
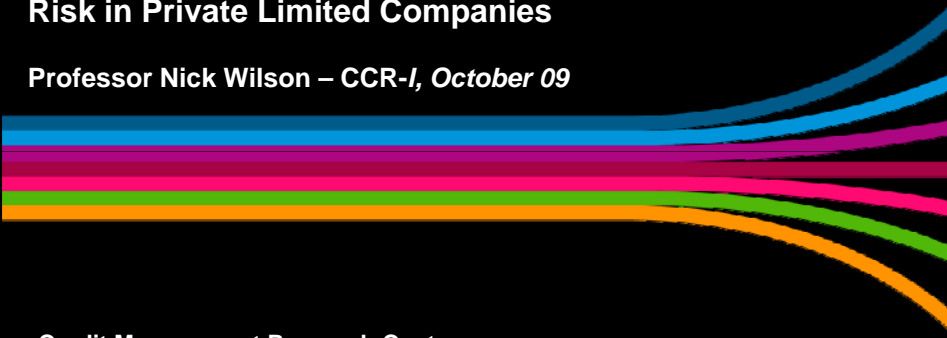



Leeds University Business School  UNIVERSITY OF LEEDS

Modelling Insolvency and Default Risk in Private Limited Companies

Professor Nick Wilson – CCR-1, October 09




Credit Management Research Centre
www.cmrc.co.uk

Modelling SME Risk: 'Enhanced Z-scores'  UNIVERSITY OF LEEDS

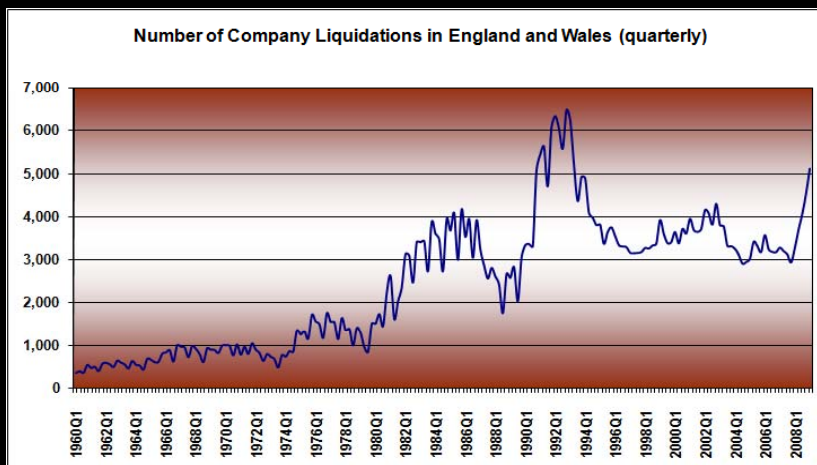
Objectives:

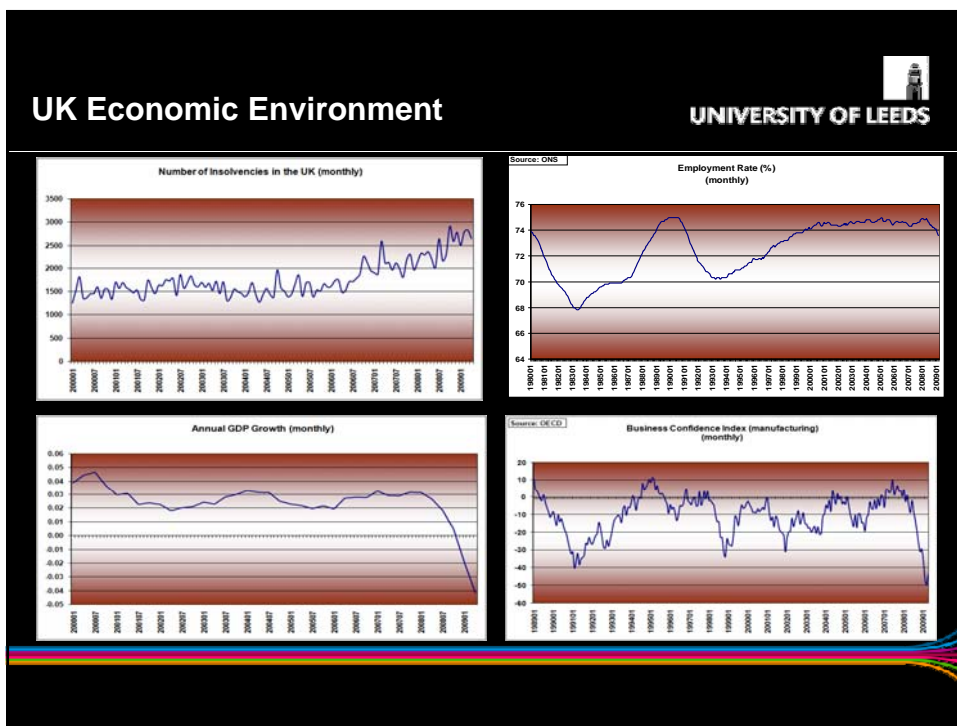
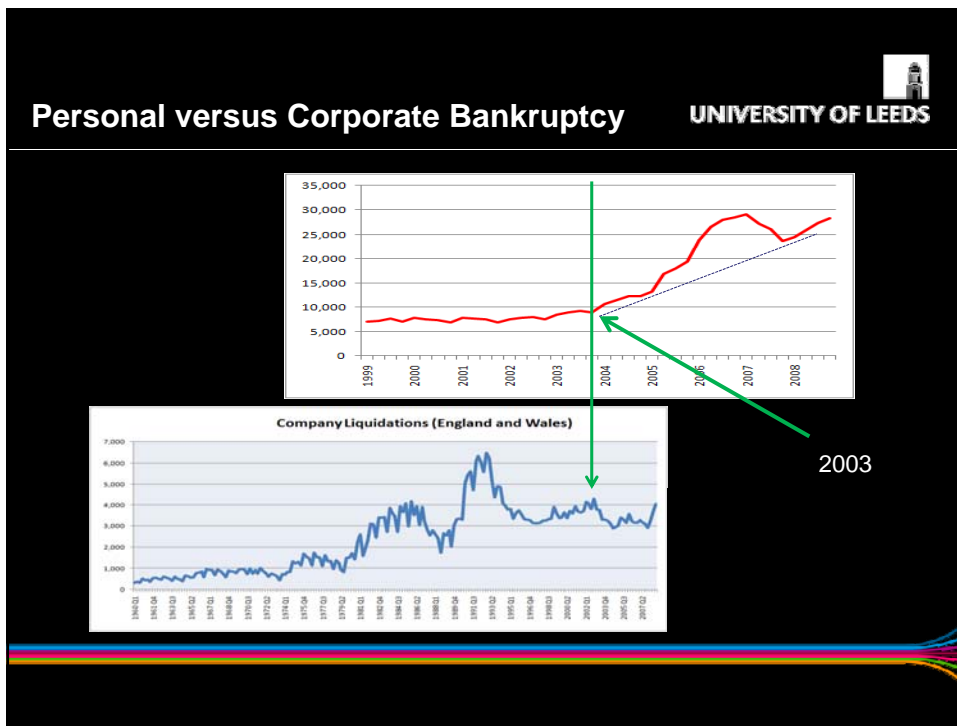
- identify the publicly available data that is most predictive of company financial distress and insolvency
- to test the traditional z-score approach on unlisted companies by applying Z-Scores to an SME model (Altman, Sabato and Wilson, 2008)
- to identify non-accounting and non-financial characteristics that help to improve the model (including 'governance')
- to identify models that can be applied when there is limited and 'infrequent' financial data available
- build-in some macro-economic dynamics
- to assess the utility of such models as Basel II PD estimates

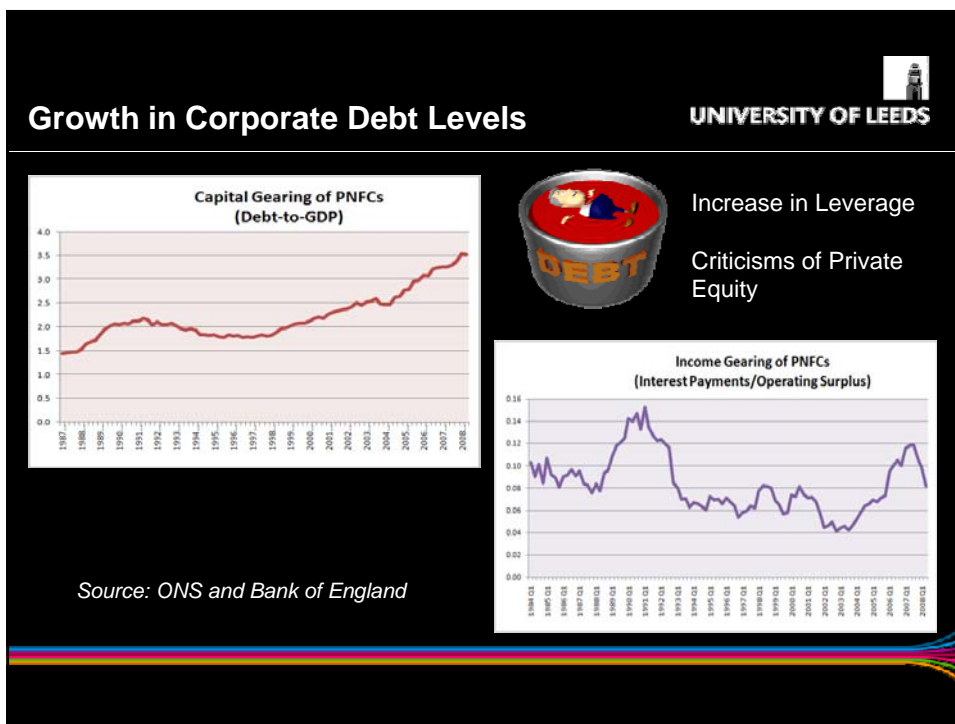
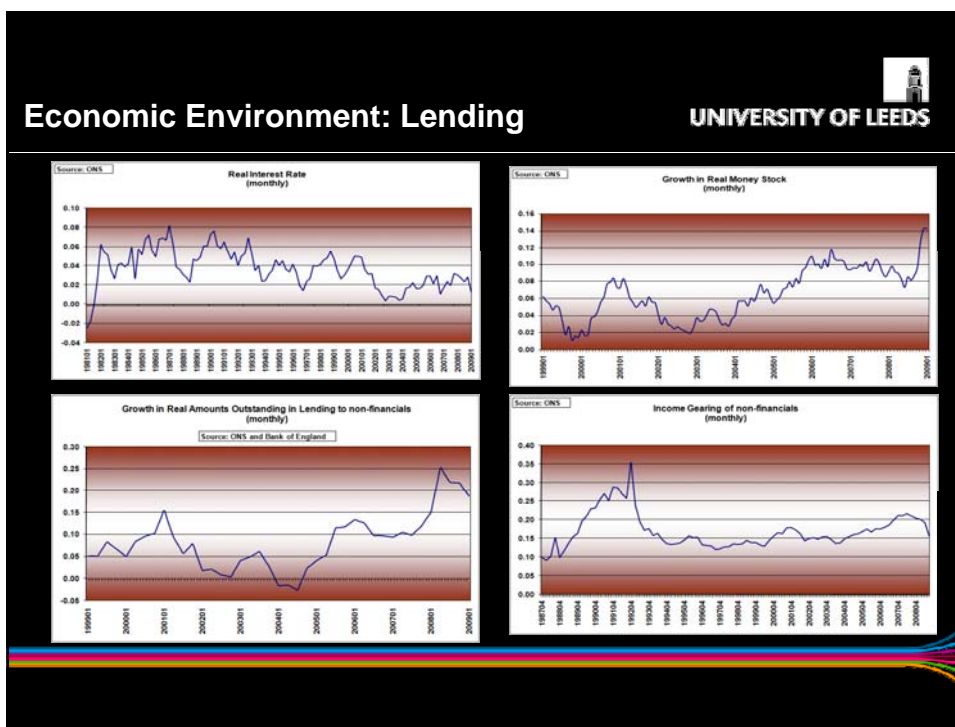


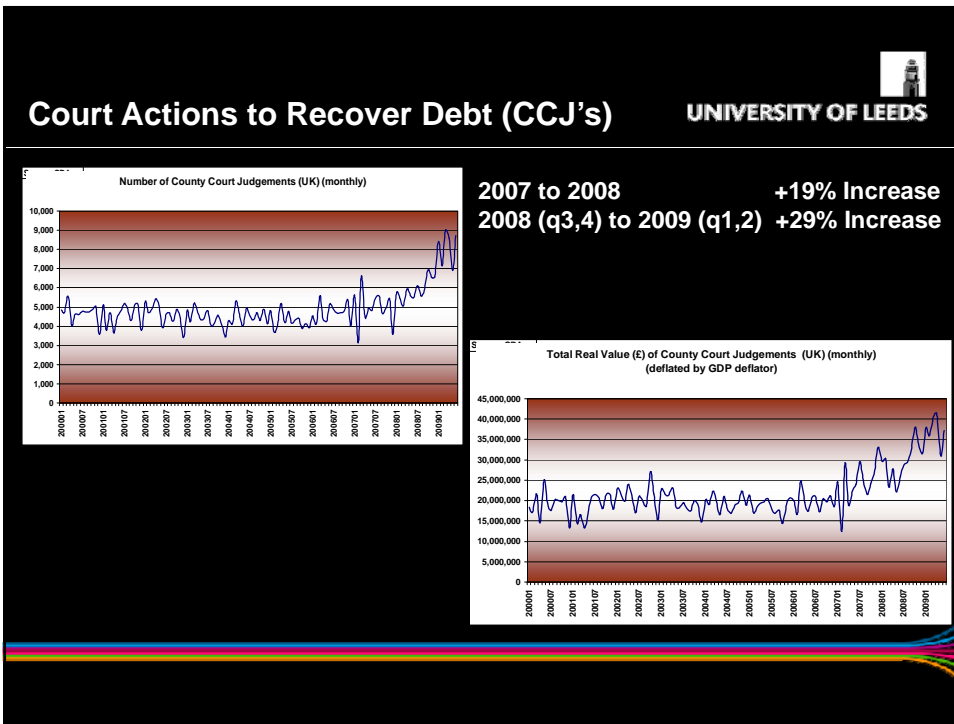
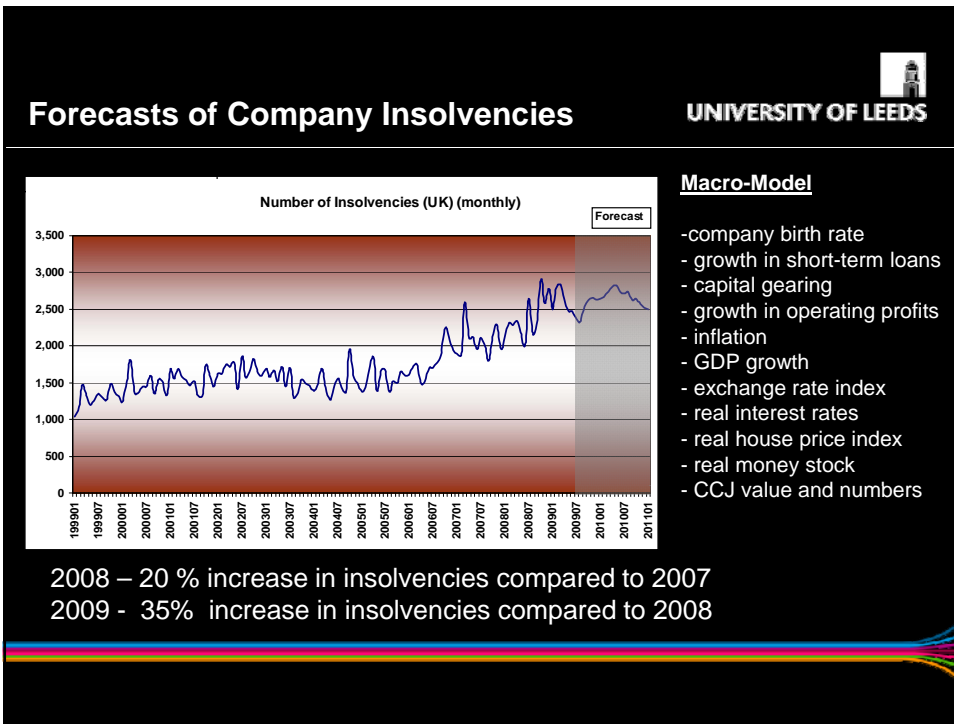
Insolvency Risk: Macro Level Models

UK Company Insolvencies





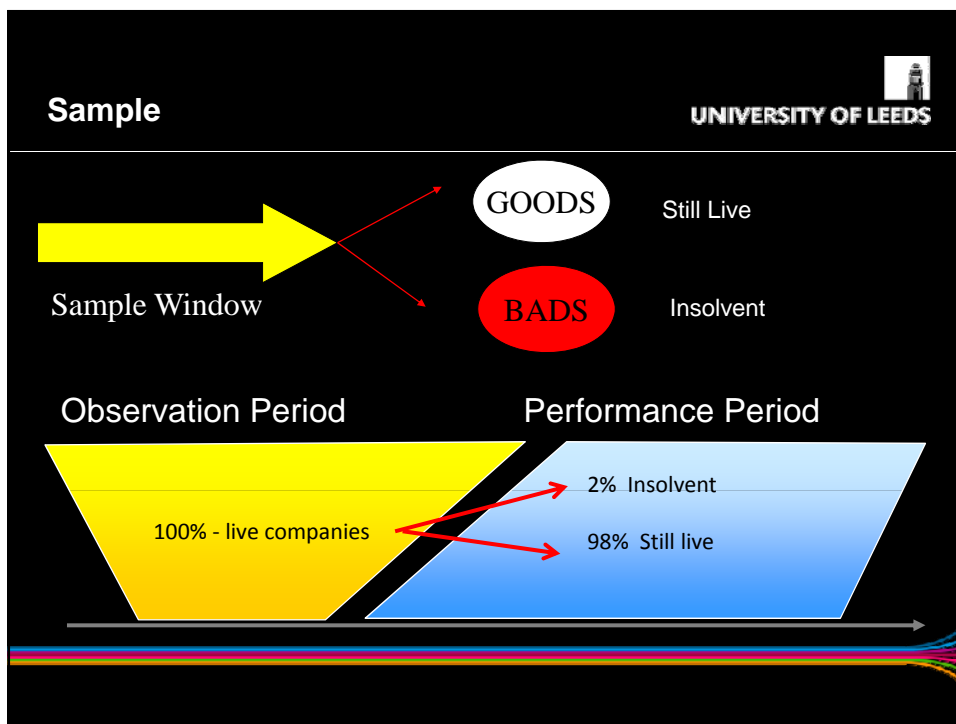
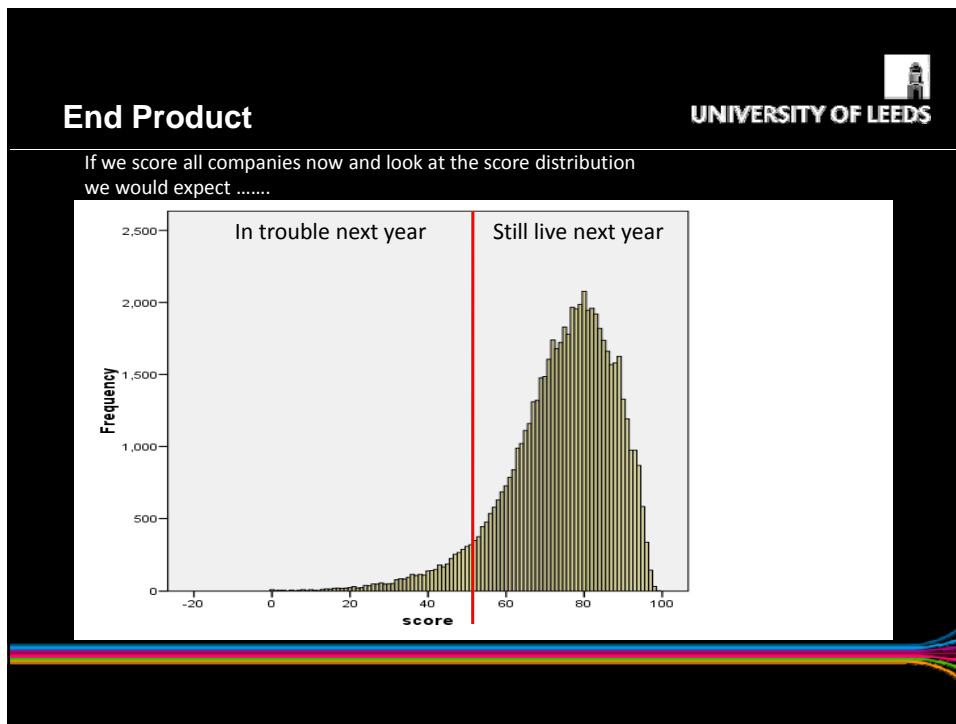




Insolvency Risk: Micro Level Models

Theoretical Perspective *Failure & Unlisted Companies*

- **Two approaches to modelling credit/default risk large listed corporations:**
 - Z-scores to predict insolvency (Altman)
 - Models relying on securities market information (Merton)
- **For private companies**
 - Limited by data frequency and availability
 - Especially market data
 - Smaller private firms have limited reporting requirements



Sample



- Population of UK companies filing accounts 1995-2008
- Over 8 million records (company-years)
- Incidence of insolvency
- Over 126,000 insolvent companies (1.6%)
- Small company abbreviated accounts (mainly Balance Sheet)
- Exclude inactive companies
- 5.5 million active companies, 102,000 insolvencies
- 2008 hold-out sample
- 1,489,076 active companies, 17,522 failed
- Data on Director Characteristics (age, experience, gender, location)


Companies in data-base 1995-2008



All Limited Companies

Analysis Year	Non-Failed	Failed	Total	Failed Rate
1995	6671	316	6,987	0.045227
1996	31043	532	31,575	0.016849
1997	54888	2250	57,138	0.039378
1998	90758	4732	95,490	0.049555
1999	150202	6511	156,713	0.041547
2000	342292	8563	350,855	0.024406
2001	502142	11046	513,188	0.021524
2002	578528	12307	590,835	0.020830
2003	712397	11623	724,020	0.016053
2004	916723	10941	927,664	0.011794
2005	1042405	11710	1,054,115	0.011109
2006	1201785	12877	1,214,662	0.010601
2007	1343152	13669	1,356,821	0.010074
2008	1489076	17522	1,506,598	0.011630
Total	8,462,062	124,599	8,586,661	0.014511

Simple Model Estimated on UK Data


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Full Accounts Company Model: Logit Estimates F=1 NF=0


Altman Model - UK Estimates 2000-2005

Variable	Coefficient	S.E.	Wald	Sig.
Cash/Total Assets	-1.487360	0.028000	2790.90	0.000000
EBITDA/Total Assets	-0.001980	0.000000	1046.34	0.000000
EBITDA/Interest paid	-0.002040	0.000000	62.03	0.000000
Retained Earnings/Total Assets	-0.836940	0.030000	781.56	0.000000
Short Term Debt/Equity	0.142100	0.005000	891.06	0.000000
Constant	-4.296258	0.008000	309527.72	0.000000

N F= 2318764 F= 24384

Source: Altman, Sabato and Wilson (2008)

Theoretical Perspective *Failure & Unlisted Companies*


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$$\ln[p/(1-p)] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$$

Insolvency risk

<p>Financial Characteristics</p> <ul style="list-style-type: none"> - Profitability - Leverage - Interest coverage - Liquidity - Cash-flow - Trade Credit - Activity 	<p>Non-financial</p> <ul style="list-style-type: none"> - Size - Ownership - Sector - Age - Age risk - Subsidiary - Co. types 	<p>'Operational Risk'</p> <ul style="list-style-type: none"> - Legal action - CCJ's - Charges on assets - Account filing - Audit qualifications - Change in auditor <p>'Governance'</p> <ul style="list-style-type: none"> - Director Characteristics 	<p>Macro</p> <ul style="list-style-type: none"> - Interest rates - Lending - Exchange rates - Confidence - GDP growth
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Multivariate Results

Variable	Coefficient	Wald	Sig.
Retained Earnings/Total Assets	-0.017733	324.86	0.000000
Cash/Total Assets	-1.107860	2025.05	0.000000
Trade debtors/Total Assets	0.373050	372.43	0.000000
Trade Creditors/Total Liabilities	0.371836	381.16	0.000000
Inventory/Working Capital	0.013345	824.44	0.000000
Sales/Total Assets	0.022205	524.71	0.000000
EBITDA/Total Liabilities	-0.050240	133.79	0.000000
EBITDA/Interest Paid	-0.000384	152.35	0.000000
Return on Assets	-0.029491	53.12	0.000000
Debt/Networth	0.000359	24.98	0.000001
Change in Profit	-0.009511	329.87	0.000000
Cashflow Statement	-0.509183	89.12	0.000000
Size1	-1.241541	1324.94	0.000000
Size4	-0.276431	181.01	0.000000
Log Total Assets	0.331825	1103.56	0.000000
(Log Total Assets) ²	-0.009051	526.61	0.000000
Log Age	-0.174756	787.45	0.000000
Age Risk 3-9 years	0.066390	38.50	0.000000
Account Qualification - Severe	0.659971	190.69	0.000000
Account Qualification - Going Concern	1.009988	190.69	0.000000
Change in Auditor	0.179827	110.44	0.000000
Late filing accounts	0.001427	443.06	0.000000
Late filing last accounts	0.003283	2076.20	0.000000
County Court Judgements/Total Liabilities	0.125361	47.92	0.000000
Number of CCJ's 12 months	0.685384	6569.58	0.000000
Industry Insolvency (log odds)	-0.571852	3488.26	0.000000
Subsidiary	-0.087543	48.97	0.000000
Small Subsidiary	1.796390	1306.05	0.000000
Charge on Assets	0.518694	1267.74	0.000000
Management Buyout	0.415032	26.15	0.000000
Management Buyin	0.752621	41.95	0.000000
VC Backed Buyout	-0.203017	3.60	0.057880
Growth Real Money Stock	-10.365035	1595.75	0.000000
GDP Growth	-2.666673	4.58	0.032357
Real Interest Rates	0.202478	1760.15	0.000000
Business Confidence Index	-0.013604	143.36	0.000000
Constant	-5.329406	3134.59	0.000000
Failed	3,016,636		
Non-Failed	46,255		

Example Output:

weighted characteristics combine to generate a score (PD)

Characteristics


Weights

Results Summary: Impact on Insolvency Risk

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<p><u>Financial Characteristics:</u></p> <p>RETA -ve</p> <p>CA/CL ambiguous</p> <p>- CASHTA -ve</p> <p>- TC/TL +ve</p> <p>- TD/TA +ve</p> <p>- STOCK/WC +ve</p> <p>COVERAGE -ve</p> <p>ROA -ve</p> <p>DEBT/NW +ve</p> <p>CHNW -ve</p> <p>CHPROF -ve</p>	<p><u>Non- Financial Characteristics:</u></p> <p>Age -ve</p> <p>Age Risk 3-8 years +ve</p> <p>Size (Assets) non-linear (quadratic)</p> <p><u>Operational Risk and Compliance:</u></p> <p>Late filing +ve</p> <p>Change in Auditor +ve</p> <p>Charge on Assets +ve</p> <p>CCJ's +ve</p> <p>Account Qualifications +ve</p>
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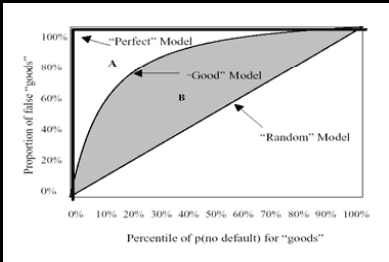
Results Summary: Impact on Insolvency Risk


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<p><u>Director Characteristics:</u></p> <table border="0"> <tr><td>Ave Age of Directors</td><td>-ve</td></tr> <tr><td>Number of Directors</td><td>-ve</td></tr> <tr><td>Number of Directorships</td><td>-ve</td></tr> <tr><td>Number of Failed Companies</td><td>+ve</td></tr> <tr><td>Close location of Directors</td><td>-ve</td></tr> <tr><td>Ratio of Female Directors</td><td>-ve</td></tr> </table>	Ave Age of Directors	-ve	Number of Directors	-ve	Number of Directorships	-ve	Number of Failed Companies	+ve	Close location of Directors	-ve	Ratio of Female Directors	-ve	<p><u>Ownership Characteristics:</u></p> <table border="0"> <tr><td>Subsidiary</td><td>?</td></tr> <tr><td>Family-Owned</td><td>-ve</td></tr> <tr><td>Owner-Managed</td><td>-ve</td></tr> <tr><td>Buyout</td><td>+ve</td></tr> <tr><td>- Private Equity-Backed</td><td>?</td></tr> </table> <p><u>Macro- Economy:</u></p> <table border="0"> <tr><td>GDP Growth</td><td>-ve</td></tr> <tr><td>Real Interest Rates</td><td>+ve</td></tr> <tr><td>Bank Lending</td><td>-ve</td></tr> <tr><td>Business Confidence</td><td>-ve</td></tr> <tr><td>Industry Risk</td><td>+ve</td></tr> </table>	Subsidiary	?	Family-Owned	-ve	Owner-Managed	-ve	Buyout	+ve	- Private Equity-Backed	?	GDP Growth	-ve	Real Interest Rates	+ve	Bank Lending	-ve	Business Confidence	-ve	Industry Risk	+ve
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Diagnostics: Hold-Out Tests


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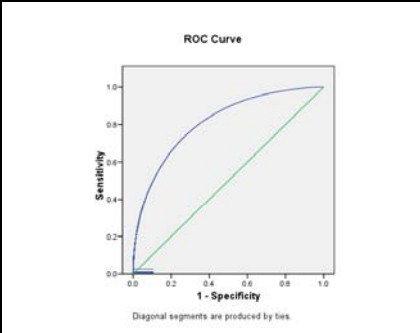
Proportion of false "goods"
0% 20% 40% 60% 80% 100%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Percentile of p(no default) for "goods"

2008 Population
AUC = 0.82
Classification Accuracy = 78%

Diagnostics
ROC Curve AUC
Gini Coefficient
K-S Statistic
Classification Accuracy



ROC Curve

Sensitivity

1 - Specificity

Diagonal segments are produced by ties.

Summary



- Z-score type models can be successfully applied to the UK Company population
- Limited and Infrequent Data is an issue
- Enhanced models inclusive of :
 - non-financial characteristics; (size, sector, ownership)
 - director characteristics;
 - characteristics reflecting 'operational risk';
improve model performance
- Macro-economic dynamics ensure scores change with economic conditions
- Good credit decisions require timely information and responsive models
 - informational infrastructure needs to be improved !