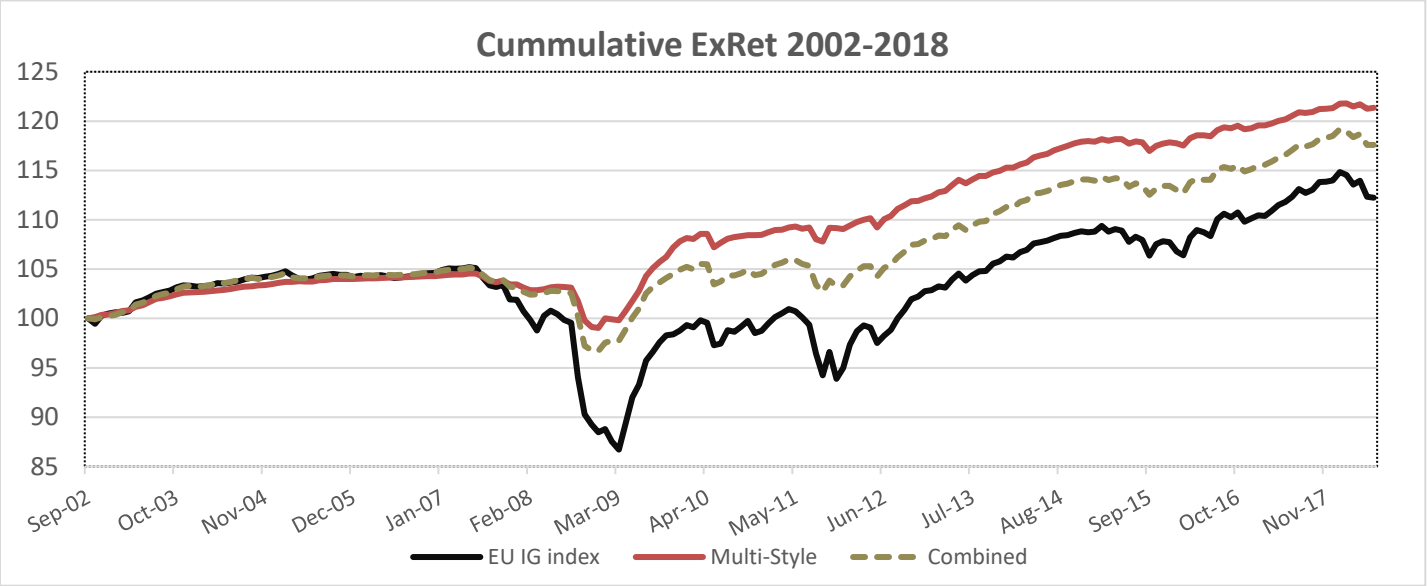
The Multi-Style portfolio exhibits a rather stable performance over the past two decades has a significant net-alpha in both total returns and excess returns.

[73] Active returns are defined as the difference of the portfolio and market returns

[74] Portfolio Blending is two-step portfolio construction in which individual factor portfolios are constructed first and then combined to create a blended portfolio

[75] Returns, Volatilities and alphas are annualized

Historical Performance of the Style Portfolios



The plot above highlights the historical performance of the multi-style portfolio and how it compares to the EU IG index (in black). The plot also shows the cumulative excess return of the equally weighted average of the momentum, value and low-risk individual portfolios described previously. The Multi-Style portfolio has largely outperformed both the EUIG index and the mix portfolio over the 2002-2018 back-testing period.

Annual Breakdown of the Style Portfolio Performance

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.2%	0.8%	0.5%	0.3%	-0.8%	-4.2%	8.9%	0.6%	0.5%	2.8%	2.8%	2.3%	-0.1%	1.2%	1.7%
3.1%	0.8%	0.0%	0.4%	-1.5%	-6.2%	8.5%	-0.4%	-1.1%	4.4%	3.2%	2.5%	-0.5%	1.5%	2.9%
2.8%	1.0%	-0.1%	0.4%	-2.6%	-13.2%	11.7%	-0.1%	-3.8%	8.2%	3.4%	2.3%	-0.9%	2.2%	3.5%

Multi-Style	EUIG index	Combined

The table above shows the annualized returns of the Multi-Style portfolio, the EUIG universe (in blue) along with of the equally weighted combination of the standalone portfolios (purple). In our back-test, the Multi-Style portfolio has realized similar returns to the IG index in credit bull markets with a significant downside protection in periods of market distress like 2007, 2008, 2011 and 2015.

Results after Transactions Costs

The integrated factor portfolio has a significant positive net-alpha in both total returns and excess returns.

	Net Excess Return	Excess return Vol	Net-Alpha ExRet	Net Total Ret	Tot Return Vol	Net TotalRet Alpha
EU IG Index	0.76%	3.34%		4.29%	3.53%	
Multi-Style	0.90%	1.26%	0.66%	3.99%	1.95%	2.15%

References

- Houweiling and Van Zundert (2017), **Factor Investing in Corporate Bond Markets** (Financial Analysts Journal)
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- Fitzgibbons, Friedman, Pomorski and Serban (2015), **Long only style investing** : **Don't mix, just integrate** (AQR research)

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