Corporate Failure Model - Z-Score for Bulgaria SME

by K. Manolov and K. Tsvetkov

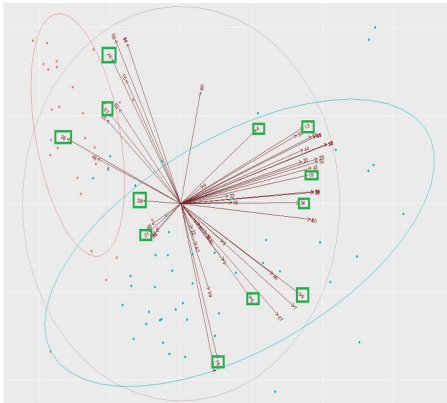
Manufacturing firms with assets in range: $0.7 – $25.9 mln. filed a bankruptcy petition under Chapter X of National Bankruptcy Act in the period '46-'65.

(I) $Z = .012X_1 + .014X_2 + .033X_3 + .006X_4 + .999X_5$

where X_1 = Working capital/Total assets
X_2 = Retained Earnings/Total assets
X_3 = Earnings before interest and taxes/Total assets
X_4 = Market value equity/Book value of total debt
X_5 = Sales/Total assets
Z = Overall Index

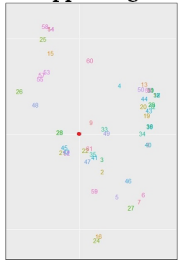
THE DATA:
- 80 firms – 29 bankrupted and 51 vital companies
- 2 years – '93 used as base and '94 as predication.
- No change in the flag (between two data sets)
- 22 accounting variables
- No missing observations (cleaned data)
- We produced more than 65+ ratios

Variables	Gini	Variables	Gini	Variables	Gini
TCE_TA	0.973	PBT_TotInco	0.799	PBT_LD	0.639
PBT_Dep_FinExp	0.943	PBT_Sales	0.798	EQ_TCE_CL_FinExp	0.612
PBT_Dep_TD	0.941	PBT_CL	0.794	TL_TA	0.586
CL_CA	0.901	TA_CA_Sales	0.794	CA_Sales	0.57
TD_LD_CA	0.893	PBT_FinExp	0.786	CL_Sales	0.57
WC_TA	0.871	CL_TL	0.782	PBT_Dep_TCE	0.556
TA_CA_TCE	0.867	PBT_Dep_Sales	0.778	TotInco_TL_CL_TCE	0.546
WC_TCE	0.863	PBT_Dep_TotInco	0.777	LD_LD_TCE	0.528
CA_CL	0.862	TD_EQ	0.773	Stock_S	0.462
QA_CL	0.844	PBT_Dep_TA	0.759	PAT_Sales	0.451
TA_CA_FinExp	0.836	PBT_EQ	0.755	PAT_TA	0.451
TD_TCE	0.827	Dep_TA_CA	0.742	PAT_TA_1	0.451
PBT_TA	0.808	WC	0.735	PAT_TCE	0.451
PBT_TCE	0.807	TL_Sales	0.719	PAT_TCE_1	0.451
PBT_TD	0.805	CL_TA	0.715	PAT_TotInco	0.451
PBT_S	0.804	TD_TA	0.715	PBT_Dep_LD	0.448
PBT_TA_1	0.802	FinExp_TD	0.672	BDI	0.446
PBT_TCE_1	0.801	EQ_TA	0.67	Dr_S360	0.442
S_TA	0.801	S_TCE	0.658	PAT_TD	0.44
TA_Sales	0.801	PBT_WC	0.646	Sales_TotInco	0.431

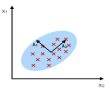


PCA was used as a supporting technique.

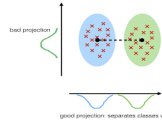
Dots:
- 28 – TL/TCE
- 26 – (TA-CA)/TCE
- 57 – CL/CA
- 25 – TD/TCE
- 4 – CA/TL
- 13 – PBT/EQ
- 19 – S/TA
- 34 – PAT/TD
- 6 – WC/TA
- 5 – CA/CL
- 16 – EQ/TA
- 21 – Stock/S



PCA:
component axes that maximize the variance



LDA:
maximizing the component axes for class-separation



Before PCA

LDA

	0	1
0	29	0
1	4	47
Accuracy		*95.00%*

MDA

	0	1
0	18	3
1	11	48
Accuracy		*82.50%*

FDA

	0	1
0	24	8
1	5	43
Accuracy		*83.75%*

RDA

	0	1
0	29	22
1	0	29
Accuracy		*72.50%*

SVM

	0	1
0	27	0
1	2	51
Accuracy		*97.50%*

NB

	0	1
0	29	2
1	0	49
Accuracy		*97.50%*

NN

	0	1
0	27	0
1	2	49
Accuracy		*97.50%*

After PCA

LDA

	0	1
0	27	0
1	2	51
Accuracy		*97.50%*

MDA

	0	1
0	27	0
1	2	51
Accuracy		*97.50%*

FDA

	0	1
0	27	0
1	2	51
Accuracy		*97.50%*

RDA

	0	1
0	28	1
1	1	50
Accuracy		*97.50%*

SVM

	0	1
0	27	0
1	2	51
Accuracy		*97.50%*

NB

	0	1
0	29	1
1	0	50
Accuracy		*98.75%*

NN

	0	1
0	23	1
1	6	50
Accuracy		*91.25%*

Dependent Variable: ____STATUS
Method: ML - Binary Logit (Newton-Raphson / Marquardt steps)
Date: 05/31/17 Time: 17:28
Sample: 1 80
Included observations: 80
Convergence achieved after 7 iterations
Coefficient covariance computed using observed Hessian

Variable	Coefficient	Std. Error	z-Statistic	Prob.
TCE_TA	26.97734	6.350619	4.247986	0.0000
C	-22.70362	5.535050	-4.101792	0.0000

McFadden R-squared	0.759967	Mean dependent var	0.637500
S.D. dependent var	0.483755	S.E. of regression	0.212273
Akaike info criterion	0.364367	Sum squared resid	3.514664
Schwarz criterion	0.423918	Log likelihood	-12.57469
Hannan-Quinn criter.	0.388243	Deviance	25.14938
Restr. deviance	104.7749	Restr. log likelihood	-52.38744
LR statistic	79.62550	Avg. log likelihood	-0.157184
Prob(LR statistic)	0.000000		

Obs with Dep=0	29	Total obs	80
Obs with Dep=1	51		

Dependent Variable: ____STATUS
Method: ML - Binary Logit (Newton-Raphson / Marquardt steps)
Date: 05/30/17 Time: 11:46
Sample: 1 80
Included observations: 80
Convergence achieved after 7 iterations
Coefficient covariance computed using observed Hessian

Variable	Coefficient	Std. Error	z-Statistic	Prob.
TD_EQ	-1.539233	0.504920	-3.048470	0.0023
C	-0.487377	0.758620	-0.642451	0.5206
PBT_DEP_TA	5.916632	1.969640	3.003915	0.0027

McFadden R-squared	0.594984	Mean dependent var	0.637500
S.D. dependent var	0.483755	S.E. of regression	0.265629
Akaike info criterion	0.605444	Sum squared resid	5.433009
Schwarz criterion	0.694770	Log likelihood	-21.21776
Hannan-Quinn criter.	0.641257	Deviance	42.43551
Restr. deviance	104.7749	Restr. log likelihood	-52.38744
LR statistic	62.33938	Avg. log likelihood	-0.265222
Prob(LR statistic)	0.000000		

Obs with Dep=0	29	Total obs	80
Obs with Dep=1	51		

Before PCA

KNN1

	0	1
0	21	4
1	8	47
Accuracy		*85.00%*

KNN2

	0	1
0	17	4
1	12	47
Accuracy		*80.00%*

KNN3

	0	1
0	20	3
1	9	48
Accuracy		*85.00%*

KNN4

	0	1
0	17	2
1	12	49
Accuracy		*82.50%*

KNN5

	0	1
0	18	1
1	11	50
Accuracy		*85.00%*

After PCA

KNN1

	0	1
0	23	1
1	6	50
Accuracy		*91.25%*

KNN2

	0	1
0	21	2
1	8	49
Accuracy		*87.50%*

KNN3

	0	1
0	26	1
1	3	50
Accuracy		*95.00%*

KNN4

	0	1
0	27	1
1	2	50
Accuracy		*96.25%*

KNN5

	0	1
0	26	1
1	3	50
Accuracy		*95.00%*

Correlations were a bit too high for some of the variables.

Decision trees were also used in the analysis.

Below are the two logit models used. The first is with 96.25% accuracy, the second with 98.75%.

Expectation-Prediction Evaluation for Binary Specification
Equation: EQ01
Date: 05/31/17 Time: 17:28
Success cutoff: C = 0.5

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P(Dep=1)<=C	27	2	29	0	0	0
P(Dep=1)>C	2	49	51	29	51	80
Total	29	51	80	29	51	80
Correct	27	49	76	0	51	51
% Correct	93.10	96.08	95.00	0.00	100.00	63.75
% Incorrect	6.90	3.92	5.00	100.00	0.00	36.25
Total Gain*	93.10	-3.92	31.25			
Percent Gain**	93.10	NA	86.21			

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
E(# of Dep=0)	25.52	3.48	29.00	10.51	18.49	29.00
E(# of Dep=1)	3.48	47.52	51.00	18.49	32.51	51.00
Total	29.00	51.00	80.00	29.00	51.00	80.00
Correct	25.52	47.52	73.04	10.51	32.51	43.03
% Correct	88.00	93.18	91.30	36.25	63.75	53.78
% Incorrect	12.00	6.82	8.70	63.75	36.25	46.22
Total Gain*	51.75	29.43	37.52			
Percent Gain**	81.18	81.18	81.18			

*Change in "% Correct" from default (constant probability) specification
**Percent of incorrect (default) prediction corrected by equation

Expectation-Prediction Evaluation for Binary Specification
Equation: EQ01
Date: 05/31/17 Time: 17:25
Success cutoff: C = 0.6

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P(Dep=1)<=C	27	3	30	0	0	0
P(Dep=1)>C	2	48	50	29	51	80
Total	29	51	80	29	51	80
Correct	27	48	75	0	51	51
% Correct	93.10	94.12	93.75	0.00	100.00	63.75
% Incorrect	6.90	5.88	6.25	100.00	0.00	36.25
Total Gain*	93.10	-5.88	30.00			
Percent Gain**	93.10	NA	82.76			

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
E(# of Dep=0)	22.95	6.05	29.00	10.51	18.49	29.00
E(# of Dep=1)	6.05	44.95	51.00	18.49	32.51	51.00
Total	29.00	51.00	80.00	29.00	51.00	80.00
Correct	22.95	44.95	67.90	10.51	32.51	43.03
% Correct	79.13	88.14	84.87	36.25	63.75	53.78
% Incorrect	20.87	11.86	15.13	63.75	36.25	46.22
Total Gain*	42.88	24.39	31.09			
Percent Gain**	67.27	67.27	67.27			

*Change in "% Correct" from default (constant probability) specification
**Percent of incorrect (default) prediction corrected by equation