Introduction to Quantitative Portfolio Strategy

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Quantitative Portfolio Strategy – Who We Are

- 25+ years as a team
- Ph.D.-level analysts in the US and Europe
- Work directly with major investors on Bespoke Portfolio Management Projects
- Quantitative orientation, no views on the market: “Let the data speak”
- Innovative timing signals in bonds, equities and cross asset
- Institutional Investor survey
  - US: 1st place since inception of Quantitative Portfolio Strategy category in 2006-2009 and in 2017 (from 2010 to 2016 this category was not included in the survey)
  - Europe: 1st place as part of “Quantitative Analytics” category 2013-2015
- Published research available on BarclaysLive

QPS FICC Research

QPS Equity Research

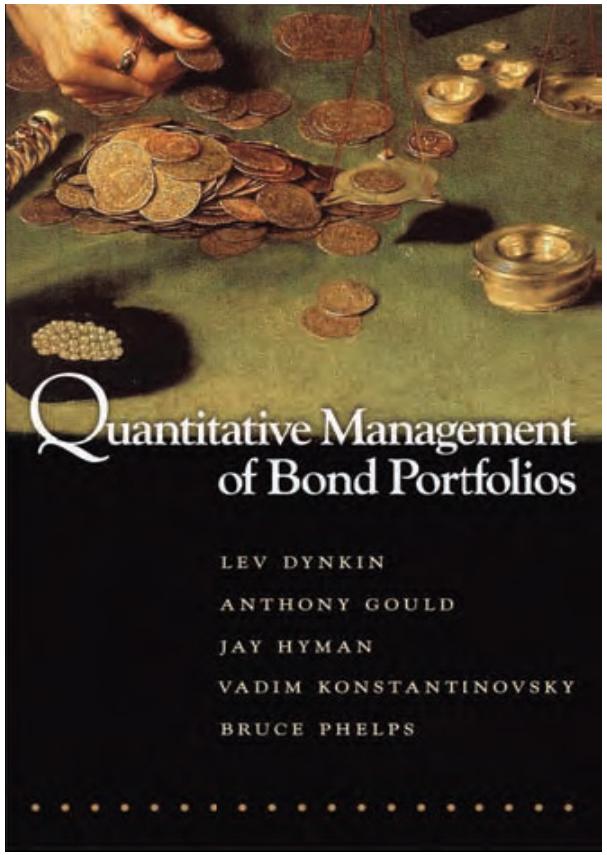
QPS Analytics

Source: Barclays Research

What gives QPS an advantage?

- **Mandate:** Bespoke, one-on-one, work with each client
- **Breadth of clients:** Large asset managers, insurance companies, SWFs, Central Banks, pension funds, large hedge funds
- **Breadth of research including bond/equities cross asset research:** Spans all major asset classes (FI, equity, FX, hedge funds)
- **Objectivity:** No market views. Analysis is based on innovative empirical studies or models
- **Practicality:** Research in response to questions from practitioners. Relevant, implementable findings
- **Client connectivity and trust:** For over two decades QPS has been a trusted advisor to global investors on portfolio management issues. Some of our innovations such as DTS and LCS have become market standards
- **Experience:** Senior members of QPS have decades of experience and have stayed together as a team for over 15 years with little turnover
- **Academic rigor:** Over 30 articles in key industry journals (Journal of Portfolio Management, Journal of Fixed Income, Journal of Alternative Investments, Journal of Index Investing); on the editorial boards of JPM and JFI. Published three books.
- **Industry recognition:** QPS was ranked #1 in its category by Institutional Investor research surveys in the US and Europe for most of the past few years as long as the category was included

Books Reflecting Two Decades of Client-Driven Research



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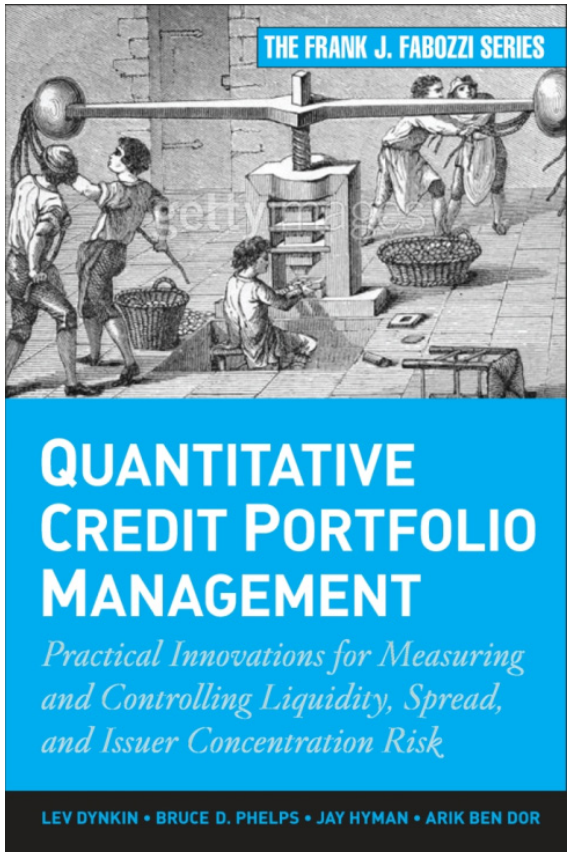

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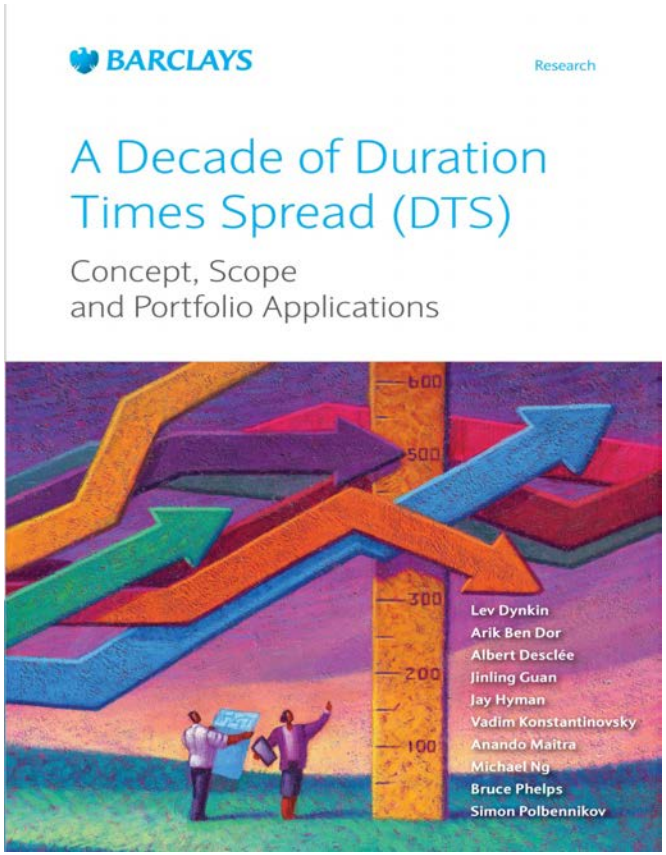

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Source: Barclays Research

Key Categories of QPS Research

QPS FICC

Index replication and hedging (cash and derivatives)

Portfolio construction

- ***DTS*** *(Duration Times Spread) – a QPS innovation that became* ***industry standard***
- *Optimal diversification of issuer-specific risk*
- *Long-horizon investing with stop-loss conditions (try-and-hold)*
- *Sector timing vs. issuer selection in different market environments*

Smart Beta – quantitative investment strategies

- *Issuance dynamics and performance of credit bonds – non-market weighted indices*
- *"Fallen angels" effect and downgrade-tolerant indices*
- *Relative value models in credit :* ***SPiDER*** *(****SP****read per unit of* ***D****ebt to* ***E****arning* ***R****atio) and* ***ESP*** *(****E****xcess* ***S****pread to* ***P****eers)*
- *Capturing term carry premium in global rates markets*
- *Performance impact of ESG (Environment, Social, Governance) investing - Barclays Impact Series*

Quantitative Equity

Quant equity strategies using credit market signals – unique approach based on the interaction of bond and equity markets

- *Using bond signals in equity momentum strategies* ***– BEAM*** *(****B****onds in* ***E****quity* ***A****sset* ***M****omentum)*
- *Using corporate bond (****SPiDER****) signals in equity value strategies*

Innovative quant equity alpha strategies

Analytics

Bond Liquidity Measures unique to Barclays – based on bid-offer quotes from Barclays traders

- ***LCS®*** *(****L****iquidity* ***C****ost* ***S****core), a bond-level liquidity metric;* ***TES*** *(****T****rade* ***E****fficiency* ***S****core)*
- ***PIM*** *(****P****rice* ***I****mpact* ***M****easure)*

Cross Asset and Hedge Funds

- *Studies of manager skill,* ***ORBS*** *(****O****ptimal* ***R****isk* ***B****udgeting with* ***S****kill) for tactical asset allocation, cost of investment constraints, Risk Parity*
- *Horizon diversification, scenario analysis, base currency diversification, optimal FX hedging of asset portfolios*
- *Comparing performance of a single HF using only public return data to peers by return, risk, fees, alpha, illiquidity exposure, etc.* ***– ALERT*** *(****AL****gorithmic* ***E****valuation of* ***R****e****T****urns)*
- *Measure of persistence in fund's performance vs. peers* ***– MMS*** *(****M****easure of* ***M****anager* ***S****kill)*
- *Case for HF allocation in pension portfolios*
- *HF index replication* ***– LBAR*** *(****L****ong* ***B****arclays* ***A****lternative* ***R****eplicator)*

Selected Quantitative Scorecards

Name	Full Name	Signal Target	Information Source	Style	Horizon
BEAM	Bonds in Equity Asset Momentum	Equity	Bonds	Momentum	Monthly
D-BEAM	Daily BEAM	Equity	Bonds	Momentum	Daily
E-SPiDER	Spread Per unit of Debt/Earnings Ratio	Equity	Fundamental, Bonds	Value	Monthly
C-SPiDER	Spread Per unit of Debt/Earnings Ratio	Corp. Bonds	Fundamental, Bonds	Value	Annual
FAR	Fallen Angel Reversal	Corp. Bonds	Bonds	Structural Mispricing	Monthly
ESP	Excess Spread to Peers	Corp. Bonds	Bonds, Fundamental	Value	Monthly
EMC	Equity Momentum in Credit	Corp. Bonds	Equity	Momentum	Monthly
GRACE	Global Rate Adjusted Carry	Global Treasuries	Rates, Economics	Carry	Monthly

Source: Barclays Research

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Using Credit Signals in Systematic Equity Strategies: Momentum and Value

31 January 2019

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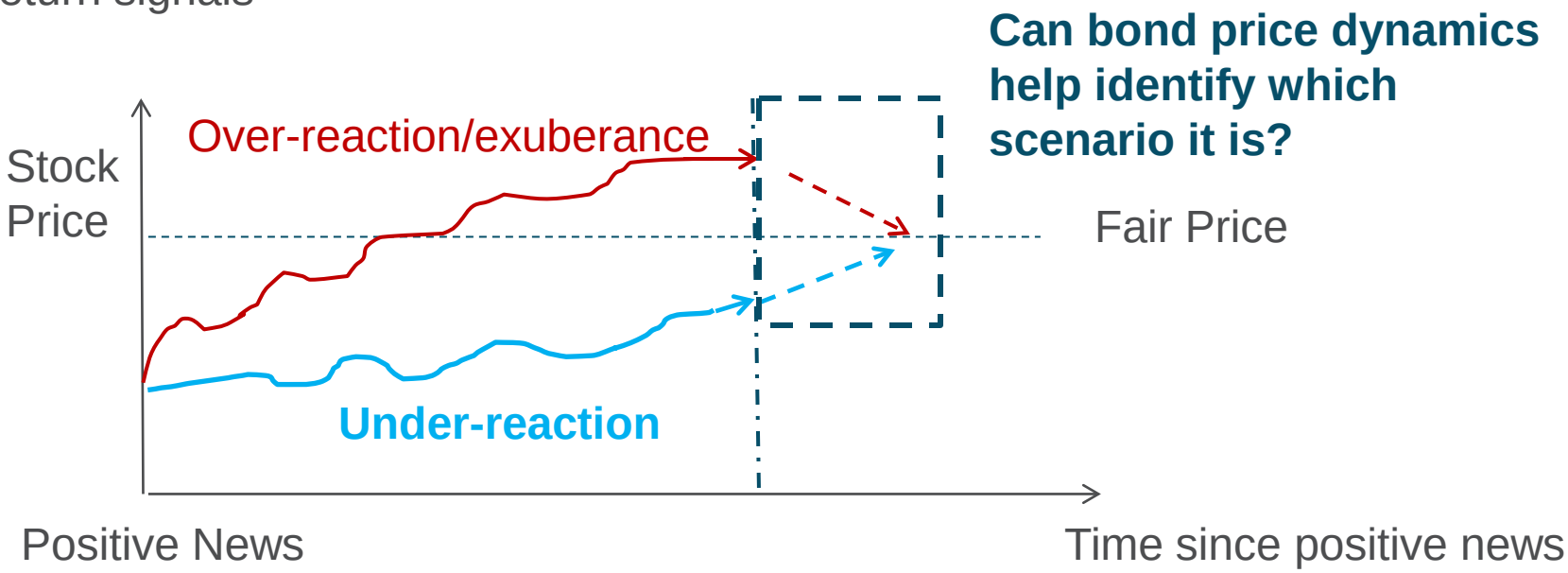
Momentum Investing – Some of What We know…

- ✓ Ample evidence that systematic equity momentum strategies offer solid returns over time
- × But susceptible to market reversals, and exhibits ‘crash’ like dynamics
- × Not consistent with market efficiency
- ✓ ‘Momentum’ phenomenon found in multiple market segments
  - ❖ Across industries (Moskowitz and Grinblatt 1999)
  - ❖ international equity markets (Rouwenhorst 1998, Asness, Liew, and Stevens 1997)
  - ❖ mutual funds chasing performance (Carhart 1997)
  - ❖ Additional asset classes such as commodities and currencies (Erb and Harvey 2006, Asness, Moskowitz, and Pedersen 2013)

Can Bond Price Dynamics Help with Equity Momentum?

- Is Momentum due to investors' under-reaction to news (Shleifer and Vishny 1998) or overreaction driven by investor psychological biases?
- Can past bond returns improve equity momentum signals?
- Is equity momentum more likely to mean-revert when observing contradictory bond return signals



Source: Barclays Research

Why May Credit Info. Be Valuable for Equity Strategies?

- Momentum signals based on bond prices (BEAM) tend to be more effective because bond price formation is more quantitatively driven than equity prices, which can be noisy and exhibit excessive volatility.
- **Clientele**: Different investor base
  - Possibly different information regarding the same company

- **Pricing:** Pricing of corporate bond and equity securities differs
  - Bond valuations is more quantitatively driven

Bond Vs. Equity Pricing		
	Bond	**Equity**
Pricing	Fairly uniform among investors	Multiple models / approaches
Inputs (growth / payouts)	Insensitive less prone to market "hypes"	Highly sensitive
Term	Fixed maturity Limiting effects of mispricing	Infinite
Information Transparency	Low OTC-traded	High Exchange-traded. Pricing and order book visible

Source: Barclays Research

Barclays' Advantage in Using Credit Signals for Equities

1. Barclays' access to comprehensive high-quality historical corporate bond data
2. A proprietary security-level bond-to-equity mapping developed by QPS
3. QPS cross-asset expertise

→ BEAM & SPiDER strategies not easily replicable

Momentum Strategy using Credit Information
BEAM (Bonds in Equity Asset Momentum)

BEAM Features

BEAM is a systematic strategy that uses corporate bond price dynamics to generate momentum signals for stocks of the same companies. It buys stocks with high past bond returns and shorts stocks with low past bond returns

- **Stable performance**: Positive returns in all years since 1994 but one, across market states and industries. Out-of-sample performance since 2014 is similar to that of the original study
- **Broad applicability**: Across regions (US and European markets), frequencies (daily and monthly), and aggregation (individual stock- and sector-level)
- **Diversification benefits**: Negative correlation with the US equity market and low correlation with commonly used factor portfolios
- **Liquid Universe**: Firms with public debt are mostly large-cap companies

BEAM has Outperformed Equity Momentum Pre- and Post-2014

- BEAM has delivered consistently better performance (higher average returns, lower volatility, higher information ratio, and better tail-risk measures) than standard equity momentum strategies, especially in periods when equity momentum experienced large crashes

BEAM Has Outperformed Equity Momentum Pre- and Post-2014 (top-bottom deciles, Jan. 1994 – Dec. 2018)

	Backtesting period (original 2014 study)			Out-of-Sample (post 2014 study)		
	Jan. 1994 - Dec. 2013			Jan. 2014 - Dec. 2018		
	BEAM (Bond Momentum)	Momentum (BEAM Universe)	Momentum (Fama French Universe)	BEAM (Bond Momentum)	Momentum (BEAM Universe)	Momentum (Fama French Universe)
Avg Ret (%/Yr)	17.38	3.70	6.95	15.68	11.87	10.57
Vol. (%/Yr)	14.97	29.35	27.43	11.56	18.57	16.47
Inf. Ratio	1.16	0.13	0.25	1.36	0.64	0.64
Worst Month Ret (%/m)	-19.28	-57.19	-59.95	-5.40	-14.86	-12.03
Max Drawdown (%)	-21.24	-87.79	-82.24	-9.10	-30.00	-24.92

Source: Compustat , Professor Kenneth French data library, Barclays Research

BEAM Performance in 2018

BEAM Performance Statistics in 2018

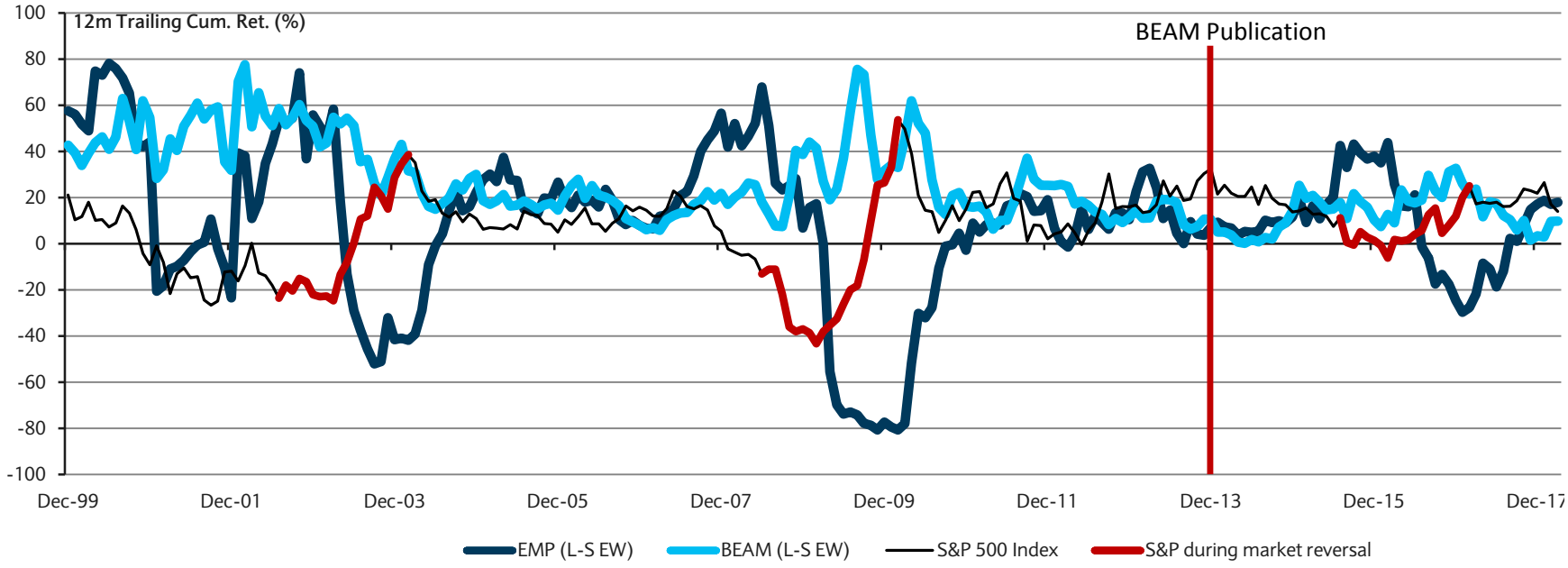
Strategy	BEAM Total Return Swaps (monthly strategy) (LS, with shorting costs, U.S.)			U.S. BEAM (theoretical, monthly strategy) (LS, EW, industry neutral)		European BEAM (monthly strategy) (LS, EW, across universe)		D-BEAM (Daily-BEAM) (LS, U.S., EW,	S&P 500
	BEAM TRS	Benchmark 1: DJTMNMO (Dow Jones US Momentum Index)	Benchmark 2: FTUSMTUT (FTSE US Momentum Long/Short)	BEAM	Benchmark: Momentum (EW, across universe)	BEAM	Benchmark: Momentum	D-BEAM	
Annual ret (%/yr)	19.61	5.76	2.87	22.42	10.62	5.67	1.57	25.15	-4.38
Vol. (%/yr)	9.72	9.03	13.22	9.92	9.62	7.61	12.13	7.29	15.33
Inf. (Sharpe) Ratio (ann.)	**2.02**	**0.64**	**0.22**	**2.26**	**1.10**	**0.75**	**0.13**	**3.45**	**-0.42**
Skew (around average)	0.76	-0.30	-0.07	-0.28	-0.59	-0.49	0.04	0.16	-0.81
Downside vol. (%/yr)	2.17	4.86	7.40	3.55	5.27	3.99	6.30	3.70	10.84
Sortino Ratio (Ann.)	**9.04**	**1.18**	**0.39**	**6.32**	**2.01**	**1.42**	**0.25**	**6.79**	**-0.40**
Worst Monthly Ret (%)	-1.84	-4.16	-5.63	-2.99	-4.88	-3.78	-5.33	-0.26	-9.03
Max. DD (%)	-2.13	-5.85	-10.70	-2.99	-5.45	-5.55	-12.31	-2.02	-13.52
November 2018	**6.33**	-2.67	-1.53	**5.52**	-0.27	**-1.83**	-2.98	**2.03**	2.04
December 2018	**2.58**	3.19	4.76	**5.57**	5.35	**3.30**	2.91	**2.67**	-9.03

Source: Bloomberg, Compustat , Barclays Research

BEAM Behavior during Market Reversal Was Consistent with Our Original Findings

- BEAM return dynamics during a market reversal in the post-publication period were consistent with earlier results

Trailing 12m Cumulative Performance of BEAM and EMP Portfolios (within ind, EW)

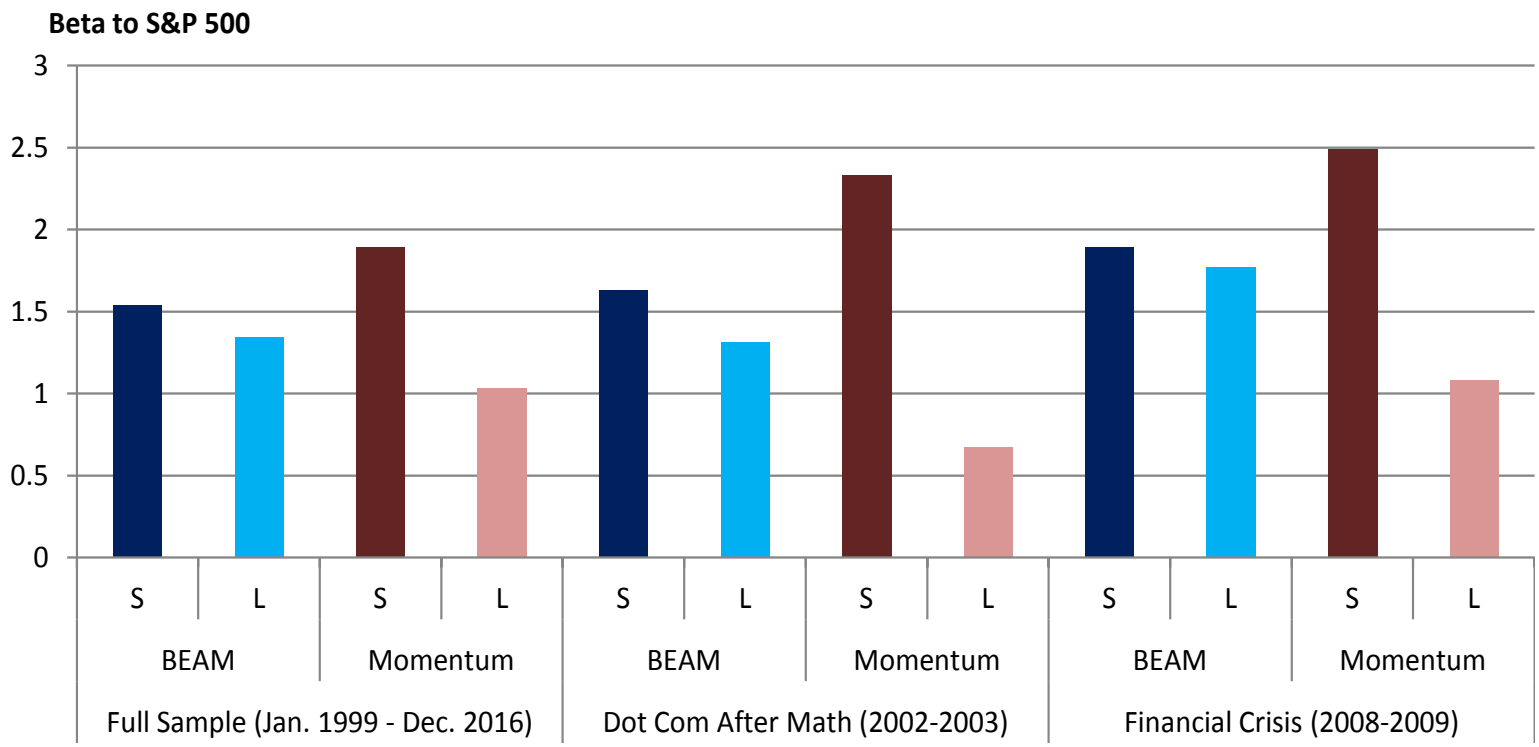


Source: Compustat, Barclays Research

Diff. in Portfolios Betas Explain Reversal Dynamics

- BEAM winner and loser portfolios showed little difference in their betas in all sub-periods
- Momentum losers had much higher market beta than winners, especially during market reversals, contributing to big losses of momentum during these periods

BEAM and Momentum Portfolio Market Beta by Time Period (within industry, EW)

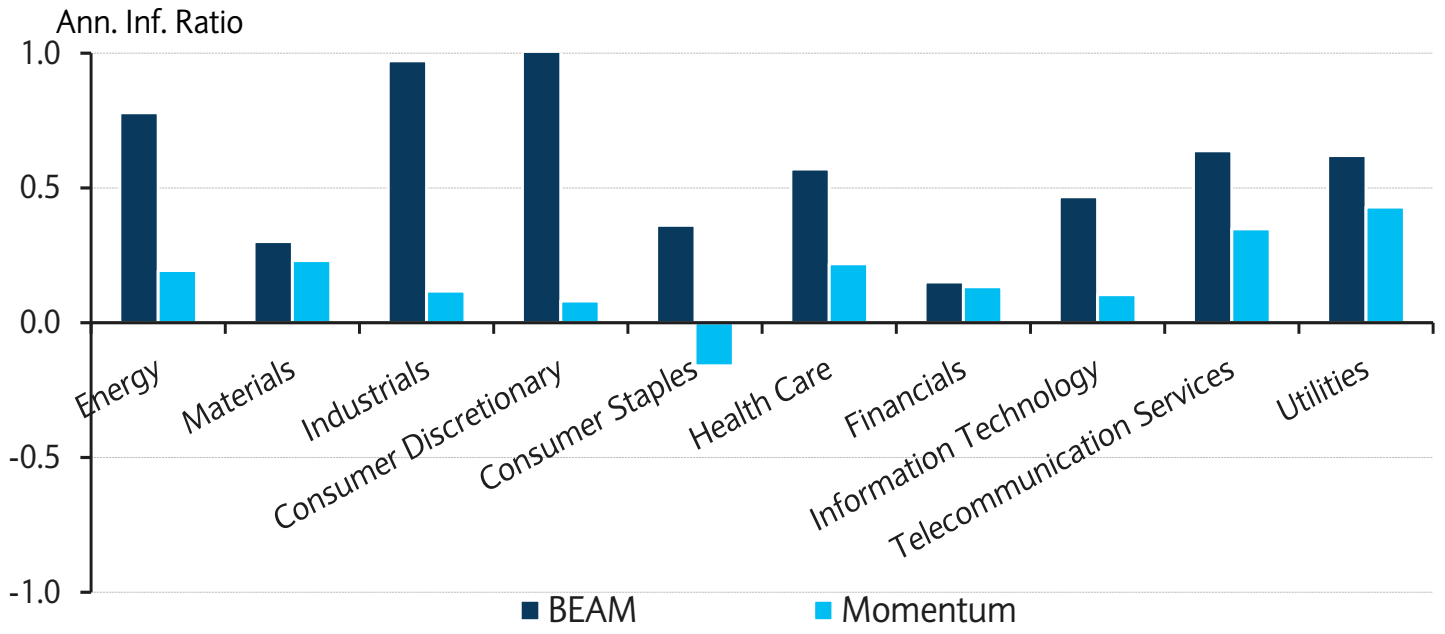


Source: Bloomberg, Compustat , Barclays Research

BEAM Generated Positive Inf. Ratio in All GICS Sectors

- ✓ Performance of BEAM top ½-Bottom ½ was positive in all GICS sectors
- ✓ Inf. Ratio ranged from 0.15 (Financials) to 1.16 (Consumer Discretionary)
- ✓ I.R. of Momentum was lower than that in BEAM in all sectors

BEAM and Momentum Inf. Ratio by GICS Sector
(EW, Top ½ - Bottom ½, Jan. 1999 – Aug. 2018)



Source: The sample period is January 1999 to August 2018. This figure plots the annualized information ratio for BEAM and momentum strategies. BEAM is based on a 3-month ranking window and Momentum on a 12-month ranking window skipping the most recent month. Each month stocks are sorted within each industry into two portfolios based on the BEAM and momentum signals, and held for one month. The portfolios are equally weighted, and the strategies are to buy stocks in the top portfolio and sell stocks in the bottom portfolio. GICS 2-digit sectors are used for BEAM and momentum portfolios. Source: Compustat, Bloomberg, Barclays Research

BEAM Has Broad Applicability

- **Across Geography**: BEAM strategy outperformed traditional momentum strategy in European markets and have similar signals dynamics as in the U.S.
- **Across Frequency**: BEAM strategy outperformed equity short-term reversal strategy at daily-frequency
- **Across Aggregation Level**: BEAM signals worked at sector-level in selecting sectors that would outperform/underperform in the subsequent month

BEAM Performance in Different Geography, Frequency, and Aggregation-Level (EW, L-S)

	European Markets				Daily Strategies		Sector Signals	
	(EW, L-S, Jan. 2005 - Dec. 2018)				(EW, L-S, Jan. 2001 - Dec. 2017)		(EW, top half - bottom halfJan. 1999 - May. 2018)	
	Across All		After removing Industry momentum		Within Industry		within industry	
	BEAM	Momentum	BEAM	Momentum	D-BEAM	Short-term Reversal	BEAM	Momentum
Avg Ret (%/Yr)	10.73	8.07	8.40	8.59	18.20	9.80	3.49	1.35
Vol. (%/Yr)	14.95	26.16	13.00	20.25	9.90	15.83	9.04	11.73
Inf. Ratio (ann.)	**0.72**	**0.31**	**0.65**	**0.42**	**1.83**	**0.62**	**0.39**	**0.12**

Source: Compustat, Barclays Research

Trading BEAM Portfolios with Practical Aspect

Shorting Costs

We include historical shorting costs in back-testing

Execution Lag

Bond signals becomes available on he last trading day of each month after the stock market close. We evaluated performance where we transacted the stocks in BEAM L/S legs after signals had become available

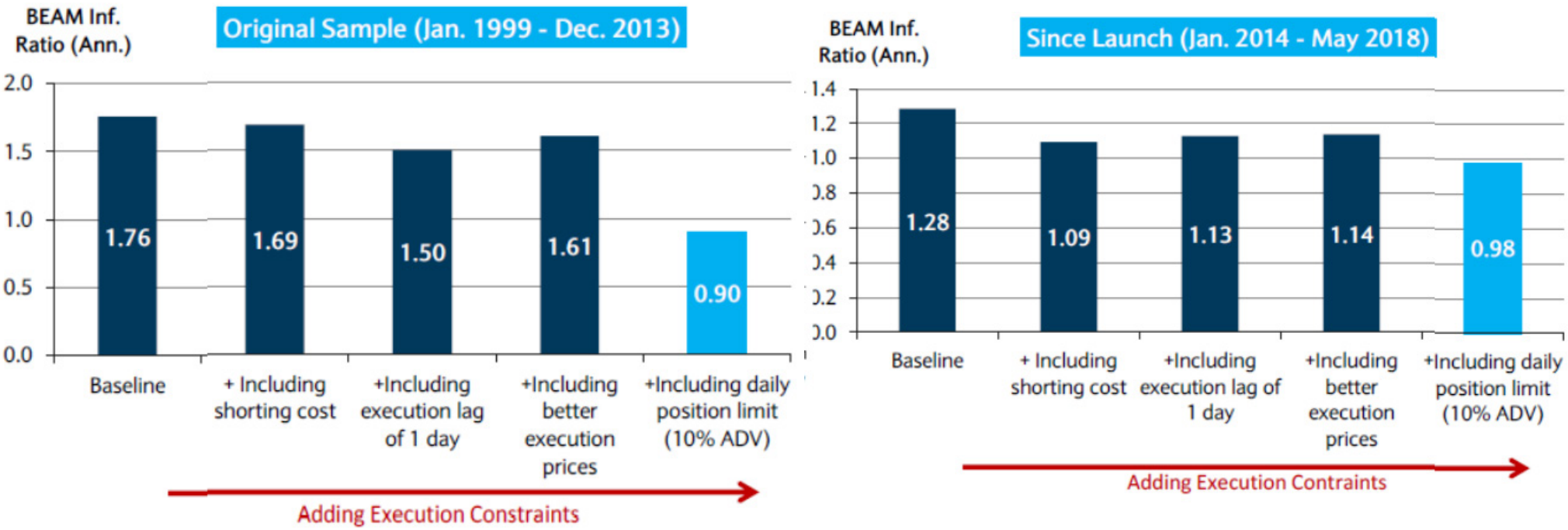
Market Impact

Large positions for small stocks may be hard to implement in reality. We start with an EW BEAM portfolio and implemented a position limit of 10% Average Daily Volume limit for each stock

BEAM Performance Stayed Strong even with Execution Constraints

- After taking into account shorting costs, execution lag, and daily position limit, BEAM strategy still delivered strong Inf. Ratio, both in the original sample and post-launch

BEAM Information Ratio with Execution Constraints



Source: Barclays Research, Compustat, Bloomberg

Identifying ‘Value’ in Equities using SPiDER

*(**S**pread **P**er un**i**t of **D**ebt to **E**arnings **R**atio)*

- A New Measure of Value in Credit Markets

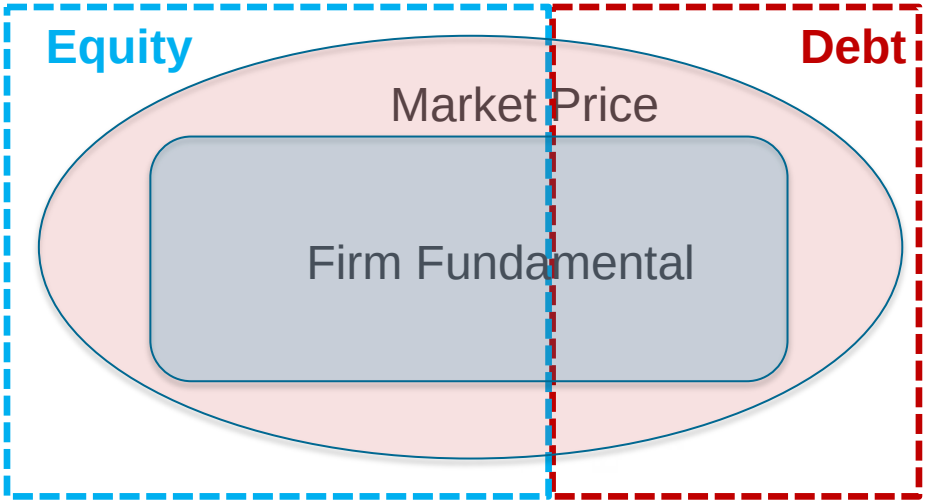
What About 'Value' Investing?

- ✓ Widely practiced by investors
- ✓ Ample evidence that systematic equity value strategies offer solid returns over time
- ✓ No uniformly accepted definition (value vs. quality) or root cause (risk-based, anomaly)
- ✓ Various measures used (B/M, E/P, D/P, CF/P, etc) individually or combined
- ✓ 'Value' phenomenon in other markets
  - ❖ Currency, government bond, and commodity (Assness, Moskowitz, and Pedersen 2013)
  - ❖ Credit (Maitra 2015, Ben Dor and Guan 2016, Houweling and van Zundert 2015, Israel, Kang and Richardson 2015)

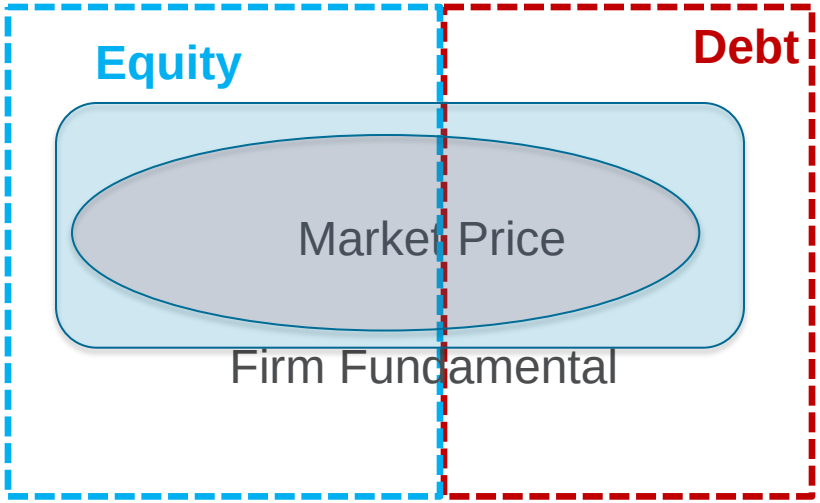
Can ‘value’ Spillover across Asset Classes?

- Can we have firm-level mispricing?
- If a firm is misunderstood by investors, can we expect **both** its equity and debt instruments to be mispriced?
- If so, can we use credit ‘value’ measures to identify ‘value’ in equity markets?
- What about using equity ‘value’ measures in credit value investing?
- Do we have other examples of credit information used in equity strategies?

Firm



Overpricing



Underpricing

What is SPiDER?

- Measure of ‘value’ in credit, similar to Shiller’s CAPE. It represents the compensation demanded by the market given an issuer’s debt level relative to its long-term earnings

- <u>Key Characteristics</u>
  - Firm-level
  - Model-free (no regression model)
  - Annual frequency
  - Combines balance sheet, earning report and market data
  - Applies to IG and HY firms across all sectors ex. Financials (currently)
  - Identifies ‘value’ *cross-sectionally* and *over time*

Calculating SPiDER Values

For company *i* at year *t*, SPiDER is defined as:

$$\boxed{\text{SPiDER}_{i,t} = \text{OAS}_{i,t} \;/\; (\text{Total Debt}_{i,t} \text{ over Sustainable EBITDA}_{i})}$$

Market price of risk

(option-adjusted spread)

Fundamental Measure of Risk

- Sustainable EBITDA based on last 10 annual EBITDA figures (min. 6 years)
- Captures firm 'true' earnings over the long-term and hence its ability to repay its debt

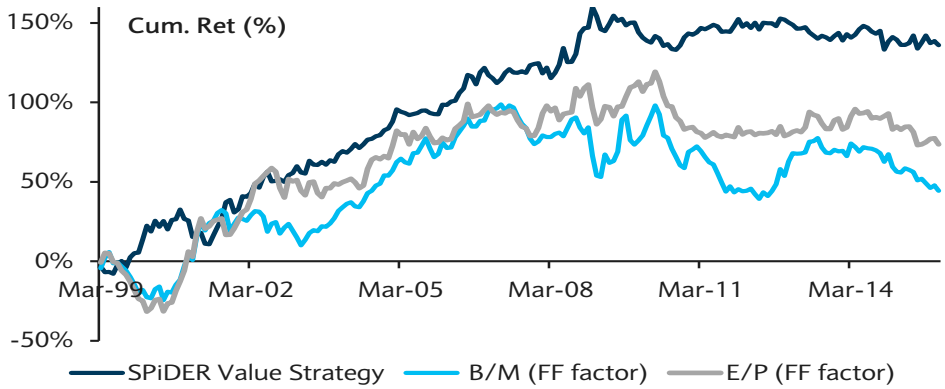
Forming Equity 'Value' Portfolios Using SPiDER

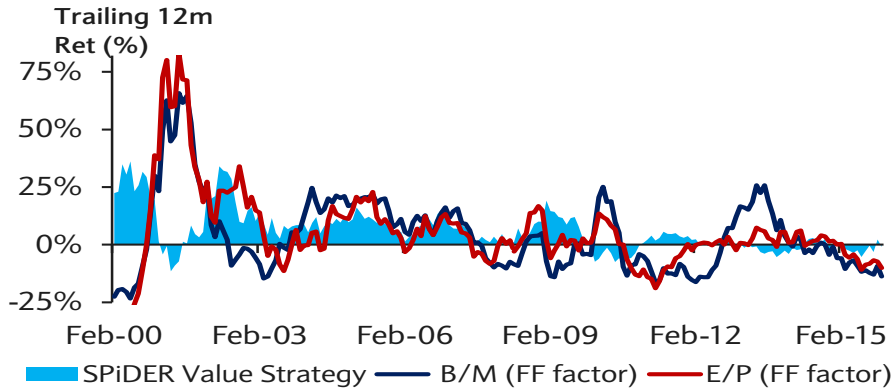
- Quintile portfolios are formed in March of each year based on SPiDER ratios
- SPiDER ratios are calculated using the annual statements from Oct.-Dec. of prior year
- IG and HY rated companies are ranked separately (within or across industries)
- At portfolio formation firms are VW and held until the next rebalancing date irrespective of rating changes during the period
- Value strategy is long issuers in Q_5 (highest SPiDER) and short Q_1 (lowest SPiDER)

SPiDER-based Strategy Outperformed B/M and E/P Strategy

- Higher return and inf. ratio than B/M and E/P strategies in FF and SPiDER samples
- More consistent performance with fewer 12-month periods of negative returns
- Significantly lower tail risk
- Diversification potential - Low correlation with B/M or E/P strategies

SPiDER Performance vs. B/M and E/P (Q5-Q1, VW, Mar. 1999 – Dec. 2015)





		SPiDER		B/M and E/P			
		Separate IG / HY Ranking	Pooled IG / HY Ranking	SPiDER Sample		Fama-French Sample	
				B/M	E/P	B/M	E/P
Performance	Avg. Ret (%/Yr)	5.85	5.64	4.81	4.01	2.95	4.00
	Vol. (%/Yr)	9.53	10.33	12.03	14.87	12.43	12.11
	Inf. Ratio	0.61	0.55	0.40	0.27	0.24	0.33
Tail Risk	Min. Monthly Ret. (%)	-10.15	-9.66	-9.89	-17.63	-9.98	-10.28
	Downside Vol. (%/Yr)	5.83	6.14	7.27	9.84	8.15	7.46
	Max Drawdown (%)	-16.15	-22.52	-32.90	-43.80	-29.93	-35.00
Correlation	Q1,Q5	0.80	0.76	0.74	0.71	0.75	0.76
	w/ SPiDER ret			-0.06	0.08	0.02	0.00
	B/M , E/P			0.24		0.67	

Source: Kenneth French Data Library , Compustat, Barclays Research

Restricted - External

Ranking within Industry Improves Strategies Inf. Ratio

- Ranking within instead of across industry improves the inf. ratio of all value strategies
- Volatility declines across the board
- SPiDER strategy advantage in terms of inf. ratio, volatility, tail-risk and correlation remain qualitatively unchanged

SPiDER Performance vs. B/M and E/P (Q5-Q1, VW, Mar. 1999 – Dec. 2015)

		SPiDER Sample								Fama-French	
		Within Industry				Across All				Across All	
		Separate IG / HY Ranking	Pooled IG / HY Ranking			Separate IG / HY	Pooled IG / HY Ranking			Pooled IG / HY Ranking	
		SPiDER	SPiDER	B/M	E/P	SPiDER	SPiDER	B/M	E/P	B/M	E/P
Performance	Avg. Ret (%/Yr)	5.47	5.07	6.65	5.44	5.85	5.64	4.81	4.01	2.95	4.00
	Vol. (%/Yr)	8.49	8.56	11.28	11.77	9.53	10.33	12.03	14.87	12.43	12.11
	Inf. Ratio	0.64	0.59	0.59	0.46	0.61	0.55	0.40	0.27	0.24	0.33
Tail Risk	Min. Monthly Ret. (%)	-8.28	-10.13	-9.40	-12.72	-10.15	-9.66	-9.89	-17.63	-9.98	-10.28
	Downside Vol. (%/Yr)	4.94	5.16	6.72	7.21	5.83	6.14	7.27	9.84	8.15	7.46
	Max Drawdown (%)	-16.47	-15.79	-29.05	-30.85	-16.15	-22.52	-32.90	-43.80	-29.93	-35.00
Correlation	Q1,Q5	0.84	0.83	0.81	0.77	0.80	0.76	0.74	0.71	0.75	0.76
	w/ SPiDER ret	1.00	0.95	-0.13	0.21	1.00	0.93	-0.06	0.08	0.02	0.00

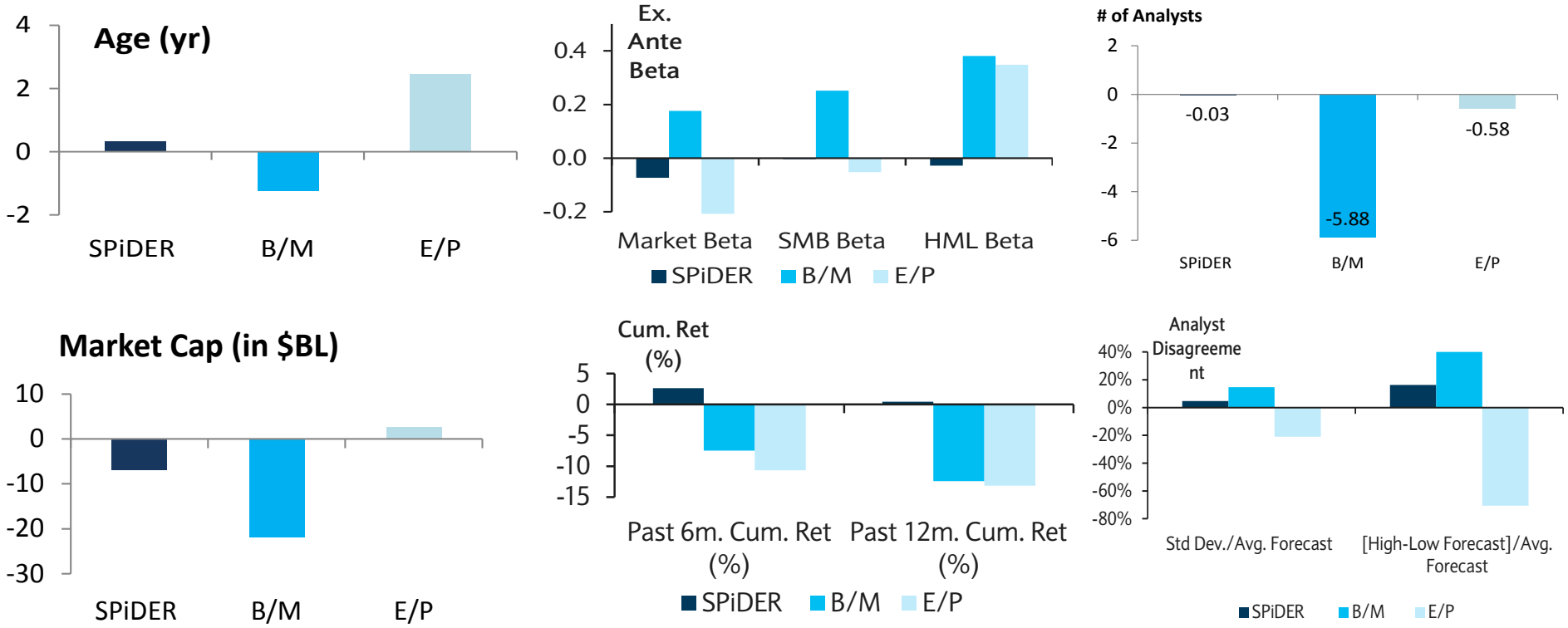
Source: Kenneth French Data Library , Compustat, Barclays Research

Restricted - External

SPiDER Port. Doesn't Exhibit Unintended Factor Exposures

- SPiDER Q5, Q1 portfolios have similar characteristics unlike B/M and E/P strategies
- High and Low SPiDER firms have same perf. during 6- and 12months pre-ranking period
- Similar analyst coverage and valuation dispersion b/w SPiDER L/S quintiles, unlike B/M and E/P quintiles
- SPiDER Q1 and Q5 may better hedge each other as they are similar

Q5-Q1 Diff. in Firm Characteristics (w/i industry, VW, Mar. 1999 – Dec. 2015)



Note: firm age is estimated as the number of year from the first COMPUTAT observation of the firm. Source: Compustat, Barclays Research

Restricted - External

SPiDER Strategy Delivers Significant Alpha

- Controlling for FF 3- and 5-factors, strategy delivered significant alpha of ~40bp/month
- Ranking across industries leads to less idiosyncratic 'value' ret. and weaker significance
- No exposure to HML factor (within industry ranking)

Regressions of SPiDER Strategy Returns Against Fama-French Factors

Ranking Methods	Dep. Variable: SPiDER Q5-Q1 Return							
	3-Factor Model				5-Factor Model			
	Within Industry		Across All		Within Industry		Across All	
	IG / HY separately	IG/ HY pooled	IG / HY separately	IG/ HY pooled	IG / HY separately	IG/ HY pooled	IG / HY separately	IG/ HY pooled
Intercept	0.47	0.43	0.40	0.36	0.39	0.36	0.25	0.21
t-stat	**3.08*** **	**3.03*** **	1.86*	1.81*	**2.29** **	**2.17** **	1.03	0.94
Mkt	-0.15	-0.15	-0.03	0.02	-0.11	-0.12	0.04	0.09
t-stat	**-2.83*** **	**-3.06*** **	-0.36	0.31	**-2.76*** **	**-2.92*** **	0.62	1.67*
SMB	0.13	0.12	0.24	0.26	0.06	0.06	0.20	0.22
t-stat	**2.47** **	**2.22** **	**3.22*** **	**3.35*** **	0.75	0.85	**3.1*** **	**2.91*** **
HML	-0.01	0.00	0.02	-0.02	-0.17	-0.17	-0.24	-0.29
t-stat	-0.08	-0.04	0.32	-0.17	-1.53	-1.44	**-2.06** **	**-2.29** **
RMW					-0.04	-0.03	0.07	0.06
t-stat					-0.28	-0.31	0.61	0.49
CMA					0.39	0.38	0.48	0.51
t-stat					**2.46** **	**2.37** **	**2.75*** **	**2.74*** **
Adj. R2	7%	7%	7%	9%	12%	12%	13%	15%

Note: Regressions are estimated between March 1999 and December 2015. Standard Errors were corrected for serial correlation using Newey-West SE with 12 lags. *** , **, * significant at the 1%, 5% and 10% level. Source: Kenneth French Data Library, Compustat, Barclays Research

Combining 'Value' Signals for L/S and Long Strategies

- Combining SPiDER signal with B/M, E/P or both to generate a 'composite' value signal marginally improves abs. return and inf. ratio in all cases
- Composite measure in Asness, Frazzini, Israel, and Moskowitz (2015)* led to inferior results
- Results for long-only case (Q5) are very similar

Portfolios Sorted on Equally Combined Value Signals (Q5-Q1 VW, Mar. 1999 – Dec. 2015)

Within Industry														
	Q5-Q1							Long-Only (Q5)						
	SPiDER	B/M	E/P	SPiDER & B/M	SPiDER & E/P	B/M & E/P	All 3	SPiDER	B/M	E/P	SPiDER & B/M	SPiDER & E/P	B/M & E/P	All 3
Avg. Ret (%/Yr)	5.47	6.65	5.44	9.09	7.36	8.54	**9.78**	9.29	11.75	11.09	13.49	11.75	13.22	**13.96**
Vol. (%/Yr)	8.49	11.28	11.77	10.66	9.60	11.42	**10.94**	13.56	18.81	15.97	18.39	14.99	17.02	**17.10**
Inf. Ratio	0.64	0.59	0.46	0.85	0.77	0.75	**0.89**	0.52	0.50	0.55	0.61	0.63	0.64	**0.68**
Min. Monthly Ret (%)	-8.28	-9.40	-12.72	-6.73	-8.04	-8.68	**-7.15**	-11.85	-24.12	-17.09	-17.08	-13.85	-23.22	**-16.11**
Max Drawdown	-16.47	-29.05	-30.85	-16.14	-24.37	-20.70	**-15.74**	-41.57	-54.12	-40.66	-50.44	-37.65	-52.60	**-49.20**

Note: The average of multiple value signal is computed as the equal average of the percentile ranking of each individual value ratio. Source: Compustat, Barclays Research
* See Asness, C., A. Frazzini, R. Israel, and T. Moskowitz. "Fact, Fiction, and Value Investing." *The Journal of Portfolio Management*, Vol. 42, No. 1 (2015).

Combining SPiDER and BEAM Dominates B/M and Equity Mom.

- Combining SPiDER and BEAM portfolios improved inf. ratio, consistent with Asness, Moskowitz and Pedersen (2013)*
- The SPiDER / BEAM combination dominated a combination of B/M and momentum irrespective of sample or ranking approach

Performance of Eq. Combined Value-Momentum Portfolio (Mar. 1999 – Dec. 2015)

		SPiDER	BEAM	Combined	B/M	MMT	Combined
Within Industry	Avg. Ret (%/Yr)	5.47	15.48	10.48	6.65	5.25	5.95
	Vol. (%/Yr)	8.49	16.60	10.14	11.28	24.41	10.77
	Inf. Ratio	0.64	0.93	1.03	0.59	0.22	0.55
	Min. Monthly Ret. (%)	-8.28	-12.17	-6.26	-9.40	-35.01	-14.55
	Downside Vol. (%/Yr)	4.94	8.02	4.86	6.72	18.79	7.68
	Max. Drawdown (%)	-16.47	-19.41	-16.97	-29.05	-69.17	-32.16
	Corr. b/w Component Strategies			0.23			-0.47

Source: Kenneth French Data Library , Compustat, Barclays Research
See Asness, C., T. Moskowitz and L. H. Pedersen, 'Value and Momentum Everywhere', *Journal of Finance, June 2013*

Key Takeaways

I. Using bond-level information from credit markets improved the performance and risk dynamics of both equity momentum and value strategies

II. Separating the signal source from the market in which it is applied leads to ‘long’ and ‘short’ portfolios with similar characteristics

III. Consequently, BEAM and SPiDER ‘long’ and ‘short’ portfolios hedged risk more effectively than their equity counterparts

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Systematic Strategies in Fixed Income

31 January 2019

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Selected Quantitative Scorecards in Bond Markets

- Focus of this presentation:
  - SPiDER, ESP, EMC in credit markets
  - GRACE in global rates markets

Name	Full Name	Signal Target	Information Source	Style	Horizon
C-SPiDER	Spread Per unit of Debt/Earnings Ratio	Corp. Bonds	Fundamental, Bonds	Value	Annual
FAR	Fallen Angel Reversal	Corp. Bonds	Bonds	Structural Mispricing	Monthly
ESP	Excess Spread to Peers	Corp. Bonds	Bonds, Fundamental	Value	Monthly
EMC	Equity Momentum in Credit	Corp. Bonds	Equity	Momentum	Monthly
GRACE	Global Rate Adjusted Carry	Global Treasuries	Rates, Economics	Carry	Monthly

Source: Barclays Research

SPiDER: SPread per unit of Debt-to-Earnings Ratio

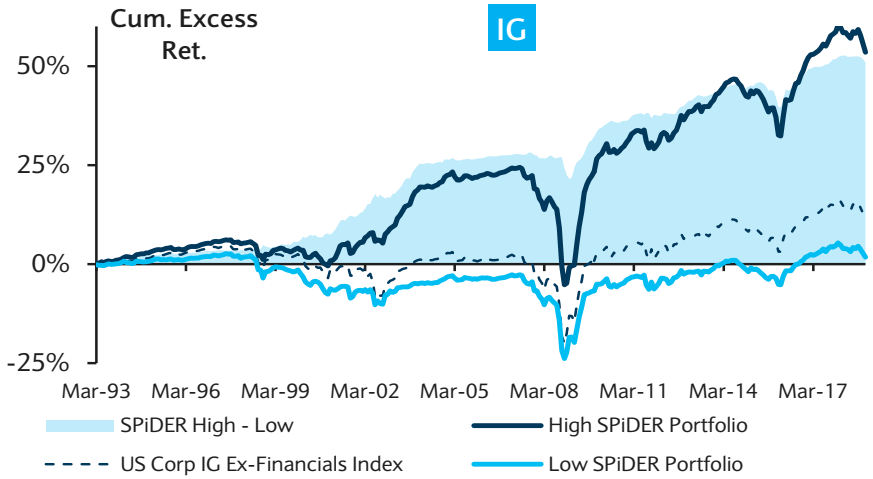
- Measure of 'value' in credit, similar to Shiller's CAPE. It represents the compensation demanded by the market given an issuer's debt level relative to its long-term earnings

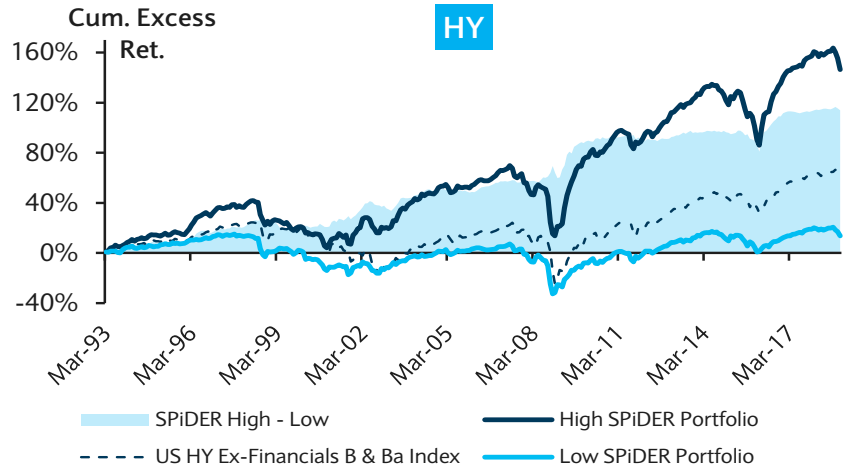
- SPiDER score is defined the ratio of issuer spread and debt per sustainable EBITDA

- <u>Key Characteristics</u>
  - Firm-level
  - Model-free (no regression model)
  - Annual frequency
  - Combines balance sheet, earning report and market data
  - Applies to IG and HY firms across all sectors ex. Financials (currently)
  - Identifies 'value' cross-sectionally and over time in both credit and equities

In Credit, High SPiDER Issuers Outperformed Low-SPiDER Issuers

Cum. Excess Return of SPiDER Strategy IG and HY (Mar. 1993 – Dec. 2018)





	Investment-Grade			High-Yield (Ba & B, and P>=40)			Equity Value Factor	
	SPiDER Strategy	Benchmark (Bloomberg Barclays US IG Index ex. financials)	SPiDER Long - Benchmark	SPiDER Strategy	Benchmark (Bloomberg Barclays US HY Index ex. financials Ba & B)	SPiDER Long - Benchmark	Book-to-Market	Earnings-to-Price
Avg. Ex. Ret (%/Yr)	1.60	0.51	1.23	3.01	2.10	1.69	8.48	3.37
Vol. (%/Yr)	1.45	4.07	1.61	3.54	8.43	4.18	12.39	8.68
Inf. Ratio (ann.)	1.11	0.12	0.77	0.85	0.25	0.40	0.68	0.39
Worst Monthly Ex. Ret. (%)	-2.02	-9.04	-2.55	-3.19	-15.26	-6.61	-15.41	-9.22
Max. Drawdown (%)	-5.26	-23.46	-6.55	-8.50	-39.20	-13.96	-31.20	-28.28
Corr. with Benchmark	0.08			-0.12				

- ✓ Strategy generates high Inf. Ratios for IG & HY, with consistent performance dynamics
- ✓ Significantly better Inf. Ratios compared with equity value strategies (using B/M or P/E)
- ✓ Positive Inf. Ratio of Q_5 vs. benchmarks in both IG and HY

Source: Barclays Research

SPiDER Perf. Was Not Driven by OAS, Industry, or Ratings

- SPiDER outperformance was **not driven by OAS** difference between Q5 and Q1
  - An OAS-neutral SPiDER strategy still produced outperformance, with an Inf. Ratio of 0.65 for IG and 0.71 for HY
- SPiDER performance is **consistent across all credit ratings**
- SPiDER strategy **holds across all industries**
- SPiDER outperformance are **insensitive to alternative definition of the debt/earning ratio** and weighting rules

Net Performance of Top Quintile Is Higher Than Benchmark

- Inf. Ratio of Q_5 net of transaction costs is still higher than the benchmark, even if we assume that investing in the benchmark **is costless**
- Q_5 constituents have high LCS but low turnover results in lower transaction costs compared with TCX and even lower TEV
- Transaction costs are lower with bi-annual rebalancing with little or no loss of perf.

Performance, Transaction Cost, and Tracking Error of Top Quintile (Feb. 2007– Aug. 2016)

	Investment Grade							High Yield		
	12m Rebalance Q5*	24m Rebalance Q5*	TCX US Corporate*	Benchmark (Corporate Index)	12m Q5 - Benchmark	24m Q5 - Benchmark	TCX - Benchmark (Corporate index)	12m Rebalance Q5 (original)	24m Rebalance Q5	Benchmark (HY Index Ex Financials)
Gross Excess Return (%/yr)	1.41	1.34	0.60	0.75	0.65	0.58	-0.16	3.75	3.93	2.99
Volatility (%/yr)	6.04	6.06	7.18	6.11	1.27	1.16	1.91	9.88	9.79	12.03
Information Ratio	0.23	0.22	0.08	0.12	0.51	0.50	-0.08	0.38	0.40	0.25
Average LCS (%)	1.24	1.24	0.86	0.93				1.92	1.90	1.70
Turnover (%/yr)*	28%	19%	240%					53%	34%	
Transaction Cost* (%)	0.35	0.24	2.06					1.01	0.64	
Net Excess Return (%/yr)	1.06	1.10	-1.47		0.30	0.35		2.74	3.29	
Net Information Ratio	0.17	0.18	-0.20		0.24	0.30		0.28	0.34	

Note: When rebalancing every 24m, there are two tracks of returns: one rebalanced in odd years and one rebalanced in even years. The overall portfolio initially assigns 50% to each track, and each year balances one track while keeping the other track untouched and alternate the following year. The 12m and 24m-SPiDER Q5 returns statistics reported are from monthly weighted average of SPiDER Q5 ex. ret and IG Financial Index ex. ret. to make SPiDER Q5 returns comparable to that of TCX returns (which includes the financials). The weights are the total MV of ex-financial and financial sectors in the IG index. Turnover reported is a weighted average of SPiDER Q5 turnover and 0 (no transaction cost associated with IG index-financials returns). Transaction cost is estimated as average annual turnover times Q5 average LCS. TCX turnover and transaction costs were from Mar. 2007 to Apr. 2010. Source: Barclays Research

ESP Scorecard

- Excess Spread over Peers (ESP) Scorecard
- Quantitative framework to identify relative value in credit
- Bonds are ranked on excess spread over peers adjusted for fundamentals

Excess Spread over Peers (ESP) Scorecard – December 2018

- The Excess Spread over Peers (ESP) is a quantitative filter designed to identify relative value opportunities in corporate bonds while controlling for issuer characteristics and fundamentals.
- In December, the performance of the ESP Scorecard varied across credit as markets continued to decline. Top-quintile ESP portfolios underperformed their bottom-quintile peers by 41bp in US IG and by 74bp in US HY, but outperformed by 24bp in Euro IG.
- Over the past ten years, top-quintile outperformed bottom-quintile ESP portfolios by 4.74%/yr in US IG, 7.20%/yr in US HY B-Ba and by 3.50%/yr in Euro IG Senior, before transaction costs, with information ratios above 1.8. Performance has been much weaker over the past 12 months.

ESP Scorecard Summary

The ESP Scorecard is a quantitative framework designed to identify relative value opportunities in credit (please see *Relative Value Investing in Credit*, 9 May 2016). The scorecard assigns scores from 1 to 10 to bonds according to their relative valuation with a high score indicating attractiveness. The ESP Scorecard incorporates both market and fundamental information. The framework is implemented in two steps:

Step1: Peer groups are identified within the corporate bond universe. In this process, individual bonds are grouped based on their characteristics to capture systematic credit risk. The ESP Scorecard calculates the excess spread of each bond over its peer group average. Bonds with *high* or *low* excess spreads over peers are deemed *undervalued* or *overvalued*, respectively.

Step 2: In the second step, the ESP Scorecard corrects excess spreads for differences in issuer fundamental data using statistical analysis.

Investors can use the ESP Scorecard as a quantitative screening tool to identify potential relative value opportunities in credit. ESP Scores can be applied in conjunction with fundamental analysis and in combination with other signals; please see *Quantitative Credit Scorecards for Relative Value (ESP) and Cross-Asset Momentum (EMC)*, 22 February 2018.

QPS Research publishes the performance of the ESP Scorecard monthly. Individual scores are made available to investors via SFTP or email distribution list at the beginning of each month.

Figure 1 provides summary performance statistics of the ESP Scorecard across US IG, Euro IG Senior, and US HY B-Ba markets. Corporate bonds are sorted into quintiles by ESP Score. Figure 1 reports returns of top (Q5) and bottom (Q1) quintile portfolios.

FIGURE 1

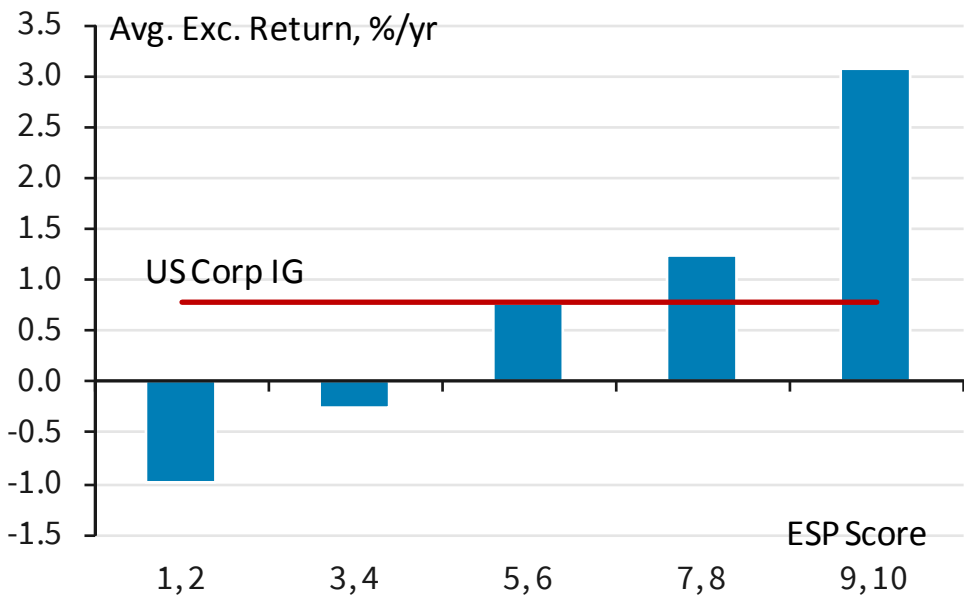
ESP Scorecard Performance: Top (Q5) vs. Bottom (Q1) EPS Quintile Portfolios

		Cum. Exc. Returns, %			Avg. Exc. Returns, %/yr			Volatility, %/yr			Information Ratio		
Universe	Portfolio	1m	3m	12m	3Y	5Y	10Y	3Y	5Y	10Y	3Y	5Y	10Y
US IG	Q5	-1.20	-3.82	-2.89	3.40	2.04	6.18	3.91	3.44	5.49	0.87	0.59	1.13
	Q1	-0.79	-2.13	-2.95	0.44	-0.60	1.44	2.46	2.14	4.42	0.18	-0.28	0.33
	Q5-Q1	*-0.41*	*-1.72*	*0.08*	*2.96*	*2.64*	*4.74*	*1.58*	*1.51*	*1.91*	*1.87*	*1.75*	*2.49*
US HY B-Ba	Q5	-3.91	-6.64	-2.18	8.08	3.92	12.65	6.23	6.56	9.34	1.30	0.60	1.35
	Q1	-3.17	-5.59	-5.09	2.91	0.61	5.44	4.66	5.05	7.44	0.63	0.12	0.73
	Q5-Q1	*-0.74*	*-1.08*	*3.10*	*5.17*	*3.32*	*7.20*	*2.26*	*2.34*	*3.98*	*2.29*	*1.42*	*1.81*
EUR IG Senior	Q5	0.11	-1.92	-2.42	1.89	1.34	3.88	2.59	2.41	3.43	0.73	0.56	1.13
	Q1	-0.13	-1.04	-1.86	0.21	0.11	0.38	1.83	1.60	2.26	0.12	0.07	0.17
	Q5-Q1	*0.24*	*-0.89*	*-0.56*	*1.68*	*1.23*	*3.50*	*1.12*	*1.11*	*1.79*	*1.50*	*1.11*	*1.95*

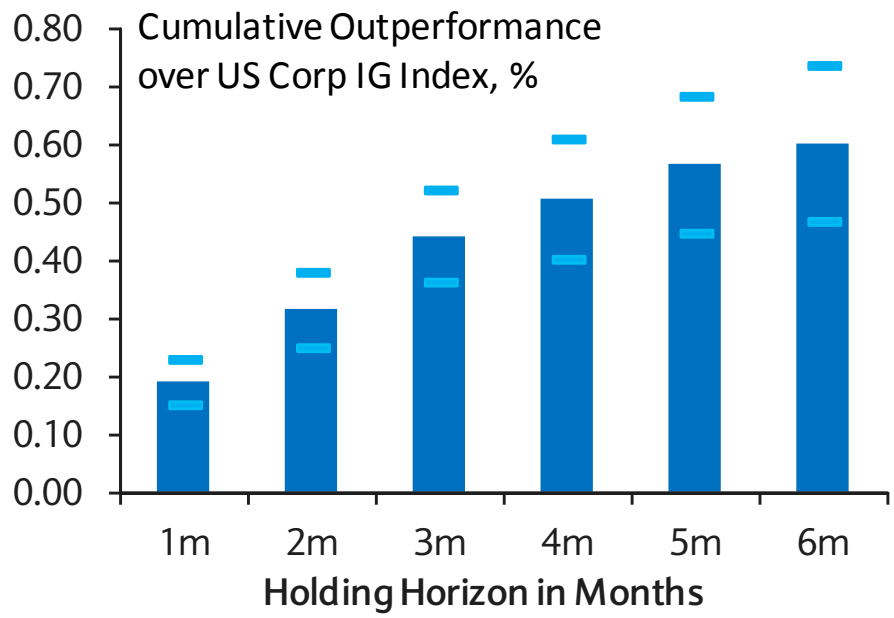
Note: ESP scores are calculated at the beginning of each month. Portfolios are rebalanced at the beginning of each month and capitalization-weighted. All reported returns are in excess of duration-matched Treasury portfolios. Monthly compounding is used to calculate cumulative returns. Transaction costs are excluded.
Source: Bloomberg, Barclays Research

ESP Performance – US Corporate IG

ESP Performance by Score, 2007-2018



ESP 9-10 No Rebalancing, 2007-2018



- Universe: US Corp IG
- Sort bonds into portfolios by ESP Scores
- Performance increases with the score

- By bonds with ESP = 9 or 10
- Hold w/o rebalancing
- Performance remains positive over 6 months

Source: Bloomberg Barclays Indices, Barclays Research

ESP Performance - Summary

Performance of the ESP Scorecard in periods ending 31 December 2018

Universe	Portfolio	Cum. Exc. Returns, %			Avg. Exc. Returns, %/yr			Volatility, %/yr			Information Ratio		
		1m	3m	12m	3Y	5Y	10Y	3Y	5Y	10Y	3Y	5Y	10Y
US IG	Q5	-1.20	-3.82	-2.89	3.40	2.04	6.18	3.91	3.44	5.49	0.87	0.59	1.13
	Q1	-0.79	-2.13	-2.95	0.44	-0.60	1.44	2.46	2.14	4.42	0.18	-0.28	0.33
	Q5-Q1	***-0.41***	***-1.72***	***0.08***	***2.96***	***2.64***	***4.74***	***1.58***	***1.51***	***1.91***	***1.87***	***1.75***	***2.49***
US HY B-Ba	Q5	-3.91	-6.64	-2.18	8.08	3.92	12.65	6.23	6.56	9.34	1.30	0.60	1.35
	Q1	-3.17	-5.59	-5.09	2.91	0.61	5.44	4.66	5.05	7.44	0.63	0.12	0.73
	Q5-Q1	***-0.74***	***-1.08***	***3.10***	***5.17***	***3.32***	***7.20***	***2.26***	***2.34***	***3.98***	***2.29***	***1.42***	***1.81***
EUR IG Senior	Q5	0.11	-1.92	-2.42	1.89	1.34	3.88	2.59	2.41	3.43	0.73	0.56	1.13
	Q1	-0.13	-1.04	-1.86	0.21	0.11	0.38	1.83	1.60	2.26	0.12	0.07	0.17
	Q5-Q1	***0.24***	***-0.89***	***-0.56***	***1.68***	***1.23***	***3.50***	***1.12***	***1.11***	***1.79***	***1.50***	***1.11***	***1.95***

Source: Bloomberg Barclays Indices, Barclays Research

EMC Scorecard

- Equity Momentum in Credit (EMC) Scorecard
- Quantitative framework to differentiate issuers according to equity momentum

Equity Momentum in Credit (EMC) Scorecard – December 2018

- Equity Momentum in Credit (EMC) Scorecard is a quantitative filter designed to differentiate corporate issuers based on their stock price momentum.
- In December, the EMC Scorecard performance varied across markets. In US IG and HY, the top EMC portfolios (scores of 9 or 10) outperformed the bottom ones (scores of 1 or 2) by 30bp and 210bp, respectively. In Euro IG, the EMC performance was negative at -6bp.
- Over the past ten years, top-quintile outperformed bottom-quintile EMC portfolios by 7.74%/yr in US IG, by 12.99%/yr in US HY and by 4.04%/yr in Euro IG with information ratios above 1.5 before transaction costs. The performance has been weaker in the past 12 months than the realised average of the last ten years.

EMC Scorecard Summary

The EMC Scorecard is a quantitative framework designed to differentiate issuers based on their stock price momentum. It is based on a positive empirical relationship between past equity returns and subsequent returns of corporate bonds (please see *Equity Momentum in Credit (EMC)*, 18 August 2017). The scorecard assigns scores from 1 to 10 to issuers with a high score indicating strong equity momentum.

Portfolios sorted on EMC scores have demonstrated attractive risk-return characteristics over the past two decades. Investors can use the EMC Scorecard as a quantitative screening tool to identify issuers with a potentially improving outlook, as reflected in past trends of respective stock prices. The Scorecard can be used on a tactical basis in conjunction with fundamental analysis and, potentially, with other signals; please see *Quantitative Credit Scorecards for Relative Value (ESP) and Cross-Asset Momentum*

We make bond-level EMC scores available on a monthly basis via SFTP or email distribution list.

Figure 1 summarises the performance of the EMC Scorecard in the US IG, US HY and Euro IG markets. Corporate issuers are sorted into quintiles by EMC score. Bonds with scores of 9 or 10 are included into the top-quintile portfolio (Q5), while bonds with scores of 1 or 2 form the bottom-quintile portfolio (Q1). Figure 1 reports returns of top (Q5) and bottom (Q1) quintile portfolios over different periods ending 31 December 2018.

FIGURE 1

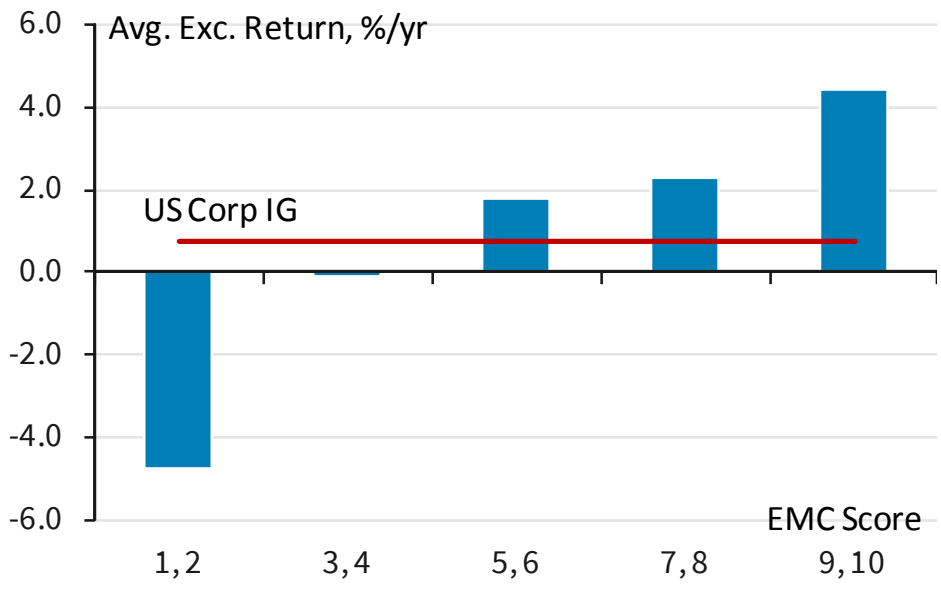
EMC Scorecard Performance: Top (Q5) vs. Bottom (Q1) EMC Quintile Portfolios

		Cum. Exc. Returns, %			Avg. Exc. Returns, %/yr			Volatility, %/yr			Information Ratio		
Universe	Portfolio	1m	3m	12m	3Y	5Y	10Y	3Y	5Y	10Y	3Y	5Y	10Y
US IG	Index	-1.06	-3.05	-3.20	1.62	0.56	3.29	3.00	2.56	4.47	0.54	0.22	0.74
	Q5	-1.03	-3.01	-2.06	3.88	2.49	6.77	3.45	2.91	5.28	1.12	0.86	1.28
	Q1	-1.33	-3.96	-6.13	-0.84	-2.70	-0.97	3.36	3.21	5.34	-0.25	-0.84	-0.18
	Q5-Q1	*0.30*	*0.98*	*4.32*	*4.72*	*5.19*	*7.74*	*1.32*	*1.68*	*4.00*	*3.58*	*3.08*	*1.94*
US HY	Index	-3.66	-6.67	-3.63	5.65	2.05	8.83	5.53	5.72	8.59	1.02	0.36	1.03
	Q5	-2.96	-5.11	-0.40	13.38	7.84	15.24	7.83	7.64	10.26	1.71	1.03	1.49
	Q1	-5.06	-9.82	-6.94	1.76	-4.35	2.25	6.43	7.29	8.57	0.27	-0.60	0.26
	Q5-Q1	*2.10*	*5.02*	*6.79*	*11.62*	*12.19*	*12.99*	*4.26*	*4.37*	*6.03*	*2.73*	*2.79*	*2.15*
Euro IG	Index	-0.03	-1.66	-2.51	1.06	0.91	2.34	2.30	2.11	3.33	0.46	0.43	0.70
	Q5	-0.03	-1.38	-2.26	1.93	1.80	4.29	2.56	2.21	3.18	0.75	0.81	1.35
	Q1	0.02	-2.10	-2.96	0.17	-0.31	0.26	2.31	2.45	4.45	0.07	-0.13	0.06
	Q5-Q1	*-0.06*	*0.72*	*0.72*	*1.75*	*2.11*	*4.04*	*0.78*	*1.11*	*2.68*	*2.25*	*1.91*	*1.50*

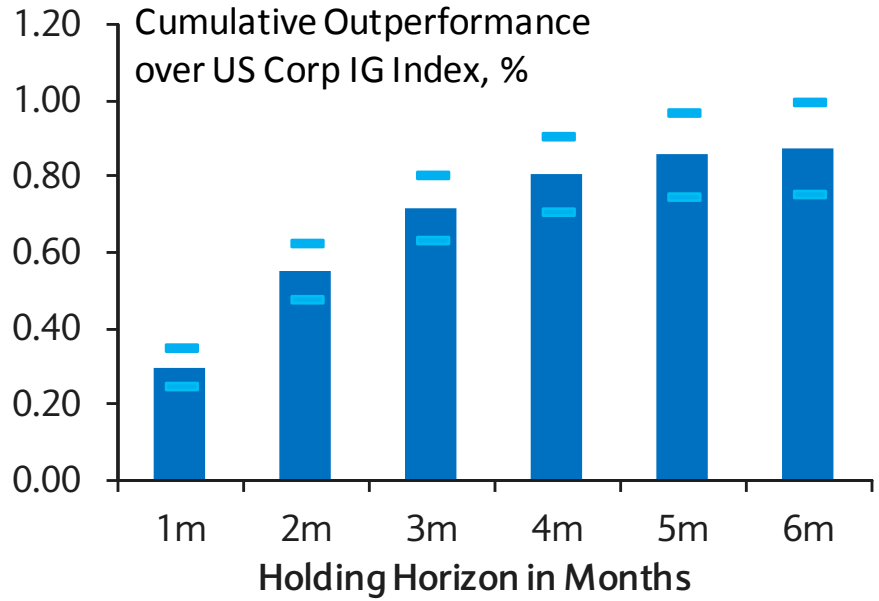
Note: EMC scores are calculated at the beginning of each month. Portfolios are rebalanced in the beginning of each month and capitalisation-weighted. All reported returns are in excess of duration-matched Treasury portfolios. Monthly compounding is used to calculate cumulative returns. Transaction costs are excluded.
Source: Bloomberg, Barclays Research

EMC Performance – US Corporate IG

EMC Performance by Score, 2007-2018



EMC 9-10 No Rebalancing, 2007-2018



- Universe: US Corp IG
- Sort bonds into portfolios by EMC Scores
- Performance increases with the score

- Bonds with EMC = 9 or 10
- Hold w/o rebalancing
- Performance positive over several months

Source: Bloomberg Barclays Indices, Barclays Research

EMC Performance - Summary

Performance of the EMC Scorecard in periods ending on 31 December 2018

Universe	Portfolio	Cum. Exc. Returns, %			Avg. Exc. Returns, %/yr			Volatility, %/yr			Information Ratio		
		1m	3m	12m	3Y	5Y	10Y	3Y	5Y	10Y	3Y	5Y	10Y
US IG	Index	-1.06	-3.05	-3.20	1.62	0.56	3.29	3.00	2.56	4.47	0.54	0.22	0.74
	Q5	-1.03	-3.01	-2.06	3.88	2.49	6.77	3.45	2.91	5.28	1.12	0.86	1.28
	Q1	-1.33	-3.96	-6.13	-0.84	-2.70	-0.97	3.36	3.21	5.34	-0.25	-0.84	-0.18
	Q5-Q1	***0.30***	***0.98***	***4.32***	***4.72***	***5.19***	***7.74***	***1.32***	***1.68***	***4.00***	***3.58***	***3.08***	***1.94***
US HY	Index	-3.66	-6.67	-3.63	5.65	2.05	8.83	5.53	5.72	8.59	1.02	0.36	1.03
	Q5	-2.96	-5.11	-0.40	13.38	7.84	15.24	7.83	7.64	10.26	1.71	1.03	1.49
	Q1	-5.06	-9.82	-6.94	1.76	-4.35	2.25	6.43	7.29	8.57	0.27	-0.60	0.26
	Q5-Q1	***2.10***	***5.02***	***6.79***	***11.62***	***12.19***	***12.99***	***4.26***	***4.37***	***6.03***	***2.73***	***2.79***	***2.15***
Euro IG	Index	-0.03	-1.66	-2.51	1.06	0.91	2.34	2.30	2.11	3.33	0.46	0.43	0.70
	Q5	-0.03	-1.38	-2.26	1.93	1.80	4.29	2.56	2.21	3.18	0.75	0.81	1.35
	Q1	0.02	-2.10	-2.96	0.17	-0.31	0.26	2.31	2.45	4.45	0.07	-0.13	0.06
	Q5-Q1	***-0.06***	***0.72***	***0.72***	***1.75***	***2.11***	***4.04***	***0.78***	***1.11***	***2.68***	***2.25***	***1.91***	***1.50***

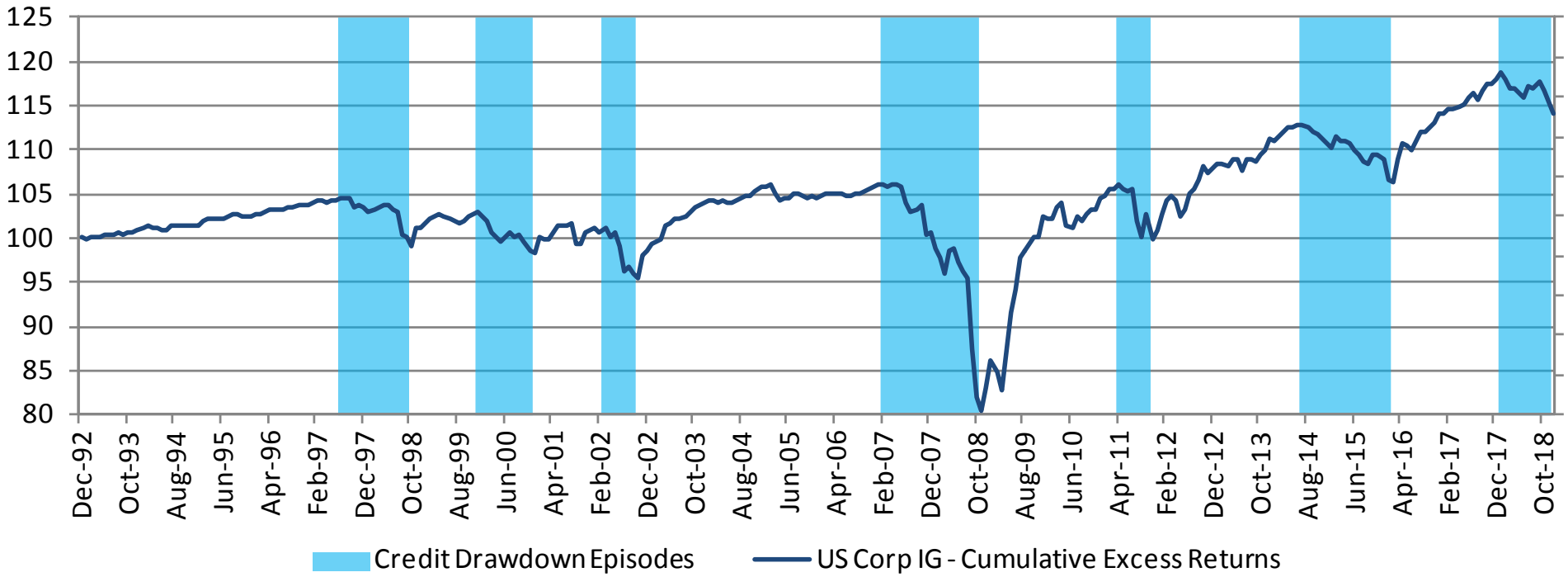
Source: Bloomberg Barclays Indices, Barclays Research

Scorecard Performance in Credit Down-Cycles

- How have EMC and ESP scorecards performed during credit down-cycles?
- Define drawdown episodes in excess returns as down-cycles

  => Measure performance of the EMC and ESP strategies

Cumulative Excess Returns of the US Corp Index and Drawdown Episodes



Source: Bloomberg Barclays Indices, Barclays Research

Scorecard Performance in Credit Down-Cycles

- EMC performance in credit down-cycles has been strong, while ESP performance has been weak
  - 2002 – telecom crisis
  - 2008 – financial crisis
  - 2015 – energy crisis
- The two strategies seem to complement each other
- Top scorecard portfolios include bonds with scores 9 and 10

Excess Returns of Top Scorecard Portfolios in Credit Down-Cycles, %

Drawdown Episodes	Excess returns over Treasuries			Over Index	
	US IG Index, %	Top EMC, %	Top ESP, %	Top EMC, %	Top ESP, %
Aug 1997 - Oct 1998	-5.2	-3.5	-4.7	1.8	0.5
Jan 2000 - Dec 2000	-4.5	-2.0	-7.0	2.5	-2.5
Apr 2002 - Oct 2002	-5.8	2.5	-11.6	8.3	-5.8
Mar 2007 - Nov 2008	-26.9	-20.3	-27.3	6.7	-0.4
May 2011 - Nov 2011	-5.8	-3.2	-7.3	2.6	-1.5
Aug 2014 - Feb 2016	-6.0	-2.6	-6.7	3.4	-0.8
Feb 2018 - Dec 2018	**-3.9**	**-3.2**	**-4.0**	**0.8**	**-0.1**

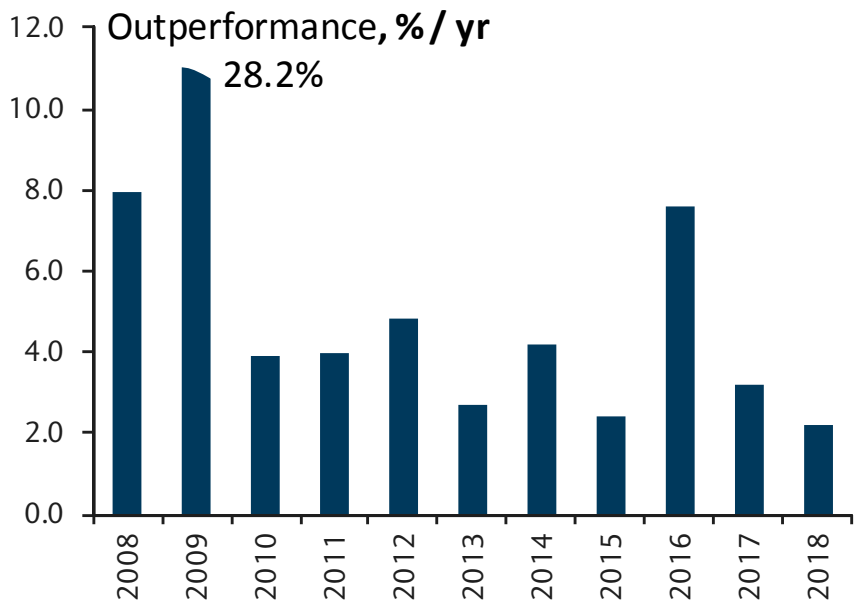
Source: Bloomberg Barclays Indices, Barclays Research

Combining ESP and EMC Scores

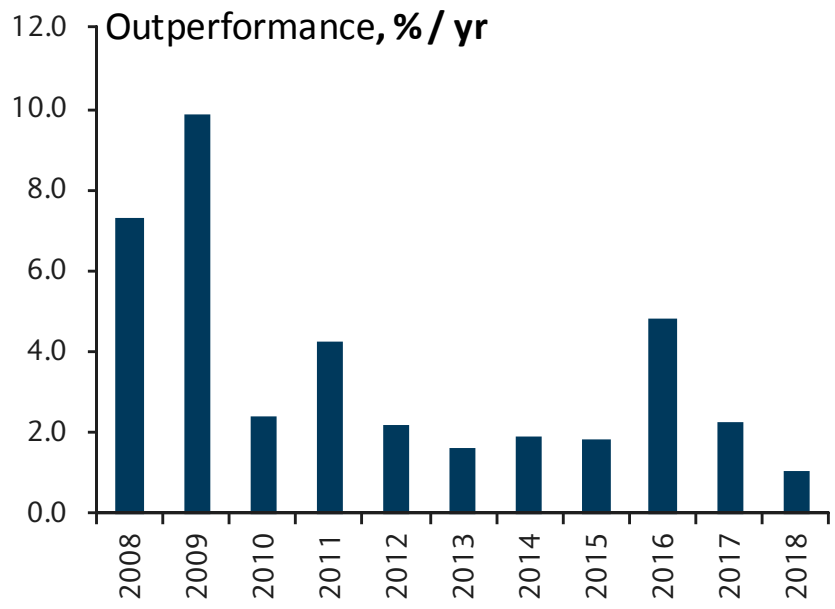
- ESP and EMC strategies seem to have opposite directionality on credit returns
  - Positive for ESP
  - Negative for EMC
- We combine ESP and EMC scores: **Combined Score = 0.5 x ESP + 0.5 x EMC**
- Top Combined Score portfolios include bonds with the Combined Score ≥ 9

Annual Outperformance of Top Combined Score Portfolios over Indices

US Corporate IG



Euro Corporate Senior IG



Source: Bloomberg, Barclays Indices, Barclays Research

Performance with Turnover Control

- We measure the performance of strategy portfolios with turnover control
- Strategy portfolio is based on the combined signal
  - Buy: liquid bonds (TES ≤ 3) with combined ESP/EMC signal in the top 20%
  - Sell: if the combined ESP/EMC signal is in the bottom 45%
  - Hold otherwise

Performance of the Strategy Portfolio with Turnover Buffer

	Avg. ExcRet, %/y	Volatility, %/y	Inf. Ratio	Avg. ExcRet, %/y	TEV, %/y	Inf. Ratio
Portfolios	**Absolute**			**Over US Corp Index**		
	March 2007 - December 2018			**March 2007 - December 2018**		
Bloomberg Barclays US Corp IG	0.77	5.56	0.14	-	-	-
ESP (top 20%) w/o Turnover Control	3.07	6.45	0.48	2.30	1.63	1.41
EMC (top 20%) w/o Turnover Control	4.39	6.18	0.71	3.62	2.11	1.72
Strategy w. Turn. Control before TC	3.46	6.18	0.56	2.69	1.50	1.79
Strategy w Turn. Control after TC	**2.57**	**6.15**	**0.42**	**1.80**	**1.43**	**1.26**
	March 2007 - December 2012			**March 2007 - December 2012**		
Bloomberg Barclays US Corp IG	0.57	7.51	0.08	-	-	-
Strategy w. Turn. Control before TC	4.52	8.13	0.56	3.94	1.85	2.14
Strategy w Turn. Control after TC	**3.37**	**8.10**	**0.42**	**2.79**	**1.75**	**1.59**
	January 2013 - December 2018			**January 2013 - December 2018**		
Bloomberg Barclays US Corp IG	0.96	2.50	0.38	-	-	-
Strategy w. Turn. Control before TC	2.43	3.30	0.74	1.47	0.95	1.55
Strategy w Turn. Control after TC	**1.80**	**3.29**	**0.55**	**0.84**	**0.94**	**0.89**

Source: Bloomberg Barclays Indices, Barclays Research

Restricted - External

GRACE Scorecard

- Global Rate Adjusted Carry (GRACE) Scorecard
- Quantitative framework to differentiate global rate markets by relative carry

Global Rate Adjusted Carry (GRACE) Scorecard – December 2018

- The Global Rate Adjusted Carry (GRACE) Scorecard is a quantitative filter designed to identify relative carry opportunities in global government bond markets.
- In December, the GRACE Scorecard had a negative performance: the Top GRACE portfolio underperformed the Bottom GRACE portfolio by 67bp. Net carry sharply declined across markets, especially for Canada, Australia, the US, and Singapore.
- Over the past 10 years, Top GRACE portfolios have outperformed Bottom ones by 2.17%/yr, with an information ratio of 1.05. Performance in the past 12 months was in line with the long-term average.

GRACE Scorecard Summary

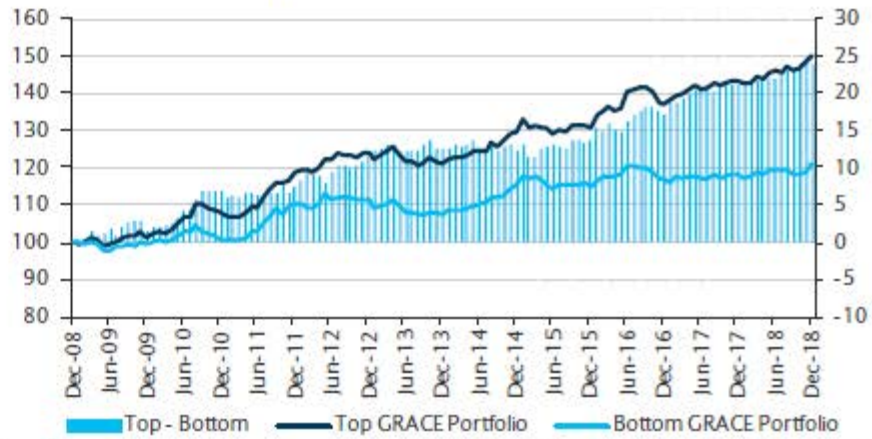
The GRACE Scorecard is a framework designed to differentiate government bonds across markets based on their carry. Bond carry is calculated by re-pricing individual bonds and deriving their total returns at a one-month horizon, while keeping the yield curve constant. We also use a statistical model to estimate expected changes in rates in different markets and adjust carry measures accordingly. GRACE calculates adjusted net carry of individual government bonds, please see *Introducing GRACE: the Global Rates Adjusted Carry (GRACE) Scorecard*, Barclays Research, 1 March 2018.

The GRACE scorecard can be used to filter the global treasury investment universe to monitor carry. It also can be used for advanced beta strategies in government bonds alongside other rates signals and strategy research. We make bond-level GRACE scores available to investors on a monthly basis.

Figure 1 summarises the performance of the GRACE Scorecard across eleven government bond markets. Markets are ranked by their GRACE score within different maturity buckets. For each maturity cell, the top and bottom-three markets form equally weighted Top and Bottom GRACE portfolios, respectively. GRACE portfolios are subsequently aggregated across maturity buckets using weights of a customized version of the Bloomberg Barclays Global Treasury Index that includes only the eleven markets covered by the scorecard. Figure 1 plots the cumulative returns of the Top and Bottom GRACE portfolios along with the cumulative outperformance of the Top portfolio.

FIGURE 1

Cumulative Returns of Top and Bottom GRACE Portfolios, %



Note: Portfolios returns are reported currency-hedged into USD. Portfolios are rebalanced at the beginning of each month, and bonds are capitalisation-weighted within each market. Monthly compounding is used to calculate cumulative returns. Transaction costs are excluded.
Source: Bloomberg, Barclays Research

Country Ranks in Different Maturity Buckets

- Independent ranking in different maturity buckets
- Different countries can come on top in for different maturities

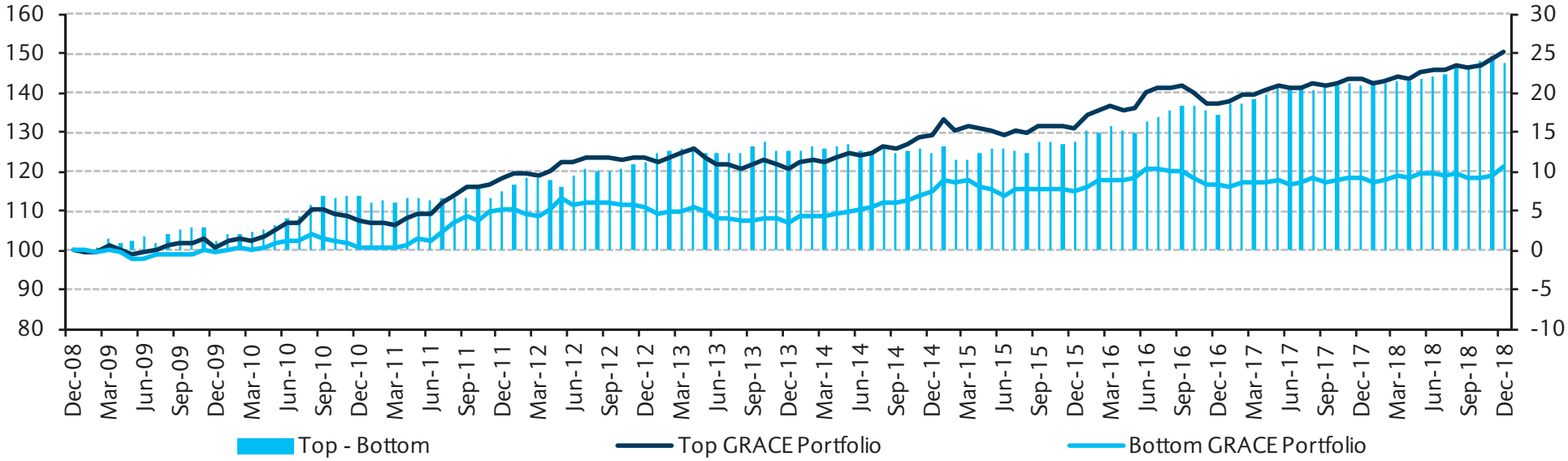
Country Ranks by GRACE Score, 31 December 2018

	Ranks by GRACE					1-month changes				
Rank	1-3Y	3-5Y	5-7Y	7-10Y	10+Y	1-3Y	3-5Y	5-7Y	7-10Y	10+Y
1 - Top	NO	DK	DK	DE	DE	↑ +5	↑ +5	↑ +6	=	=
2	CH	SE	DE	DK	DK	↑ +2	↓ -1	↑ +2	↑ +1	↑ +1
3	SE	NO	CH	GB	CH	=	↑ +6	↓ -1	↓ -1	↓ -1
4	SG	CH	SE	CH	JP	↓ -2	=	↓ -3	↑ +1	↑ +1
5	DK	DE	GB	SE	GB	↑ +2	↑ +2	↑ +3	↓ -1	↓ -1
6	GB	GB	NO	NO	SE	↑ +2	↑ +2	↑ +3	↑ +4	=
7	JP	SG	SG	AU	SG	↑ +3	↓ -5	↓ -4	↓ -1	=
8	AU	AU	AU	SG	AU	↓ -3	↓ -3	↓ -3	↓ -1	=
9	US	US	US	JP	US	↓ -8	↓ -6	↓ -3	=	=
10	DE	JP	JP	US	CA	↑ +1	=	=	↓ -2	=
11 - Btm	CA	CA	CA	CA	-	↓ -2	=	=	=	-

Source: Bloomberg Barclays Indices, Barclays Research

Performance of GRACE Scorecard

Cumulative Returns of Top and Bottom GRACE Portfolios, 31 December 2018



Cumulative Excess Returns (Top - Bottom), %				Avg. Annualized Excess Returns, %/yr			Annualized Volatility, %/yr			Information Ratio		
Maturity	1m	6m	12m	3Y	5Y	10Y	3Y	5Y	10Y	3Y	5Y	10Y
1-3 Yr	0.03	-0.02	-0.07	0.11	0.08	0.38	0.51	0.55	0.79	0.22	0.15	0.48
3-5 Yr	0.18	0.19	-0.24	1.04	0.80	1.02	1.11	1.43	1.74	0.94	0.56	0.59
5-7 Yr	-0.04	0.43	0.55	2.22	1.21	1.50	1.48	1.96	2.29	1.50	0.62	0.65
7-10 Yr	-0.67	0.98	2.01	2.68	1.24	2.12	2.01	2.46	2.83	1.33	0.51	0.75
10+ Yr	-2.08	4.64	7.07	6.69	4.86	5.20	4.08	4.20	4.73	1.64	1.16	1.10
All	**-0.67**	**1.61**	**2.37**	**2.88**	**1.93**	**2.17**	**1.71**	**1.87**	**2.06**	**1.68**	**1.03**	**1.05**

Source: Bloomberg Barclays Indices, Barclays Research

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Fallen Angel Signals

31 January 2019

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Time-line of QPS Research on Fallen Angels

1st Publication

Documented price reversal dynamics and proposed a simple rule-based strategy ('3m Reversal')

JFI

3rd Publication

Re-examined FA dynamics in changing demand/supply environment

Introducing FAR Scorecard

2010 2011 2012 2015 2018 2019

2nd Publication

Explored Cash-CDS basis and existence in European market

4th Publication

Show that the '3m Reversal' strategy delivered consistent outperformance since 2010
Same strategy worked in Europe

What's Special about Fallen Angels?

Supply

- ❖Most investors are required to sell
- ❖Selling takes place over a short window

Demand

- ❖HY market << IG market
- ❖IG bonds are larger than HY bonds, on average

Forced Selling + Supply Overwhelms Demand

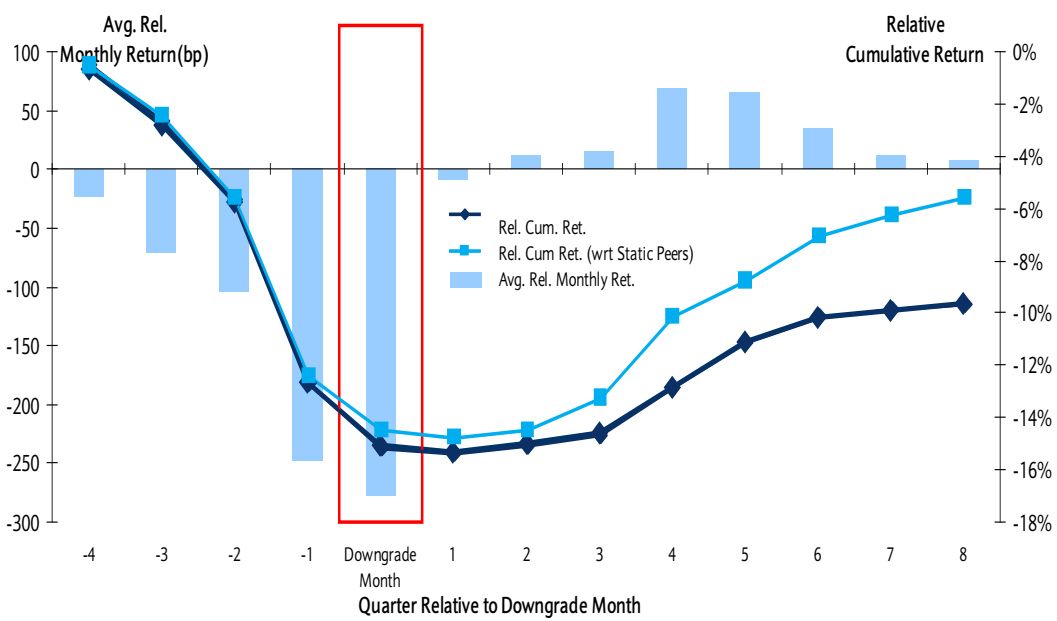
Excessive declines in fallen angels' bond prices followed by <u>strong mean-reversion</u>

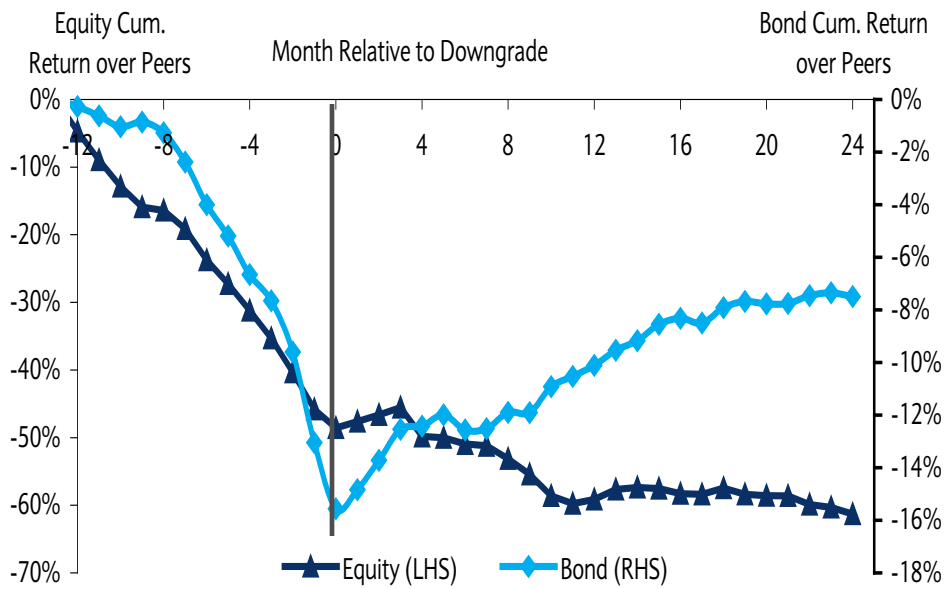
Excessive Declines Followed by Mean-Reversion in Prices

- **Ben Dor and Xu (2010)** Fallen Angels: Characteristics, Performance Implications for Investors
- Fallen angels (FA) underperformed IG peers by 15.1% in the downgrade month and preceding year
- Outperformed IG and HY peers by 10.2% and 6.3% over the next two years, respectively
- Reversal is limited to bonds. FA equities continue to underperform

FA Performance Around Downgrade Month | **FA Performance: Bonds Vs. Equities**

Based on Monthly Observations January 1990 – June 2010





Note: Returns computed using value weighting. Source: Compustat, Barclays Research

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Fallen Angel 3M Reversal: Rule-based Fallen Angel Strategy

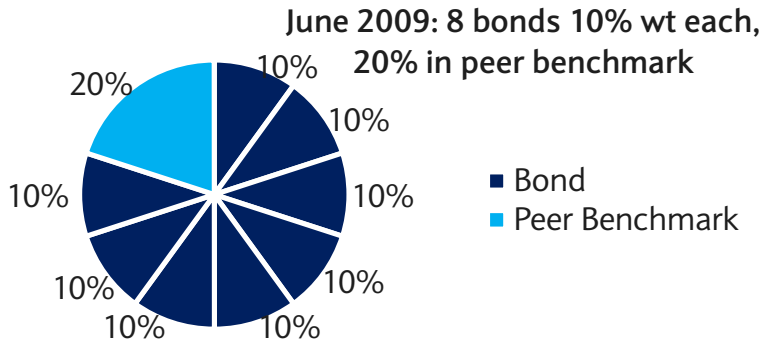
FA '3-Month Reversal' – invest in fallen angels while using rel. spread as buy and sell triggers

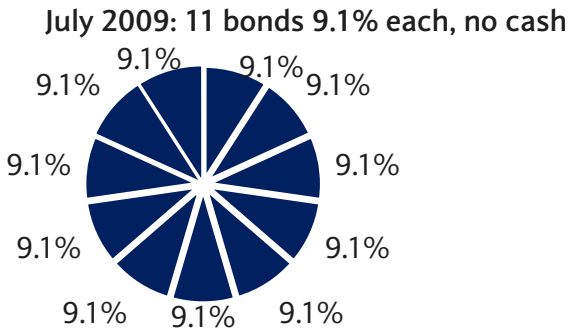
Fallen Angel '3m Reversal' Strategy Bond Inclusion/Exclusion Criteria		
Buy Conditions (if all are satisfied)	Timing	Month 3
	Spread relative to Peers	>= 40 bps
	Bond Price	>=40
Sell Triggers (if any one is satisfied)	Timing	Month 24
	Spread relative to Peers	Negative
	Technical	Bonds matured, defaulted or were called
Weighting		Equally weighted with 10% issuer cap
Rebalancing		Monthly

Source: Barclays Research

- **Peer group**: bonds with same credit ratings in the same fixed-income industry
- Fully seeded with cash at inception
- Unallocated capital invested in peer benchmark

Example





Source: Barclays Research

FA 3m Reversal Strategy Stayed Profitable Over Time

- **FA 3m Reversal** strategy still outperformed peers and had similar inf. ratios over the peer group in the recent period (January 2015 to Dec. 2018)

The Performance of FA 3m Reversal Portfolios

	FA '3m Reversal' Portfolio	Peer Group	FA Ret. over Peer Group	High-Yield Index	FA Ret over HY Index
Jan. 1991 - Jun. 2010 (Ben Dor and Xu 2010 study)					
Average (Monthly)	1.62%	0.84%	0.78%	0.81%	0.82%
Volatility (Monthly)	3.99%	2.31%	2.63%	2.68%	2.56%
Sharpe/Inf. Ratio (Ann.)	1.12	0.76	1.03	0.61	1.11
% of Positive Ret. Months	75%	76%	63%	76%	64%
% Invested in Fallen Angels	69%				
Jul. 2010 - Dec. 2014 (Ben Dor and Xu 2015 update)					
Average (Monthly)	1.11%	0.80%	0.31%	0.74%	0.38%
Volatility (Monthly)	1.85%	1.62%	0.88%	1.78%	0.92%
Sharpe/Inf. Ratio (Ann.)	2.06	1.67	1.23	1.40	1.42
% of Positive Ret. Months	74%	74%	65%	74%	70%
% Invested in Fallen Angels	55%				
Jan. 2015 - Dec. 2018					
Average (Monthly)	0.87%	0.32%	0.55%	0.35%	0.52%
Volatility (Monthly)	2.77%	1.51%	1.61%	1.52%	1.54%
Sharpe/Inf. Ratio (Ann.)	0.99	0.56	1.18	0.62	1.18
% of Positive Ret. Months	63%	67%	65%	63%	65%
% Invested in Fallen Angels	87%				

Note: The returns for the portfolios' peer group were computed as the equal–weighted performances of the individual bonds' peer groups . Sharpe Ratio was calculated using 1m Libor. Inf. ratio is the ratio of average and standard deviation of relative returns. Source: Barclays Research

FA 3m Reversal Strategy Outperformed FA ETFs

- **FA 3m Reversal** strategy outperformed popular FA ETFs
- Transaction cost does not account for the difference in performance

The Performance of FA 3m Reversal Portfolios vs Fallen Angel ETFs

Fallen Angel '3m Reversal' Strategy vs. Fallen Angel ETFs			
iShare Fallen Angel ETF (FALN, Jul. 2016 - Nov. 2018)			
	FA '3m Reversal'	FALN US Equity	FA over FALN US Equity
Avg. Ret (%/m)	1.06	0.46	0.6
Vol. (%/m)	1.7	1.3	1.19
Sharpe (Inf.) Ratio (ann.)	1.91	0.92	1.74
Corr(FALN US Equity, FA)	0.71		
VanEck Vectors Fallen Angel ETF (ANGL, May 2012 - Nov. 2018)			
	FA '3m Reversal'	ANGL US Equity	FA over ANGL US Equity
Avg. Ret (%/m)	0.95	0.6	0.35
Vol. (%/m)	2.34	1.86	1.16
Sharpe (Inf.) Ratio (ann.)	1.33	1.02	1.05
Corr(ANGL US Equity, FA)	0.87		

Source: Barclays Research, Bloomberg

FA 3m Reversal Outperformed in European Markets

- FA '3m Reversal' strategy had persistent returns in European markets, even after publication of our 2010 paper and 2015 update

Performance of FA '3m Reversal' strategy in European Markets

	FA '3m Reversal'	Peer Group	Ret. over Peer Group	High-Yield Index	Ret. over HY Index
Jan. 1999 -Jun. 2010 (Original Ben Dor and Xu 2010)					
Average (Monthly)	0.73%	0.33%	0.40%	0.48%	0.25%
Volatility (Monthly)	4.63%	3.89%	1.86%	4.01%	1.90%
Sharpe/Inf. Ratio (Ann.)	0.34	0.05	0.74	0.18	0.46
% of Positive Ret. Months	63%	66%	46%	67%	47%
% Invested in Fallen Angels	21.16%				
Jul. 2010 - Dec. 2014 (Ben Dor and Xu 2015 update)					
Average (Monthly)	1.36%	0.80%	0.56%	0.85%	0.51%
Volatility (Monthly)	5.20%	3.25%	2.89%	2.44%	3.31%
Sharpe/Inf. Ratio (Ann.)	0.89	0.84	0.67	1.18	0.53
% of Positive Ret. Months	78%	78%	70%	76%	72%
% Invested in Fallen Angels	85.19%				
Jan. 2015 - Apr. 2018					
Average (Monthly)	0.68%	0.38%	0.30%	0.42%	0.26%
Volatility (Monthly)	1.75%	1.00%	0.92%	1.27%	0.74%
Sharpe/Inf. Ratio (Ann.)	1.24	1.12	1.13	0.99	1.22
% of Positive Ret. Months	68%	60%	60%	63%	60%
% Invested in Fallen Angels	46.75%				

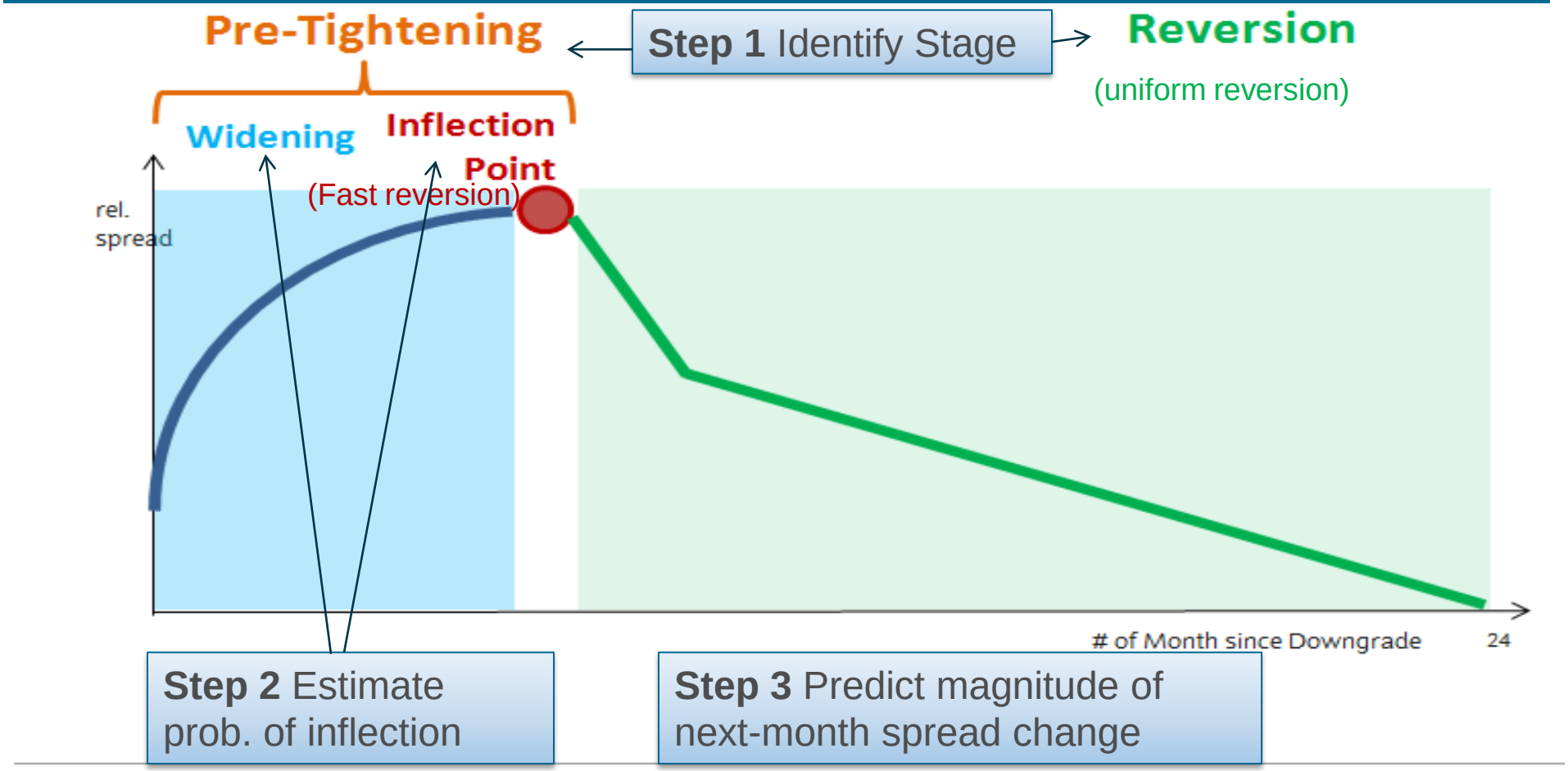
Note: The returns for the portfolios' peer group were computed as the equal–weighted performances of the individual bonds' peer groups . Sharpe Ratio was calculated using 1m Libor. Inf. ratio is the ratio of average and standard deviation of relative returns. Source: Barclays Research

Constructing the FAR Scores

How is FAR different from '3m Reversal'?

- The '3m Reversal' strategy uses average dynamics of all FAs
- FAR scores take into account each FA specific characteristics
- FAR offers a ranking for each FA and allows more flexibility in selecting FAs

Fallen Angels Reversal Cycle After Downgrade



Source: Barclays Research

FAs with Higher FAR Scores Outperformed Peers More

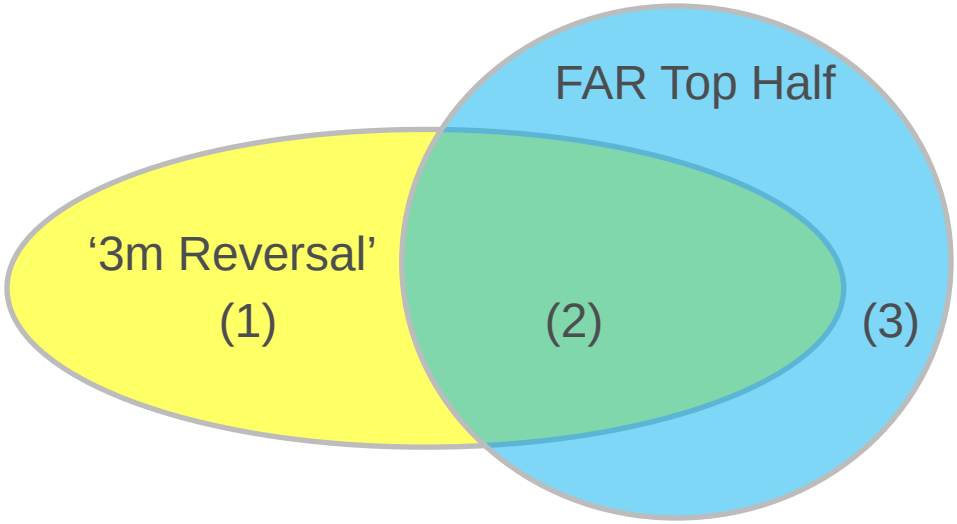
Ret. over Peers of Top and Bottom Portfolios Ranked on FAR Scores

		Top / Bottom Half Portfolios Sorted on								
		Rel. OAS			Rel. OAS / rm			FAR Scores		
		Bottom Half	Top Half	Top Half - Bottom Half	Bottom Half	Top Half	Top Half - Bottom Half	Bottom Half	Top Half	Top Half - Bottom Half
Jul. 2010 - Dec. 2014 (Ben Dor and Xu 2015 update)	Average (%/yr)	1.79	4.46	2.67	0.59	5.67	5.07	0.95	5.33	4.38
	Volatility (%/yr)	3.01	6.16	5.42	4.01	5.72	5.73	4.25	4.96	4.55
	Inf. Ratio (Ann.)	**0.59**	**0.72**	**0.49**	**0.15**	**0.99**	**0.89**	**0.22**	**1.08**	**0.96**
	Worst Monthly Ret.(%)	-2.02	-5.40	-5.36	-3.87	-5.58	-5.73	-3.78	-3.91	-2.38
	Max. DD (%)	-3.62	-11.16	-8.69	-6.69	-9.21	-7.84	-7.81	-7.39	-4.45
Jan. 2015 - Dec. 2018	Average (%/yr)	7.09	13.44	6.34	7.28	13.26	5.98	5.68	14.84	9.17
	Volatility (%/yr)	7.85	16.56	13.40	8.31	16.04	12.64	9.88	15.02	12.32
	Inf. Ratio (Ann.)	**0.90**	**0.81**	**0.47**	**0.88**	**0.83**	**0.47**	**0.57**	**0.99**	**0.74**
	Worst Monthly Ret.(%)	-4.92	-8.75	-9.29	-4.47	-8.62	-9.03	-8.52	-5.42	-6.54
	Max. DD (%)	-4.92	-20.91	-24.96	-4.47	-20.05	-23.90	-13.72	-11.70	-9.42

Note: all bonds were EW subject to a 10% cap. Excess capital will have a return over peers of 0. Universe is FA with positive spreads immediately following downgrades and for as long as rel. spreads are positive. Source: Trace, Bloomberg, Barclays Research

What is the value of FAR Scores given '3m Reversal'?

- FAR scores are useful in
  - ✓ Distinguishing better performing FAs within the '3m Reversal' strategy
  - ✓ Identifying profitable FAs not included in the '3m Reversal' strategy



Ret over peers in Sub-Samples (Jul. 2010 - Dec. 2018)			
Sub-sample	(1)	(2)	(3)
	In '3m Reversal' exclusively	In both '3m Reversal' and FAR top half	In FAR top half exclusively
Avg. Ret over peers (%/m)	0.53	1.27	1.72
Std. Dev. (%/m)	5.82	7.47	9.36
t-stat	3.08	5.8	3.84
1st Quartile	-1.3	-0.97	-2.04
Median	0.14	0.57	0.91
3rd Quartile	1.81	2.44	4.82
# of monthly obs.	1155	1163	404

T-tests of Avg Rets being equal in sub-samples (Jul. 2010 - Dec. 2018)		
Test	t-stat	p-value
Avg(1)=Avg(2)	2.66	0.008
Avg(1)=Avg(3)	2.40	0.017
Avg(2)=Avg(3)	0.87	0.382

Source: Trace, Bloomberg, Barclays Research

Restricted - External

Key takeaways

- ✓ FAR scores rank fallen angels on their expected reversal magnitude in the subsequent month
- ✓ FAR scores incorporate volume dynamics and identification of the stage of the reversion cycle of the fallen angel bonds and offer more flexibility than the '3m Reversal' strategy
- ✓ In July 2010 – Oct. 2018, the top half portfolio with higher FAR scores had higher return over peers in the subsequent months than the bottom half portfolio with lower FAR scores. The Inf. Ratio of top half over bottom half is 0.73
- ✓ Such outperformance of bonds with high FAR scores is persistent through time
- ✓ FAR scores can be used to enhance the '3m Reversal' strategy

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Barclays Bond-Level Measures of Liquidity:

Liquidity Cost Scores (LCS®)
Trade Efficiency Scores (TES)

31 January 2019

Restricted - External

LCS®: Liquidity Cost Scores

- LCS measures the cost of an *immediate, institutional-size, round-trip* transaction, expressed as a percent of the bond's price
- LCS is computed in two different but conceptually identical ways:

OASD × (Bid spread – Ask spread) *if quoted on spread*

or

(Ask price – Bid price)/Bid price *if quoted on price*

- Example
  - For a bond with an OASD of 5, a trader quotes a bid spread of 140bp and an ask spread of 125bp
  - Given the bid-ask spread of 15bp, the bond's LCS = 5 × 0.15 = 0.750%
  - In other words, an immediate, round-trip trade would cost 75bp of the bond's value

- LCS relies on simultaneous, bond-level, bid-ask quotes issued by Barclays traders
  - The quotes are mapped to bond-level indicative and analytical information
  - Econometric models are used to estimate LCS for bonds without trader quotes

Uniform Bond-Level Metric vs. Multiple Indirect Indicators

Investors and academics use various indicators/proxies of liquidity, such as:

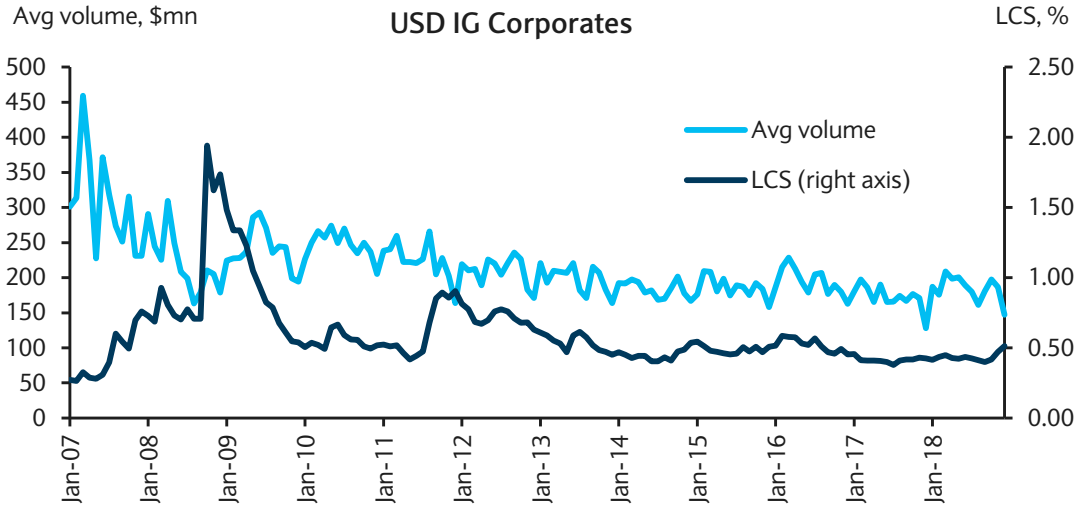
- Trading volume
- Issue size
- Age, maturity, etc.

Which do you expect to be the most liquid:

- a five-year old, $300mn issue with OAS of 200?
- a two-year old, $800mn issue with OAS of 400?
- a seasoned $1bn issue with one year to maturity and OAS of 100?

For example –

Trading volume, a frequently used proxy for liquidity, and transaction costs are often decoupled



Source: Barclays Research, TRACE

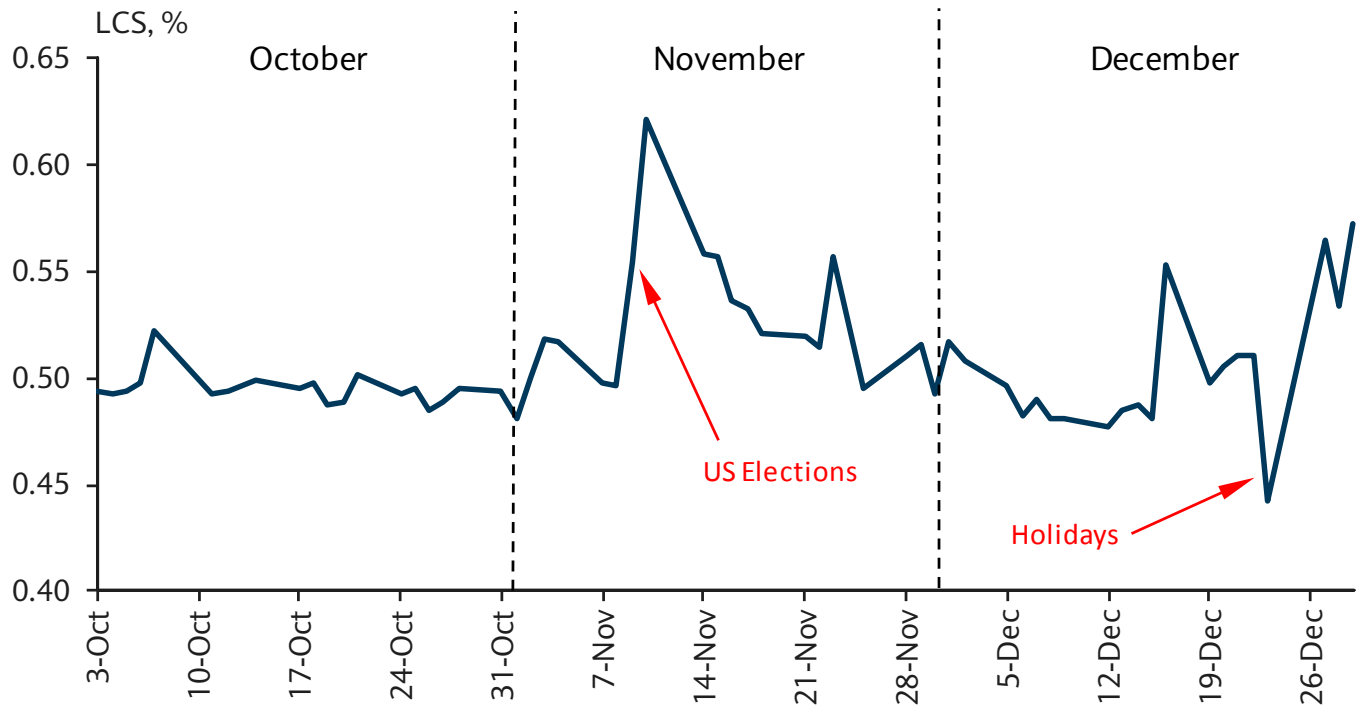
LCS Asset Class Coverage

- Launched in October 2009 for USD IG and HY corporate bonds (about 5,000 cusips at the time), with history available back to January 2007
- Currently, LCS is computed for more than 20,000 bonds

Index	Data since
USD Credit IG	Jan-07
USD Credit HY	Jan-07
USD IG Credit 144A (no registration rights)	Jan-07
USD Treasuries	Nov-09
USD TIPS	Jul-10
USD Fixed Rate Agency MBS	Mar-10
USD Emerging Markets	Feb-12
Pan Euro Credit IG	May-10
Pan Euro Credit HY	May-10
Pan Euro Credit FRN	May-10
GBP Corporate 100–200mm Amt Outstand	May-10
Pan Euro Agencies	May-10
Pan Euro Local Authorities	May-10
Pan Euro Treasuries	Feb-11
Pan Euro Inflation Linked	Mar-11
Global Covered Bonds	Sep-12
JPY Treasuries	Sep-13

- *LCS Extended Coverage Models* for non-index USD Credit and EM bonds, as well as for USD agency ABS and CMBS

Daily LCS: USD and EUR Corporates, USD Emerging Markets

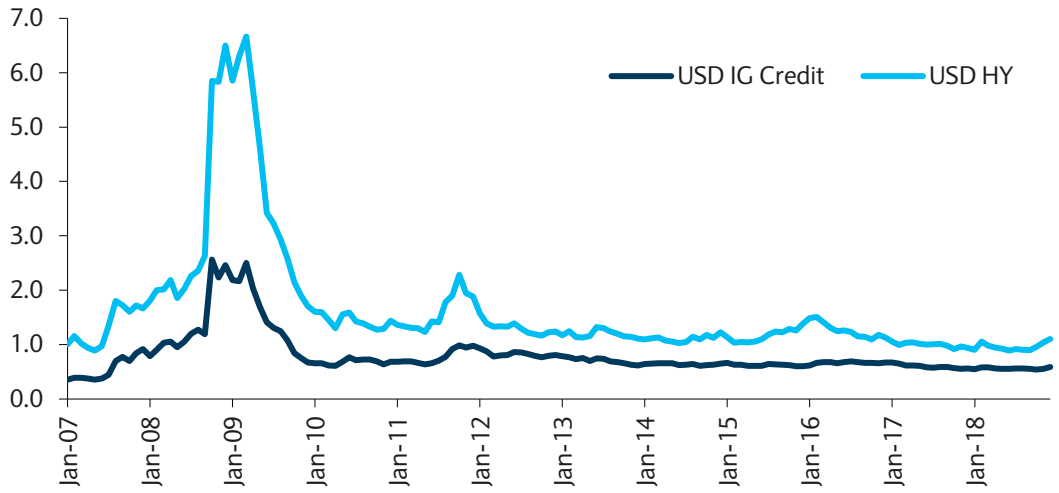


Source: Barclays Research

- Provide insights unavailable on the monthly basis (at best, delayed until month-end)
- Computed on liquid market segments consisting of actively-quoted bonds
- Approximate average daily bond universe
  - USD Corporate: 1,700 IG; 700 HY
  - EUR Corporate: 2,000 IG; 350 HY
  - USD EM: 1,200 IG; 500 HY

LCS Applications: Analysis of Market Liquidity Trends

USD Credit, January 2007 – December 2018

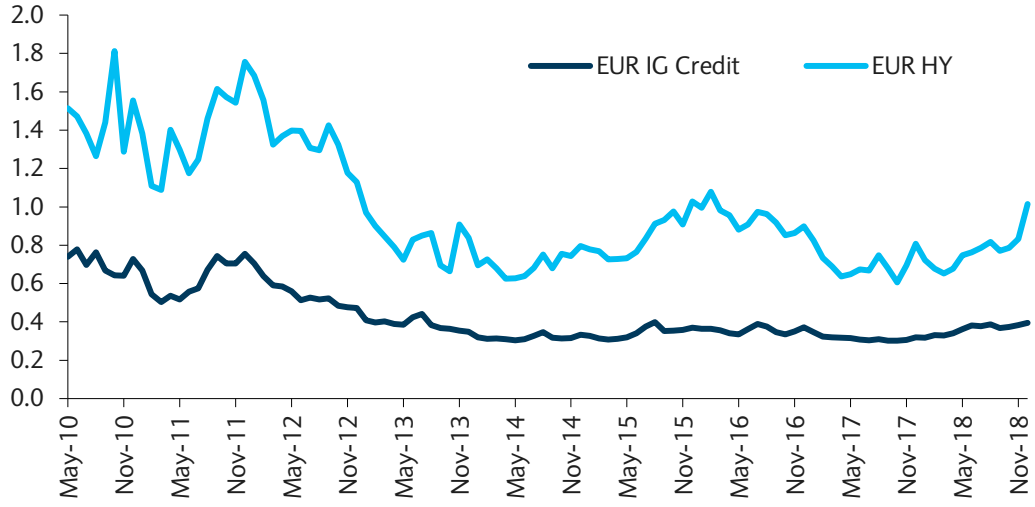


Source: Barclays Research

HY LCS is consistently larger than IG LCS, confirming its higher risk and lower liquidity

Both time series exhibit fluctuations consistent with investors' perceptions of liquidity conditions

EUR Credit, May 2010 – December 2018

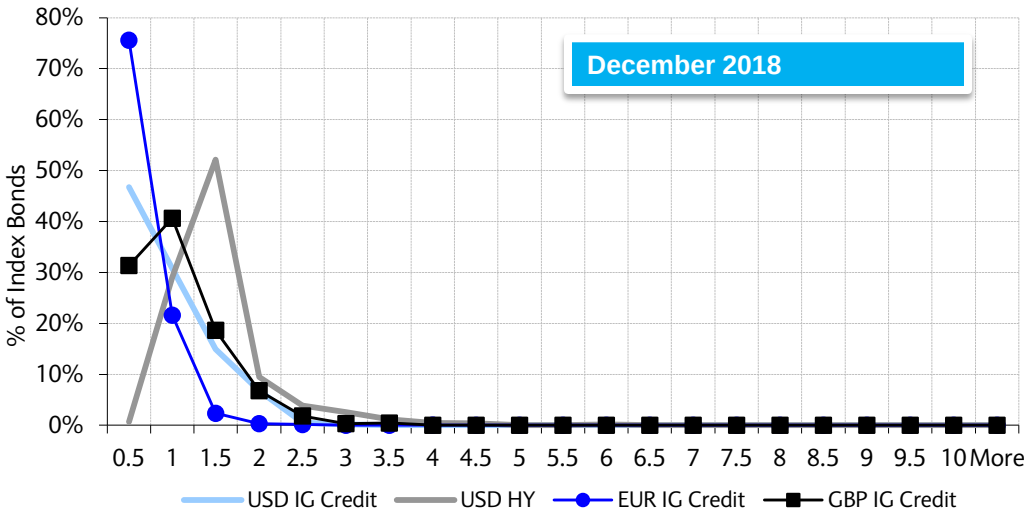


Source: Barclays Research

Note:

When comparing LCS across markets, it is important to take into consideration potentially different market attributes, eg, typical bond duration, age, issue size, etc.

LCS Applications: Cross-Sectional Market Liquidity Analysis



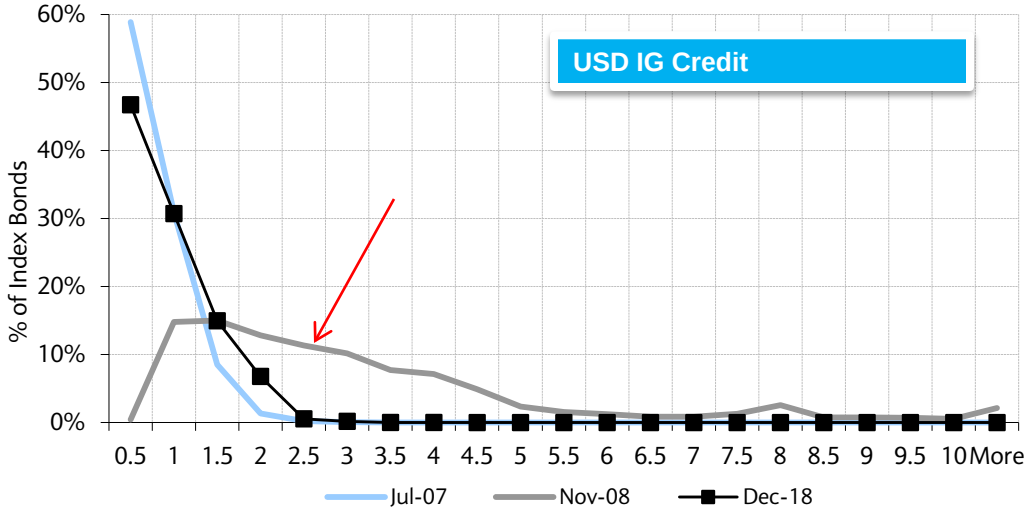
Source: Barclays Research

A more detailed picture of different markets – beyond aggregate LCS level comparisons

The frequency distribution highlights the high liquidity of 2007

A very different picture in Nov 2008

Since Nov 2008, the distributions have been drifting back to the 2007 pattern



Source: Barclays Research

LCS Applications: Insights into Drivers of Liquidity

Average LCS by Issue Size and Age. USD IG Credit

Maturity: 1-5 (41.7% MV)

Size, $mn	Age, yr <1	1-5	5-7.5	7.5+
<500	0.39	0.36	0.47	0.30
500-750	0.34	0.31	0.39	0.25
750-1,500	0.28	0.26	0.36	0.23
1,500-2,000	0.26	0.21	0.42	0.19
2,000-3,000	0.22	0.21	0.35	0.22
>3,000	0.20	0.19	0.32	

Maturity: 5-10 (28.2% MV)

Size, $mn	Age, yr <1	1-5	5-7.5	7.5+
<500	0.71	0.69		0.77
500-750	0.65	0.64	0.73	0.90
750-1,500	0.55	0.55	0.48	0.51
1,500-2,000	0.51	0.47		
2,000-3,000	0.40	0.43		
>3,000	0.41	0.36		

Maturity: 10+ (30.1% MV)

Size, $mn	Age, yr <1	1-5	5-7.5	7.5+
<500	1.29	1.43	1.38	1.15
500-750	1.15	1.36	1.33	1.16
750-1,500	0.98	1.18	1.20	1.11
1,500-2,000	0.82	0.99	1.16	0.99
2,000-3,000	0.85	0.95		0.94
>3,000	0.79	0.84		

Maturity: All

Size, $mn	Age, yr <1	1-5	5-7.5	7.5+
<500	0.81	0.84	0.77	0.90
500-750	0.66	0.72	0.74	0.81
750-1,500	0.53	0.55	0.63	0.75
1,500-2,000	0.52	0.48	0.60	0.70
2,000-3,000	0.38	0.48	0.56	0.69
>3,000	0.41	0.38	0.43	0.60

Buckets with fewer than 10 bonds are not shown

Predictable gradients:

Bond age - Newer issues are more liquid

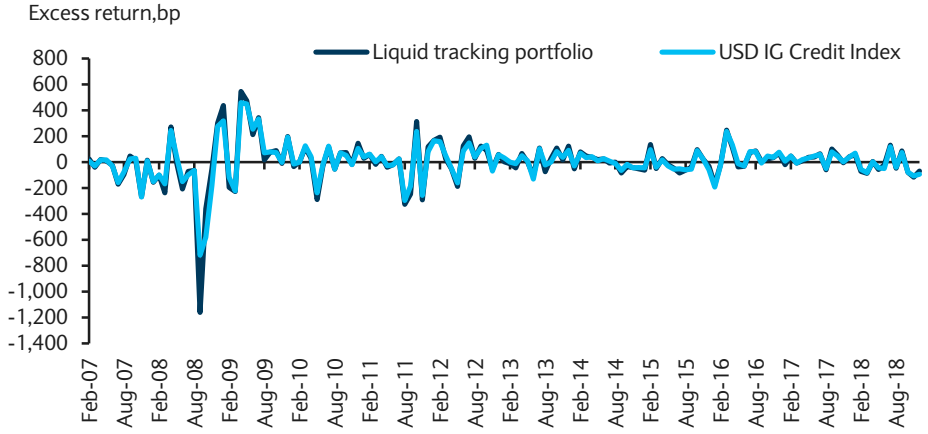
Outstanding – Larger issues are more liquid

Source: Barclays Research

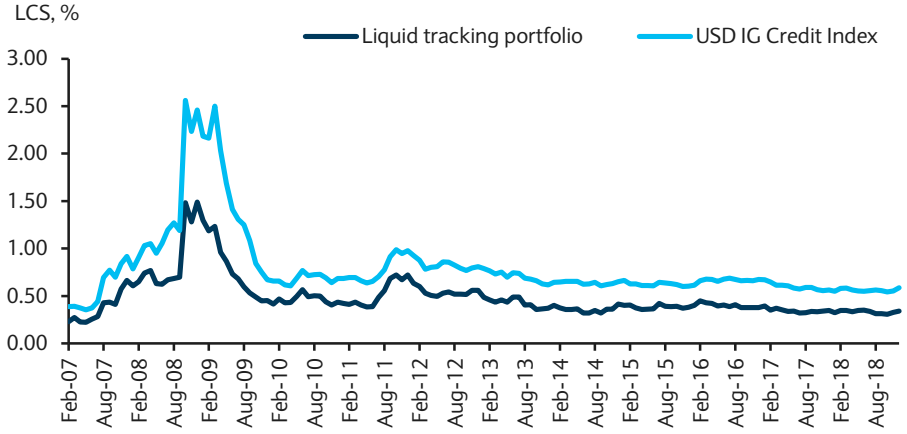
LCS Applications: Structuring Liquid Tracking Portfolios

	USD Credit	USD Long Credit	USD Corporate	EUR Credit	EUR Corporate	USD EM Corp
Inception	Feb-07	Feb-07	Feb-07	Jun-10	Aug-10	Feb-12
# of bonds	50	36	50	48	40	28
Rebalancing	Monthly	Monthly	Quarterly	Monthly	Quarterly	Monthly
	Dec 2018			Dec 2018		
LCS	0.342	0.727	0.516	0.220	0.249	0.647
Index LCS	0.588	1.074	0.634	0.394	0.369	0.864
	Since January 2009			Since inception		
Avg. monthly TE	-1.6	1.7	-1.4	1.5	-1.4	-8.3
TEV	50.1	37.7	49.9	12.3	24.4	47.0
Index ExcRet Vol	142.5	241.4	160.6	75.3	85.5	141.3

Source: Barclays Research



Source: Barclays Research

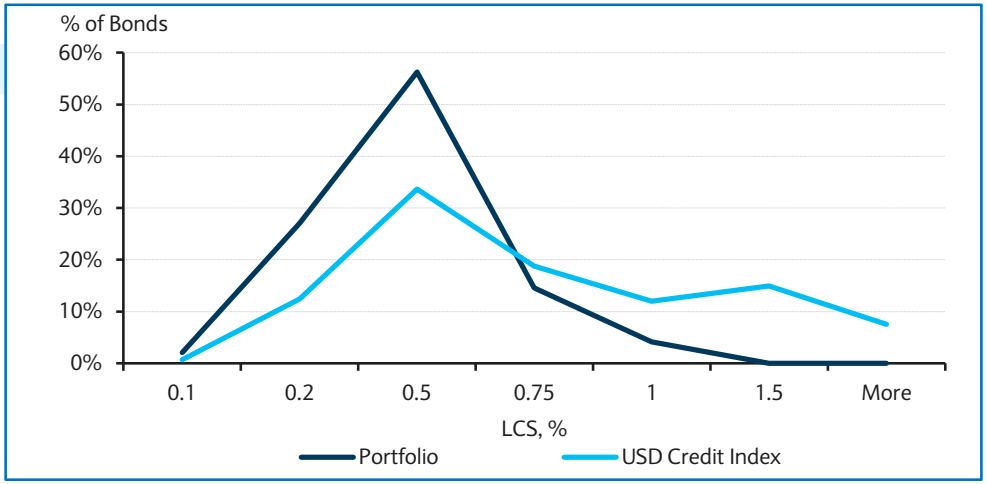


Source: Barclays Research

LCS Applications: Portfolio vs. Benchmark Comparisons

	Market Value [%]		Liquidity Cost Score [%]		DTS	
	Portfolio	USD Credit	Portfolio	USD Credit	Portfolio	USD Credit
12/31/2018			**0.342**	**0.587**	**11.51**	**11.87**
SUPRANATIONAL	2.99	5.05	0.188	0.186	1.15	0.34
SOVEREIGN	9.43	3.19	0.369	0.514	20.71	15.76
AGENCIES	9.79	7.96	0.136	0.381	1.88	9.09
INDUSTRIAL	50.45	50.41	0.380	0.640	13.50	13.97
UTILITY		6.05		1.045		15.37
FINANCIAL	27.34	27.35	0.354	0.531	9.23	9.70
5/31/2018			**0.348**	**0.554**	**9.25**	**9.35**
SUPRANATIONAL		5.22		0.183		0.23
SOVEREIGN	5.50	3.17	0.393	0.546	21.43	14.48
AGENCIES	13.98	8.20	0.172	0.426	1.61	7.64
INDUSTRIAL	50.73	50.73	0.410	0.613	10.74	10.94
UTILITY	3.01	5.90	0.713	0.981		
FINANCIAL	26.78	26.78	0.273	0.461		

Source: Barclays Research



Source: Barclays Research

LCS Applications: Portfolio Optimization

POINT 3.17.9.5

File Edit View Tools Actions Window Help

New Open Transact

POINT® Today | Liq opt

Portfolio Explorer

As of 1/9/2018

Benchmark	(none)
Base Currency	USD
Partition	(none)
Scenario Result Set	(none)
Access	Read-only for Others
Pricing Set	Private,BarCap,BarCap No...

Positions [100 positions]
Summary
Transaction History
Scenario Analysis
Cashflows
Risk Model
Optimizer

New Help

Optimizer Report 1

Performance Attribution
Performance
Reports
Notes & Attachments

Currency: USD - United States Dollar **As of:** Previous Close Run Cancel

Benchmark: US Credit Corp (System) **Faq** **Help**

Asset Allocation Benchmark: None ☑ Commit Trades after Run

Profile: DefaultProfile*

Tradable Universe Options

No.	Name	Type	Trade/Buy/Sell	Long/Short
1	Initial Portfolio	Initial Portfolio	Buy and Sell	Long Only

Risk Model Options Monthly, Weighted, Basis Points

Normalization

Returns (bps) P&L (currency) Benchmark MV Do not scale Scale (Amount) Scale (Percent) ScaleTo:

Objectives (Robust Optimization available)

Minimize Maximize

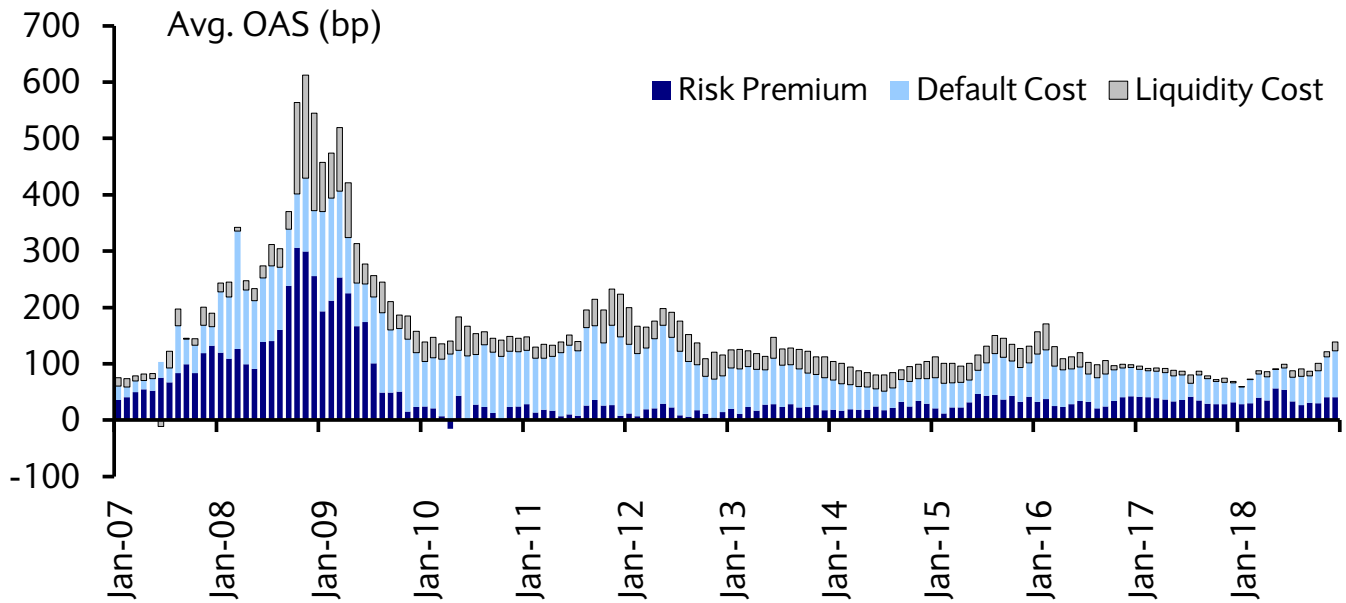
No.	Attribute	Measure	Weight	Unit	Initial Value	R
1	Liquidity Cost Score		1.000	decimal		

Common Constraints

Final Portfolio Cash (base currency): Long/Short Long Only Short Only No Cash

Ready

LCS Applications: Spread Decomposition



Source: Barclays Research

- Spreads are largely explained by three variables: a market-wide risk premium; expected default cost; and (il)liquidity premium
- Application examples:
  - Buy-and-hold investors can ride out periods of low liquidity and high market risk. But if the wide spreads owe to an increase in expected default losses, they may take action
  - Active managers may take short-term exposure to bonds with a high default component but avoid those with a high liquidity component

Relative Liquidity Metric: Trade Efficiency Score (TES)

- LCS is an absolute measure of liquidity
  - Difficult to compare bonds' relative liquidity across diverse market environments
- TES is a bond-level, *intra-market*, relative liquidity rank, combining cost and flow:
  - Transaction cost per unit of duration; and
  - Trading volume
- Each month, bonds are sorted into LCS quintiles (1 lowest – 5 highest) and volume deciles (1 highest – 10 lowest); and mapped onto one TES score ranging from 1 (best) to 10 (worst)

LCS Quintile + Trading Volume Decile	TES
2 and 3	1
4 and 5	2
6	3
7	4
8	5
9	6
10	7
11	8
12	9
13-15	10

TES Buckets Statistics, USD Corporate Index, Dec 2018

Vol Decile + LCS Quintile	TES	# bonds	# bonds %	MV %	Age, yr	Issue size mn	OAS, bp	OASD	LCS, %	Vol, mn
2 and 3	1	803	13.77	29.25	2.5	1,880	154	8.06	0.505	177
4 and 5	2	743	12.74	16.19	3.3	1,113	146	6.84	0.546	54
6	3	493	8.45	9.32	4.4	960	156	6.69	0.650	50
7	4	493	8.45	8.12	4.2	831	155	6.17	0.616	32
8	5	468	8.03	7.00	4.7	756	157	7.02	0.698	22
9	6	528	9.06	6.83	4.7	649	148	6.81	0.696	15
10	7	538	9.23	6.52	5.2	604	150	6.80	0.703	10
11	8	502	8.61	5.28	5.7	522	156	7.35	0.785	6
12	9	450	7.72	4.47	6.5	485	157	7.39	0.873	4
13-15	10	813	13.94	7.00	7.5	415	161	7.42	0.913	2

LCS is Not a Research Offering from the Regulatory Standpoint

- **Quantitative Portfolio Strategies**
  - QPS Abstracts
  - QPS FICC
  - QPS Equity
  - QPS Analytics
    - White Papers
    - Periodic Reports
      - LCS (Liquidity Cost Scores) Weekly
      - LCS (Liquidity Cost Scores) Monthly
    - Data
      - LCS (Liquidity Cost Scores) Daily
      - LCS (Liquidity Cost Scores) Monthly
      - LCS (Liquidity Cost Scores) Annual

Research publications

Data and reports (paid subscription)

Monthly LCS Data

- On the first business day of each month, a new file is ready for download
- Two delivery platforms: Dedicated SFTP and Barclays Live download

31-Dec-18								
Contact: Vadim Konstantinovsky, vkonstan@barclays.com								
ISIN	CUSIP	LCS	TESUSDCORP	TESUSDHY	TESEURCORP	TESEURHY	TESUSDEM	TESCOV
AT000B049507		0.081047439						6
AT000B092622		0.117625475						6
AT000B093273		0.297957008						2
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AT0000A1LHT0		0.30194845			8			
AT0000A20F93		1.450725232				10		
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US01609WAS17	01609WAS	0.259275975					4	
US01609WAT99	01609WAT	0.45913735					1	
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G2SF 4.5 2009 Mtge	GNB04409	0.076151104						
G2SF 4.5 2010 Mtge	GNB04410	0.076149577						
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Source: Barclays Research

Daily LCS Data

- Each Monday morning, the previous week's data are ready for download: USD and EUR Corp, USD EM

Barclays Liquidity Cost Scores (LCS®), %

Contact: Vadim Konstantinovsky, *vkonstan@barclays.com*

14-Jan-19

	Investment Grade USD Corporates									High Yield USD Corporates								
	All	Industry sectors					Quality ratings			All	Industry sectors					Quality ratings		
Date		Financial	Basic Industry	Consumer	Technology	Energy & Utility	Aaa-Aa	A	Baa		Financial	Basic Industry	Consumer	Technology	Energy & Utility	Ba	B	Caa-C
11/15/2018	0.500	0.500	0.664	0.458	0.459	0.514	0.368	0.455	0.555	0.948	0.817	0.938	0.915	0.929	1.246	0.855	0.913	1.339
11/16/2018	0.476	0.434	0.671	0.418	0.477	0.506	0.336	0.419	0.534	0.949	0.811	0.963	0.923	0.927	1.110	0.863	0.950	1.256
11/19/2018	0.457	0.374	0.634	0.423	0.540	0.524	0.354	0.398	0.534	0.944	0.828	0.958	0.915	0.902	1.082	0.871	0.928	1.251
11/20/2018	0.463	0.389	0.655	0.421	0.565	0.490	0.344	0.409	0.540	0.920	0.884	0.939	0.894	0.838	1.142	0.851	0.883	1.278
11/21/2018	0.589	0.584	0.706	0.460	0.744	0.349	0.495	0.577	0.613	0.952	0.853	0.954	0.903	0.909	1.130	0.861	0.944	1.254
11/23/2018	0.398	0.436	0.575	0.264	0.281		0.247	0.362	0.478	1.050	0.885	0.996	0.999		1.171	0.926	1.041	1.681
11/26/2018	0.507	0.453	0.661	0.462	0.549	0.540	0.423	0.452	0.566	0.910	0.836	0.907	0.915	0.833	1.121	0.836	0.911	1.187
11/27/2018	0.528	0.479	0.682	0.424	0.654	0.540	0.451	0.481	0.575	0.903	0.852	0.932	0.886	0.814	1.162	0.830	0.884	1.222
11/28/2018	0.502	0.450	0.652	0.403	0.593	0.540	0.415	0.447	0.566	0.932	0.853	0.975	0.902	0.877	1.167	0.850	0.935	1.222
11/29/2018	0.527	0.469	0.650	0.407	0.709	0.538	0.485	0.468	0.579	0.905	0.875	0.973	0.874	0.805	1.182	0.852	0.893	1.178
11/30/2018	0.506	0.407	0.642	0.413	0.703	0.511	0.456	0.426	0.571	0.881	0.880	0.928	0.868	0.803	1.244	0.837	0.850	1.160
12/3/2018	0.562	0.601	0.707	0.493	0.545	0.558	0.477	0.558	0.581	0.903	0.903	0.929	0.864	0.831	1.117	0.858	0.886	1.156
12/4/2018	0.558	0.582	0.684	0.469	0.579	0.535	0.469	0.536	0.592	0.863	0.919	0.890	0.834	0.811	1.009	0.842	0.850	1.010
12/6/2018	0.602	0.484	0.758	0.571	0.740	0.718	0.496	0.523	0.693	0.953	0.931	1.024	0.891	0.906	1.160	0.896	0.947	1.207
12/7/2018	0.533	0.396	0.778	0.481	0.769	0.547	0.442	0.444	0.631	0.959	0.953	0.957	0.937	0.877	1.254	0.915	0.921	1.383
12/10/2018	0.528	0.452	0.739	0.466	0.609	0.601	0.410	0.476	0.604	0.913	0.938	0.953	0.863	0.874	1.050	0.880	0.896	1.110
12/11/2018	0.489	0.450	0.705	0.455	0.390	0.598	0.355	0.437	0.560	0.900	0.939	0.895	0.843	0.849	1.165	0.851	0.873	1.175
12/12/2018	0.455	0.358	0.749	0.429	0.392	0.575	0.318	0.378	0.541	0.887	0.929	0.887	0.848	0.836	1.119	0.854	0.853	1.155
12/13/2018	0.493	0.403	0.686	0.441	0.578	0.580	0.414	0.432	0.558	0.893	0.923	0.893	0.852	0.828	1.114	0.860	0.869	1.124
12/14/2018	0.540	0.463	0.712	0.459	0.600	0.611	0.427	0.519	0.581	0.895	0.869	0.910	0.870	0.853	1.037	0.843	0.877	1.174
12/17/2018	0.526	0.398	0.770	0.511	0.599	0.593	0.418	0.456	0.599	0.903	0.869	1.014	0.892	0.838	1.002	0.848	0.896	1.159
12/18/2018	0.494	0.402	0.554	0.509	0.600	0.494	0.423	0.428	0.561	0.952	0.902	1.064	0.894	0.879	1.296	0.878	0.921	1.312
12/19/2018	0.529	0.409	0.724	0.504	0.613	0.606	0.425	0.461	0.602	0.952	0.907	1.127	0.908	0.900	1.099	0.889	0.952	1.242
12/20/2018	0.548	0.447	0.742	0.557	0.624	0.498	0.482	0.455	0.627	1.037	1.002	1.106	1.011	1.021	1.271	0.955	1.024	1.406
12/21/2018	0.597	0.424	0.798	0.638	0.761	0.489	0.576	0.465	0.705	1.055	1.025	1.045	1.022	1.084	1.081	0.967	1.081	1.367
12/24/2018	0.930	0.784	0.794	1.033	0.641		0.637	0.718	1.027	1.053	1.026	0.916	0.966	1.214		0.967	1.051	1.293
12/26/2018	0.584	0.316	0.814	0.918	0.662	1.073	0.393	0.481	0.740	1.158	0.755	1.115	1.074	1.160	2.288	1.017	1.138	1.799
12/27/2018	0.704	0.673	0.954	0.346	0.870	1.091	0.777	0.634	0.751	1.153	0.882	1.079	1.080	1.187	2.283	1.063	1.137	1.763
12/28/2018	0.786	0.798	0.839	1.080	0.604	0.696	0.697	0.737	0.822	1.114	0.920	1.117	1.039	1.158	2.303	0.981	1.125	1.502
12/31/2018	0.487	0.448	0.858	0.300	0.549	0.700	0.355	0.440	0.564	1.114	1.029	1.168	1.051	1.083	1.252	0.986	1.145	1.507
1/2/2019	0.567	0.483	0.850	0.575	0.604	0.598	0.454	0.507	0.640	1.083	1.016	1.111	1.031	1.070	1.235	0.987	1.102	1.435
1/3/2019	0.555	0.502	0.746	0.519	0.598	0.581	0.462	0.509	0.614	1.031	0.985	1.066	0.985	1.026	1.158	0.962	1.033	1.312
1/4/2019	0.563	0.510	0.731	0.538	0.599	0.592	0.457	0.514	0.626	1.049	0.961	1.085	1.011	1.035	1.273	0.961	1.058	1.364
1/7/2019	0.551	0.485	0.734	0.530	0.597	0.605	0.456	0.499	0.612	1.004	0.949	0.998	0.963	1.020	1.215	0.932	1.013	1.244
1/8/2019	0.551	0.484	0.757	0.537	0.592	0.593	0.445	0.495	0.618	0.970	0.911	1.024	0.929	0.936	1.111	0.907	0.969	1.270
1/9/2019	0.558	0.513	0.745	0.523	0.592	0.570	0.458	0.513	0.611	0.949	0.894	1.002	0.915	0.909	1.098	0.888	0.951	1.215
1/10/2019	0.557	0.500	0.717	0.536	0.595	0.605	0.458	0.500	0.623	0.942	0.879	0.999	0.917	0.898	1.123	0.897	0.927	1.195
1/11/2019	0.553	0.541	0.750	0.519	0.554	0.533	0.492	0.512	0.595	0.918	0.860	1.000	0.866	0.854	1.118	0.879	0.910	1.123

Source: Barclays Research

Market Liquidity Monitors and Liquidity-Related Research

BARCLAYS

Quantitative Portfolio Strategy
24 July 2015

Measuring Bond-Level Liquidity: Liquidity Cost Scores (LCS)

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- In 2009, Barclays introduced Liquidity Cost Scores (LCS) for USD credit bonds, a bond-level liquidity measure. LCS is defined as the cost of a standard, institutional-size, round-trip transaction and is expressed as a percentage of the bond's price. LCS can be aggregated across bonds in a portfolio, as well as compared over time and vs. a
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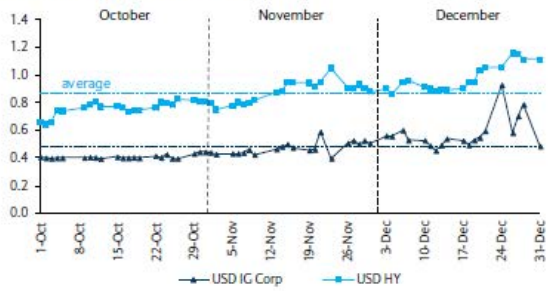
LCS® Report – December 2018

FIGURE 1
Daily LCS, USD IG and HY Corporates, %



Daily LCS are computed using a universe of the most-frequently quoted bonds that do not undergo any model adjustments, unlike many bonds in broad indices, which see much less activity. Hence, Daily LCS tend to be lower than the monthly values reported in Figure 2.
Source: Unless stated otherwise, the source for all figures is Barclays Research.

The usual holiday season slowdown in December was reflected in higher LCS across credit markets in the US and Europe (Figure 2). Trading volume was significantly lower with the declines ranging from 20 to 50% (Figure 5).

There was also a very significant deterioration of liquidity in the European government debt markets, especially inflation-linked (Figure 6). The two most liquid nominal government debt markets in Europe were Germany and France (Figure 7).

FIGURE 2
LCS for Various Markets, by Sector, %

	Current Month	-1m	-3m			
USD IG Credit Index*	0.587	0.552	0.558			
Industrials	0.640	0.607	0.606			
Utilities	1.045	0.962	1.010			
Financial Institutions	0.531	0.471	0.473			
Non-corporate	0.346	0.365	0.370			
USD HY Index	1.103	1.040	0.899			
Industrials	1.110	1.051	0.904			
Utilities	1.035	1.030	0.871			
Financial Institutions	1.047	0.936	0.862			
USD EM Index	0.722	0.696	0.730			
Non-corporate	0.676	0.654	0.685			
Industrials	0.881	0.822	0.810			
Financial Institutions	0.829	0.819	1.010			
EUR IG Credit Index	0.394	0.384	0.367			
Industrials	0.394	0.386	0.373			
Utilities	0.401	0.405	0.409			
Financial Institutions	0.329	0.315	0.334			
Non-corporate	0.455	0.443	0.381			
EUR HY Index	1.015	0.832	0.770			
Industrials	1.071	0.867	0.788	0.782	0.876	0.874
Utilities	0.742	0.571	0.662	0.490	0.799	0.675
Financial Institutions	0.801	0.708	0.710	0.724	0.563	1.032
Global Covered Bonds	0.227	0.217	0.238	0.233	0.239	0.251

* Throughout this report, "index" refers to Bloomberg Barclays bond indices

Current and historical bond-level LCS and TES data are available for download with an annual subscription. Please contact us for details.

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BARCLAYS

Quantitative Portfolio Strategy
Analytics
7 January 2019

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Weekly LCS Monitor, December 31-January 4

NEW: We are introducing Daily LCS for USD Emerging Markets (page 3)

USD Corporates

FIGURE 1
Daily LCS, USD IG and HY Corporates, %

FIGURE 2
Daily LCS and Bond Universe Statistics, USD IG and HY Corporates

Inv. Grade	31-Dec	1-Jan	2-Jan	3-Jan	4-Jan
# bonds	1,196	-	1,900	1,873	1,815
Financial	609	-	645	621	553
Basic Indust.	129	-	183	213	213
Consumer	234	-	490	438	461
Technology	6	-	317	319	317
Energy & Util.	218	-	265	282	271
Aaa-Aa	105	-	193	188	187
A	512	-	703	699	651
Baa	579	-	1,004	986	977
Avg LCS	0.487	-	0.567	0.555	0.563
Financial	0.448	-	0.483	0.502	0.510
Basic Indust.	0.858	-	0.850	0.746	0.731
Consumer	0.300	-	0.575	0.519	0.538
Technology	0.549	-	0.604	0.598	0.599
Energy & Util.	0.700	-	0.598	0.581	0.592
Aaa-Aa	0.355	-	0.454	0.462	0.457
A	0.440	-	0.507	0.509	0.514
Baa	0.564	-	0.640	0.614	0.626
MV%					
Financial	60.1%	-	37.5%	37.3%	35.3%
Basic Indust.	7.8%	-	6.7%	8.3%	8.4%
Consumer	18.2%	-	25.4%	22.6%	24.3%
Technology	0.8%	-	20.3%	20.9%	21.3%
Energy & Util.	13.1%	-	10.1%	10.9%	10.6%
Aaa-Aa	8.8%	-	11.5%	11.7%	11.8%
A	47.3%	-	38.8%	39.4%	38.4%
Baa	44.0%	-	49.7%	48.9%	49.7%

High Yield	31-Dec	1-Jan	2-Jan	3-Jan	4-Jan
# bonds	611	-	760	743	719
Financial	19	-	73	72	72
Basic Indust.	116	-	145	131	143
Consumer	203	-	239	238	232
Technology	119	-	159	181	181
Energy & Util.	154	-	144	121	91
Ba	269	-	357	346	326
B	258	-	311	309	304
Caa-C	84	-	92	88	89
Avg LCS	1.114	-	1.083	1.031	1.049
Financial	1.029	-	1.016	0.985	0.961
Basic Indust.	1.168	-	1.111	1.066	1.085
Consumer	1.051	-	1.031	0.985	1.011
Technology	1.083	-	1.070	1.026	1.035
Energy & Util.	1.252	-	1.235	1.158	1.273
Ba	0.986	-	0.987	0.962	0.961
B	1.145	-	1.102	1.033	1.058
Caa-C	1.507	-	1.435	1.312	1.364
MV%					
Financial	4.2%	-	10.0%	10.1%	10.4%
Basic Indust.	15.3%	-	16.2%	14.8%	16.7%
Consumer	34.6%	-	32.1%	32.5%	32.7%
Technology	27.3%	-	27.3%	30.5%	31.5%
Energy & Util.	18.5%	-	14.4%	12.2%	8.8%
Ba	46.0%	-	48.3%	47.3%	46.1%
B	42.4%	-	40.9%	41.4%	42.3%
Caa-C	11.6%	-	10.8%	11.3%	11.6%

Note: Daily LCS are computed using a universe of the most-frequently quoted bonds that do not undergo any model adjustments, unlike many bonds in broad indices, which see much less activity. Hence, Daily LCS tend to be lower than monthly values. See *Introducing Daily LCS*, February 2015, Barclays Cross Asset Research.
Source for all figures: Barclays Research

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