# 7. FACTORS THAT AFFECT CREDIT RATING: AN APPLICATION OF ORDERED PROBIT MODELS[1]

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## Abstract

*Corporate credit ratings have become more important after the 2008 financial crisis. To explore the mystery, we employ the ordered probit regression models to examine the relationship between the credit rating and financial ratios in electric utilities, chemicals and communications equipment companies whose credits were rated by the S&P between 2006 and 2010 in North America. Consistent with prior research, we show that credit ratings are positively related to EBITDA interest coverage, return on assets and total assets while negatively related to debt ratio and cash to current liabilities ratio. Furthermore, we show that all the models over-predict the low rating categories while under-predict the high rating categories. The result of our model is among the best in terms of predictive power.*

**Keywords:** ordered probit regression model; credit rating; financial ratios; 2008 financial crisis; Standard&Poor

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## 1. Introduction

The 2007 global financial crisis ushered in critics that focus on credit rating agencies that failed to accurately measure the credit risk of companies, such as Lehman

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Brothers Holdings Inc. Before Lehman Brothers Holdings Inc. (LBHI) declared bankruptcy in 2008, Standard&Poor (S&P) awarded LBHI the credit rating of an A. This misclassification phenomenon shows that credit rating early warning mechanism simply did not work.

Without doubt, credit rating has played an important role in the pricing of credit-risky instruments and asset allocation decisions (Amato&Furfine, 2004). Prior studies on credit ratings tended to focus on bond ratings or issue ratings. Some examined whether ratings measure what they were supposed to measure (Hickman, 1958; Ang&Patel, 1975; Kuo&Wu, 1990). Others examined whether bond ratings contained information beyond what was publicly available. However, empirical tests indicated mixed results (Katz, 1974; Grier&Katz, 1976; Weinstein, 1977; Wakeman, 1978; Ingram *et al*., 1983; Hand *et al*., 1992). Others analyzed how the rating agencies used public information in setting bond ratings (Horrigan, 1966; Pogue and Soldofsky, 1969; West, 1970; Pinches&Mingo, 1973, 1975; Altman&Katz, 1976; Kaplan&Urwitz, 1979; Ederington, 1985; Blume *et al*., 1988; Gentry, Whitford&Newbold, 1988; Bhojraj&Sengupta, 2003; Chan&Jegadeesh, 2004).

Analyses in most of credit rating studies concentrate on bond ratings or issue ratings; however, corporate credit ratings (or issuer ratings) have become more and more important after the 2008 financial crisis. Thus, we are interested in explaining ratings of firms, as these are the purest measure of default risk. It is reasonable to hypothesize that the financial ratios of a company are connected with its credit rating.

## 2. The Ordered Probit Models

Because of the discrete and ordering nature of the dependent variable in this study, ordinary least squares regression would be an inappropriate model (Mckelvey and Zavoina, 1975; Ederington, 1985; Yang&Raehsler, 2005). Therefore, we follow Amato&Furfine (2004) and Blume *et al*. (1988) by using the ordered probit model in our empirical analysis.

Define $R_{it}$ to be the credit rating category of company $i$ in year $t$. $R_{it}$ is continuous and its range is the set of real numbers. The ordered probit model consists of two parts. The first part maps the rating categories $R_{it}$ into a partition of the unobserved linking variable $R_{it}^*$, as follow:

$$R_{it} = \begin{cases} 1 & \text{if } R_{it}^* \le \mu_1 \\ 2 & \text{if } \mu_1 < R_{it}^* \le \mu_2 \\ 3 & \text{if } \mu_2 < R_{it}^* \le \mu_3 \\ 4 & \text{if } \mu_3 < R_{it}^* \le \mu_4 \\ 5 & \text{if } R_{it}^* \ge \mu_4 \end{cases}$$

where: $\mu_r \quad r = 1,2,3,4$ are threshold variables that define the partitions of the range of $R_{it}^*$ associated with each value of a rating and independent of $t$. That is, $R_{it}$ is

assigned the value of 5 if company $i$ in year $t$ has a rating by S&P of 5 if AAA or AA, 4 if A, 3 if BBB, 2 if BB, 1 if B or below.

The second part of the ordered probit model relates $R_{it}^{*}$'s to the observed variables that measure the business and financial risk of company $i$ by means of a linear model.

$$R_{it}^{*} = \beta' X_{it} + \varepsilon_{it}$$

where: $\beta$ is the vector of slope coefficients of explanatory variables. $X_{it}$ is vectors of observed explanatory variables measured at year $t$. The random variable $\varepsilon_i$ is an unobserved error term with standard normal distribution and constant variance.

We suppose that credit rating agencies are referred to the annual balance sheet to measure the credit rating of a firm. Therefore, there is linkage between a company's financial ratios of one year and credit rating of next year due to a company's report of their annual balance sheet in the April of next year. As a result, we use financial ratios of year $t-1$ as explanatory variables, while the credit rating of year $t$ as dependent variables.

From the slope parameter and threshold estimates, it is relatively straightforward to calculate the probability of a company falling into rating $r$. Given the cumulative normal function $\Phi(\beta' X)$, the probability of obtaining credit rating that a company will receive can be as below:

$$\Pr(R=r) = \begin{cases} \Phi(\mu_r - \beta' X) & \text{if } r = 1 \\ \Phi(\mu_r - \beta' X) - \Phi(\mu_{r-1} - \beta' X) & \text{if } r = 2,3,4 \\ 1 - \Phi(\mu_{r-1} - \beta' X) & \text{if } r = 5 \end{cases}$$

where: $\beta' X$ is a set of specific values of $X$ for the estimated coefficients $\beta$ and the threshold values $\mu$'s.

We could detect the influence of financial ratios on credit ratings by calculating the marginal effects of the explanatory variables on the probability of ratings (Yang&Raehsler, 2005). For example, the marginal effect of *TDTA* on the probability of rating A is:

$$\frac{\partial \Pr(R=4)}{\partial TDTA} = [\Phi(\mu_3 - \beta' X) - \Phi(\mu_4 - \beta' X)] \times \beta_2$$

One should notice that the sum of the marginal effect equals zero.

## 3. Data and Variables

The source of our data on financial ratios and issuer ratings is the S&P COMPUSTAT-North America database. We examine utility (SIC code 2800-2899), chemical (SIC code 4800-4899) and telecom service (SIC code 4900-4999) firms rated by the S&P between 2006 and 2009 in North America. We follow Amato&Furfine (2004) to group firms into rating categories without consideration of notches (i.e. + or -) and eliminate

observations with a D or SD rating. The firms which received a rating AAA or AA are assigned a value of 5, A of 4, BBB of 3, BB of 2 and others of 1.

The definitions of independent variables are summarized in Table 1. S&P takes into account both business risk and financial risk in its new rating methodology (Standard&Poor's, 2008). In this study, four key indicators were considered to capture financial risk: cash flow, capital structure, short-term liquidity, and long-term liquidity, while three key indicators were used to capture business risk: industry factors, profitability and competitive position. We follow Blume *et al*. (1988), Amato&Furfine (2004) and Ashbaugh-Skaife *et al*., (2006) to measure the firm's size by the natural logarithm of total assets.

## 4. Empirical Model and Estimation Results

Our study considers following four ordered probit models, as shown below.
**Model 1**. Cross-sectional ordered probit model
**Model 2.** Pooled ordered probit model
**Model 3.** Panel ordered probit model with time dummies (fixed effect)

**Table 1**

**Table 1 Variable Definitions**

| Variables (Notation) | Formula | Predic-ted sign | Definitions and interpretation |
|---|---|---|---|
| Cash flow | | | |
| Free cash flow (FCF) | cash flows from operations-capital expenditures | + | Free cash flow represents the cash that a company is able to generate after laying out the money required to maintain or expand its asset base. |
| Cash turnover (CT) | $\frac{\text{sales revenue}}{\text{average cash balance}}$ | ? | This ratio measures how effectively company is using cash assets for generation of sales revenue. |
| Capital structure | | | |
| Debt ratio (TDTA) | $\frac{\text{total debt}}{\text{total assets}}$ | - | Leverage is direct measure of the magnitude of a firm's debt obligations (Ashbaugh-Skaife et al., 2006). |
| Fixed ratio (FACE) | $\frac{\text{fixed assets}}{\text{common equity}}$ | ? | Financial leverage increases the risk of a company in that debt leads to fixed costs. |
| Short-term liquidity | | | |
| Working capital (WC) | current assets - current liabilities | + | It measures the capability of a firm to disburse maturing short-term debt and upcoming operational expenses. |
| Cash to current liabilities ratio (CCL) | $\frac{\text{cash}}{\text{current liabilities}}$ | ? | This ratio is useful for determining the ability of a company to meet its short-term liability obligations. |
| Receivable turnover (RT) | $\frac{\text{net sales}}{\text{average accounts receivable}}$ | ? | It measures the number of times receivables are collected during the period and determines how quickly a company collects outstanding cash balances from its customers. |

| Variables (Notation) | Formula | Predic-ted sign | Definitions and interpretation |
|---|---|---|---|
| Days to pay account payable (DPAP) | $\frac{\text{average accounts payable} \times 365}{\text{total purchases}}$ | ? | The average number of days a company takes to pay its bills, used as a measure of how much it depends on trade credit for short-term financing. |
| Long-term liquidity | | | |
| Debt to EBITDA ratio (TDEBI) | $\frac{\text{total debt}}{\text{EBITDA}}$ | - | It is one of key ratios of S&P's (2008) credit ratings analysis and measures debt repayment capacity of issuers. |
| EBITDA interest coverage(EBTIC) | $\frac{\text{EBITDA}}{\text{interest expenses}}$ | + | Standard & Poor (2008) used this ratio as debt service ratio and one of key ratios of credit ratings analysis. |
| Industry factors | | | |
| Chemicals ($d_1$) | | | It reflects the external business and operating environment of a company in the chemical industry. (dummy variable) |
| Electric utility & communications equipment ($d_2$) | | | It reflects the external business and operating environment of a company in the electric utility and communications equipment industries. (dummy variable) |
| Beta of the CAPM (BETA) | | - | The beta of the Capital Assets Pricing Model (CAPM) measuring the systematic business risk (Amato & Furfine, 2004; Blume et al., 1988). |
| Profitability | | | |
| Return on assets (ROA) | $\frac{\text{net income}}{\text{total assets}}$ | + | It is an indicator of how effectively a company's assets are being used to generate earnings before contractual obligations must be paid (Ashbaugh-Skaife et al., 2006). |
| Dividend payout ratio (DP) | $\frac{\text{dividend per equity share} \times 100}{\text{earnings per share}}$ | ? | It provides an idea of how well earnings support the dividend payments. More mature companies tend to have a higher payout ratio. |
| Competitive position | | | |
| Total Assets (lnTA) | $\ln(\text{total assets})$ | + | Larger companies could benefit from economies of scale and diversification, thus facing lower risk (Blume et al., 1988; Amato & Furfine, 2004; Standard & Poor's, 2008). |
| Time (dummy variable) | | | |
| Year t ($T_t$) | $t = 2005, 2006, 2007$ | | |

**Model 4.** First difference ordered probit model[6]

Estimates of the model 1 covering the years 2006 through 2009 are presented in Table 2. Besides, we report marginal effect of explanatory variables on credit ratings in 2006 and 2009 in Table 3. The marginal effects via normal density function measure the change in the probability of obtaining a credit rating for a one standardized unit change in each financial ratio while holding the firm characteristics at their mean vales. The results of Table 2 reveal that most of the coefficients on cash flow, capital structure, profitability and competitive position characteristics have the correctly predicted signs. Consistent with prior research (Blume *et al*., 1988; Amato&Furfine, 2004; Ashbaugh-Skaife *et al*., 2006), we find that credit ratings are positively related to *EBITDA interest coverage*, *return on assets* and *total assets*. Regardless of whether S&P changed the rating standards, *return on assets* and *total assets* are always associated with S&P's credit ratings significantly. An examination of Table 3 indicates that larger *total assets* companies improve their chances of getting an A (7.8452%), BBB (5.9326%), AAA or AA (0.4006%) credit rating in 2006. However, the marginal effects of *total assets* on A (6.2999%) and AAA or AA (0.2494%) in 2009 are smaller than in 2006. Besides, as *return on assets* increase, probabilities of receiving A, BBB, and AAA or AA credit rating are expected to increase by 2.0622 percent, 1.5594 percent, and 0.1053 percent, respectively. Similarly, the marginal effects of *return on assets* on BBB (0.9889%), A (0.6227%) and AAA or AA (0.0246%) in 2009 are smaller than in 2006. It implies that after the global financial crisis the credit agencies were more rigorous in using *total assets* and *return on assets* to assess a firm's credit rating.

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[6] *Model 1:*

$$R_i^* = \beta_1 \ln TA_i + \beta_2 TDTA_i + \beta_3 TDEBI_i + \beta_4 ROA_i + \beta_5 FCF_i + \beta_6 CT_i + \beta_7 WC_i + \beta_8 EBTIC_i + \beta_9 CCL_i + \beta_{10} FACE_i + \beta_{11} BETA_i + \beta_{12} RT_i + \beta_{13} DP_i + \beta_{14} DPAP_i + \beta_{15} d_1 + \beta_{16} d_2 + \varepsilon_i$$

*Model 2:*

$$R_{it+1}^* = \beta_1 \ln TA_{it} + \beta_2 TDTA_{it} + \beta_3 TDEBI_{it} + \beta_4 ROA_{it} + \beta_5 FCF_{it} + \beta_6 CT_{it} + \beta_7 WC_{it} + \beta_8 EBTIC_{it} + \beta_9 CCL_{it} + \beta_{10} FACE_{it} + \beta_{11} BETA_{it} + \beta_{12} RT_{it} + \beta_{13} DP_{it} + \beta_{14} DPAP_{it} + \beta_{15} d_1 + \beta_{16} d_2 + \varepsilon_{it}$$

*Model 3:*

$$R_{it+1}^* = \beta_1 \ln TA_{it} + \beta_2 TDTA_{it} + \beta_3 TDEBI_{it} + \beta_4 ROA_{it} + \beta_5 FCF_{it} + \beta_6 CT_{it} + \beta_7 WC_{it} + \beta_8 EBTIC_{it} + \beta_9 CCL_{it} + \beta_{10} FACE_{it} + \beta_{11} BETA_{it} + \beta_{12} RT_{it} + \beta_{13} DP_{it} + \beta_{14} DPAP_{it} + \beta_{15} d_1 + \beta_{16} d_2 + \beta_{17} T_{2005} + \beta_{18} T_{2006} + \beta_{19} T_{2007} + \varepsilon_{it}$$

*Model 4:*

$$\Delta R_{it}^* = \beta_1 \Delta \ln TA_{it} + \beta_2 \Delta TDTA_{it} + \beta_3 \Delta TDEBI_{it} + \beta_4 \Delta ROA_{it} + \beta_5 \Delta FCF_{it} + \beta_6 \Delta CT_{it} + \beta_7 \Delta WC_{it} + \beta_8 \Delta EBTIC_{it} + \beta_9 \Delta CCL_{it} + \beta_{10} \Delta FACE_{it} + \beta_{11} \Delta BETA_{it} + \beta_{12} \Delta RT_{it} + \beta_{13} \Delta DP_{it} + \beta_{14} \Delta DPAP_{it} + \beta_{15} d_1 + \beta_{16} d_2 + \varepsilon_{it}$$

$$\text{where } \Delta R_{it} = \begin{cases} -1, & \Delta R_{it}^* \le \mu_1 \\ 0, & \mu_1 < \Delta R_{it}^* < \mu_2 \\ 1, & \mu_2 < \Delta R_{it}^* \end{cases}$$

**Table 2**

**Estimated Results of the Ordered Probit Model- Model 1**

| Years / Variables | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Cash flow | | | | |
| Free cash flow | 0.000254*** (4.4321) | 0.000210*** (4.0411) | 0.000196** (3.0206) | 0.000136* (2.4426) |
| Cash turnover | 0.000095 (0.5724) | 0.000098 (0.4298) | 0.001434 (1.0136) | 0.004039** (2.6644) |
| Capital structure | | | | |
| Debt ratio | 0.021607*** - (-3.7653) | -0.011406* (-1.9919) | -0.020319** (-2.8837) | -0.021173*** (-3.6422) |
| Fixed ratio | 0.017067 (0.6351) | -0.012260 (-0.4156) | 0.013388 (0.3364) | 0.001289 (0.3013) |
| Short-term liquidity | | | | |
| Working capital | 0.000077*** (3.3002) | 0.000043 (1.7040) | 0.000067* (2.3461) | 0.000016 (1.0189) |
| Cash to current liabilities ratio | -0.007362*** (-3.9292) | -0.004677* (-2.4249) | -0.007444** (-3.2725) | -0.006276** (-2.6749) |
| Receivable turnover | -0.034212* (-2.4636) | -0.014994 (-1.2038) | -0.016223 (-1.1589) | -0.046331** (-2.6704) |
| Days to pay account payable | 0.000572 (0.3360) | -0.000766 (-0.5841) | 0.002228* (2.1142) | 0.001994 (1.0511) |
| Long-term liquidity | | | | |
| Debt to EBITDA ratio | -0.026352* (-2.2450) | -0.063707* (-2.4076) | 0.000884 (0.8002) | -0.018398*** (-3.3458) |
| EBITDA interest coverage | 0.000415** (2.8768) | 0.001977 (0.9785) | 0.011388** (2.6150) | 0.016320* (2.2865) |
| Industry factors | | | | |
| Chemicals | -0.352753 (-1.5499) | -0.344374 (-1.5505) | -0.386741 (-1.7194) | -0.427514* (-1.9641) |
| Electric utility & communications equipment | -0.856780*** (-4.0991) | -1.103839*** (-4.8501) | -1.212603*** (-5.0744) | -0.892559*** (-3.8741) |
| Beta of the CAPM | -0.001269*** (-6.9216) | -0.000634*** (-4.5746) | 0.000104 (1.1581) | 0.000130 (0.8148) |
| Profitability | | | | |
| Return on assets | 0.096710*** (5.7180) | 0.066357*** (3.2954) | 0.052797*** (3.6065) | 0.043049** (3.1039) |
| Dividend payout ratio | 0.001384 (1.6004) | -0.000414 (-0.8238) | 0.002192** (2.7068) | 0.000914 (0.7944) |
| Short-term liquidity | | | | |
| Total Assets | 0.367917*** (4.4872) | 0.416970*** (5.1232) | 0.448443*** (5.2398) | 0.435542*** (5.2621) |
| $\mu_1$ | 0.273484 (0.3389) | 1.167688 (1.4411) | 1.419874 (1.6016) | 1.039514 (1.1680) |
| $\mu_2$ | 1.612786 (1.9481) | 2.317802** (2.7646) | 2.693476** (2.9614) | 2.075612* (2.3114) |
| $\mu_3$ | 2.949809*** (3.4149) | 3.599822*** (4.0759) | 4.173490*** (4.3585) | 3.783735*** (4.0197) |
| $\mu_4$ | 4.559634*** (4.8482) | 5.012967*** (5.2401) | 5.652264*** (5.4884) | 5.300159*** (5.2872) |
| Pseudo R-squared | 0.345364 | 0.298424 | 0.345828 | 0.363805 |
| Sample size | 245 | 250 | 252 | 262 |

*Notes: ***, **, * indicate significance at the 0.01, 0.05, and 0.10 level or better, respectively.*

**Table 3**

**Marginal Effects of Cross-Sectional Ordered Probit Model- 2006 (2009)[1]**

| Marginal Probability / Variables | B or below B | BB | BBB | A | AAA or AA |
|---|---|---|---|---|---|
| Cash flow | | | | | |
| Free cash flow | -0.0028% (-0.0022%) | -0.0070% (-0.0030%) | 0.0041% (0.0031%) | 0.0054% (0.0020%) | 0.0003% (0.0001%) |
| Cash turnover | -0.0011% (-0.0650%) | -0.0026% (-0.0885%) | 0.0015% (0.0928%) | 0.0020% (0.0584%) | 0.0001% (0.0023%) |
| Capital structure | | | | | |
| Debt ratio | 0.2387% (0.3408%) | 0.5939% (0.4639%) | -0.3484% (-0.4864%) | -0.4607% (-0.3063%) | -0.0235% (-0.0121%) |
| Fixed ratio | -0.1886% (-0.0208%) | -0.4691% (-0.0283%) | 0.2752% (0.0296%) | 0.3639% (0.0187%) | 0.0186% (0.0007%) |
| Short-term liquidity | | | | | |
| Working capital | -0.0008% (-0.0003%) | -0.0021% (-0.0004%) | 0.0012% (0.0004%) | 0.0016% (0.0002%) | 0.0001% (0.0000%) |
| Cash to current liabilities ratio | 0.0813% (0.1010%) | 0.2024% (0.1375%) | -0.1187% (-0.1442%) | -0.1570% (-0.0908%) | -0.0080% (-0.0036%) |
| Receivable turnover | 0.3780% (0.7458%) | 0.9404% (1.0152%) | -0.5517% (-1.0643%) | -0.7295% (-0.6702%) | -0.0372% (-0.0265%) |
| Days to pay account payable | -0.0063% (-0.0321%) | -0.0157% (-0.0437%) | 0.0092% (0.0458%) | 0.0122% (0.0288%) | 0.0006% (0.0011%) |
| Long-term liquidity | | | | | |
| Debt to EBITDA ratio | 0.2912% (0.2962%) | 0.7244% (0.4031%) | -0.4249% (-0.4226%) | -0.5619% (-0.2661%) | -0.0287% (-0.0105%) |
| EBITDA interest coverage | -0.0046% (-0.2627%) | -0.0114% (-0.3576%) | 0.0067% (0.3749%) | 0.0088% (0.2361%) | 0.0005% (0.0093%) |
| Industry factors | | | | | |
| Chemicals | 4.3405% (7.6123%) | 9.3879% (8.8493%) | -6.3522% (-10.6248%) | -7.0425% (-5.6278%) | -0.3337% (-0.2091%) |
| Electric utility & communications equipment | 12.2680% (17.8193%) | 20.6915% (16.2753%) | -16.5414% (-23.0184%) | -15.6627% (-10.6673%) | -0.7554% (-0.4089%) |
| Beta of the CAPM | 0.0140% (-0.0021%) | 0.0349% (-0.0029%) | -0.0205% (0.0030%) | -0.0271% (0.0019%) | -0.0014% (0.0001%) |
| Profitability | | | | | |
| Return on assets | -1.0686% (-0.6930%) | -2.6583% (-0.9433%) | 1.5594% (0.9889%) | 2.0622% (0.6227%) | 0.1053% (0.0246%) |
| Dividend payout ratio | -0.0153% (-0.0147%) | -0.0380% (-0.0200%) | 0.0223% (0.0210%) | 0.0295% (0.0132%) | 0.0015% (0.0005%) |
| Short-term liquidity | | | | | |
| Total Assets | -4.0651% (-7.0110%) | -10.1132% (-9.5433%) | 5.9326% (10.0051%) | 7.8452% (6.2999%) | 0.4006% (0.2494%) |

*Note 1: The numbers in parentheses present the marginal probability in 2009.*

Leverage increases the risk of a firm to serve its debt obligations. In the literature, however, the sign of the estimated coefficients on *debt ratio* have mixed results. The result of Ashbaugh-Skaife *et al*., (2006) is consistent with the conjecture that a firm

with higher *debt ratio* will tend to receive a lower credit rating. Nevertheless, other studies have the sign reversed (Blume *et al*., 1988; Amato&Furfine, 2004). In this study, we find a correct sign of estimated coefficients on *debt ratio*. As is evident from Table 3, a company with a higher *debt ratio* increases the probability of receiving a BB, B or below B by 0.5939 percent, 0.2387 percent in 2006 and 0.4639 percent, 0.3408 percent in 2009, respectively.

Specifically, we extend the credit rating literature by incorporating *free cash flow* and *Debt to EBITDA ratio* to capture the firms' financial risk. Moreover, it has a significant explanatory power. *Free cash flow* measures the firms' ability to generate cash. The positive coefficient on *free cash flow* indicates the firms with a larger amount of free cash have higher credit ratings. In addition, *Debt to EBITDA ratio* measures debt repayment capacity of issuers and is one of key ratios of S&P's new credit ratings analysis (Standard&Poor, 2008). A higher *debt to EBITDA ratio* indicates a higher financial risk of the firm. Therefore, a company with a higher *debt to EBITDA ratio* increases the probability of receiving a BB, B or below B by 0.7244 percent, 0.2912 percent in 2006 and 0.4031 percent, 0.2962 percent in 2009, respectively.

A greater *cash to current liabilities ratio* indicates a higher capacity for the firm to serve its immediate debt. However, we find the estimated coefficients on *cash to current liabilities ratio* are significantly negative. Although a company could pay its current liability on time when the company's *cash to current liabilities ratio* is high enough, nevertheless, too much cash on hand may crowd out the company's investment and profitability and, thus, increase its risk in the future. Hence, a higher *cash to current liabilities ratio* company increases the probability of receiving a BB, B or below B by 0.2024 percent, 0.0813 percent in 2006 and by 0.1375 percent, 0.1010 percent in 2009, respectively.

Most of the estimated coefficients on the long-term liquidity characteristics have correctly predicted signs, except for the coefficient on *Debt to EBITDA ratio* in 2008 that does not differ significantly from zero.

We use the *beta* of the Capital Assets Pricing Model (CAPM) to measure the systematic business risk. A higher *beta* indicates that the firm could be relatively sensitive to aggregate business conditions. The estimated coefficients on the *beta* in 2006 and 2007 are significantly negative and consistent with previous literature (Blume *et al*., 1988; Amato&Furfine, 2004; Ashbaugh-Skaife *et al*., 2006), while that of 2008 and 2009 are positive, but do not differ significantly from zero. In addition, the marginal effects of *beta* in 2009 are smaller than 2006. This implies that the S&P has not taken *beta* into account as an important measure in assigning credit ratings since the global financial crisis.

Besides, most of the estimated coefficients on *cash turnover* do not differ significantly from zero, except in 2009. This exception means that the *cash turnover* ratio becomes more important in S&P's new standard of credit ratings. Therefore, the marginal effects of *cash turnover* in 2009 are larger than in 2006. The positive coefficient on *cash turnover* in 2009 indicates that firms that are more effective in using cash assets for generating sales revenue will have higher credit ratings.

Finally, evident from Table 3, companies of chemicals, electric utility and communications equipment industries get worse credit ratings. The marginal effects of these industries on B or below B credit rating in 2009 are larger than those in 2006.

The estimation results of models 2, 3 and 4 can be found in Table 4. The estimated coefficients on the time dummies decrease over time. These results are consistent with other literature (for instance, Blume *et al*., 1988; and Amato&Furfine, 2004) and imply that the standards in assigning credit ratings have become increasingly more stringent over time. The decrease in time dummies of this study may result from the criticism of credit agencies' misclassification after the global financial crises and the change in the S&P's rating standards in 2008. The judgments regarding misclassification led the credit agencies to be more rigorous in assigning ratings.

A comparison of the most probable ratings to the actual ratings can be used to assess the goodness-of-fit of a probit model (Amato&Furfine, 2004). The results of fitness are summarized in Table 5. Reading across each row gives the number of predictions in each category labeled across the top for all observations with an actual rating equal to the label in the leftmost column. The results of Table 5 indicates that all the models over-predict the low rating categories while under-predict the high rating categories. Besides, we followed Gujarati (2003) using the count R-squared which gives the average correct predictions of models to measure the fitness of our models since a satisfactory measure of fit is lacking in the models of discrete dependent variables. Our results are consistent with that of Amato&Furfine (2004) and Ashbaugh-Skaife *et al*. (2006): count R-squared between 57.6% and 78.26%. In addition, we show that the fitness measure or degree of accuracy of our cross-sectional ordered probit model (model 1) improves since S&P changed his rating standards. This is because the count R-squared in 2008 and 2009 is larger than those in 2006 and 2007.

**Table 4**

**Estimated Results of the Ordered Probit Model- Models 2, 3 and 4**

| Estimated coefficient<br>Variables | model 2 | model 3 | model 4 |
|---|---|---|---|
| Cash flow | | | |
| Free cash flow | 0.000193***<br>(5.1889) | 0.000193***<br>(6.8872) | -0.000053<br>(-1.3476) |
| Cash turnover | 0.000308<br>(0.9160) | 0.000295<br>(1.2836) | -0.000212<br>(-1.1616) |
| Capital structure | | | |
| Debt ratio | -0.018912***<br>(-4.0792) | -0.018905***<br>(-6.5012) | 0.024040**<br>(2.6292) |
| Fixed ratio | 0.006064<br>(1.6276) | 0.006115<br>(1.6827) | -0.006062<br>(-1.5421) |
| Short-term liquidity | | | |
| Working capital | 0.000048**<br>(3.0982) | 0.000048***<br>(4.6214) | -0.000016<br>(-0.6671) |
| Cash to current liabilities ratio | -0.006289***<br>(-4.4064) | -0.006280***<br>(-6.0991) | 0.000571<br>(0.6837) |
| Receivable turnover | -0.021041*<br>(-2.1077) | -0.020665***<br>(-3.3488) | -0.063869<br>(-1.9140) |

| Estimated coefficient<br>Variables | model 2 | model 3 | model 4 |
|---|---|---|---|
| Days to pay account payable | 0.001416<br>(1.3692) | 0.001389*<br>(2.1001) | 0.001539<br>(0.8193) |
| Long-term liquidity | | | |
| Debt to EBITDA ratio | -0.001898<br>(-0.4863) | -0.002125<br>(-0.5170) | -0.019126*<br>(-2.5424) |
| EBITDA interest coverage | 0.000817*<br>(2.0967) | 0.000771*<br>(2.1627) | -0.002380<br>(-1.5451) |
| Industry factors | | | |
| Chemicals | -0.287126<br>(-1.5060) | -0.285988**<br>(-2.6980) | -0.203582<br>(-1.6461) |
| Electric utility & communications equipment | -0.958990***<br>(-5.3021) | -0.962309***<br>(-8.9053) | -0.251971<br>(-1.6564) |
| Beta of the CAPM | -0.000161<br>(-1.5632) | -0.000150<br>(-0.6695) | 0.000810***<br>(4.2798) |
| Profitability | | | |
| Return on assets | 0.059721***<br>(6.3661) | 0.060131***<br>(7.1340) | -0.017156<br>(-1.3854) |
| Dividend payout ratio | 0.000595<br>(1.1737) | 0.000587<br>(1.1240) | 0.001236***<br>(3.4526) |
| Short-term liquidity | | | |
| Total Assets | 0.405819***<br>(5.7052) | 0.408417***<br>(10.3364) | 0.042162<br>(1.4275) |
| $T_{2005}$ | | 0.092078<br>(0.9022) | |
| $T_{2006}$ | | -0.036547<br>(-0.3455) | |
| $T_{2007}$ | | -0.083446<br>(-0.8343) | |
| $\mu_1$ | 1.015763<br>(1.4132) | 1.029431*<br>(2.4780) | -1.130117***<br>(-5.8698) |
| $\mu_2$ | 2.151486**<br>(2.9102) | 2.167280***<br>(5.1087) | 1.446580***<br>(7.1112) |
| $\mu_3$ | 3.538352***<br>(4.5470) | 3.557059***<br>(8.0506) | |
| $\mu_4$ | 4.965626***<br>(5.8419) | 4.986735***<br>(10.5058) | |
| Pseudo R-squared | 0.313003 | 0.314042 | 0.058764 |
| Sample size | 1009 | 1009 | 543 |

**Table 5**

**Predicted Versus Actual Ratings**

| Predicted rating / Actual rating | B or below B | BB | BBB | A | AAA or AA | Total |
|---|---|---|---|---|---|---|
| *Model 1: Cross-sectional ordered probit model- 2006 (Count $R^2$=58.78%)* | | | | | | |
| B or below B | 30 | 9 | 5 | 0 | 0 | 44 |
| BB | 4 | 24 | 22 | 1 | 0 | 51 |
| BBB | 0 | 6 | 55 | 15 | 0 | 76 |

| Predicted rating / Actual rating | B or below B | BB | BBB | A | AAA or AA | Total |
|---|---|---|---|---|---|---|
| A | 0 | 4 | 25 | 28 | 1 | 58 |
| AAA or AA | 0 | 0 | 3 | 6 | 7 | 16 |
| Total | 34 | 43 | 110 | 50 | 8 | 245 |
| *Model 1: Cross-sectional ordered probit model- 2007 (Count $R^2$=57.60%)* | | | | | | |
| B or below B | 29 | 12 | 7 | 0 | 0 | 48 |
| BB | 9 | 22 | 21 | 1 | 0 | 53 |
| BBB | 0 | 5 | 63 | 12 | 0 | 80 |
| A | 1 | 5 | 25 | 20 | 1 | 52 |
| AAA or AA | 0 | 0 | 3 | 4 | 10 | 17 |
| Total | 39 | 44 | 119 | 37 | 11 | 250 |
| *Model 1: Cross-sectional ordered probit model- 2008 (Count $R^2$=60.32%)* | | | | | | |
| B or below B | 32 | 14 | 3 | 0 | 0 | 49 |
| BB | 5 | 28 | 18 | 1 | 0 | 52 |
| BBB | 0 | 9 | 65 | 13 | 0 | 87 |
| A | 0 | 4 | 22 | 21 | 2 | 49 |
| AAA or AA | 0 | 0 | 3 | 6 | 6 | 15 |
| Total | 37 | 55 | 111 | 41 | 8 | 252 |
| *Model 1: Cross-sectional ordered probit model- 2009 (Count $R^2$=62.21%)* | | | | | | |
| B or below B | 43 | 8 | 6 | 0 | 0 | 57 |
| BB | 6 | 17 | 19 | 1 | 0 | 43 |
| BBB | 1 | 11 | 73 | 12 | 0 | 97 |
| A | 0 | 2 | 25 | 22 | 1 | 50 |
| AAA or AA | 0 | 0 | 3 | 4 | 8 | 15 |
| Total | 50 | 38 | 126 | 39 | 9 | 262 |
| *Model 2: Pooled ordered probit model (Count $R^2$=58.47%)* | | | | | | |
| B or below B | 129 | 46 | 22 | 1 | 0 | 198 |
| BB | 21 | 84 | 91 | 3 | 0 | 199 |
| BBB | 2 | 25 | 265 | 48 | 0 | 340 |
| A | 1 | 12 | 109 | 81 | 6 | 209 |
| AAA or AA | 0 | 0 | 15 | 17 | 31 | 63 |
| Total | 153 | 167 | 502 | 150 | 37 | 1009 |
| *Model 3: Panel ordered probit model with fixed effect (Count $R^2$=57.87%)* | | | | | | |
| B or below B | 130 | 47 | 20 | 1 | 0 | 198 |
| BB | 23 | 82 | 91 | 3 | 0 | 199 |
| BBB | 2 | 25 | 264 | 49 | 0 | 340 |
| A | 1 | 12 | 113 | 77 | 6 | 209 |
| AAA or AA | 0 | 0 | 15 | 17 | 31 | 63 |
| Total | 156 | 166 | 503 | 147 | 37 | 1009 |

| *Model 4: First difference ordered probit model (Count $R^2$=78.26%)* | | | | |
|---|---|---|---|---|
| Predicted rating / Actual rating | -1 (Deterioration) | 0 (No Change) | 1 (Improvement) | Total |
| -1 (Deterioration) | 3 | 61 | 0 | 64 |
| 0 (No Change) | 0 | 421 | 1 | 422 |
| 1 (Improvement) | 0 | 56 | 1 | 57 |
| Total | 3 | 538 | 2 | 543 |

## 5. Conclusion

Our study finds that most of the coefficients on the cash flow, capital structure, profitability and competitive position characteristics have the correct signs as expected. Consistent with prior research, we show that credit ratings are positively related to *EBITDA interest coverage*, *return on assets* and *total assets*. In addition, credit ratings are negatively related to *Debt ratio* and *Cash to current liabilities ratio*. Furthermore, we show that all the models over-predict the low rating categories while under-predict the high rating categories. The goodness of fit measure of our cross-sectional ordered probit model improves since S&P changed his rating standards. The result of our ordered probit credit rating model is among the best in terms of predictive power.

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