Financial ratios used for rating

4) Liquidity
   - Current ratio
   - Quick ratio
   - Inventory/Net Sales
   - Inventory/Net working capital
   - Current debt/Inventory
   - Raw materials/Total Inventory
   - Work in Progress/Total Inventory
   - Finished goods/Total inventory

Financial ratios used for rating

5) Receivables
   - Aging of receivables: 30, 60, 90, 90+ days
   - Average collection period

Rating analysis procedure

1) A banker begins by finding why the company needs a loan. Using his/her preliminary knowledge of the company, the banker will test this need against the bank's current policies. If there is a green signal then the bank proceeds further.
2) The company's B/S, P/L account are analyzed to highlight the financial structure of the company. Figures for business segment operating results, budgets, business plan are all helpful for this credit analysis process. Hence a thorough understanding of the financial statements is very important.
3) The trial balance is analyzed, along with the supporting schedules, footnotes.
4) The accounting principles are analyzed to see the consistency.

Rating analysis procedure

5) The purpose for the loan is evaluated and so is the projected cash flows.
6) Hard and soft assumptions are identified.
7) The industry′s structure is analyzed, like emerging trends, company's position within the industry, the potential of regulatory actions.
8) The company′s executive management and their operating strategies are evaluated. Managers involved with the specific projects are evaluated.
9) Loan and security documentations are prepared, covering such issues as conditions of loan, mode of payments, guarantees, conditions of default etc.

What the banker should think

Each industry has its own unique structure and dynamics. A firm's position is affected by the relative level of maturity of its industry. A mature industry for example, is characterized by market saturation, lack of technology opportunity and a trend toward a decreasing rate of return. A firm attempting to prosper within any industry has to contend with potential entrants, existing rivals, suppliers, buyers, substitute products. Its competitive weapon may include barriers to entry, cost control through economies of scale, control of distribution channels, favourable government policies, retaliatory pricing, product differentiation, product innovation etc.

Thus when the bankers/evaluator is trying to make judgments about the company for loans then the person should try to analyze what the strategies of the company are, what are its advantages, etc.

Problem for banks

1) Lack of experts.
2) Too much focus on any particular sector of economy.
3) Biasedness.
4) External dictate so as to lend to particular sector, company etc.
5) Lack of knowledge.
6) Unforeseen circumstances/situations.

Why credit models?

1) Deregulation, which stimulated financial innovations and enabled new entrants to provide services.
2) The broadening of the credit market to encompass new borrowing sectors.
3) A continuing shift from B/S lending to cash flow lending.

Why credit models?

4) An increase in off B/S risks.
5) Shrinking margins in loan, which have forced banks to explore less costly ways of measuring and managing risks.
6) Development of more efficient credit risk models.
7) Advances in finance theory, which provided new ways to look at credit risk, e.g., CAPM, APT, Black Scholes Model etc.

Domain of application of credit risk models

1) Credit approval: Used in conjunction with a judgmental override system for approving credit to customers.
2) Credit rating determination: Used to rate, unrated securities with the help of rated securities

Domain of application of credit risk models

3) Credit pricing: Used to suggest the risk premium that should be charged in view of the loss/default
4) Financial early warning: Used to flag potential problems in portfolio to facilitate early warning

Domain of application of credit risk models

5) Common credit language: Used to select assets from a pool to construct a portfolio acceptable to investors or to achieve minimum credit quality needed to obtain the desired credit rating
6) Collection strategies: Used in deciding on the best collection strategy to pursue. Credit model will indicate whether the borrower is experiencing short term liquidity problems or long term problems

Accounting based credit scoring system

- Each industry has some norms for each and every ratios. So a company is analyzed against the standard industry norm and judgement is passes regarding the company
- These univariate models are inadequate in predicting the sickness of companies
- Hence multivariate models are used, but the question now is
  - Which ratios are most important in detecting bankruptcy potential
  - What weights should be attached to these selected ratios
  - How should the weight values be objectively established

Altman's Z-Score

Altman, E. I.; "Financial Ratios, Discriminant Analysis and Prediction of Corporate Bankruptcy "; *Journal of Finance*, 1968, 23, 189-209

Note: The author used Multivariate Discriminant Analysis for finding this score

$$Z = 0.012*X_1 + 0.014*X_2 + 0.033*X_3 + 0.006*X_4 + 0.999*X_5$$

Where
Z = Overall Index
X_1 = Working Capital/Total Assets
X_2 = Retained Earnings/Total Assets
X_3 = Earning before Interest and Income Tax/Total Assets
X_4 = Market value of Equity/Book value of Total Liabilities
X_5 = Sales/Total Assets

Altman's Z-Score

1) Working Capital/Total Assets = (WC/TA) = (Current Assets – Current Liabilities)/Total Assets
   - Firms doing poorly would have a shrinking value of Current Assets in relationship to Total Assets
2) Retained Earnings/Total Assets = (RE/TA):
   - Retained Earnings or Earned Surplus is the total amount of reinvested earnings/losses of a firm over its entire life. Young firms have a low value of (RE/TA)
3) Earning before Interest and Income Tax/Total Assets = (EBIT/TA):
   - It is a measure of productivity of the firm's assets independent of tax etc.
4) Market value of Equity/Book value of Total Liabilities = (MVE/TL):
   - Equity is measured by the combined value of all shares of stock preferred and common, whereas liabilities includes both Current Liabilities (CL) as well as Long term Liabilities (LL)
5) Sales/Total Assets = (S/TA):
   - This capital turnover ratio illustrates the sales generating ability of the firm's assets

Altman's Z-Score

Ranges of Z-Score

1) The Z-Score model for Public industrial companies is

$$Z = 0.012*X_1 + 0.014*X_2 + 0.033*X_3 + 0.006*X_4 + 1.0*X_5$$

   - Company is healthy if Z >2.99
   - Company is in the grey zone if 1.81 < Z < 2.99
   - Company is unhealthy if Z < 1. 81

2) The Z-Score model for Private industrial companies is

$$Z = 0.0656*X_1 + 0.0326*X_2 + 0.0672*X_3 + 1.05*X_4$$

   - Company is healthy if Z >2.60
   - Company is in the grey zone if 1. 1 < Z < 2.59
   - Company is unhealthy if it has a Z <1.1.

Emerging Market Score Model

Models applied to the USA market may not be applicable to other markets due the the reasons given below:

Altman,. E. I., Hartzell,. J., Peck,.M., *"Emerging Markets Corporate Bonds: A Scoring System*". New York: Salomon Brothers.

Reprinted in *Emerging Market Capital Flows*, edited R. Levich; Amsterdam: Kluwer Publishing, 1997

- Different currency
- Industry risk different
- Industry characteristics different
- Economy different
- Political environment different
- Lack of credit experience

ZETA Score

Altman,. E. I., Haldeman,. R. G., Narayanan,. P.; ″ZETA Analysis: A New Model to Identify Bankruptcy Risk of Corporations″. *Journal of Banking and Finance*, 1977, 1, 29-54

Main difference with the Z-Score model

- Changing trends/government rules regarding bankruptcy
- Focused on much larger (in terms of size) firms
- Changing trends in standards and accepted accounting practices
- Refinement in discriminant statistical analysis

ZETA Score

NOTE: ZETA Score is a proprietary model and unfortunately we do not have the explicit formula for the index

Variables are

1) X_1 = Return on Assets (ROA) = EBIT/Total Sales
2) X_2 = Stability of Earnings
   - Measures the normalized standard error of estimate in X_1
3) X_3 = Debt Service = Interest Coverage Ratio = EBIT/Total Interest Payments
4) X_4 = Cumulative profitability = Retained Earnings
   - Gives a picture of the age of the firm
   - Gives a picture of the Dividend policy of the firm
   - Gives a picture of the Profitability of the firm over time
5) X_5 = Liquidity = Current Ratio = (Current Assets/Current Liabilities)
6) X_6 = Capitalization = (Common Equity/Total Capital)
7) X_7 = Size = $\log_e$(Total Assets)

Ohlson′s O-Score

Ohlson, J.; ″Financial Ratios and the Probabilistic Prediction of Bankruptcy″; *Journal of Accounting Research*, 1980, 18, 109-131

Ohlson's O-Score

Probability of bankruptcy = $1/\{1 + \exp(-NV)\}$

$NV = - 1.249 – 0.211*Y_1 + 2.262*Y_2 - 3.451*Y_3 – 0.293*Y_4 - 0.907*Y_5 + 1.08*Y_6 – 0.838*Y_7 + 1.266*Y_8$

Where

O = Overall Index

$Y_1 = \log_e$[Total Assets/GDP price index level]

Y_2 = Total Liabilities/Total Assets

Y_3 = Working Capital/Total Assets

Y_4 = Current Liabilities/Current Assets

Y_5 = Fund from Operations/Total Liability

Y_6 = Dummy variable which is set to 1 if Net Income is negative for the last two consecutive years

Y_7 = Dummy variable which is set to 1 if Total Liabilities > Total Assets

$Y_8 = \{(\text{Net Income}_t - \text{Net Income}_{t-1})/(|\text{Net Income}_t| - |\text{Net Income}_{t-1}|)\}$

Ohlson's O-Score

If Probability < 0.038 then the company is not bankrupt, else we say the company is bankrupt.

Ohlson's O-Score

Griffin, J., M. and Lemmon, M., L., "Book–to–Market Equity, Distress Risk, and Stock Returns", *Journal of Finance*, 2002, 57, 2317-2336.

$O = -1.32 - 0.41*Y_1 + 6.03*Y_2 - 1.43*Y_3 + 0.08*Y_4 – 2.37*Y_5 – 1.83*Y_6 + 0.285*Y_7 - 1.72*Y_8 - 0.52*Y_9$

Where

O = Overall Index

$Y_1 = \log_e$[Total Assets/GDP price index level]

Y_2 = Total Liabilities/Total Assets

Y_3 = Working Capital/Total Assets

Y_4 = Current Liabilities/Current Assets

Y_5 = Net Income/Total Assets

Y_6 = [Pretax Income + Depreciation +Amortization]/Total Liabilities

Y_7 = Indicator variable which is 1 if cumulative Net Income is negative for the last two consecutive years and 0 otherwise

Y_8 = Indicator variable which is 1 if owner's equity is negative and 0 otherwise

$Y_9 = \{(\text{Net Income}_t - \text{Net Income}_{t-1})/(|\text{Net Income}_t| - |\text{Net Income}_{t-1}|)\}$

Ohlson's O-Score (with updated coefficients)

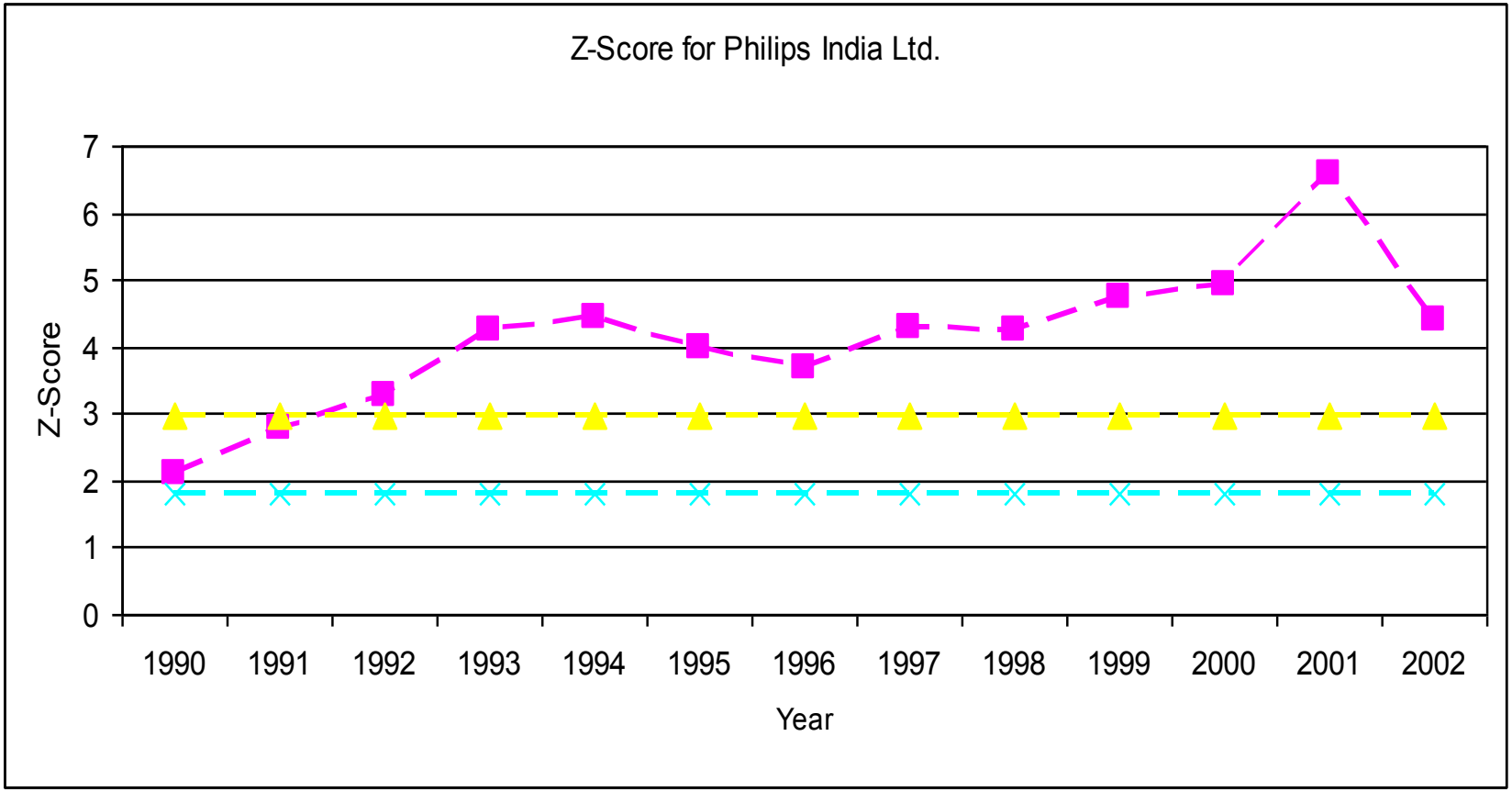
$$O = -5.91 + 0.04*Y_1 + 0.08*Y_2 + 0.01*Y_3 - 0.01*Y_4 + 1.20*Y_5 + 0.18*Y_6 + 0.01*Y_7 + 1.59*Y_8 - 1.10*Y_9$$

Values of Z-Score and O-Score for Philips India Ltd.

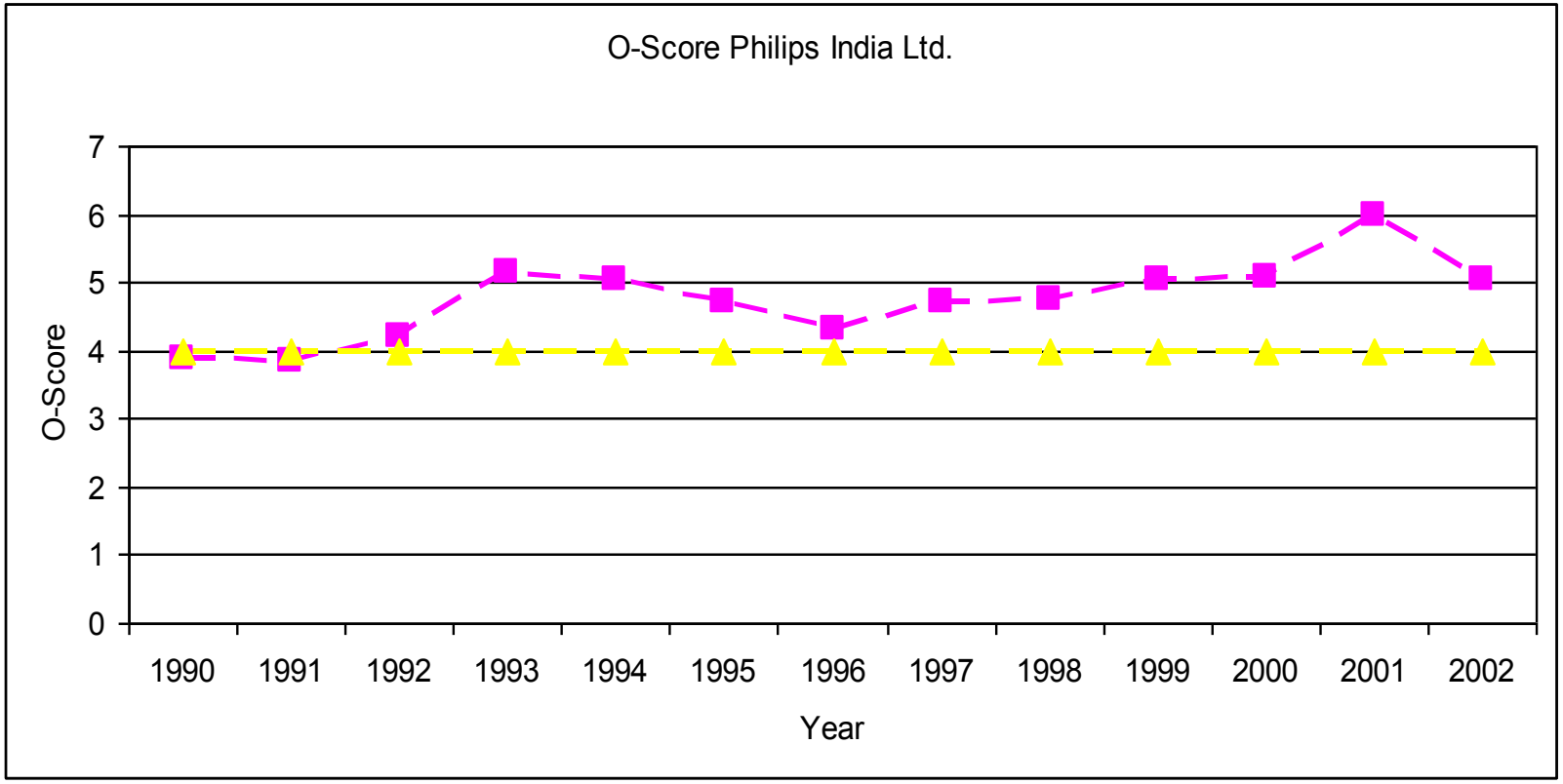
Year	1990	1991	1992	1993	1994	1995	1996
Z-Score	2.120479	2.787238	3.283604	4.265834	4.423882	3.983140	3.685362
O-Score	3.890588	3.843578	4.205020	5.147435	5.032618	4.731958	4.320980

Year	1997	1998	1999	2000	2001	2002
Z-Score	4.290883	4.239720	4.728869	4.920595	6.577242	4.412970
O-Score	4.718085	4.761340	5.059113	5.081353	5.994083	5.038103

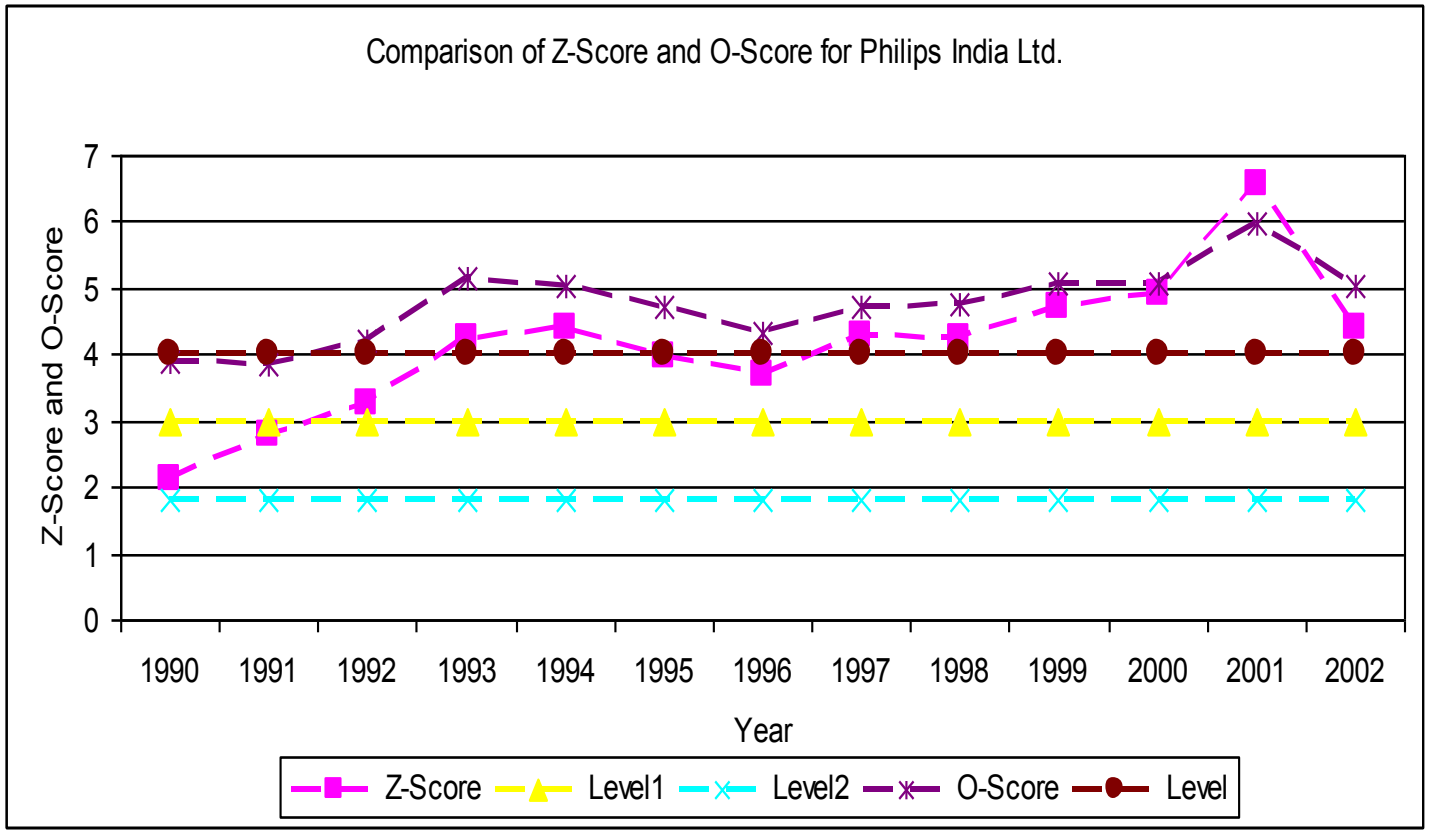
Z-Score for Philips India Ltd.



O-Score for Philips India Ltd.



Z-Score and O-Score comparison for Philips India Ltd.



Zmijewski's Model

Zmijewski, M. E., "Methodological issues related to the estimation of financial distress prediction models", *Journal of Accounting Research*, 1984, 22, 59-82.

$$\text{Probability of failure} = [1/\{1 + \exp(-AS_1)\}]$$

Where

$AS_1 = f(X_1, X_2, X_3)$

X_1 = Net Income/Total Assets

X_2 = Total Debts/Total Assets

X_3 = Current Assets/Current Liabilities

Remember if the value of this probability is ≥ 0.5 then it implies bankruptcy, else the company is not bankrupt

Zavgren's Model

Zavgren, C., V., "The prediction of corporate failure: the state of the art", *Journal of Accounting Literature*, 1983, 2, 1-33.

$$\text{Probability of failure} = [1/\{1 + \exp(-AS_2)\}]$$

Where

$AS_2 = g(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8)$

X_1 = Net Income/Total Assets

X_2 = Average Receivables/Average Inventories

X_3 = Current Assets/Current Liabilities

X_4 = (Cash + Marketable Securities)/Short-term assets + Long-term Assets + Intangibles

X_5 = (Cash + Marketable Securities)/Current Liabilities

X_6 = EBDIT/Long-term Liabilities + Stockholders' Equity

X_7 = Long-Term Debt/(Total Equities - Short-term Debt)

X_8 = Net Sales/(Fixed Assets + Net Working Capital)

Remember if the value of this probability is ≥ 0.5 then it implies bankruptcy, else the company is not bankrupt

Techniques for quantifying credit risk

1) Econometric techniques: Game theoretic approach
2) Neural networks
3) Optimization models: Deterministic as well as Probabilistic models
4) Expert system/Decision Support System
5) Hybrid system using direct computation, estimation, and simulation techniques
6) Different meta-heuristic techniques like GA, SA, TS, ACO, PSO, AIS, etc.

Use of AIS for quantifying credit risk

Bankruptcy Prediction Using Artificial Immune Systems; Singh, R. and Sengupta, R. N., *Lecture Notes in Computer Science* (Book: Artificial Immune Systems), (Edited L.N. de Castro, F.J.Zuben and H.Knidel), **4628**, 131-141, 2007, Springer-Verlag, ISBN: 978-3-540-73921-0.

Corporate Credit Risk Models based on Stock Price

- The leading example of stock market based credit measures is the Expected Default Frequency (EDF) model of KMV [Kealhofer-Merton-Vasicek] corporation (1995), which was a San Francisco based firm that sold credit analysis software and information products to financial institutions. In 2002 Moody′s purchased KMV corporation.
- KMV Corporation has created an approach for estimating the default probability of a firm that is based conceptually on Merton's (1994) approach.
- The starting point of this model is the proposition that when the market value of the firm drops below a certain level, the firm will default on its obligation.