# S&P Issuer Credit Rating and Understated Pension Liabilities

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# Outline

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# Introduction

- Defined benefit pension plan
  - Pension payment follows a formula

    Payment

    = 1% × Expected [final salary] × (# of service years)
  - Projected benefit obligation (PBO) = present value of all expected future pension payments
  - Assumptions to calculate the present value

    Pension discount rate

    Low rate: high PBO

    High rate: low PBO

# Introduction

- Guidelines for choice of pension discount rates
  - Employee Retirement Income Security Act (ERISA) requires the rates to be within a specified range above or below the weighted average of the interest rates on 30-year Treasury bonds for the previous four-year period.
  - SFAS No. 87 of Financial Accounting Standard Board (FASB) suggests employers to refer to rates of return on high-quality fixed-income investments for financial reporting purpose.

# Introduction

- The 30-year Treasury bond yield was 4.83% in December 2002.
- Johnson & Johnson Co. (AAA) assumed a pension discount rate of 6.75%; the firm's PBOs were understated by 0.7% of the beginning of the fiscal market value
- Goodyear Tire & Rubber Co. (B) assumed a pension discount rate of 7.25%; the reported PBO is understated by 29.2% relative to the beginning of the fiscal year market value.

# Introduction

- S&P rating plays a key role in financial markets (Graham and Harvey, 2001)
- On the balance sheet information
- Off the balance sheet information (Martin and Henderson, 1983; Maher, 1987; Carroll and Niehaus, 1998; Campbell, Dhaliwal, and Schwartz Jr., 2012)
- S&P wants to normalize pension discount rates for all firms.
- But it conducts surveys and see if pension discount rates confirm to the norm.

# Introduction

- Former Security and Exchange Commission Chairman Arthur Levitt's comment.
- "Off-balance sheet debt persists, distorting the financial picture investors have been given in companies in many sectors" (*Wall Street Journal*, February 10, 2003).
- In this study, we aim to answer two relevant questions.
- First, how large is the economic value of these hidden liabilities relative to alternative interest rate benchmarks?
- Second, do the understated pension liabilities affect the credit rating of individual firms?

# Introduction

- Early studies include Horrigan (1966), Pogue and Soldofsky (1969), West (1970), Pinches and Mingo (1973, 1975), Altman and Katz (1976), Kaplan and Urwitz (1979), and Blume, Lim, and MacKinlay (1998).

- Sengupta (1998), Anderson, Mansi, and Reeb (2003), Bhojraj and Sengupta (2003), Klock, Mansi, and Maxwell (2005), and Ashbaugh-Skaife, Collins, and LaFond (2006) examine the impact of corporate governance, ownership structure, board structure, and transparency on debt ratings and costs of debt.

- Other have investigated the economic and information role of rating changes issued by multiple rating agencies (Bongaerts, Cremers, and Goetzmann, 2012) and the impact of credit rating related regulatory changes on cost of debt capital (Kliger and Sarig, 2000; Tang, 2009; Kisgen and Strahan, 2010).

# Introduction

- Brown and Wilcox (2009) and Novy-Marx and Rauh (2009, 2011) examine the measurement of public pension liabilities.

- They report much larger state public pension liabilities after applying financial valuation to the pension liabilities of U.S. states by using appropriate discount rates rather than expected rate of return on pension assets stipulated under Government Accounting Standards Board.

# Introduction

- Hann, Lu, and Subramanyam (2007) develop methods for obtaining estimates on corporate pension benefit formula parameters.

- They replace the assumed discount rate by the corresponding industry median discount rates and examine the value relevancy of discretionary versus nondiscretionary components of projected benefit obligations.

# Introduction

- Campbell et al. (2012) consider the role of funded status and mandatory contributions in affecting both credit rating and cost of capital including cost of debt.

- They find that an increase in mandatory contributions increase cost of capital, but only for firms facing greater external financing constraints.

# Introduction

- Lucas and Zeldes (2006) attempts to measure the “true value” or “theoretically correct’ value of PBOs.
- PBOs depend on expected future salary.
- Aggregate wage growth rates and stock returns are positively correlated in the long run.
- The discount rates for PBOs annuities should be time varying.
- Suppose we measure PBO in 2001, the discount rates in 2002, 2003,…, should be time-varying.

# Introduction

- Lucas and Zeldes (2006) use simulation to show that the “theoretically correct” discount rate for Alcoa in 2001 is 5.7%.
- The assumed discount rate for Alcoa is 7.75%.
- The difference is more than 2%.
- This 2% servers as a benchmark.

# Data Sources, FASB Statements, and Variable Definitions

- CRSP: Market capitalization, daily individual stock returns, value-weighted market returns; and 30-year Treasury bond yields, one-year Treasury bill yields.
- COMPUSTAT: annual accounting items and pension variables.
- COMPUSTAT: S&P issuer credit ratings.
- Mergent Corporate Bond Securities Database (FISD): corporate debt issue characteristics, S&P issue specific ratings.
  - Debt issues have bond type codes of CDEB, CMTN, CMTZ, CPAS, CPIK, CS, CZ, RNT, USBN.
  - Coupon payments are fixed and payment frequency is twice a year.
- Barclays Bank PLC: yields on AAA- and AA-grade corporate bond yields. Data are available from October 1988 – December 2013.

# Data Sources, FASB Statements, and Variable Definitions

- FASB Statements
  - SFAS No. 87 (effective after December 1986) requires a smoothed model for pension accounting that gradually incorporates fair value *FS*, or the difference between *PA* and *PBO*.
  - SFAS No. 132 (effective in 1998) only requires the disclosure of *ABO* if *ABO* exceeds *PA*.
  - SFAS No. 132(R) (effective in 2003) again requires the disclosure of *ABO*.
  - SFAS No. 158 (effective after December 2006) requires firms to immediately incorporate fair value *FS* in their consolidated statements.

# Data Sources, FASB Statements, and Variable Definitions

Four categories of variables

- Market and accounting
- Ownership and governance
- Traditional pension variables, funded status and mandatory contributions
- Understated pension liabilities

# Data Sources, FASB Statements, and Variable Definitions

- Market and accounting
  - *ME_INF* = market value in 2013 billion dollars
  - *COVERAGE* = (operating income after depreciation + interest expense)/interest expense
  - *MARGIN* = operating income before depreciation/sales
  - *LLEV* = long-term debt /total assets
  - *PPE* = net property, plant, and equipment/total assets
  - *BETA* = systematic risk
  - *R2* = price synchronicity
  - *TRANS* = transparency

# Data Sources, FASB Statements, and Variable Definitions

Transparency measures

Use  Dechow, Sloan, and Sweeney (1995) model to obtain residual., Use absolute value of the residuals  (Hutton, Marcus, and Tehranian, 2009)

Other measures generate similar results.

Francis et al. (2004, 2005)
Lang and Maffett (2011), Lang, Lins, and Maffett (2012)

Ashbaugh-Skaife, Collins, and LaFond  (2006)

Barth, Konchitchki, and Landsman (2013)

# Data Sources, FASB Statements, and Variable Definitions

- Traditional pension variables

$FS = (PA - PBO)/ME(-1)$

*MC*, non-positive, scaled by $ME(-1)$

$$MC_{i,t} = -[SC_{i,t} + (ABO_{i,t} - PA_{i,t})/30], \quad if\ PBO_{i,t} \geq PA_{i,t},$$

$$= 0, \quad if\ PBO_{i,t} < PA_{i,t},$$

# Data Sources, FASB Statements, and Variable Definitions

Off-balance sheet item:

*PCPP*: part of *FS* that appears in balance sheet.

$$PCPP_{i,t} = -PBO_{i,t} + PA_{i,t} + UGL_{i,t} + UPSC_{i,t} + UTAL_{i,t}$$

$$= FS_{i,t} + UGL_{i,t} + UPSC_{i,t} + UTAL_{i,t}$$

$$= FS_{i,t} + OFFB_{i,t},$$

# Data Sources, FASB Statements, and Variable Definitions

- Understated PBOs

*PCT_TB30Y, PCT_AAA20Y, PCT_AAA25Y, PCT_AAATM*

*PCT_AA20Y, PCT_AA25Y, PCT_AATM*

# Data Sources, FASB Statements, and Variable Definitions

- Understated ABOs

*APCT_TB30Y, APCT_AAA20Y, APCT_AAA25Y, APCT_AAATM*

*APCT_AA20Y, APCT_AA25Y, APCT_AATM*

# Data Sources, FASB Statements, and Variable Definitions

- Pension discount rate ($r^{DISCOUNT}$)
  - Assumed rate of return that firms use to value their pension liabilities
- Discount rate benchmarks
  - 30-year Treasury bond yield ($r^{TB30Y}$)
  - 20-year and 25-year AAA- and AA-grade corporate bond yields ($r^{AAA20Y}$, $r^{AAA25Y}$, and $r^{AA20Y}$, $r^{AA25Y}$)
  - Term-structure AAA- and AA-grade corporate bond yields ($r^{AAATM}$ and $r^{AATM}$)

# S&P Credit Ratings and Summary Statistics

- The S&P issuer credit rating dataset from COMPUSTAT contains 590,792 non-missing monthly ratings on 5,450 firms from January 1988 to December 2013.
- The pension dataset from COMPUSTAT contains 29,038 firm-year observations with non-missing PAs and PBOs on 2,338 firms over the same period.
- After merging these two datasets by CUSIP and calendar month corresponding to the fiscal year end, we can retain 11,904 firm-year observations.

# S&P Credit Ratings and Summary Statistics

- We require that the last monthly credit rating within the fiscal year be available when pension data and other accounting information for the same fiscal year are available.
- Eliminate 1,600 observations with missing pension discount rates and 1,084 observations with missing compensation growth rates, 9,220 observations.
- Additional variables be available, final sample 8,604 observations.
- Firm-year observations and number of firms with pension information are similar to those reported in Rauh (2006) and Picconi (2006).

# S&P Credit Ratings and Summary Statistics

- Among 8,604 observations, ABOs are missing for 1,546 observations.
- This is because FASB issued SFAS 132 in 2003, under which disclosure of ABOs are not required when PA > ABO.
- We impute ABOs from estimated N, number of years to retirement.

# S&P Credit Ratings and Summary Statistics

- Treatment on missing *ABO*s (mainly from 1998-2003 due to SFAS No. 132)
  - $PBO = ABO(1+g)^{\widehat{N}}$, $g$ = compensation growth rate
  - For non-missing PBOs and ABOs, estimate the average expected remaining years of service
  - $\widehat{N} = \log(PBO/ABO)\ /\log(1+g)$.
  - Replace missing $\widehat{N}$ by the corresponding median value from the non-missing observations.
  - Replace missing $ABO$ by $ABO = PBO/(1+g)^{\widehat{N}}$

# S&P Credit Ratings and Summary Statistics

- S&P issuer credit rating

  AAA, AA, A, BBB, BB, B, CCC, CC, C, and D
  We group into AAA, AA, A, BBB, BB, B and below in the probit model, correspond to
  6, 5, 4, 3, 2, 1.

  S&P issuer credit rating for instrumental variable (IV) analysis:
  AAA=22, AA+=21, …, D=1.

# S&P Credit Ratings and Summary Statistics: Table 1

| Year | Rating | | | | | | |
|---|---|---|---|---|---|---|---|
| | AAA | AA | A | BBB | BB | <= B | Total |
| | Panel A: Number | | | | | | |
| 1991 | 6 | 41 | 84 | 78 | 26 | 12 | 247 |
| 1992 | 9 | 45 | 96 | 97 | 33 | 10 | 290 |
| 1993 | 9 | 42 | 109 | 98 | 43 | 14 | 315 |
| 1994 | 8 | 43 | 106 | 108 | 47 | 11 | 323 |
| 1995 | 8 | 37 | 113 | 111 | 40 | 13 | 322 |
| 1996 | 8 | 34 | 117 | 111 | 47 | 13 | 330 |
| 1997 | 7 | 29 | 117 | 115 | 52 | 9 | 329 |
| 1998 | 5 | 33 | 118 | 135 | 51 | 11 | 353 |
| 1999 | 6 | 27 | 122 | 126 | 61 | 10 | 352 |
| 2000 | 5 | 22 | 106 | 124 | 63 | 8 | 328 |
| 2001 | 4 | 16 | 104 | 123 | 65 | 12 | 324 |
| 2002 | 7 | 21 | 117 | 149 | 90 | 26 | 410 |
| 2003 | 6 | 18 | 117 | 162 | 95 | 39 | 437 |
| 2004 | 7 | 17 | 115 | 178 | 104 | 46 | 467 |
| 2005 | 7 | 15 | 114 | 184 | 103 | 45 | 468 |
| 2006 | 7 | 16 | 103 | 176 | 106 | 44 | 452 |
| 2007 | 6 | 15 | 101 | 174 | 104 | 50 | 450 |
| 2008 | 5 | 17 | 92 | 177 | 92 | 41 | 424 |
| 2009 | 4 | 18 | 83 | 180 | 85 | 43 | 413 |
| 2010 | 3 | 16 | 85 | 182 | 83 | 32 | 401 |
| 2011 | 3 | 13 | 85 | 181 | 89 | 33 | 404 |
| 2012 | 3 | 10 | 88 | 170 | 82 | 32 | 385 |
| 2013 | 3 | 12 | 89 | 167 | 76 | 33 | 380 |
| Total | 136 | 557 | 2,381 | 3,306 | 1,637 | 587 | 8,604 |

# S&P Credit Ratings and Summary Statistics: Table 1

Panel B: Percentage

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1991 | 2.4 | 16.6 | 34.0 | 31.6 | 10.5 | 4.9 | 100 |
| 1992 | 3.1 | 15.5 | 33.1 | 33.4 | 11.4 | 3.4 | 100 |
| 1993 | 2.9 | 13.3 | 34.6 | 31.1 | 13.7 | 4.4 | 100 |
| 1994 | 2.5 | 13.3 | 32.8 | 33.4 | 14.6 | 3.4 | 100 |
| 1995 | 2.5 | 11.5 | 35.1 | 34.5 | 12.4 | 4.0 | 100 |
| 1996 | 2.4 | 10.3 | 35.5 | 33.6 | 14.2 | 3.9 | 100 |
| 1997 | 2.1 | 8.8 | 35.6 | 35.0 | 15.8 | 2.7 | 100 |
| 1998 | 1.4 | 9.3 | 33.4 | 38.2 | 14.4 | 3.1 | 100 |
| 1999 | 1.7 | 7.7 | 34.7 | 35.8 | 17.3 | 2.8 | 100 |
| 2000 | 1.5 | 6.7 | 32.3 | 37.8 | 19.2 | 2.4 | 100 |
| 2001 | 1.2 | 4.9 | 32.1 | 38.0 | 20.1 | 3.7 | 100 |
| 2002 | 1.7 | 5.1 | 28.5 | 36.3 | 22.0 | 6.3 | 100 |
| 2003 | 1.4 | 4.1 | 26.8 | 37.1 | 21.7 | 8.9 | 100 |
| 2004 | 1.5 | 3.6 | 24.6 | 38.1 | 22.3 | 9.9 | 100 |
| 2005 | 1.5 | 3.2 | 24.4 | 39.3 | 22.0 | 9.6 | 100 |
| 2006 | 1.5 | 3.5 | 22.8 | 38.9 | 23.5 | 9.7 | 100 |
| 2007 | 1.3 | 3.3 | 22.4 | 38.7 | 23.1 | 11.1 | 100 |
| 2008 | 1.2 | 4.0 | 21.7 | 41.7 | 21.7 | 9.7 | 100 |
| 2009 | 1.0 | 4.4 | 20.1 | 43.6 | 20.6 | 10.4 | 100 |
| 2010 | 0.7 | 4.0 | 21.2 | 45.4 | 20.7 | 8.0 | 100 |
| 2011 | 0.7 | 3.2 | 21.0 | 44.8 | 22.0 | 8.2 | 100 |
| 2012 | 0.8 | 2.6 | 22.9 | 44.2 | 21.3 | 8.3 | 100 |
| 2013 | 0.8 | 3.2 | 23.4 | 43.9 | 20.0 | 8.7 | 100 |

# S&P Credit Ratings and Summary Statistics: Table 2

Panel A: Mean Values by S&P Rating Categories

| | | AAA | AA | A | BBB | BB | <= B | |
|---|---|---|---|---|---|---|---|---|
| Market Value (billion US$) | *ME_INF* | 109.98 | 40.87 | 19.04 | 8.13 | 3.02 | 1.62 | 8,604 |
| Interest Coverage | *COVERAGE* | 32.45 | 16.97 | 10.74 | 6.78 | 5.75 | 1.81 | 8,604 |
| Operating Margin | *MARGIN* | 0.29 | 0.22 | 0.22 | 0.19 | 0.15 | 0.13 | 8,604 |
| Long Term Debt Leverage | *LLEV* | 0.10 | 0.19 | 0.23 | 0.27 | 0.31 | 0.38 | 8,604 |
| Fixed Assets | *PPE* | 0.32 | 0.43 | 0.42 | 0.43 | 0.34 | 0.38 | 8,604 |
| Beta | *BETA* | 0.83 | 0.73 | 0.77 | 0.86 | 1.08 | 1.23 | 8,604 |
| Synchronicity | *R2* | 0.31 | 0.23 | 0.25 | 0.27 | 0.25 | 0.20 | 8,604 |
| Transparency Measure | *TRANS* | -0.03 | -0.03 | -0.03 | -0.04 | -0.05 | -0.05 | 8,604 |
| Funded Status (%) | *FS* | 1.18 | 2.15 | -0.11 | -2.78 | -5.71 | -12.90 | 8,604 |
| Off Balance Sheet Items (%) | *OFFB* | 0.48 | 0.73 | -1.87 | -4.48 | -8.15 | -12.97 | 8,192 |
| Mandatory Contribution (%) | *MC* | -0.14 | -0.21 | -0.35 | -0.60 | -0.88 | -1.48 | 8,604 |
| Institutional Ownership | *INST* | 0.55 | 0.56 | 0.60 | 0.68 | 0.73 | 0.68 | 6,313 |
| Block Ownership | *BLOCK* | 0.04 | 0.07 | 0.10 | 0.15 | 0.20 | 0.25 | 6,313 |
| Top-5 Ownership | *TOP5* | 0.16 | 0.18 | 0.21 | 0.26 | 0.29 | 0.32 | 6,313 |
| Percentage of Board Member Stock Holding Stocks | *BHOL* | 0.82 | 0.79 | 0.85 | 0.89 | 0.89 | 0.90 | 5,788 |

# S&P Credit Ratings and Summary Statistics: Table 2

Panel B: Pairwise Correlations

| | *COVERAGE* | *MARGIN* | *LLEV* | *PPE* | *BETA* | *R2* | *TRANS* | *FS* | *OFFB* | *MC* |
|---|---|---|---|---|---|---|---|---|---|---|
| *ME_INF* | 0.27** | 0.22** | -0.24** | -0.13** | -0.02* | 0.17** | 0.03** | 0.08** | 0.06** | 0.11** |
| *COVERAGE* | | 0.09** | -0.43** | -0.23** | 0.06** | 0.15** | -0.03** | 0.05** | 0.05** | 0.11** |
| *MARGIN* | | | 0.15** | 0.38** | -0.18** | 0.03** | 0.08** | 0.19** | 0.22** | 0.26** |
| *LLEV* | | | | 0.27** | -0.10** | -0.15** | 0.05** | -0.06** | -0.05** | -0.09** |
| *PPE* | | | | | -0.21** | -0.17** | 0.13** | 0.10** | 0.14** | 0.06** |
| *BETA* | | | | | | 0.52** | -0.18** | -0.29** | -0.31** | -0.20** |
| *R2* | | | | | | | 0.01 | -0.22** | -0.26** | -0.06** |
| *TRANS* | | | | | | | | 0.05** | 0.03** | 0.01 |
| *FS* | | | | | | | | | 0.80** | 0.77** |
| *OFFB* | | | | | | | | | | 0.69** |

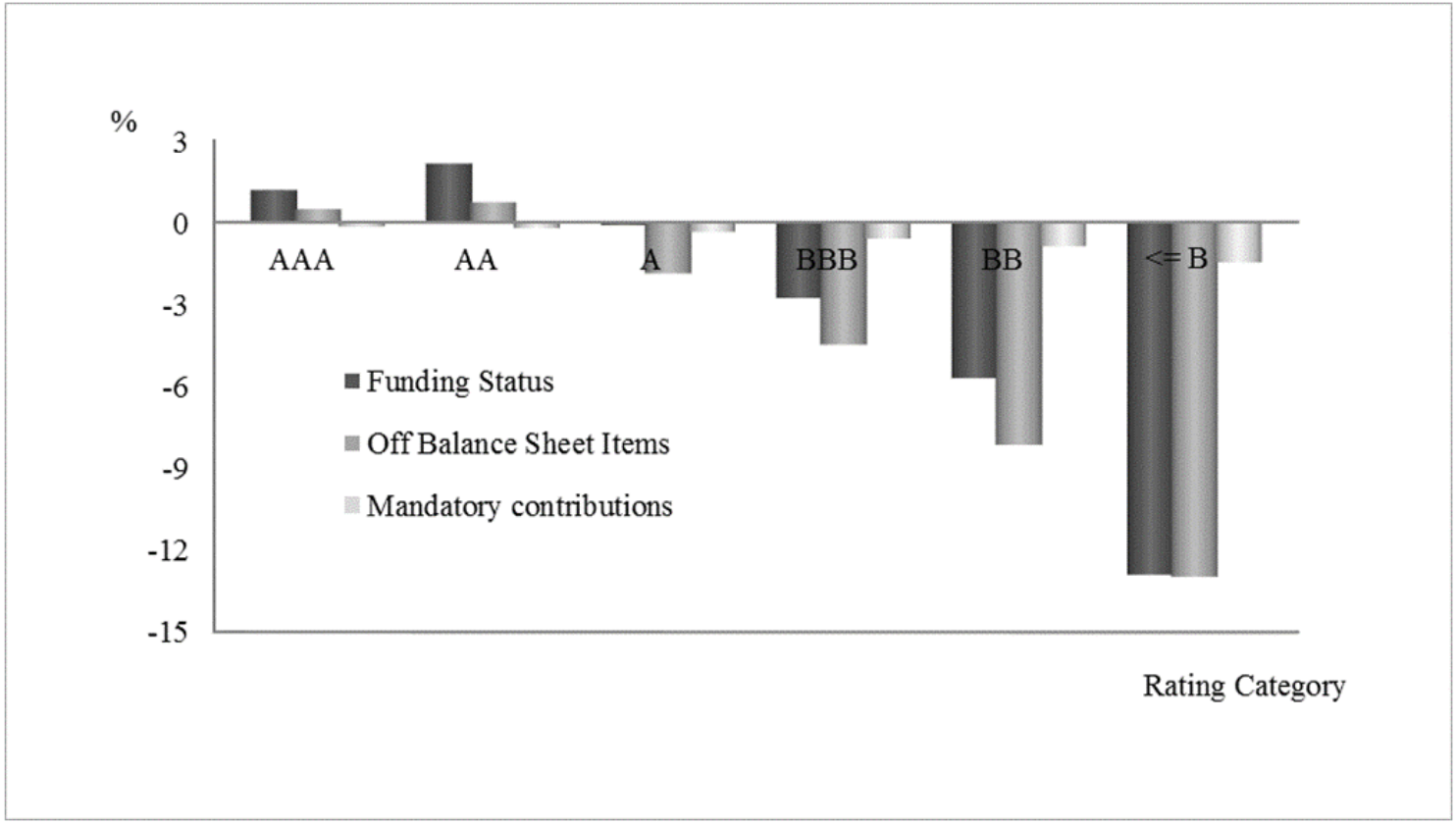
| | *BLOCK* | *TOP5* | *BHOL* |
|---|---|---|---|
| *INST* | 0.59** | 0.70** | 0.21** |
| *BLOCK* | | 0.93** | 0.08** |
| *TOP5* | | | 0.12** |

# S&P Credit Ratings and Summary Statistics

- The average size is $109.98 billion for firms with a AAA rating. The corresponding average size is only $1.62 billion for firms with a B rating or below.
- The mean interest coverage is 32.45 for AAA-rated firms and 1.81 for B and below firms.
- *FS* is 1.18% for AAA-rated firms and -12.90% for B-rated firms. B-rated firms have a shortage of funding for their pension plans as large as 12.90% of the beginning of the fiscal year market value.
- *MC* ranges from -0.14% to -1.48%. Lower rated firms face more mandatory contributions.

# S&P Credit Ratings and Summary Statistics

**Figure 1 Funding Status, Off Balance Sheet Items, and Mandatory Contributions by Rating Categories**



# Ordered Probit Model

$$\Pr ob(RATING_{i,t} = j) = \begin{cases} \Pr ob(RATING_{i,t} = 6) = \Phi(\mu_5 - X_{i,t}\beta), & j = 6 \\ \Pr ob(RATING_{i,t} = j) = \Phi(\mu_j - X_{i,t}\beta) - \Phi(\mu_{j-1} - X_{i,t}\beta), & j = 5,4,3,2 \\ \Pr ob(RATING_{i,t} = 1) = \Phi(\mu_1 - X_{i,t}\beta), & j = 1. \end{cases} \quad (3)$$

# Ordered Probit Model

The likelihood function for a sample of panel data takes the following form:

$$Likelihood \quad (X_{i,t} \mid \beta, \mu_1, .., \mu_5) = \prod_{i,t} \prod_{j=1}^{6} \Pr ob\,(RATING_{i,t} = j)^{D_j}, \quad (4)$$

where the indicator variable $D_j$ takes the value of one when $RATING_{i,t}$ is equal to $j$ and zero other wise.

# Basic Ordered Probit Model Estimates: Table 3

Panel A: Basic Ordered Probit Models

| | Estimates | T-statistics |
|---|---|---|
| Firm Characteristics | | |
| *ME_INF* | 0.480 | 12.99 ** |
| *COVERAGE* | 0.012 | 4.70 ** |
| *MARGIN* | 1.446 | 3.56 ** |
| *LLEV* | -3.578 | -13.35 ** |
| *PPE* | 0.689 | 3.10 ** |
| *BETA* | -0.912 | -16.04 ** |
| *R2* | 2.694 | 14.19 ** |
| *TRANS* | 6.298 | 5.63 ** |
| Fiscal Year Dummies | | |
| 1991 | | |
| 1992-1993 | -0.043 | -0.71 |
| 1994-1995 | -0.207 | -2.80 ** |
| 1996-1997 | -0.599 | -7.23 ** |
| 1998-1999 | -0.689 | -8.00 ** |
| 2000-2001 | -0.854 | -8.90 ** |
| 2002-2003 | -1.246 | -12.74 ** |
| 2004-2005 | -1.384 | -13.54 ** |
| 2006-2007 | -1.752 | -15.83 ** |
| 2008-2009 | -2.000 | -17.23 ** |
| 2010-2011 | -2.256 | -18.33 ** |
| 2012-2013 | -1.905 | -16.36 ** |

| | Estimates | Std. Errors |
|---|---|---|
| Lower Bound for Rating Category | | |
| $\mu_1$ | -0.587 | 0.398 |
| $\mu_2$ | 0.972 | 0.408 |
| $\mu_3$ | 2.729 | 0.422 |
| $\mu_4$ | 4.413 | 0.453 |
| $\mu_5$ | 5.732 | 0.490 |
| Industry Dummies | Yes | |
| Pseudo $R^2$ | 0.326 | |
| Observations | 8,604 | |

# Basic Ordered Probit Model Estimates: Table 3

Panel B: Ordered Probit Models with Funded Status, Off-Balance Sheet Items, and Mandatory Contributions

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| *ME_INF* | 0.478 | 0.490 | 0.476 | 0.486 | 0.476 |
| | (12.83) ** | (13.29) ** | (12.77) ** | (13.12) ** | (12.77) ** |
| *COVERAGE* | 0.012 | 0.012 | 0.011 | 0.012 | 0.011 |
| | (4.72) ** | (4.51) ** | (4.67) ** | (4.57) ** | (4.69) ** |
| *MARGIN* | 1.248 | 1.261 | 1.117 | 1.219 | 1.129 |
| | (3.04) ** | (3.03) ** | (2.69) ** | (2.92) ** | (2.73) ** |
| *LLEV* | -3.552 | -3.543 | -3.560 | -3.537 | -3.553 |
| | (-12.26) ** | (-12.08) ** | (-12.26) ** | (-12.01) ** | (-12.24) ** |
| *PPE* | 0.721 | 0.701 | 0.704 | 0.727 | 0.715 |
| | (3.22) ** | (3.05) ** | (3.15) ** | (3.14) ** | (3.20) ** |
| *BETA* | -0.873 | -0.866 | -0.882 | -0.854 | -0.873 |
| | (-15.01) ** | (-14.90) ** | (-15.26) ** | (-14.60) ** | (-14.93) ** |
| *R2* | 2.653 | 2.673 | 2.633 | 2.644 | 2.634 |
| | (13.94) ** | (13.45) ** | (13.84) ** | (13.22) ** | (13.84) ** |
| *TRANS* | 6.495 | 6.726 | 6.733 | 6.754 | 6.683 |
| | (5.81) ** | (5.89) ** | (6.04) ** | (5.89) ** | (6.00) ** |
| *FS* | 0.015 | | | 0.015 | 0.008 |
| | (5.57) ** | | | (3.53) ** | (2.02) ** |
| *OFFB* | | 0.010 | | -0.001 | |
| | | (4.48) ** | | (-0.01) | |
| *MC* | | | 0.177 | | 0.116 |
| | | | (6.75) ** | | (3.13) ** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.331 | 0.331 | 0.332 | 0.334 | 0.332 |
| Observations | 8,604 | 8,192 | 8,604 | 8,192 | 8,604 |

# Basic Ordered Probit Model Estimates

The estimated coefficients (*t*-stat.)

- *ME_INF*: 0.480 (12.99)
- *COVERAGE*: 0.012 (4.70)
- *MARGIN*: 1.446 (3.56)
- *LLEV*: -3.578 (-13.35)
- *PPE*: 0.689 (3.10).
- *BETA*: -0.912 (-16.04)
- *R2*: 2.694 (14.19).
- *TRANS* : 6.298 (5.63).

# Basic Ordered Probit Model Estimates

The estimated coefficients on the year dummy exhibit a clear pattern of declining magnitude from -0.043 to -1.905. Nine out of eleven dummies are highly significant.

The pattern confirms the results from Blume, Lim, and MacKinlay (1998) for an earlier period from 1975 to 1998.

The negative coefficients on the year dummies suggest that given the constant slope coefficients on eight firm characteristics, firms need to have higher values on *COVERAGE* or lower values on *LLEV*, for example, in order to cross the same threshold of $\mu_1,\ldots, \mu_5$.

# Basic Ordered Probit Model Estimates

The estimated coefficients on pension variables:

Our last model includes *FS* and *MC* only.

The estimates (*t*-stat.) are 0.008 (2.02) and 0.116 (3.13)

*FS* has a high correlation of 0.77 with *MC*.

*OFFB* is dominated by *FS*.

# Basic Ordered Probit Model Estimates

Throughout the paper, the t-statistics have been adjusted for clustering in firm effect.

See Petersen (2009) and Thompson (2011).

Angrist and Pischke (2008) suggest a minimum number of above 40 for the number of clustering.

In this case, the clustering should be adjusted.

# Discount Rate Change and Interest Rate Benchmarks

Table 4 compares the pension discount rates with interest rate benchmarks.

# Discount Rate Change and Interest Rate Benchmarks: Table 4

Panel A1: Percentage of Firm-Year Observations with $r^{DISCOUNT} > r^{Benchmark}$

| | All | AAA | AA | A | BBB | BB | <= B |
|---|---|---|---|---|---|---|---|
| $r^{DISCOUNT} > r^{TB30Y}$ | 98.0 | 98.5 | 97.3 | 97.7 | 98.5 | 97.7 | 97.1 |
| $r^{DISCOUNT} > r^{AAA20Y}$ | 96.1 | 97.1 | 92.3 | 95.5 | 97.0 | 96.4 | 95.7 |
| $r^{DISCOUNT} > r^{AAA25Y}$ | 96.0 | 97.1 | 92.6 | 95.6 | 97.0 | 96.0 | 95.7 |
| $r^{DISCOUNT} > r^{AA20Y}$ | 50.9 | 48.5 | 38.1 | 48.3 | 53.6 | 51.8 | 55.7 |
| $r^{DISCOUNT} > r^{AA25Y}$ | 61.1 | 61.8 | 51.5 | 59.6 | 63.4 | 61.0 | 63.7 |
| Observations | 8604 | 136 | 557 | 2381 | 3306 | 1637 | 587 |

Panel A2: Mean Percentage Difference in $r^{DISCOUNT} - r^{Benchmark}$

| | All | AAA | AA | A | BBB | BB | <= B |
|---|---|---|---|---|---|---|---|
| $r^{DISCOUNT} - r^{TB30Y}$ | 1.32 | 1.29 | 1.17 | 1.28 | 1.36 | 1.32 | 1.35 |
| $r^{DISCOUNT} - r^{AAA20Y}$ | 1.12 | 1.09 | 0.97 | 1.09 | 1.17 | 1.14 | 1.16 |
| $r^{DISCOUNT} - r^{AAA25Y}$ | 1.13 | 1.10 | 0.99 | 1.09 | 1.18 | 1.14 | 1.16 |
| $r^{DISCOUNT} - r^{AA20Y}$ | 0.01 | -0.01 | -0.12 | -0.03 | 0.04 | 0.01 | 0.06 |
| $r^{DISCOUNT} - r^{AA25Y}$ | 0.08 | 0.11 | -0.01 | 0.06 | 0.10 | 0.07 | 0.12 |

Panel A3: Median Percentage Difference in $r^{DISCOUNT} - r^{Benchmark}$

| | All | AAA | AA | A | BBB | BB | <= B |
|---|---|---|---|---|---|---|---|
| $r^{DISCOUNT} - r^{TB30Y}$ | 1.16 | 1.17 | 1.09 | 1.16 | 1.19 | 1.18 | 1.15 |
| $r^{DISCOUNT} - r^{AAA20Y}$ | 1.04 | 1.04 | 0.92 | 1.04 | 1.07 | 1.06 | 1.05 |
| $r^{DISCOUNT} - r^{AAA25Y}$ | 1.03 | 1.01 | 0.92 | 1.02 | 1.09 | 1.04 | 0.99 |
| $r^{DISCOUNT} - r^{AA20Y}$ | 0.01 | -0.01 | -0.12 | -0.02 | 0.05 | 0.02 | 0.09 |
| $r^{DISCOUNT} - r^{AA25Y}$ | 0.11 | 0.11 | 0.02 | 0.08 | 0.11 | 0.10 | 0.14 |

# Discount Rate Change and Interest Rate Benchmarks: Table 4

Panel B: OLS Regressions of Change in Pension Discount Rate on Change in Interest Rate

| | Model | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Constant | -0.379<br>(-14.03) ** | -0.343<br>(-12.64) ** | -0.369<br>(-13.64) ** | -0.143<br>(-5.22) ** | -0.152<br>(-5.59) ** |
| $\Delta r_{TB30Y}$ | 0.233<br>(21.27) * | | | | |
| $\Delta r_{AAA20Y}$ | | 0.313<br>(27.41) ** | | | |
| $\Delta r_{AAA25Y}$ | | | 0.275<br>(24.07) ** | | |
| $\Delta r_{AA20Y}$ | | | | 0.609<br>(47.32) ** | |
| $\Delta r_{AA25Y}$ | | | | | 0.598<br>(47.44) ** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.300 | 0.351 | 0.324 | 0.507 | 0.561 |
| Observations | 7,548 | 7,548 | 7,548 | 7,548 | 7,548 |

# Discount Rate Change and Interest Rate Benchmarks

- Panel A1, the first column shows

$r^{DISCOUNT} > r^{TB30Y}$, 98.0%

$r^{DISCOUNT} > r^{AAA20Y}$, 96.1%

$r^{DISCOUNT} > r^{AAA25Y}$, 96.0%

$r^{DISCOUNT} > r^{AA20Y}$, 50.9%

$r^{DISCOUNT} > r^{AA25Y}$, 61.1%

# Discount Rate Change and Interest Rate Benchmarks

- Panel A2, first column, mean value of

  $r^{DISCOUNT} - r^{Benchmark}$

  $r^{DISCOUNT} - r^{TB30Y}$, 1.32%

  $r^{DISCOUNT} - r^{AAA20Y}$, 1.12%

  $r^{DISCOUNT} - r^{AAA25Y}$, 1.13%

  $r^{DISCOUNT} - r^{AA20Y}$, 0.01%

  $r^{DISCOUNT} - r^{AA25Y}$, 0.08%

# Discount Rate Change and Interest Rate Benchmarks

- Panel A2, first column, median value of

  $r^{DISCOUNT} - r^{Benchmark}$

  $r^{DISCOUNT} - r^{TB30Y}$, 1.16%

  $r^{DISCOUNT} - r^{AAA20Y}$, 1.04%

  $r^{DISCOUNT} - r^{AAA25Y}$, 1.03%

  $r^{DISCOUNT} - r^{AA20Y}$, 0.01%

  $r^{DISCOUNT} - r^{AA25Y}$, 0.11%

# Discount Rate Change and Interest Rate Benchmarks

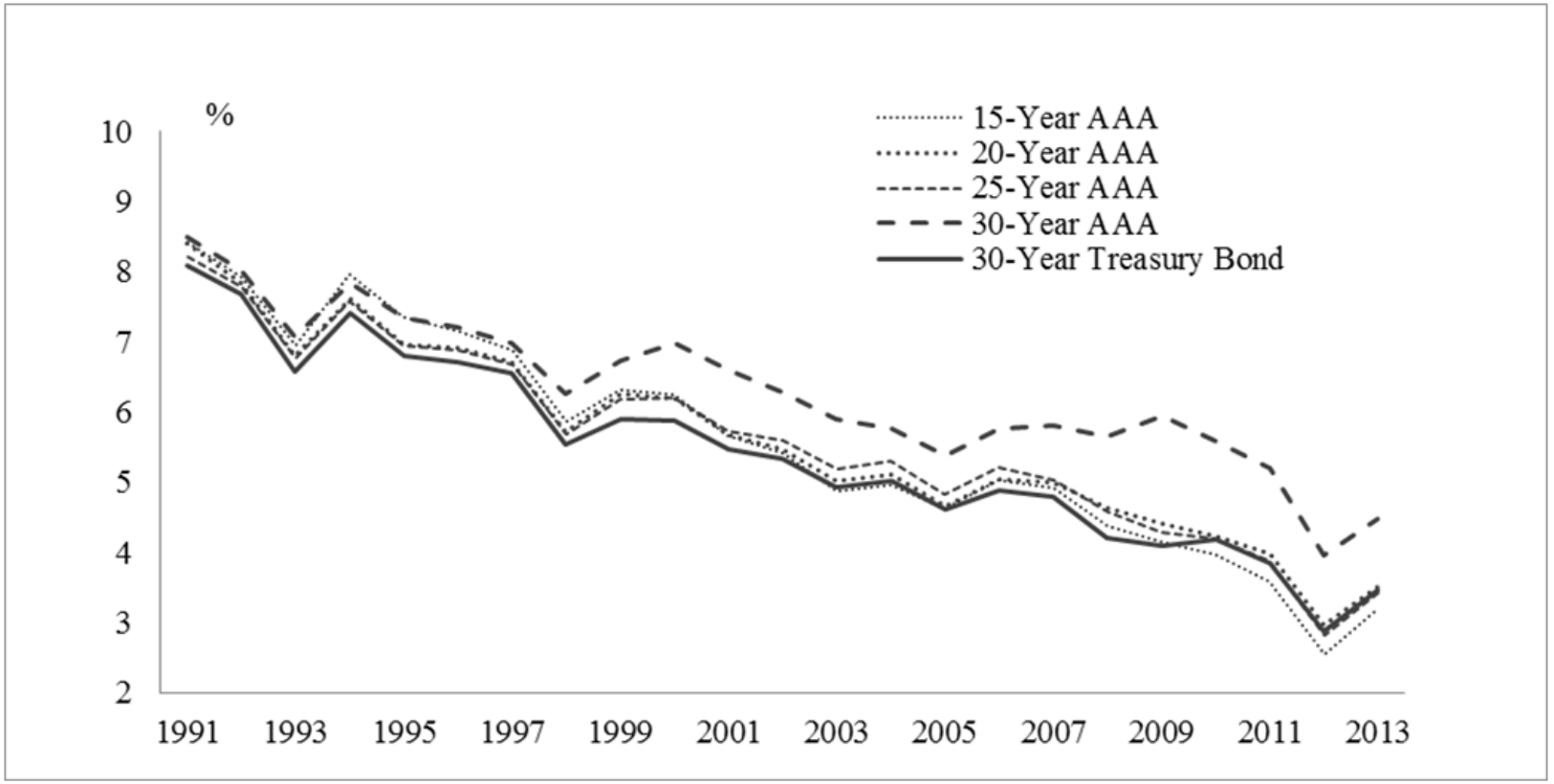
Panel B shows the regressions results:

$$\Delta r_{i,t}^{DISCOUNT} = \delta_0 + \delta_1 \Delta r_{i,t}^{Benchmark} + \sum_{j=1}^{11} YD_j + \sum_{k=1}^{28} ID_k + \varepsilon_{i,t}, \quad (5)$$

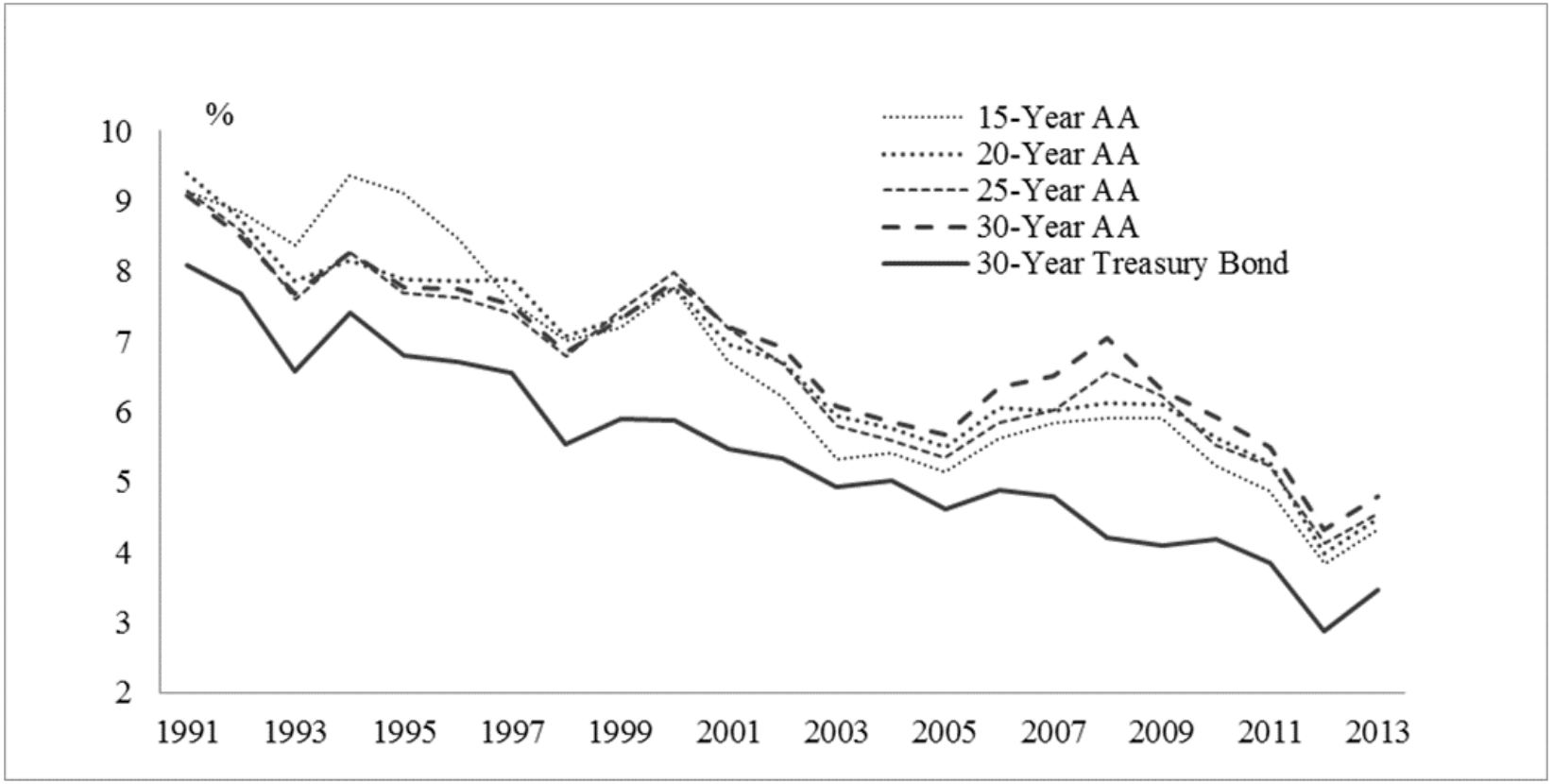
The t-statistics are also adjusted for the clustering in firm effect.

# Discount Rate Change and Interest Rate Benchmarks

**Figure 2 Treasury Bond and High Grade Corporate Bond Yields: 1991-2013**

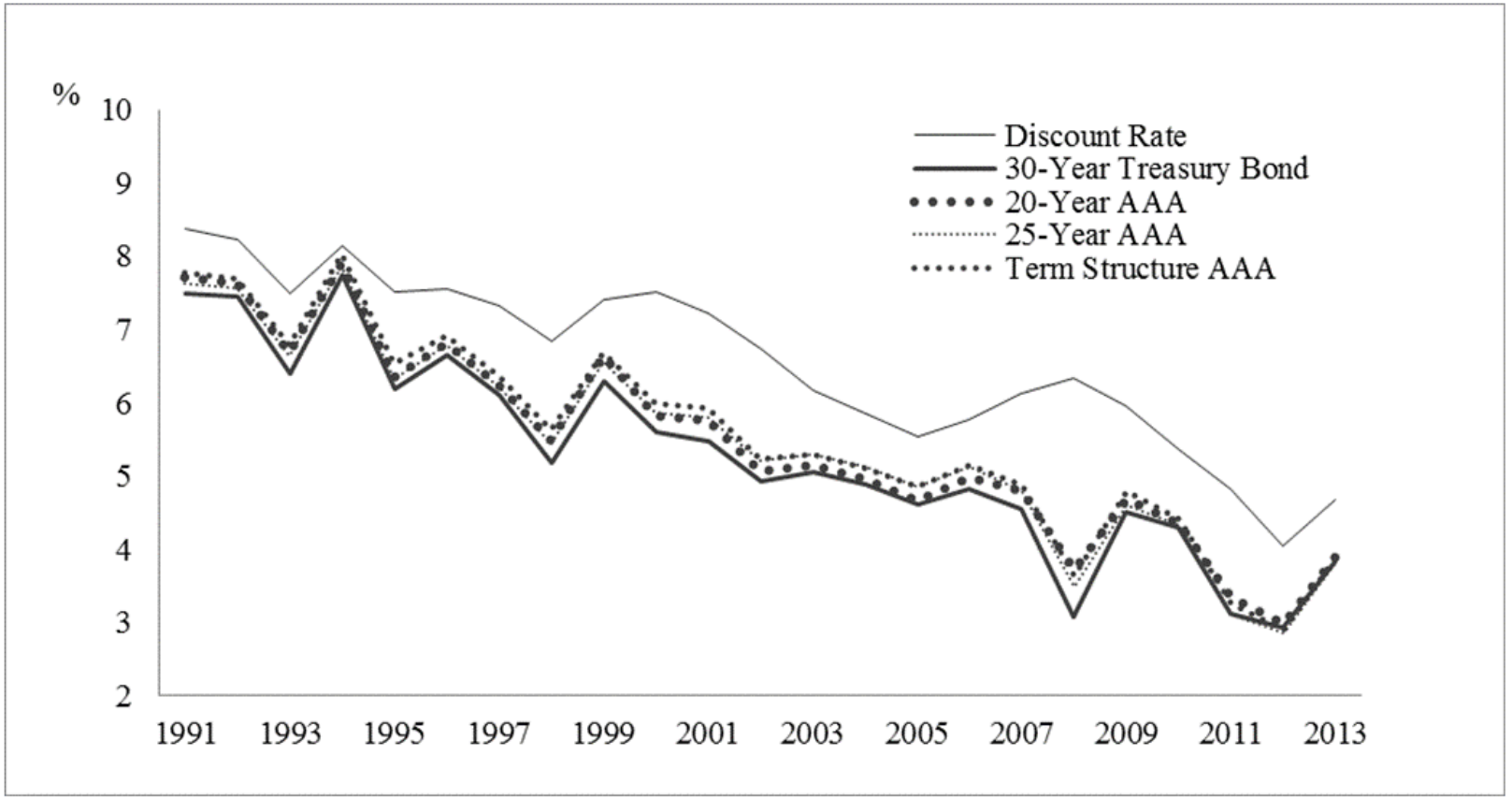


# Discount Rate Change and Interest Rate Benchmarks

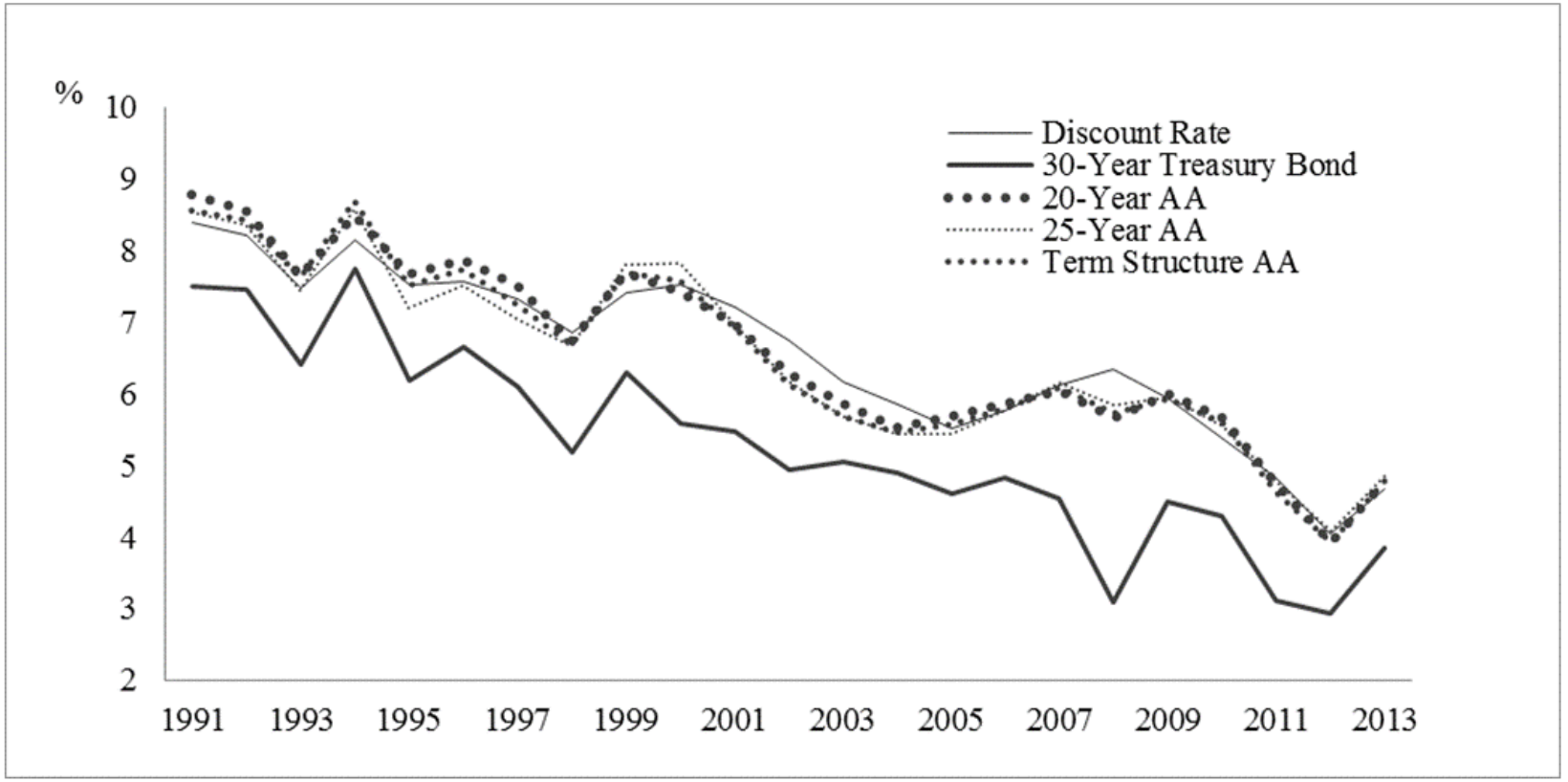


# Discount Rate Change and Interest Rate Benchmarks

**Figure 3 Pension Discount Rates and Interest Rate Benchmarks**



# Discount Rate Change and Interest Rate Benchmarks



# Discount Rate Change and Interest Rate Benchmarks

- From Panel B of Table 4, the estimate for the slope coefficient (*t*-stat.) is 0.233 (21.27) when the benchmark is the 30-year Treasury bond. This suggests that a 100 basis point drop in long-term Treasury bond yields will result in a 23.3 basis point drop in pension discount rates.

- The estimates (*t*-stat.) are 0.313 (27.41) and 0.275 (24.07) when the benchmark is long-term AAA-grade corporate bond yields

- The estimates (*t*-stat.) are 0.609 (47.32) and 0.598 (47.44) when the benchmark is long-term AA-grade corporate bond yields.

- Overall, pension discount rates respond to changes in benchmark interest rates by less than one to one.

# Understated Pension Liabilities

- $A = (1 - (1 + r)^{-L})/r$: the annuity factor of an $L$ period annuity at a pension discount rate of $r$
- $KW \times (1 + g)^N$ : expected annuity employees will receive after retirement
- $L$: the life expectancy of workers, i.e., $L = 15$
- $K$ : the proportion of employees' wages that are payable given current service performed and vesting
- W : current wage
- $g$ : compensation growth rate
- $N$ : number of years to retirement

# Understated Pension Liabilities

as:

From the relation:

$$PBO = ABO(1+g)^{N}. \qquad (7)$$

We solve for

$$\hat{N} = \log(PBO / ABO) / \log(1+g). \qquad (8)$$

# Understated Pension Liabilities

as:

Then we obtain estimate for *KW:*

$$\hat{KW} = \frac{PBO \times (1 + r^{DISCOUNT})^{\hat{N}}}{A(r^{DISCOUNT}, \hat{L}) \times (1 + g)^{\hat{N}}}, \qquad (9)$$

where

$$A(r^{DISCOUNT}, \hat{L})$$

is the annuity factor valued at $r^{DISCOUNT}$ and $\hat{L} = 15.$

# Understated Pension Liabilities

- PBO discounted at the 30-year Treasury bond yield can be calculated as:

$$PBO^{TB30Y} = \frac{A(r^{TB30Y}, \hat{L}) \times K\hat{W} \times (1+g)^{\hat{N}}}{(1+r^{TB30Y})^{\hat{N}}}. \qquad (10)$$

# Understated Pension Liabilities

- The understated PBO is the difference between the reported PBO and $PBO^{TB30Y}$ divided by the beginning of the fiscal year market value *ME*(-1):

$$PCT\_TB30Y = \frac{PBO - PBO^{TB30Y}}{ME(-1)}. \qquad (11)$$

# Understated Pension Liabilities

- The understated ABO is the difference between the reported ABO and $ABO^{TB30Y}$ divided by the beginning of the fiscal year market value *ME*(-1):

$$APCT\_TB30Y = \frac{ABO - ABO^{TB30Y}}{ME(-1)}. \quad (13)$$

# Understated Pension Liabilities: Table 5

Panel A: Understated PBOs and ABOs

| Benchmark | AAA | AA | A | BBB | BB | <= B |
|---|---|---|---|---|---|---|
| | | | Understated PBOs (million $) | | | |
| $r^{TB30Y}$ | -1314.6 | -533.5 | -364.8 | -218.6 | -109.1 | -85.2 |
| $r^{AAA20Y}$ | -1124.8 | -450.7 | -313.7 | -189.4 | -93.8 | -73.4 |
| $r^{AAA25Y}$ | -1098.0 | -463.8 | -316.5 | -192.7 | -94.1 | -72.6 |
| $r^{AAATM}$ | -1033.3 | -429.2 | -311.8 | -189.2 | -99.1 | -74.8 |
| $r^{AA20Y}$ | -85.6 | 10.5 | -17.9 | -18.7 | -3.6 | -6.6 |
| $r^{AA25Y}$ | -144.1 | -11.8 | -29.1 | -24.2 | -7.4 | -9.8 |
| $r^{AATM}$ | -100.4 | 4.0 | -29.2 | -28.2 | -14.4 | -13.7 |
| | | | Understated PBOs (%) | | | |
| $r^{TB30Y}$ | -1.1 | -2.2 | -2.7 | -3.9 | -4.9 | -7.2 |
| $r^{AAA20Y}$ | -0.9 | -1.8 | -2.3 | -3.4 | -4.2 | -6.2 |
| $r^{AAA25Y}$ | -0.9 | -1.8 | -2.3 | -3.4 | -4.2 | -6.1 |
| $r^{AAATM}$ | -0.8 | -1.7 | -2.2 | -3.3 | -4.2 | -5.9 |
| $r^{AA20Y}$ | -0.1 | 0.3 | -0.1 | -0.2 | -0.2 | -0.5 |
| $r^{AA25Y}$ | -0.1 | -0.1 | -0.2 | -0.4 | -0.5 | -0.9 |
| $r^{AATM}$ | -0.1 | 0.3 | -0.0 | -0.4 | -0.6 | -1.0 |

# Understated Pension Liabilities: Table 5

| | Understated ABOs (million $) | | | | | |
|---|---|---|---|---|---|---|
| $r^{TB30Y}$ | -1172.0 | -477.7 | -323.7 | -197.9 | -98.3 | -77.9 |
| $r^{AAA20Y}$ | -1006.3 | -404.1 | -279.3 | -171.9 | -84.6 | -67.4 |
| $r^{AAA25Y}$ | -987.6 | -417.1 | -283.0 | -175.0 | -85.3 | -66.8 |
| $r^{AAATM}$ | -933.6 | -386.9 | -279.5 | -172.7 | -90.0 | -69.1 |
| $r^{AA20Y}$ | -75.4 | 9.1 | -16.0 | -17.1 | -3.1 | -5.9 |
| $r^{AA25Y}$ | -127.8 | -11.1 | -26.3 | -21.9 | -6.5 | -9.0 |
| $r^{AATM}$ | -91.8 | 1.3 | -27.0 | -26.2 | -13.5 | -12.8 |
| | Understated ABOs (%) | | | | | |
| $r^{TB30Y}$ | -1.0 | -1.9 | -2.3 | -3.5 | -4.5 | -6.5 |
| $r^{AAA20Y}$ | -0.8 | -1.5 | -2.0 | -3.0 | -3.8 | -5.6 |
| $r^{AAA25Y}$ | -0.8 | -1.6 | -2.0 | -3.0 | -3.8 | -5.5 |
| $r^{AAATM}$ | -0.7 | -1.5 | -1.9 | -3.0 | -3.9 | -5.4 |
| $r^{AA20Y}$ | -0.1 | 0.2 | -0.1 | -0.2 | -0.2 | -0.5 |
| $r^{AA25Y}$ | -0.1 | -0.1 | -0.2 | -0.4 | -0.4 | -0.8 |
| $r^{AATM}$ | -0.1 | 0.2 | -0.0 | -0.4 | -0.5 | -1.0 |

# Understated Pension Liabilities: Table 5

| | Pension Benefit Formula | | | | | |
|---|---|---|---|---|---|---|
| KW | 1258.37 | 518.02 | 328.70 | 176.01 | 109.94 | 86.26 |
| N | 3.00 | 3.37 | 3.30 | 2.96 | 2.74 | 2.72 |
| g (%) | 4.94 | 4.74 | 4.51 | 4.34 | 4.13 | 4.05 |
| $(1+g)^N$ | 1.16 | 1.17 | 1.19 | 1.17 | 1.13 | 1.13 |
| $KW(1+g)^N$ | 1418.56 | 578.69 | 376.61 | 203.19 | 122.22 | 92.54 |
| | Discount Factor | | | | | |
| Discount factor at $r^{DISCOUNT}$ | 7.62 | 7.34 | 7.73 | 8.07 | 8.26 | 8.40 |
| Discount factor at $r^{TB30Y}$ | 8.60 | 8.22 | 8.72 | 9.13 | 9.28 | 9.47 |
| Discount factor at $r^{AAA20Y}$ | 8.44 | 8.06 | 8.56 | 8.97 | 9.13 | 9.31 |
| Discount factor at $r^{AAA25Y}$ | 8.44 | 8.08 | 8.57 | 8.99 | 9.13 | 9.32 |
| Discount factor at $r^{AAATM}$ | 8.33 | 8.00 | 8.49 | 8.91 | 9.06 | 9.20 |
| Discount factor at $r^{AA20Y}$ | 7.63 | 7.26 | 7.72 | 8.09 | 8.26 | 8.43 |
| Discount factor at $r^{AA25Y}$ | 7.71 | 7.34 | 7.77 | 8.14 | 8.30 | 8.47 |
| Discount factor at $r^{AATM}$ | 7.65 | 7.27 | 7.72 | 8.12 | 8.31 | 8.45 |

# Understated Pension Liabilities: Table 5

Panel B: Correlations of Understated PBOs and ABOs

| | *PCT_AAA20* | *PCT_AAA25* | *PCT_AAATM* | *PCT_AA20* | *PCT_AA25* | *PCT_AATM* |
|---|---|---|---|---|---|---|
| *PCT_T30Y* | 0.99** | 0.99** | 0.97** | 0.50** | 0.58** | 0.57** |
| *PCT_AAA20* | | 0.99** | 0.98** | 0.52** | 0.61** | 0.60** |
| *PCT_AAA25* | | | 0.97** | 0.50** | 0.57** | 0.56** |
| *PCT_AAATM* | | | | 0.51** | 0.58** | 0.63** |
| *PCT_AA20* | | | | | 0.84** | 0.83** |
| *PCT_AA25* | | | | | | 0.79** |

| | *APCT_AAA20* | *APCT_AAA25* | *APCT_AAAT* | *APCT_AA20* | *APCT_AA25* | *APCT_AATM* |
|---|---|---|---|---|---|---|
| *APCT_T30Y* | 0.99** | 0.99** | 0.97** | 0.50** | 0.59** | 0.58** |
| *APCT_AAA20* | | 0.99** | 0.98** | 0.53** | 0.62** | 0.61** |
| *APCT_AAA25* | | | 0.97** | 0.51** | 0.58** | 0.58** |
| *APCT_AAATM* | | | | 0.52** | 0.58** | 0.64** |
| *APCT_AA20* | | | | | 0.85** | 0.83** |
| *APCT_AA25* | | | | | | 0.79** |

Panel C: Difference in Wage Growth Assumptions and PBOs due to Wage Growth Assumptions

| | AAA | AA | A | BBB | BB | <= B |
|---|---|---|---|---|---|---|
| $g - g^{MEDIAN}$ (%) | 0.380 | 0.061 | 0.064 | 0.017 | -0.093 | -0.092 |
| *DPBO_WGRO* (%) | 0.086 | 0.027 | 0.029 | -0.037 | -0.117 | -0.122 |

# Understated Pension Liabilities

- Panel A shows UPBOs (million USD)

| | AAA (highest) | B (lowest) |
|---|---|---|
| $r^{TB30Y}$ | -1314.6 | -85.2 |
| $r^{AAA20Y}$ | -1124.8 | -73.4 |
| $r^{AAA25Y}$ | -1098.0 | -72.6 |
| $r^{AAATM}$ | -1033.3 | -74.8 |
| $r^{AA20Y}$ | -85.6 | -6.6 |
| $r^{AA25Y}$ | -144.1 | -9.8 |
| $r^{AATM}$ | -100.4 | -13.7 |

# Understated Pension Liabilities

- Panel A shows UPBOs (%)

| | AAA (highest) | B (lowest) |
|---|---|---|
| $r^{TB30Y}$ | -1.1 | -7.2 |
| $r^{AAA20Y}$ | -0.9 | -6.2 |
| $r^{AAA25Y}$ | -0.9 | -6.1 |
| $r^{AAATM}$ | -0.8 | -5.9 |
| $r^{AA20Y}$ | -0.1 | -0.5 |
| $r^{AA25Y}$ | -0.1 | -0.9 |
| $r^{AATM}$ | -0.1 | -1.0 |

# Understated Pension Liabilities

- Panel A shows UABOs (million USD)

| | AAA (highest) | B (lowest) |
|---|---|---|
| $r^{TB30Y}$ | -1172.0 | -77.9 |
| $r^{AAA20Y}$ | -1006.3 | -67.4 |
| $r^{AAA25Y}$ | -987.6 | -66.8 |
| $r^{AAATM}$ | -933.6 | -69.1 |
| $r^{AA20Y}$ | -75.4 | -5.9 |
| $r^{AA25Y}$ | -127.8 | -9.0 |
| $r^{AATM}$ | -91.8 | -12.8 |

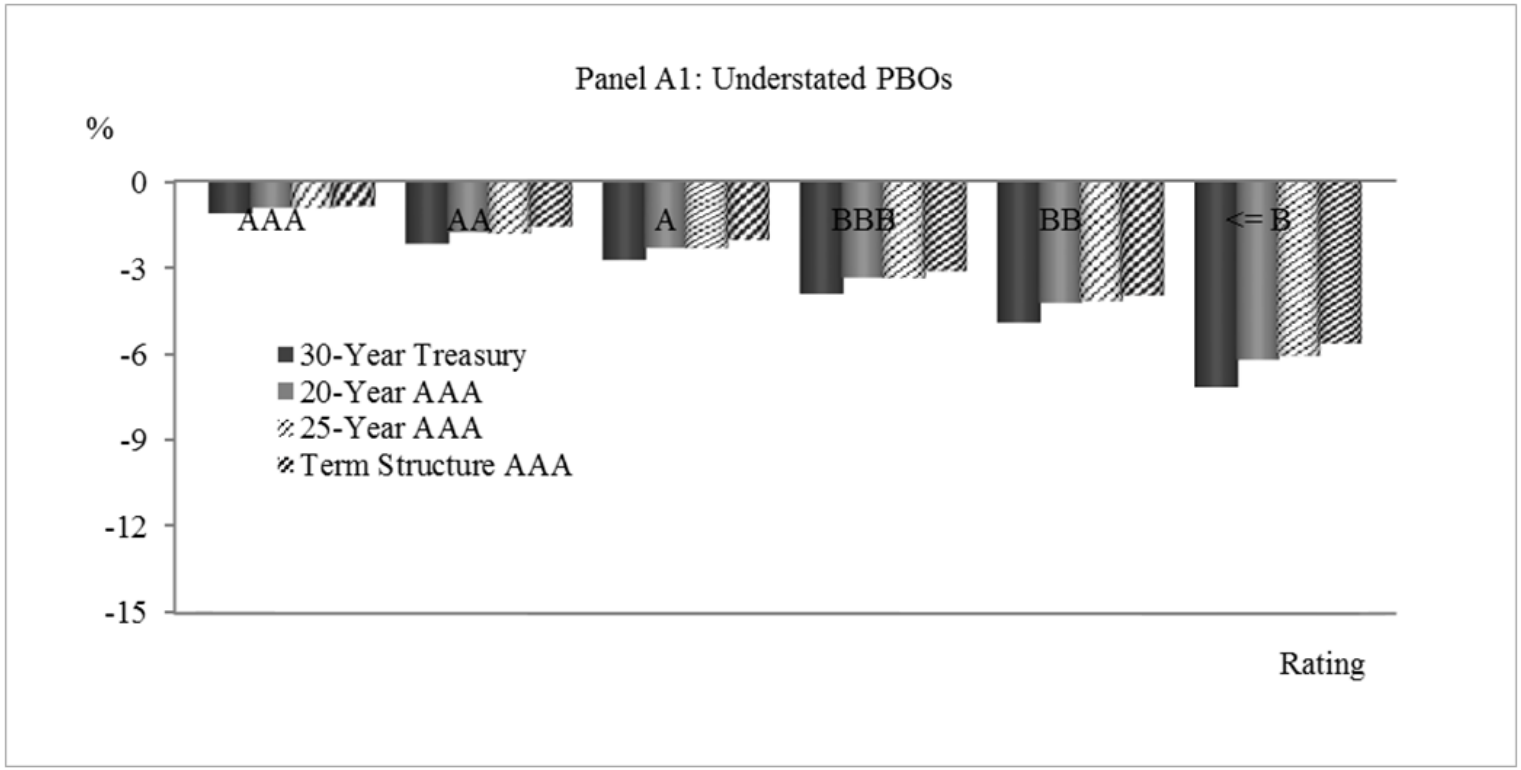
# Understated Pension Liabilities

- Panel A shows UABOs (%)

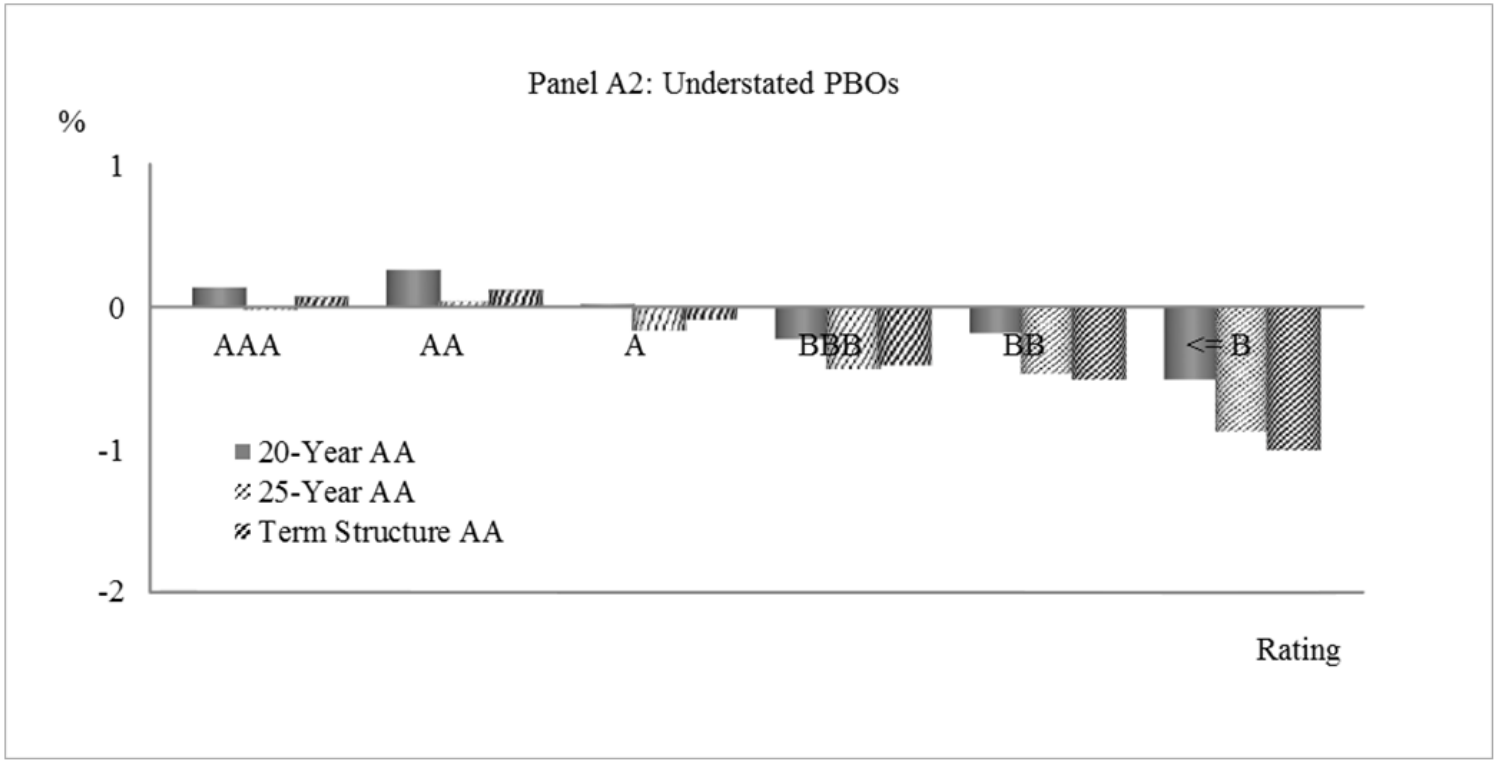
| | AAA (highest) | B (lowest) |
|---|---|---|
| $r^{TB30Y}$ | -1.0 | -6.5 |
| $r^{AAA20Y}$ | -0.8 | -5.6 |
| $r^{AAA25Y}$ | -0.8 | -5.5 |
| $r^{AAATM}$ | -0.7 | -5.4 |
| $r^{AA20Y}$ | -0.1 | -0.5 |
| $r^{AA25Y}$ | -0.1 | -0.8 |
| $r^{AATM}$ | -0.1 | -1.0 |

# Understated Pension Liabilities

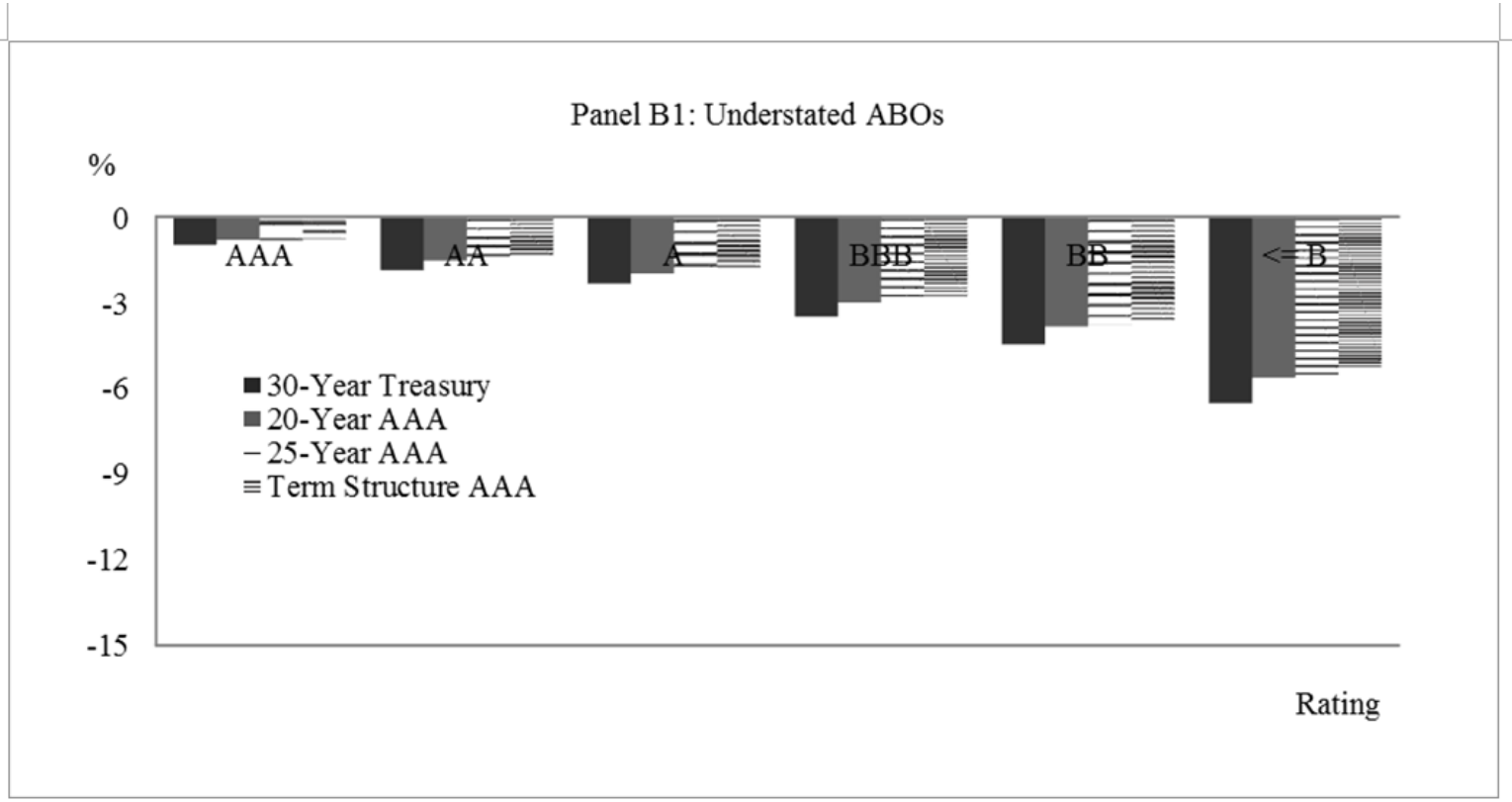
**Figure 4 Understated PBOs and ABOs**



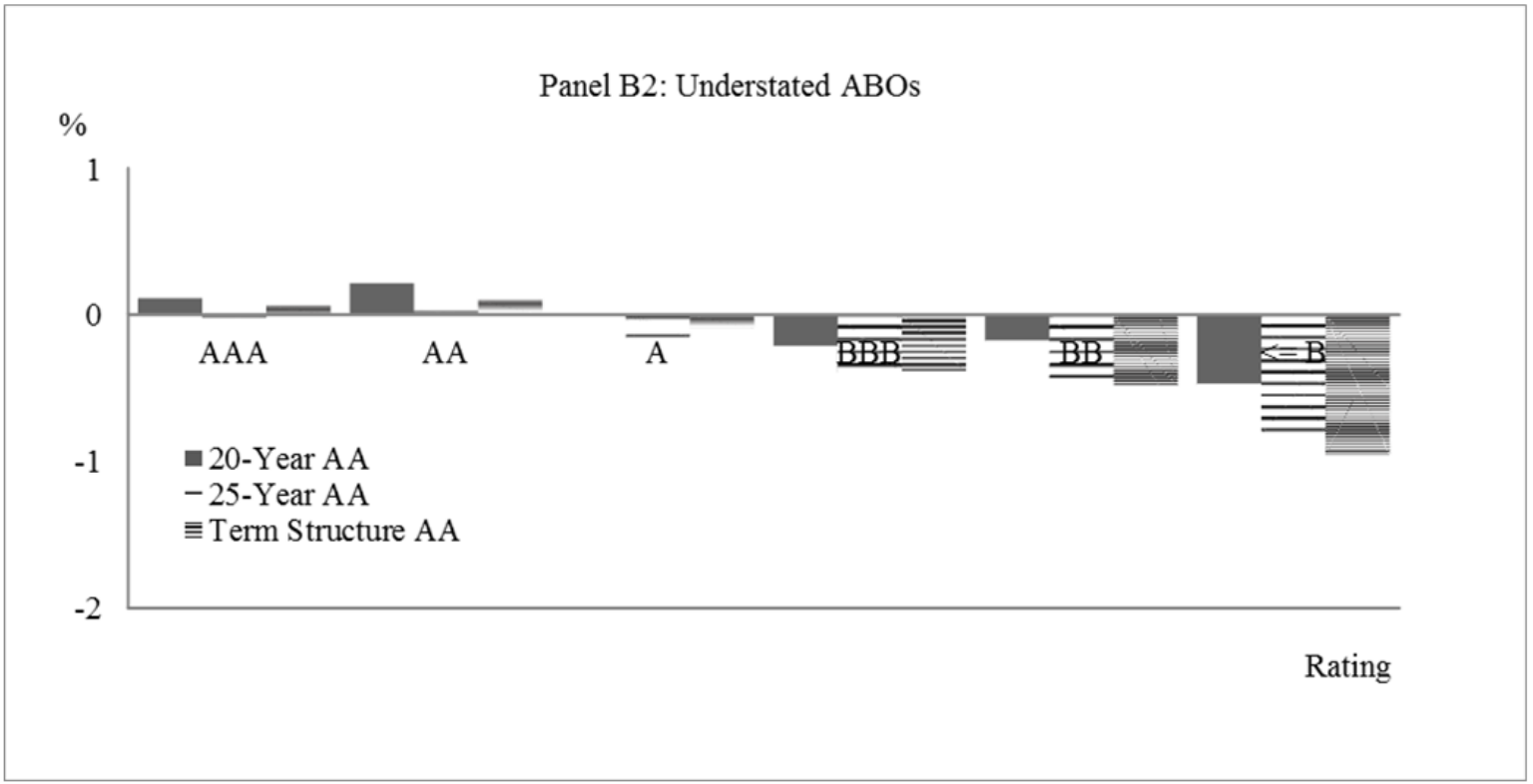
# Understated Pension Liabilities



# Understated Pension Liabilities



# Understated Pension Liabilities



# Ordered Probit Model with Understated Pension Liabilities: Table 6

Panel A: Understated PBOs

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
|---|---|---|---|---|---|---|---|
| *ME_INF* | 0.474 | 0.474 | 0.474 | 0.475 | 0.474 | 0.474 | 0.474 |
| | (12.71) ** | (12.72) ** | (12.72) ** | (12.76) ** | (12.71) ** | (12.72) ** | (12.73) ** |
| *COVERAGE* | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| | (4.65) ** | (4.66) ** | (4.66) ** | (4.63) ** | (4.71) ** | (4.71) ** | (4.71) ** |
| *MARGIN* | 1.089 | 1.091 | 1.088 | 1.085 | 1.126 | 1.119 | 1.110 |
| | (2.64) ** | (2.65) ** | (2.64) ** | (2.63) ** | (2.72) ** | (2.71) ** | (2.69) ** |
| *LLEV* | -3.567 | -3.565 | -3.566 | -3.568 | -3.555 | -3.551 | -3.553 |
| | (-12.30) ** | (-12.29) ** | (-12.29) ** | (-12.28) ** | (-12.22) ** | (-12.21) ** | (-12.23) ** |
| *PPE* | 0.713 | 0.714 | 0.715 | 0.717 | 0.714 | 0.716 | 0.724 |
| | (3.19) ** | (3.19) ** | (3.20) ** | (3.21) ** | (3.18) ** | (3.19) ** | (3.22) ** |
| *BETA* | -0.879 | -0.878 | -0.879 | -0.879 | -0.870 | -0.871 | -0.875 |
| | (-14.86) ** | (-14.85) ** | (-14.85) ** | (-14.85) ** | (-14.80) ** | (-14.83) ** | (-14.85) ** |
| *R2* | 2.654 | 2.650 | 2.656 | 2.660 | 2.631 | 2.640 | 2.656 |
| | (13.85) ** | (13.84) ** | (13.83) ** | (13.86) ** | (13.64) ** | (13.71) ** | (13.80) ** |
| *TRANS* | 6.671 | 6.677 | 6.667 | 6.690 | 6.722 | 6.711 | 6.700 |
| | (5.96) ** | (5.97) ** | (5.96) ** | (5.98) ** | (6.01) ** | (6.00) ** | (6.00) ** |
| *DPBO_WGRO* | 0.052 | 0.054 | 0.054 | 0.059 | 0.061 | 0.061 | 0.063 |
| | (1.04) | (1.07) | (1.06) | (1.17) | (1.21) | (1.21) | (1.25) |
| *FS* | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 |
| | (2.22) ** | (2.16) ** | (2.15) ** | (2.06) ** | (2.02) ** | (1.98) ** | (1.86) ** |
| *MC* | 0.068 | 0.072 | 0.072 | 0.069 | 0.112 | 0.109 | 0.108 |
| | (1.86) * | (2.01) ** | (2.03) ** | (1.92) * | (3.03) ** | (2.95) ** | (2.92) ** |
| *PCT_TB30Y* | 0.013 | | | | | | |
| | (2.24) ** | | | | | | |
| *PCT_AAA20Y* | | 0.013 | | | | | |
| | | (2.04) ** | | | | | |
| *PCT_AAA25Y* | | | 0.014 | | | | |
| | | | (2.17) ** | | | | |
| *PCT_AAATM* | | | | 0.017 | | | |
| | | | | (2.71) ** | | | |
| *PCT_AA20Y* | | | | | -0.001 | | |
| | | | | | (-0.07) | | |
| *PCT_AA25Y* | | | | | | 0.007 | |
| | | | | | | (0.64) | |
| *PCT_AATM* | | | | | | | 0.019 |
| | | | | | | | (1.73) * |
| Year Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.333 | 0.333 | 0.333 | 0.333 | 0.333 | 0.333 | 0.333 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 |

# Ordered Probit Model with Understated Pension Liabilities: Table 6

Panel B: Understated ABOs

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
|---|---|---|---|---|---|---|---|
| *ME_INF* | 0.475 | 0.475 | 0.475 | 0.475 | 0.474 | 0.474 | 0.474 |
| | (12.72) ** | (12.73) ** | (12.73) ** | (12.77) ** | (12.70) ** | (12.72) ** | (12.73) ** |
| *COVERAGE* | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| | (4.63) ** | (4.64) ** | (4.63) ** | (4.61) ** | (4.71) ** | (4.71) ** | (4.71) ** |
| *MARGIN* | 1.108 | 1.108 | 1.108 | 1.079 | 1.123 | 1.118 | 1.108 |
| | (2.61) ** | (2.62) ** | (2.61) ** | (2.61) ** | (2.72) ** | (2.70) ** | (2.69) ** |
| *LLEV* | -3.572 | -3.569 | -3.571 | -3.572 | -3.554 | -3.551 | -3.554 |
| | (-12.31) ** | (-12.30) ** | (-12.30) ** | (-12.29) ** | (-12.22) ** | (-12.21) ** | (-12.23) ** |
| *PPE* | 0.716 | 0.716 | 0.717 | 0.719 | 0.715 | 0.717 | 0.726 |
| | (3.20) ** | (3.21) ** | (3.21) ** | (3.22) ** | (3.19) ** | (3.20) ** | (3.23) ** |
| *BETA* | -0.881 | -0.880 | -0.882 | -0.880 | -0.871 | -0.872 | -0.875 |
| | (-14.86) ** | (-14.85) ** | (-14.86) ** | (-14.85) ** | (-14.81) ** | (-14.83) ** | (-14.86) ** |
| *R2* | 2.661 | 2.657 | 2.664 | 2.664 | 2.635 | 2.641 | 2.660 |
| | (13.89) ** | (13.87) ** | (13.87) ** | (13.89) ** | (13.67) ** | (13.72) ** | (13.83) ** |
| *TRANS* | 6.680 | 6.685 | 6.673 | 6.697 | 6.719 | 6.710 | 6.700 |
| | (5.97) ** | (5.98) ** | (5.96) ** | (5.99) ** | (6.01) ** | (6.00) ** | (6.00) ** |
| *DPBO_WGRO* | 0.053 | 0.054 | 0.054 | 0.060 | 0.061 | 0.061 | 0.063 |
| | (1.05) | (1.08) | (1.08) | (1.20) | (1.21) | (1.21) | (1.26) |
| *FS* | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 |
| | (2.24) ** | (2.17) ** | (2.15) ** | (2.03) ** | (2.00) ** | (1.97) ** | (1.83) * |
| *MC* | 0.054 | 0.060 | 0.060 | 0.064 | 0.112 | 0.108 | 0.107 |
| | (1.53) | (1.70) * | (1.74) * | (1.78) * | (3.02) ** | (2.94) ** | (2.90) ** |
| *APCT_TB30Y* | 0.019 | | | | | | |
| | (3.18) ** | | | | | | |
| *APCT_AAA20Y* | | 0.020 | | | | | |
| | | (2.86) ** | | | | | |
| *APCT_AAA25Y* | | | 0.020 | | | | |
| | | | (3.03) ** | | | | |
| *APCT_AAATM* | | | | 0.021 | | | |
| | | | | (3.25) ** | | | |
| *APCT_AA20Y* | | | | | 0.003 | | |
| | | | | | (0.20) | | |
| *APCT_AA25Y* | | | | | | 0.010 | |
| | | | | | | (0.78) | |
| *APCT_AATM* | | | | | | | 0.024 |
| | | | | | | | (1.98) ** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.334 | 0.334 | 0.334 | 0.334 | 0.333 | 0.333 | 0.333 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 |

# Ordered Probit Model with Understated Pension Liabilities

Panel A of Table 6 shows:

*PCT_TB30Y*: 0.013 (2.24)

*PCT_AAA20Y*: 0.013 (2.04)

*PCT_AAA25Y*: 0.014 (2.17)

*PCT_AAATM*: 0.017 (2.71)

Firms with more severely understated PBOs are associated with a lower credit rating

# Ordered Probit Model with Understated Pension Liabilities

Panel B shows

| | |
|---|---|
| *APCT_TB30Y*: | 0.019 (3.18) |
| *APCT_AAA20Y*: | 0.020 (2.86) |
| *APCT_AAA25Y*: | 0.020 (3.03) |
| *APCT_AAATM*: | 0.021 (3.25) |

The understated ABOs not only have large slope coefficients but also large t-statistics, implying that understated ABOs have a greater impact on S&P issuer ratings than understated PBOs.

# Ordered Probit Model with Understated Pension Liabilities: Table 7

| | Understated PBOs | | | | Understated ABOs | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
| *ME_INF* | 0.734 | 0.734 | 0.734 | 0.735 | 0.734 | 0.734 | 0.734 | 0.736 |
| *COVERAGE* | 0.158 | 0.159 | 0.158 | 0.157 | 0.157 | 0.157 | 0.157 | 0.156 |
| *MARGIN* | 0.121 | 0.121 | 0.121 | 0.121 | 0.120 | 0.120 | 0.120 | 0.120 |
| *LLEV* | -0.461 | -0.460 | -0.461 | -0.461 | -0.461 | -0.461 | -0.461 | -0.461 |
| *PPE* | 0.170 | 0.171 | 0.171 | 0.171 | 0.171 | 0.171 | 0.171 | 0.172 |
| *BETA* | -0.479 | -0.478 | -0.479 | -0.479 | -0.480 | -0.479 | -0.480 | -0.479 |
| *R2* | 0.494 | 0.493 | 0.494 | 0.495 | 0.495 | 0.494 | 0.496 | 0.496 |
| *TRANS* | 0.156 | 0.156 | 0.156 | 0.157 | 0.156 | 0.157 | 0.156 | 0.157 |
| *DPBO_WGRO* | 0.031 | 0.032 | 0.032 | 0.035 | 0.031 | 0.032 | 0.032 | 0.036 |
| *FS* | 0.091 | 0.089 | 0.088 | 0.085 | 0.091 | 0.089 | 0.088 | 0.084 |
| *MC* | 0.065 | 0.070 | 0.070 | 0.067 | 0.052 | 0.058 | 0.058 | 0.062 |
| *PCT_TB30Y* | 0.069 | | | | | | | |
| *PCT_AAA20Y* | | 0.063 | | | | | | |
| *PCT_AAA25Y* | | | 0.065 | | | | | |
| *PCT_AAATM* | | | | 0.075 | | | | |
| *APCT_TB30Y* | | | | | 0.091 | | | |
| *APCT_AAA20Y* | | | | | | 0.083 | | |
| *APCT_AAA25Y* | | | | | | | 0.085 | |
| *APCT_AAATM* | | | | | | | | 0.088 |

# Ordered Probit Model with Understated Pension Liabilities

Table 7 shows:

$\beta_X \times \sigma_X$, where $\beta_X$ is the estimated coefficient and $\sigma_X$ is the standard deviation of the independent variable *X*.

Model 1 in Table 7 shows that the products $\beta_X \times \sigma_X$ are 0.734, 0.158, 0.121, -0.461, 0.170, -0.479, 0.494, and 0.156 respectively, for *ME_INF*, *COVERAGE*, *MARGIN*, *LLEV*, *PPE*, *BETA*, *R2*, and *TRANS*.

# Ordered Probit Model with Understated Pension Liabilities

Model 1 in Table 7 also shows:

| | $\beta_X \times \sigma_X$ |
|---|---|
| *FS* | 0.091 |
| *MC* | 0.065 |
| *PCT_TB30Y* | 0.069 |

From Model 5 in Table 7:

| | |
|---|---|
| *FS* | 0.091 |
| *MC* | 0.052 |
| *APCT_TB30Y* | 0.091 |

# Ordered Probit Model with Understated Pension Liabilities

We calculate the value of PBOs by replacing firms' assumed wage growth rate $g$ by the corresponding industry median $g^{MEDIAN}$,

$$PBO^{MEDIAN} = \frac{A_L^r \times KW \times (1+g^{MEDIAN})^N}{(1+r^{DISCOUNT})^N}. \quad (14)$$

# Ordered Probit Model with Understated Pension Liabilities

Then the difference between the reported PBO and the PBO valued at the industry median wage growth rate is calculated as:

$$DPBO\_WGRO = \frac{PBO - PBO^{MEDIAN}}{ME(-1)}. \qquad (15)$$

# Ordered Probit Model with Understated Pension Liabilities

Panel C of Table 5 shows that g - $g^{MEDIAN}$ are 0.380, 0.061, 0.064, 0.017, -0.093, and -0.092%, respectively.

*DPBO_WGRO*, are 0.086, 0.027, 0.029, -0.037, -0.117, and -0.122%, respectively, for firms rated AAA to firms rated B and below

# Ordered Probit Model with Understated Pension Liabilities

We include the variable *DPBO_WGRO* in the probit models in Table 6. From Model 1 in Panel A, the estimate (*t*-stat.) for *DPBO_WGRO* is 0.052 (1.04).

Therefore, S&P credit ratings are not significantly related to the differences in PBO values due to differences in wage growth assumptions.

# Ordered Probit Model with Understated Pension Liabilities

The impact is small. It is about half the impact of understated PBOs (0.031 versus 0.069 in Model 1 of Table 7) and less than half the impact of understated ABOs (0.031 versus 0.091 in Model 5 of Table 7).

In addition, we find that *DPBO_WGRO* becomes insignificant after we incorporate ownership and corporate governance variables with fewer firm-year observations.

# Instrumental Variable Analysis

Pension discount rates are decision variables. Therefore, there is an endogeneity issue with respect to the positive relation we find in the probit model.

We use instrumental variable (IV) estimators (two-stage (2SLS) and three-stage (3SLS) least squares). We treat *RATING* and understated PBOs or understated ABOs as endogenous variables.

# Instrumental Variable Analysis

$$RATING_{i,t} = \beta_0 + \beta_1 USPL_{i,t} + Z_{i,t} \bullet \beta + \sum_{j=1}^{11} YD_j + \sum_{k=1}^{28} ID_k + \varepsilon_{\mathrm{i,t}}, \qquad (16)$$

$$USPL_{i,t} = \gamma_0 + \gamma_1 RATING_{i,t} + Z_{i,t} \bullet \gamma + \sum_{j=1}^{11} YD_j + \sum_{k=1}^{28} ID_k + \varepsilon_{\mathrm{i,t}}, \quad (17)$$

# Instrumental Variable Analysis

where Z = [*ME_INF COVERAGE MARGIN LLEV PPE BETA R2 TRANS TB1Y FS MC*] .

*TB1Y* refers to the yield on one-year Treasury note.

USPL refers to

*UPBO=(PCT_TB30Y, PCT_AAA20Y, PCT_AAA25Y, PCT_AAATM)*

*UABO=(PCT_TB30Y, PCT_AAA20Y, PCT_AAA25Y, PCT_AAATM).*

# Instrumental Variable Analysis: Table 8

Panel A: The Dependent Variables are *RATING* and *UPBO*s

| | *RATING* | *PCT_TB30Y* | *PCT_AAA20Y* | *PCT_AAA25Y* | *PCT_AAATM* |
|---|---|---|---|---|---|
| Exogenous Variable | F-statistic (*p*-value) | F-statistic (*p*-value) | F-statistic (*p*-value) | F-statistic (*p*-value) | F-statistic (*p*-value) |
| *ME_INF* | 234.04 (0.00) *** | 0.49 (0.48) | 0.28 (0.60) | 0.35 (0.56) | 0.12 (0.73) |
| *COVERAGE* | 24.84 (0.00) *** | 7.18 (0.01) | 6.94 (0.01) | 7.32 (0.01) | 10.76 (0.00) *** |
| *MARGIN* | 8.81 (0.00) | 13.14 (0.00) *** | 13.70 (0.00) *** | 15.33 (0.00) *** | 13.74 (0.00) *** |
| *LLEV* | 124.02 (0.00) *** | 0.54 (0.46) | 0.43 (0.51) | 0.59 (0.44) | 0.29 (0.59) |
| *PPE* | 10.52 (0.00) *** | 0.09 (0.77) | 0.03 (0.86) | 0.03 (0.87) | 0.03 (0.87) |
| *BETA* | 238.03 (0.00) *** | 8.78 (0.00) | 8.05 (0.00) | 11.83 (0.00) *** | 5.56 (0.02) |
| *R2* | 195.55 (0.00) *** | 0.95 (0.33) | 0.82 (0.36) | 2.39 (0.12) | 3.26 (0.07) |
| *TRANS* | 38.18 (0.00) *** | 0.62 (0.43) | 0.61 (0.44) | 0.94 (0.33) | 0.18 (0.67) |
| *TB1Y* | 9.98 (0.00) *** | 48.05 (0.00) *** | 43.22 (0.00) *** | 52.00 (0.00) *** | 47.51 (0.00) *** |
| *FS* | 5.22 (0.02) | 0.66 (0.42) | 0.22 (0.64) | 0.13 (0.72) | 0.05 (0.82) |
| *MC* | 6.96 (0.01) | 145.95 (0.00) *** | 141.65 (0.00) *** | 136.88 (0.00) *** | 110.33 (0.00) *** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.652 | 0.487 | 0.489 | 0.472 | 0.455 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 |

# Instrumental Variable Analysis: Table 8

Panel B: The Dependent Variables are *UABOs*

| Exogenous Variable | *APCT_TB30Y* F-statistic (*p*-value) | *APCT_AAA20Y* F-statistic (*p*-value) | *APCT_AAA25Y* F-statistic (*p*-value) | *APCT_AAATM* F-statistic (*p*-value) |
|---|---|---|---|---|
| *ME_INF* | 0.18 (0.67) | 0.06 (0.80) | 0.09 (0.76) | 0.22 (0.64) |
| *COVERAGE* | 8.52 (0.00) | 8.29 (0.00) | 8.87 (0.00) | 11.03 (0.00) *** |
| *MARGIN* | 14.23 (0.00) *** | 15.48 (0.00) *** | 17.21 (0.00) *** | 13.08 (0.00) *** |
| *LLEV* | 0.54 (0.46) | 0.41 (0.52) | 0.60 (0.44) | 0.38 (0.54) |
| *PPE* | 0.01 (0.97) | 0.01 (0.94) | 0.01 (0.92) | 0.09 (0.77) |
| *BETA* | 6.14 (0.01) | 5.75 (0.02) | 9.07 (0.00) *** | 4.14 (0.04) |
| *R2* | 1.06 (0.30) | 0.99 (0.32) | 2.77 (0.10) | 2.80 (0.09) |
| *TRANS* | 0.19 (0.66) | 0.19 (0.66) | 0.40 (0.53) | 0.08 (0.78) |
| *TB1Y* | 47.54 (0.00) *** | 42.42 (0.00) *** | 51.28 (0.00) *** | 41.80 (0.00) *** |
| *FS* | 0.32 (0.57) | 0.05 (0.82) | 0.01 (0.91) | 0.29 (0.59) |
| *MC* | 137.23 (0.00) *** | 135.88 (0.00) *** | 129.32 (0.00) *** | 102.23 (0.00) *** |
| Year Dummies | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes |
| $R^2$ | 0.501 | 0.505 | 0.486 | 0.454 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 |

# Instrumental Variable Analysis

Stock and Yogo (2002) and Stock, Wright, and Yogo (2002) estimate the critical value to be 8.96 when testing the strength of one instrument.

We use this criterion to identify the strong instruments for both credit rating and understated pension liabilities.

# Instrumental Variable Analysis

Table 8 shows

Strong instruments for *RATING*: 8 variables:

*ME_INF COVERAGE LLEV PPE BETA R2 TRANS TB1Y*

# Instrumental Variable Analysis

Table 8 shows

Strong instruments for *USPL*: 4 variables:

*COVERAGE MARGIN TB1Y MC*

# Instrumental Variable Analysis

The level of one-year Treasury bond yields, *TB1Y*, also serves as a strong instrument for understated pension liabilities.

This happens because firms lower their pension discount rates by less than one for one (Panel B of Table 4) following a decline in interest rate benchmarks.

# Instrumental Variable Analysis

As interest rates, including *TB1Y*, drop significantly from 1991 to 2013, we find pension liabilities are less responsive, indicating more hiding behavior by firms.

This leads to a significant positive correlation between *TB1Y* and various measures of understated pension liabilities.

# Instrumental Variable Analysis: Table 9

Panel A: The Determinants of *RATING* and *UPBO*s

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| | *RATING* | *PCT_TB30Y* | *RATING* | *PCT_AAA20Y* | *RATING* | *PCT_AAA25Y* | *RATING* | *PCT_AAATM* |
| *UPBOs (instrumented)* | 0.911 | | 1.049 | | 0.999 | | 0.911 | |
| | (4.03)** | | (4.01)** | | (4.12)** | | (4.19)** | |
| *RATING (instrumented)* | | -0.085 | | -0.067 | | -0.080 | | -0.065 |
| | | (-0.63) | | (-0.58) | | (-0.69) | | (-0.53) |
| *ME_INF* | 0.784 | 0.121 | 0.796 | 0.089 | 0.793 | 0.103 | 0.857 | 0.031 |
| | (8.89)** | (0.74) | (9.14)** | (0.63) | (9.36)** | (0.74) | (10.99)** | (0.21) |
| *COVERAGE* | | 0.017 | | 0.014 | | 0.015 | | 0.019 |
| | | (2.38)** | | (2.35)** | | (2.45)** | | (2.95)** |
| *MARGIN* | | 3.243 | | 2.805 | | 2.974 | | 2.838 |
| | | (4.00)** | | (3.98)** | | (4.23)** | | (3.93)** |
| *LLEV* | -6.417 | | -6.383 | | -6.439 | | -6.163 | |
| | (-8.30)** | | (-8.27)** | | (-8.54)** | | (-8.19)** | |
| *PPE* | 0.999 | | 1.053 | | 1.062 | | 1.253 | |
| | (1.70)* | | (1.81)* | | (1.87)* | | (2.32)** | |
| *BETA* | -1.907 | 0.308 | -1.888 | 0.259 | -1.954 | 0.324 | -1.815 | 0.234 |
| | (-10.05)** | (1.24) | (-10.05)** | (1.22) | (-10.19)** | (1.50) | (-10.28)** | (1.04) |
| *R2* | 5.250 | -0.121 | 5.216 | -0.102 | 5.508 | -0.356 | 5.582 | -0.576 |
| | (8.96)** | (-0.14) | (8.96)** | (-0.14) | (9.42)** | (-0.48) | (10.06)** | (-0.76) |
| *TRANS* | 8.849 | 3.785 | 8.875 | 3.162 | 8.457 | 3.843 | 10.119 | 1.999 |
| | (2.53)** | (0.91) | (2.53)** | (0.88) | (2.50)** | (1.08) | (3.16)** | (0.55) |
| *TB1Y* | -0.297 | 0.406 | -0.271 | 0.327 | -0.289 | 0.362 | -0.228 | 0.329 |
| | (-2.80)** | (6.82)** | (-2.70)** | (6.45)** | (-2.85)** | (7.08)** | (-2.61)** | (6.76)** |
| *FS* | 0.039 | -0.023 | 0.029 | -0.011 | 0.026 | -0.008 | 0.012 | 0.007 |
| | (1.44) | (-0.78) | (1.11) | (-0.43) | (1.03) | (-0.32) | (0.52) | (0.27) |
| *MC* | -3.025 | 3.518 | -2.976 | 3.006 | -2.735 | 2.918 | -2.155 | 2.558 |
| | (-3.53)** | (12.09)** | (-3.50)** | (11.91)** | (-3.57)** | (11.71)** | (-3.47)** | (10.51)** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Over-Identifying Restriction Tests | 0.89 (0.35) | 0.27 (0.60) | 1.12 (0.29) | 0.14 (0.71) | 1.23 (0.27) | 0.16 (0.69) | 0.42 (0.52) | 0.01 (0.99) |
| $R^2$ | 0.651 | 0.486 | 0.651 | 0.489 | 0.651 | 0.471 | 0.651 | 0.454 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 |

# Instrumental Variable Analysis: Table 9

Panel B: The Determinants of *RATING* and *UABO*s

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| | *RATING* | *APCT_TB30Y* | *RATING* | *APCT_AAA20Y* | *RATING* | *APCT_AAA25Y* | *RATING* | *APCT_AAATM* |
| *UABOs (instrumented)* | 0.940 | | 1.081 | | 1.028 | | 0.955 | |
| | (4.20)** | | (4.22)** | | (4.33)** | | (4.18)** | |
| *RATING (instrumented)* | | -0.086 | | -0.066 | | -0.080 | | -0.075 |
| | | (-0.67) | | (-0.61) | | (-0.74) | | (-0.63) |
| *ME_INF* | 0.806 | 0.099 | 0.817 | 0.070 | 0.814 | 0.085 | 0.865 | 0.032 |
| | (9.65)** | (0.65) | (9.95)** | (0.54) | (10.16)** | (0.65) | (11.25)** | (0.23) |
| *COVERAGE* | | 0.018 | | 0.015 | | 0.016 | | 0.019 |
| | | (2.64)** | | (2.61)** | | (2.73)** | | (3.03)** |
| *MARGIN* | | 2.965 | | 2.583 | | 2.745 | | 2.636 |
| | | (4.05)** | | (4.09)** | | (4.35)** | | (3.84)** |
| *LLEV* | -6.351 | | -6.314 | | -6.380 | | -6.190 | |
| | (-8.39)** | | (-8.40)** | | (-8.67)** | | (-8.22)** | |
| *PPE* | 1.146 | | 1.191 | | 1.199 | | 1.324 | |
| | (2.02)** | | (2.12)** | | (2.19)** | | (2.46)** | |
| *BETA* | -1.825 | 0.205 | -1.810 | 0.177 | -1.875 | 0.233 | -1.773 | 0.159 |
| | (-10.52)** | (0.89) | (-10.57)** | (0.90) | (-10.77)** | (1.17) | (-10.29)** | (0.75) |
| *R2* | 5.240 | -0.091 | 5.215 | -0.093 | 5.497 | -0.321 | 5.535 | -0.441 |
| | (9.40)** | (-0.12) | (9.49)** | (-0.14) | (9.89)** | (-0.48) | (10.01)** | (-0.60) |
| *TRANS* | 10.001 | 2.391 | 10.010 | 1.957 | 9.542 | 2.637 | 10.486 | 1.630 |
| | (2.97)** | (0.62) | (2.99)** | (0.59) | (2.96)** | (0.80) | (3.27)** | (0.46) |
| *TB1Y* | -0.269 | 0.364 | -0.241 | 0.290 | -0.258 | 0.322 | -0.202 | 0.288 |
| | (-2.81)** | (6.78)** | (-2.71)** | (6.40)** | (-2.86)** | (7.04)** | (-2.48)** | (6.36)** |
| *FS* | 0.032 | -0.015 | 0.023 | -0.005 | 0.020 | -0.002 | 0.004 | 0.014 |
| | (1.21) | (-0.52) | (0.90) | (-0.19) | (0.81) | (-0.06) | (0.19) | (0.59) |
| *MC* | -2.776 | 3.145 | -2.714 | 2.674 | -2.492 | 2.598 | -2.029 | 2.311 |
| | (-3.65)** | (11.73)** | (-3.64)** | (11.67)** | (-3.70)** | (11.39)** | (-3.44)** | (10.11)** |
| Year Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Over-Identifying Restriction Tests | 0.60 (0.44) | 0.07 (0.79) | 0.86 (0.35) | 0.01 (0.91) | 0.93 (0.34) | 0.02 (0.89) | 0.28 (0.60) | 0.01 (0.91) |
| $R^2$ | 0.651 | 0.501 | 0.651 | 0.505 | 0.651 | 0.486 | 0.651 | 0.454 |
| Observations | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 | 8,604 |

# Instrumental Variable Analysis

- In summary, the 2SLS results provide strong evidence that the causal direction is from understated pension liabilities to S&P credit rating, rather than from S&P credit rating to understated pension liabilities.

- In simple terms, firms try to hide, but rating agencies detect this behavior and award higher ratings to firms who hide less and award lower ratings to firms who hide more.

- The positive relation between S&P credit rating is not driven by the other possibility that low quality firms, possibly with a low rating in the past or anticipating a low rating, tend to hide more.

# Instrumental Variable Analysis

- The three stage least square analysis developed by Zellner and Theil (1962) goes one step further by using the 2SLS estimated variance-covariance matrix of the error terms to simultaneously estimate the equations determining *RATING* and *UPBO* (*UABO*).

- We also estimate the 3SLS system and find results that essentially mirror those from the 2SLS analysis. We do not report the 3SLS results in this paper.

- In 2SLS and 3SLS, t-statistics are adjusted for the clustering-in-firm effect.

# Instrumental Variable Analysis

- The existing literature typically treats funded status and mandatory contributions as exogenous. We follow this tradition and use funded status and mandatory contributions as instruments in our 2SLS and 3SLS analyses.

- Because the measurement of *FS* depends on PBOs and the measurement of *MC* depends on both PBOs and ABOs, which in turn depend on the assumed pension discount rates, the traditional measures of *FS* and *MC* are not strictly exogenous.

# Instrumental Variable Analysis

- We, therefore, measure *FS* and *MC* using yields from the 30-year Treasury bond as the discount rate. Our new measures, *FS0* and *MC0*, are strictly exogenous and have a highly significant correlation (*p*-value) of 0.91 (0.00) and 0.96 (0.00), respectively, with traditional measures of *FS* and *MC*.

- We repeat all 2SLS and 3SLS analyses using *FS0* and *MC0* as instruments and obtain the same conclusions.

# Ownership and Corporate Governance

Adding the following variables do not change our conclusions. The sample size becomes smaller.

*INST, BLOCK, TOP5*

*BHOL* = percentage of board members holding stocks in the firms

# Ownership and Corporate Governance

*GINDEX*, Gompers, Ishii, and Metrick (2003) index

E*INDEX*, Bebchuk, Cohen, and Ferrell (2009)

are not significant.

BIND, percentage of board members that are independent.

# Ownership and Corporate Governance: Table 10

| | Understated PBOs | | | | Understated ABOs | | | |
|---|---|---|---|---|---|---|---|---|
| | *PCT_ TB30Y* | *PCT_ AAA20Y* | *PCT_ AAA25Y* | *PCT_ ATM* | *APCT_ TB30Y* | *APCT_ AAA20Y* | *APCT_ AAA25Y* | *APCT_ ATM* |
| *INST* | -1.496 | -1.494 | -1.494 | -1.490 | -1.493 | -1.492 | -1.492 | -1.488 |
| | (-5.72) ** | (-5.72) ** | (-5.72) ** | (-5.70) ** | (-5.71) ** | (-5.71) ** | (-5.71) ** | (-5.70) ** |
| *FS* | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 |
| | (1.43) | (1.39) | (1.37) | (1.29) | (1.43) | (1.37) | (1.35) | (1.24) |
| *MC* | 0.066 | 0.073 | 0.072 | 0.071 | 0.053 | 0.060 | 0.060 | 0.066 |
| | (1.60) | (1.76) * | (1.77) * | (1.74) * | (1.30) | (1.48) | (1.51) | (1.63) |
| *UPBO*s or *UABO*s | 0.012 | 0.012 | 0.013 | 0.015 | 0.018 | 0.018 | 0.019 | 0.018 |
| | (1.95) * | (1.68) * | (1.84) * | (2.03) ** | (2.63) ** | (2.27) ** | (2.46) ** | (2.40) ** |
| Observations | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 |
| *BLOCK* | -1.473 | -1.475 | -1.474 | -1.470 | -1.469 | -1.471 | -1.470 | -1.468 |
| | (-5.05) ** | (-5.06) ** | (-5.06) ** | (-5.05) ** | (-5.05) ** | (-5.05) ** | (-5.05) ** | (-5.04) ** |
| *FS* | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 | 0.007 |
| | (1.77) * | (1.73) * | (1.71) * | (1.63) | (1.77) * | (1.72) * | (1.69) * | (1.58) |
| *MC* | 0.049 | 0.055 | 0.053 | 0.050 | 0.034 | 0.041 | 0.040 | 0.044 |
| | (1.17) | (1.31) | (1.30) | (1.22) | (0.83) | (0.99) | (1.00) | (1.08) |
| *UPBO*s or *UABO*s | 0.010 | 0.010 | 0.011 | 0.013 | 0.016 | 0.016 | 0.017 | 0.017 |
| | (1.57) | (1.34) | (1.50) | (1.84) * | (2.34) ** | (2.02) ** | (2.21) ** | (2.27) ** |
| Observations | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 |

# Ownership and Corporate Governance: Table 10

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *TOP5* | -2.284 | -2.286 | -2.285 | -2.279 | -2.277 | -2.280 | -2.279 | -2.275 |
| | (-5.14) ** | (-5.15) ** | (-5.14) ** | (-5.14) ** | (-5.13) ** | (-5.14) ** | (-5.14) ** | (-5.13) ** |
| *FS* | 0.008 | 0.008 | 0.007 | 0.007 | 0.008 | 0.007 | 0.007 | 0.007 |
| | (1.86) * | (1.82) * | (1.81) * | (1.73) * | (1.86) * | (1.81) * | (1.79) * | (1.68) * |
| *MC* | 0.043 | 0.049 | 0.047 | 0.044 | 0.028 | 0.035 | 0.034 | 0.038 |
| | (1.03) | (1.17) | (1.16) | (1.08) | (0.69) | (0.85) | (0.85) | (0.94) |
| *UPBOs* or *UABOs* | 0.010 | 0.010 | 0.010 | 0.013 | 0.015 | 0.016 | 0.017 | 0.017 |
| | (1.54) | (1.30) | (1.47) | (1.78) * | (2.29) ** | (1.97) ** | (2.17) ** | (2.21) ** |
| Observations | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 | 6,313 |
| *BHOL* | 0.656 | 0.654 | 0.657 | 0.657 | 0.660 | 0.657 | 0.660 | 0.658 |
| | (3.82) ** | (3.81) ** | (3.82) ** | (3.83) ** | (3.85) ** | (3.82) ** | (3.84) ** | (3.84) ** |
| *FS* | 0.008 | 0.008 | 0.008 | 0.007 | 0.008 | 0.008 | 0.008 | 0.007 |
| | (1.71) * | (1.66) * | (1.62) | (1.53) | (1.75) * | (1.68) * | (1.62) | (1.49) |
| *MC* | 0.033 | 0.038 | 0.040 | 0.025 | 0.010 | 0.017 | 0.021 | 0.019 |
| | (0.63) | (0.74) | (0.79) | (0.49) | (0.20) | (0.35) | (0.42) | (0.36) |
| *UPBOs* or *UABOs* | 0.015 | 0.015 | 0.016 | 0.022 | 0.023 | 0.024 | 0.024 | 0.026 |
| | (1.88) * | (1.70) * | (1.79) * | (2.75) ** | (2.92) ** | (2.60) ** | (2.73) ** | (3.21) ** |
| Observations | 5,788 | 5,788 | 5,788 | 5,788 | 5,788 | 5,788 | 5,788 | 5,788 |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

Pension annuities are long-term liabilities for firms. It is, therefore, interesting to see what yields investors require when firms issue debts, especially long-term debts.

In this section, we compare pension discount rates with yields on debts issued by the firms.

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

Our sample of 8,604 firm-year observations contains S&P issuer credit ratings for 860 firms over the June 1991 to December 2013 period.

We search the Mergent Corporate Bond Securities Database (FISD) for bonds issue by these 860 firms in these 8,604 fiscal years.

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

We also require that S&P issue-specific credit ratings be available during the same fiscal year when bonds are issued.

Since S&P issue-specific credit ratings are issued monthly, we use the first rating after the debt is issued. We identify a total of 3,043 debt issues by 542 firms during the July 1991 to December 2013 period.

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms: Table 11

Panel A: Number of Bonds

| | AAA | AA | A | BBB | BB | <= B | All |
|---|---|---|---|---|---|---|---|
| Maturity | | | | | | | |
| 1-4 years | 5 | 26 | 70 | 83 | 3 | 3 | 190 |
| 5-9 years | 9 | 68 | 274 | 322 | 163 | 67 | 903 |
| 10-14 years | 16 | 79 | 419 | 552 | 188 | 33 | 1,287 |
| 15-19 years | 1 | 5 | 15 | 7 | 2 | 3 | 33 |
| 20-24 years | 1 | 3 | 28 | 39 | 5 | 0 | 76 |
| 25-29 years | 0 | 2 | 2 | 2 | 2 | 0 | 8 |
| 30 years and above | 8 | 59 | 253 | 217 | 8 | 1 | 546 |
| All | 40 | 242 | 1,061 | 1,222 | 371 | 107 | 3,043 |

Panel B: Median Pension Discount Rates (%)

| | AAA | AA | A | BBB | BB | <= B | All |
|---|---|---|---|---|---|---|---|
| Maturity | | | | | | | |
| 1-4 years | 5.22 | 6.25 | 5.50 | 6.00 | 7.00 | 6.00 | 5.90 |
| 5-9 years | 6.50 | 6.07 | 6.10 | 6.21 | 5.93 | 5.40 | 6.00 |
| 10-14 years | 6.50 | 6.94 | 6.25 | 6.00 | 6.00 | 5.92 | 6.00 |
| 15-19 years | 6.30 | 8.25 | 7.25 | 6.18 | 7.13 | 5.75 | 7.00 |
| 20-24 years | 4.78 | 6.60 | 7.50 | 7.25 | 7.75 | - | 7.25 |
| 25-29 years | - | 6.45 | 7.75 | 5.50 | 5.62 | - | 6.45 |
| 30 years and above | 6.25 | 7.25 | 6.50 | 6.23 | 5.75 | 7.00 | 6.50 |
| All | 6.30 | 6.75 | 6.25 | 6.01 | 6.00 | 5.73 | 6.13 |

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms: Table 11

Panel C: Median Yields on Bonds (%)

| | AAA | AA | A | BBB | BB | <= B | All |
|---|---|---|---|---|---|---|---|
| Maturity | | | | | | | |
| 1-4 years | 1.24 | 4.03 | 2.01 | 4.09 | 7.41 | 8.95 | 3.72 |
| 5-9 years | 4.81 | 4.18 | 4.74 | 5.80 | 8.00 | 8.63 | 5.85 |
| 10-14 years | 5.39 | 5.82 | 5.51 | 6.07 | 7.50 | 8.63 | 6.12 |
| 15-19 years | 4.68 | 7.62 | 7.48 | 7.25 | 7.68 | 7.88 | 7.30 |
| 20-24 years | 4.42 | 6.32 | 7.07 | 7.69 | 8.00 | - | 7.32 |
| 25-29 years | - | 7.39 | 8.97 | 6.14 | 6.63 | - | 7.16 |
| 30 years and above | 5.92 | 6.78 | 6.61 | 6.71 | 6.79 | 8.88 | 6.68 |
| All | 5.11 | 5.55 | 5.55 | 6.13 | 7.75 | 8.63 | 6.16 |

Panel D: Median Differences betweeen Pension Discount Rates and Yields on Bonds (%)

| | AAA | AA | A | BBB | BB | <= B | All |
|---|---|---|---|---|---|---|---|
| Maturity | | | | | | | |
| 1-4 years | 3.98 ** | 2.78 ** | 3.24 ** | 1.50 ** | 0.10 | -2.33 ** | 2.46 ** |
| 5-9 years | 2.49 ** | 2.03 ** | 1.67 ** | 0.70 ** | -1.93 ** | -2.88 ** | 0.73 ** |
| 10-14 years | 1.32 ** | 1.14 ** | 0.80 ** | 0.20 | -1.52 ** | -2.75 ** | 0.29 |
| 15-19 years | 1.62 | 0.68 | 0.12 | -0.08 | -0.55 | -2.75 | 0.12 |
| 20-24 years | 0.36 | 0.74 | 0.11 | -0.37 * | -1.55 | - | -0.09 |
| 25-29 years | - | -0.94 | -1.22 | -0.64 | -1.01 | - | -1.04 |
| 30 years and above | 0.58 | 0.05 | -0.07 | -0.43 ** | -0.96 ** | -1.88 | -0.20 ** |
| All | 1.32 ** | 1.15 ** | 0.74 ** | 0.20 * | -1.63 ** | -2.83 ** | 0.26 ** |

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

Panel D of Table 11 shows Pension discount rates are significantly lower than bond yields with maturity of 30 years and above. The median difference is -0.20%. The significant median difference of -0.20% is driven primarily by firms rated BBB, BB, and B and below.

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

Lower rated firms choose pension discount rates that are below the yields on the bonds they issue.

Firms rated AAA, AA, and A choose pension discount rates that are similar to yields on the 30-year bonds they issue.

# Compare Pension Discount Rated with Yields on Bonds Issued by Firms

In other words, although lower rated firms tend to hide their pension liabilities by choosing discount rates above the high quality long-term AAA-grade and AA-grade corporate bond yields, they are not so aggressive as to assume pension discount rates above the yields on the low quality long-term bonds they issue.

# Conclusions

- Because pension liabilities are long-term fixed income contracts, a small change in the pension discount rate will lead to a large change in pension liabilities.

- We assess the magnitude of understated pension liabilities and relate them to S&P credit ratings.

# Conclusions

- Both firms' PBOs and ABOs are severely understated relative to long-term Treasury bond and AAA-grade corporate bond yields. This is not the case relative to AA-grade corporate bond yields.

- Understated pension liabilities are significantly related to S&P credit ratings; firms with more hidden pension liabilities have lower credit ratings.

# Appendix

**Appendix I Construction of Pension, Market, and Accounting Variables**

This appendix provides the definitions, references, and details of the COMPUSTAT accounting items used to construct the pension, market, and accounting variables.

| Variable Name and References | COMPUSTAT Items |
|---|---|
| Pension Variables | |
| Plan assets (*PA*) | *PA* = pension plan assets + underfunded pension plan assets<br>= *PPLAO* + *PPLAU* |
| Plan benefit obligation (*PBO*) | *PBO* = projected benefit obligation + underfunded projected benefit obligation<br>= *PBPRO* + *PBPRU* |
| Funded status (*FS*) | *FS* = plan assets – plan benefit obligation = *PA* – *PBO* |
| Accumulated benefit obligations (*ABO*) | *ABO* = accumulated benefit obligation + underfunded accumulated benefit obligation<br>= *PBACO* + *PBACU* |
| Service cost (*SC*) | *SC* = pension plans service cost = *PPSC* |
| Interest cost (*IC*) | *IC* = pension plans interest cost = *PPIC* |
| Mandatory contributions (*MC*) | *MC* = -(service cost + minimum pension liabilities/30)<br>= -[*SC* + *MPL*/30] if *PBO* ≥ *PA*; *MC* = 0 if *PBO* < *PA*.<br><br>*MPL* = minimum pension liabilities<br>= *ABO* – *PA* if *ABO* ≥ *PA*; *MPL* = 0 if *ABO* < *PA*. |
| Off balance sheet asset/liability (*OFFB*) | *OFFB* = unrecognized gain and loss + unrecognized prior service cost<br>= *UGL* + *UPSC* |
| Unrecognized gain and loss (*UGL*) | *UGL* = pension other adjustments + underfunded pension other adjustments<br>= *POAJO* + *POAJU* |
| Unrecognized prior service cost (*UPSC*) | *UPSC* = pension unrecognized prior service cost + underfunded pension unrecognized prior service cost<br>= *PCUPSO* + *PCUPSU* |

# Appendix

Understated Pension Liabilities

| | |
|---|---|
| (*PCT_TB30Y*, *PCT_AAA20Y*, *PCT_AAA25Y*, *PCT_AAATM*, *PCT_AA20Y*, *PCT_AA25Y*, *PCT_AATM*) | $PCT\_TB30Y = (PBO - PBO^{Benchmark})/ME(-1)$, $PBO^{Benchmark}$ = PBO evaluated at 30-year Treasury bond yield. Others are defined in a similar way relative to 20-year, 25-year, and term structure AAA-grade corporate bond yields, and 20-year, 25-year, and term structure AA-grade corporate bond yields. |
| (*APCT_TB30Y*, *APCT_AAA20Y*, *APCT_AAA25Y*, *APCT_AAATM*, *APCT_AA20Y*, *APCT_AA25Y*, *APCT_AATM*) | $APCT\_TB30Y = (ABO - ABO^{Benchmark})/ME(-1)$, $ABO^{Benchmark} = ABO$ evaluated at 30-year Treasury bond yield. Others are defined in a similar way relative to 20-year, 25-year, and term structure AAA-grade corporate bond yields, and 20-year, 25-year, and term structure AA-grade corporate bond yields. |

Difference in Pension Liabilities Due to Difference in Wage Growth Assumptions

| | |
|---|---|
| (*DPBO_WGRO*) | $DPBO\_WGRO = (PBO - PBO^{Median})/ME(-1)$, $PBO^{Median} = PBO$ evaluated at the industry median wage growth rate. |

# Appendix

Market and Accounting Variables

Inflation-adjusted market value (*ME_INF*)

*ME* the market equity at fiscal year end
= fiscal year end stock price × common shares outstanding
= fiscal year end stock price × *CSHO*

*ME_INF* is adjusted for inflation and is in December 2010 constant dollars

Interest coverage (*COVERAGE*)

*COVERAGE* = (operating income after depreciation + interest expense)/interest expense
= (*OIADP+INT*)/*INT*

Operating margin (*MARGIN*)

MARGIN = operating income before depreciation/sales
= *OIBDP*/*SALE*

Long-term debt leverage (*LLEV*)

*LLEV* = long-term debt /total assets = *DLTT*/*AT*

Ratio of fixed assets to total assets (*PPE*)

*PPE* = fixed assets/total assets = *PPENT*/*AT*

Beta within the fiscal year (*BETA*)

BETA = $\beta_1 + \beta_2 + \beta_3$ from the following regression (Dimson, 1979):

$$r_{i,t} = \beta_0 + \beta_1 r_{m,t} + \beta_2 r_{m,t+1} + \beta_3 r_{m,t-1} + \varepsilon_{i,t},$$

where $r_{i,t}$ is daily individual stock returns within the fiscal year and $r_{m,t}$ is the corresponding daily return on CRSP value-weighted market portfolio.

Price synchronicity (*R2*)

$R^2$ from the following regression (Dimson, 1979):

$$r_{i,t} = \beta_0 + \beta_1 r_{m,t} + \beta_2 r_{m,t+1} + \beta_3 r_{m,t-1} + \varepsilon_{i,t},$$

where $r_{i,t}$ is daily individual stock returns within the fiscal year and $r_{m,t}$ is the corresponding daily return on CRSP value-weighted market portfolio.

# Appendix

Transparency (*TRANS*)

$ACR = IBC - CFO = IBC - (OANCF - XIDOC)$

*ACR* = Total accrual = Earnings – cash flow
*IBC* = Income before extraordinary items
*CFO* = *OANCF* – *XIDOC*
= cash flow from operating activities –
extraordinary items and discontinued operations
*SALE* = sales
*RECEIVABLE* = accounts receivables
*PPENT* = fixed assets

$$\frac{ACR_{i,t}}{TA_{i,t-1}} = \alpha_0 + \alpha_1 \frac{\Delta SALES_{i,t} - \Delta RECEIVABLE_{i,t}}{TA_{i,t-1}} + \alpha_2 \frac{PPENT_{i,t}}{TA_{i,t-1}} + \varepsilon_{i,t},$$

*DACR* = discretionary accrual = $\hat{\varepsilon}_{i,t}$ = the residual from the above regression that also include the year and industry dummies.

$$TRANS_{i,t} = -\frac{DACR_{i,t} + DACR_{i,t-1} + DACR_{i,t-2} + DACR_{i,t-3} + DACR_{i,t-4}}{5}$$

# Appendix

| | |
|---|---|
| Ownership Variables | |
| Institutional ownership (*INST*) | Total institutional ownership |
| Block ownership (*BLOCK*) | Total ownership by institutional block holders |
| Top-5 ownership (*TOP5*) | Largest 5 institutional ownership |
| Governance Variables | |
| Board member stock holding (*BHOL*) | Percentage of board members that hold shares in the firm |
| Interest Rate Variable | |
| *TB1Y* | Yield on one-year Treasury note |