Quantitative Portfolio Strategy

Arik Ben Dor
+1 212 526 7713
arik.bendor@barclays.com
BCI, US

Jay Hyman
+972 3 623 8745
jay.hyman@barclays.com
Barclays, UK

Common Risk Factors of Corporate Bond Returns

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Introduction

A credit factor model for corporate bond markets

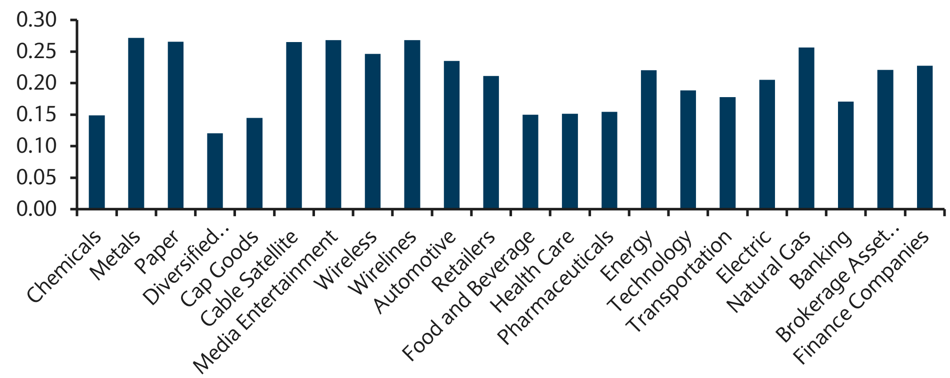
- The Fama-French Model for equity returns has been widely embraced by both academics and market practitioners
- We are developing a factor model for the corporate bond market
- Goals:
  - Capture the cross sectional variation in excess returns among corporate bonds
  - Identify a parsimonious set of risk factors (or the returns to long – short portfolios) that capture the risk premium to different sources of risk in the corporate universe
- Potential applications:
  - Help understand the key drivers of returns in corporate bond markets
  - Control for systematic biases when analyzing corporate bond strategies
  - Prediction of factor realizations can be instrumental to portfolio positioning

How many factors do we need?

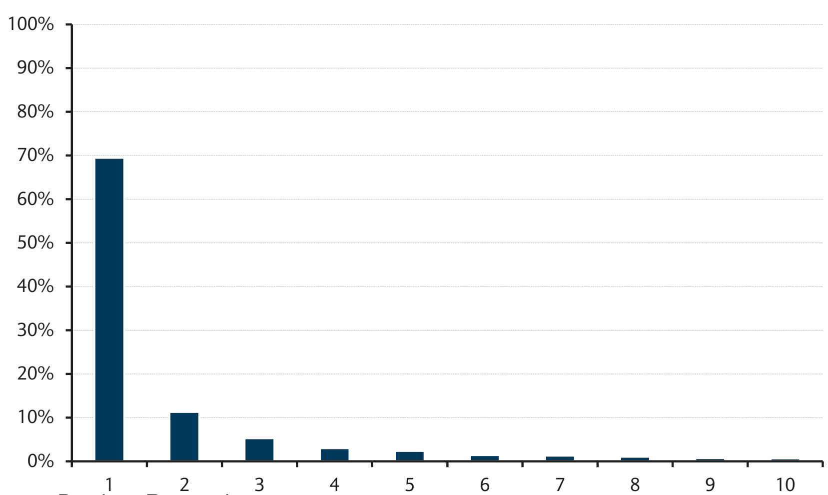
Principal components analysis (PCA) of corporate sector excess returns, January 2000 – February 2016

- First factor explains 70% of variance
- First three factors explain 86%
- Analysis suggests that three to five factors can capture most systematic risk in corporate bonds
- But PCA factors are not stable or intuitive

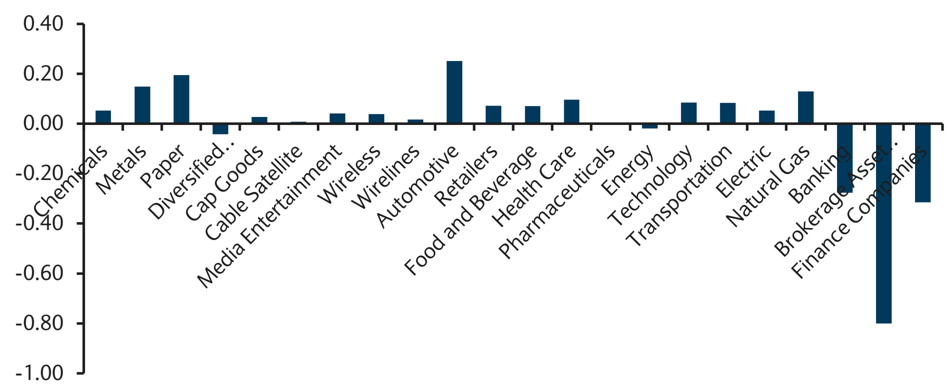
First principal component ~ Market risk



Explanatory power of principal components



Second principal component ~ Fin vs. Non-Fin



Source: Barclays Research

Credit Risk Factors

Factor selection based on prior QPS research in credit markets

- We seek to isolate the key dimensions of corporate bond risk:
  - Credit risk – As measured by Duration Times Spread (DTS)
  - Credit curve slope – Short-dated vs. long-dated credit
  - Liquidity – As per our extensive research on Liquidity Cost Scores (LCS)
  - Default risk – As measured by firm leverage
- In each case, we seek to define our factors as long-short portfolios constructed algorithmically within the bond market
- Our efforts to align stock and bond tickers allow use of firm-level fundamentals in factor construction
- Factor realizations will be the excess returns (over Treasuries) of these long-short portfolios
- To construct each risk factor:
  - We use the subset of the corporate bond market that we can map to equity tickers
  - We partition the corporate bond market in multiple dimensions
  - Construction of each factor is controlled for other factors

Key Metrics Used to Define Credit Risk Factors

- Liquidity Measure
  - We do not use LCS in this study because it is only available since 2007
  - We use a liquidity proxy which is similar to LCS in cross-sectional ranking
  - Liquidity is defined by age and size: large size and low age => high liquidity
  - Liquidity Proxy = average of percentile by size, inverse percentile by age

- Firm leverage
  - Market value of equity for each equity ticker from Compustat
  - Book value of debt for each ticker is taken as maximum of:
    - Total amount outstanding of bonds in Barclays index database
    - Total of long-term and short-term debt from Compustat firm balance sheet data
  - Firm leverage is calculated as the percentage of debt in the capital structure:

$$\frac{BV\,Debt}{BV\,Debt + MV\,Equity}$$

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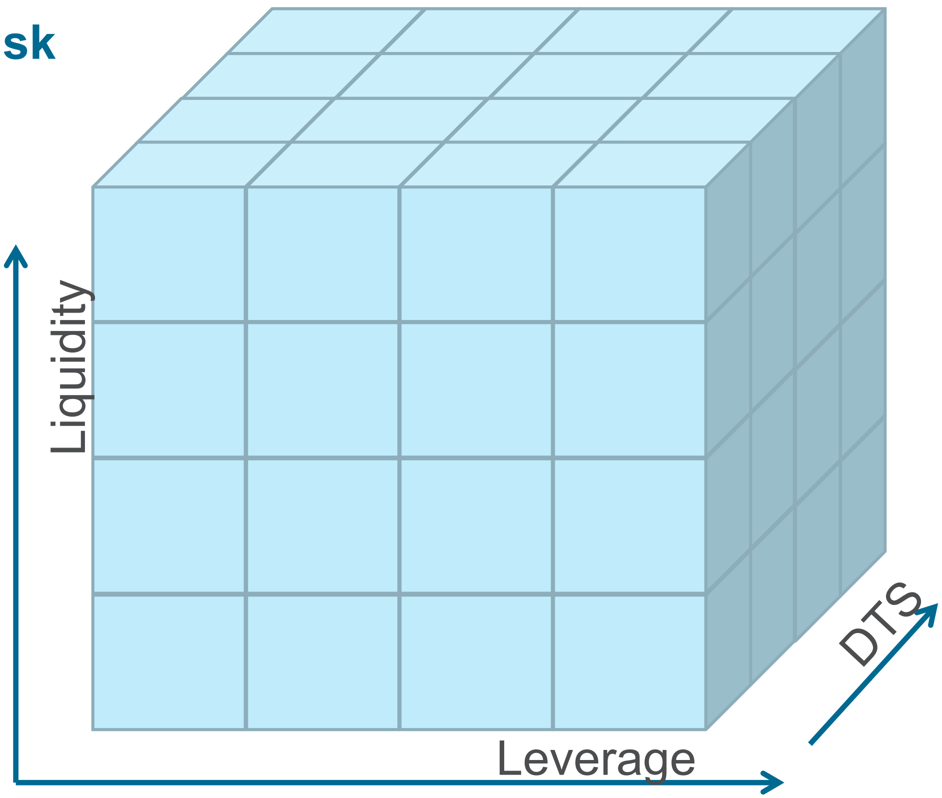
Construction of DTS Factor

DTS represents a primary unit of credit risk

- Partition into quartiles by firm leverage
- Within each leverage quartile, partition into liquidity quartiles
- Within each cell (Lvg x Liq):
  - Partition into DTS quartiles
  - Long the high-DTS quartile
  - Short the low-DTS quartile
- Average over all cells
- DTS Factor = net excess returns on this long-short portfolio



DTS Factor: Statistics and Returns, July 1995 – December 2015

Position	Description	Control For	Dur	Spread (%)	DTS	Ex. Ret (%/yr)	ER Vol (%/yr)	IR
Long	High DTS	Lvg, Liq	10.65	2.10	20.35	1.23	7.88	0.16
Short	Low DTS	Lvg, Liq	2.52	0.90	2.27	0.41	1.77	0.23
Net	DTS Factor		8.12	1.19	18.08	0.82	6.57	0.12

Source: Barclays Research

Construction of the Credit Barbell Factor

Duration vs. spread tilt within DTS cells

- Partition by duration within each DTS cell (actually DTS / Leverage / Liquidity cells)
- Go long the short-duration (and high spread) cell and short the long-duration cell
- Do this within each DTS cell, and equally weight the results
- Barbell factor = monthly time series of net excess returns on this long-short portfolio

- Controlling for DTS at cell level does not fully net out DTS exposure, but excess return volatility is very closely matched, and correlation between the two portfolios is 0.91.
- However, the two portfolios have very different characteristics and average returns

Barbell Factor: Statistics and Returns, July 1995 – December 2015

Position	Description	Control For	Dur	Spread (%)	DTS	Ex. Ret (%/yr)	ER Vol (%/yr)	IR
Long	Short Dur	DTS, Lvg, Liq	4.25	1.92	8.74	1.69	4.30	0.39
Short	Long Dur	DTS, Lvg, Liq	8.37	1.12	10.31	-0.38	4.32	-0.09
Net	Barbell Factor		-4.11	0.79	-1.57	2.07	1.81	1.14

Source: Barclays Research

Construction of the Leverage Factor

Avoid firms whose capital structure relies too heavily on debt

- Firm leverage is defined as $$\frac{BV\,Debt}{BV\,Debt + MV\,Equity}$$
- For all issuers for which we have both bond and equity data, we calculate the firm leverage ratio, and rank issuers on this ratio
- Within each cell by DTS, Duration and Liquidity, we go long the low-leverage cells and short the highest-leverage quartile
- Equally weight the results across all DTS/Duration/Liquidity cells
- Result: underweight issuers with high default risk relative to peers

Leverage Factor: Statistics and Returns, July 1995 – December 2015

Position	Description	Control For	Dur	Spread (%)	DTS	Firm Leverage	Ex. Ret (%/yr)	ER Vol (%/yr)	IR
Long	Low Leverage	DTS, Dur, Liq	6.39	1.34	9.16	15%	1.16	3.96	0.29
Short	High Leverage	DTS, Dur, Liq	6.19	1.58	10.05	65%	0.18	4.81	0.04
Net	Leverage Factor		0.20	-0.24	-0.89	-49%	0.98	2.51	0.39

Source: Barclays Research

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Portfolios bucketed by DTS and Liquidity

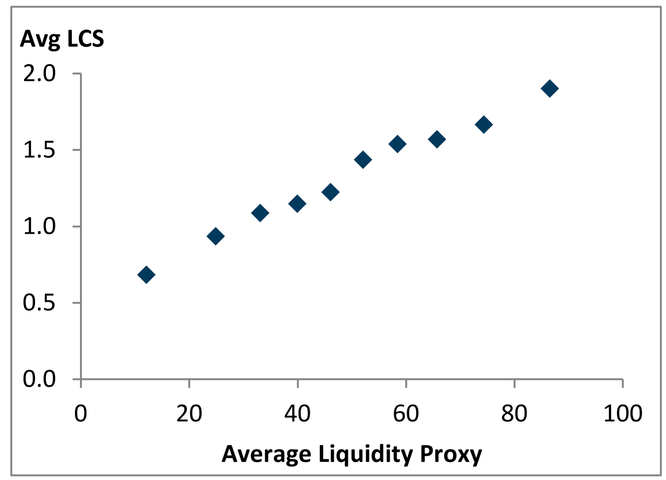
We partition the universe of bonds by quintiles of DTS and liquidity

- Increasing DTS => higher volatility and higher return
- Increasing liquidity => higher volatility, lower return and lower autocorrelations

Increasing liquidity quintiles (decreasing LCS and LiqProxy) across; Increasing DTS quintiles down.

Increasing DTS quintiles	1	2	3	4	5
Average returns by bucket					
1	0.69	0.63	0.58	0.45	0.35
2	0.79	0.81	0.59	0.46	0.39
3	0.92	0.90	0.64	0.60	0.06
4	0.67	0.66	0.46	0.41	0.77
5	1.27	1.09	1.42	1.20	1.40
Volatility by bucket					
1	1.45	1.46	1.60	1.76	1.61
2	2.33	2.47	3.00	3.01	2.69
3	3.44	3.59	3.88	3.93	4.33
4	4.72	4.84	5.36	5.81	5.67
5	7.05	7.55	8.15	8.69	9.35
Autocorrelations by buckets					
1	45%	41%	36%	43%	36%
2	50%	41%	45%	43%	33%
3	42%	43%	40%	34%	27%
4	37%	37%	34%	29%	18%
5	34%	30%	27%	15%	12%

LiqProxy vs. LCS, Jan07-Nov15



- Liquidity Proxy lines up well with LCS in cross-section

Source: Barclays Research

Construction of the Liquidity Factor

- Partition by DTS, Duration, and Firm Leverage
- Within each cell, partition by liquidity proxy (based on age and size – higher numbers mean less liquid)
- Long the least liquid quartile
- Short the most liquid quartile
- Equally weight the results across all DTS/Duration/Leverage cells
- Our controls do a good job matching duration and spread in the two portfolios
- More liquid bonds have greater volatility, lower auto-correlation
- Differences in mean returns are small

Liquidity Factor: Statistics and Returns, July 1995 – December 2015

Position	Description	Control For	Dur	Spread (%)	DTS	Liquidity Proxy	Auto-Correl	Ex. Ret (%/yr)	ER Vol (%/yr)	IR
Long	Less Liquid	DTS, Dur, Lev	6.25	1.48	9.70	75	0.37	0.70	3.91	0.18
Short	More Liquid	DTS, Dur, Lev	6.30	1.45	9.70	22	0.27	0.67	4.71	0.14
Net	Leverage Factor		-0.04	0.03	0.00	52	-0.13	0.03	1.51	0.02

Source: Barclays Research

Risk Factor Statistics

Statistics of four credit factor realizations, July 1995 – December 2015

- Static factor positions that are profitable over the long term:
  - Long the market (DTS)
  - Long low-dur high-spread vs. high-dur low-spread
  - Short bonds with higher firm leverage relative to peers
  - Long illiquid bonds
- Market risk (DTS) has highest risk, but low IR for static position => biggest potential for improving returns by market timing (if it can be done)
- Factor correlations are higher than desired, but hard to avoid

Basic Factor Statistics

	DTS	Barbell	Leverage	Liquidity
Mean (%/year)	0.82	2.07	0.98	0.03
Vol (%/year)	6.57	1.81	2.51	1.51
Inf. Ratio	0.12	1.14	0.39	0.02

Factor Correlations

	DTS	Barbell	Leverage	Liquidity
DTS	100%	3%	-42%	-61%
Barbell	3%	100%	10%	11%
Leverage	-42%	10%	100%	55%
Liquidity	-61%	11%	55%	100%

Source: Barclays Research

How Does Our Model Relate to the Fama-French Model?

Correlations with Fama-French 3-factor model, July 1995 – December 2015

- The DTS factor has a fairly high correlation with the equity market factor
- Leverage and liquidity have negative correlations with the equity market factor
- Our barbell factor is not correlated with any of the 3 FF factors

Factor Correlations			
	Mkt-RF	SMB	HML
DTS	53%	22%	-4%
Barbell	-3%	5%	1%
Leverage	-23%	-5%	0%
Liquidity	-38%	-4%	7%

Source: Barclays Research

An Issuer-Neutral Credit Curve Slope Factor

- It is well known that short-duration corporate bonds have outperformed in IR
- Our Barbell Factor hedges its long position in short-dated corporates with a short position (with hedge ratio 1) in longer-duration but lower-spread bonds
- In another slope factor implementation, we hedge each short-duration bond using a small amount of long-duration bonds from the same issuer:
  - Partition the bonds of each issuer into those above/below the index median duration
  - Rescale both groups of bonds to match the index average DTS
  - Go long the short-dur bonds, and short a DTS-neutral amount of the long-dur bonds
  - Build up a long-short portfolio spanning all issuers with high and low duration bonds
- This approach produces another slope factor with IR>1
- But … correlation with our barbell factor is only 0.23!

Slope Factor: Statistics and Returns, July 1995 – November 2015

			Unscaled Portfolios			Scaled Portfs		Factor Returns		
Position	Description	Control For	Dur	Spread (%)	DTS	Dur	Spread (%)	Ex. Ret (%/yr)	ER Vol (%/yr)	IR
Long	Short Duration	Issuer DTS	4.22	1.48	6.16	7.12	2.55	1.51	4.93	0.31
Short	Long Duration	Issuer DTS	9.76	1.67	16.29	6.04	1.07	-0.25	4.01	-0.06
Net	Slope Factor					1.08	1.48	1.76	1.67	1.06

Source: Barclays Research

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How well does our model explain sector excess returns?

Percent of absolute exc. return variance explained, July 1995 – Dec 2015

- We regress sector excess returns against our four factors
- Factors can explain most of index return volatility
- Most systematic volatility is interpreted as DTS factor exposure

Percentage of Excess Return Variance Explained, selected sectors, July 1995 – December 2015

Sector	R-sq	DTS	Barbell	Liquidity	Leverage	Idiosyncratic
Chemicals	0.74	82%	1%	-6%	-3%	26%
Metals & Mining	0.66	66%	0%	0%	0%	34%
Telecom	0.80	59%	1%	26%	-6%	20%
Food/Beverage	0.76	71%	5%	0%	0%	24%
Energy	0.75	78%	1%	1%	-4%	25%
Banking	0.81	51%	3%	12%	14%	19%

Source: Barclays Research

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How well does it explain sector-specific returns vs. index?

Percent of exc. return variance explained (sector – index), July 1995 – Dec 2015

- We now look at active returns relative to the corporate index
- R-squared is lower for explanation of active returns
- DTS factor no longer dominates – other factors can be quite important
- Results can vary a lot by sector and over time

Percentage of Active Excess Return Variance Explained (relative to Corp Index), July 1995 – December 2015

Sector	R-sq	DTS	Barbell	Liquidity	Leverage	Idiosyncratic
Chemicals	0.55	16%	0%	25%	14%	45%
Metals & Mining	0.34	7%	2%	1%	25%	66%
Telecom	0.41	3%	0%	25%	13%	59%
Food/Beverage	0.74	24%	3%	8%	40%	26%
Energy	0.13	0%	0%	1%	12%	87%
Banking	0.43	28%	1%	0%	13%	57%

Source: Barclays Research

Using the model to analyze active strategies

Analysis of “Credit Smart Beta” strategies, July 1995 – Dec 2015

- We regress active excess returns against our four factors
- To what extent do our systematic factors capture the risk of a given strategy?
- Active strategies can take large loadings on factors that do not play a major role in sector indices

Percentage of Active Exc. Return Variance Explained, “Smart Beta” Strategies, July 1995 – December 2015

Sector	R-sq	DTS	Barbell	Liquidity	Leverage	Idiosyncratic
Downgrade-Tolerant	0.44	29%	8%	8%	-2%	56%
Constant Sector Weights	0.53	-4%	0%	12%	44%	47%
DGT CSW	0.49	30%	9%	1%	9%	51%
Barbell	0.79	73%	6%	5%	-4%	21%
DGT Barbell	0.49	37%	17%	-3%	-2%	51%

Source: Barclays Research

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Using the model to attribute active strategy returns

Return attribution of "Credit Smart Beta" strategies, July 1995 – Dec 2015

- We regress strategy active returns against our four factors
- The betas with respect to the factors give insight into systematic biases of each strategy
- We multiply these betas by average factor returns to obtain the return contribution from each such systematic bias
- Unexplained return represents strategy alpha – the t-stat of this alpha can provide a test of whether the strategy provides return beyond the factor exposures
- We find that our barbell factor explains much of the returns of these strategies, but that some still retain significant alpha after controlling for factor exposures
- Constant sector weight strategies load on leverage factor (reduce exposure to highly leveraged firms)

Factor contributions to average "smart beta" active returns (%/yr), July 1995 – December 2015

Sector	DTS	Barbell	Liquidity	Leverage	Alpha	Total	T-Stat (α)
Downgrade-Tolerant	0.03	0.16	0.00	0.04	0.03	**0.26**	0.39
Constant Sector Weights	0.01	0.01	0.00	0.07	0.03	**0.12**	0.65
DGT CSW	0.04	0.18	0.00	0.10	0.07	**0.39**	0.70
Barbell	-0.10	0.26	0.00	-0.11	0.21	**0.26**	**2.20**
DGT Barbell	-0.07	0.41	0.00	-0.06	0.28	**0.56**	**2.06**

Source: Barclays Research

Credit Factor Model – Potential Applications

- Test any time series of portfolio or strategy returns for systematic effects
- Characterization of market sector conditions over a given time period
- Factor-based investing – Investable portfolios with desired factor exposures
- Factor prediction for market timing strategies?

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