An Innovative Look at Credit Risk

George Bonne, PhD, PRM, Director of Quantitative Research
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Tim Gaumer, CFA, Director of Fundamental Research

29 September 2011

THOMSON REUTERS
STARMINE

AGENDA

- CREDIT RISK BASICS

- CREDIT RISK MODEL
  - STRUCTURAL MODEL (MERTON APPROACH)
  - RATIO ANALYSIS
  - TEXT MINING
  - CDS
  - LOSS GIVEN DEFAULT

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Credit risk basics

- Two fundamental quantities of interest
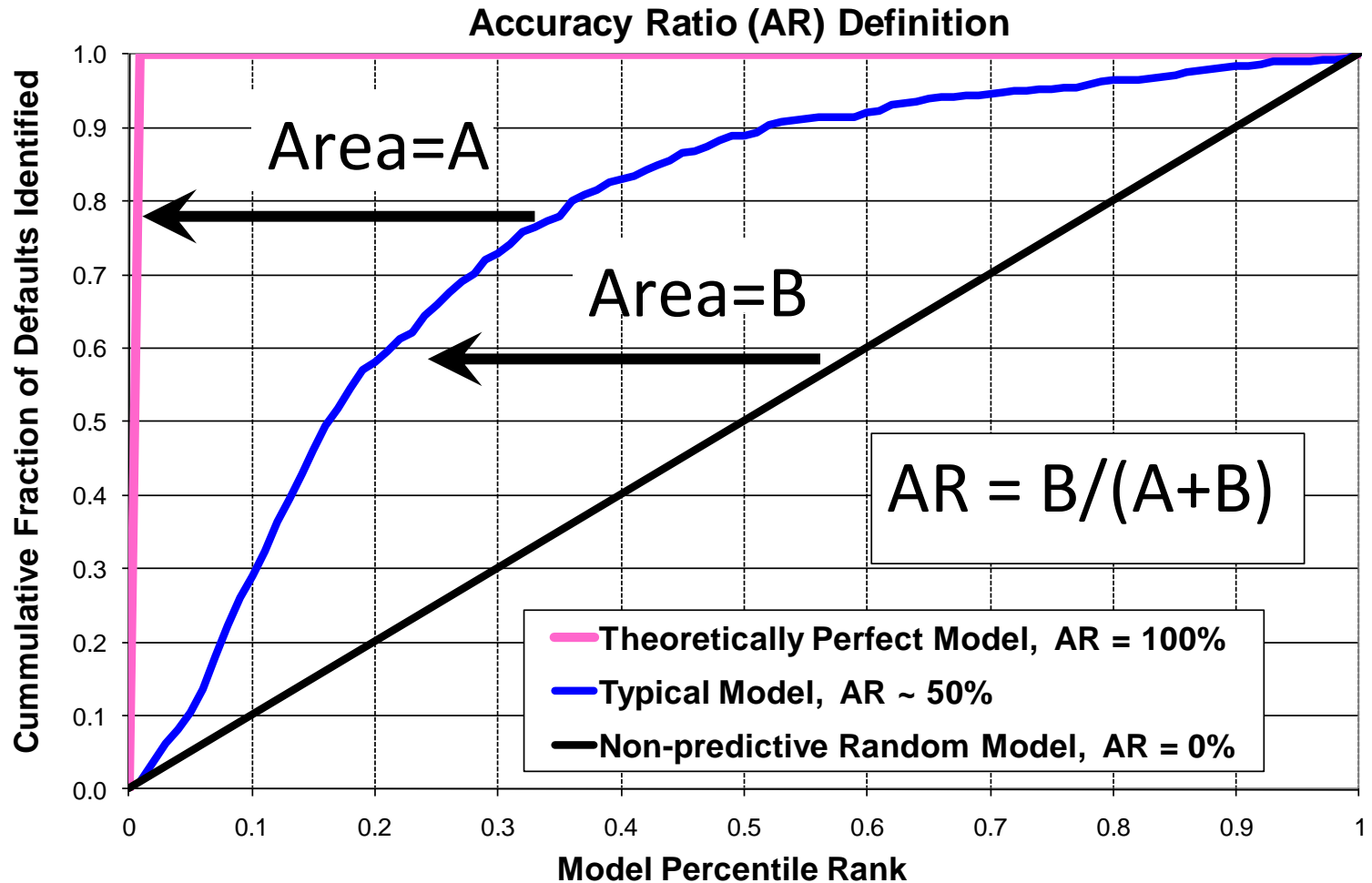 - Probability of Default (PD)
  - Loss Given Default (LGD)

Expected Loss = PD * LGD * Exposure

- Traditionally, two fundamental types of data used to model PD
  - Market prices (e.g., Structural/Merton model)
  - Accounting data (reported financials)
  - Analyst estimates
  - Text (News, conf call transcripts, filings, analyst research)

StarMine adds two more

Default prediction model performance metric

Accuracy Ratio (AR) Definition

Area=A

Area=B

$$AR = B/(A+B)$$

- Theoretically Perfect Model, AR = 100%
- Typical Model, AR ~ 50%
- Non-predictive Random Model, AR = 0%

Cummulative Fraction of Defaults Identified (y-axis: 0.0 to 1.0)

Model Percentile Rank (x-axis: 0 to 1)

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Structural default models have three key input components.

Input	Effect on default probability
Leverage	Higher leverage increases default %
Volatility of assets	Higher asset volatility increases default %
Drift rate of assets	Higher growth rate decreases default %

- **Based on the Black-Sholes option pricing framework.**

- **Models a company's equity as a call option on its assets.**

- **Probability of default (PD) equates to the probability that the option expires worthless.**

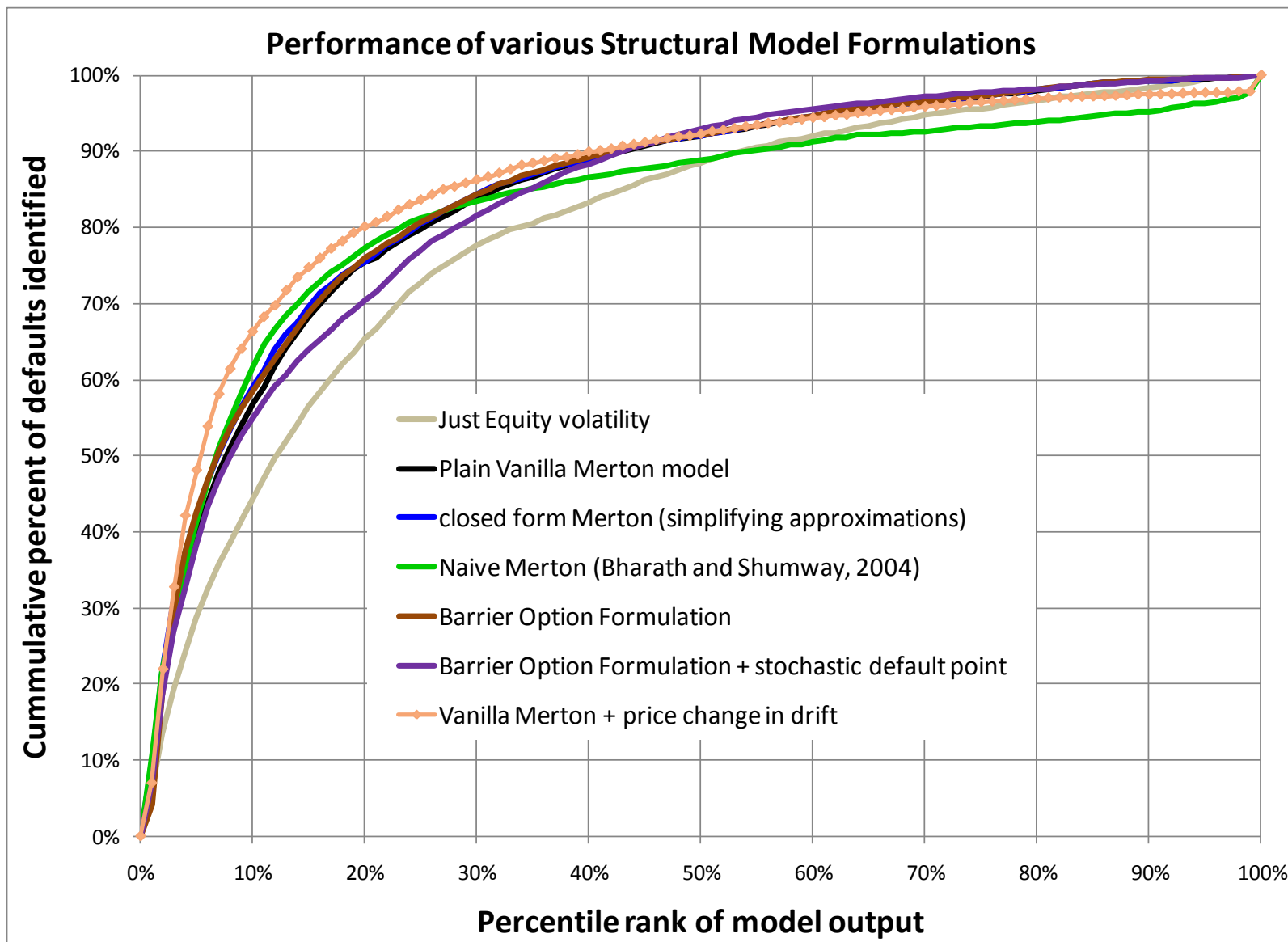- **We use a 1-year forecast horizon.**

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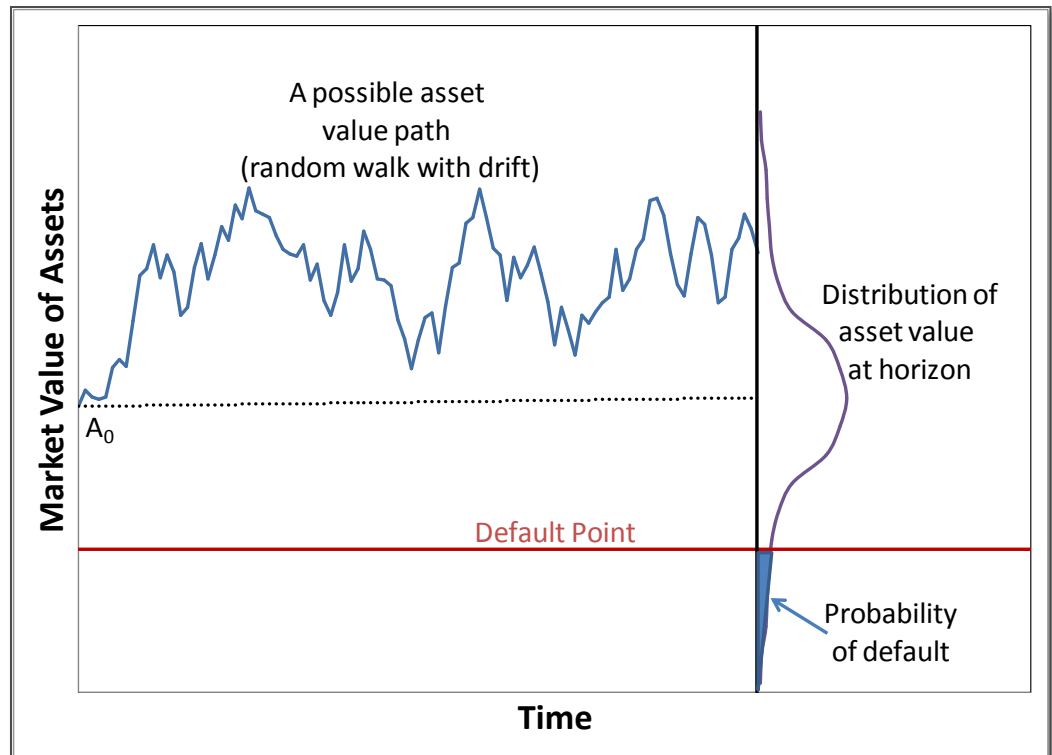
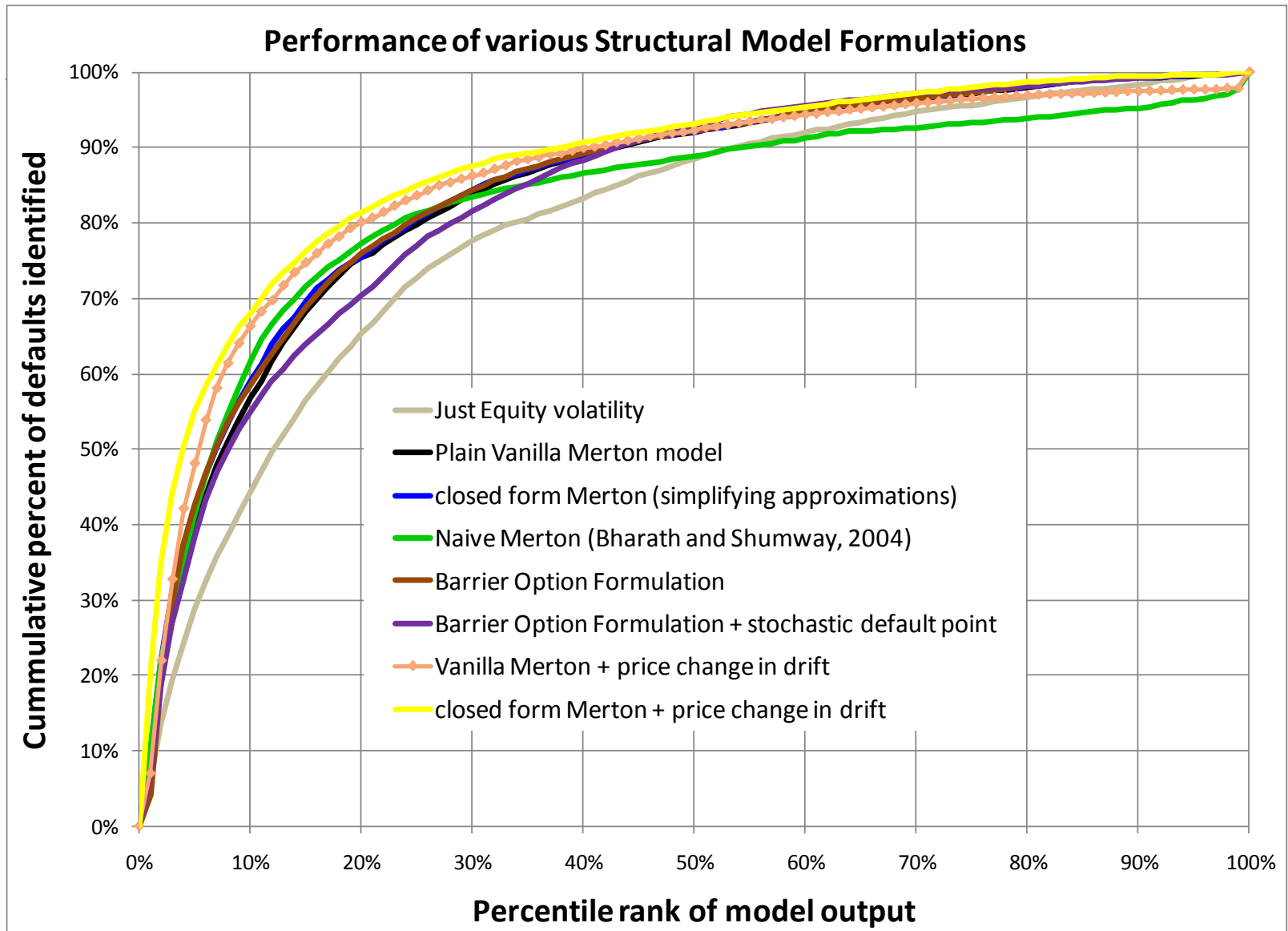# Research questions we asked in creating the structural model

- What mathematical framework should we use?

  – Barrier option, numerical solving method, stochastic or fixed default barrier, approximations to use

- How should we define the default point (what function of liabilities)?

- How should we define equity volatility – EWMA, GARCH, etc.?

- How should we estimate the drift component? Can we do better than just using R_f for all companies?

We tested many Merton model flavors. More complexity did not translate to more performance.
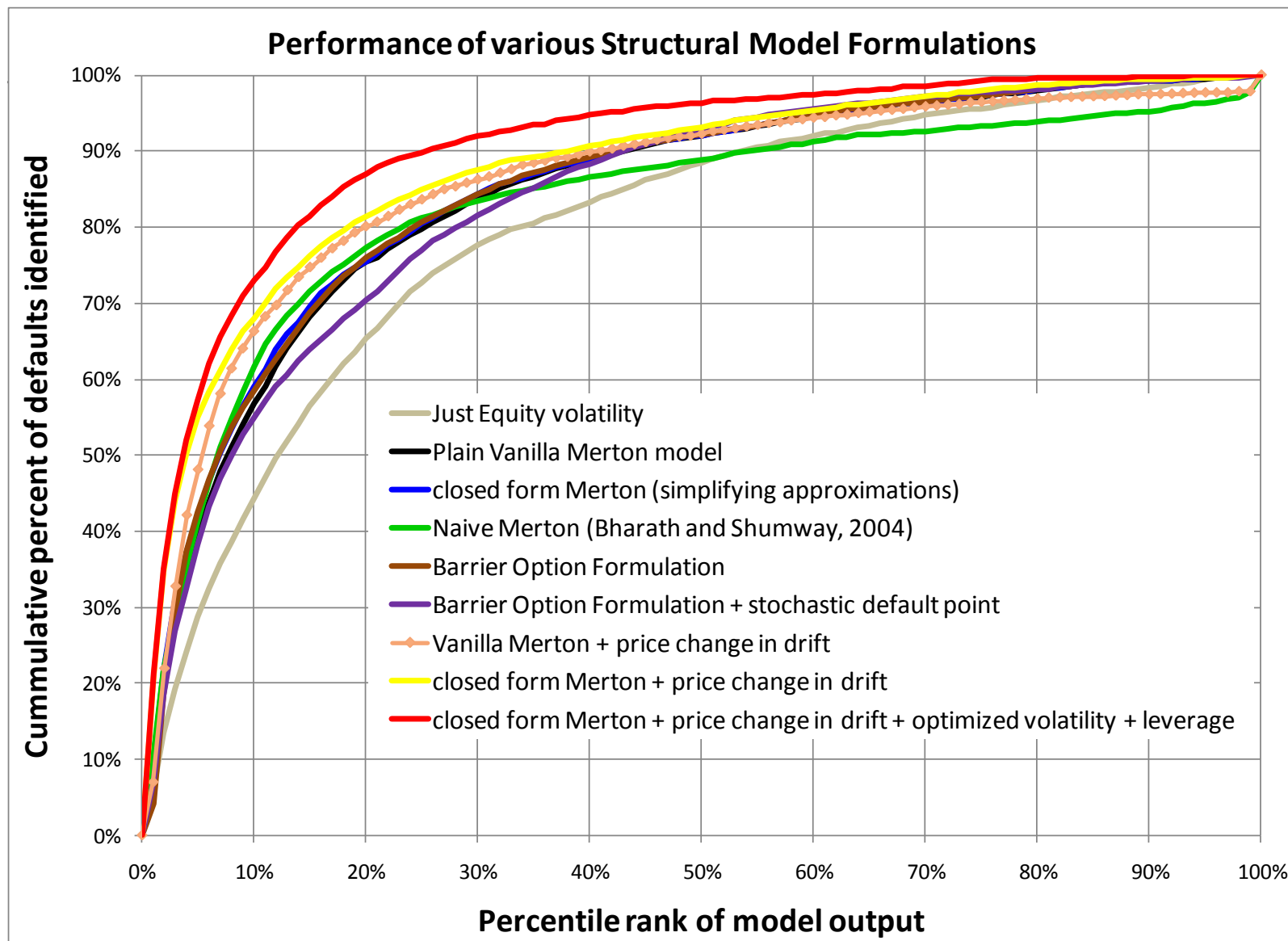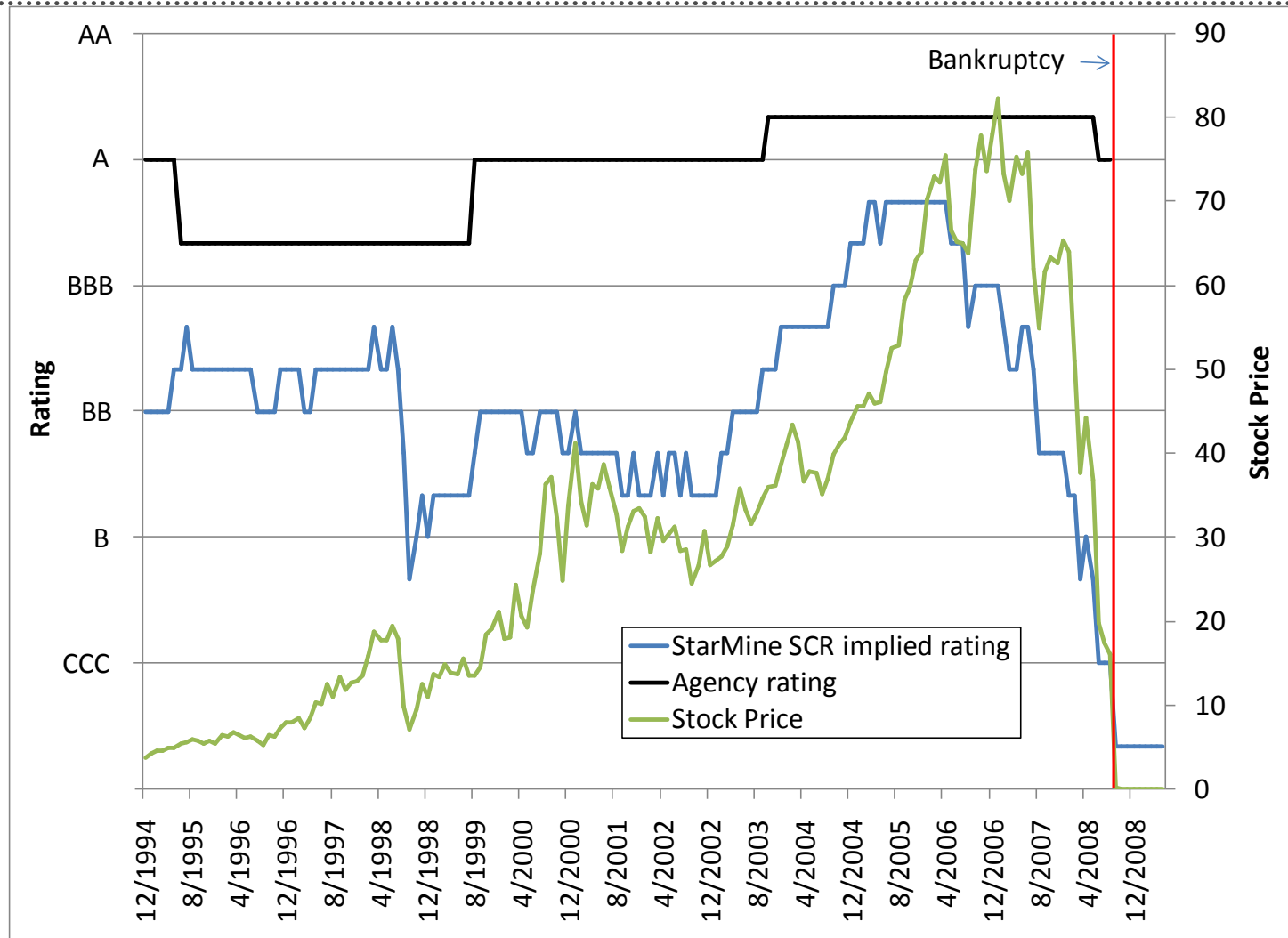

Performance of various Structural Model Formulations

Legend:
- Just Equity volatility
- Plain Vanilla Merton model
- closed form Merton (simplifying approximations)
- Naive Merton (Bharath and Shumway, 2004)
- Barrier Option Formulation
- Barrier Option Formulation + stochastic default point
- Vanilla Merton + price change in drift

Y-axis: Cummulative percent of defaults identified
X-axis: Percentile rank of model output

But price change (market sentiment) matters.

Performance of various Structural Model Formulations

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- closed form Merton + price change in drift

Y-axis: Cummulative percent of defaults identified

X-axis: Percentile rank of model output

Volatility and Leverage matter.

Performance of various Structural Model Formulations

Legend:
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- Plain Vanilla Merton model
- closed form Merton (simplifying approximations)
- Naive Merton (Bharath and Shumway, 2004)
- Barrier Option Formulation
- Barrier Option Formulation + stochastic default point
- Vanilla Merton + price change in drift
- closed form Merton + price change in drift
- closed form Merton + price change in drift + optimized volatility + leverage

Y-axis: Cummulative percent of defaults identified

X-axis: Percentile rank of model output

Historical Example: Lehman Brothers.

Current Example: Societe Generale.

Societe Generale

24 Jan 2008
Rogue trader scandal.
Losses of ~ $7 Billion

Legend: StarMine Structural Credit Risk Model — Agency Rating — Stock Price
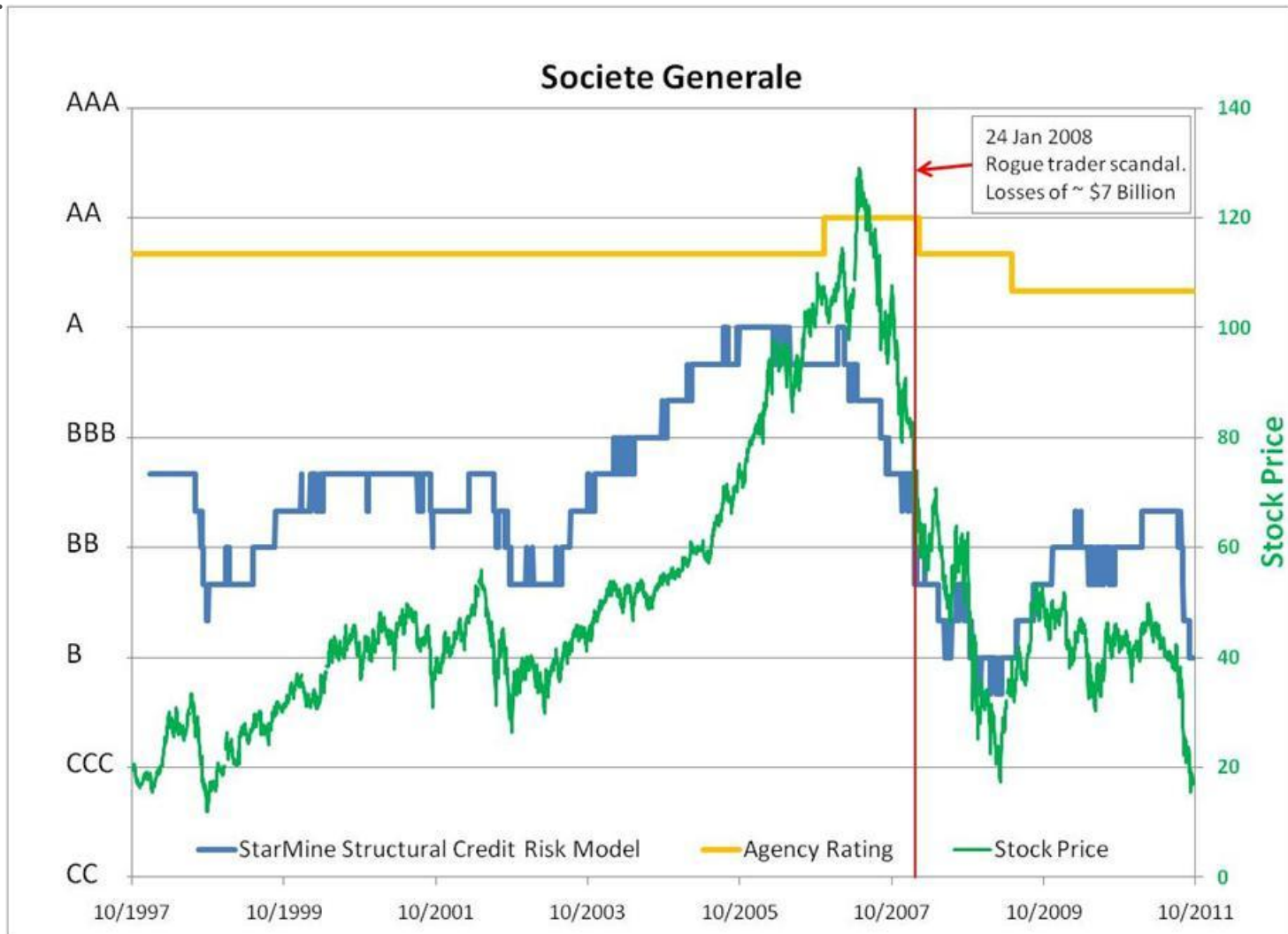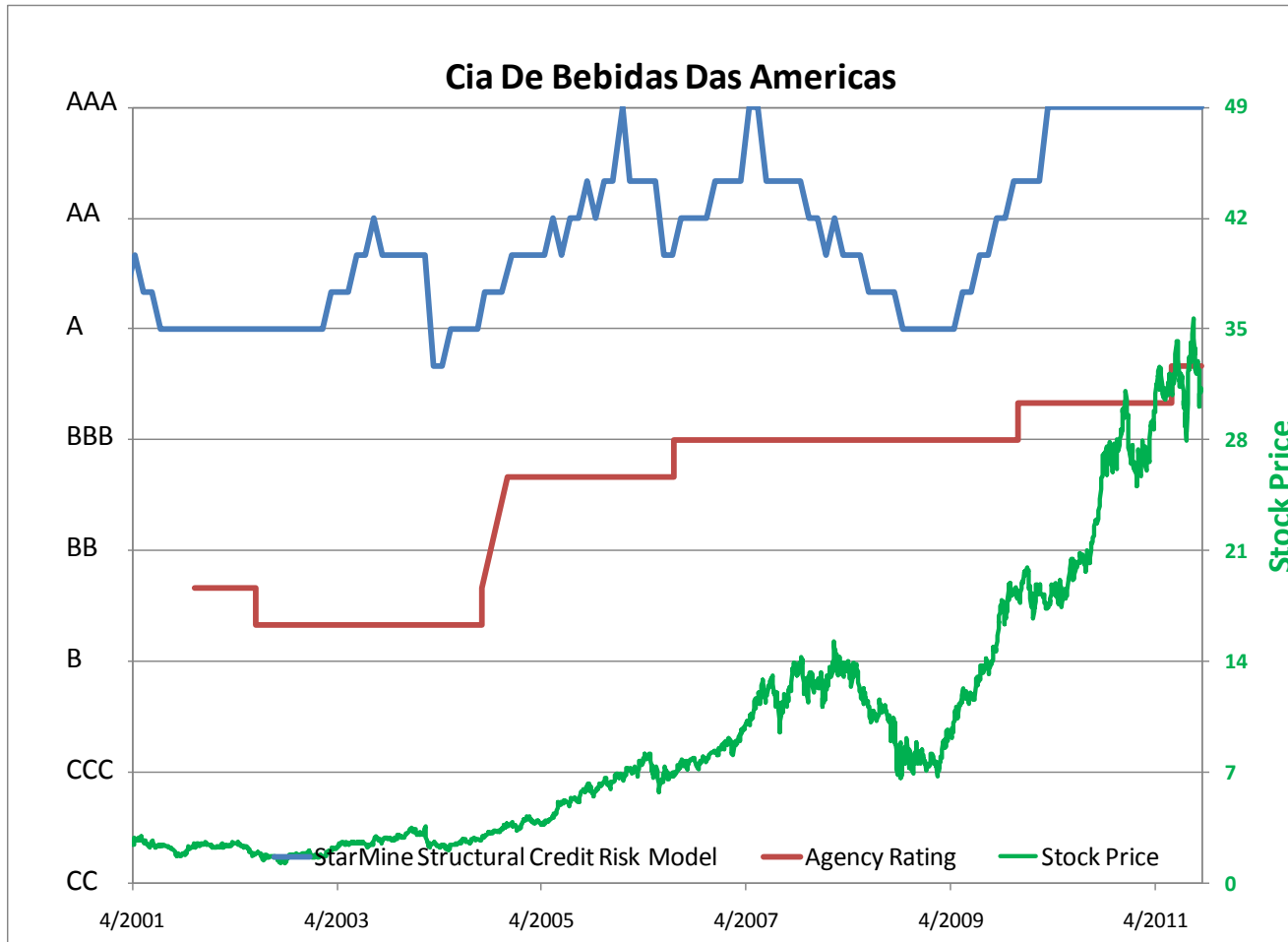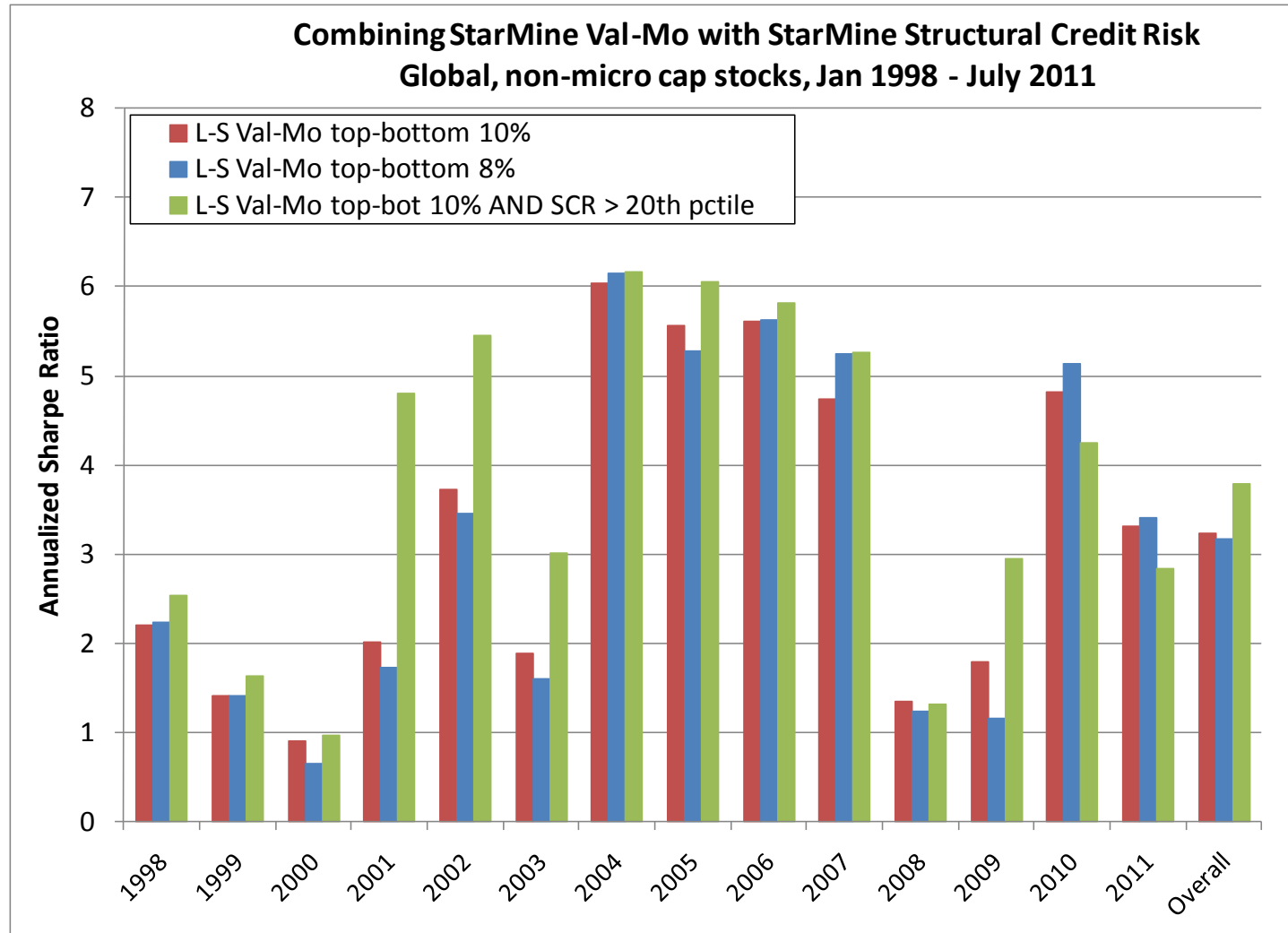
Brazil example 1: Banco Bradesco
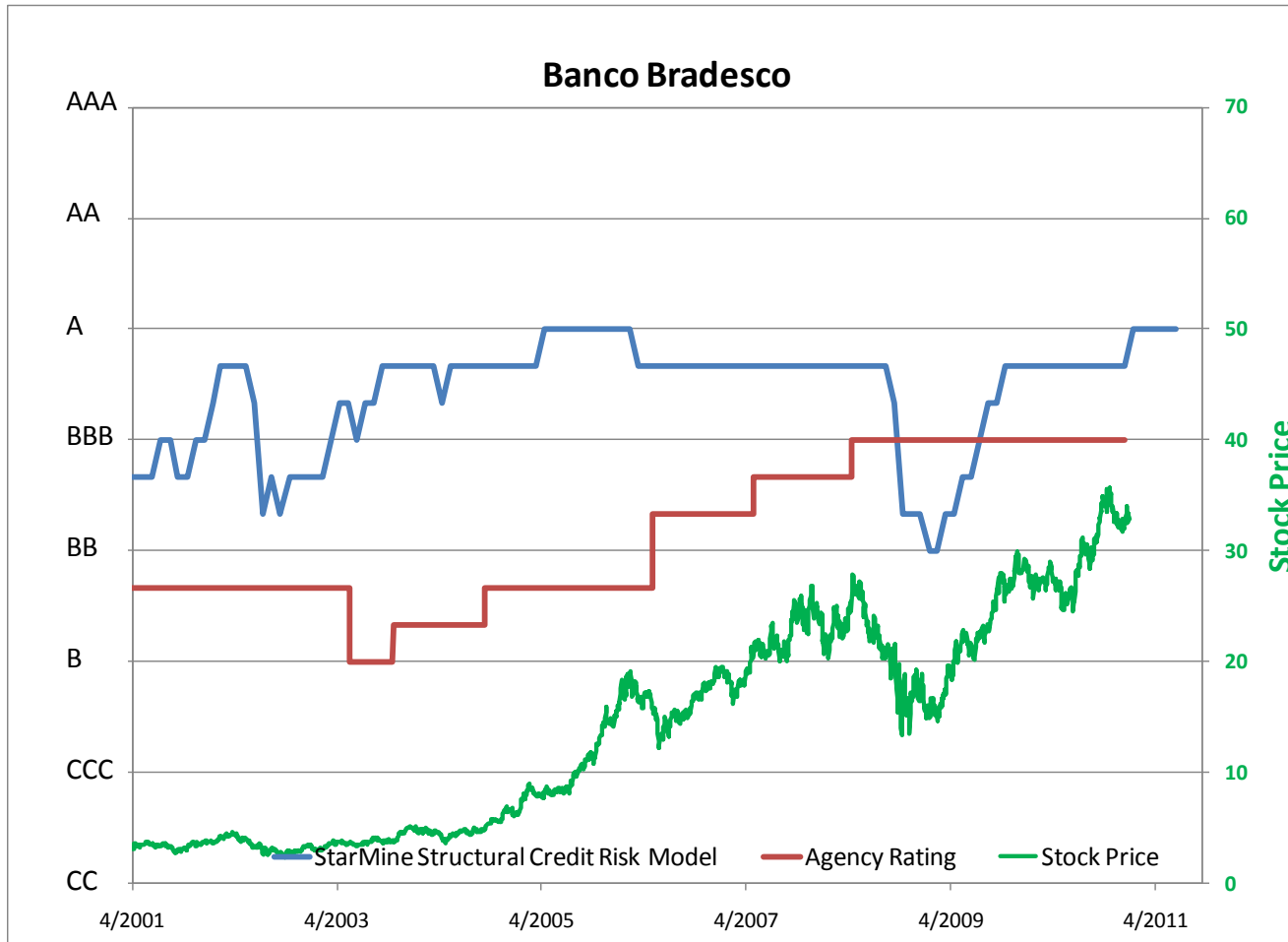
Brazil example 2: Cia de Bebidas Das Americas

# Structural model can improve long-short equity portfolio risk/return via negative screening.

Combining StarMine Val-Mo with StarMine Structural Credit Risk
Global, non-micro cap stocks, Jan 1998 - July 2011

Legend:
- L-S Val-Mo top-bottom 10%
- L-S Val-Mo top-bottom 8%
- L-S Val-Mo top-bot 10% AND SCR > 20th pctile

Y-axis: Annualized Sharpe Ratio
X-axis: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, Overall

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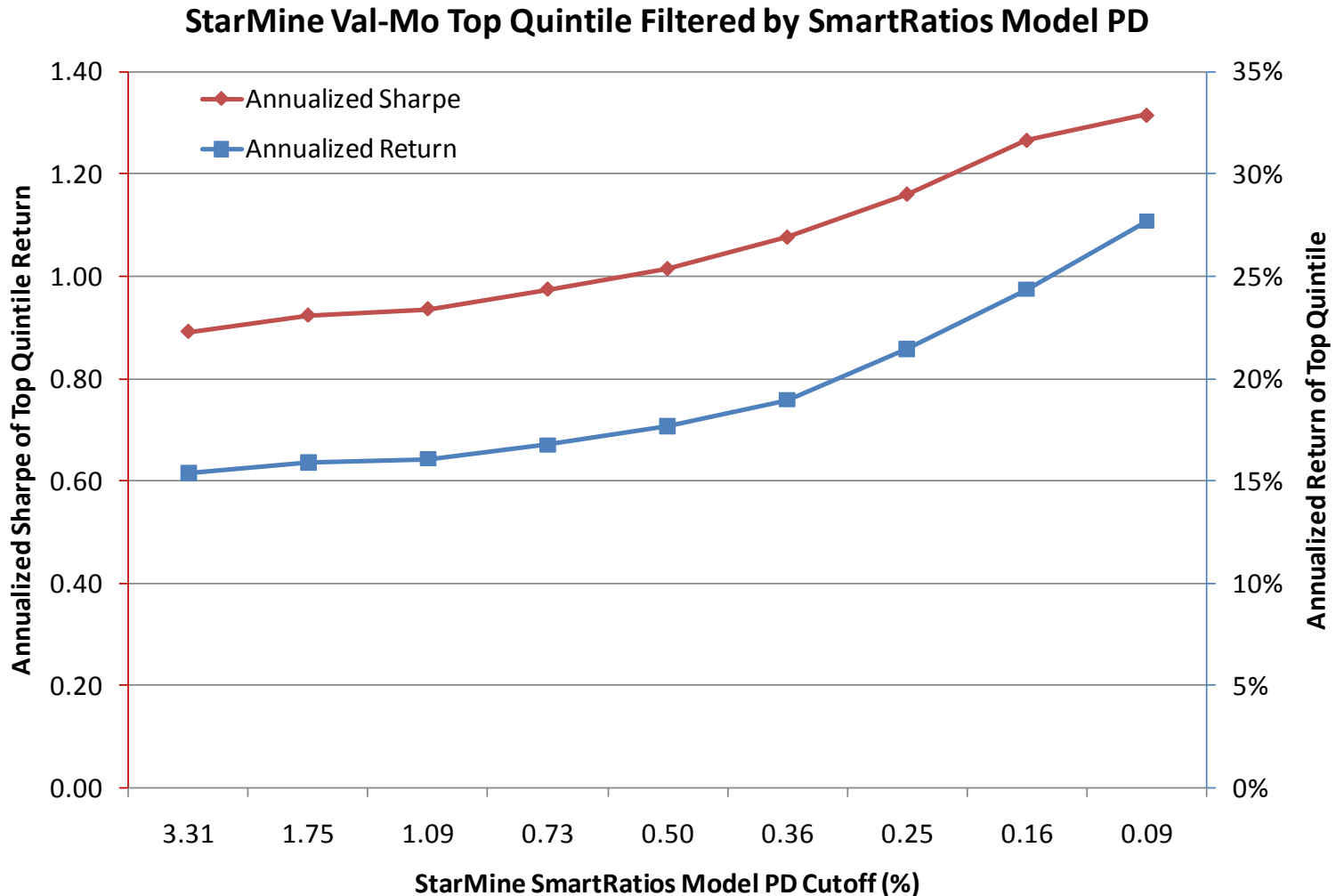 - TEXT MINING
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SmartRatios Model structure
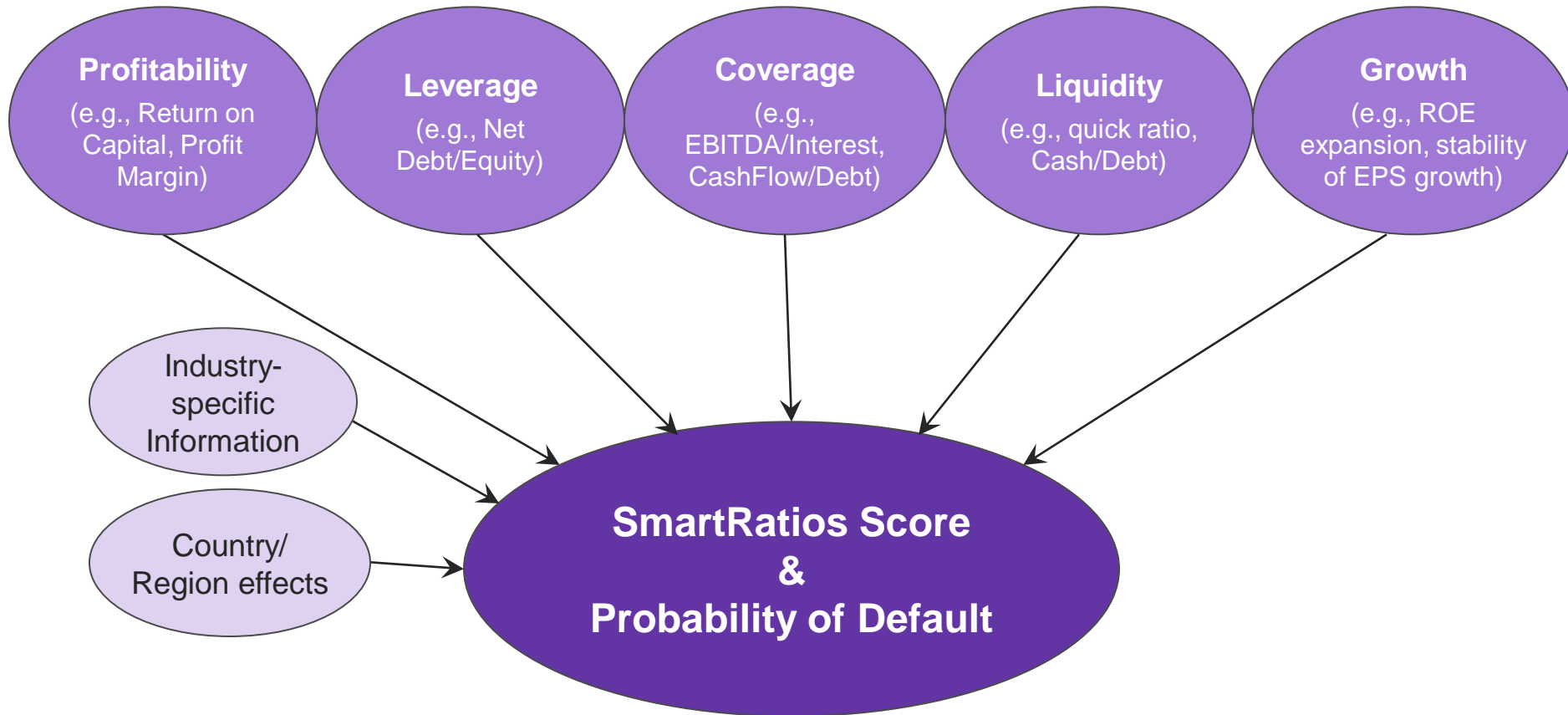
Ratios based on Estimates are better at predicting defaults than backward-looking ratios.

Value of Forward-looking Ratios
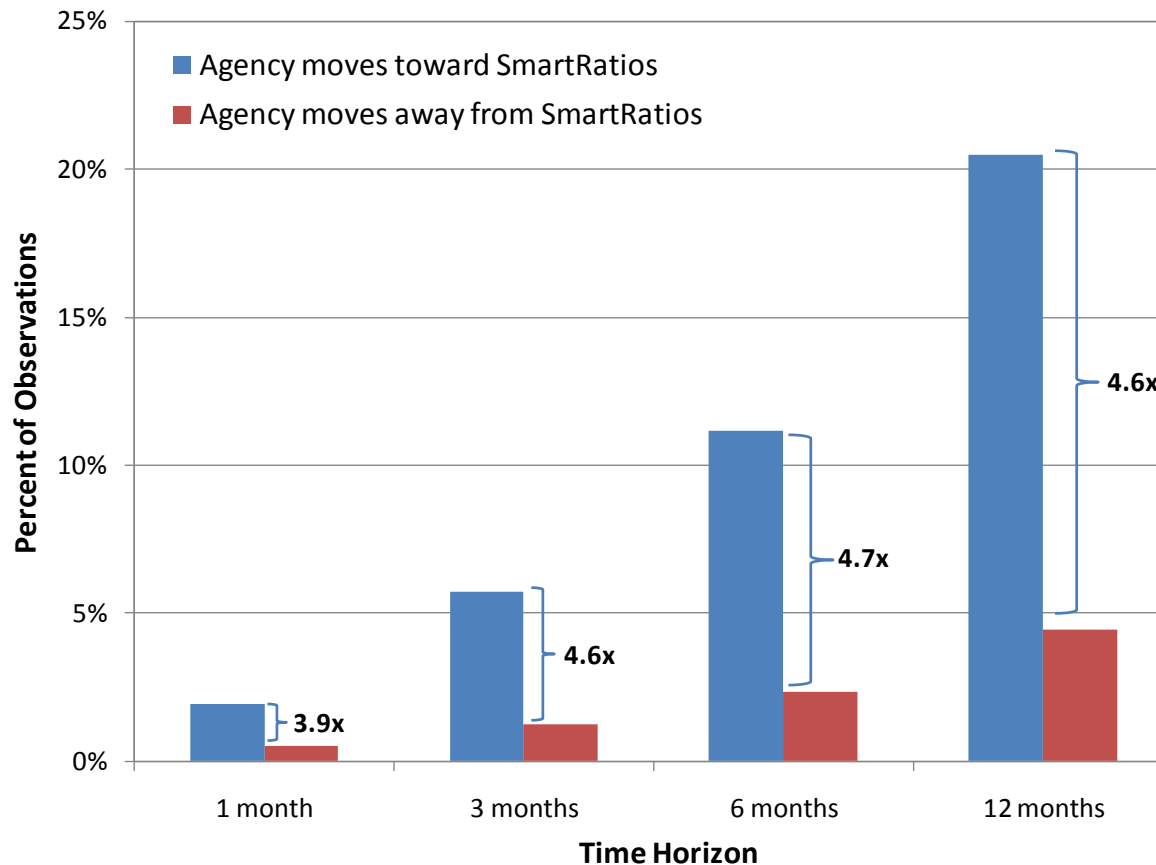
Hit Rate: % of Failures Identified among High Risk (bottom 20%) Firms

Legend:
- FY0 actuals
- FY1 SmartEstimates

Y-axis: Hit Rate (0% to 80%)

Categories:
- Earnings/Tangible Capital (FY0, FY1)
- Net Debt/Equity (FY0, FY1)
- Free Cash Flow/Debt (FY0, FY1)
- EBIT/Interest (FY0, FY1)
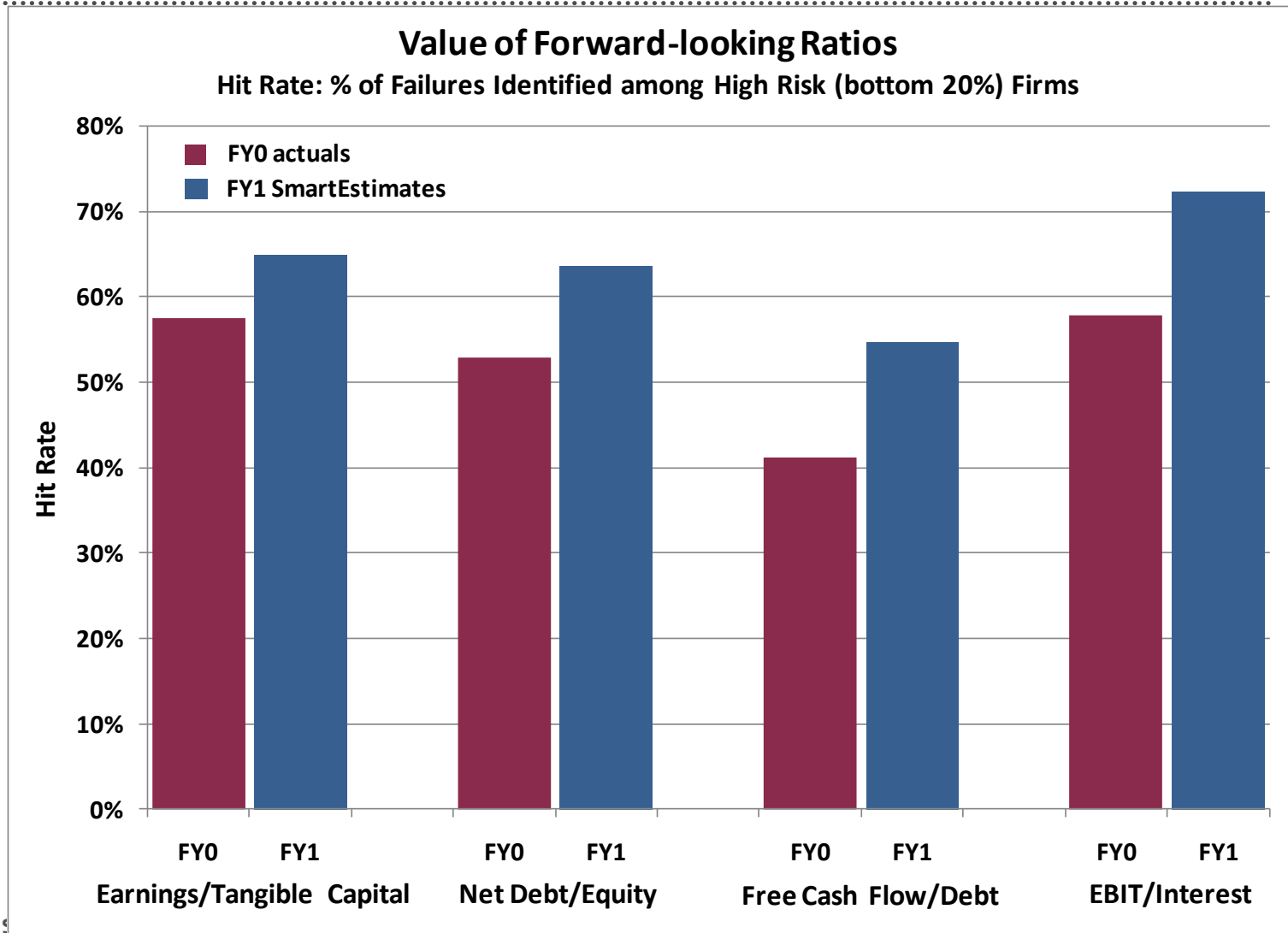
The SmartRatios model can improve equity selection performance.

StarMine Val-Mo Top Quintile Filtered by SmartRatios Model PD

Legend:
- Annualized Sharpe
- Annualized Return

X-axis (StarMine SmartRatios Model PD Cutoff (%)): 3.31, 1.75, 1.09, 0.73, 0.50, 0.36, 0.25, 0.16, 0.09

Left Y-axis: Annualized Sharpe of Top Quintile Return (0.00–1.40)

Right Y-axis: Annualized Return of Top Quintile (0%–35%)

The SmartEstimate can predict estimate revisions. Can the SmartRatios rating predict agency rating changes?

YES. When the agency & SmartRatios ratings differ significantly, the agency rating moves toward the SmartRatios rating 4-5x more often than it moves away.

Example: Pilgrim's Pride
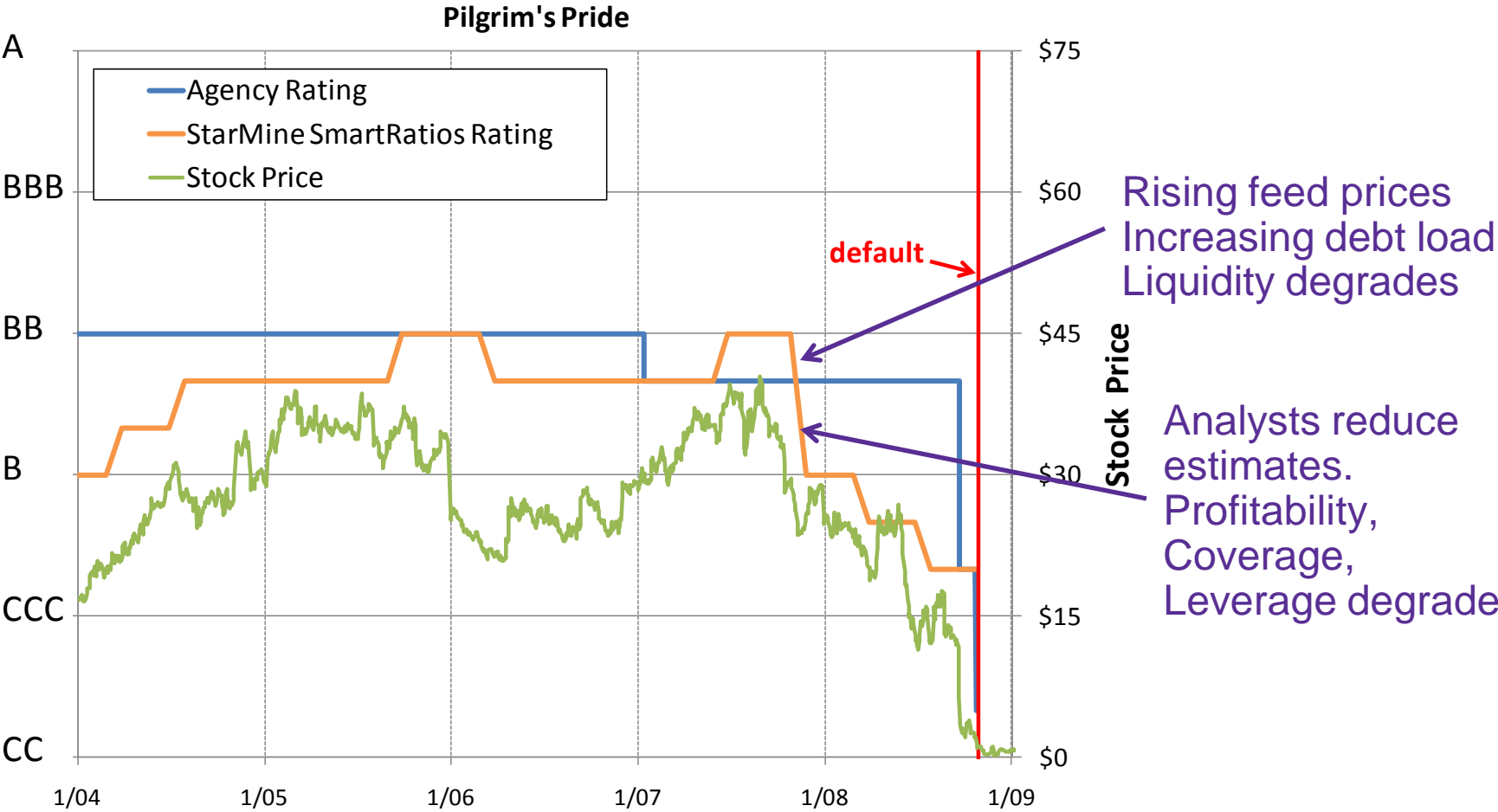
Pilgrim's Pride

Legend:
- Agency Rating
- StarMine SmartRatios Rating
- Stock Price

default

Rising feed prices
Increasing debt load
Liquidity degrades

Analysts reduce
estimates.
Profitability,
Coverage,
Leverage degrade

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Text mining of company documents can predict financial failure

- Identify linguistic content that provides best discrimination between firms that fail vs. those that do not

- Apply sophisticated machine learning algorithms to these high-dimensional data to provide unique and powerful failure predictions

FINAL TRANSCRIPT

Feb. 09. 2011 / 3:00PM, ENER - Q2 2011 Energy Conversion Devices Earnings Conference Call

Mark Morelli - *Energy Conversion Devices - CEO, President, Director*

Well, certainly. I lived in Italy and worked in Italy for four years, and it's a great market. However, the way that market may work may not be as deterministic as we may expect in some areas in the United States. So it's quite understandable how noise may be introduced into that system, and I think we'll probably find out. It's tough to understand exactly what the truth is.
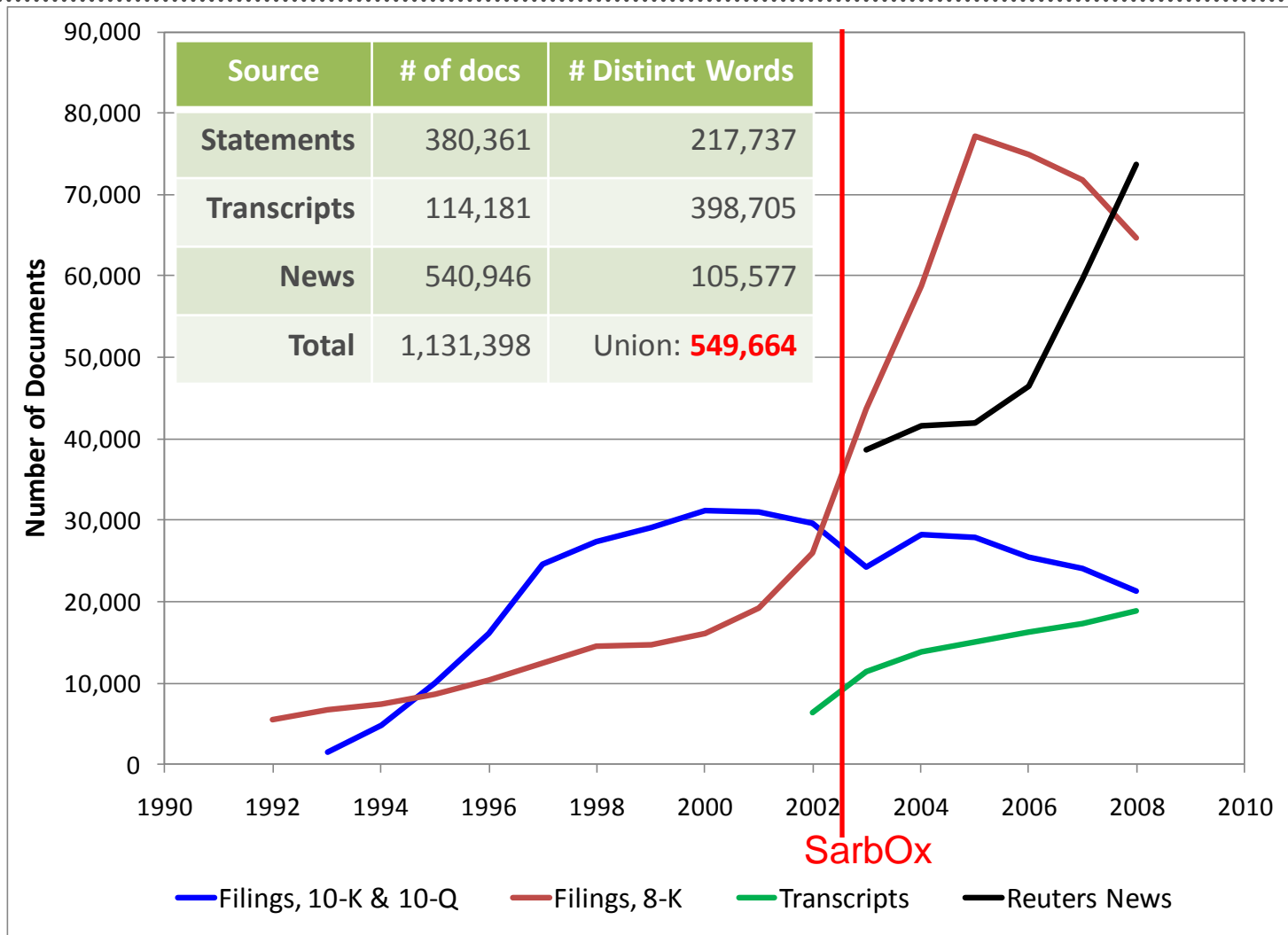
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visit: www.reutersreprints.com.

UPDATE 2-Energy Conversion says Europe projects on hold

Thu, Mar 10 2011

* Slashing production to 25 MW for the fiscal Q3

* Had previously forecast production of 27-33 MW

* Projects in France, Italy being put on hold

* Delays could impact 50 pct of quarterly revenue (Adds CEO quote, stock activity, background)

LOS ANGELES, March 10 (Reuters) - U.S. solar company Energy Conversion Devices (ENER.O: Quote, Profile, Research, Stock Buzz) said it was slashing production for the current quarter because cutbacks in French and Italian solar subsidies have put projects there on hold.

The company's shares slid more than 20 percent in extended trade following Thursday's announcement. It said the stalled projects could impact as much as half of its expected revenue for the fiscal third qu

ENERGY CONVERSION DEVICES, INC. and SUBSIDIARIES
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

g-Term Debt

it

During September 2010, the Company terminated its $30.0 million and $25.0 million secured revolving credit facilities entered into in February 2008 revolving credit facility has been released. The secured revolving credit facility was replaced with a Letter of Credit Facility, also with JP Morgan Cha letters of credit, which will be secured by cash equal to 102% of the letters of credit exposure. The Letter of Credit Facility matures on February 4, 201 transferred from the cancelled secured revolving credit facility to the new Letter of Credit Facility. As of December 31, 2010, outstanding letters of cre

# Volume of text has grown and presents computational challenges.

Source	# of docs	# Distinct Words
Statements	380,361	217,737
Transcripts	114,181	398,705
News	540,946	105,577
Total	1,131,398	Union: **549,664**

Number of Documents

SarbOx

—— Filings, 10-K & 10-Q   —— Filings, 8-K   —— Transcripts   —— Reuters News

Reduce computational complexity by eliminating very rare words …

Word occurrence histogram

Rare words

Log_{10} (# docs)
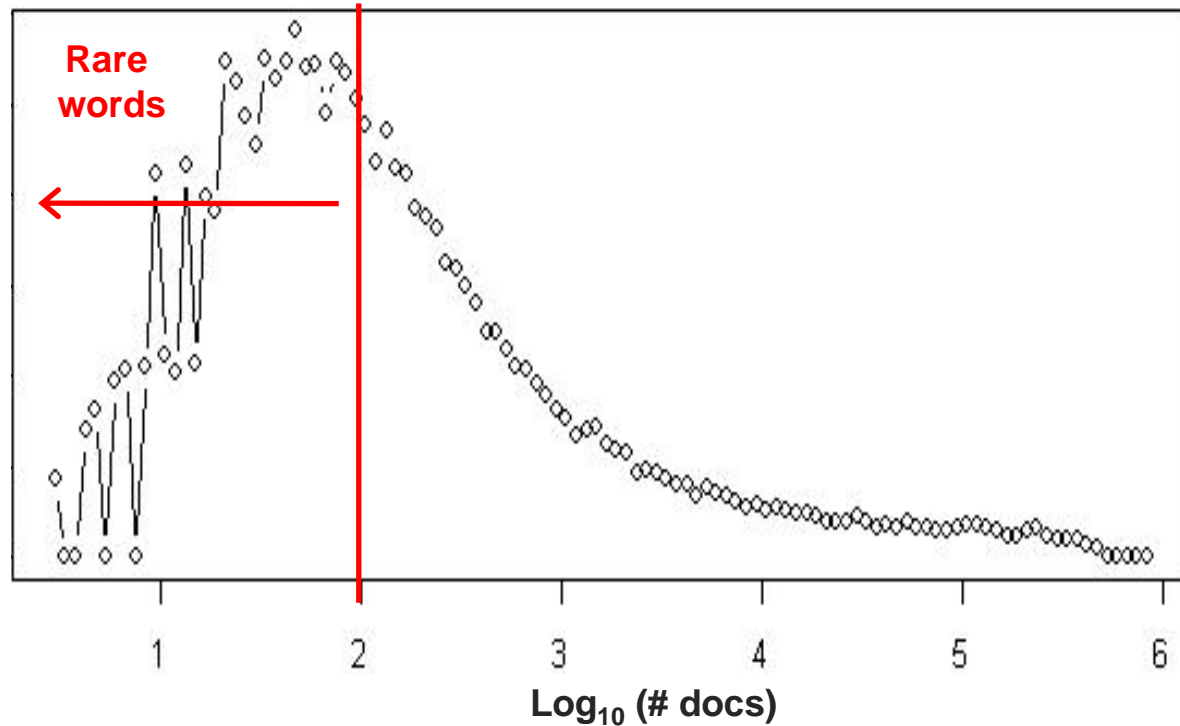
… and by eliminating very common words.

Common "stop words" words (a, and, the,…) appear

- in documents frequently → high mean frequency

- in docs equally → low StDev of frequency

Inverse coefficient of variance,   ICV= mean/StDev

ICV histogram

~1900 very common
words eliminated
High ICV

ICV
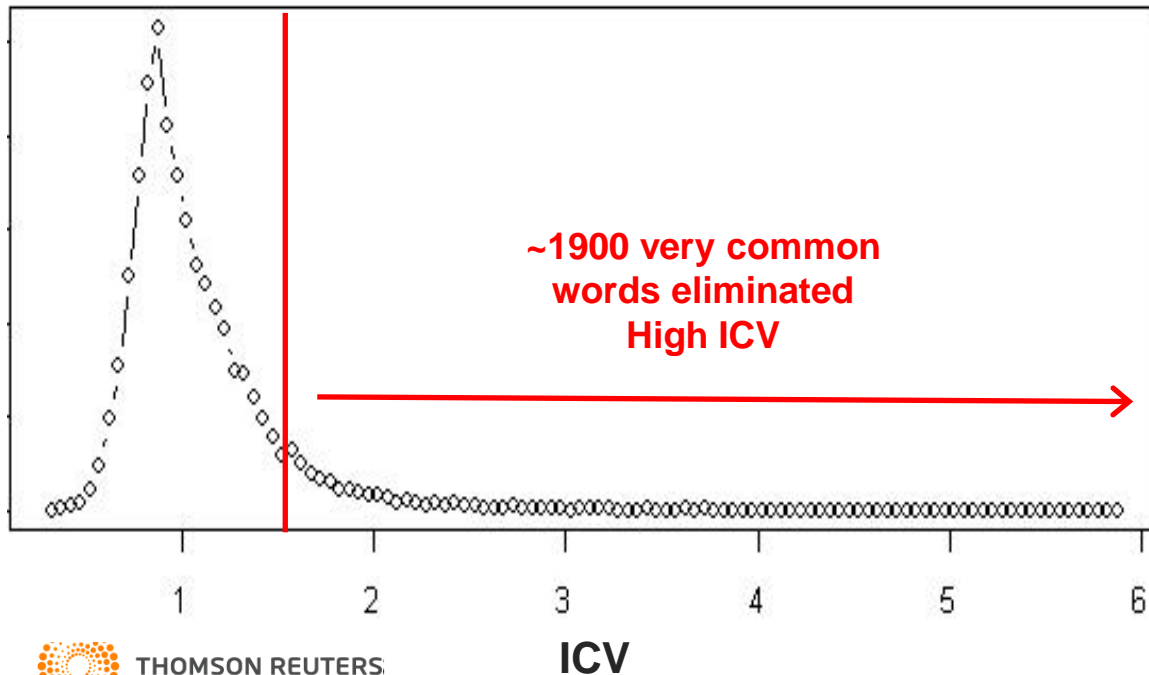
Result

Left with ~5000 word "dictionary" that spans ~50% of the text volume

Dimensionality reduced by > 100x !

There are many sections (types) of 8-Ks

Section	Section Title	Sub Sections
Section 1	Registrant's Business and Operations	1. Entry into a Material Definitive Agreement 2. Termination of a Material Definitive Agreement 3. Bankruptcy or Receivership
Section 2	Financial Information	1. Completion of Acquisition or Disposition of Assets 2. Results of Operations and Financial Condition 3. Creation of a Direct Financial Obligation or an Obligation under an Off-Balance Sheet Arrangement of a Registrant 4. Triggering Events That Accelerate or Increase a Direct Financial Obligation or an Obligation under an Off-Balance Sheet Arrangement 5. Costs Associated with Exit or Disposal Activities 6. Material Impairments
Section 3	Securities and Trading Markets	1. Notice of Delisting or Failure to Satisfy a Continued Listing Rule or Standard; Transfer of Listing 2. Unregistered Sales of Equity Securities 3. Material Modification to Rights of Security Holders
Section 4	Matters Related to Accountants and Financial Statements	1. Changes in Registrant's Certifying Accountant 2. Non-Reliance on Previously Issued Financial Statements or a Related Audit Report or Completed Interim Review
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Section 9	Financial Statements and Exhibits	1. Financial Statements and Exhibits

Some are red flags just by their presence

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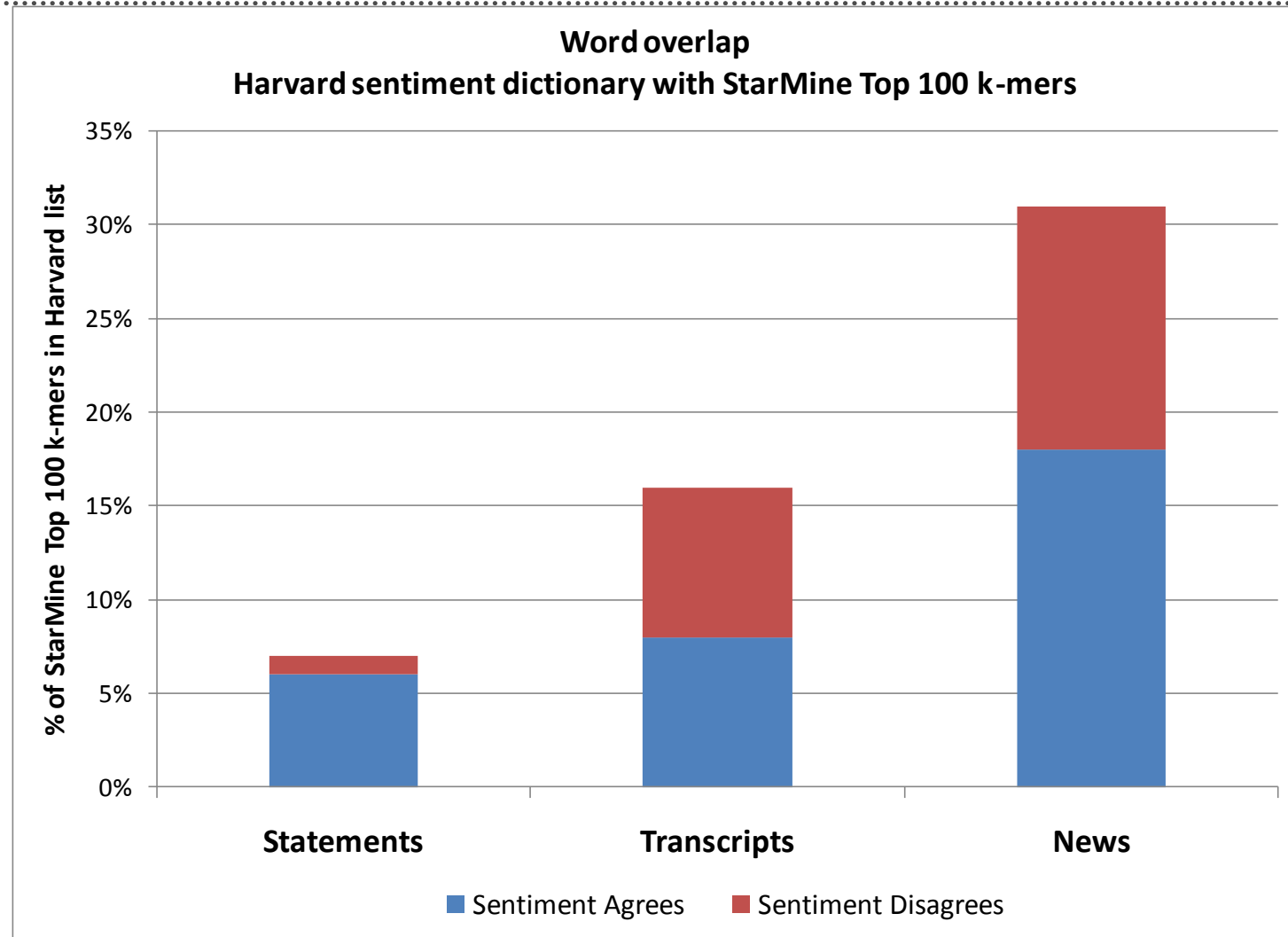| Section	Section Title	Sub Sections
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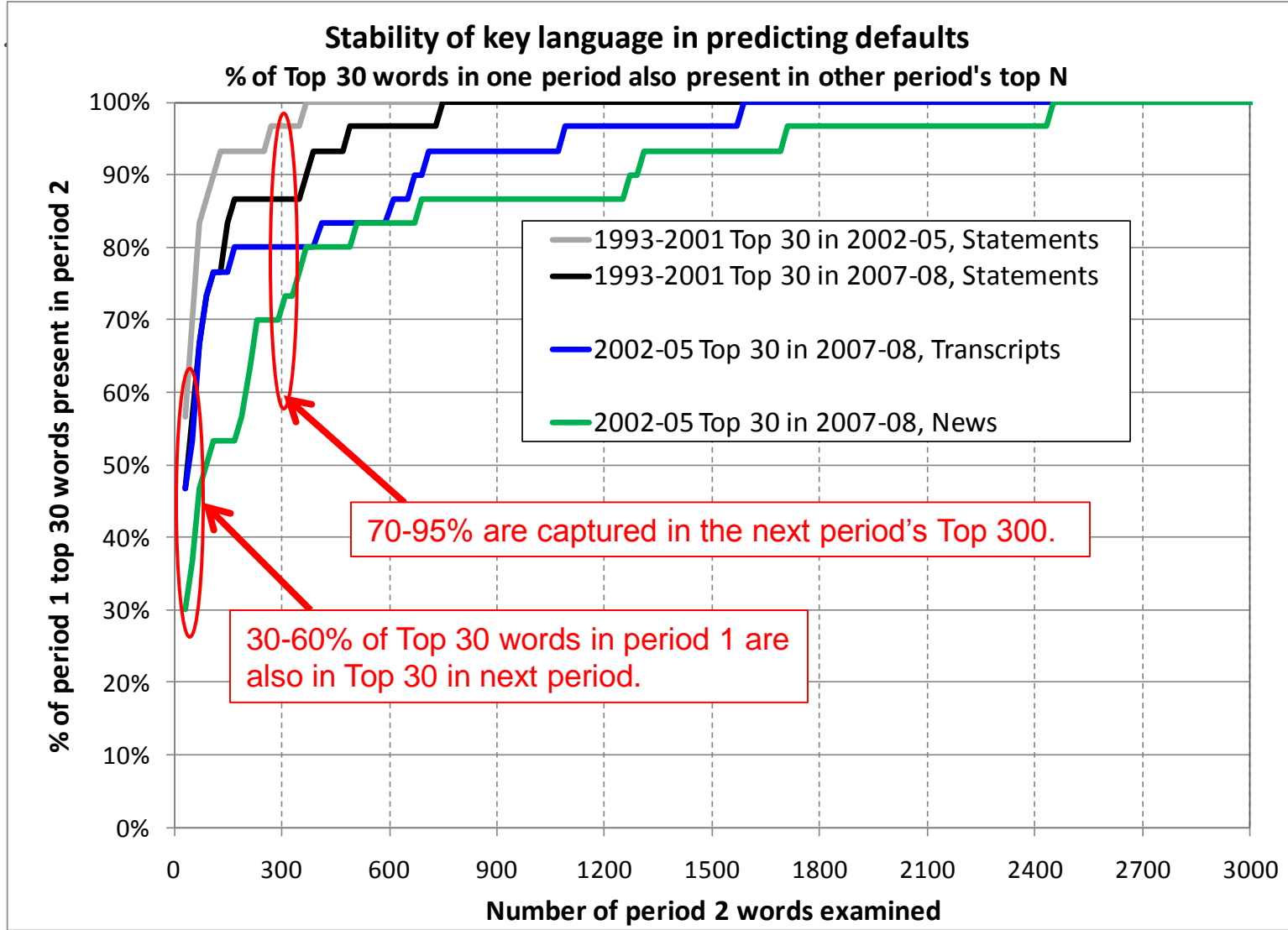| Section	Section Title	Sub Sections
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Financial language and context is unique. Standard sentiment classification does not work for default prediction.

Word overlap
Harvard sentiment dictionary with StarMine Top 100 k-mers

Y-axis: **% of StarMine Top 100 k-mers in Harvard list** (0% to 35%)

X-axis categories: Statements, Transcripts, News

Legend: ■ Sentiment Agrees ■ Sentiment Disagrees

Harvard GI IV, ~3023 unique words, available at http://www.wjh.harvard.edu/~inquirer/homecat.htm

Key language is fairly stable over time.

Stability of key language in predicting defaults

% of Top 30 words in one period also present in other period's top N

Legend:
- 1993-2001 Top 30 in 2002-05, Statements (gray)
- 1993-2001 Top 30 in 2007-08, Statements (black)
- 2002-05 Top 30 in 2007-08, Transcripts (blue)
- 2002-05 Top 30 in 2007-08, News (green)

70-95% are captured in the next period's Top 300.

30-60% of Top 30 words in period 1 are also in Top 30 in next period.

Y-axis: **% of period 1 top 30 words present in period 2**

X-axis: **Number of period 2 words examined**

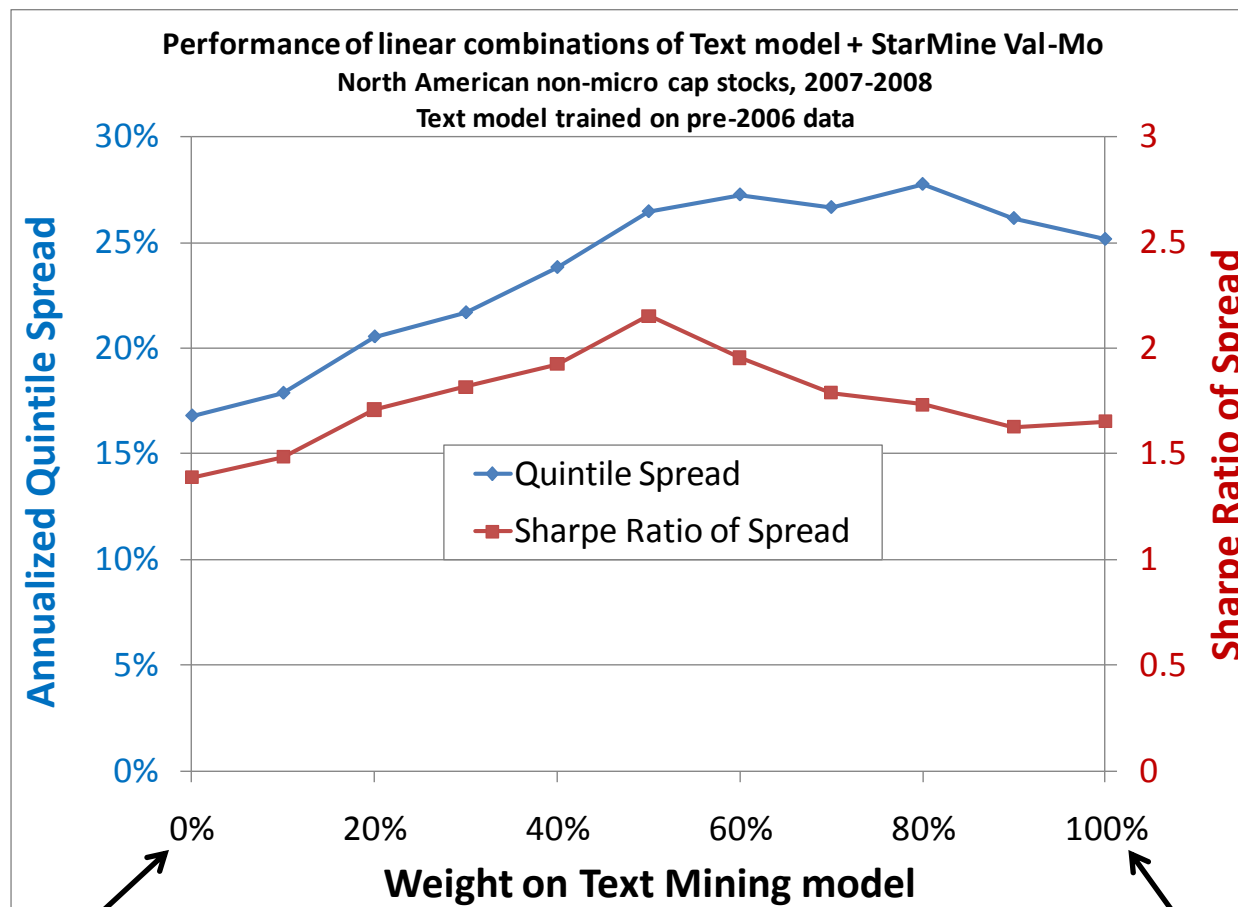# Combining information from different textual sources creates a stronger model.
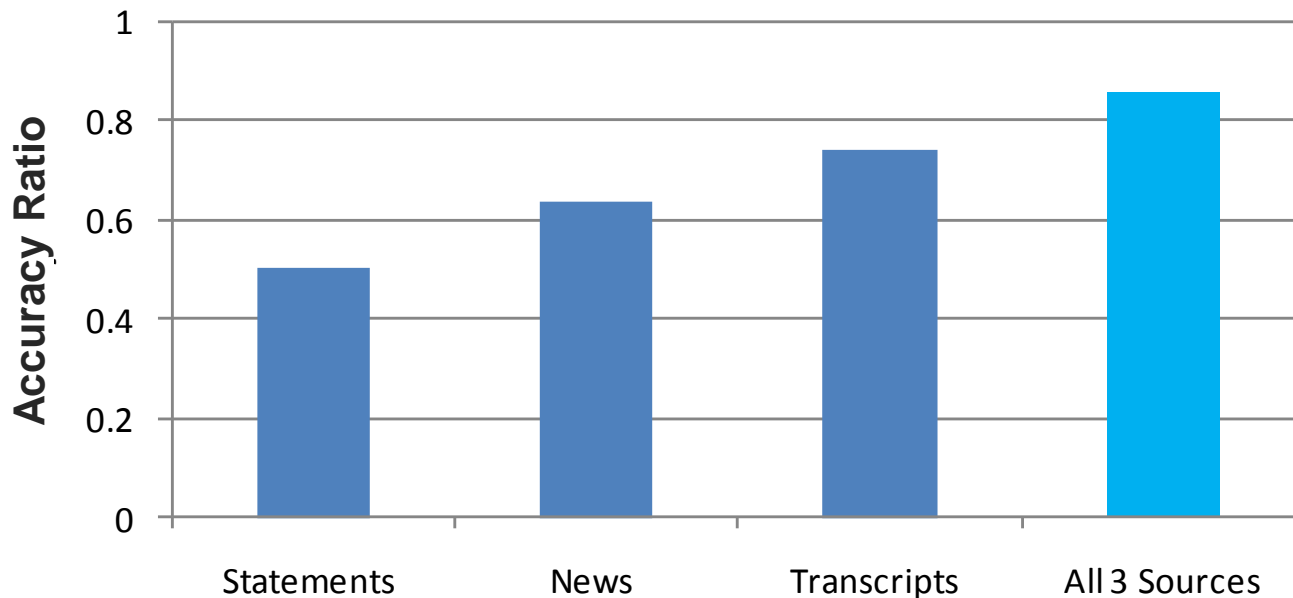
Preliminary performance

The Text Mining model can add value in an equity multi-factor framework.

Combo = w*Text score + (1-w)*Val-Mo score,   w in [0,1]

Performance of linear combinations of Text model + StarMine Val-Mo
North American non-micro cap stocks, 2007-2008
Text model trained on pre-2006 data

Legend:
- Quintile Spread
- Sharpe Ratio of Spread

X-axis: **Weight on Text Mining model**
Left Y-axis: **Annualized Quintile Spread**
Right Y-axis: **Sharpe Ratio of Spread**

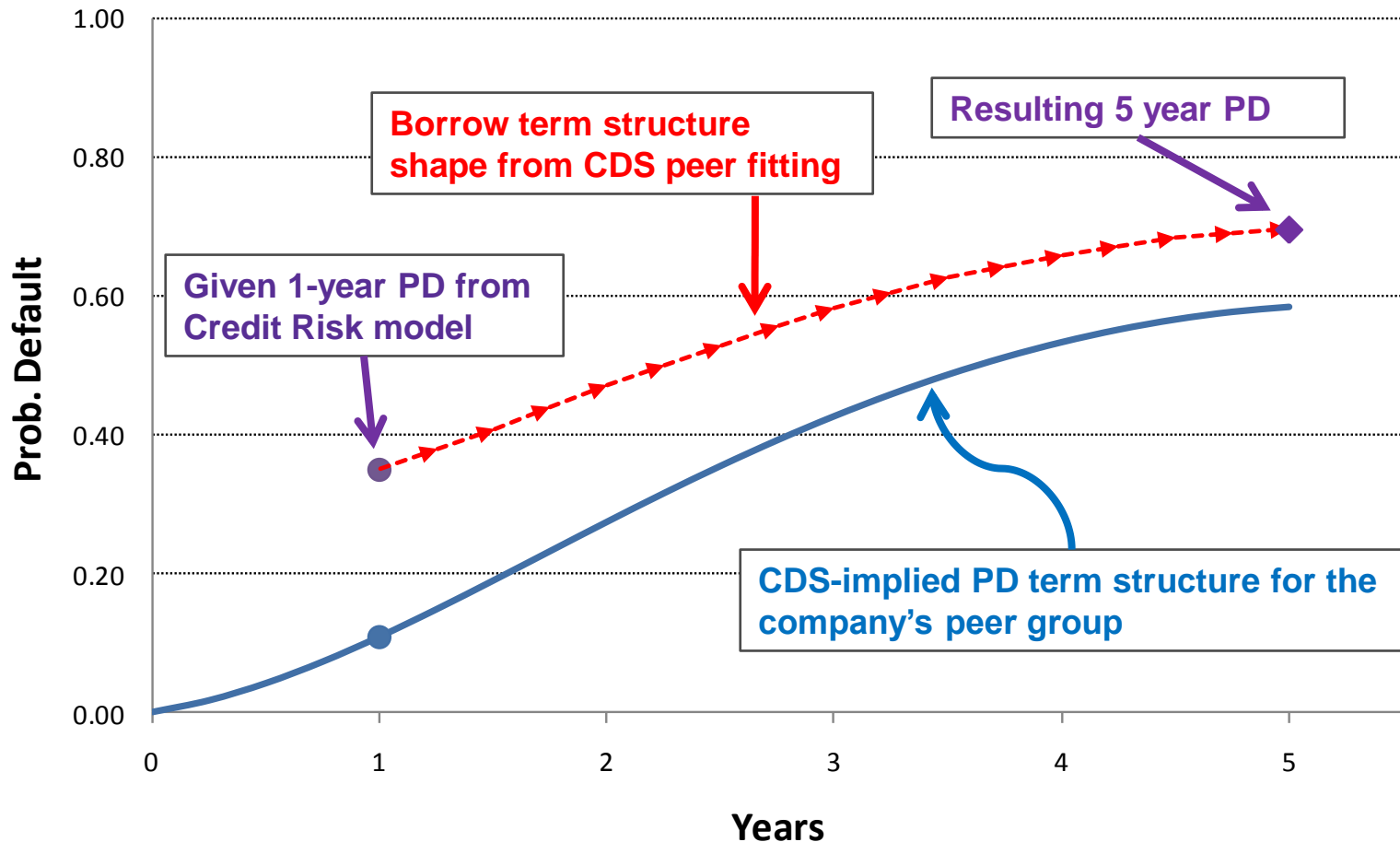**100% Val-Mo**

100% Text model

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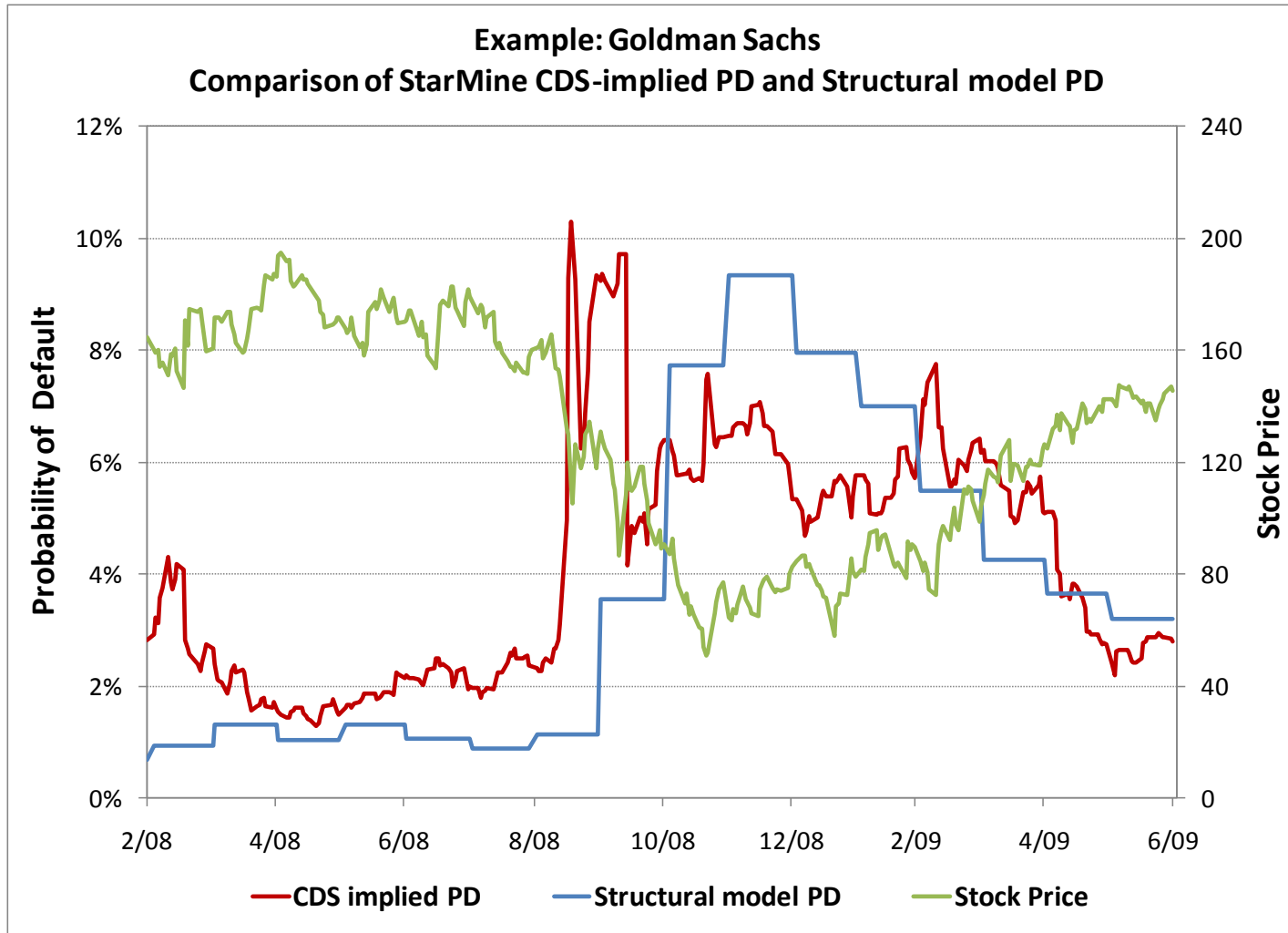
CDS Model: Analyze the CDS market's view of credit risk.

- Reduced form modeling approach which uses all daily pricing data to derive a PD curve

- Create CDS market-implied values, compare with StarMine forecasts.
  - Input: StarMine PD + StarMine LGD
  - Output: StarMine fair value CDS
  - Input: observed CDS price + StarMine LGD (or ISDA LGD)
  - Output: CDS market-implied PD

- Produce term structure of PD
  - Group similar companies, fit hazard rate function to their CDS, apply same shape to like companies w/o CDS

Apply term structure of PD from CDS to estimate PD at any horizon.

Prob. Default (y-axis, 0.00 to 1.00)

Years (x-axis, 0 to 5)

Borrow term structure shape from CDS peer fitting

Resulting 5 year PD

Given 1-year PD from Credit Risk model

CDS-implied PD term structure for the company's peer group

Compare CDS view with other pieces.

Example: Goldman Sachs
Comparison of StarMine CDS-implied PD and Structural model PD

— CDS implied PD   — Structural model PD   — Stock Price

AGENDA

- CREDIT RISK BASICS

- CREDIT RISK MODEL
  - STRUCTURAL MODEL (MERTON APPROACH)
  - RATIO ANALYSIS
  - TEXT MINING
  - CDS
  - LOSS GIVEN DEFAULT

THOMSON REUTERS

STARMINE®

Loss Given Default (LGD) basics.

- **Definition:**

  LGD = 1 – recovery rate

  = 1 – post-default price/redemption price, where the post-default price refers to the price quoted one month after the default event, and redemption price normally equals $100.

- **Usage:**

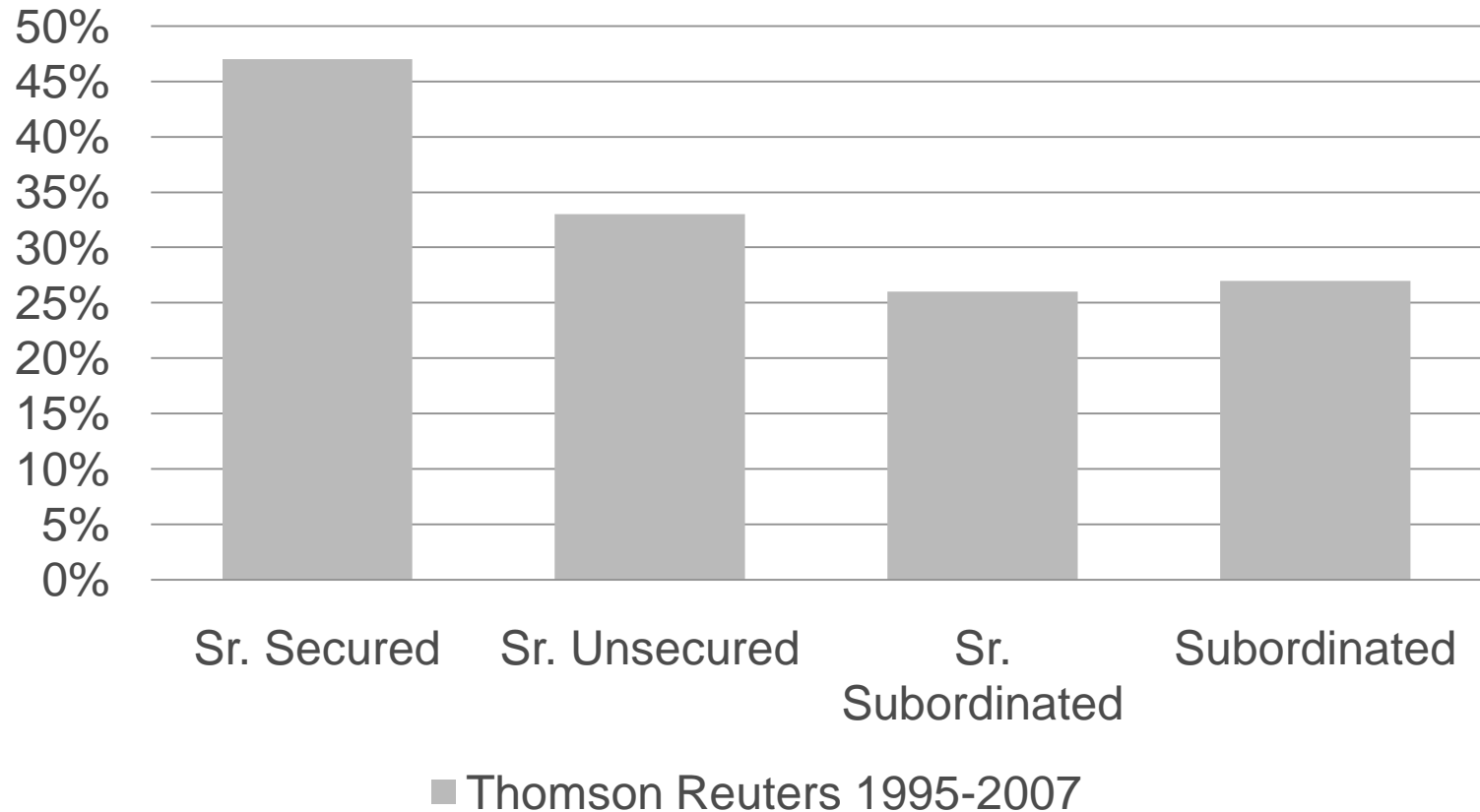 Expected loss = Exposure at Default (EAD) * Probability of Default (PD) * **LGD**

  Basel II Capital Requirement (LGD errors are more expensive than PD errors):

  $$K = LGD \times \left(\Phi \left(\sqrt{\frac{1}{1-\rho}} \Phi^{-1}(PD) + \sqrt{\frac{\rho}{1-\rho}} \Phi^{-1}(0.999) \right) - PD \right)$$
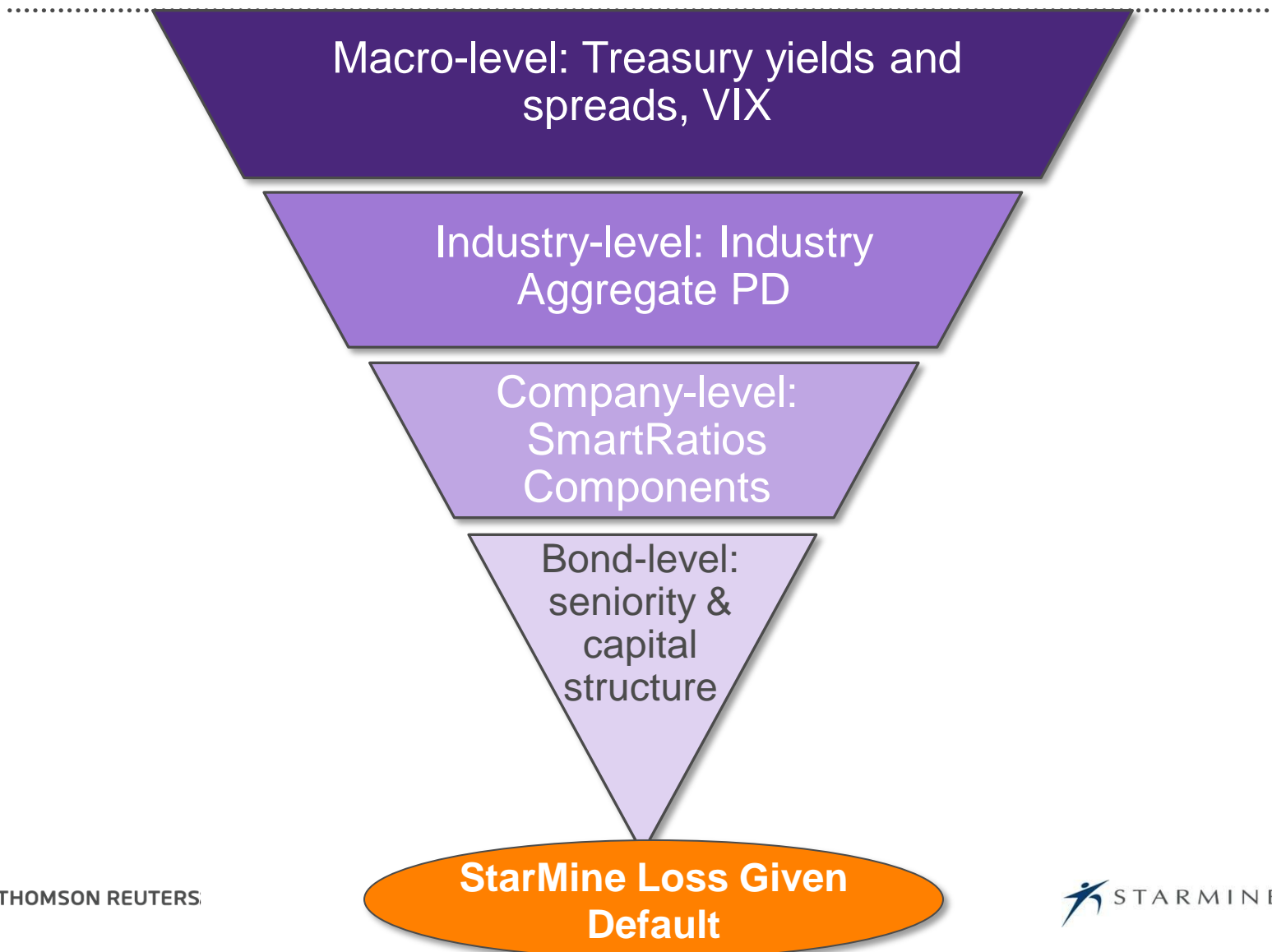
Seniority is important in determining LGD, but not the only thing …

Average Recovery Rate by Bond Seniority

Thomson Reuters 1995-2007

Company, industry, and macro data are also important.

Macro-level: Treasury yields and spreads, VIX

Industry-level: Industry Aggregate PD

Company-level: SmartRatios Components

Bond-level: seniority & capital structure

StarMine Loss Given Default

What did we learn about modeling credit risk?

- – Incorporating information from multiple perspectives improves upon any single source of data or type of analysis

- – You can often be more responsive by incorporating market intelligence embedded in stock prices and CDS

- – There is great value in using more forward-looking, timely information

- – Incorporating textual analytics from several sources can flag problems before they show up in the numbers. And, text is underused from a quant perspective

- – Used to filter out risky stocks, credit risk factors can add value to equity portfolios