Japanese Corporate Bankruptcy Prediction Models

Teikoku Databank, Ltd.
Agenda

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- Procedure of Model Development
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- Model Development and Calculation Procedure
- Accuracy of Models
- Validation of Predicted Value
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### About TDB

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Teikoku Databank, Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branches:</td>
<td>83 in Japan</td>
</tr>
<tr>
<td>Founded:</td>
<td>March 1900</td>
</tr>
<tr>
<td>Employees:</td>
<td>3,100 (including 1,500 reporters)</td>
</tr>
<tr>
<td>Turnover:</td>
<td>43.7 bn JPY (400 M EURO) Sep 2001</td>
</tr>
<tr>
<td>Yearly Survey:</td>
<td>1.43 million cases</td>
</tr>
<tr>
<td>Business Domain:</td>
<td>Credit survey, database supply, marketing research, EC support, publishing</td>
</tr>
</tbody>
</table>
Enterprises in Japan

- More than 5 million enterprises and 99.7% of them are SMEs
- SMEs play an important role for Japanese economy

Total Enterprises: 5,102,642
Number of Enterprises = no. of companies + no. of sole proprietorships
Number of Companies: 1,665,181

Source: Small and Medium Enterprise Agency(1996)
Both the number of bankruptcies and the amount of bad loans should be increasing…
Motivation to Develop Bankruptcy Prediction Models

TDB’s Credit Rating (since 1959) is quite popular for Japanese enterprises not only to estimate credit risk, but to search for potential customers, because of lacking public infrastructure for corporate information.

The change of approach of credit estimation….

- Human based credit estimation: Costly & time consuming process
- Automatic credit estimation by scoring system: Low cost & quick operation

Our customers need:

- More specialised measure than Credit Rating in terms of bankruptcy risk
- Qualitative analysis to estimate corporate bankruptcy risk
**TDB’s Database**

<table>
<thead>
<tr>
<th>Database</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCR</strong>: Corporate Credit Report</td>
<td>Approx. 890,000 companies</td>
</tr>
<tr>
<td><strong>COSMOS1</strong>: Corporate Financial Database</td>
<td>Approx. 470,000 companies (2.56 million financial periods)</td>
</tr>
</tbody>
</table>
| **COSMOS2**: Corporate Profile Database | - Company profile file: Approx. 1.2 million companies  
- Corporate bankruptcy file: Approx. 390,000 companies (since 1977) |

- **COSMOS2** is one of the largest corporate profile database in Japan  
- **CCR & COSMOS2** include TDB Credit Rating  

[TEIKOKU DATABANK]
TDB’s Corporate Bankruptcy Prediction Models

- Estimate probabilities of corporate bankruptcy within a year
- Use TDB’s Databases: CCR, COSMOS1, and internal credit information database
- Apply the logistic regression model

**CCR model**
- Use only qualitative information derived from on-site investigation (i.e. CCR and TDB’s internal credit information)
- Calculate predicted value without financial information

**MIX model**
- Use both qualitative and quantitative information (i.e. CCR, TDB’s internal credit information and COSMOS1)
- Have relatively high accuracy
- Fall into two types

Predicted value from these models is TDB’s new index for estimating corporate bankruptcy risk.
# TDB’s Corporate Credit Report and Credit Rating

![Credit Rating Table]

<table>
<thead>
<tr>
<th>CREDIT RATING</th>
<th>MARKS</th>
<th>CREDIT RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>1 ~ 5</td>
<td>5</td>
</tr>
<tr>
<td>Net Worth</td>
<td>0 ~ 12</td>
<td>6</td>
</tr>
<tr>
<td>Business Scale</td>
<td>2 ~ 19</td>
<td>10</td>
</tr>
<tr>
<td>Profitability</td>
<td>0 ~ 10</td>
<td>8</td>
</tr>
<tr>
<td>Financial Condition</td>
<td>0 ~ 20</td>
<td>12</td>
</tr>
<tr>
<td>Management</td>
<td>1 ~ 15</td>
<td>10</td>
</tr>
<tr>
<td>Business Vitality</td>
<td>4 ~ 19</td>
<td>13</td>
</tr>
<tr>
<td>Additional Marks if necessary</td>
<td>+1 ~ +5</td>
<td>[x] C (51 ~ 65)</td>
</tr>
<tr>
<td>Demerit Marks if necessary</td>
<td>-1 ~ -10</td>
<td>[ ] D (36 ~ 50)</td>
</tr>
<tr>
<td><strong>TOTAL (/100)</strong></td>
<td></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>
These are qualitative evaluation assessed by TDB’s investigators.

**FINANCIAL PROFILE**

<table>
<thead>
<tr>
<th>Trend (Sales)</th>
<th>Upsurge</th>
<th>[x] Upward</th>
<th>[ ] Leveling off</th>
<th>[ ] Downward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td>[ ] High</td>
<td>[x] Fair</td>
<td>[ ] Poor but may improve</td>
<td>[ ] Poor</td>
</tr>
<tr>
<td>Collection</td>
<td>[ ] Satisfactory</td>
<td>[x] Fair</td>
<td>[ ] Slow at times</td>
<td>[ ] Slow</td>
</tr>
<tr>
<td>Solvency</td>
<td>[ ] Strong</td>
<td>[x] Moderate</td>
<td>[ ] Weak</td>
<td>[ ] Poor</td>
</tr>
<tr>
<td>Funds required</td>
<td>[ ] No extra funds required</td>
<td>[x] Positive use*</td>
<td>[ ] Negative use**</td>
<td></td>
</tr>
<tr>
<td>Fund-raising capacity</td>
<td>[x] High</td>
<td>[ ] Adequate</td>
<td>[ ] Nearly limited</td>
<td>[ ] Limited</td>
</tr>
</tbody>
</table>

* Funds required for investment in fixed assets and some other constructive purposes that would promote business development

** Funds required for paying or reducing debts and some other non-constructive purpose
Difference of Distribution between Bankruptcy and Non-Bankruptcy
by TDB Credit Rating in January 2002

Credit range: D & E
Credit range: C or higher

Many companies would go bankrupt, but many would be alive…

Company size is likely to be large in this group. So, once it goes bankrupt…

Problem: It’s difficult to know a company goes bankrupt next.

Non-Bankruptcy (417,252 cases)
Bankruptcy (2,473 cases)
Outline of Model Development

Jul 2000
- Project start
- Study on analysis method and available Data
- Develop system
- SAS training

Nov 2000
- Install SAS
- Convert & Edit data
- Analyse data & develop prototype

Mar 2001
- Complete prototype
- Verify & selecting the model

Jun 2001
- Complete CCR MODEL
- Analyse data & develop prototype
- Verify & select the model

Feb 2002
- Complete MIX MODEL
Outline of Model Development (Converting & Editing Data)

Data for Analysis:
- Volume of Raw Data is 50GB
- The number of files is more than 50
- Each file has 0.7 to 2.4 million records

SAS data set
Initial volume: 100GB

- Data handling
  - Loading
  - Editing

- Analysing
  - Enterprise Miner
  - SAS STAT

Data loading & editing(40%) + Data mining & Analysing(40%) + Verifying(20%)
Prior probabilities of the bankruptcy: 1.37%
Model Development and Calculation Procedure (MIX MODEL)

**MIX MODEL Separate Type**
- P-Value
- Construction
- Manufactng
- Wholesale & Retail
- Others

**COSMOS1**
Corporate Financial Database
450,000 companies

**CCR**
820,000 companies

**TDB Internal Credit Information**

**MIX MODEL Hybrid Type**
- P as a variable
- Construction
- Manufactng
- Wholesale & Retail
- Others

- P as a variable
- P as a variable
- P as a variable
- P as a variable

**CCR MODEL**
- P-Value
- MODEL
- MODEL
- MODEL
- MODEL
- MODEL
- P-Value
Accuracy of Models

CCR MODEL:
More than 70% accuracy without using financial information

MIX MODELS:
Approx. 75-85% accuracy using both financial and qualitative information

<table>
<thead>
<tr>
<th>Industry</th>
<th>CCR MODEL</th>
<th>MIX MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Separated Type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction</td>
</tr>
<tr>
<td>Number of Variables</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Initial Sample (Estimation Data)</td>
<td>418,567</td>
<td>34,776</td>
</tr>
<tr>
<td>Prior Probabilities</td>
<td>1.37%</td>
<td>1.77%</td>
</tr>
</tbody>
</table>

**Accuracy**

- **Sensitivity**: Predicted Bankruptcy/Actual Bankruptcy
- **Specificity**: Predicted Non-Bankruptcy/Actual Non-Bankruptcy

<table>
<thead>
<tr>
<th>Estimation Data (Year 2000)</th>
<th>CCR MODEL</th>
<th>MIX MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>71.30%</td>
<td>82.57%</td>
</tr>
<tr>
<td>Specificity</td>
<td>73.70%</td>
<td>74.93%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Data (Year 2001)</th>
<th>CCR MODEL</th>
<th>MIX MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>70.94%</td>
<td>76.89%</td>
</tr>
<tr>
<td>Specificity</td>
<td>72.59%</td>
<td>73.93%</td>
</tr>
</tbody>
</table>

Sensitivity: Predicted Bankruptcy/Actual Bankruptcy
Specificity: Predicted Non-Bankruptcy/Actual Non-Bankruptcy
Validation of Predicted Value

Difference of Distribution between Bankruptcy and Non-Bankruptcy by Predicted Value in January 2002 (CCR MODEL)

Cut-off P Value = 0.013:
Sensitivity = 71.3%
Specificity = 73.7%

Logarithm of Predicted Value
Validation of Predicted Value

Difference of Distribution between Bankruptcy and Non-Bankruptcy by TDB Credit Rating in January 2002

Cut-off CR = 48:
Sensitivity = 62.47%
Specificity = 58.47%

Cut-off CR = 50:
Sensitivity = 70.85%
Specificity = 49.07%
Validation of Predicted Value

Change of Predicted Value of CCR MODEL
(20 bankruptcy cases in Feb 2002)

Liabilities in million JPY

a certain OTC company
Liab: 11,600 MM JPY

a certain OTC company
Liab: 30,581 MM JPY
Validation of Predicted Value

Distribution of Credit Rating
(Bankruptcy divided by predicted value range)

Predicted bankruptcies are more than 70% of actual bankruptcies.
Validation of Predicted Value

Distribution of Credit Rating
(Non-Bankruptcy divided by predicted value range)

Credit rating is low, but its bankruptcy risk is supposedly not so high...
Summary

- Predicted value derived from qualitative information would be able to discriminate between bankruptcy and non-bankruptcy accurately, compared to TDB’s credit rating.

- TDB’s corporate bankruptcy prediction model allows our customers to:
  - Evaluate both initial and ongoing credit
  - Cultivate new customer

- SAS allows us to develop models quickly.
  - 8 months for developing CCR MODEL after installing SAS due to Enterprise Miner and technical support.