Deutsche Bank
Research

Factor Investing in Corporate Credit

DB Cross Asset Quantitative & Derivatives Research

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Time To Cross the Bridge: Factor Investing in Credit Markets

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This is the twenty first edition of our Quantcraft series. This periodical outlines new trading and analytical models across different asset classes.

This Quantcraft report connects factor investing and Corporate Credit markets. It provides a bridge to the systematic investor seeking to exploit one of the final frontiers of factor investing. It also introduces the Credit investor to the art and science of quant investing.

To tackle the challenges of frontier markets, we had to adapt. We used credit default swaps instead of corporate bonds, for reasons including liquidity, standardisation, position symmetry and their unfunded nature. We also applied innovative transaction cost management techniques to slow turnover where needed.

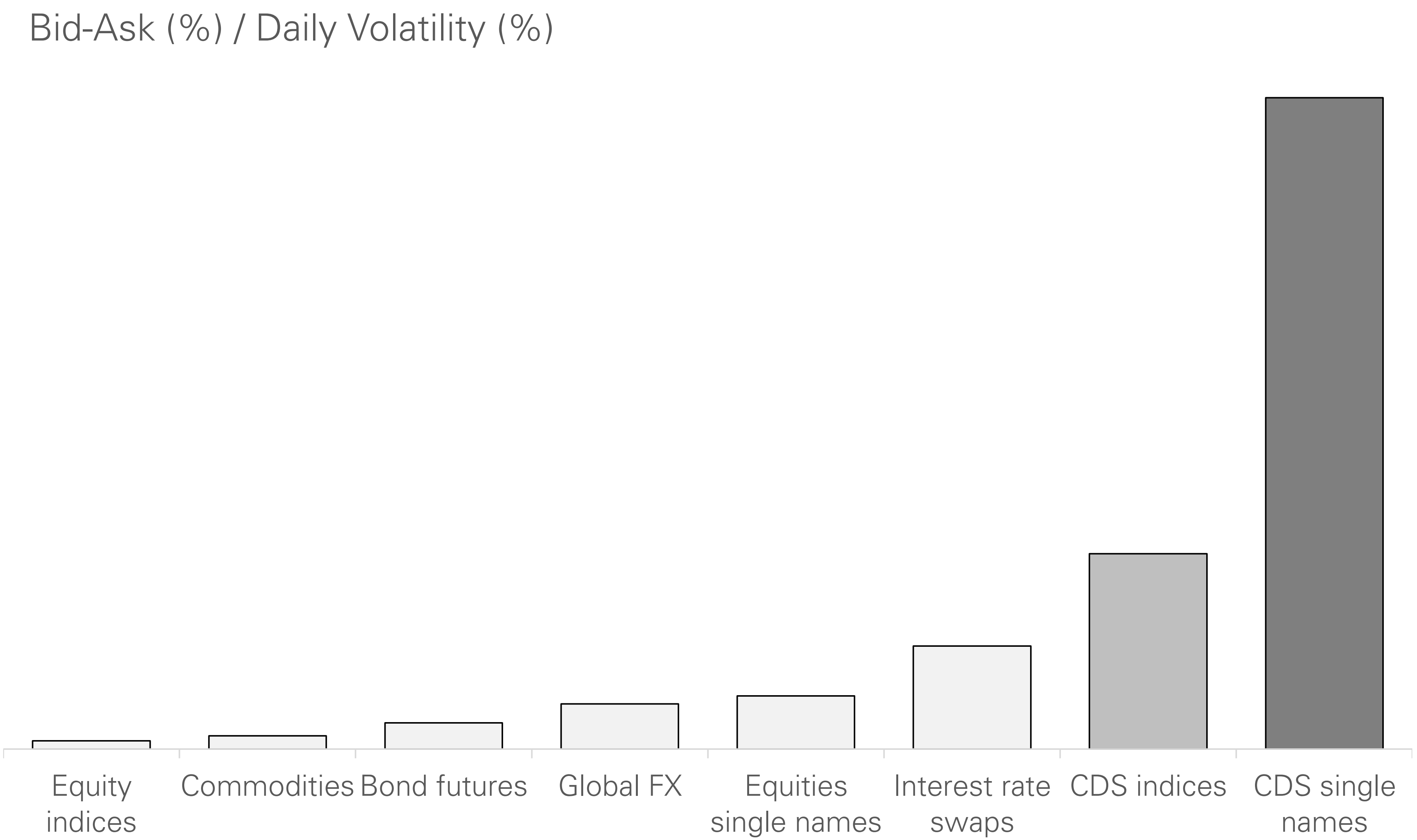
In our factor harvesting process, we employed tools that are unique to the asset class. We used duration-times-spread as a risk measure, distance-to-default as a signal-generating variable and duration to uncover structural inefficiencies.

We have found six investable factors - divided into market-related and company-specific. Some involve following the crowd, but others go distinctly against it. We believe that "reaching for yield", for example, is often an unrewarded practice. As a result, some of our strategies are notably defensive - a welcome characteristic given the number of hidden risks in the asset class.

Time To Cross the Bridge

Source of all images: Deutsche Bank Research.

1. Introduction: Costs (1)



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1. Introduction: Data (2)

CDS contracts, Not Corporate Bonds

- CDS spread quotes constitute a straight measure of credit risk
- CDS contracts have similar specifications
- Enhanced Liquidity
- Ability to short credits

Data

- Period January 2004 - December 2018 (15 years)
- Corporate issuers that are part of the US CDS Indices (CDX.IG and CDX.HY)
- The CDX.IG is an index contract with 125 constituents, which are the most liquid North American credit entities with investment grade credit ratings.
- The CDX.HY is an index contract comprised by the 100 most liquid North American credit entities with non investment grade credit ratings

2. Dissecting the Credit Asset Class: *Identifying credit returns factors*

- PCA
- Panel Regressions

Source of all images: Deutsche Bank Research.

2. Dissecting the Credit Asset Class: PCA (1)

- PCA on the *cross section* of single names CDSs
- PC1 explains 38% of the common variations and the PC2 explanatory power drops to 7.5%

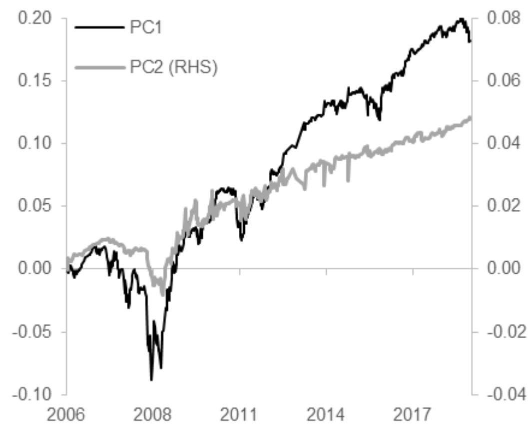
PC1 Correlation to Economic Variables

	PC1
GSI	-0.34
US Nowcast Growth	0.03
US Nowcast Inflation	0.02
Global Treasuries	-0.32
Global Equities	0.58
USD/FX	-0.47
Global Commodities	0.39
CDS Indices	0.85

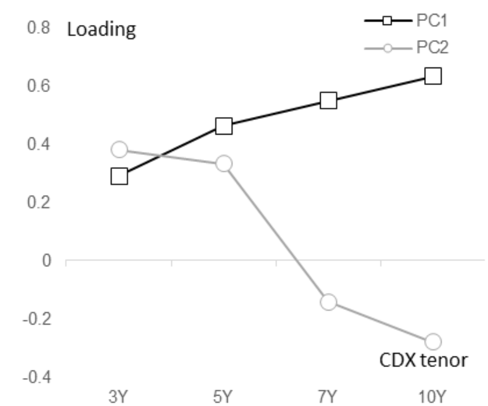
- Correlation to global equities and commodities -proxies for growth- is positive and significant
- Correlation to GSI -proxy for volatility- is negative and significant.
- We can therefore conclude that this "market factor" is heavily pro-cyclical

- *Term Structure* *PCA* on the 3Y, 5Y, 7Y and 10Y CDX indices
- PC1 and PC2 explain 94% of the curve common variations

PCs – Historical Progression



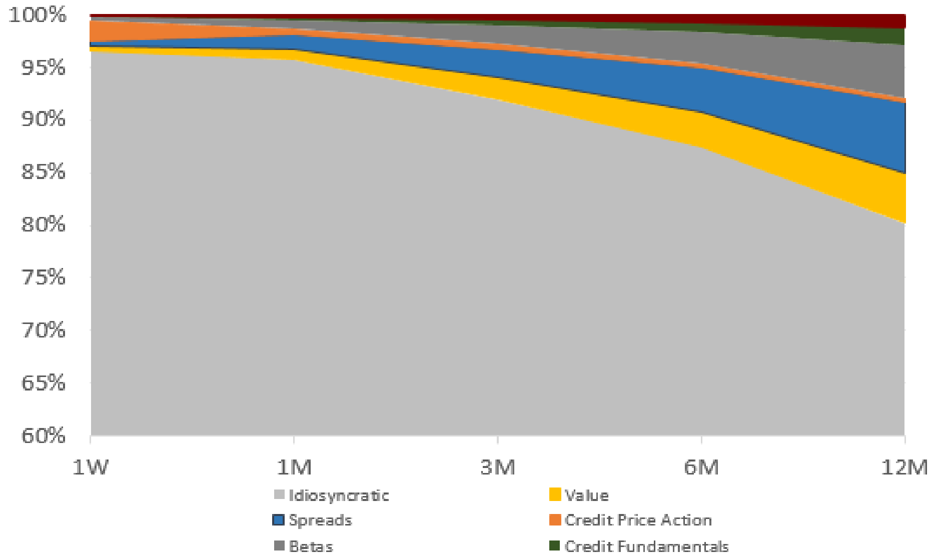
PCs Loadings



- The historical progression of PC1 and PC2 suggest exposure is rewarded over the long run
- The PC1 loads similarly on different tenors. It is representative of long exposure to credit
- The PC2 loads with opposite signs in the short and long end of the curve. The PC2 mimics a curve steepener trade.

2. Dissecting the Credit Asset Class: Panel Regressions (2)

- Complements PCA. It adds tangible variables to the mix of drivers. Focus on returns prediction, not current returns.
- The analysis shows the signals explanatory power, measured by the marginal contribution to the regression R^2.



Price action factor: credit momentum proxy

Credit ratings factor: quality signal proxy

Value factor: The residual between market spread - fair value estimation

Spread factor: CDS spreads - tangible measure of expected returns

Market betas: risk proxy. US Credit and Equity indices

Fundamental factor: 4 indicators commonly used to assess credit quality

- A large portion of the systematic returns not predicted by our choice of factors → This vindicates the presence of active managers
- However, the explained portion is not insignificant and similar to that of other asset classes.
- The predictive power of our factors increases over time.
- Spreads is the most important driver
- Betas and Value become increasingly important the further we move in the time horizon scale.

3. Signal Neutralization and Portfolio Construction : *Dealing with credit risk dispersion*

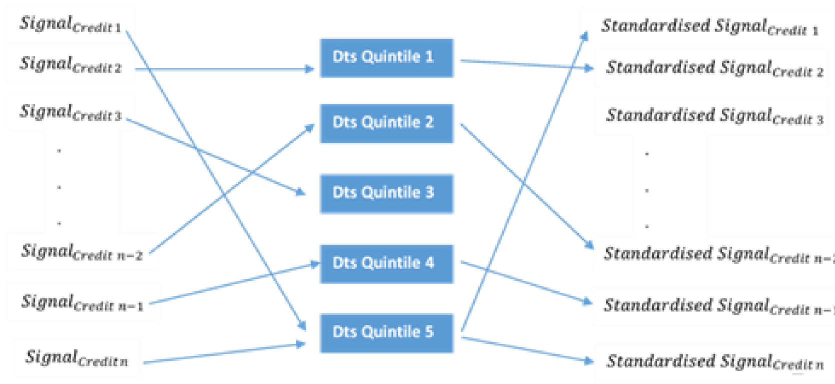
Source of all images: Deutsche Bank Research.

3. Signal Neutralization and Portfolio Construction: Signal Neutralization (1)

- Literature has highlighted that the cross-section of corporate credit shows a larger dispersion in beta and risk than that of other asset classes.
- We address the issue taking two steps: first at the signal level and then at the portfolio construction level.
- We neutralize our signal in DTS (duration-time-spreads) quintile buckets

$$DTS = Duration\ x\ Credit\ Spread$$

- Ben Dor et al (2007) argue that changes in credit spreads are not parallel, but linearly proportional to the spread level. They demonstrate the advantages of using DTS over spread duration in the risk modelling credit portfolios.
- Neutralizing in DTS buckets allows for a cleaner comparison of the signal values across the complete credit spectrum



$$\widehat{s_{i,t}} = \frac{s_{i,t} - \overline{s_{k,t}}}{s_{k,t\,max} - s_{k,t\,min}}$$

where:

$k = 1,2,3,4,5$

$\widehat{s_{i,t}}$ = intrument i standardised signal value on time t

$s_{i,t}$ = instrument i signal value on time t

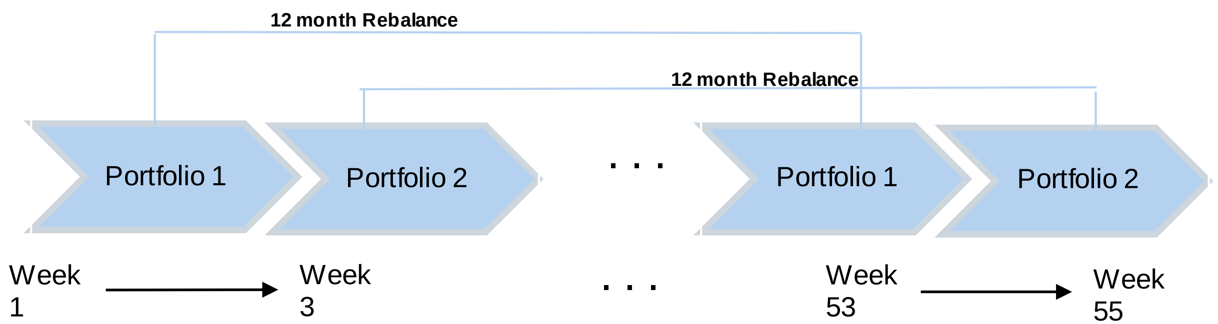
$\overline{s_{k,t}}$ = mean signal value in dts group k on time t

$s_{k,t\,max}$ = max signal value in dts group k on time t

$s_{k,t\,max}$ = min signal value in dts group k on time t

3. Signal Neutralization and Portfolio Construction: Portfolio Construction (2)

- We create top-bottom decile portfolios by ranking credits based on the signal value
- Each leg is created targeting a pre-defined DTS level of risk
- Each position carries the same level of DTS risk
- We apply portfolio tranching: we create sub-portfolios carrying an equal proportion of total portfolio risk but rebalanced two weeks period apart from the other



- Tranching contributes with two aspects: adaptivity, as the final portfolio rebalances far more often than the original ones, and less "pin risk", as it accesses the market on a far more frequent basis.

4. Credit Factors: *company-specific and market factors*

- Quality
- Low Duration
- Value
- Low Beta
- Residual and Market Momentum

Source of all images: Deutsche Bank Research.

4. Credit Factors: Quality (1)

Academic Rationale

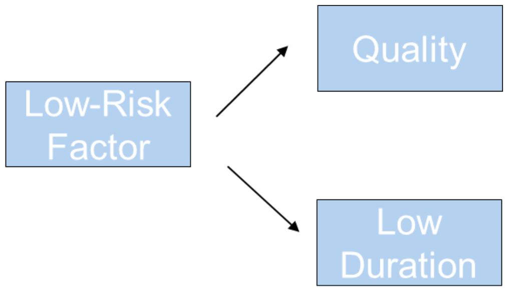
- The quality factor is based on the hypothesis that high quality assets returns -on a risk adjusted basis- outperforms the returns of low quality assets over the long run. This factor has been tested and developed in a number asset classes.
- In the equity space for instance the factor is defined using profitability, efficiency and balance sheet strength metrics.

Previous Work

- Previous work in credit factors - *Houweling et al. (2016) and Brooks et al. (2018)*- has mixed quality signals in the definition of a low-risk factor
- A common definition of the low-risk factor is shorting low-rated-long-dated credits in conjunction with a long leg composed of highly-rated-short-dated credits.

Factor Definition

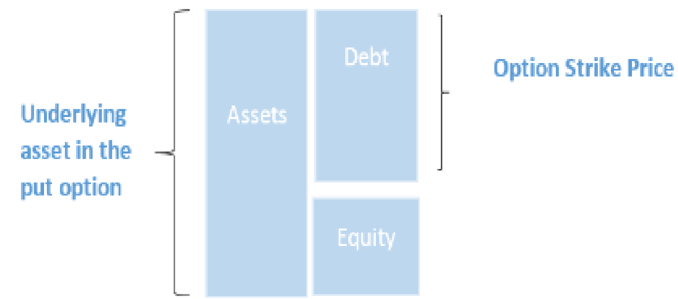
- In our work we split the low-risk factor into two components:



- We believe that dividing the signal is a plausible path for two reasons:
  - The low-duration component is positively correlated to the market and the quality component is not.
  - The low duration component is not company specific. Therefore, it is an anomaly that is easier to implement at the CDS index level

4. Credit Factors: Quality (2)

- Our fundamental quality anchor is the distance to default derived from the Merton (1974) model.
- Merton's framework equates the bondholder position to that of being short a put option on the underlying assets of the firm, with a strike price equal to the company debt. If the assets value falls below the threshold the option is exercised and the company enters into default.
- The distance to default can intuitively be understood as the number of asset-returns-standard-deviations that the company is away from its default point.
- One critical assumption made on the model is that asset volatility is known. However, this measure is not observable and some assumptions must be made for its estimation. We follow Bharath and Shumway (2004) for the estimation of asset volatility and Correia et al (2013) in defining a "naive" distance to default.

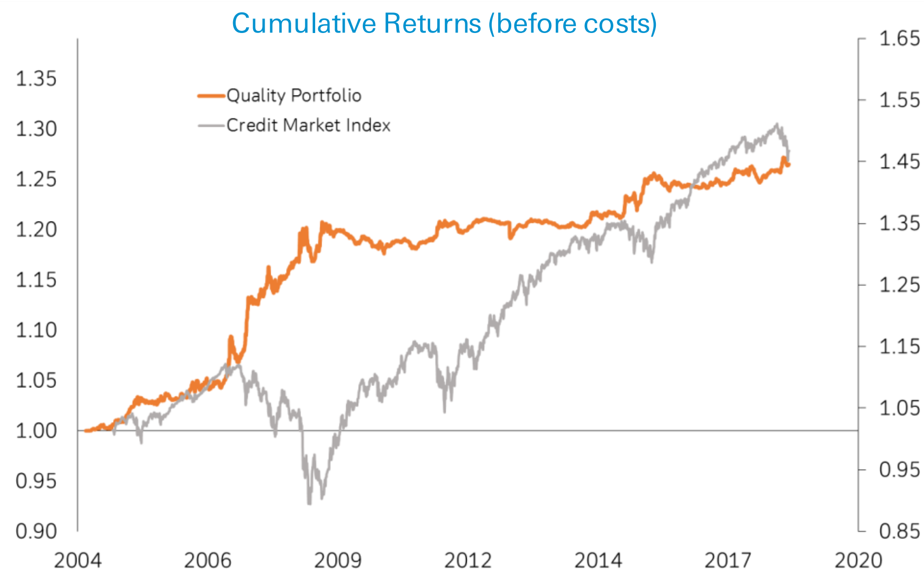


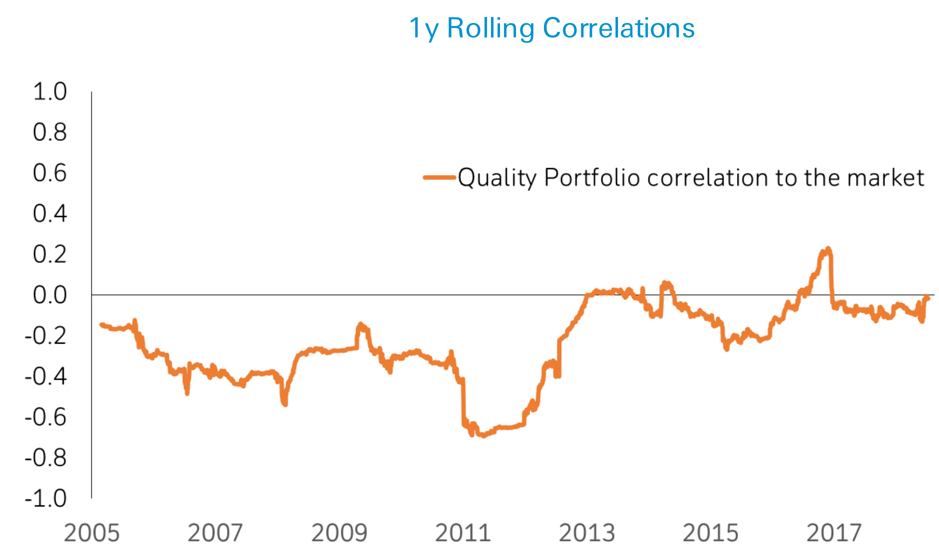
Naïve Distance To Default

$$\text{Distance To Default} = \frac{\ln\left(\frac{Assets}{Short\ Term\ debt + 0.5\ Long\ Term\ Debt}\right)}{\sigma_{Assets} * \sqrt{Time}}$$

4. Credit Factors: Quality (3)

- The Quality factor is implemented through a cross sectional construct using top-bottom decile portfolios
- The signal is neutralized within risk (DTS) buckets. Positions are DTS weighted
- We utilize portfolio tranching and create 13 different sub portfolio which are rebalanced semi-annually





Quality Factor Portfolio

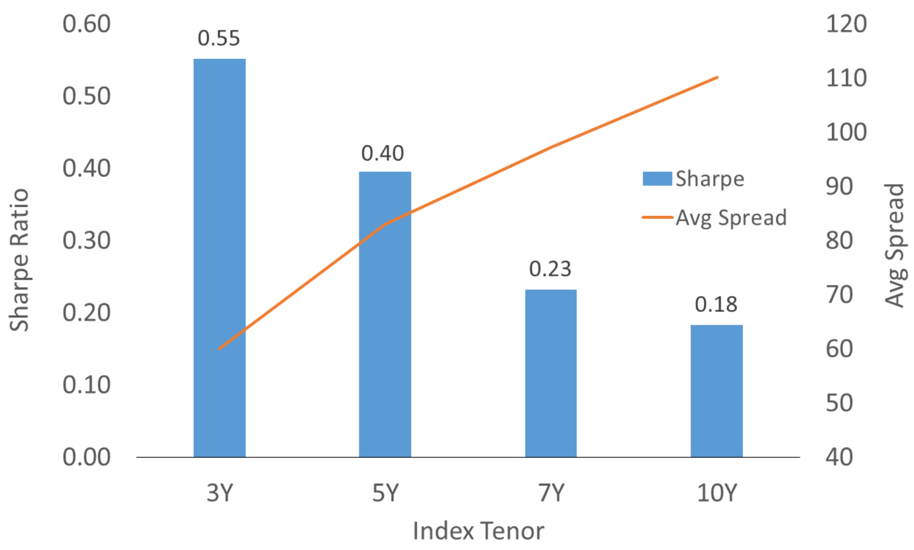
Total Return	26.49%
Annual Return	1.61%
Annual Std	1.46%
Max DD	-2.80%
Sharpe Ratio	1.10
Market Correlation	-0.26

- Predominantly negative rolling correlations to the credit market
- Outperforms during stress periods
- Counter-cyclicality is similar to that experienced in the equity space

4. Credit Factors: Low Duration (4)

- As noted earlier, the literature often points to short-dated fixed income instruments outperforming their long-dated counterparts, on a risk adjusted basis
- The PC2 of the credit term structure mimics this trade. As we saw before, exposure to this statistical factor is rewarded over long run
- The existence of CDS indices allows the risk premia investor to tackle this anomaly and harness its respective returns
- A potential explanation for this phenomenon, is that benchmarked active fixed income investors tend to prefer longer dated-higher yielding bonds under the perception that the higher duration and yield exposure will lead to outperformance over the benchmark

Historical CDX IG performance by tenor average spread



Signal generation:

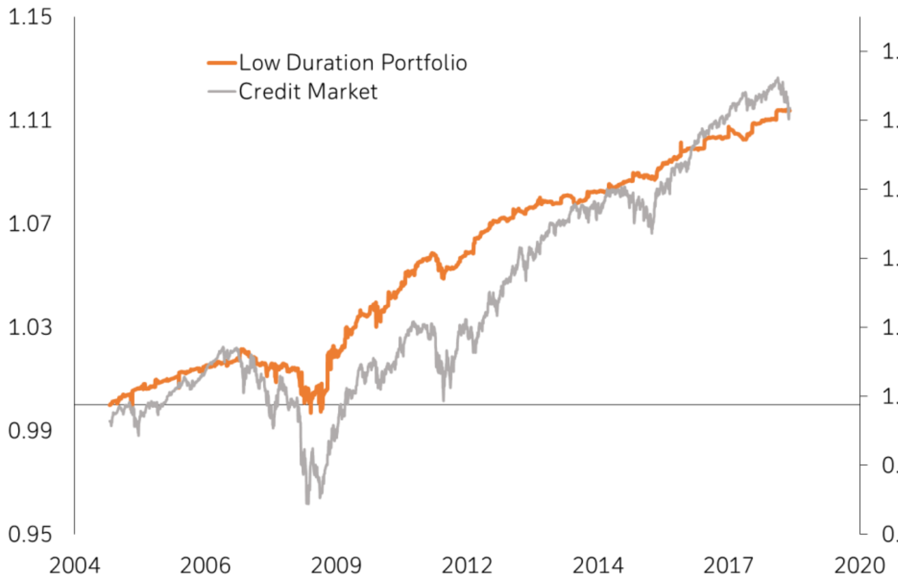
- Time homogenous steepener on CDX IG indices
- DV01 weighted* long positions on the 3y contract vs short positions on the 10y

** Different from the rest of studied factors we do not use DTS weighted positions. The reason is that DV01 Weighted positions would result in higher leverage ratios and consequently higher Jump to Default.*

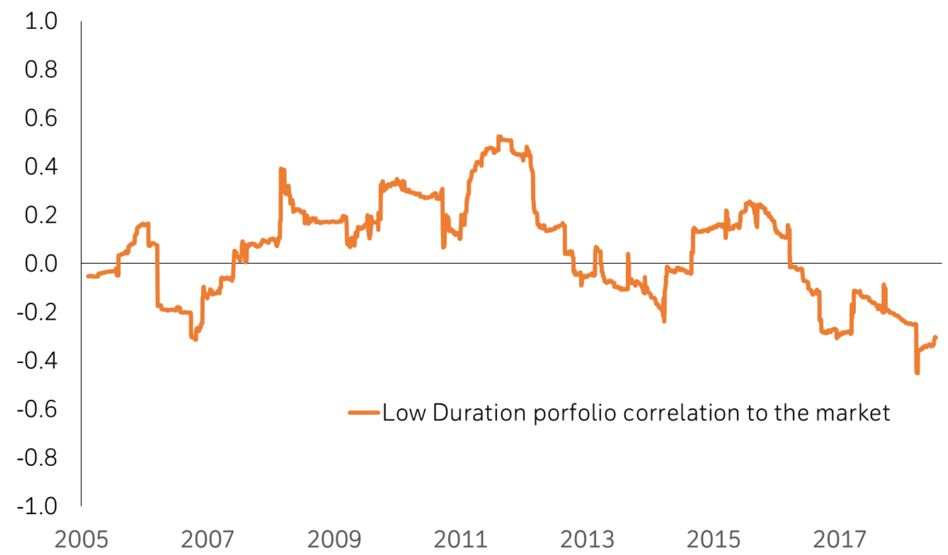
4. Credit Factors: Low Duration (5)

- The strategy is implemented using 3y and 10y CDX.IG contracts. We disregard its application in HY given the poor liquidity of contracts outside the 5y maturity bucket
- We use portfolio tranching and create 26 sub-portfolios that are annually rebalanced

Cumulative Returns (before costs)



1y Rolling Correlations



	Low Duration
Total Return	11.37%
Annual Return	0.76%
Annual Std	1.06%
Max DD	-2.41%
Sharpe Ratio	0.72
Market Correlation	0.15

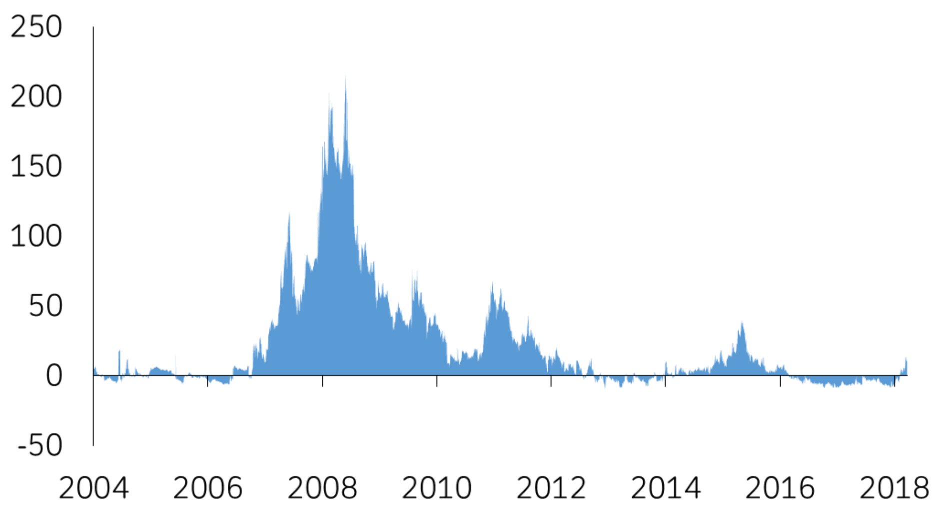
- Low Duration shows a pro-cyclical behaviour. The factor is a curve steepener trade and on stress periods the credit curve flattens or inverts

4. Credit Factors: Low Duration (6)

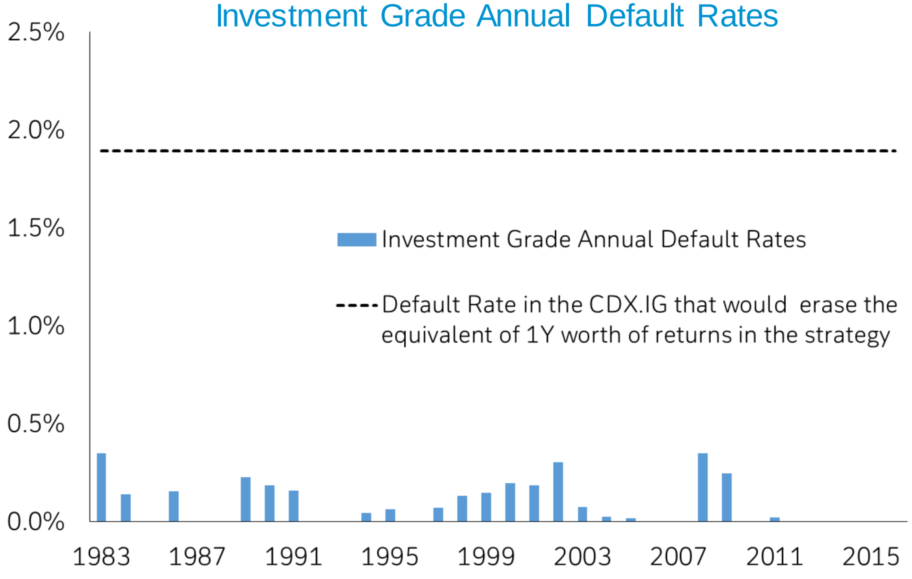
Key Characteristics:

- The low duration factor is typically carry positive. Despite being long short dated instruments vs long dated instruments on term structures that generally are positive slopping, the risk weighted notionals compensate for it.
- By taking unequal risk notionals -in short and longer dated CDX contracts- the investor is naturally exposed to jump-to-default (JTD) risk
- This was a potential concern during our implementation. However, the historical default rates in the IG sector shows that defaults are rare. Default would need to increase substantially to erase 1y worth of results in the strategy

Carry Profile

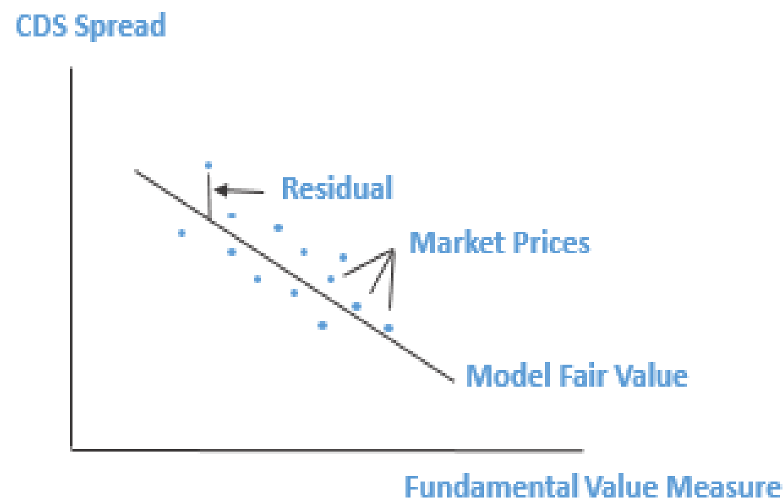


Investment Grade Annual Default Rates



4. Credit Factors: Value (7)

- The value factor is based on the hypothesis that cheap assets outperforms expensive assets risk adjusted returns over the long run
- Literature in the credit space has focused on the comparison of fair values (inferred from theoretical models) and actual market credit spreads
- Previous credit academic work has focused on the use of credit ratings or distance to default measures as fundamental anchors



Factor Definition

- Fair value is estimated through a linear regression of log-scaled single name CDS spreads against distance to default

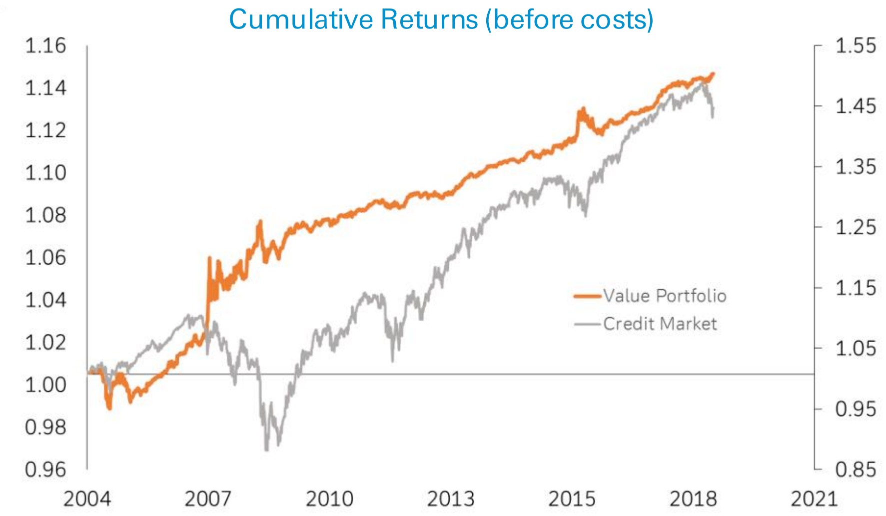
$$Log\ Spreads = \beta_0 + \beta_1\ .Log\ DTD$$

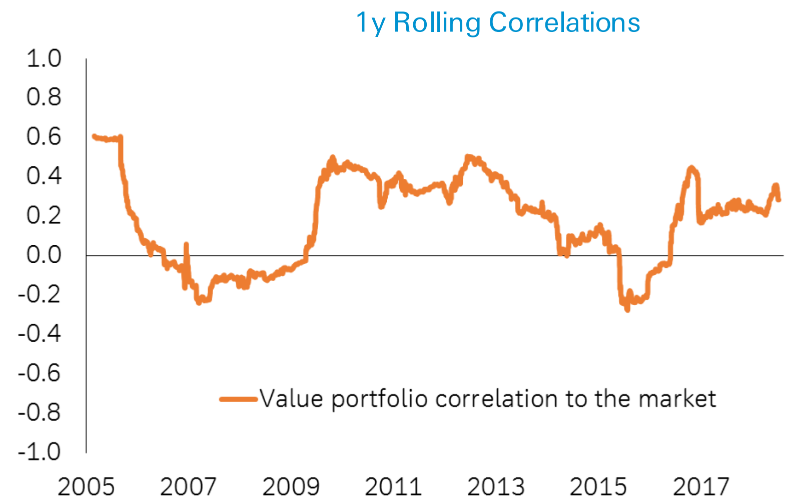
- Different from earlier literature, we do not use duration or maturity as a variable in our regressions. We also work with time series as opposed to cross sectional regressions
- The final signal is then estimated as:

$$Value\ Signal = Fair\ Value\ Cds\ Spread - \ Mkt\ Cds\ Spread$$

4. Credit Factors: Value (8)

- The Value factor is implemented through a cross sectional construct using top-bottom decile portfolios
- The signal is neutralized within risk (DTS) buckets. Positions are DTS weighted.
- We utilize portfolio tranching and create 26 different sub portfolio which are annually rebalanced





	Value Portfolio
Total Return	14.2%
Annual Return	0.9%
Annual Std	0.9%
Max DD	-1.9%
Sharpe Ratio	1.08
Market Correlation	0.06

- The gross Sharpe ratio is high in line with other strategies that are structurally short regime shifts
- Correlations to the Credit market tend to be positive over time, in line with the pro-cyclicality of fundamental Value strategies
- The strategy outperformed in 2008 and 2015, which goes against long-term pro-cyclicality, but is in line with the performance of price reversal strategies during those periods

4. Credit Factors: Low Beta Factor (9)

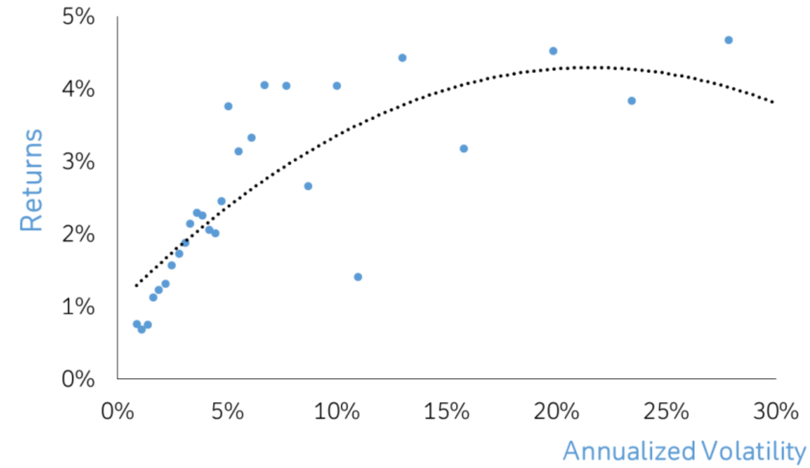
- The Low Beta investment factor is based on the premise that riskier assets underperform their less risky counterparts on a risk-adjusted basis

- As pointed in Ang (2014), leverage-constrained investors prefer assets with built-in leverage or exhibiting higher total return potential. Such demand leaves these assets relatively overpriced

- The phenomenon is also manifested in a Markowitz-like context by observing that, while there is a positive relationship between return and volatility, this relationship flattens as asset volatility rises

- One unit rise in historical asset volatility, historical asset returns rise by less than unity. As such, the riskier the asset, the lower the historical Sharpe ratio.

CDS Historical Risk Return Relationship



Source: Deutsche Bank. Annualized volatility and annualized returns observations of single name CDS contracts over the period 2004-2018 with a minimum of 500 observations. The data was grouped in 30 buckets according to the annualized volatility values. The data shown is the average annualized returns and volatility of each group.

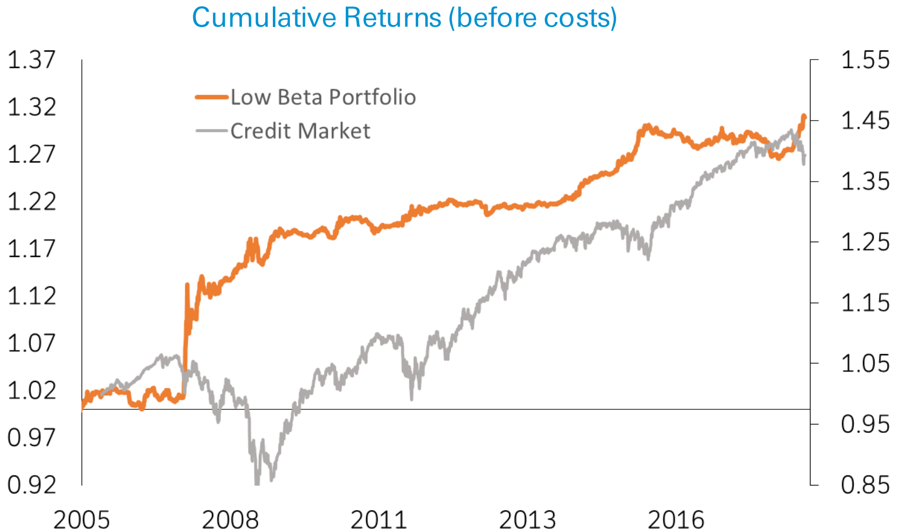
Factor Definition

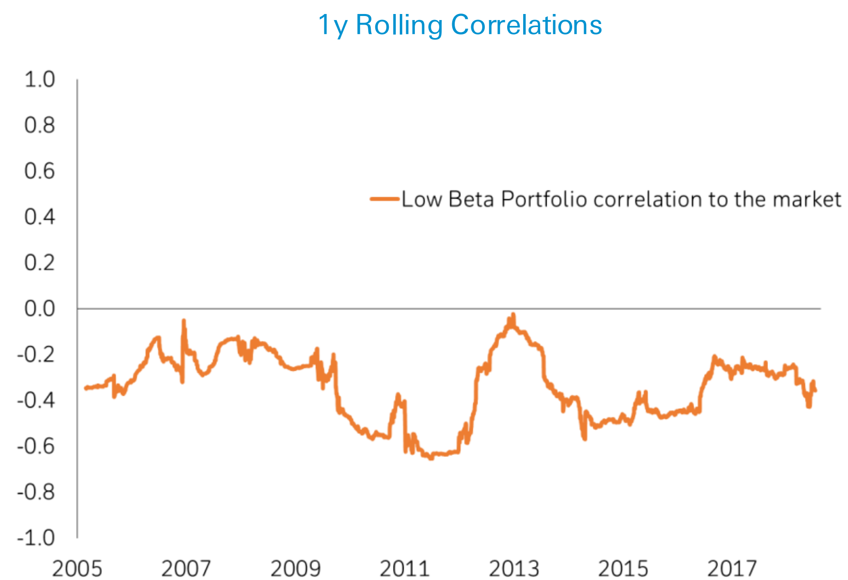
- Our signal is defined as the (rolling) beta of asset returns against the CDS market

- The covariance matrices used for beta estimation are based on 3-day non-overlapping returns and 5-year lookback windows. Values are decayed with a 1-year half-life in the main diagonal and a 3-year half-life in the off-diagonal elements.

4. Credit Factors: Low Beta Factor (10)

- The Low Beta factor is implemented through a cross sectional construct using top-bottom decile portfolios
- The signal is neutralized within risk (DTS) buckets. Positions are DTS weighted
- We utilize portfolio tranching and create 13 different sub portfolio which are semi annually rebalanced





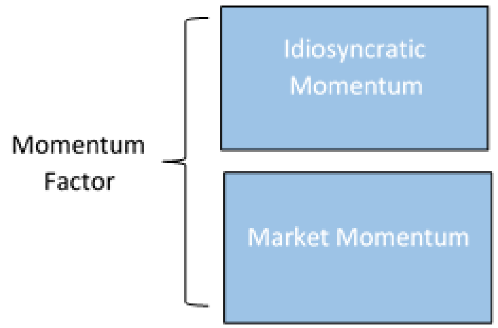
	Low Beta Factor
Total Return	30.92%
Annual Return	1.96%
Annual Std	1.64%
Max DD	-4.56%
Sharpe Ratio	1.19
Market Correlation	-0.25

- Consistent negative rolling correlations to the credit market
- The strategy is highly defensive in nature. This is no surprise as safer (riskier) assets, which the strategy is long (short), outperform (underperform) during periods of market aversion

4. Credit Factors: Residual and Market Momentum (11)

Previous Work:

- The phenomenon is more clearly observed in non-IG relative to IG bonds. However it is significant in a broad IG and HY sample
- Momentum in debt returns is complementary to Equity Momentum



Our approach:

- We take a fresh approach to the topic, bringing some tools from our experience with this investment factor in other asset classes
- A key difference in our approach is the direct separation between market-related momentum and idiosyncratic or company-specific momentum

Sequential Dependencies Scores on Market Returns

Lookahead Window (columns) / Lookback Window (rows)

	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M
1M	0.10	0.10	0.13	0.17	0.19	0.20	0.21	0.20	0.21	0.18	0.17	0.18
2M	0.19	0.18	0.23	0.28	0.29	0.30	0.30	0.28	0.29	0.26	0.26	0.25
3M	0.15	0.28	0.32	0.31	0.32	0.33	0.34	0.33	0.33	0.29	0.29	0.29
4M	0.24	0.24	0.34	0.31	0.30	0.33	0.34	0.33	0.32	0.30	0.29	0.30
5M	0.37	0.32	0.32	0.34	0.34	0.36	0.37	0.34	0.35	0.33	0.34	0.35
6M	0.23	0.24	0.40	0.42	0.37	0.38	0.37	0.37	0.38	0.35	0.35	0.37
7M	0.47	0.48	0.42	0.38	0.38	0.41	0.43	0.44	0.44	0.42	0.42	0.41
8M	0.17	0.19	0.44	0.47	0.43	0.39	0.43	0.45	0.44	0.41	0.40	0.39
9M	0.55	0.26	0.31	0.34	0.34	0.39	0.42	0.43	0.42	0.40	0.38	0.37
10M	0.28	0.41	0.45	0.46	0.42	0.35	0.34	0.35	0.36	0.37	0.35	0.34
11M	0.21	0.25	0.24	0.11	0.17	0.21	0.30	0.34	0.34	0.33	0.33	0.32
12M	0.13	- 0.01	0.12	0.14	0.19	0.28	0.34	0.39	0.38	0.35	0.31	0.30

Impulse Response Dynamics:

- There is momentum in both market returns and idiosyncratic returns
- There are no patterns suggesting an optimal formation window to assess market momentum. In line with findings in CTA markets
- Residual momentum exhibits a slow pattern, both in terms of formation windows and potential holding periods. This supports the argument that the residual momentum information diffuses slowly

Sequential Dependencies Scores on Idiosyncratic Returns

Lookahead Window (columns) / Lookback Window (rows)

	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M
1M	0.10	0.10	0.09	0.09	0.08	0.09	0.10	0.10	0.10	0.10	0.10	0.10
2M	0.11	0.10	0.10	0.09	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11
3M	0.10	0.10	0.09	0.09	0.09	0.10	0.11	0.11	0.11	0.11	0.11	0.11
4M	0.12	0.09	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12
5M	0.07	0.11	0.10	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.12	0.12
6M	0.13	0.12	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.13	0.13	0.13
7M	0.09	0.12	0.11	0.11	0.11	0.12	0.13	0.13	0.13	0.14	0.13	0.14
8M	0.10	0.10	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.14
9M	0.11	0.09	0.12	0.15	0.14	0.13	0.12	0.13	0.13	0.14	0.14	0.15
10M	0.14	0.14	0.13	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.15
11M	0.10	0.13	0.11	0.08	0.09	0.10	0.11	0.13	0.14	0.15	0.15	0.15
12M	0.16	0.10	0.07	0.05	0.06	0.09	0.11	0.13	0.14	0.15	0.15	0.15

4. Credit Factors: Residual and Market Momentum (12)

Signal Generation

- Market Momentum is implemented using IG and HY CDX contracts. Company-specific Momentum is implemented using single name CDS.
- Company-specific momentum refers to residual momentum or market orthogonalized returns:

$$ResidualReturn_{i,t} = Returns_{i,t} - \beta_{i,t}\, MarketReturns_t$$

- Having defined both momentum measures, we follow an approach taken in other asset classes. The signals are built using the *DB cross asset trend algorithm*
- The *DB cross asset trend algorithm* is created on the premise that returns signs, as opposed to intensity, carry the greatest explanatory power
- Opposite to traditional implementations, it uses information from multiple look back windows.
- The signal is noised controlled and deflated by dispersion

Credit Momentum Signal

At a given rebalancing date, the ***Market Momentum*** signal is calculated as follows:

1. We calculate returns between t-h and t, where h ε [21,252].

2. We record the sign of each of the 232 values above → vector of -1 and +1 values.

$$s_{t-h,t} = 1 \;\; if \;\; r_{t-h,t} > 0$$
$$and$$
$$s_{t-h,t} = -1 \;\; if \;\; r_{t-h,t}| < 0$$

3. The raw signal value is the average of the vector constructed in step 2. We record the vector's standard deviation

$$\bar{s} = \frac{1}{252-21}\sum_{h=21}^{252} \hat{S}_{t-h,t}$$

4. We apply noise control to the signal. The method, is hysteresis based

$$s_t = \bar{s}_t \;\; if \;\; |\,\bar{s}_t| > \frac{1}{3}$$
$$and$$
$$s_t = s_{t-1} \;\; if \;\; |\,\bar{s}_t| < \frac{1}{3}$$

5. Finally, we further control for noise by deflating the signal by its dispersion, as recorded in Step 3. This gives us the final signal.

$$Final\, Signal = \frac{s_t}{\sigma_{\bar{s}_t}}$$

The ***Residual Momentum*** signal, on the other hand, is calculated as follows:

1. We calculate the raw residual signal:

$$s_{i,t} = r_{i,t} - \beta_{i,t}\, r_t$$

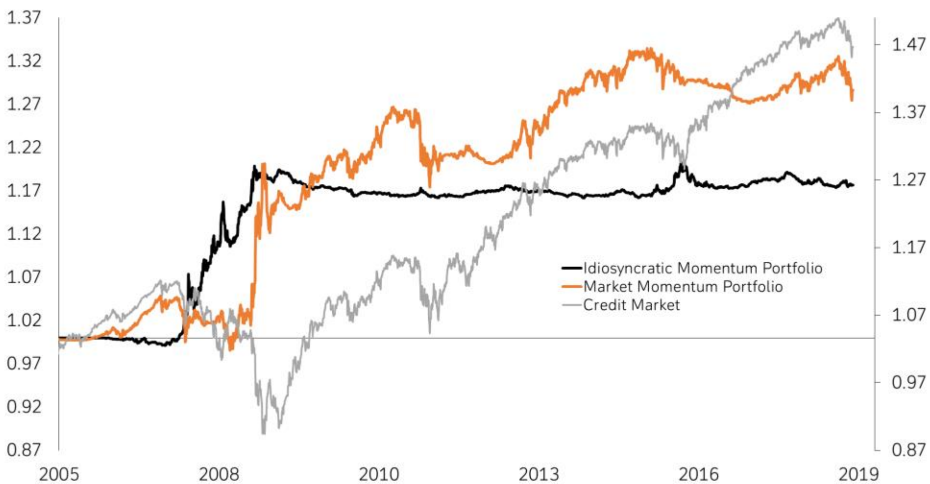
2. We calculate residual returns between t-h and t, where h ε [126,252].

3. The remaining steps for the raw signal follow Steps 2, 3, 4 and 5 in Market Momentum.

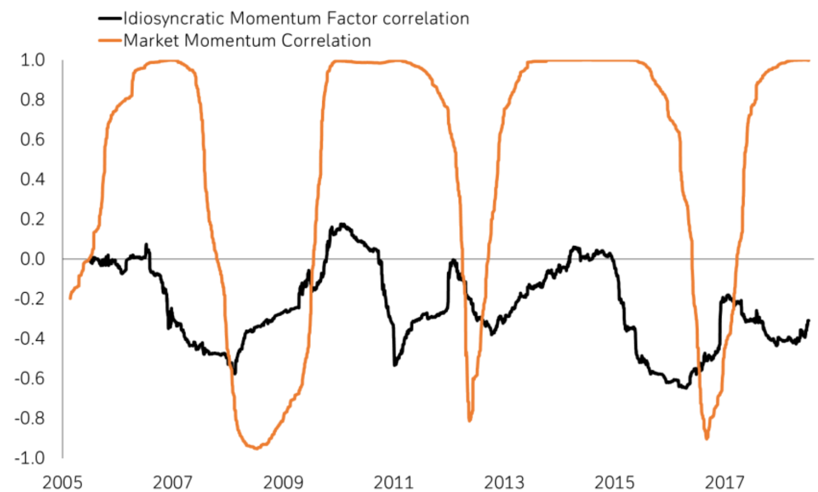
4. Credit Factors: Residual and Market Momentum (13)

- Residual momentum is implemented on a cross sectional basis using top-bottom decile portfolios and Market momentum on a time series basis
- The signal is neutralized within risk (DTS) buckets. The positions are DTS weighted
- We utilize portfolio tranching and create 26 different sub portfolio which are annually rebalanced for both market and times series momentum

Cumulative Returns (before costs)



1y Rolling Correlations



	Idiosyncratic Momentum	Market Momentum
Total Return	17.7%	28.7%
Annual Return	1.3%	1.9%
Annual Std	1.6%	3.8%
Max DD	-4.4%	-7.3%
Sharpe Ratio	0.77	0.48
Market Correlation	-0.26	0.16

- The residual momentum strategy is highly defensive. It shows a long term negative market correlation
- Market momentum is highly directional. Correlations vary overtime
- Residual and market momentum are complementary to each other

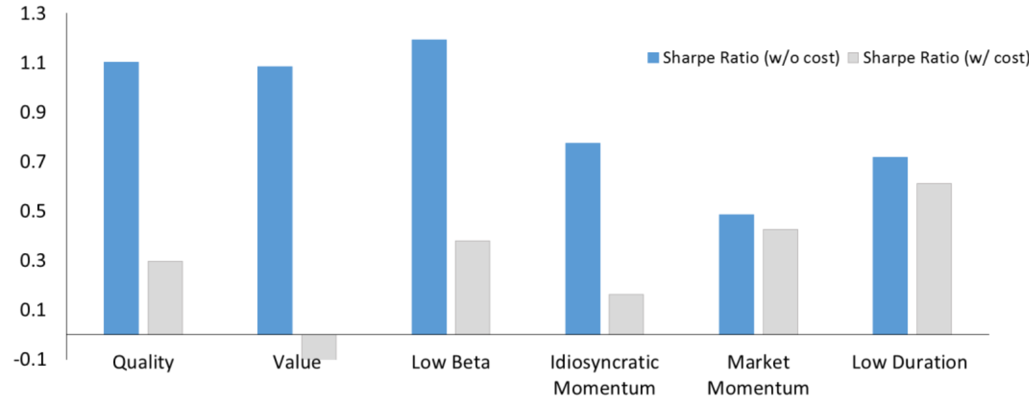
5. Factor Aggregation and Applications: *Dealing with transaction costs in the asset class*

Source of all images: Deutsche Bank Research.

5. Factor Aggregation and Applications: The transaction costs effect (1)

- The individual strategies results suffer significant deterioration on an after cost scenario
- The company-specific factors suffer the greatest performance deterioration. The market factors are much less affected

Individual Factor Strategies Sharpe Ratios

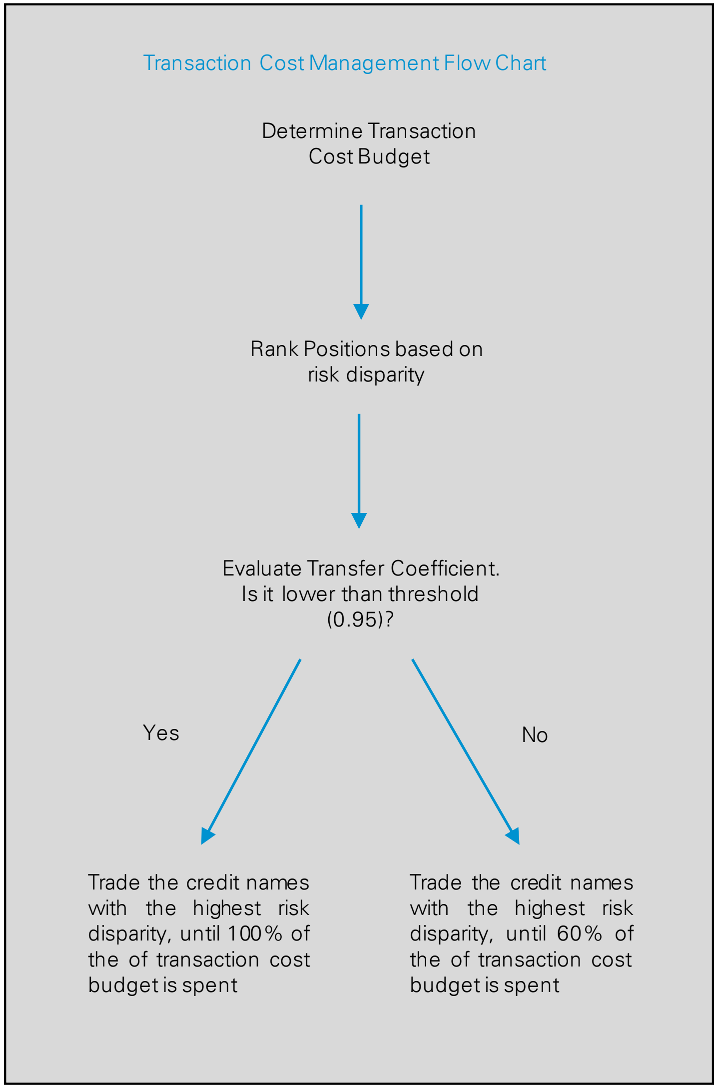


We approach this issue applying <u>two</u> separate measures:

- Factor Aggregation. We create two distinctive multifactor portfolio:
  - Company-specific factors portfolio → combines the 4 single name factors - Quality, Value, Low Beta and Idiosyncratic Momentum- using equal weights
  - Market factors portfolio → combines the 2 market factors -Market Momentum and Low Duration- using inverse volatilities
- Apply a risk-disparity based transaction costs and turnover control mechanism to the company-specific factors portfolio

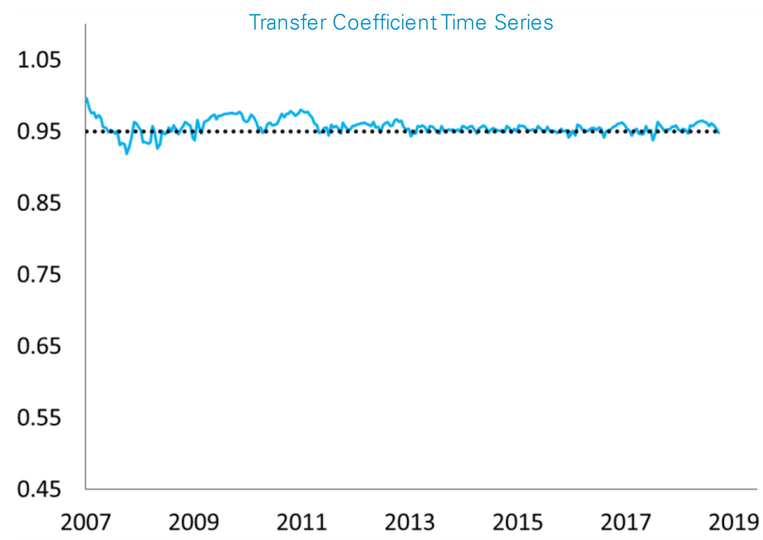
5. Factor Aggregation and Applications: Turnover Control Mechanism (2)

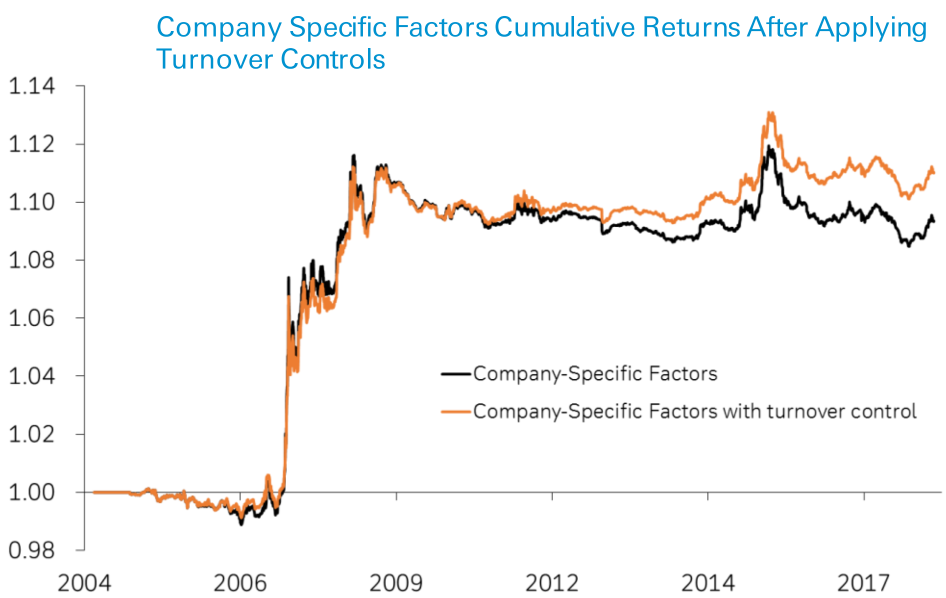
- Turnover deceleration is common in expensive asset classes
- It must be done without significantly affecting the information carried by our signals.
- Our scheme strikes a balance between both the aggregate amount of portfolio turnover level and the turnover distribution -what positions require rebalancing-
- The turnover level is a function of the correlation between the weights of the target portfolio and the traded portfolio (Also known as transfer coefficient)
- The idea is to decrease portfolio turnover when the transfer coefficient is high and increase turnover when it falls below a threshold
- The turnover distribution is a function of the individual position risk distance between the target and actual portfolio
- The mechanism assigns priority to the most influential positions i.e those with largest risk distance



5. Factor Aggregation and Applications: Turnover Control Mechanism (3)

- Our cost control mechanism leads to a 30% improvement in the strategy cost profile an 22% increase in its Sharpe ratio
- While annual returns significantly benefit from the transaction cost savings, there is some alpha slippage.
- The transfer coefficient stabilize around the target threshold without significant oscillations

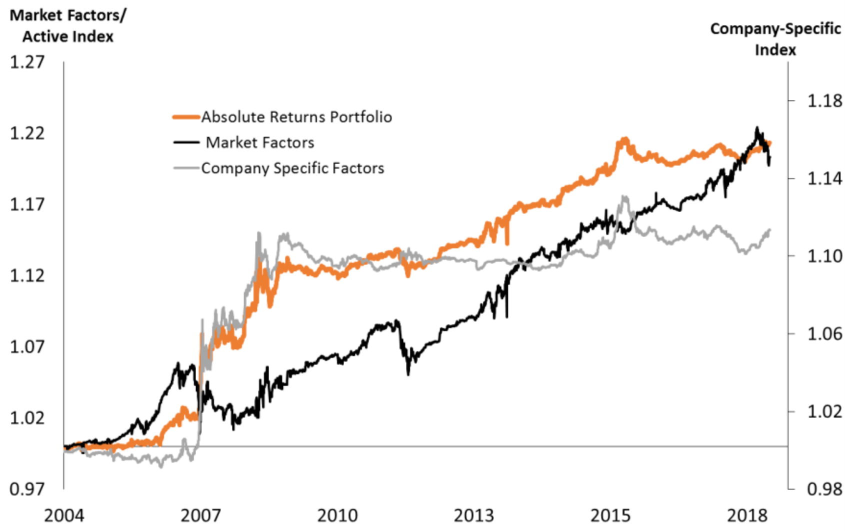




	Without T/C Controls	With T/C Control
Total Return	9.64%	11.35%
Annual Return	0.65%	0.76%
Annual Std	1.18%	1.13%
Max DD	-3.10%	-2.64%
Sharpe Ratio	0.55	0.67
Market Correlation	-0.28	-0.29
Annual Turnover	1.98	1.29
Annual Transaction Costs	0.57%	0.40%

5. Factor Aggregation and Applications: Absolute Returns Portfolio (4)

- The *company-specific factors* portfolio and the *market factors* portfolio show distinctly different behaviours. The latter shows some degree of procyclicality, while the former displays a defensive pattern. This makes them ideal candidates for further aggregation.
- As a result, we create an absolute return strategy that combines both portfolios using an inverse volatility weighting approach.
- As opposed to targeting a pre-defined volatility level, we dynamically change the *market factors* exposure in order to target the *company-specific factors* volatility. Turning over only the *market factors* portfolio improves the new strategy transaction cost profile.



	Market Factors	Company Specific Factors	Absolute Returns Portfolio
Total Returns	20.34%	11.35%	21.31%
Annual Returns	1.32%	0.76%	1.37%
Volatility	1.98%	1.13%	1.56%
Sharpe	0.67	0.67	0.88
Market Correlation	0.27	-0.29	-0.01

- The active/ absolute returns portfolio shows both higher risk adjusted returns uncorrelated return streams over time

5. Factor Aggregation and Applications: Absolute Returns Portfolio (5)

- Given the DTS-led differences in weights between our multi-factor portfolios and credit benchmarks, the standard "smart beta" construction formulae does not apply
- Nevertheless, we use an overlay structure with targeted volatility approach which achieves comparable goals

Our solution utilises the following portfolios:

A strategic portfolio (SP) comprised of a corporate bond benchmark*. We assume a static 100% capital allocation to this funded portfolio.

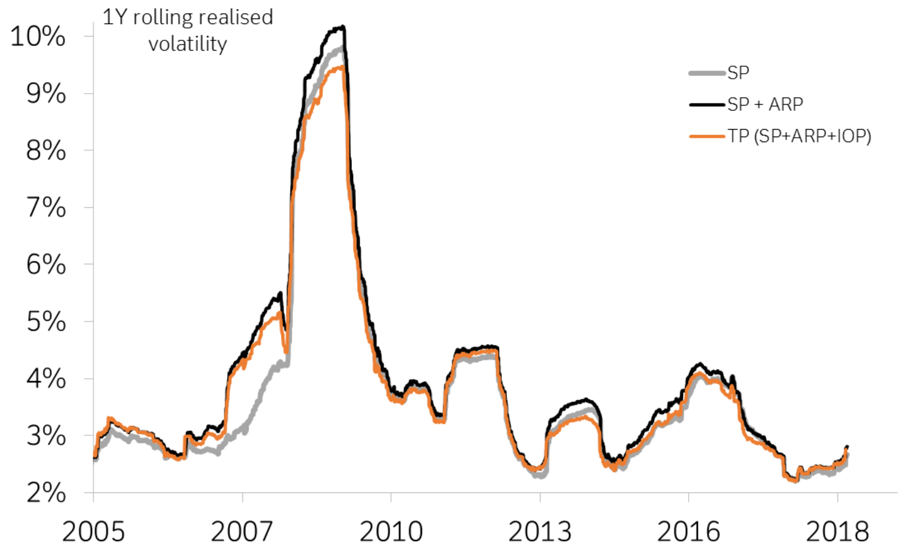
The absolute returns portfolio (ARP) comprised of our absolute return portfolio as previously defined. The allocation to this portfolio is static overtime. Its historical volatility has on average been 0.3x that of the strategic portfolio.

An index overlay portfolio (IOP) comprised of an equal weights index between the IG and HY CDX contracts, whose allocation vary over time. This portfolio will be used exclusively to ensure that the observed volatility of the combined portfolio (SP + ARP + IOP) matches that of the original strategic portfolio.

*This is represented by an equal weights combination of two cash bond indices covering the Investment Grade and High Yield universe. The first one is the Bloomberg Barclays US Corporate Total Return Value Index (Bloomberg ticker: LUACTRUU Index), which covers the Investment Grade Universe. The second one is the Bloomberg Barclays US Corporate High Yield Total Return Index Value (Bloomberg ticker: LF98TRUU Index), which covers the High Yield Universe.

5. Factor Aggregation and Applications: Overlay to Long Only Portfolio (6)

1Y rolling volatility – volatility target portfolios



	SP	SP + ARP	TP (SP+ARP+IOP)
Total Retuns	119.2%	167.6%	155.8%
Annualized Returns	5.7%	7.2%	6.8%
Std	3.9%	4.1%	3.9%
Sharpe Ratio	1.46	1.73	1.74

The results of our long only solution allows to arrive to the following conclusions:

- The absolute returns portfolio adds value to the funded Credit investor. This an expected outcome given that the factor overlay strategy is uncorrelated to Credit returns
- However, it is not a volatility mitigating portfolio, especially given the often positive correlation between the market factor sub-portfolio and the strategic portfolio. The ARP contributes to both returns and volatility
- Adding the IOP helps reduce aggregate volatility without significantly affecting returns, thereby keeping risk-adjusted returns high

Appendix 1
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