Junk bonds: Money makers or money takers?

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1. Background & Aim of Research
2. Literature Study
3. Our Study
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   3.2 Macroeconomic factors
4. Application
5. South African Markets
6. Conclusion
Background of High-yield Bonds

“Despite their superior performance, high-yield bonds are seldom mentioned without pejoratives such as 'non-investment-grade,' 'speculative' or 'junk.' ... By creating a false perception of risk, they increase the returns investors receive.”

– Michael Milken, the “father” of junk bonds.
Background of High-yield Bonds

• “A high paying bond with a lower credit rating than investment-grade corporate bonds, Treasury bonds and municipal bonds.”*
  
  • Standard & Poor’s Rating BB+ or lower
  • Moody’s rating Ba1 or lower
  • Higher yields than investment grade bonds
  • Subordinate to conventional debt

• Largest junk bond market is in the USA

*Source: www.investopedia.com
Aim of Research

• Enable junk bond investors take sensible, calculated risks and still get a good night’s sleep

• Find objective predictors of default using:
  • Microeconomic factors:
    • Balance sheet and statement of income
    • Financial ratios
  • Macroeconomic factors

• Create models that give probability of future default

• Results in the context of South African markets
Literature Study
Previous studies – general credit default

• Linked single financial ratio to default – Beaver (1966)
  • Conventional ratios were “window dressed”
    
    $\text{Ratio} \rightarrow \% \text{ Default}$
    
    e.g. Cash flow to debt ratio

• Well-known Z-score model – Altman (1968)
  • Used a combination of financial ratios
    
    $\begin{align*}
    \text{Ratio} \\
    \text{Ratio} \\
    \text{Ratio}
    \end{align*}$
    
    $\rightarrow \% \text{ Default}$
Literature Study
Previous studies - general credit default

• Credit ratings – Hilscher and Wilson (2010)
  • Financial ratios vs. pure credit ratings
• Suggest that rating agencies:
  • Respond slowly to new information
  • Do not have the sole objective of making accurate default predictions

\[ \text{Credit ratings} \quad \xrightarrow{\text{No}} \quad \% \text{ Default} \]
Literature Study
Previous studies – Junk bond specific

• Data at time of issue – Huffman & Ward (1996)
  • Regression analysis using financial ratios

\[ \text{Cash flows at issue} \rightarrow \% \text{ Default} \]

  • More accurate predictions

\[ \text{Recent cash flows} \rightarrow \% \text{ Default} \]
\[ \text{Recent ratios} \]
Literature Study
Other methods

• Merton model
  • Notional exercise of put-option representing risk of default

• Moody’s KMV Model
  • Equity based method which extends Black-Scholes-Merton framework

• Competing risks hazard model
  • Bond-age, issue specific characteristics and economic conditions simultaneously taken into account
Literature Study
Actuarial context

Junk bonds in investment portfolios - Paul Sweeting (2002)
Literature Study
Actuarial context

• Credit risk playing a bigger role in actuarial profession
  • 2008 economic crisis
  • Risk management in investment context
  • Opportunities

• M.A.R.C model - Miccoci (2000)
  • Stochastic simulation used to determine credit risk
  • Link between Actuarial Science and Credit industry
Literature Study

Insights

• Missing in previous studies
  • Credit ratings were not significant individually
  • What if they were used in conjunction with financial ratios?
  • Macroeconomic variables were never considered
Our Study

• Aim – Find objective predictors of default

• Microeconomic factors
  • Sampling
  • Preliminary analysis
  • Methodology
  • Results

• Macroeconomic factors
  • NGDP, RGDP, UMICS
  • Aggregate default rates
Our Study – Microeconomic Factors Sampling

- Data from US junk bond markets
  - Altman reports
  - Bond exchange-trader funds
- 102 different companies
  - 52 defaulted
  - 50 non-defaulted
- Similar credit ratings combined
Our Study – Microeconomic Factors
Sampling

- Definition of default used in Altman reports:
  - Missed interest or capital payment
  - Bankruptcy
  - Regulatory directive
  - Distressed exchange
### Our Study – Microeconomic Factors Sampling

#### Excerpt of our data

<table>
<thead>
<tr>
<th>Name</th>
<th>Default</th>
<th>S/P</th>
<th>Sector</th>
<th>Date of default</th>
<th>Issue Amount</th>
<th>Statement Year</th>
<th>Cash</th>
<th>Accounts Receivable</th>
<th>Current Assets</th>
<th>Total assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Builders FirstSource</td>
<td>Yes</td>
<td>CCC</td>
<td>Forest Products</td>
<td>2010/01/21</td>
<td>270</td>
<td>2010</td>
<td>103.2</td>
<td>55.6</td>
<td>235.4</td>
<td>412.8</td>
</tr>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
<td>2009</td>
<td></td>
<td>84.1</td>
<td>60.7</td>
<td>240.3</td>
<td>435</td>
<td>...</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td>2008</td>
<td></td>
<td>107</td>
<td>85</td>
<td>311</td>
<td>521.1</td>
<td>...</td>
</tr>
</tbody>
</table>

From the data we can calculate our ratios (2010):

- Net working capital: 0.38
- Return on assets: -0.23
- Debt ratio: 0.46
- Etc.
## Our Study – Microeconomic Factors
### Preliminary analysis

<table>
<thead>
<tr>
<th>2 years prior to 2010</th>
<th>Ratings</th>
<th>B and above</th>
<th>CCC or below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defaulted</td>
<td>13%</td>
<td>87%</td>
<td></td>
</tr>
<tr>
<td>Non-defaulted</td>
<td>78%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 year prior to 2010</th>
<th>Ratings</th>
<th>B and above</th>
<th>CCC or below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defaulted</td>
<td>10%</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Non-defaulted</td>
<td>78%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

- Fairly high percentage of poorly rated, non-defaulted debt
- Results corresponds with Hilscher and Wilson study
Our Study – Microeconomic Factors

Preliminary analysis

• T-test used to determine significant differences in means

• Items that were significantly different between defaults and non-defaults:
  • Total assets
  • Total Equity
  • Earnings before interest and tax (EBIT)
  • Net Income
  • Operating Cash flows
Our Study – Microeconomic Factors

Methodology

- Type of ratios & variables (52) used:
  - Credit ratings
  - Cash flows
  - Liquidity
  - Efficiency
  - Profitability
  - Leverage
  - Size

- Regression analysis used to determine the probability of default
  - Multivariate logistic regression
  - Purposeful selection of covariates
Our Study – Microeconomic Factors
Methodology

- 4 models developed in total

<table>
<thead>
<tr>
<th></th>
<th>Predicts default in a year</th>
<th>Predicts default in 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes credit ratings</td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>Excludes credit ratings</td>
<td>Model 3</td>
<td>Model 4</td>
</tr>
</tbody>
</table>
Our Study – Microeconomic Factors

Results

- Model 3: \( \ln \left( \frac{\vartheta}{1-\vartheta} \right) = 17.9995 - 22.0935 \text{BEPR} - 1.7696 \text{LNTA} - 0.9715 \text{LNTA}_{\text{TETA}} + 5.4392 \text{CFOSALES} - 43.0116 \text{CFOTA} + 3.1164 \text{RETA} \)

- Where \( \vartheta \) is the probability of default

<table>
<thead>
<tr>
<th>Ratio/Variable</th>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEPR</td>
<td>EBIT/Total Assets</td>
<td>Basic Earnings Power Ratio</td>
</tr>
<tr>
<td>LNTA</td>
<td>ln(Total Assets)</td>
<td></td>
</tr>
<tr>
<td>CFOSALES</td>
<td>Operating Cash Flows/Revenues</td>
<td></td>
</tr>
<tr>
<td>CFOTA</td>
<td>Operating Cash Flows/Total Assets</td>
<td></td>
</tr>
<tr>
<td>RETA</td>
<td>Retained Earnings/Total Assets</td>
<td></td>
</tr>
<tr>
<td>TETA</td>
<td>Total Equity/Total Assets</td>
<td></td>
</tr>
<tr>
<td>LNTA_TETA</td>
<td>LNTA \times TETA</td>
<td></td>
</tr>
</tbody>
</table>

- All variables were significant within the 10\% level
Our Study – Microeconomic Factors

Results

- Significant ratios consisted of:
  - EBIT*
  - Total assets*
  - Total equity*
  - Operating cash flows*
  - Short term debt
  - Retained earnings
  - EBITDA

  e.g. The basic earnings power ratio: \( \frac{EBIT}{Total \text{ assets}} \)

- Current ratio, Debt ratio, Return on equity

- Consistent with Beaver’s study suggesting that well-known ratios are “window dressed”
## Our Study – Microeconomic Factors

### Results

<table>
<thead>
<tr>
<th>$R^2$</th>
<th>Predicts default in a year</th>
<th>Predicts default in 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes credit ratings</td>
<td>Model 1: 67.4%</td>
<td>Model 2: 59.3%</td>
</tr>
<tr>
<td>Excludes credit ratings</td>
<td>Model 3: 64.7%</td>
<td>Model 4: 50.8%</td>
</tr>
</tbody>
</table>

- Including credit ratings increases the $R^2$
Our Study – Macroeconomic Factors

- Do they affect default?
- Aggregate junk bond default rates from 2000 – 2010
- Indicators of state of economy
  - Nominal and real GDP growth
  - University of Michigan Index of Consumer Sentiment (UMICS)
Our Study – Macroeconomic Factors

- UMICS Index Value/100
- Real GDP Growth
- Nominal GDP Growth
- Aggregate Default Rate

Year

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

%
Our Study – Macroeconomic Factors
Integration with microeconomic factors

- Nominal GDP growth and UMICS were correlated with aggregate default
  - 70% of variation explained
- Integrate macro with previous micro model
- Acquired additional information for 33 companies over 2000-2010
- A viable model could not be obtained
  - Macroeconomic factors vs. ratios in the long term
Our Study
Application of model

Goodyear Tire and Rubber

(All monetary amounts are in millions)

<table>
<thead>
<tr>
<th>Financial data one year prior to 2010</th>
<th>Financial data two years prior to 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td>Total Assets</td>
</tr>
<tr>
<td>15630</td>
<td>15226</td>
</tr>
<tr>
<td>Shareholders’ Equity</td>
<td>PPE</td>
</tr>
<tr>
<td>921</td>
<td>5634</td>
</tr>
<tr>
<td>Revenues</td>
<td>Shareholders’ Equity</td>
</tr>
<tr>
<td>18832</td>
<td>1022</td>
</tr>
<tr>
<td>Interest Expense</td>
<td>Interest Expense</td>
</tr>
<tr>
<td>316</td>
<td>320</td>
</tr>
<tr>
<td>Tax</td>
<td>Depreciation &amp; Amortisation</td>
</tr>
<tr>
<td>172</td>
<td>660</td>
</tr>
<tr>
<td>Net Income</td>
<td>Tax</td>
</tr>
<tr>
<td>-216</td>
<td>209</td>
</tr>
<tr>
<td>EBIT</td>
<td>Net Income</td>
</tr>
<tr>
<td>272</td>
<td>-77</td>
</tr>
<tr>
<td>Retained Earnings</td>
<td>EBIT</td>
</tr>
<tr>
<td>866</td>
<td>452</td>
</tr>
<tr>
<td>Operating Cash Flows</td>
<td>EBITDA</td>
</tr>
<tr>
<td>924</td>
<td>1112</td>
</tr>
</tbody>
</table>

- Model 3 predicts a probability of default of 8.3% in 2010.
- In 2010, Goodyear Tire and Rubber did not default.
## Our Study
Application of model

**Xerium Technologies Inc.**

(All monetary amounts are in millions)

<table>
<thead>
<tr>
<th></th>
<th>Financial data one year prior to 2010</th>
<th>Financial data two years prior to 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Assets</strong></td>
<td>693.5</td>
<td>818.1</td>
</tr>
<tr>
<td><strong>Shareholders’ Equity</strong></td>
<td>-119.7</td>
<td>PPE</td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>500.1</td>
<td>Shareholders’ Equity -27.6</td>
</tr>
<tr>
<td><strong>Interest Expense</strong></td>
<td>68.5</td>
<td>Interest Expense 60.3</td>
</tr>
<tr>
<td><strong>Tax</strong></td>
<td>12.3</td>
<td>Depreciation &amp; Amortisation 46</td>
</tr>
<tr>
<td><strong>Net Income</strong></td>
<td>-112</td>
<td>Tax 3.9</td>
</tr>
<tr>
<td><strong>EBIT</strong></td>
<td>-31.2</td>
<td>Net Income 26.6</td>
</tr>
<tr>
<td><strong>Retained Earnings</strong></td>
<td>-330.9</td>
<td>EBIT 90.8</td>
</tr>
<tr>
<td><strong>Operating Cash Flows</strong></td>
<td>16.1</td>
<td>EBITDA 136.8</td>
</tr>
</tbody>
</table>

- Model 3 predicts a probability of default of 99.8% in 2010.
- In 2010, Xerium Technologies defaulted.
South African markets

- Relatively underdeveloped
- Bank lending thought to be more popular form of funding in the past
- 1st junk bond issues off-shore - 2005
- Few domestic junk bonds
  - Almost all trading at discount
  - Indicative of default risk
  - Not enough to create diversified portfolio
- Our model is not suitable for the SA market
Conclusions

Our results

• Important ratios consist of: EBIT, total assets, operating cash flows
  • Consistent with Huffman and Ward study

• Credit ratings in conjunction with ratios enhances accuracy
  • Contrasts Hilscher and Wilson study

• Model strength: high percentage of variation explained in short term by model

• Model weakness: macroeconomic fluctuation in the long term

• Consumer sentiment index correlated with default rates
Conclusions
Suggestions for further research

- More data
  - Strenuous data capture exercise
  - Limitations

- Correlations between consumer indices and default rates
  - Subjective sources have some credibility

- Integrating ratios with macroeconomic variables
  - Access to data set that spans a number of years required
### Questions

<table>
<thead>
<tr>
<th>Fuxun Xia</th>
<th>Wayron Lewis</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:FuxunX@assupol.co.za">FuxunX@assupol.co.za</a></td>
<td><a href="mailto:walewis@deloitte.co.za">walewis@deloitte.co.za</a></td>
</tr>
</tbody>
</table>
Details of model

- **Model 1**: \( \ln \left( \frac{\theta}{1-\theta} \right) = 15.0025 + 2.0468 \Theta - 51.9534 \text{BEPR} - 1.7463 \text{LNTA} + 50.6348 \text{EBITDATA} - 3.3867 \Psi - 0.6452 \text{EBITINT} \)

- **Model 2**: \( \ln \left( \frac{\theta}{1-\theta} \right) = 13.9078 + 1.4690 \Theta - 1.3327 \Psi - 1.6499 \text{LNTA} + 1.1774 \text{STDEBT} \)

- **Model 3**: \( \ln \left( \frac{\theta}{1-\theta} \right) = 17.9995 - 22.0935 \text{BEPR} - 1.7696 \text{LNTA} - 0.9715 \text{LNTA}_\text{TETA} + 5.4392 \text{CFOSALES} - 43.0116 \text{CFOTA} + 3.1164 \text{RETA} \)

- **Model 4**: \( \ln \left( \frac{\theta}{1-\theta} \right) = 9.9247 - 30.9643 \text{BEPR} - 1.3580 \text{LNTA} + 0.1183 \text{TAE} + 31.7967 \text{EBITDATA} - 0.1551 \text{TAE}_\text{PPETA} \)
<table>
<thead>
<tr>
<th>Ratio/Variable</th>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATINGBB</td>
<td></td>
<td>S&amp;P rating in the BB category</td>
</tr>
<tr>
<td>RATINGCC</td>
<td></td>
<td>S&amp;P rating in the CC category</td>
</tr>
<tr>
<td>EBIT</td>
<td></td>
<td>Earnings Before Interest &amp; Tax</td>
</tr>
<tr>
<td>EBITINT</td>
<td>EBIT/Interest Expense</td>
<td>TIE Ratio</td>
</tr>
<tr>
<td>BEPR</td>
<td>EBIT/Total Assets</td>
<td>Basic Earnings Power Ratio</td>
</tr>
<tr>
<td>STDEBTE</td>
<td>Short Term Debt/Shareholders' Equity</td>
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</tr>
<tr>
<td>LNTA</td>
<td>ln(Total Assets)</td>
<td></td>
</tr>
<tr>
<td>CFOSALES</td>
<td>Operating Cash Flows/Revenues</td>
<td></td>
</tr>
<tr>
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<td>Operating Cash Flows/Total Assets</td>
<td></td>
</tr>
<tr>
<td>RETA</td>
<td>Retained Earnings/Total Assets</td>
<td></td>
</tr>
<tr>
<td>TAE</td>
<td>Total Assets/Shareholders' Equity</td>
<td></td>
</tr>
<tr>
<td>EBITDA</td>
<td>EBIT + Depreciation &amp; Amortisation</td>
<td>Earnings Before Interest, Tax, Depreciation &amp; Amortisation</td>
</tr>
<tr>
<td>EBITDATA</td>
<td>EBITDA/Total Assets</td>
<td></td>
</tr>
<tr>
<td>PPE</td>
<td>Property, Plant &amp; Equipment</td>
<td></td>
</tr>
<tr>
<td>PPETA</td>
<td>PPE/Total Assets</td>
<td></td>
</tr>
<tr>
<td>TAE_PPETA</td>
<td>TAE × PPETA</td>
<td></td>
</tr>
<tr>
<td>TETA</td>
<td>Total Equity/Total Assets</td>
<td></td>
</tr>
<tr>
<td>LNTA_TETA</td>
<td>LNTA × TETA</td>
<td></td>
</tr>
</tbody>
</table>
References

References


  <http://www.actuaries.org/ASTIN/Colloquia/Porto_Cervo/Micocci.pdf>

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