# 50 Years of Z-Score: What Have We Learned and Where Are We in the Credit Cycle?

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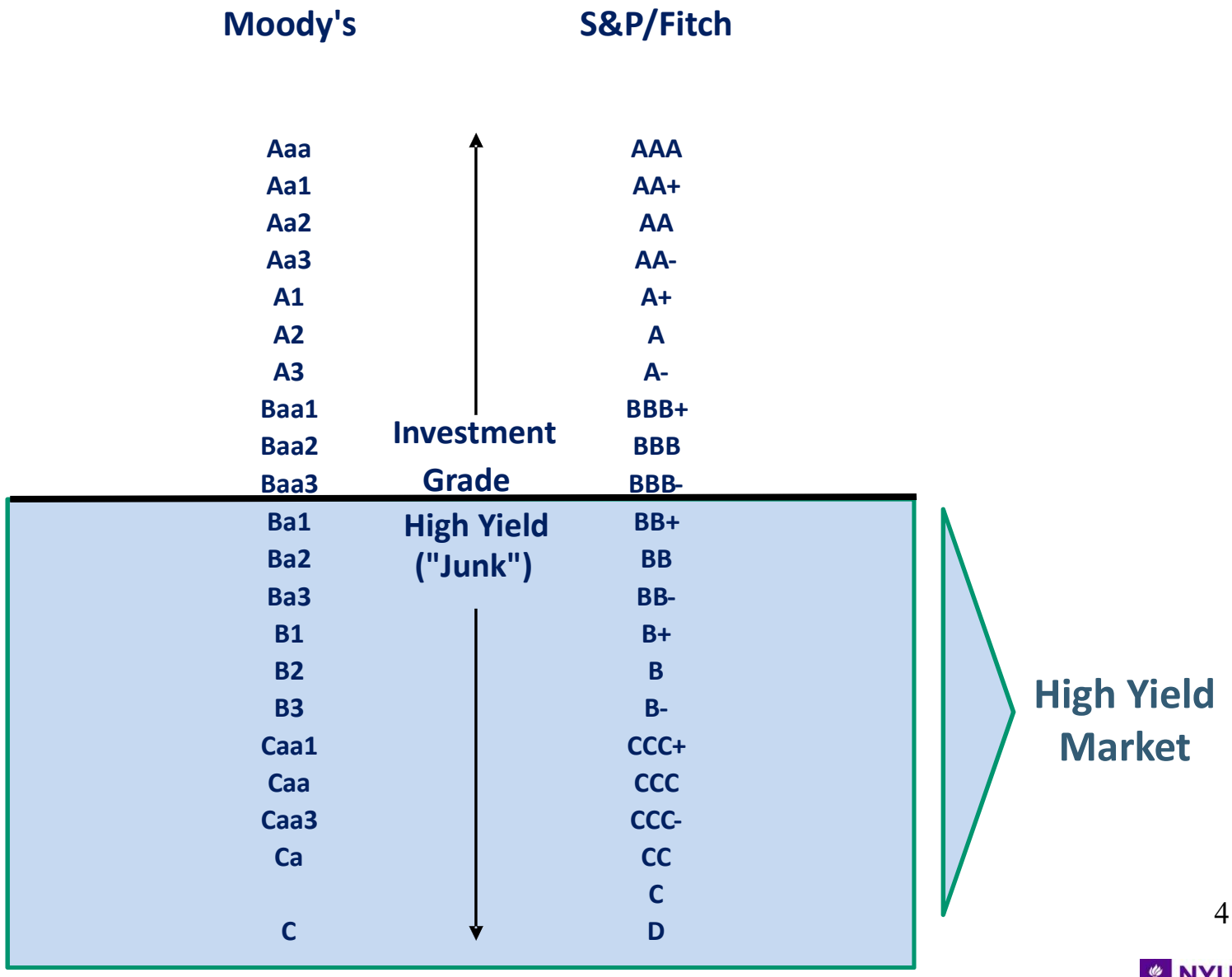
# Scoring Systems

- Qualitative (Subjective) – 1800s
- Univariate (Accounting/Market Measures)
  - Rating Agency (e.g. *Moody's* (1909), *S&P Global Ratings* (1916) and Corporate (e.g., *DuPont*) Systems (early 1900s)
- Multivariate (Accounting/Market Measures) – 1968 (Z-Score) $\rightarrow$ Present
  - Discriminant, Logit, Probit Models (Linear, Quadratic)
  - Non-Linear and "Black-Box" Models (e.g., Recursive Partitioning, Neural Networks, 1990s), Machine Learning , Hybrid
- Discriminant and Logit Models in Use for
  - Consumer Models - *Fair Isaacs* (FICO Scores)
  - Manufacturing Firms (1968) – Z-Scores
  - Extensions and Innovations for Specific Industries and Countries (1970s – Present)
  - ZETA Score – Industrials (1977)
  - Private Firm Models (e.g., Z'-Score (1983), Z"-Score (1995))
  - EM Score – Emerging Markets (1995)
  - Bank Specialized Systems (1990s)
  - SMEs (e.g. Edmister (1972), Altman & Sabato (2007) & *Wiserfunding* (2016))
- Option/Contingent Claims Models (1970s – Present)
  - Risk of Ruin (Wilcox, 1973)
  - *KMVs* Credit Monitor Model (1993) – Extensions of Merton (1974) Structural Framework

# Scoring Systems
**(continued)**

- Artificial Intelligence Systems (1990s – Present)
  - Expert Systems
  - Neural Networks
  - Machine Learning
- Blended Ratio/Market Value/Macro/Governance/Invoice Data Models
  - Altman Z-Score (*Fundamental Ratios and Market Values)* – 1968
  - Bond Score (*Credit Sights*, 2000; RiskCalc *Moody's*, 2000)
  - Hazard (Shumway), 2001)
  - *Kamakura's* Reduced Form, Term Structure Model (2002)
  - Z-Metrics (Altman, et al, *Risk Metrics*©, 2010)
- Re-introduction of Qualitative Factors/FinTech
  - Stand-alone Metrics, e.g., Invoices, Payment History
  - Multiple Factors – Data Mining (Big Data Payments, Governance, time spent on individual firm reports [e.g., *CreditRiskMonitor's* revised FRISK Scores, 2017], etc.)

# Major Agencies Bond Rating Categories



# Z-Score (1968) Component Definitions and Weightings

| Variable | Definition | Weighting Factor |
|---|---|---|
| $X_1$ | $\frac{\text{Working Capital}}{\text{Total Assets}}$ | 1.2 |
| $X_2$ | $\frac{\text{Retained Earnings}}{\text{Total Assets}}$ | 1.4 |
| $X_3$ | $\frac{\text{EBIT}}{\text{Total Assets}}$ | 3.3 |
| $X_4$ | $\frac{\text{Market Value of Equity}}{\text{Book Value of Total Liabilities}}$ | 0.6 |
| $X_5$ | $\frac{\text{Sales}}{\text{Total Assets}}$ | 1.0 |

# Zones of Discrimination: Original Z - Score Model (1968)

| |
|---|
| Z > 2.99 - "Safe" Zone |
| 1.8 < Z < 2.99 - "Grey" Zone |
| Z < 1.80 - "Distress" Zone |

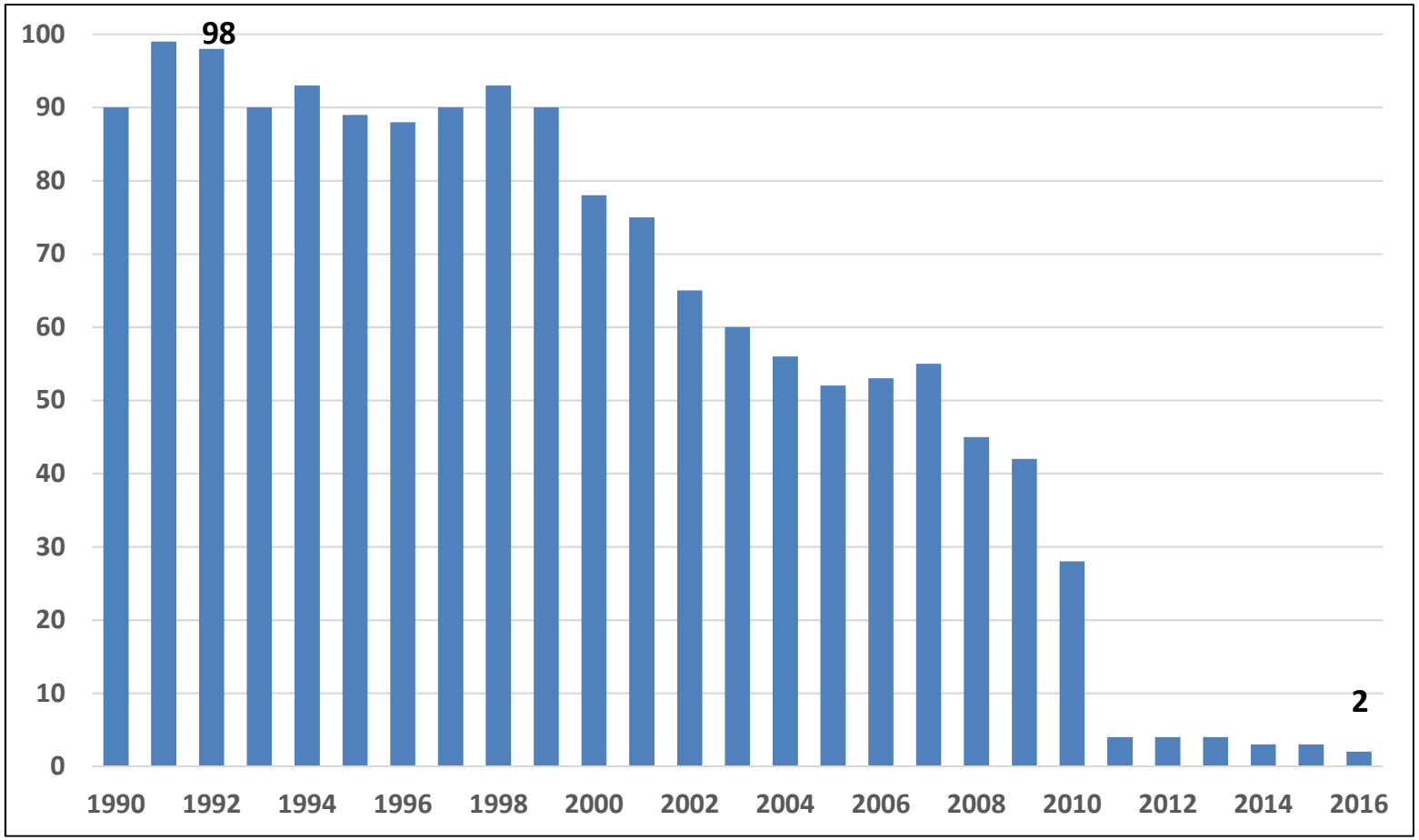
# Time Series Impact On Corporate Z-Scores

- Credit Risk Migration
  - Greater Use of Leverage
  - Impact of HY Bond & Lev Loan Markets
  - Global Competition
  - More and Larger Bankruptcies
  - Near Extinction of U.S. AAA Firms

- Increased Type II Error

# The Near Extinction of the U.S. AAA Rated Company

Number of AAA Rated Groups in the U.S.




Sources: Standard & Poor's, Estimated from Platt, E., "Triple A Quality Fades as Companies Embrace Debt", *Financial Times*, May 24, 2016.

# Estimating Probability of Default (PD) and Probability of Loss Given Defaults (LGD)

Method #1

- Credit scores on new or existing debt
- Bond rating equivalents on new issues (Mortality) or existing issues (Rating Agency Cumulative Defaults)
- Utilizing mortality or cumulative default rates to estimate marginal and cumulative defaults
- Estimating Default Recoveries and Probability of Loss

or

Method #2

- Credit scores on new or existing debt
- Direct estimation of the probability of default
- Based on PDs, assign a rating

# Median Z-Score by S&P Bond Rating for U.S. Manufacturing Firms: 1992 - 2017

| Rating | 2017 (No.) | 2013 (No.) | 2004-2010 | 1996-2001 | 1992-1995 |
|---|---|---|---|---|---|
| AAA/AA | 4.20 (14) | 4.13 (15) | 4.18 | 6.20* | 4.80* |
| A | 3.85 (55) | 4.00 (64) | 3.71 | 4.22 | 3.87 |
| BBB | 3.10 (137) | 3.01 (131) | 3.26 | 3.74 | 2.75 |
| BB | 2.45 (173) | 2.69 (119) | 2.48 | 2.81 | 2.25 |
| B | 1.65 (94) | 1.66 (80) | 1.74 | 1.80 | 1.87 |
| CCC/CC | 0.73 (4) | 0.23 (3) | 0.46 | 0.33 | 0.40 |
| D | -0.10 (6)[1] | 0.01 (33)[2] | -0.04 | -0.20 | 0.05 |

*AAA Only.

[1] From 1/2014-11/2017, [2]From 1/2011-12/2013.

Sources: S&P Global Market Intelligence's *Compustat* Database, mainly S&P 500 firms, compilation by NYU Salomon Center, Stern School of Business.

# Marginal and Cumulative Mortality Rate Actuarial Approach

$$\mathbf{MMR_{(r,t)}} = \frac{\textit{total value of defaulting debt from rating (r) in year (t)}}{\textit{total value of the population at the start of the year (t)}}$$

MMR = Marginal Mortality Rate

One can measure the cumulative mortality rate (CMR) over a specific time period (1,2,…, T years) by subtracting the product of the surviving populations of each of the previous years from one (1.0), that is,

$$\boldsymbol{CMR}_{(r,t)} = 1 - \prod_{t=1 \rightarrow N} SR_{(r,t)}\ ,$$
$$r = AAA \rightarrow CCC$$

here CMR $_{(r,t)}$ = Cumulative Mortality Rate of (r) in (t),

SR $_{(r,t)}$ = Survival Rate in $_{(r,t)}$ , 1 - MMR $_{(r,t)}$

# Mortality Rates by Original Rating

**All Rated Corporate Bonds***
**1971-2018**

Years After Issuance

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| AAA | Marginal | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.01% | 0.00% | 0.00% | 0.00% |
| | Cumulative | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.03% | 0.04% | 0.04% | 0.04% | 0.04% |
| | | | | | | | | | | | |
| AA | Marginal | 0.00% | 0.00% | 0.18% | 0.05% | 0.02% | 0.01% | 0.03% | 0.04% | 0.03% | 0.04% |
| | Cumulative | 0.00% | 0.00% | 0.18% | 0.23% | 0.25% | 0.26% | 0.29% | 0.33% | 0.36% | 0.40% |
| | | | | | | | | | | | |
| A | Marginal | 0.01% | 0.02% | 0.09% | 0.10% | 0.07% | 0.04% | 0.02% | 0.22% | 0.05% | 0.03% |
| | Cumulative | 0.01% | 0.03% | 0.12% | 0.22% | 0.29% | 0.33% | 0.35% | 0.57% | 0.62% | 0.65% |
| | | | | | | | | | | | |
| BBB | Marginal | 0.29% | 2.26% | 1.20% | 0.95% | 0.46% | 0.20% | 0.21% | 0.15% | 0.15% | 0.31% |
| | Cumulative | 0.29% | 2.54% | 3.71% | 4.63% | 5.07% | 5.26% | 5.46% | 5.60% | 5.74% | 6.03% |
| | | | | | | | | | | | |
| BB | Marginal | 0.89% | 2.01% | 3.79% | 1.95% | 2.38% | 1.52% | 1.41% | 1.07% | 1.38% | 3.07% |
| | Cumulative | 0.89% | 2.88% | 6.56% | 8.38% | 10.57% | 11.92% | 13.17% | 14.10% | 15.28% | 17.88% |
| | | | | | | | | | | | |
| B | Marginal | 2.84% | 7.62% | 7.71% | 7.73% | 5.71% | 4.44% | 3.58% | 2.03% | 1.70% | 0.71% |
| | Cumulative | 2.84% | 10.24% | 17.16% | 23.57% | 27.93% | 31.13% | 33.60% | 34.94% | 36.05% | 36.50% |
| | | | | | | | | | | | |
| CCC | Marginal | 8.05% | 12.36% | 17.66% | 16.21% | 4.87% | 11.58% | 5.38% | 4.76% | 0.61% | 4.21% |
| | Cumulative | 8.05% | 19.42% | 33.65% | 44.40% | 47.11% | 53.23% | 55.75% | 57.86% | 58.11% | 59.88% |

*Rated by S&P at Issuance
Based on 3,454 issues

Source: S&P Global Ratings and Author's Compilation

# Mortality Losses by Original Rating

**All Rated Corporate Bonds***
**1971-2018**

Years After Issuance

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| AAA | Marginal | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% |
| | Cumulative | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.03% | 0.03% | 0.03% | 0.03% |
| | | | | | | | | | | | |
| AA | Marginal | 0.00% | 0.00% | 0.01% | 0.02% | 0.01% | 0.01% | 0.00% | 0.01% | 0.01% | 0.01% |
| | Cumulative | 0.00% | 0.00% | 0.01% | 0.03% | 0.04% | 0.05% | 0.05% | 0.06% | 0.07% | 0.08% |
| | | | | | | | | | | | |
| A | Marginal | 0.00% | 0.01% | 0.03% | 0.03% | 0.04% | 0.04% | 0.02% | 0.01% | 0.04% | 0.02% |
| | Cumulative | 0.00% | 0.01% | 0.04% | 0.07% | 0.11% | 0.15% | 0.17% | 0.18% | 0.22% | 0.24% |
| | | | | | | | | | | | |
| BBB | Marginal | 0.20% | 1.47% | 0.68% | 0.56% | 0.24% | 0.14% | 0.07% | 0.08% | 0.08% | 0.16% |
| | Cumulative | 0.20% | 1.67% | 2.34% | 2.88% | 3.12% | 3.25% | 3.32% | 3.40% | 3.47% | 3.63% |
| | | | | | | | | | | | |
| BB | Marginal | 0.53% | 1.14% | 2.26% | 1.09% | 1.35% | 0.74% | 0.79% | 0.49% | 0.70% | 1.05% |
| | Cumulative | 0.53% | 1.66% | 3.89% | 4.93% | 6.22% | 6.91% | 7.65% | 8.10% | 8.74% | 9.70% |
| | | | | | | | | | | | |
| B | Marginal | 1.88% | 5.33% | 5.30% | 5.18% | 3.76% | 2.41% | 2.33% | 1.12% | 0.88% | 0.50% |
| | Cumulative | 1.88% | 7.11% | 12.03% | 16.59% | 19.73% | 21.66% | 23.49% | 24.34% | 25.01% | 25.38% |
| | | | | | | | | | | | |
| CCC | Marginal | 5.33% | 8.65% | 12.45% | 11.43% | 3.39% | 8.58% | 2.28% | 3.30% | 0.37% | 2.66% |
| | Cumulative | 5.33% | 13.52% | 24.29% | 32.94% | 35.21% | 40.77% | 42.12% | 44.03% | 44.24% | 45.72% |

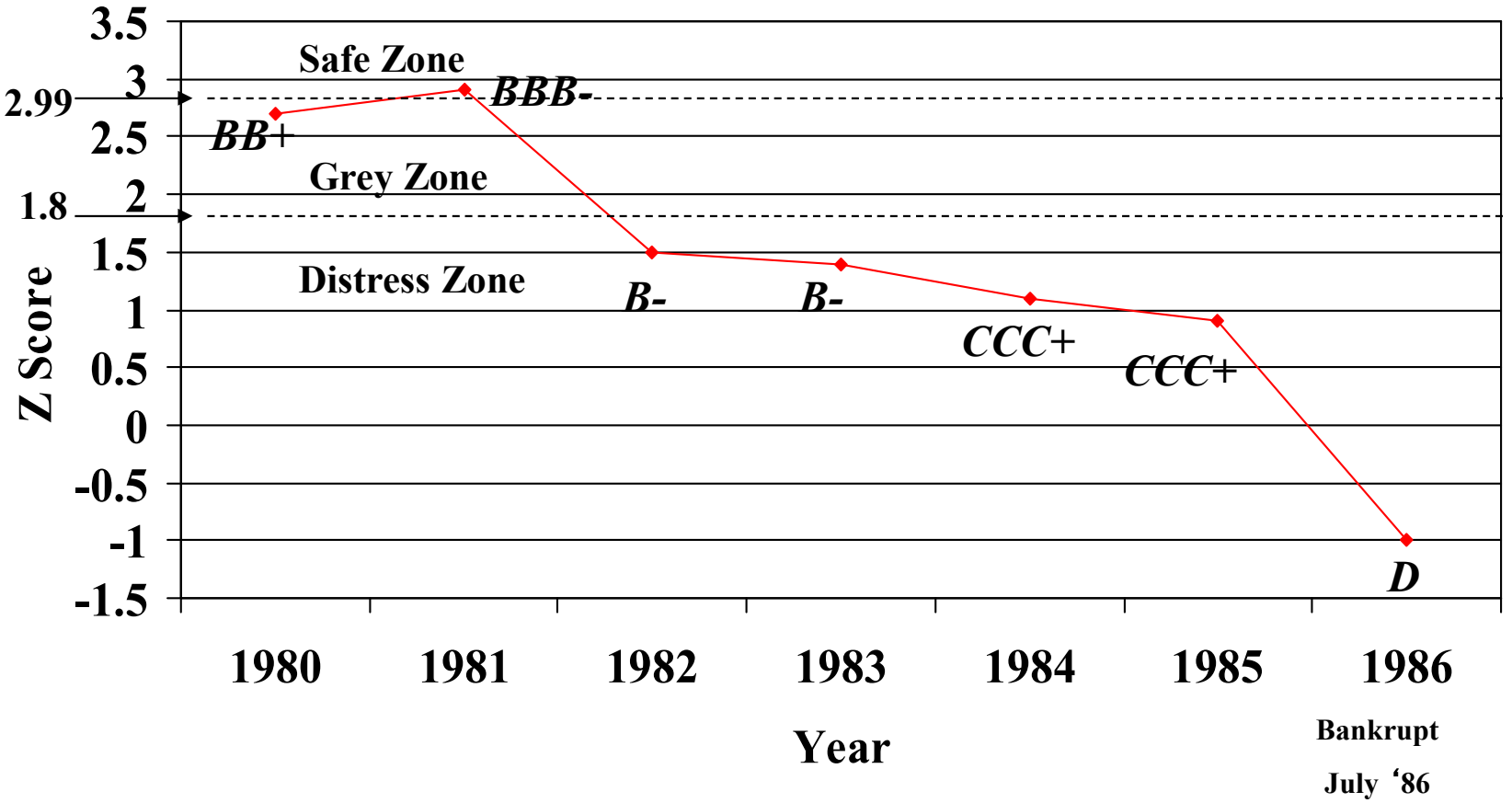
*Rated by S&P at Issuance
Based on 2,894 issues

Source: S&P Global Ratings and Author's Compilation

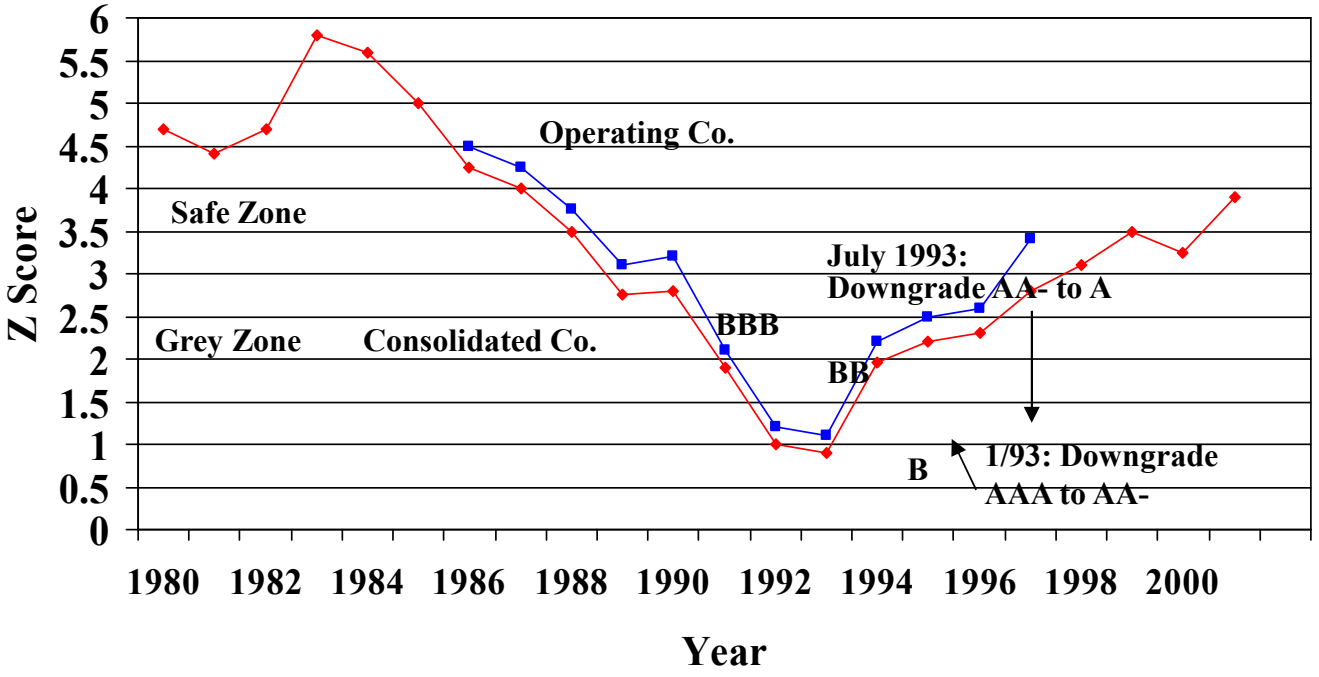
# Financial Distress (Z-Score) Prediction Applications

| External (To The Firm) Analytics | Internal (To The Firm) & Research Analytics |
|---|---|
| • **Lenders (e.g., Pricing, Basel Capital Allocation)**<br>• Bond Investors (e.g., Quality Junk Portfolio<br>• Long/Short Investment Strategy on Stocks (e.g. Baskets of Strong Balance Sheet Companies & Indexes, e.g. STOXX, Goldman, Nomura)<br>• Security Analysts & Rating Agencies<br>• Regulators & Government Agencies<br>• Auditors (Audit Risk Model) – Going Concern<br>• Advisors (e.g., Assessing Client's Health)<br>• M&A (e.g., Bottom Fishing) | • **To File or Not (e.g., General Motors)**<br>• **Comparative Risk Profiles Over Time**<br>• **Industrial Sector Assessment (e.g., Energy)**<br>• Sovereign Default Risk Assessment<br>• Purchasers, Suppliers Assessment<br>• Accounts Receivables Management<br>• Researchers – Scholarly Studies<br>• Chapter 22 Assessment<br>• Managers – Managing a Financial Turnaround |

# Z Score Trend - LTV Corp.



# IBM Corporation
# Z Score (1980 – 2001, update 2015-2017)



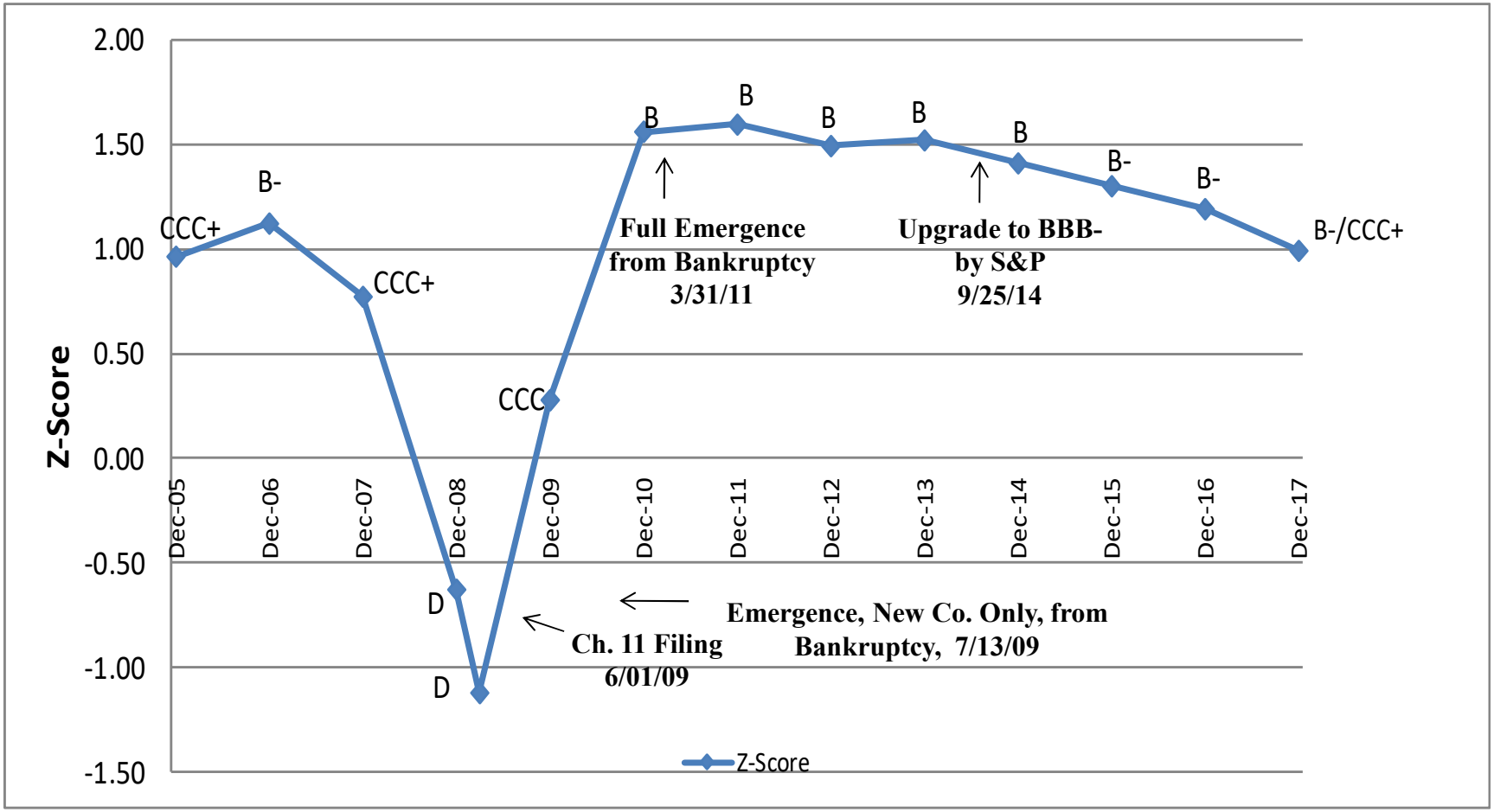

| Recent Z-Scores & BREs | | | |
|---|---|---|---|
| Year -End | Z-Score | BRE | Actual S&P Rating |
| 2015 | 3.63 | A- | |
| 2016 | 3.58 | A- | |
| 2017 | 3.27 | BBB+ | A+ |

# Z-Score Model Applied to General Motors (Consolidated Data): Bond Rating Equivalents and Scores from 2005 – 2017

| | Z-Scores | BRE |
|---|---|---|
| 12/31/17 | 0.99 | B-/CCC+ |
| 12/31/16 | 1.19 | B- |
| 12/31/15 | 1.30 | B- |
| 12/31/14 | 1.41 | B |
| 12/31/13 | 1.52 | B |
| 12/31/12 | 1.49 | B |
| 12/31/11 | 1.59 | B |
| 12/31/10 | 1.56 | B |
| 12/31/09 | 0.28 | CCC |
| 03/31/09 | (1.12) | D |
| 12/31/08 | (0.63) | D |
| 12/31/07 | 0.77 | CCC+ |
| 12/31/06 | 1.12 | B- |
| 12/31/05 | 0.96 | CCC+ |

Note: Consolidated Annual Results. Data Source: S&P Global Market Intelligence's S&P Capital IQ platform, Bloomberg., Edgar

# Z-Score Model Applied to GM (Consolidated Data): Bond Rating Equivalents and Scores from 2005 – 2017



# Additional Altman Z-Score Models:

**Private Firm Model (1968)**

**Non-U.S., Emerging Markets Models for Non Financial Industrial Firms (1995)**

**e.g. Latin America (1977, 1995), China (2010), etc.**

**Sovereign Risk Bottom-Up Model (2011)**

**SME Models for the U.S. (2007) & Europe**

**e.g. Italian Minibonds (2016), U.K. (2017), Spain (2018)**

# *An Example of A European SME Model*

## The Italian SME & Mini-Bond Markets

**Our Work with the U.S. H.Y. Bond Market and SMEs Globally (WiserFunding Ltd.)**

**Italy - Classis Capital, Italian Borsa, Wiserfunding and Minibond Advising, Issuance and Trading**

**Providing a Credit Market Discipline (Credit Culture) to the Italian Mini-bond Market and SMEs Globally**

# Z" Score Model for Manufacturers, Non-Manufacturer Industrials; Developed and Emerging Market Credits (1995)

$$Z'' = 3.25 + 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4$$

$$X_1 = \frac{\text{Current Assets - Current Liabilities}}{\text{Total Assets}}$$

$$X_2 = \frac{\text{Retained Earnings}}{\text{Total Assets}}$$

$$X_3 = \frac{\text{Earnings Before Interest and Taxes}}{\text{Total Assets}}$$

$$X_4 = \frac{\text{Book Value of Equity}}{\text{Total Liabilities}}$$

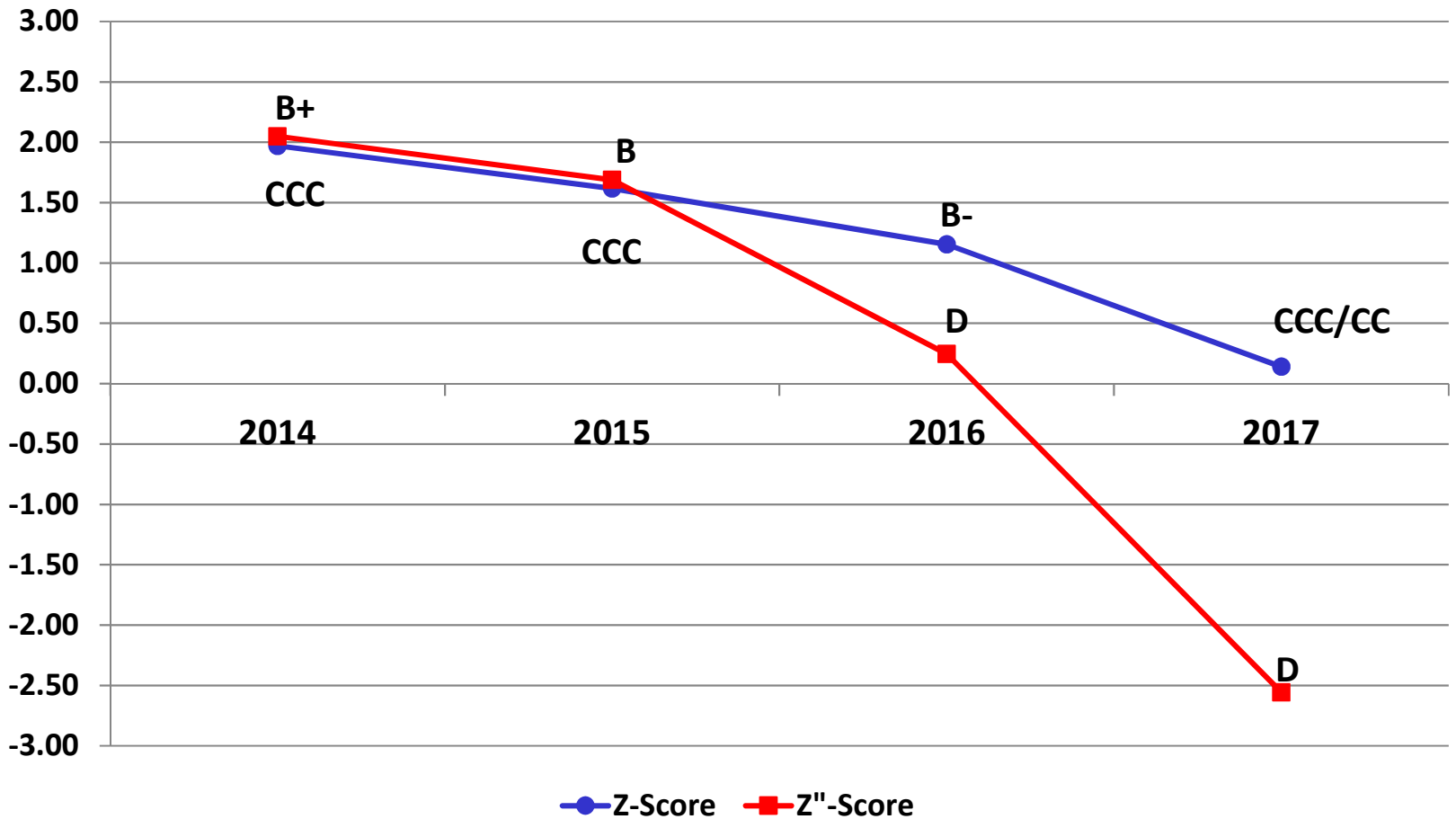
# US Bond Rating Equivalents Based on Z”-Score Model

$$Z'' = 3.25 + 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4$$

| Rating | Median 1996 Z”-Score[a] | Median 2006 Z”-Score[a] | Median 2013 Z”-Score[a] |
|---|---|---|---|
| AAA/AA+ | 8.15 (8) | 7.51 (14) | 8.80 (15) |
| AA/AA- | 7.16 (33) | 7.78 (20) | 8.40 (17) |
| A+ | 6.85 (24) | 7.76 (26) | 8.22 (23) |
| A | 6.65 (42) | 7.53 (61) | 6.94 (48) |
| A- | 6.40 (38) | 7.10 (65) | 6.12 (52) |
| BBB+ | 6.25 (38) | 6.47 (74) | 5.80 (70) |
| BBB | 5.85 (59) | 6.41 (99) | 5.75 (127) |
| BBB- | 5.65 (52) | 6.36 (76) | 5.70 (96) |
| BB+ | 5.25 (34) | 6.25 (68) | 5.65 (71) |
| BB | 4.95 (25) | 6.17 (114) | 5.52 (100) |
| BB- | 4.75 (65) | 5.65 (173) | 5.07 (121) |
| B+ | 4.50 (78) | 5.05 (164) | 4.81 (93) |
| B | 4.15 (115) | 4.29 (139) | 4.03 (100) |
| B- | 3.75 (95) | 3.68 (62) | 3.74 (37) |
| CCC+ | 3.20 (23) | 2.98 (16) | 2.84 (13) |
| CCC | 2.50 (10) | 2.20 (8) | 2.57(3) |
| CCC- | 1.75 (6) | 1.62 (-)[b] | 1.72 (-)[b] |
| CC/D | 0 (14) | 0.84 (120) | 0.05 (94)[c] |

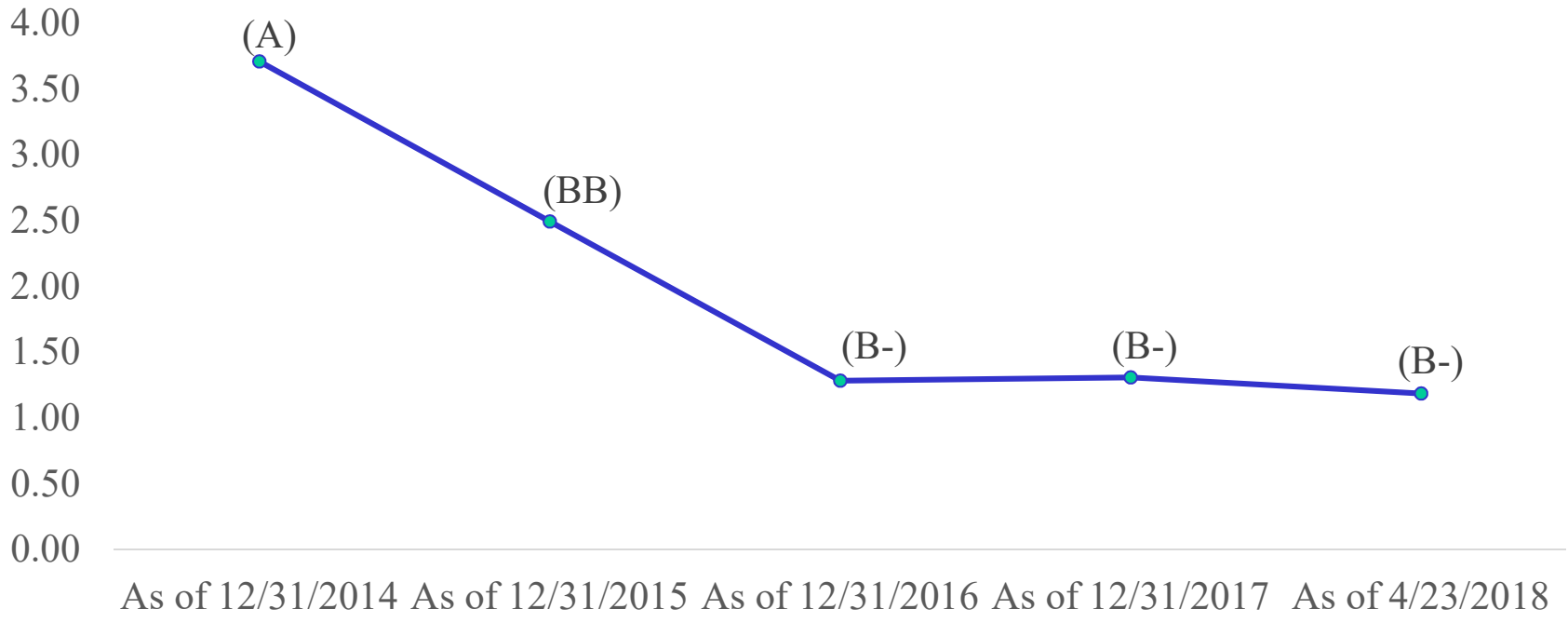
[a]Sample Size in Parantheses. [b]Interpolated between CCC and CC/D. [c]Based on 94 Chapter 11 bankruptcy filings, 2010-2013.
Sources: Compustat, Company Filings and S&P.

# Z and Z”-Score Models Applied to Sears, Roebuck & Co.: Bond Rating Equivalents and Scores from 2014 – 2017




Source: E. Altman, NYU Salomon Center

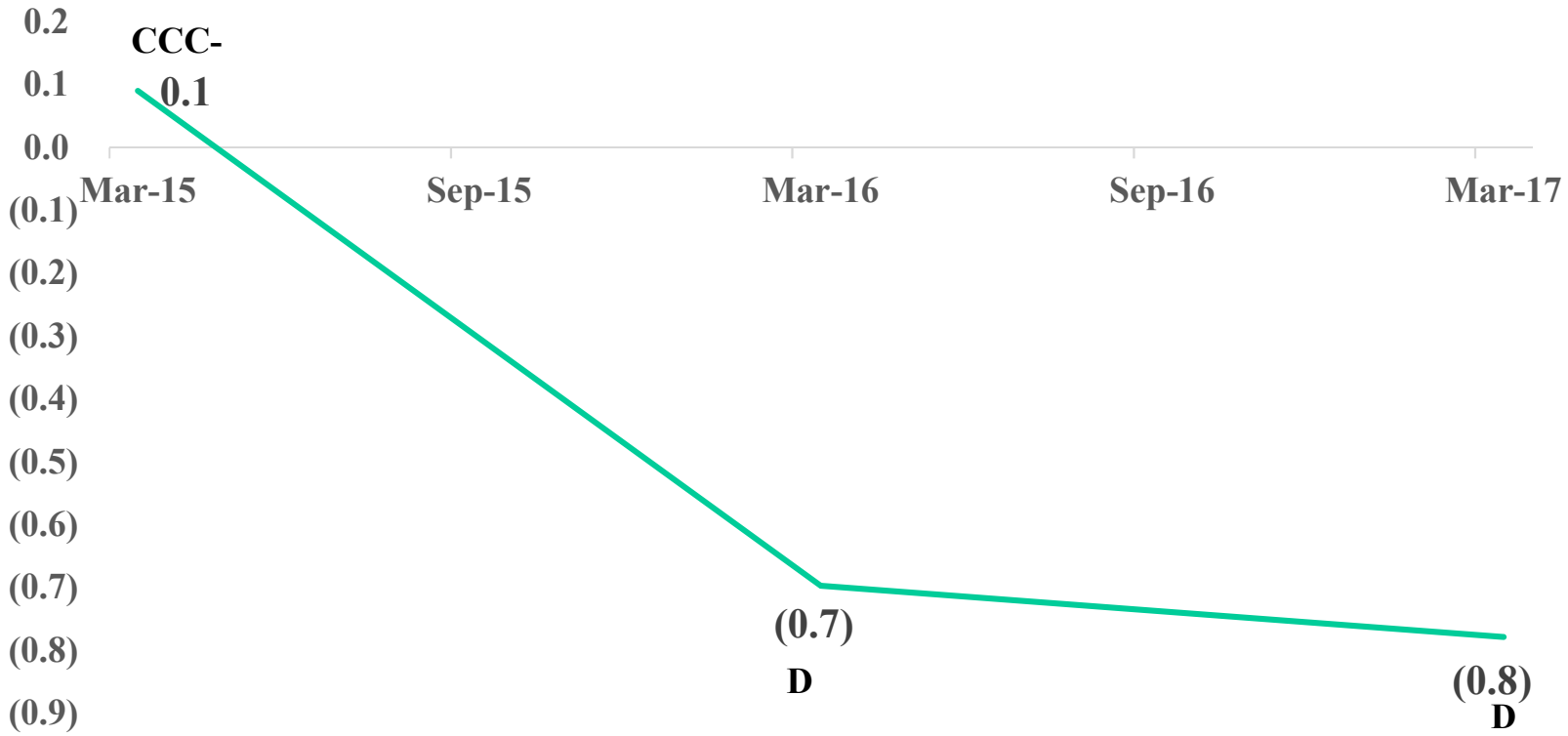
# Tesla Z Scores and BREs (2014 – April 2018)



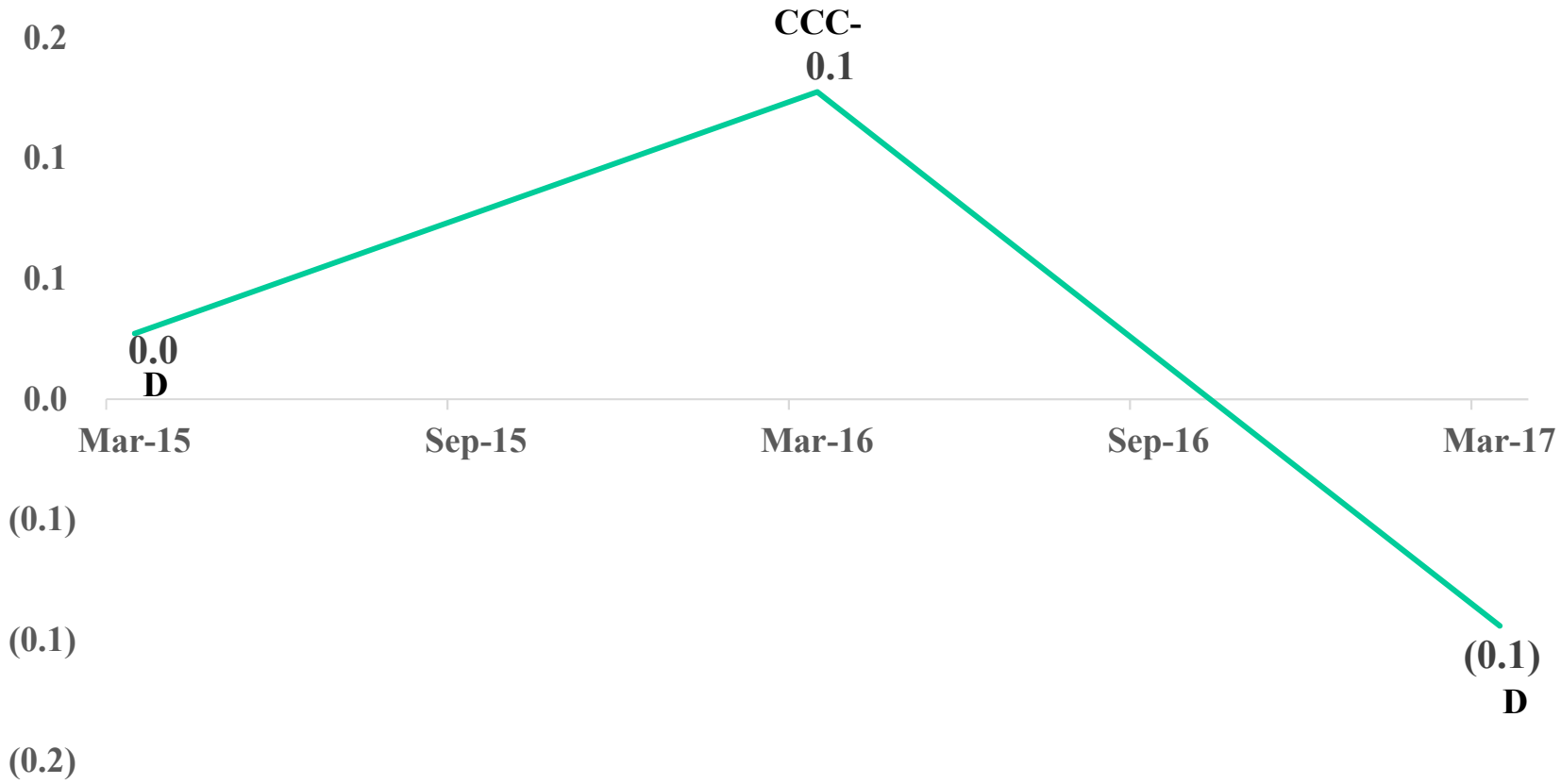

Source: E. Altman, NYU Salomon Center

# Recent Indian Bankruptcies:
# Z-Score Tests

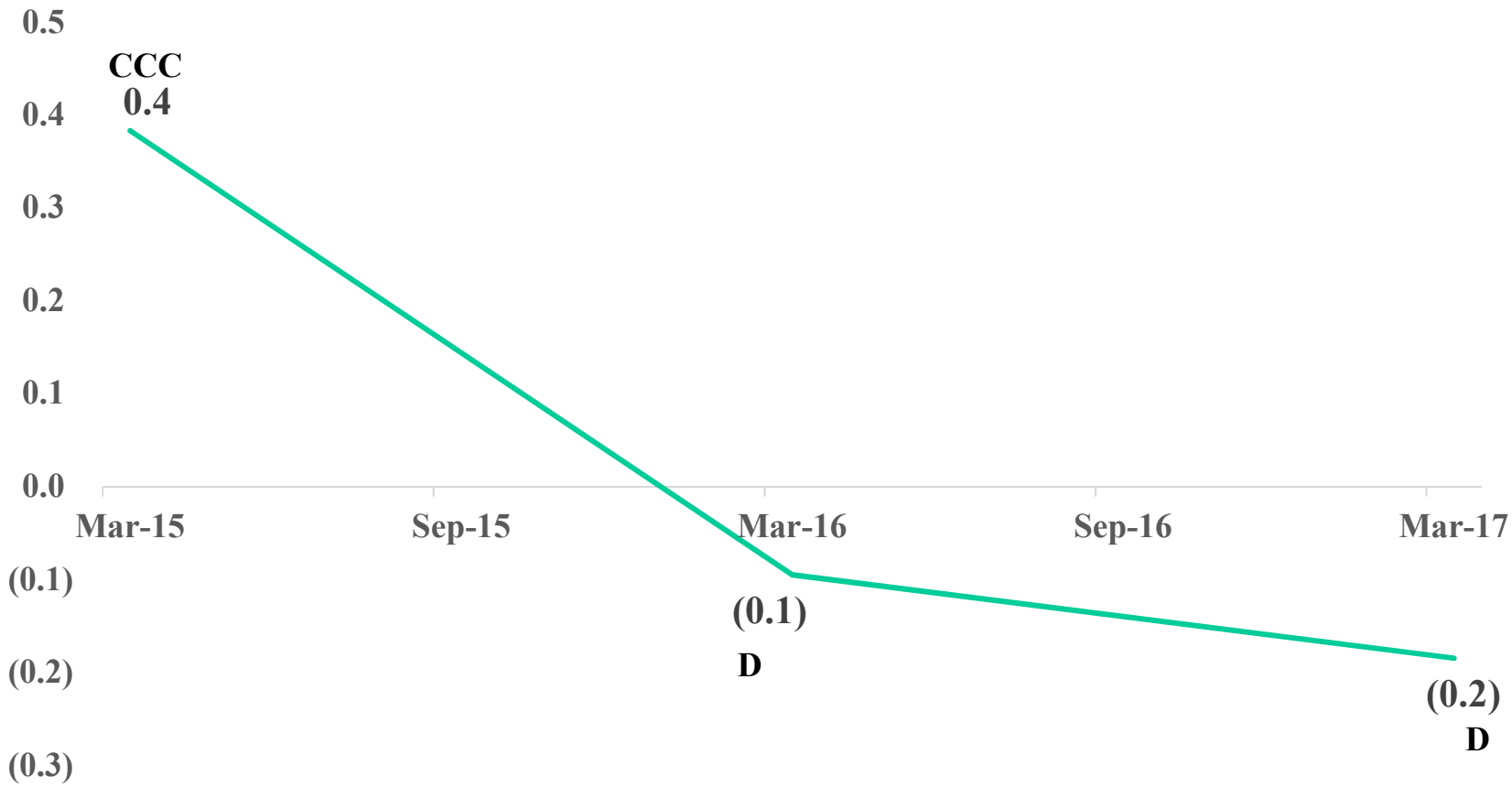
# Essar Steel (Manufacturing); Default: Aug. 03, 2017



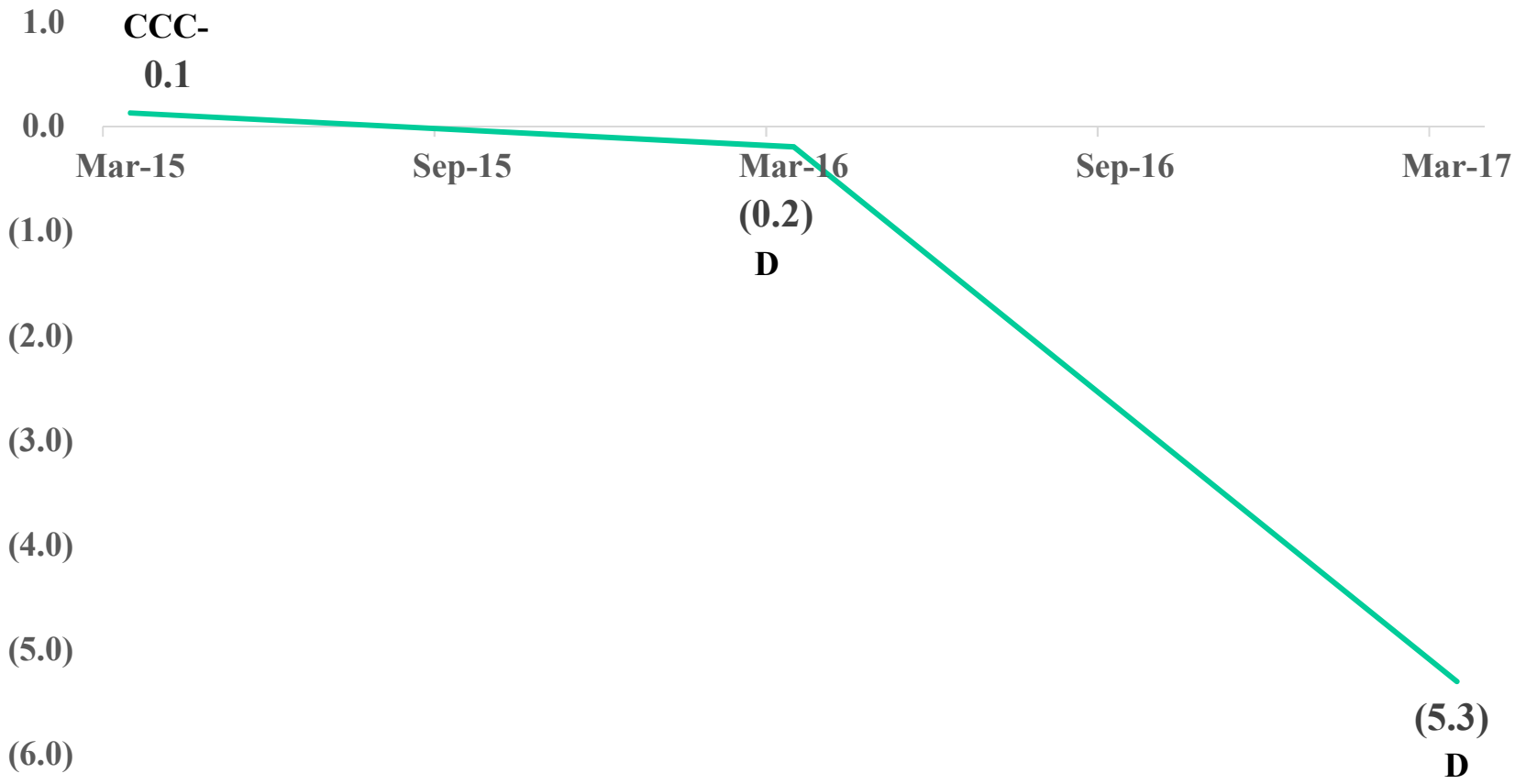
# Lanco Infratech (Manufacturing); Default: Aug. 27, 2018



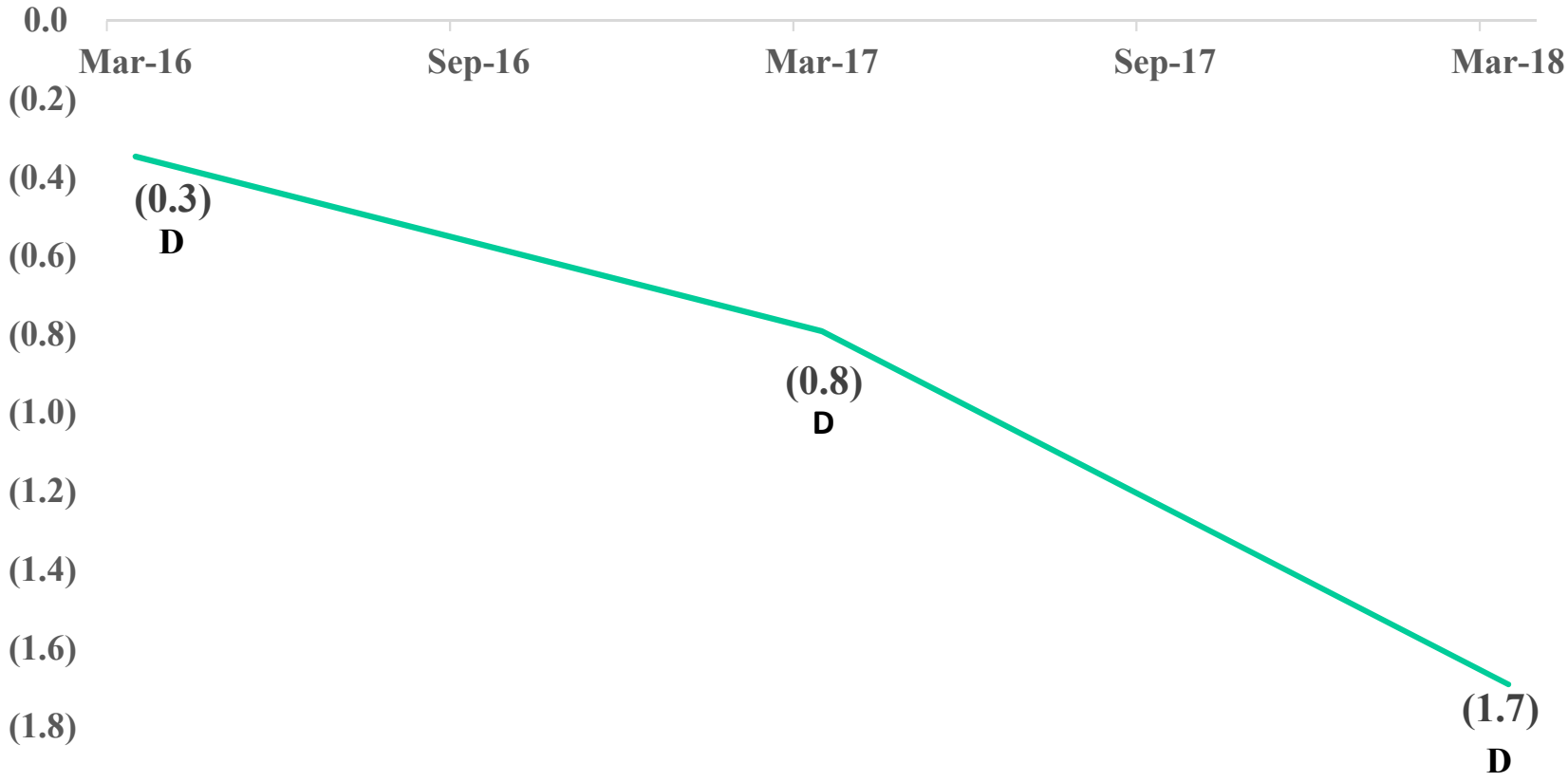
# Bhushan Power and Steel (Manufacturing); Default: Jul. 27, 2017



# Alok Industries (Manufacturing); Default: Apr. 20, 2018



# Monnet Ispat (Manufacturing)



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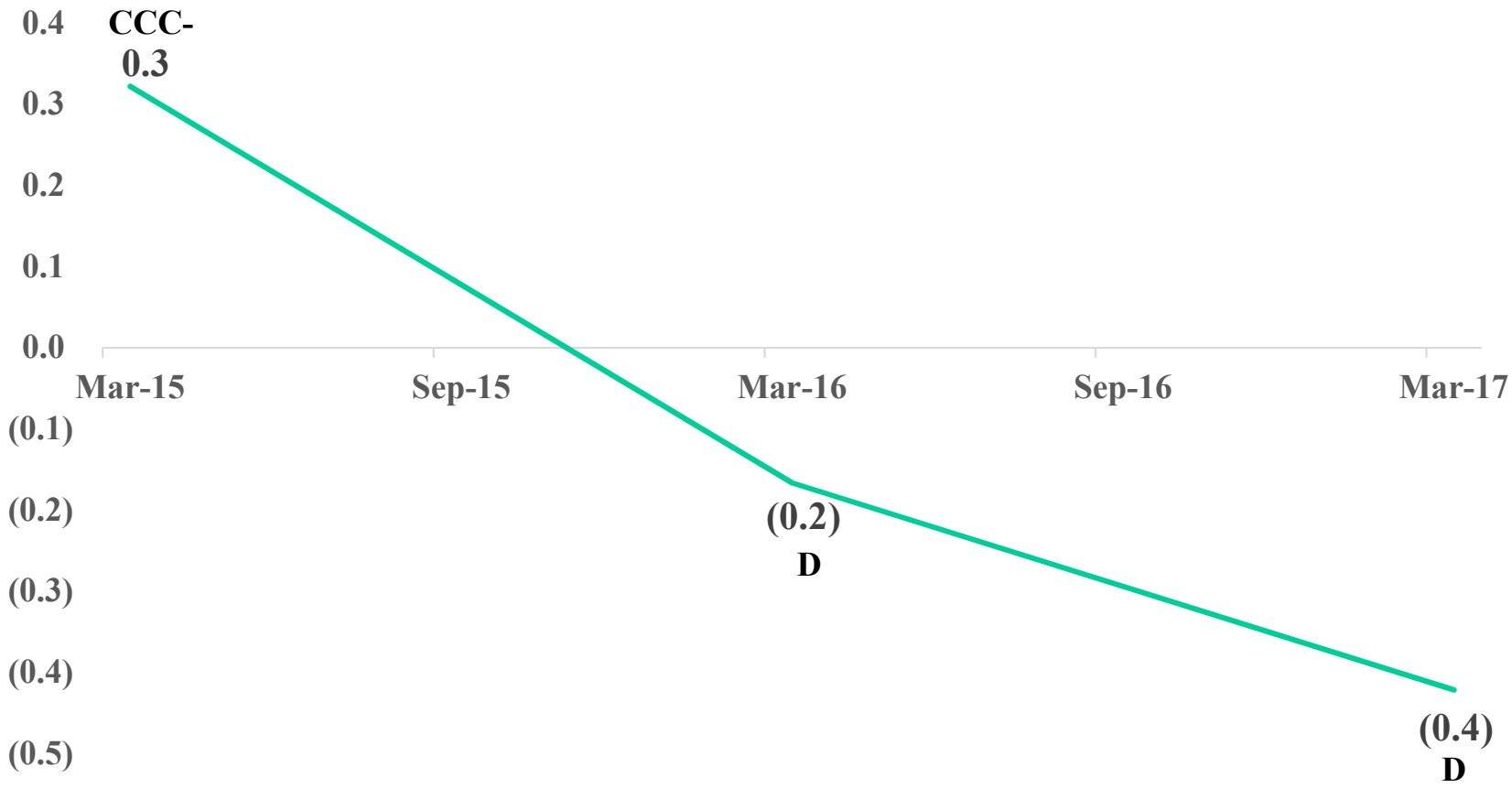
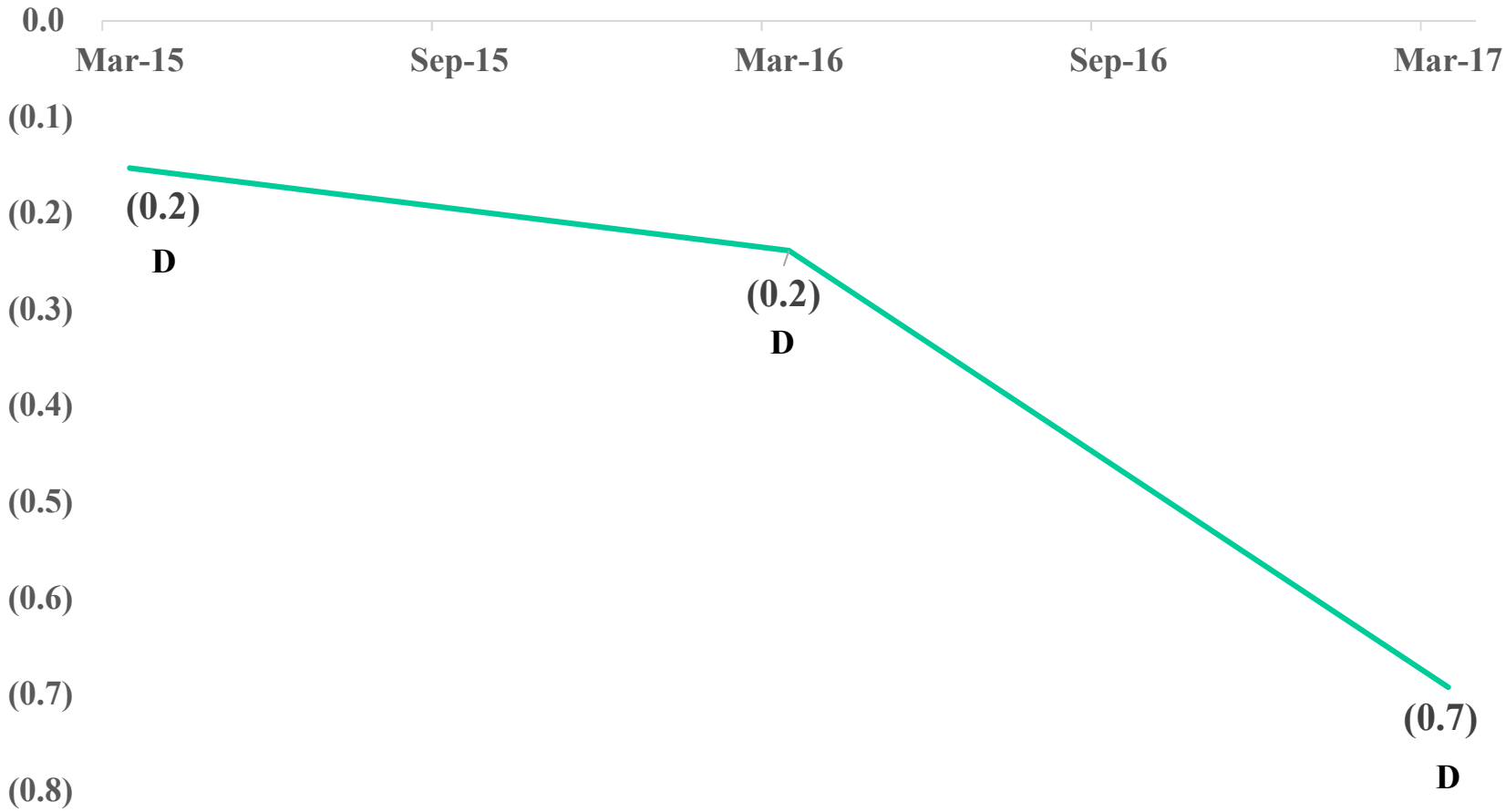
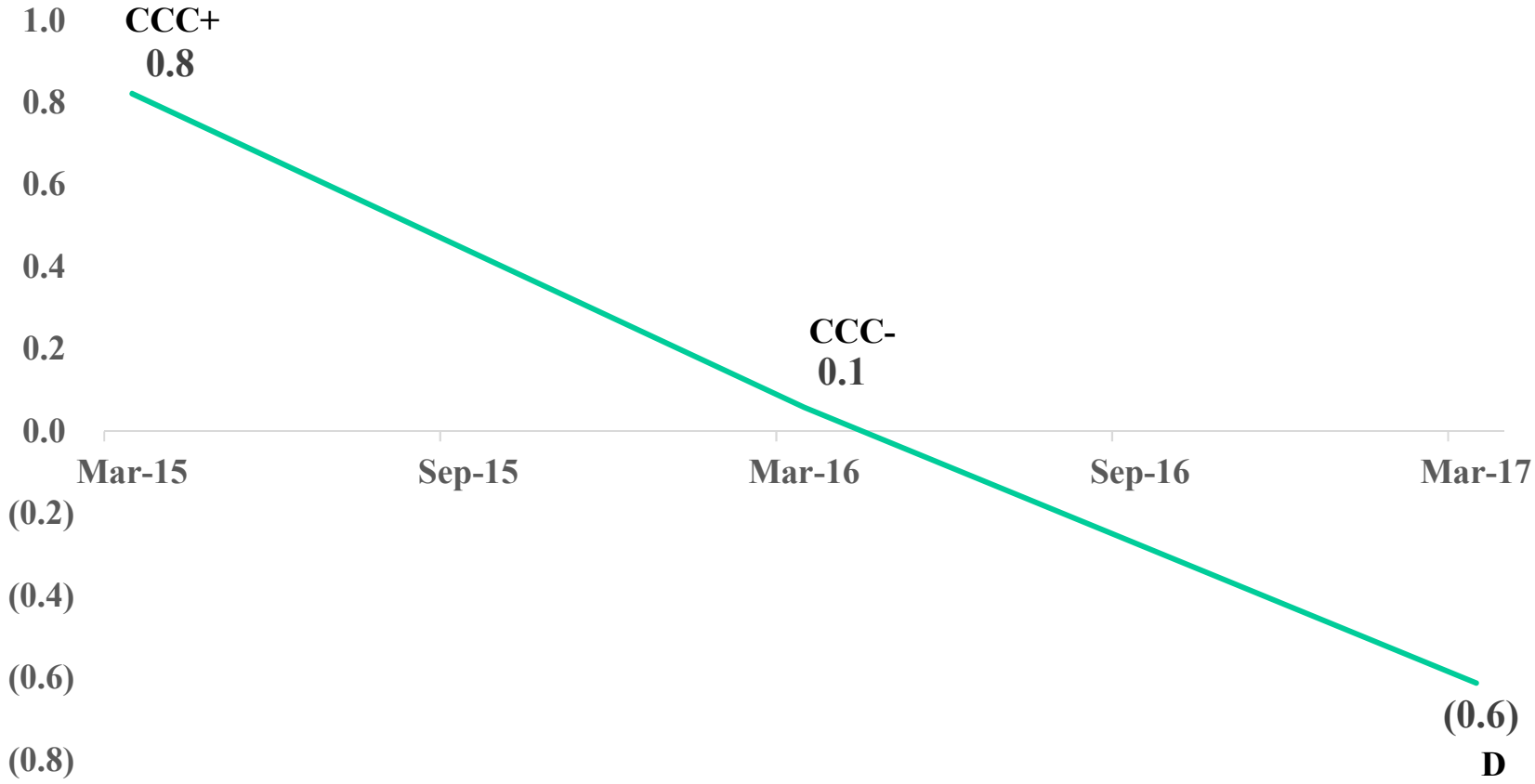
# Era Infra Engineering (Manufacturing); Default: Feb. 19, 2018



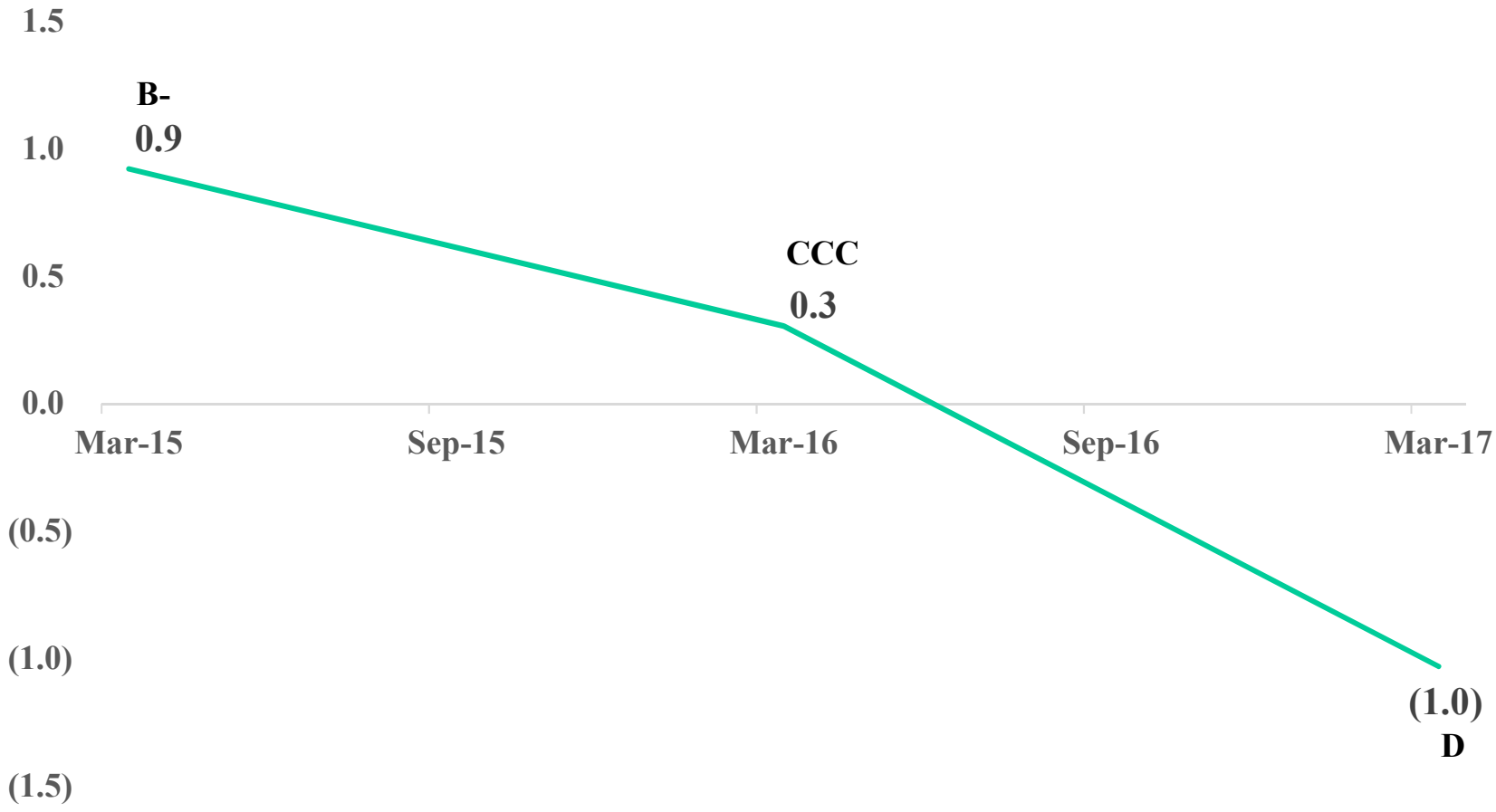
# Electrosteel Steels (Manufacturing); Default: Jun. 29, 2017



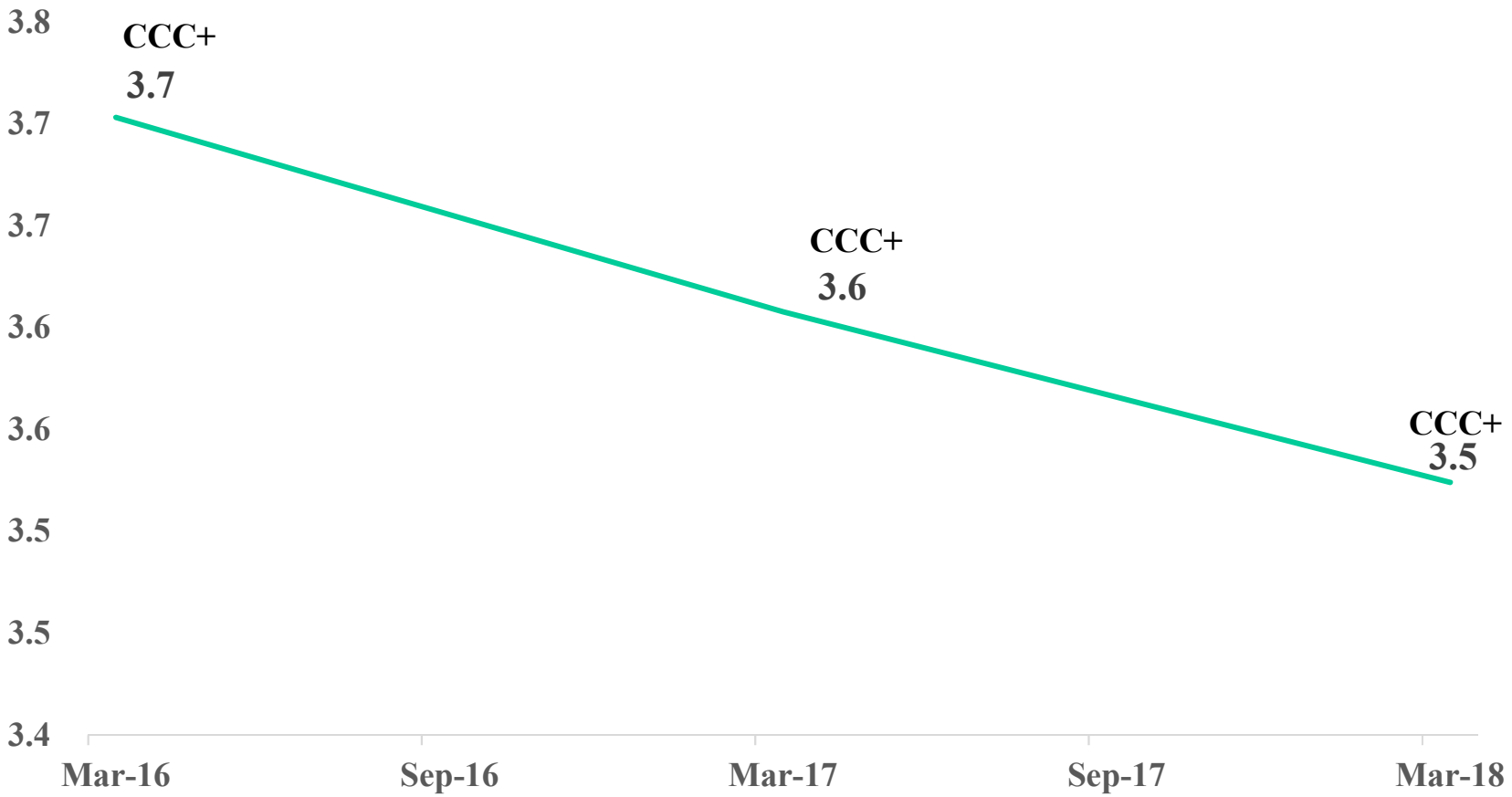
# Amtek Auto (Manufacturing); Default: Jul. 25, 2017



# Jyoti Structures (Manufacturing); Default: Jul. 26, 2018



# IL&FS (Non-manufacturing); Default: Oct. 15, 2018



# Current Conditions and Outlook in Global Credit Markets

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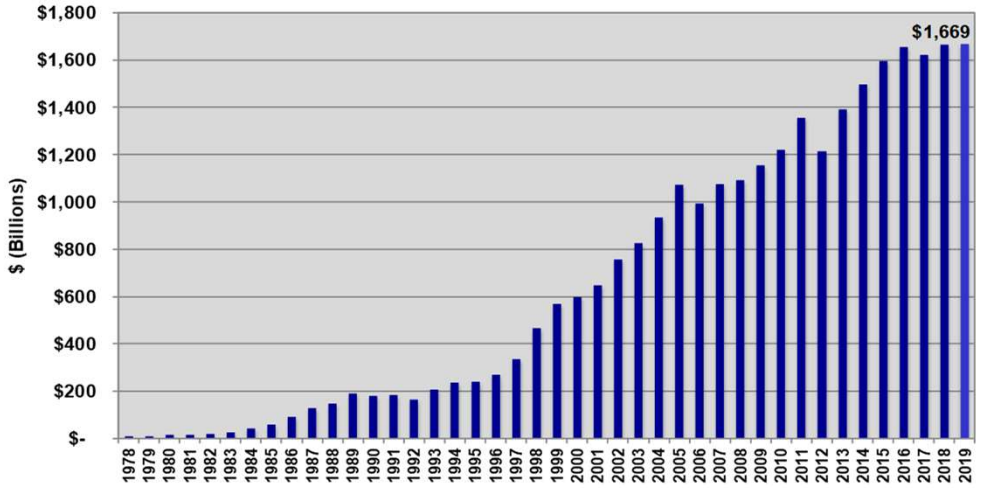
# Size Of High-Yield Bond Market

US Market

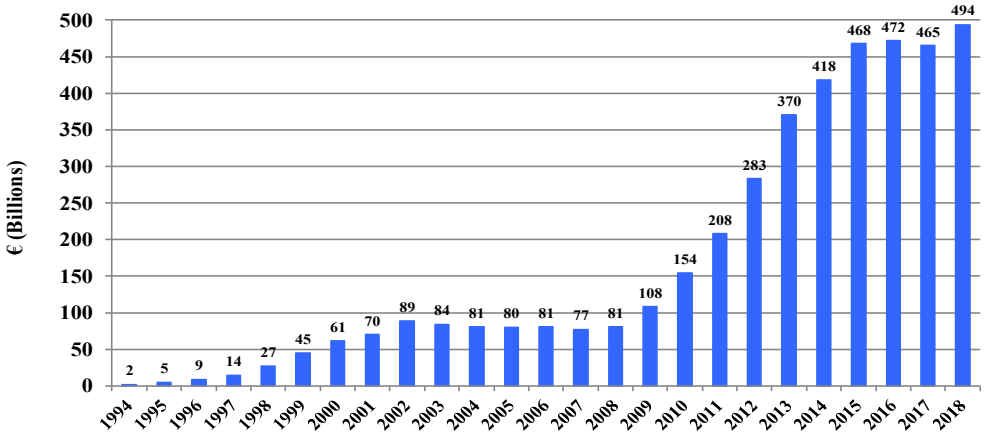
**1978 – 2019** *(Mid-year US$ billions)*




Source: NYU Salomon Center estimates using Credit Suisse, S&P and Citi data

Western Europe Market

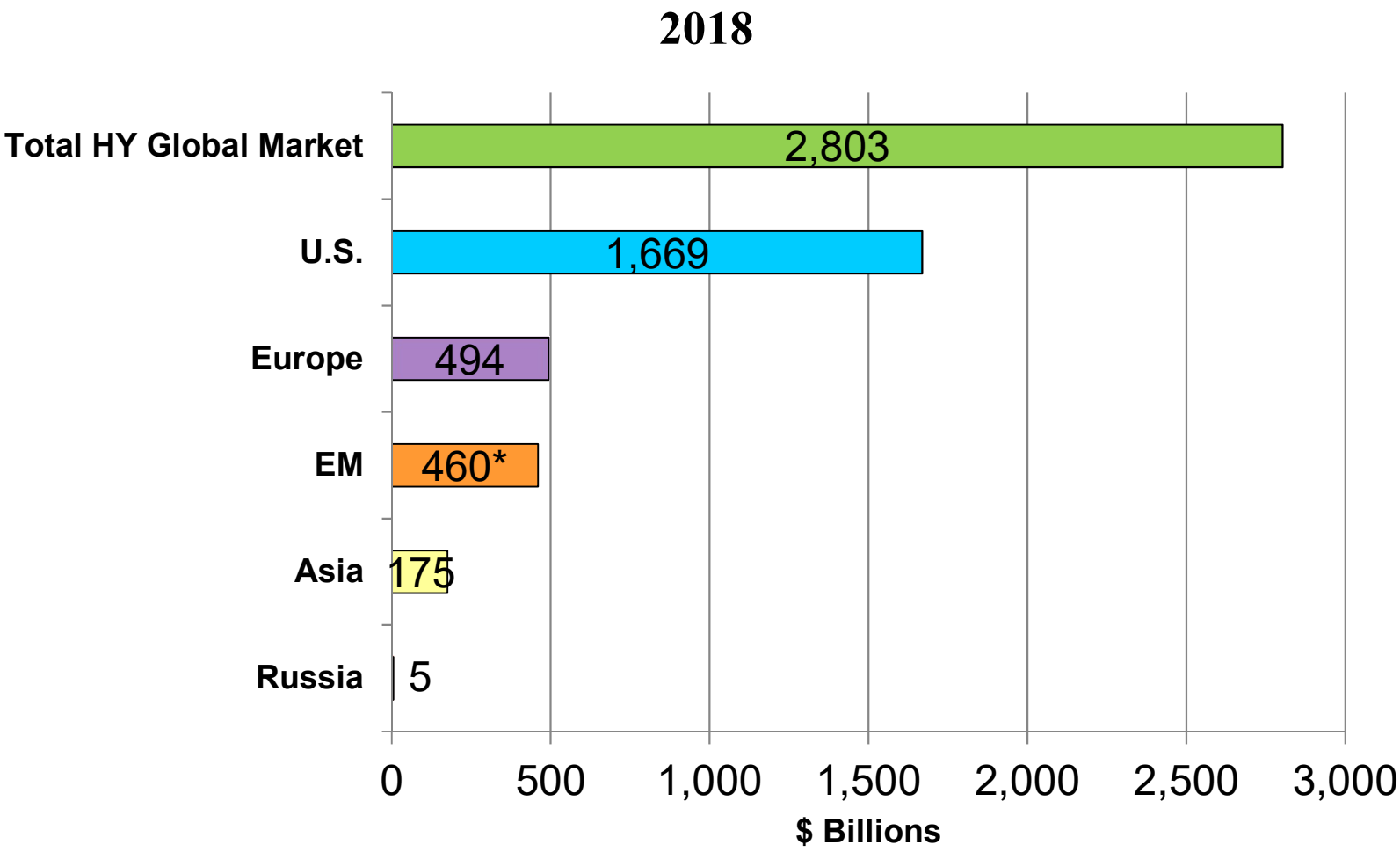
**1994 – 2018***




Source: Credit Suisse

*Includes non-investment grade straight corporate debt of issuers with assets located in or revenues derived from Western Europe, or the bond is denominated in a Western European currency. Floating-rate and convertible bonds and preferred stock are not included.

# Size of Corporate HY Bond Market: U.S., Europe, Emerging Markets & Asia (ex. Japan) ($ Billions)

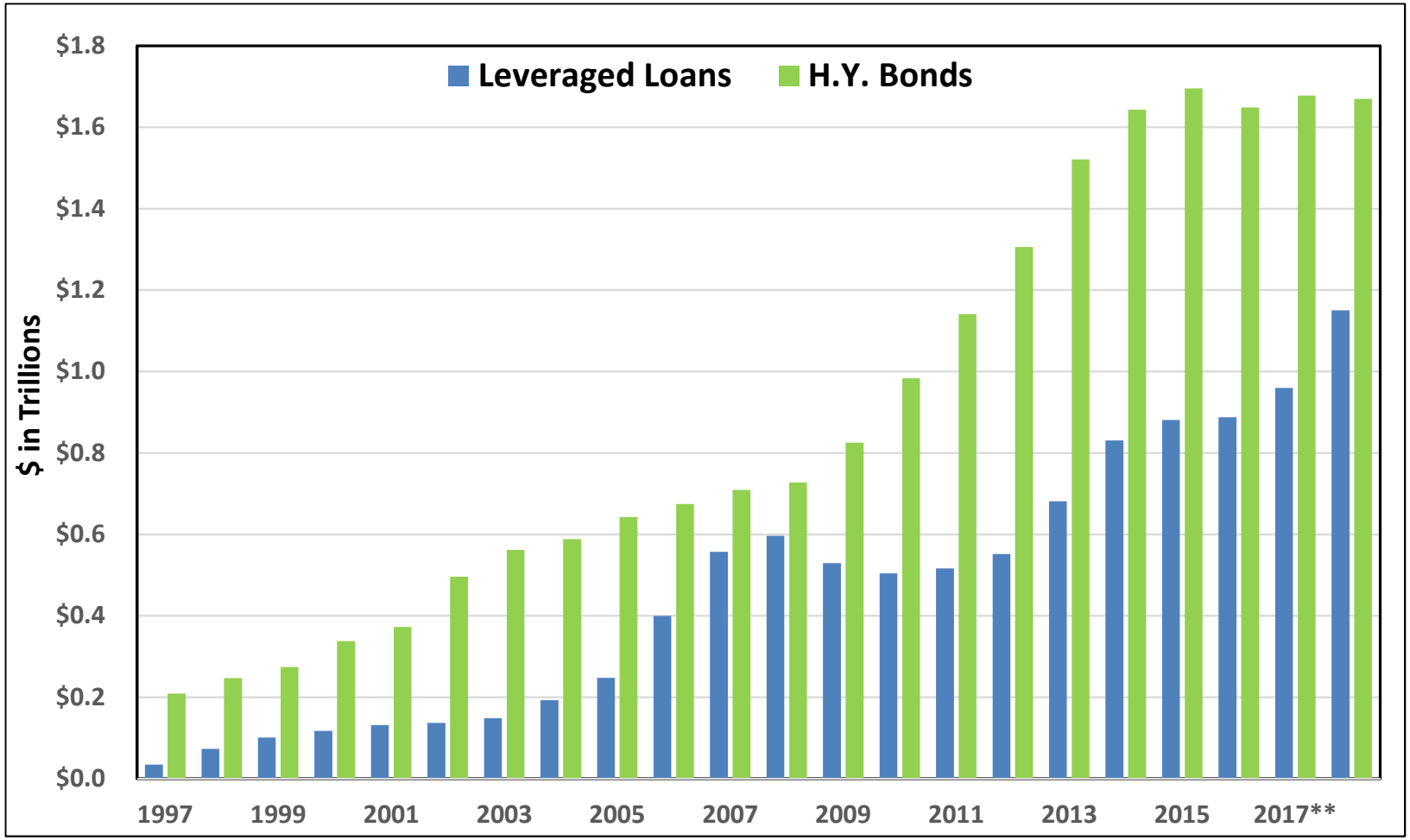



*Mainly Latin America. Note: EM & Asia value as of 2017.

Source: NYU Salomon Center, Credit Suisse, LIM Advisors Ltd.

# Size of The U.S. High-Yield and Leveraged Loan* Markets

**1997-2018**




*Primarily Institutional Tranches. **NYU Salomon Center High-Yield Market Size as of 12/31/17 and 12/31/2018.
Source: S&P Global Market Intelligence.

# Benign Credit Cycle: Is It Over?

- **Length of Benign Credit Cycles: Is the Current Cycle Over? No.**
- **Default Rates (no), Default Forecast (no), Recovery Rates (no), Yields (no) & Liquidity (no)**
- **Coincidence with Recessions: U.S. & European Scenarios**
- **Level of Non-financial Debt as a Percent of GDP**
- **Global Debt Levels**
- **Comparative Health of High-Yield Firms (2007 vs. 2017)**
- **High-Yield CCC New Issuance as a Liquidity Measure**
- **LBO Statistics and Trends**
- **Liquidity Concerns (Market and Market-Makers)**
- **Possible Timing of the Bubble Burst (Short-term versus Longer-term)**

# Benign Credit Cycle? Is It Over?

- **Length of Benign Credit Cycles: Is the Current Cycle Over? No.**
- **Default Rates (no), but Rising**
- **Default Forecast (no)**
- **Recovery Rates (no)**
- **Yields (no)**
- **Liquidity (no)**

# Historical H.Y. Bond Default Rates

Straight Bonds Only Excluding Defaulted Issues From Par Value Outstanding, (*US$ millions),* 1971 – 2018 (Preliminary)

| Year | Par Value Outstanding[a] ($) | Par Value Defaults ($) | Default Rates (%) |
|---|---|---|---|
| **2018** | **1,664,166** | **28,994** | **1.742** |
| 2017 | 1,622,365 | 29,301 | 1.806 |
| 2016 | 1,656,176 | 68,066 | 4.110 |
| 2015 | 1,595,839 | 45,122 | 2.827 |
| 2014 | 1,496,814 | 31,589 | 2.110 |
| 2013 | 1,392,212 | 14,539 | 1.044 |
| 2012 | 1,212,362 | 19,647 | 1.621 |
| 2011 | 1,354,649 | 17,963 | 1.326 |
| 2010 | 1,221,569 | 13,809 | 1.130 |
| 2009 | 1,152,952 | 123,878 | 10.744 |
| 2008 | 1,091,000 | 50,763 | 4.653 |
| 2007 | 1,075,400 | 5,473 | 0.509 |
| 2006 | 993,600 | 7,559 | 0.761 |
| 2005 | 1,073,000 | 36,209 | 3.375 |
| 2004 | 933,100 | 11,657 | 1.249 |
| 2003 | 825,000 | 38,451 | 4.661 |
| 2002 | 757,000 | 96,855 | 12.795 |
| 2001 | 649,000 | 63,609 | 9.801 |
| 2000 | 597,200 | 30,295 | 5.073 |
| 1999 | 567,400 | 23,532 | 4.147 |
| 1998 | 465,500 | 7,464 | 1.603 |
| 1997 | 335,400 | 4,200 | 1.252 |
| 1996 | 271,000 | 3,336 | 1.231 |
| 1995 | 240,000 | 4,551 | 1.896 |
| 1994 | 235,000 | 3,418 | 1.454 |
| 1993 | 206,907 | 2,287 | 1.105 |
| 1992 | 163,000 | 5,545 | 3.402 |
| 1991 | 183,600 | 18,862 | 10.273 |

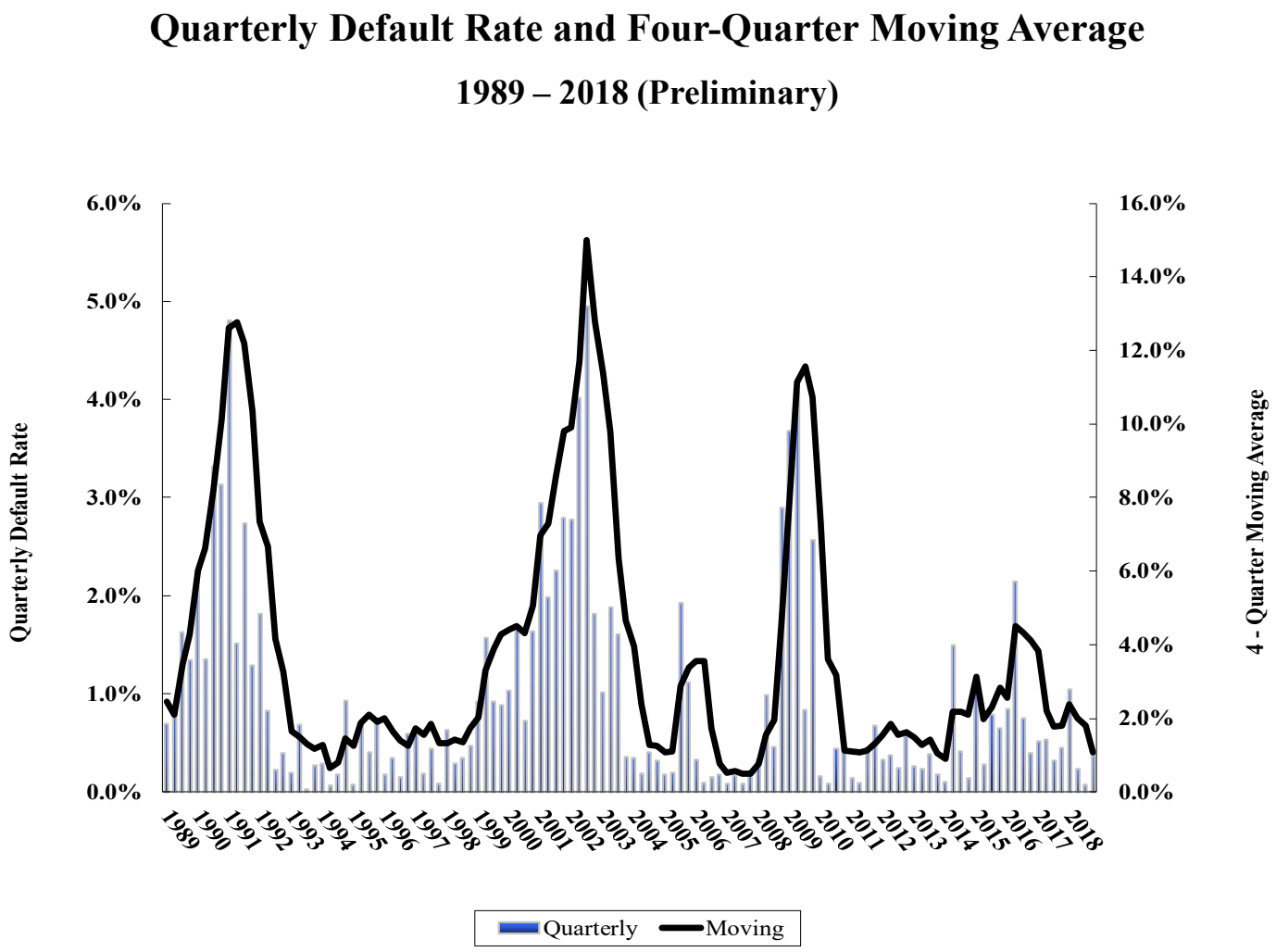
[a] Weighted by par value of amount outstanding for each year.

| Year | Par Value Outstanding* ($) | Par Value Defaults ($) | Default Rates (%) |
|---|---|---|---|
| 1990 | 181,000 | 18,354 | 10.140 |
| 1989 | 189,258 | 8,110 | 4.285 |
| 1988 | 148,187 | 3,944 | 2.662 |
| 1987 | 129,557 | 7,486 | 5.778 |
| 1986 | 90.243 | 3,156 | 3.497 |
| 1985 | 58,088 | 992 | 1.708 |
| 1984 | 40,939 | 344 | 0.840 |
| 1983 | 27,492 | 301 | 1.095 |
| 1982 | 18,109 | 577 | 3.186 |
| 1981 | 17,115 | 27 | 0.158 |
| 1980 | 14,935 | 224 | 1.500 |
| 1979 | 10,356 | 20 | 0.193 |
| 1978 | 8,946 | 119 | 1.330 |
| 1977 | 8,157 | 381 | 4.671 |
| 1976 | 7,735 | 30 | 0.388 |
| 1975 | 7,471 | 204 | 2.731 |
| 1974 | 10,894 | 123 | 1.129 |
| 1973 | 7,824 | 49 | 0.626 |
| 1972 | 6,928 | 193 | 2.786 |
| 1971 | 6,602 | 82 | 1.242 |

| | | Standard Deviation (%) |
|---|---|---|
| **Arithmetic Average Default Rate (%)** | | |
| 1971 to 2018 | 3.076 | 2.981 |
| 1978 to 2018 | 3.270 | 3.131 |
| 1985 to 2018 | 3.699 | 3.249 |
| **Weighted Average Default Rate (%)** | | |
| 1971 to 2018 | 3.273 | |
| 1978 to 2018 | 3.276 | |
| 1985 to 2018 | 3.287 | |
| **Median Annual Default Rate (%)** | | |
| 1971 to 2018 | 1.774 | |

Source: NYU Salomon Center and Citigroup/Credit Suisse estimates

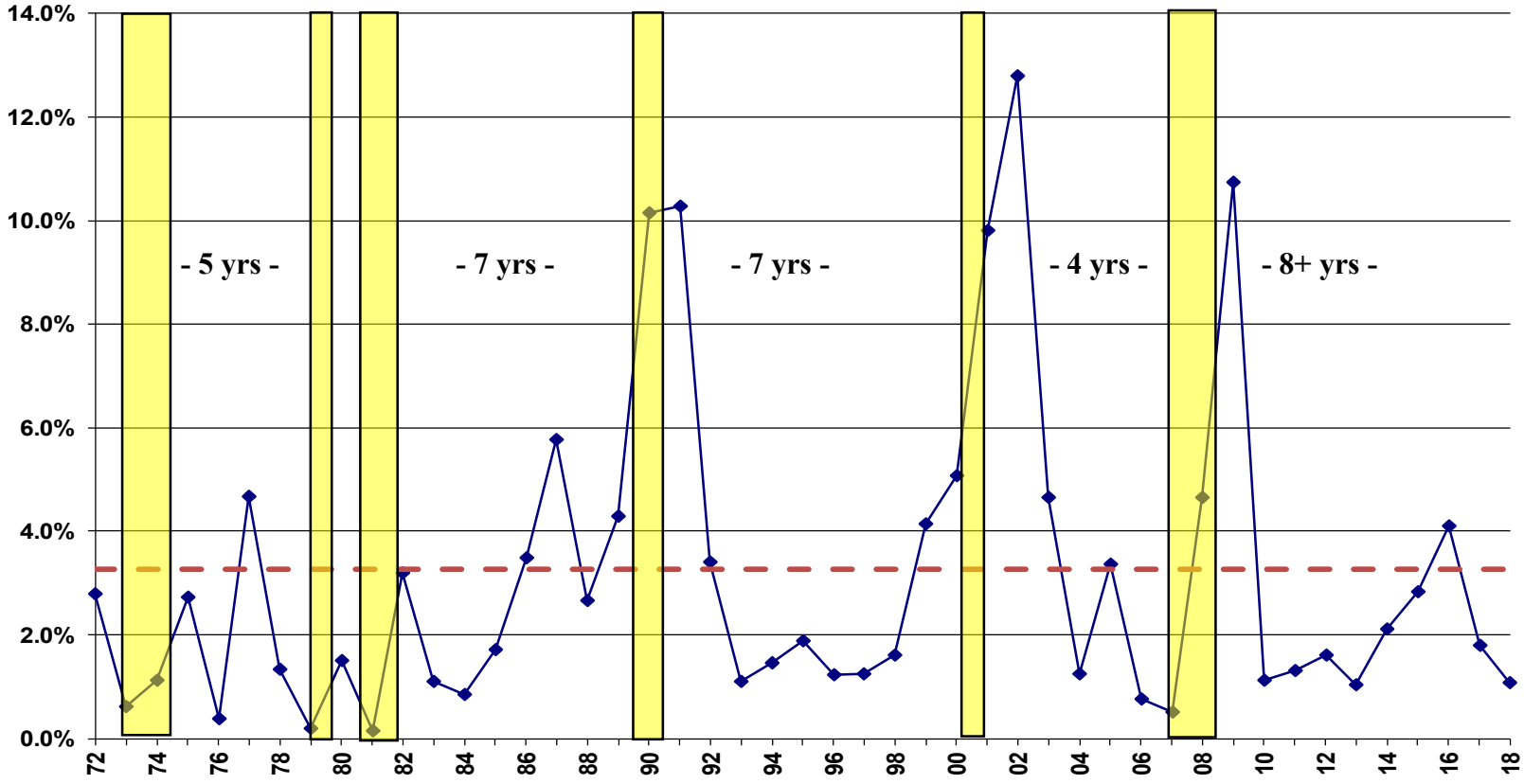
# Default Rates on High-Yield Bonds




Source: Author's Compilations

# Historical Default Rates, Benign Credit Cycles and Recession Periods in the U.S.*

**High-Yield Bond Market (1972 – 2018 (Preliminary))**




**Periods of Recession: 11/73 - 3/75, 1/80 - 7/80, 7/81 - 11/82, 7/90 - 3/91, 4/01 – 12/01, 12/07 - 6/09**

***Benign credit cycles are approximated.**

Source: E. Altman (NYU Salomon Center) & National Bureau of Economic Research

# Forecasting Default Rates

## Mortality Rate Approach (1989)

## Yield-Spread vs. Default Rate Method (2008)

## Distress Ratio vs. Default Rate Method (2008)

# Default and Recovery Forecasts: Summary of Forecast Models

| Model | 2018 (12/31) Default Rate Forecast as of 12/31/2017 | 2019 (12/31) Default Rate Forecast as of 12/31/2018 |
|---|---|---|
| Mortality Rate | 3.90% | 4.20% |
| Yield-Spread | 1.95%[c] | 3.91%[c] |
| Distress Ratio | 1.75%[d] | 2.28%[d] |
| Average of Models | 2.53% | 3.46% |
| Recovery Rates* | 45.1% | 41.3% |

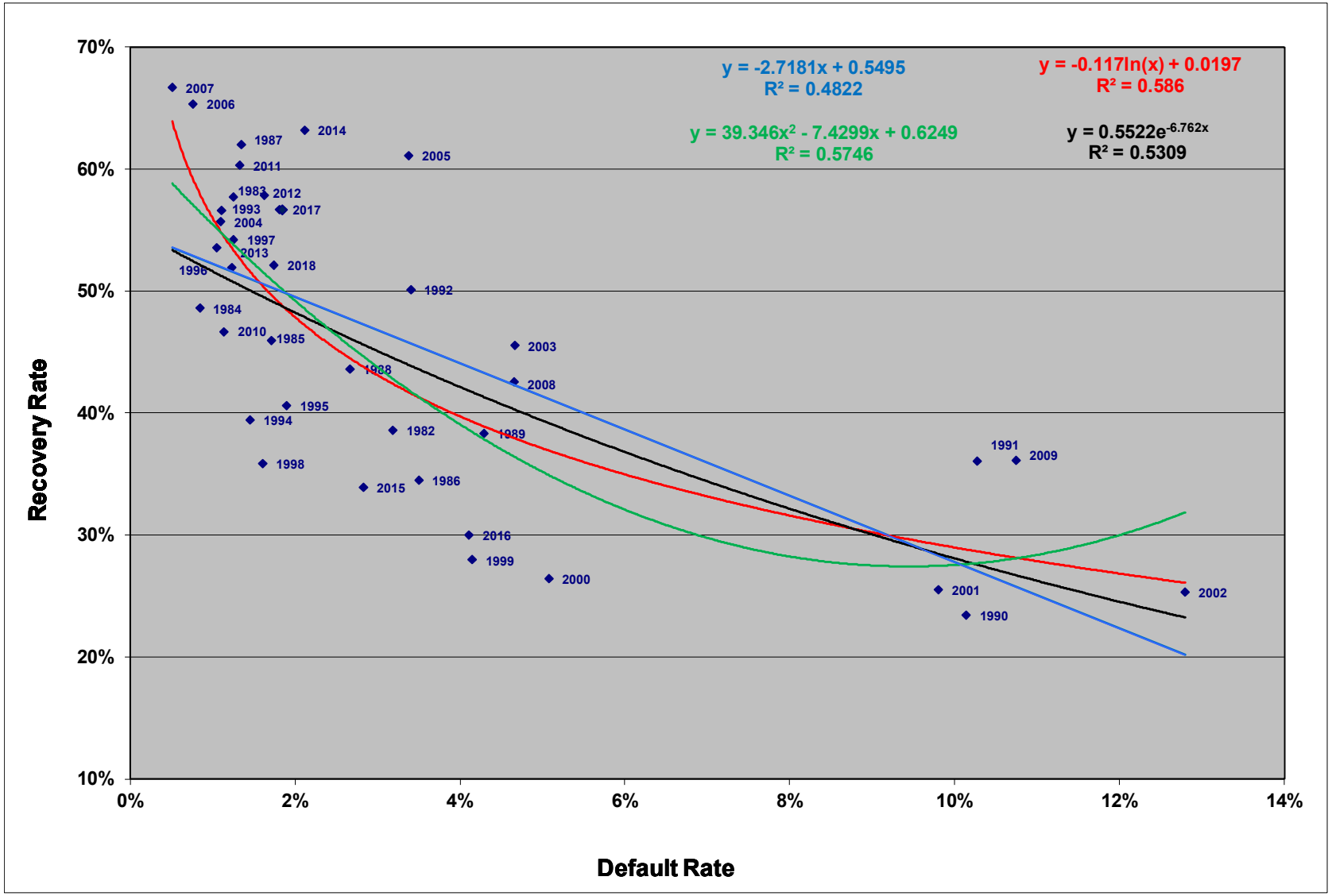
* Recovery rate based on the log Linear equation between default and recovery rates, see Altman, et al (2005) Journal of Business, November and Slide 37. [a] Based on Dec. 31, 2017 yield-spread of 394.6bp. [b] Based on Dec. 31, 2017 Distress Ratio of 6.11%. [c] Based on Dec. 31, 2018 yield-spread of 547.2bp. [d] Based on Dec. 31, 2018 Distress Ratio of 9.91%.



Source: All Corporate Bond Issuance and Authors' Estimates of Market Size in 2018 & 2019.

# Recovery Rates

# Recovery Rate/Default Rate Association: Dollar-Weighted Average Recovery Rates to Dollar Weighted Average Default Rates, 1982 – 2018 (Preliminary)




Source: E. Altman, et. al., "The Link Between Default and Recovery Rates", NYU Salomon Center, S-03-4.

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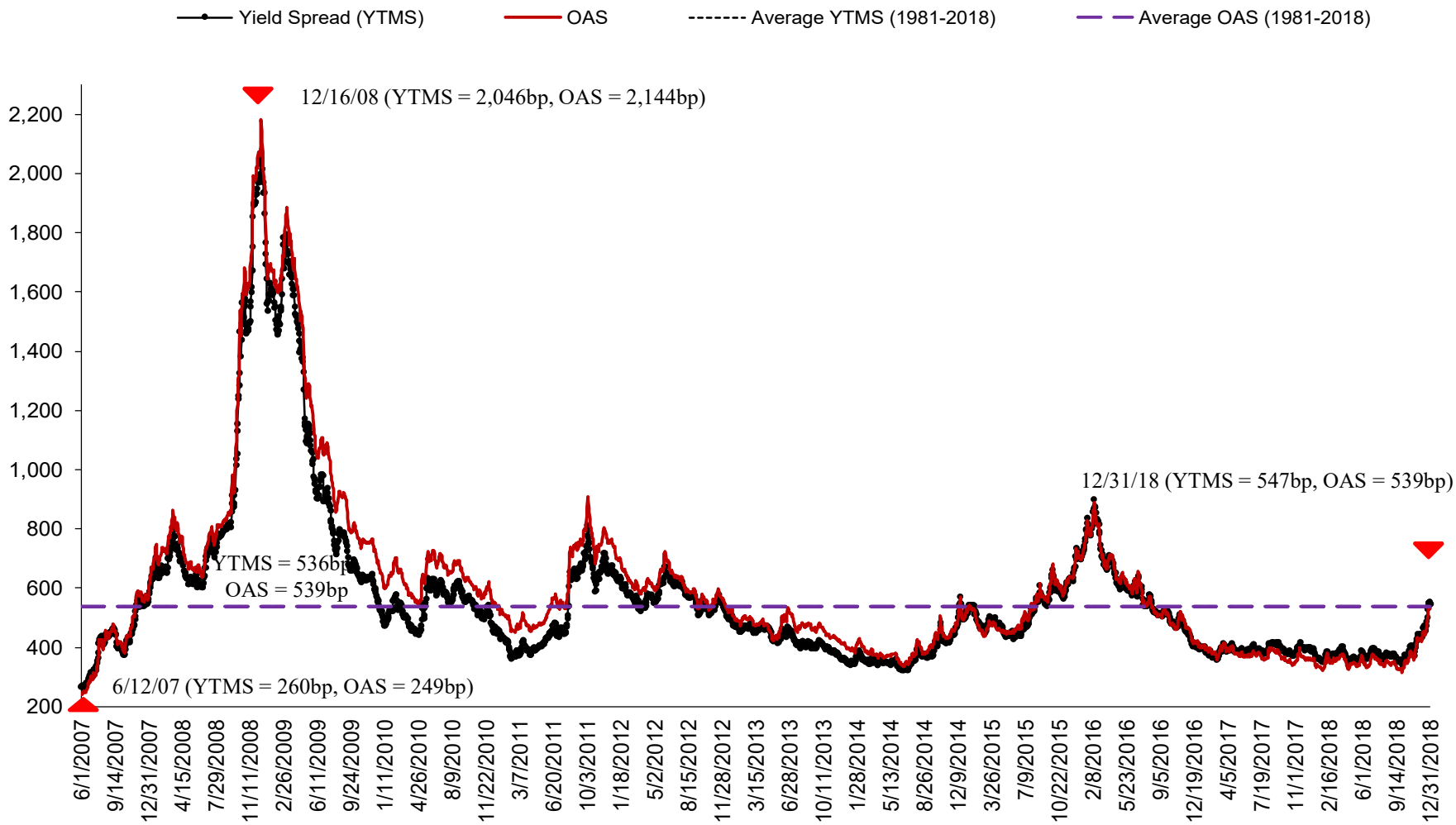
# YTM & Option-Adjusted Spreads Between High Yield Markets & U.S. Treasury Notes

**June 01, 2007 – December 31, 2018**




Sources: Citigroup Yieldbook Index Data and Bank of America Merrill Lynch.

# Annual Returns (1978 – 2018)

## Yields and Spreads on 10-Year Treasury (Treas) and High Yield (HY) Bonds[a]

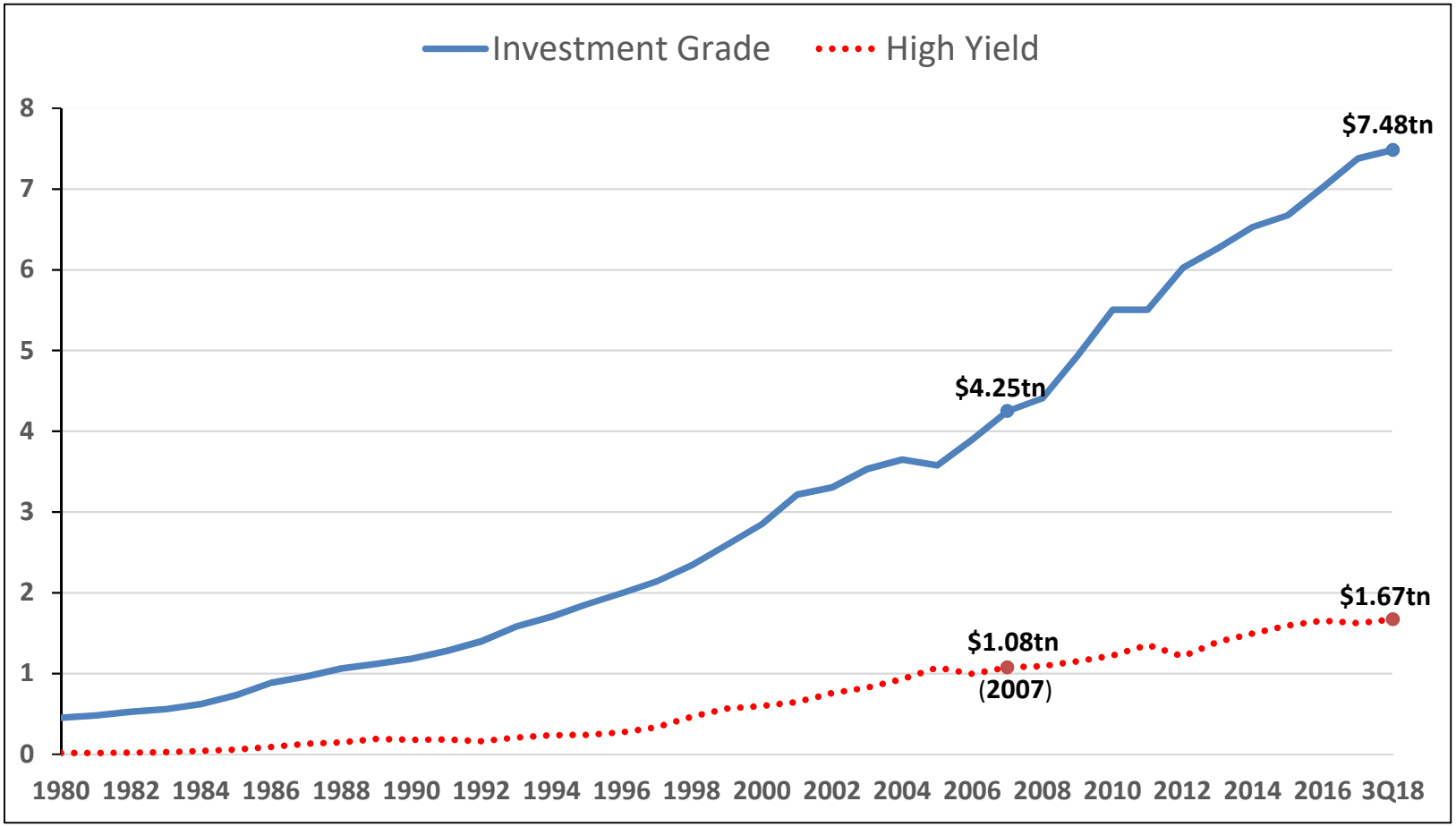
| | Return (%) | | | Promised Yield (%) | | |
|---|---|---|---|---|---|---|
| Year | HY | Treas | Spread | HY | Treas | Spread |
| 2018 | (2.13) | (0.02) | (2.11) | 8.16 | 2.69 | 5.47 |
| 2017 | 7.05 | 2.13 | 4.92 | 6.35 | 2.41 | 3.95 |
| 2016 | 17.83 | (0.14) | 17.96 | 6.55 | 2.43 | 4.12 |
| 2015 | (5.56) | 0.90 | (6.46) | 9.27 | 2.27 | 7.00 |
| 2014 | 1.83 | 10.72 | (8.89) | 7.17 | 2.17 | 5.00 |
| 2013 | 7.22 | (7.85) | 15.06 | 6.45[b] | 3.01 | 3.45 |
| 2012 | 15.17 | 4.23 | 10.95 | 6.80 | 1.74[b] | 5.06 |
| 2011 | 5.52 | 16.99 | (11.47) | 8.41 | 1.88 | 6.54 |
| 2010 | 14.32 | 8.10 | 6.22 | 7.87 | 3.29 | 4.58 |
| 2009 | 55.19 | (9.92) | 65.11 | 8.97 | 3.84 | 5.14 |
| 2008 | (25.91) | 20.30 | (46.21) | 19.53 | 2.22 | 17.31 |
| 2007 | 1.83 | 9.77 | (7.95) | 9.69 | 4.03 | 5.66 |
| 2006 | 11.85 | 1.37 | 10.47 | 7.82 | 4.70 | 3.11 |
| 2005 | 2.08 | 2.04 | 0.04 | 8.44 | 4.39 | 4.05 |
| 2004 | 10.79 | 4.87 | 5.92 | 7.35 | 4.21 | 3.14 |
| 2003 | 30.62 | 1.25 | 29.37 | 8.00 | 4.26 | 3.74 |
| 2002 | (1.53) | 14.66 | (16.19) | 12.38 | 3.82 | 8.56 |
| 2001 | 5.44 | 4.01 | 1.43 | 12.31 | 5.04 | 7.27 |
| 2000 | (5.68) | 14.45 | (20.13) | 14.56 | 5.12 | 9.44 |
| 1999 | 1.73 | (8.41) | 10.14 | 11.41 | 6.44 | 4.97 |
| 1998 | 4.04 | 12.77 | (8.73) | 10.04 | 4.65 | 5.39 |
| 1997 | 14.27 | 11.16 | 3.11 | 9.20 | 5.75 | 3.45 |
| 1996 | 11.24 | 0.04 | 11.20 | 9.58 | 6.42 | 3.16 |
| 1995 | 22.40 | 23.58 | (1.18) | 9.76 | 5.58 | 4.18 |
| 1994 | (2.55) | (8.29) | 5.74 | 11.50 | 7.83 | 3.67 |
| 1993 | 18.33 | 12.08 | 6.25 | 9.08 | 5.80 | 3.28 |
| 1992 | 18.29 | 6.50 | 11.79 | 10.44 | 6.69 | 3.75 |
| 1991 | 43.23 | 17.18 | 26.05 | 12.56 | 6.70 | 5.86 |
| 1990 | (8.46) | 6.88 | (15.34) | 18.57 | 8.07 | 10.50 |
| 1989 | 1.98 | 16.72 | (14.74) | 15.17 | 7.93 | 7.24 |
| 1988 | 15.25 | 6.34 | 8.91 | 13.70 | 9.15 | 4.55 |
| 1987 | 4.57 | (2.67) | 7.24 | 13.89 | 8.83 | 5.06 |
| 1986 | 16.50 | 24.08 | (7.58) | 12.67 | 7.21 | 5.46 |
| 1985 | 26.08 | 31.54 | (5.46) | 13.50 | 8.99 | 4.51 |
| 1984 | 8.50 | 14.82 | (6.32) | 14.97 | 11.87 | 3.10 |
| 1983 | 21.80 | 2.23 | 19.57 | 15.74 | 10.70 | 5.04 |
| 1982 | 32.45 | 42.08 | (9.63) | 17.84 | 13.86 | 3.98 |
| 1981 | 7.56 | 0.48 | 7.08 | 15.97 | 12.08 | 3.89 |
| 1980 | (1.00) | (2.96) | 1.96 | 13.46 | 10.23 | 3.23 |
| 1979 | 3.69 | (0.86) | 4.55 | 12.07 | 9.13 | 2.94 |
| 1978 | 7.57 | (1.11) | 8.68 | 10.92 | 8.11 | 2.81 |
| Arithmetic Annual Average | | | | | | |
| 1978-2018 | 10.08 | 7.37 | 2.72 | 11.17 | 5.99 | 5.19 |
| Compound Annual Average | | | | | | |
| 1978-2018 | 9.21 | 6.84 | 2.36 | | | |

[a] End-of-year yields. [b] Lowest yield in time series. Source: FTSE's High Yield Composite Index

# Some Concerns About the Benign Credit Cycle

# U.S. Corporate Leverage Surges to Almost $10 Trillion

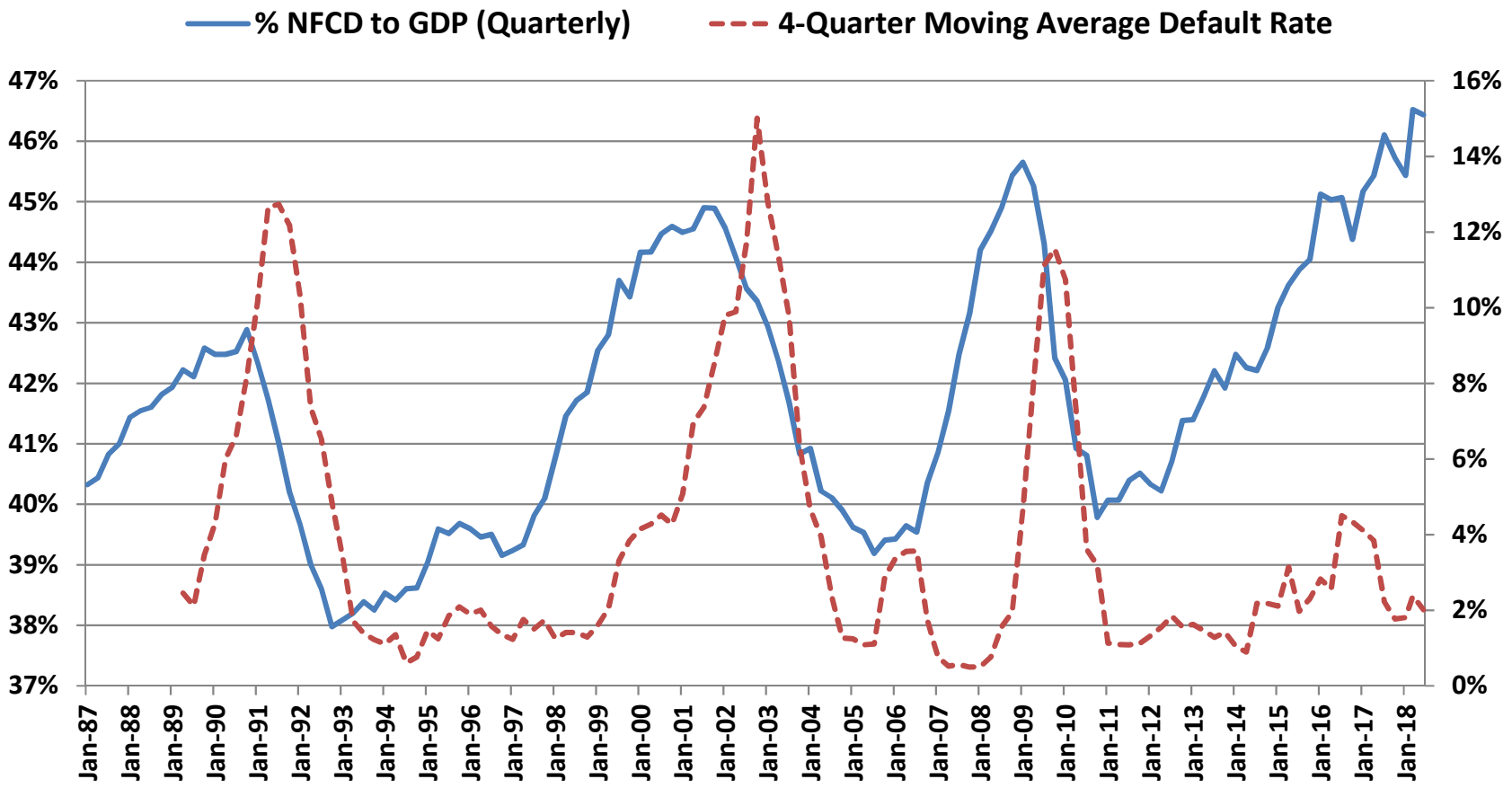
Outstanding Corporate Bonds, by Rating ($tn)




Sources: SIFMA and NYU Salomon Center.

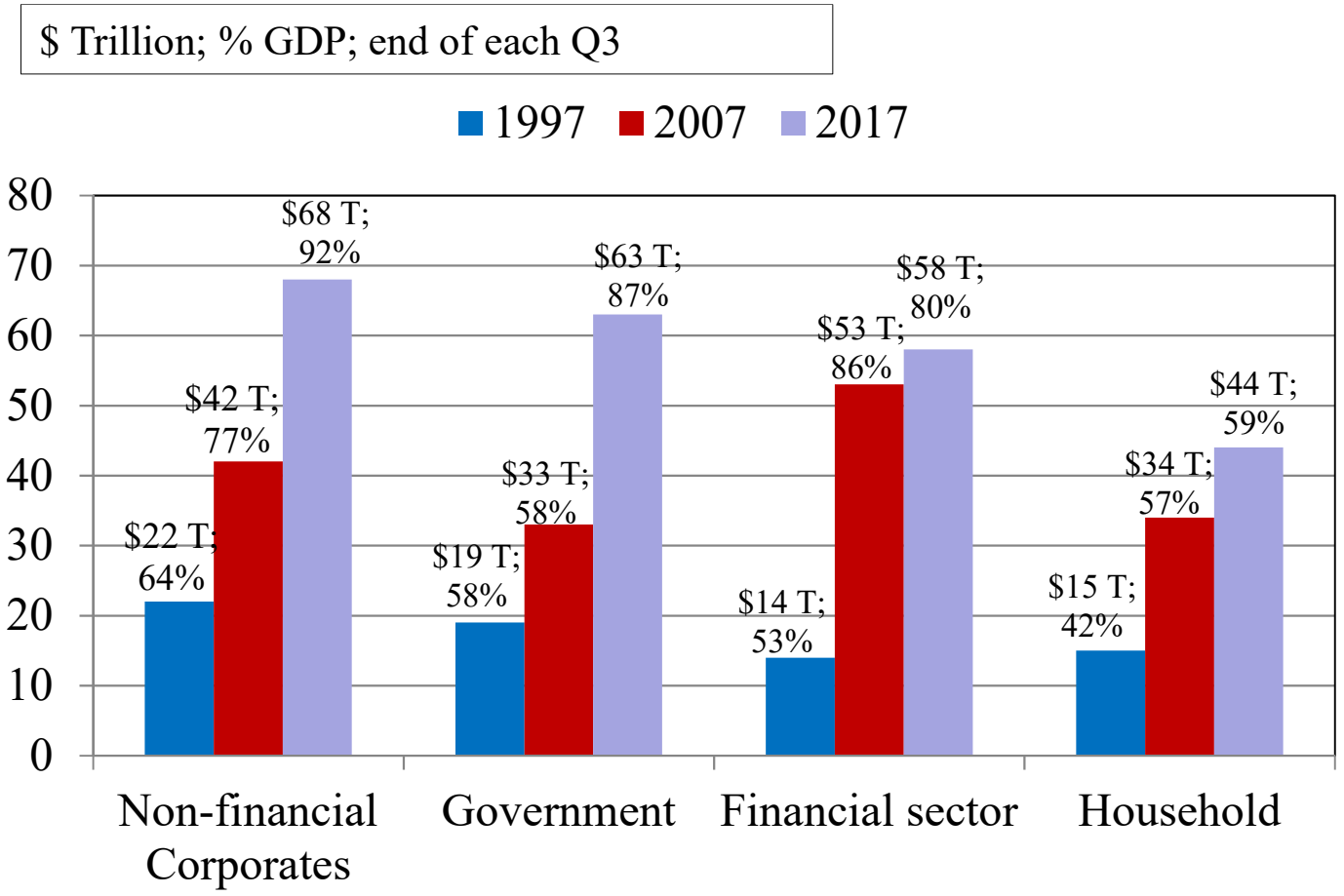
# U.S. Non-financial Corporate Debt (Credit Market Instruments) to GDP: Comparison to 4-Quarter Moving Average Default Rate

**January 1, 1987 – June 30, 2018**




Sources: FRED, Federal Reserve Bank of St. Louis and Altman/Kuehne High-Yield Default Rate data.

# Global Sectoral Indebtedness




| Year | % of GDP | Total $ Amt. ($ T) |
|---|---|---|
| 1997 | 217% | 70 |
| 2007 | 278% | 162 |
| 2017 | 318% | 233 |

Sources: Chart from *Independent UK* using IIF, BIS, IMF and Haver data.

# Comparative Health of High-Yield Firms (2007 vs. 2017)

# Comparing Financial Strength of High-Yield Bond Issuers in 2007& 2012/2014/2017

| Number of Firms | | |
|---|---|---|
| | Z-Score | Z”-Score |
| 2007 | 294 | 378 |
| 2012 | 396 | 486 |
| 2014 | 577 | 741 |
| 2017 | 529 | 583 |

| Year | Average Z-Score/ (BRE)* | Median Z-Score/ (BRE)* | Average Z”-Score/ (BRE)* | Median Z”-Score/ (BRE)* |
|---|---|---|---|---|
| 2007 | 1.95 (B+) | 1.84 (B+) | 4.68 (B+) | 4.82 (B+) |
| 2012 | 1.76 (B) | 1.73 (B) | 4.54 (B) | 4.63 (B) |
| 2014 | 2.03 (B+) | 1.85 (B+) | 4.66 (B+) | 4.74 (B+) |
| 2017 | 2.08 (B+) | 1.98 (B+) | 5.08 (BB-) | 5.09 (BB-) |

*Bond Rating Equivalent

Source: Authors’ calculations, data from Altman and Hotchkiss (2006) and S&P Global Market Intelligence’s S&P *Capital IQ platform/Compustat database.*

# Major Risks Going Forward

- Global Economic Performance – Primarily U.S., China and Europe: Impact on Default Rates, Credit Availability and Quality (No Current Major Concern)
- Falling Oil Prices (No Current Major Concern)
- Global Debt Excess and Increasing Interest Rates
- High-Yield Fundamentals Still Fairly Weak
- Contagion Between Markets – Risky Debt and Equity
- Interest Rates and Inflation – Reduced Importance of the Search-for-Yield
- LBO, Covenant-Lite and CCC New Issuance
- Sovereign Debt Crisis – Asia (1997), Europe (2009-13), Emerging Markets?
- Uncertainties (non-quantifiable) – e.g. Political, Trade, Other