The Actuarial Profession
making financial sense of the future

The influence of pensions risk on equity and bond prices
Louise McCarthy

# Corporate Bond Spreads, Equity Volatility and Pension Funds

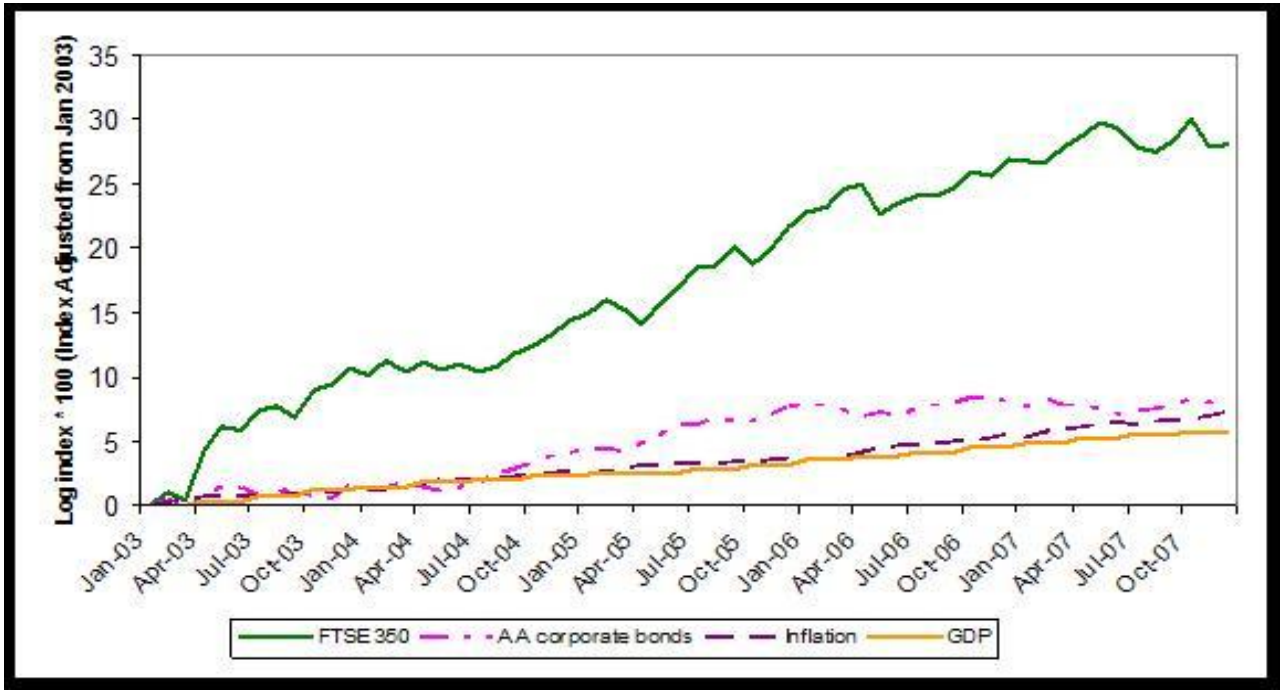
July 2010

# The aim of the investigation….

- Investigate what drives corporate bond spreads….
- Over the period 2003 – 2007….
- Using regression analysis…
- Under the assumptions of the Merton Model…
- Draw some conclusions…
- And finish my Masters!

# Economic Environment

Overall the economy was quite stable, with relatively stable GDP growth, stable inflation rises (except early 2003). Until mid 2007…



# Subprime Crisis

- US subprime mortgage-backed securities
- Financial sector US and here hit hardest
- Uncertainty in a market leads to volatility
- Doubts on stability of firms => unwillingness to lend => shortage of cash => spread increased

# Pensions Environment

MFR (1997)

- Encouraged investment in government bonds
- Strong demand causes return on gov. bonds to fall

Replaced by Pensions Act 2004

- Relieved demand for government bonds with the introduction of scheme specific funding

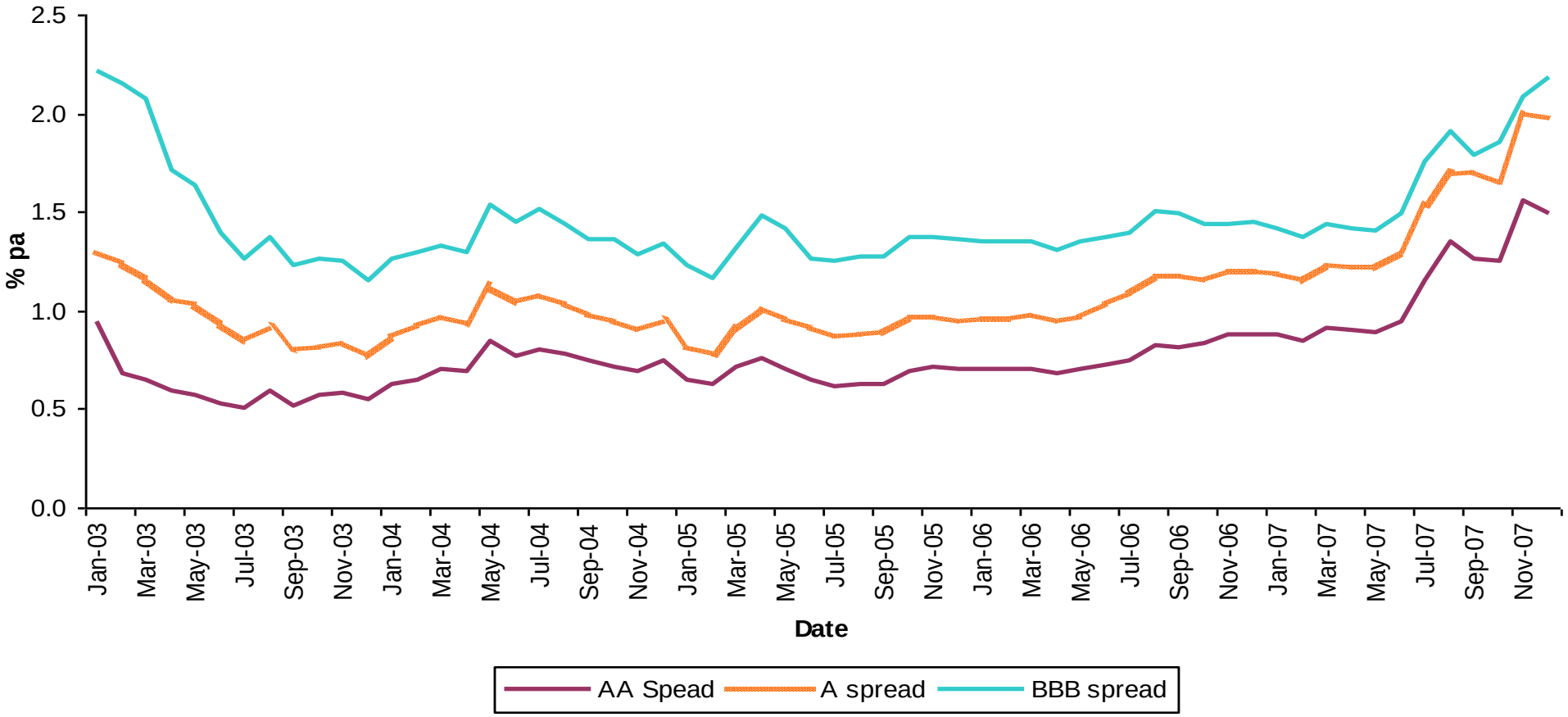
FRS17 2002

- Brought in requirement to disclose pension cost in accounts – volatile measure
- Volatility reduced by safer asset investment

PPF 2004

- Motivation to underfund and invest in risky assets

# Corporate Bond Spread



# In Theory

- Corporate bonds are more likely to default than government bonds.

Structural/Black-Scholes type models

- E.g. Merton Model
- Corporate Debt = Government bond – put option on the value of a firm's assets
- Uses bond characteristics, leverage & volatility
- High equity volatility => more likely to cross bankruptcy threshold
- All internal
- This is what I have used and helps dictates the variables I should investigate
- Empirical tests show it doesn't hold up to explaining all the spread seen in corporate bonds

# The alternative

## Augmented/Reduced Form Models

- Model interest rate through term structure models
- Takes into account market information, yield curves and their volatility
- Also recognises correlation in default rates
- External facing
- Empirical tests have not shown this to be the answer to explaining spread either
- There have been models developed incorporating the two principals

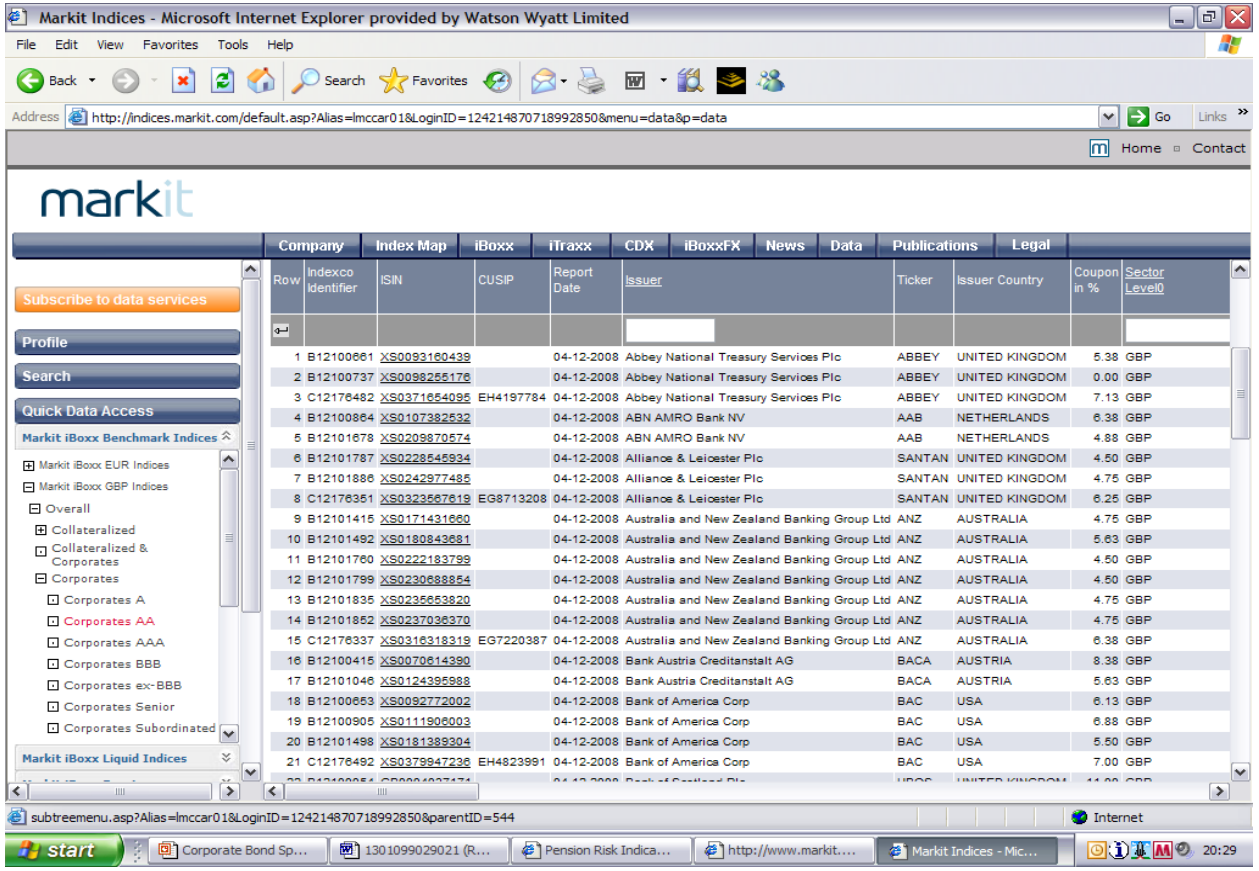
# Variable

| Variable | *Expected effect on Spread* | Variable | *Expected effect on Spread* |
|---|---|---|---|
| Good credit rating | | Long term debt to assets | |
| Equity Volatility | | Op inc to sales | |
| Equity Return | | Weak Interest Cover | |
| Pension Liability | | Total debt to Market Cap | |
| Pension Funding | | Wages & Salaries | |
| Financial Sector Issue | | Coupon | |
| US Treasury Return | | Years to Maturity | |

# Variable

| Variable | *Expected effect on Spread* | Variable | *Expected effect on Spread* |
|---|---|---|---|
| Good credit rating | *Decrease* | Long term debt to assets | *Increase* |
| Equity Volatility | *Increase* | Op inc to sales | *Decrease* |
| Equity Return | *Decrease* | Weak Interest Cover | *Increase* |
| Pension Liability | *Increase* | Total debt to Market Cap | *Increase* |
| Pension Funding | *Decrease* | Wages & Salaries | *?* |
| Financial Sector Issue | *Increase* | Coupon | *Decrease* |
| US Treasury Return | *Decrease* | Years to Maturity | *Increase* |

# Corporate Bond Data - iBoxx




- Register to access data
- Only bonds with cash flows known in advance included (coupon, step-ups)
- Monthly data
- Rating (AA, A, BBB)
- Maturity, coupon, yield etc
- BOE data used to determine spread over the duration

# What I was working with

**Number of Bonds**

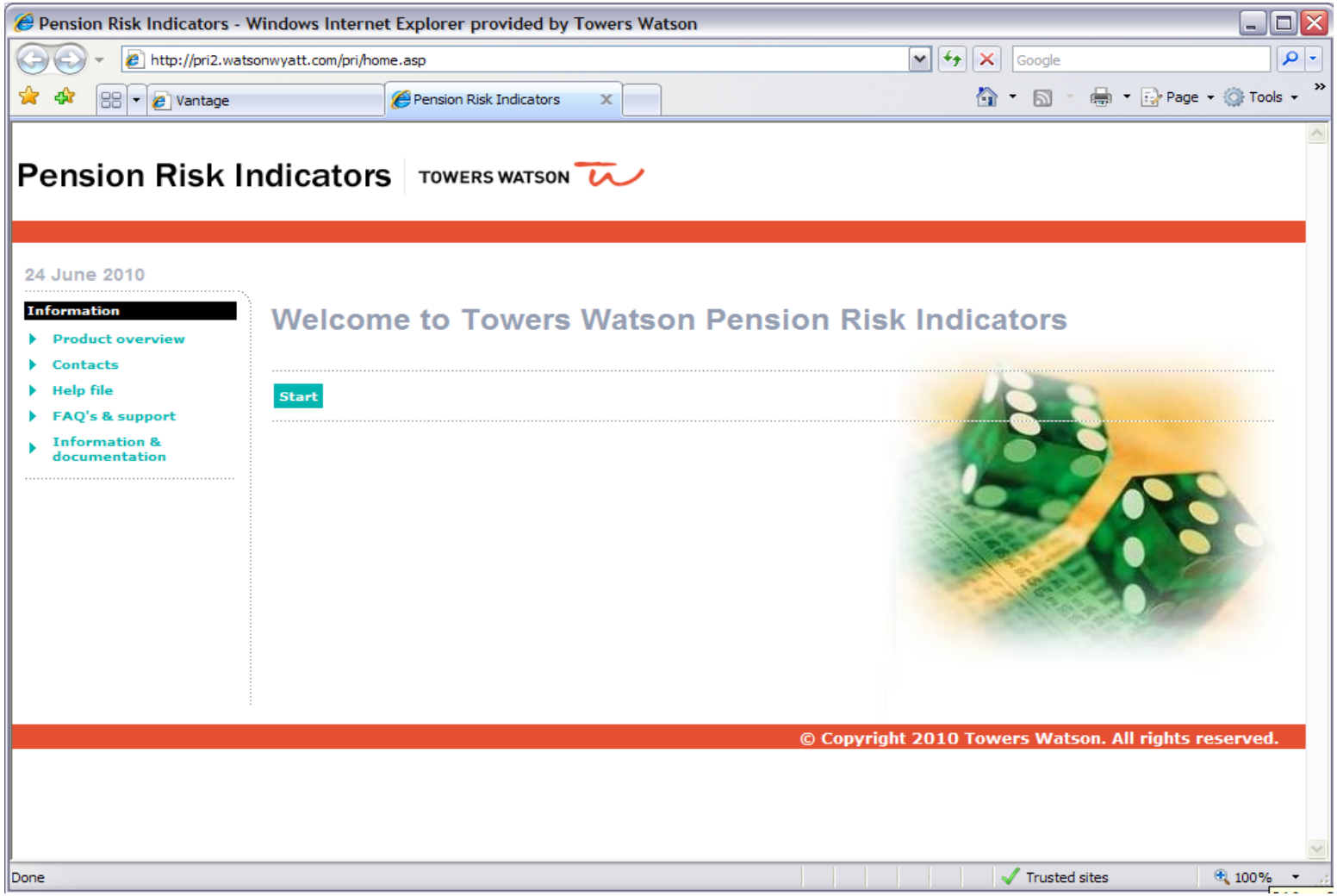
| | AA | A | BBB | Total | Financial | Non Financial |
|---|---|---|---|---|---|---|
| | Breakdown by years to maturity | | | | | |
| Short ≤ 7yrs | 633 | 1,243 | 828 | 2,704 | 1,222 | 1,482 |
| Medium 7< yrs ≤15 | 763 | 4,250 | 3,733 | 8,746 | 4,558 | 4,188 |
| Long >15 yrs | 1,586 | 5,511 | 3,027 | 10,124 | 6,123 | 4,001 |
| | Breakdown by year, all maturities | | | | | |
| 2003-2007 | 2,982 | 11,004 | 7,588 | 21,574 | 11,903 | 9,671 |
| 2003 | 572 | 2,262 | 1,217 | 4,051 | 2,092 | 1,959 |
| 2004 | 619 | 2,238 | 1,430 | 4,287 | 2,245 | 2,042 |
| 2005 | 600 | 2,171 | 1,541 | 4,312 | 2,356 | 1,956 |
| 2006 | 592 | 2,158 | 1,613 | 4,363 | 2,552 | 1,811 |
| 2007 | 599 | 2,175 | 1,787 | 4,561 | 2,658 | 1,903 |

# Summary of spreads in data

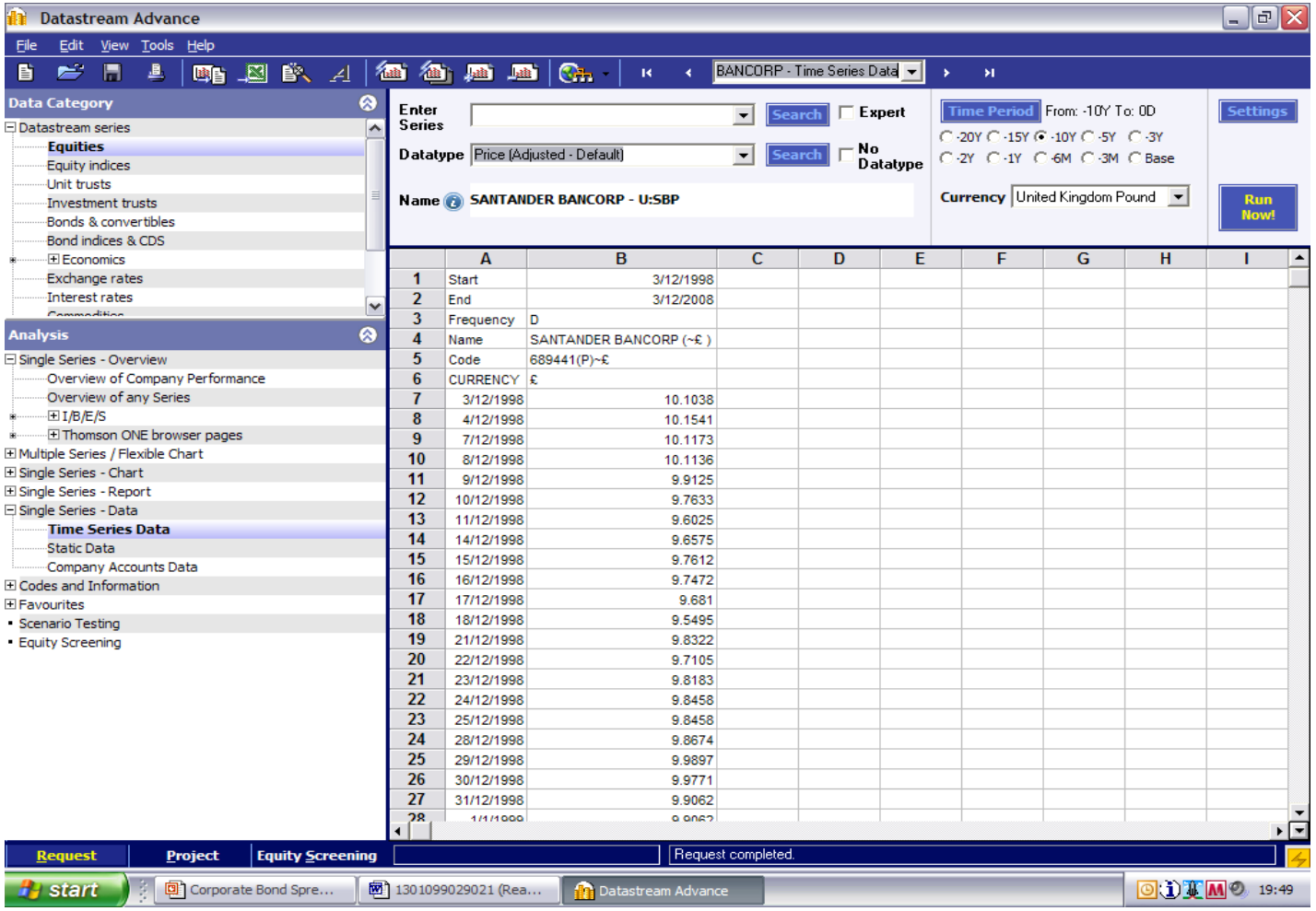
**Excess Return over Gilts**

| | AA | A | BBB | Total | Financial | Non Financial |
|---|---|---|---|---|---|---|
| Breakdown by years to maturity | | | | | | |
| Short ≤ 7yrs | 49 | 75 | 122 | 83 | 89 | 78 |
| Medium 7< yrs ≤15 | 64 | 99 | 141 | 114 | 121 | 106 |
| Long >15 yrs | 99 | 115 | 140 | 120 | 122 | 117 |
| Breakdown by year, all maturities | | | | | | |
| 2003-2007 | 79 | 104 | 139 | 113 | 118 | 106 |
| 2003 | 73 | 100 | 168 | 117 | 120 | 114 |
| 2004 | 76 | 97 | 131 | 105 | 108 | 102 |
| 2005 | 66 | 85 | 123 | 96 | 96 | 97 |
| 2006 | 75 | 99 | 124 | 105 | 108 | 100 |
| 2007 | 107 | 140 | 150 | 140 | 156 | 117 |

# Accounting Info

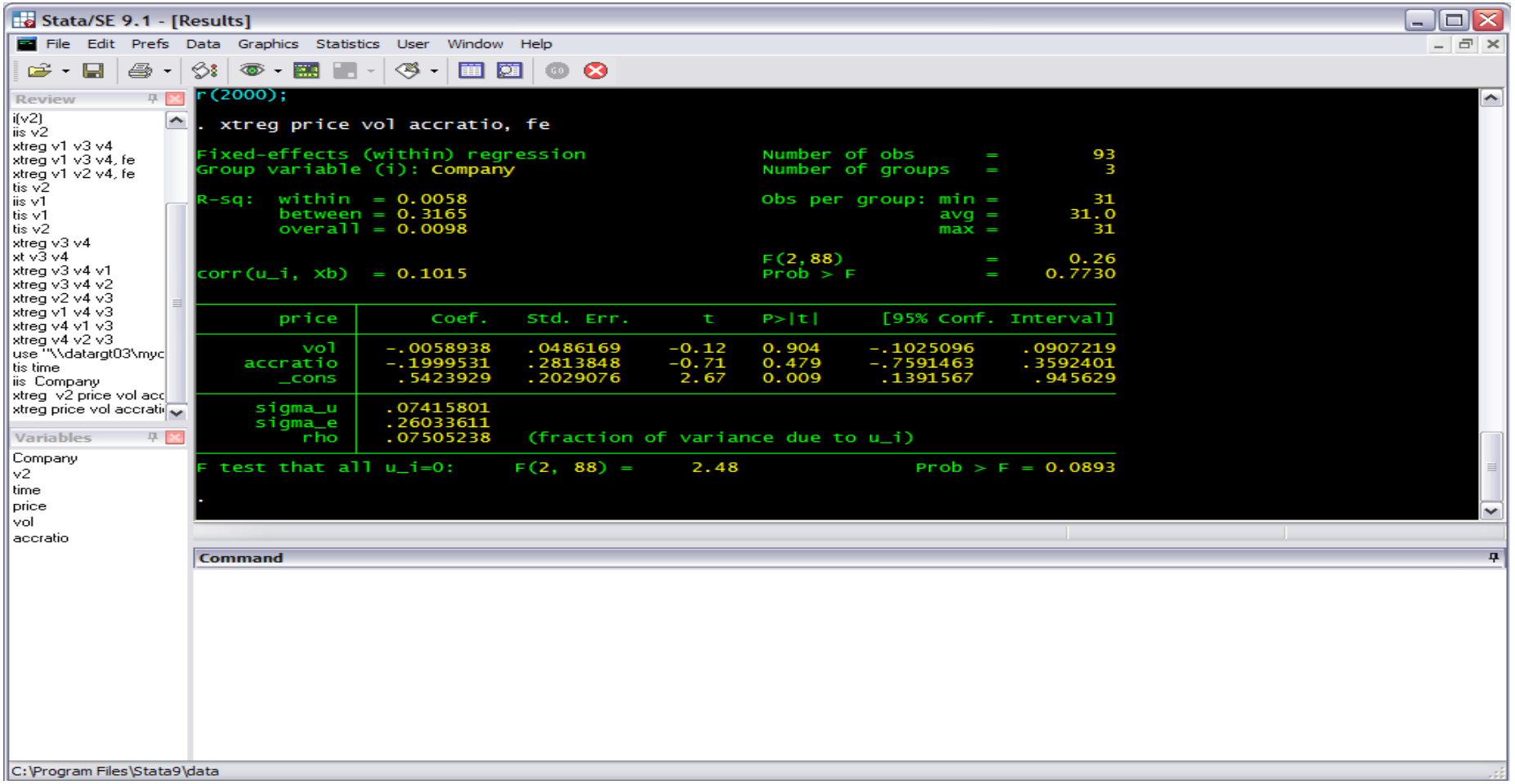


# DataStream Advance




| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Start | 3/12/1998 | | | | | | | |
| 2 | End | 3/12/2008 | | | | | | | |
| 3 | Frequency | D | | | | | | | |
| 4 | Name | SANTANDER BANCORP (~£ ) | | | | | | | |
| 5 | Code | 689441(P)~£ | | | | | | | |
| 6 | CURRENCY | £ | | | | | | | |
| 7 | 3/12/1998 | 10.1038 | | | | | | | |
| 8 | 4/12/1998 | 10.1541 | | | | | | | |
| 9 | 7/12/1998 | 10.1173 | | | | | | | |
| 10 | 8/12/1998 | 10.1136 | | | | | | | |
| 11 | 9/12/1998 | 9.9125 | | | | | | | |
| 12 | 10/12/1998 | 9.7633 | | | | | | | |
| 13 | 11/12/1998 | 9.6025 | | | | | | | |
| 14 | 14/12/1998 | 9.6575 | | | | | | | |
| 15 | 15/12/1998 | 9.7612 | | | | | | | |
| 16 | 16/12/1998 | 9.7472 | | | | | | | |
| 17 | 17/12/1998 | 9.681 | | | | | | | |
| 18 | 18/12/1998 | 9.5495 | | | | | | | |
| 19 | 21/12/1998 | 9.8322 | | | | | | | |
| 20 | 22/12/1998 | 9.7105 | | | | | | | |
| 21 | 23/12/1998 | 9.8183 | | | | | | | |
| 22 | 24/12/1998 | 9.8458 | | | | | | | |
| 23 | 25/12/1998 | 9.8458 | | | | | | | |
| 24 | 28/12/1998 | 9.8674 | | | | | | | |
| 25 | 29/12/1998 | 9.9897 | | | | | | | |
| 26 | 30/12/1998 | 9.9771 | | | | | | | |
| 27 | 31/12/1998 | 9.9062 | | | | | | | |

# Stata 9.1


Stata/SE 9.1 - [Results]
File Edit Prefs Data Graphics Statistics User Window Help
Review
i(v2)
iis v2
xtreg v1 v3 v4
xtreg v1 v3 v4, fe
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iis v1
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xtreg v4 v1 v3
xtreg v4 v2 v3
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xtreg v2 price vol acc
xtreg price vol accrati
Variables
Company
v2
time
price
vol
accratio
r(2000);
. xtreg price vol accratio, fe
Fixed-effects (within) regression Number of obs = 93
Group variable (i): Company Number of groups = 3
R-sq: within = 0.0058 Obs per group: min = 31
between = 0.3165 avg = 31.0
overall = 0.0098 max = 31
F(2,88) = 0.26
corr(u_i, Xb) = 0.1015 Prob > F = 0.7730
price | Coef. Std. Err. t P>|t| [95% Conf. Interval]
vol | -.0058938 .0486169 -0.12 0.904 -.1025096 .0907219
accratio | -.1999531 .2813848 -0.71 0.479 -.7591463 .3592401
_cons | .5423929 .2029076 2.67 0.009 .1391567 .945629
sigma_u | .07415801
sigma_e | .26033611
rho | .07505238 (fraction of variance due to u_i)
F test that all u_i=0: F(2, 88) = 2.48 Prob > F = 0.0893
Command
C:\Program Files\Stata9\data

# Results (GLS)

| | 1 | 2 | 3 | 3a | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **Equity Volatility** | | | | | | | | | |
| Standard deviation of daily excess returns over preceding 6 months | | **0.2044** | | | | **0.1964** | **0.1898** | | **0.1811** |
| | | **(25.38)** | | | | **(24.56)** | **(23.49)** | | **(22.52)** |
| Standard deviation of daily index return over preceding 6 months | | **0.2584** | | | | **0.2633** | **0.2657** | | **0.2687** |
| | | **(24.74)** | | | | **(25.44)** | **(25.46)** | | **(26.04)** |
| Daily Excess Return | | 0.0003 | | | | 0.0000 | 0.0002 | | -0.0001 |
| | | (0.5) | | | | (-0.04) | (0.26) | | (-0.12) |
| Daily Index Return | | **0.0055** | | | | **0.0049** | **0.0054** | | **0.0050** |
| | | **(6.75)** | | | | **(6.09)** | **(6.57)** | | **(6.16)** |
| **Credit Rating** | | | | | | | | | |
| Better/Worse than A rating | | | -0.0152 | | -0.0101 | **-0.1964** | | **-0.0686** | **-0.1971** |
| | | | (-1.33) | | (-0.86) | **(-20.16)** | | **(-6.13)** | **(-20.44)** |
| **Pension Fund Position** | | | | | | | | | |
| Pension Liability | | | | **-0.00001** | **-0.00001** | **0.00001** | | **0.00000** | **0.00001** |
| | | | | **(-2.91)** | **(-2.65)** | **(4.87)** | | **(2.55)** | **(5.04)** |
| Surplus/(deficit) | | | | 0.00000 | 0.00000 | **0.00107** | | 0.00001 | **0.00002** |
| | | | | (-0.84) | (-0.11) | **(2.88)** | | (1.67) | **(3.75)** |
| Funding Level | | | | -0.00013 | 0.00035 | **0.00002** | | 0.00053 | **0.00110** |
| | | | | (-0.38) | (1) | **(5.15)** | | (1.51) | **(2.97)** |

# Results (GLS) cont.

| Table 2 *Continued* | 1 | 2 | 3 | 3a | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **Accounting** | | | | | | | | | |
| Long-term Debt to Assets | | | | | | | **0.0022** | 0.0006 | **0.0013** |
| | | | | | | | **(7.31)** | (1.83) | **(4.19)** |
| Operating Income to Sales | | | | | | | **-0.0007** | -0.0003 | **-0.0007** |
| | | | | | | | **(-3.44)** | (-1.52) | **(-3.49)** |
| Pre-Tax Interest Coverage (PIC < 5) | | | | | | | 0.0151 | **0.0227** | 0.0073 |
| | | | | | | | (1.59) | **(2.49)** | (0.77) |
| Total Debt to Market Cap | | | | | | | **0.0001** | **0.0001** | **0.0001** |
| | | | | | | | **(8.36)** | **(6.35)** | **(8.27)** |
| Wages and Salaries £m | | | | | | | **0.0000** | **0.0000** | 0.0000 |
| | | | | | | | **(-2.62)** | **(-2.93)** | (-1.42) |
| **Macroeconomic and bond trait variables** | | | | | | | | | |
| US Treasury Return | **-0.0721** | **-0.0509** | **-0.0850** | **-0.0735** | **-0.0920** | **-0.0526** | **-0.0506** | **-0.0729** | **-0.0516** |
| | **(-22.14)** | **(-14.61)** | **(-25.7)** | **(-22.43)** | **(-29.77)** | **(-15.21)** | **(-14.51)** | **(-21.95)** | **(-14.93)** |
| Issue Size (log(market value)) | **-1.6501** | **-0.4532** | **-2.5135** | **-1.7311** | **-2.8334** | **-0.4124** | **-0.3848** | **-1.4386** | **-0.3735** |
| | **(-27.98)** | **(-12.34)** | **(-33.72)** | **(-27.93)** | **(-37.56)** | **(-11.21)** | **(-10.64)** | **(-24.72)** | **(-10.53)** |
| Duration of Bond (total length of bond life) | **-0.0205** | **0.0203** | **0.0296** | **-0.0131** | **0.0390** | **0.0209** | **0.0194** | **0.0338** | **0.0191** |
| | **(-3.85)** | **(7.08)** | **(4.33)** | **(-2.38)** | **(3.59)** | **(7.44)** | **(6.97)** | **(7.44)** | **(7.05)** |
| Years To Maturity | **0.0541** | 0.0007 | 0.0081 | **0.0475** | **-0.0142** | 0.0004 | 0.0010 | -0.0036 | 0.0019 |
| | **(9.96)** | (0.24) | (1.39) | **(8.54)** | **(-2.3)** | (0.13) | (0.35) | (-0.81) | (0.69) |
| Coupon | **0.1084** | **-0.0331** | **0.1815** | **0.1064** | **0.7175** | **-0.0400** | **-0.0332** | **-0.0715** | **-0.0383** |
| | **(7.1)** | **(-4.59)** | **(5.75)** | **(6.5)** | **(8.08)** | **(-5.67)** | **(-4.77)** | **(-5.19)** | **(-5.66)** |
| Sector Indicator | **-0.3502** | **0.0671** | **-0.8300** | **-0.3637** | **-2.7867** | **0.1638** | **0.0869** | 0.0559 | **0.1582** |
| | **(-9.18)** | **(4.06)** | **(-8.44)** | **(-8.58)** | **(-8.64)** | **(9.84)** | **(4.91)** | (1.53) | **(9.17)** |
| Constant | **14.1664** | **4.4807** | **20.8352** | **14.8530** | **20.5148** | **4.0185** | **3.8602** | **13.4557** | **3.6536** |
| | **(27.99)** | **(14.17)** | **(31.05)** | **(27.78)** | **(26.09)** | **(12.67)** | **(12.45)** | **(26.45)** | **(11.97)** |
| Improvement to fit (change to log likelihood) | 150 | 610 | 3 | 120 | -57 | 467 | 598 | 298 | 467 |

# Results (FE)

| | 1 | 2 | 3 | 3a | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **Equity Volatility** | | | | | | | | | |
| Standard deviation of daily excess returns over preceding 6 months | | **0.4951** | | | | **0.5118** | **0.3901** | | **0.4002** |
| | | **(58.42)** | | | | **(60.64)** | **(44.7)** | | **(45.87)** |
| Standard deviation of daily index return over preceding 6 months | | -0.0037 | | | | -0.0121 | **0.0630** | | **0.0579** |
| | | (-0.32) | | | | (-1.06) | **(5.6)** | | **(5.15)** |
| Daily Excess Return | | -0.0001 | | | | -0.0022 | -0.0014 | | -0.0032 |
| | | (-0.05) | | | | (-0.94) | (-0.59) | | (-1.4) |
| Daily Index Return | | **0.0312** | | | | **0.0326** | **0.0311** | | **0.0320** |
| | | **(8.8)** | | | | **(9.26)** | **(9.15)** | | **(9.46)** |
| **Credit Rating** | | | | | | | | | |
| Better/Worse than A rating | | | **-0.0637** | | **-0.0684** | **-0.0628** | | **-0.0808** | **-0.0714** |
| | | | **(-3.54)** | | **(-3.8)** | **(-4.08)** | | **(-4.78)** | **(-4.74)** |
| **Pension Fund Position** | | | | | | | | | |
| Pension Liability | | | | **0.00002** | **0.00002** | **0.00005** | | **0.00001** | **0.00004** |
| | | | | **(7.21)** | **(7.56)** | **(18.43)** | | **(3.87)** | **(12.15)** |
| Surplus/(deficit) | | | | **0.00005** | **0.00005** | **0.00003** | | **0.00004** | **0.00003** |
| | | | | **(6.2)** | **(6.14)** | **(4.09)** | | **(5.84)** | **(4.43)** |
| Funding Level | | | | **0.00400** | **0.00395** | **0.00121** | | **0.00287** | 0.00045 |
| | | | | **(6.2)** | **(6.12)** | **(2.19)** | | **(4.75)** | (0.84) |

# Results (FE) cont.

| Table 3 *Continued* | 1 | 2 | 3 | 3a | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| **Accounting** | | | | | | | | | |
| Long-term Debt to Assets | | | | | | | **0.0059** | **0.0083** | **0.0061** |
| | | | | | | | **(14.2)** | **(17.98)** | **(14.86)** |
| Operating Income to Sales | | | | | | | -0.0003 | **-0.0018** | **-0.0008** |
| | | | | | | | (-1.16) | **(-5.81)** | **(-2.78)** |
| Pre-Tax Interest Coverage (PIC < 5) | | | | | | | **0.0329** | **0.0379** | 0.0185 |
| | | | | | | | **(2.71)** | **(2.79)** | (1.53) |
| Total Debt to Market Cap | | | | | | | **0.0003** | **0.0004** | **0.0003** |
| | | | | | | | **(29.92)** | **(43.26)** | **(29.68)** |
| Wages and Salaries £m | | | | | | | **0.0001** | **0.0001** | **0.0001** |
| | | | | | | | **(15.73)** | **(10.08)** | **(6.5)** |
| **Macroeconomic and bond trait variables** | | | | | | | | | |
| US Treasury Return | **-0.2509** | **-0.1786** | **-0.2516** | **-0.2495** | **-0.2507** | **-0.1859** | **-0.1717** | **-0.2275** | **-0.1765** |
| | **(-32.04)** | **(-26.09)** | **(-32.14)** | **(-31.85)** | **(-31.98)** | **(-27.35)** | **(-26.19)** | **(-31.42)** | **(-26.96)** |
| Issue Size (log(market value)) | **-2.3163** | **-1.3685** | **-2.3191** | **-2.2615** | **-2.2662** | **-1.3531** | **-1.2277** | **-1.8623** | **-1.2143** |
| | **(-23.91)** | **(-16.21)** | **(-23.95)** | **(-23.42)** | **(-23.48)** | **(-16.2)** | **(-15.18)** | **(-20.84)** | **(-15.1)** |
| Duration of Bond (total length of bond life) | **0.1756** | **0.0932** | **0.1749** | **0.1669** | **0.1654** | **0.0640** | **0.0338** | **0.0861** | **0.0351** |
| | **(9.01)** | **(5.55)** | **(8.98)** | **(8.57)** | **(8.5)** | **(3.83)** | **(2.06)** | **(4.72)** | **(2.16)** |
| Years To Maturity | **-0.0549** | **-0.0833** | **-0.0548** | **-0.0289** | **-0.0284** | **-0.0503** | **-0.0580** | **-0.0152** | **-0.0388** |
| | **(-19.47)** | **(-32.66)** | **(-19.47)** | **(-7.84)** | **(-7.7)** | **(-15.51)** | **(-21.47)** | **(-4.31)** | **(-11.99)** |
| Coupon | -0.0871 | -0.1768 | -0.0872 | **-1.0116** | **-1.0171** | **-1.0722** | -0.2781 | **-0.8958** | **-1.0860** |
| | (-0.2) | (-0.48) | (-0.2) | **(-2.3)** | **(-2.32)** | **(-2.86)** | (-0.79) | **(-2.21)** | **(-3)** |
| Constant | **20.0821** | **13.4807** | **20.1093** | **25.3258** | **25.4094** | **19.1562** | **13.3092** | **21.9279** | **18.2899** |
| | **(6.54)** | **(5.1)** | **(6.55)** | **(8.11)** | **(8.14)** | **(7.17)** | **(5.27)** | **(7.6)** | **(7.1)** |
| R-squared: | 0.1084 | 0.3413 | 0.1092 | 0.1183 | 0.1192 | 0.3571 | 0.3991 | 0.2536 | 0.4069 |

# What are the conclusions?

| Variable | Expected effect on Spread | Variable | Expected effect on Spread |
|---|---|---|---|
| Good credit rating | Decrease | Long term debt to assets | Increase |
| Equity Volatility | Increase | Op inc to sales | Decrease |
| Equity Return | Decrease | Weak Interest Cover | Increase |
| Pension Liability | Increase | Total debt to Market Cap | Increase |
| Pension Funding | Decrease | Wages & Salaries | ? |
| Financial Sector Issue | Increase | Coupon | Decrease |
| US Treasury Return | Decrease | Years to Maturity | Increase |

# Credit Rating

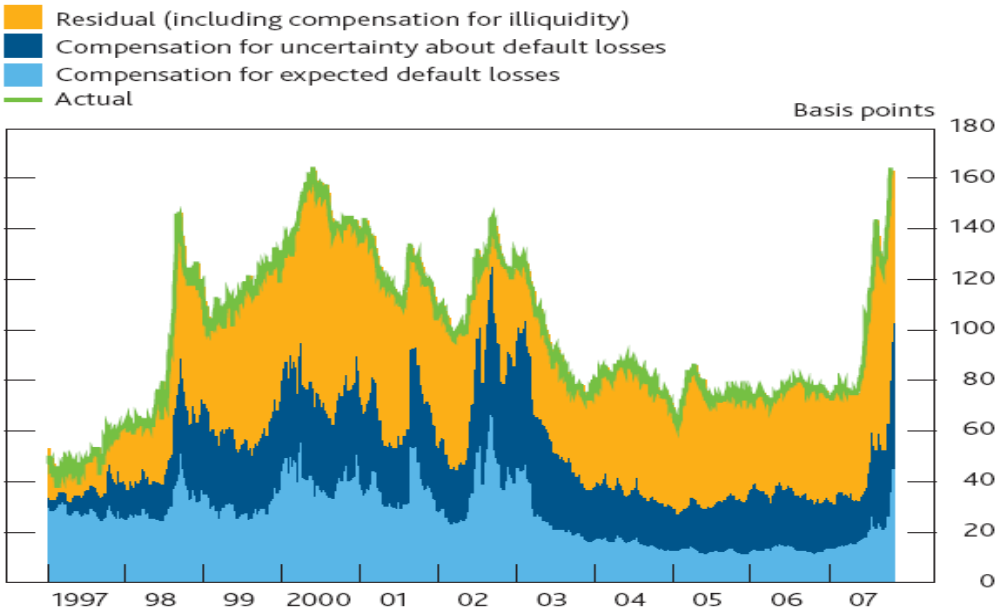
- Equity volatility was shown to be more significant a determinant of corporate bond spreads than credit rating
- Does this imply a fault in the methodology of credit ratings agencies?
- *"Standard & Poor's opinion [is that a credit rating is a view] on the ability and willingness of an obligor to meet its debts as they fall due, or the ability and willingness of an obligor to respect the financial terms of a particular debt security or other financial obligation."*
- A rating is not a measure of liquidity or a measure of market value or volatility (both of which depend on market sentiment). It is not an assessment of corporate governance, an audit of the Company or its advisors or a way of defining "good" or "bad" companies.
- S&P do take note of market data (e.g. spreads, CDS pricing) but their rating decisions are not driven by this data. The are primarily focussed on the underlying risk fundamentals of the businesses
- Change in iBoxx rating methodology the day after the end of my study!
- Equity volatility is a reflection of what is going on in the market as well as the firm

# Pension Funding

- Conflicting methods:
  - Actuaries use a discount rate to reflect asset performance
  - Accountants use a corporate bond discount rate
  - Economists use the risk-free rate
- Economists include pension assets and liabilities on the company balance sheet and thus level of funding is immaterial

# Summing up

- Results mainly in line with expectations
- Credit rating and Pension funding results give pause for thought
- Scope for more work to be done
- My work is line with other major studies




Decomposition of sterling-denominated investment-grade corporate bond spreads (Source: Bank of England Quarterly Monitoring Report (2007), Vol. 47, No. 4, Chart 1)

- Remember correlation does not mean causation