

INFLUENCE OF DEBT, CAPITAL INTENSITY, AND COMPANY SIZE ON
MINING AND PROCESSING INDUSTRY PROFITABILITY LEVELS

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Abstract

An investigation was conducted on the interactions between long-term debt, net income, company size, and capital intensity. The mining and processing industry was studied using 18 year pooled data for 30 mining and processing companies. The debt-profitability pair gave an extremely significant inverse, linear relationship strongly suggesting that any amount of long-term debt reduced net income. The investigation also showed that there was a direct relationship between debt level and the revenue to capitalization ratio. Finally, profitability was found to be complexly related to the revenue to capitalization ratio. During difficult business conditions, greatest profitability accrued to those firms that had a high revenue to capitalization ratio which is consistent with theory.

Introduction

The interaction between debt level (capital structure) and firm valuation has been subjected to much theoretical and empirical study. This was spurred by the Modigliani and Miller (MM) treatise[1] which theorized that long-term debt was irrelevant to firm valuation. However, there has been a general retreat from the debt irrelevance theory as actual market conditions have been included in later studies.

The cost of capital and optimum debt level values may vary between industries and companies in an industry. Scott and Scott and Martin presented evidence that capital structures are significantly related to industry classification. This may be the result of differing business risks between industries.[2][3] On the other hand, Remmers, et al. did not find that industry classification was a clear determinant of capital structure.[4] Ferri and Jones and Scott and Martin found that debt levels were related to firm size, but the relationships were generally quite complicated; however, again, Remmers, et al. did not find a relationship between debt level and firm size.[5][6][7] Overall the studies suggest that relatively lower optimum debt levels may be expected for industries that encounter considerable business risk.

Methodology

Unless debt levels become fairly high, there may be no capital structure effect on net income. A study was conducted to assess the capital structure - net income relationship in the mining and processing industry group which is capital intensive and subject to considerable business risk. These traits may magnify the debt - net income relationship.

Bivariate correlations were employed to assess the relationships between long-term debt, net income, company size, and capital intensity. A pool of annualized data for 30 firms was obtained from 1966-1983.

Moody's Industrial Manuals were used for classifying the industrial group and to obtain the financial information. From 88 companies listed in 1984, the number was reduced to 30 companies having continuous and appropriate data over the 18 year period. See Table 1.

Table 1

Listing of Companies Included in the Study

Aluminum Company of America	Handy and Harmon
Amax, Inc.	Hanna Mining Co.
Asarco, Inc.	Hecla Mining Co.
Atlas Corp.	Homestake Mining Co.
Bethlehem Steel Corp.	Ideal Basic Industries
Callahan Mining Corp.	Kaiser Alum. & Chem. Corp.
Cleveland-Cliffs Iron Co.	Kaiser Cement Corp.
Copperweld Corp.	Newmont Mining Corp.
Eagle-Picher Industries, Inc.	Pacific Tin Consol. Corp.
Englehard Minerals & Chemicals.	Phelps Dodge Corp.
Federal Resources Corp.	Republic Steel
Foot Mineral Co.	Reynolds Metals Co.
Freeport-McMoran, Inc.	Sunshine Mining Co.
General Refractories Co.	UNC Resources Corp.
Gulf Resources and Chemical Corp.	United Park City Mines Co.

The following derived variables were used in the study: long-term debt (LTDEBT) = long-term debt + notes + notes payable; net shareholder equity (EQUITY) = the total of common par value + capital paid in excess + retained earnings + preferred stock - treasury stock; and percentage long-term debt (PD) = LTDEBT / (LTDEBT + EQUITY).

Total assets (TOTASSETS) was selected as the firm size measure. Inflation has an effect on total asset levels over time, and the data were standardized to make the 18 year data set consistent. The standardized asset size of each company (SIZE) was calculated each year as the proportion of each firm's net assets to the 30 company pool of total assets.

Net revenue (REV) data were used in the intensity calculation as follows: capital intensity (CAPINT) = REV / (LTDEBT + EQUITY).

Net income after taxes (NI) was used in calculating the income ratios. Two net income ratios were employed which related income to total capitalization (CNI) and to total assets (PNI). CNI (net income as % of capitalization) = (NI / (LTDEBT + EQUITY)) x 100. PNI (net income as a % of total assets) = (NI / TOTASSETS) x 100.

The 18 year period was subdivided into six year subperiods for comparative study.

Results

The average and standard deviation values for each variable in each period were determined and are presented in Table 2.

Table 2

Variable Average and Standard Deviation
for the 18 Year Period and the Three Subperiods

		18 Year Period	1966- 1971	1972- 1977	1978- 1983
(PD)	- average	23.80	20.45	23.83	27.14
	- std. dev.	17.05	16.18	17.00	17.38
(PNI)	- average	3.64	5.59	5.45	-.13
	- Std. dev.	36.29	5.26	4.91	62.38
(CNNI)	- average	1.30	6.94	7.29	-10.35
	- std. dev.	114.99	6.18	6.42	198.83
(SIZE)	- average	.033	.033	.033	.033
	- std. dev.	.045	.048	.044	.042
(CAPINT)	- average	1.36	1.17	1.40	1.52
	- std. dev.	1.46	1.12	1.56	1.63

(PD) = Percentage Long Term Debt
(PNI) = Net Income as a % of Total Assets
(CNNI) = Capitalization Standardized Net Income
(SIZE) = Standardized Asset Size
(CAPINT) = Capital Intensity

The following observations are made from the results: PD (long term debt as a % of total assets) - The average PD values increased over time from 20.45% to 27.14% from the earliest to latest subperiod. The increasing debt ratios probably were the result of a combination of factors, but inflation, investment in increasingly larger projects, increasing costs of complex technology, and environmental protection probably predominate.[8] An inability to obtain sufficient external equity financing under acceptable conditions may have necessitated use of debt financing. The standard deviations increased from 16.18% in the 1966-1971 subperiod to 17.38% in the 1978-1983 subperiod, indicating a small increase in financial risk over the 18 year period.

PNI and CNNI (net income as a % of total assets and capitalization, respectively) - The trends for both ratios were similar. PNI values were 5.59, 5.45 and -.13% from the first through third subperiods and CNNI values were 6.94, 7.29 and -10.35% for the same subperiods. The standard deviations for both variables ranged from 4.91 to 6.42% in the first two subperiods but rose dramatically in the third period to 62.38 and 198.83% for PNI and CNNI, respectively. This occurrence was probably due to the large 1978 to 1983 profit-loss swings.

SIZE (% of total assets for all the firms) - The average values of .033 did not change over time due to the method of calculating this standardized value (Σ SIZE = 1.0) Significant dispersion in company sizes was shown by the higher standard deviation values compared to the average values. The standard deviations were .048,

.044, .042 from the earliest to last subperiods.

CAPINT (ratio of revenues to capitalization) - Overall, CAPINT rose from 1.17 to 1.52 from the 1966-1971 to 1978-1983 subperiods which means that revenues rose more than book capitalization. This disparity may be partially explained by inflation which increases revenues before capitalization. Also, projects that have higher CAPINT ratios may have gained increasing prominence over time since these projects could be less risky than low CAPINT projects. Because of the increasingly more difficult economic conditions encountered by the mining and processing industry and rising debt ratios over time, it is likely that less risky, lower capital intensive projects would be pursued.

Simple correlation coefficients for all variable combinations are given in Table 3.

Table 3

Simple Correlation Values for All Variables
Employed in the Investigation for Each Period Studied

<u>Variable Pair</u>	18 <u>Year^a</u>	1966- <u>1971^b</u>	1972- <u>1977^b</u>	1978- <u>1983^b</u>
PD - PNI	-.93	-.46	-.38	-.95
PD - CNNI	-.94	-.44	-.32	-.96
PD - SIZE	.05	.34	.32	-.02
PD - CAPINT	.25	.08	.07	.33
PNI - Size	.01	-.03	-.16	.04
CNNI - SIZE	.03	-.02	-.14	.06
PNI - CAPINT	-.22	-.05	.11	-.30
CNNI - CAPINT	-.22	.16	.36	-.31
SIZE - CAPINT	-.01	-.06	.06	.12

^a For 18 year period, .05 when $|r|$.09

^b For each subperiod, .05 when $|r|$.15

Throughout the study, .05 was considered the acceptable statistical significance level. The most significant simple correlations obtained in the study were for the debt level (PD) to income (PNI and CNNI) variable pairs. 18 year r values of $-.93$ to $-.94$ were obtained. These high values show that strong negative linear relationships existed between debt and profitability for this industry.

18 year PD to PNI and CNNI scatterplots were investigated. The plots showed linear, negative relationships between net income and debt. Most of the data points fell within relatively narrow ranges. Additionally, since no inflections were apparent in the data clusters, the plots suggested that net income was maximized when there was no debt. Based on this analysis, mining and processing companies experienced reduced profit levels using debt financing. However, because of the increasing debt levels and deteriorating business conditions over the 18 year period which may have acted independently on the debt and profit variables, a strong cause-effect relationship may not have been reflected in the plots.

Overall, debt level did not correlate well with company size

but statistically significant direct relationships occurred during the 1966-1971 and 1972-1977 subperiods. The situation was completely opposite for the debt level - capital intensity association. The 1966-1971 and 1972-1977 subperiods showed no significant relationships, but the results were significant and positive in the 1978-1983 subperiod and 18 year period. The reversal in the relationships in the 1978-1983 subperiod is explainable only if, as business conditions deteriorated, smaller firms had to obtain proportionately greater amounts of debt over time because of initially limited resources and a greater inability to dispose of assets to meet capital requirements compared to larger companies. The SIZE - CAPINT relationship was not linearly significant in any of the periods which, however, does not discount the existence of more complex relationships.

Interestingly, relationships between PNI and CNI to CAPINT (capital intensity factor) were statistically significant. The CNI - CAPINT was significant for all three subperiods and the PNI - CAPINT pair was significant in one subperiod. Both variable pairs were significant on an 18 year period basis. The first two subperiod correlation coefficients for CNI - CAPINT were positive, but it was negative in the last subperiod. Because CAPINT is calculated as the ratio of revenues to capital, the positive relationships for the first two subperiods suggest that greater profits were obtained by companies that had higher revenue to capitalization ratios. However, profits were higher in the 1978-1983 subperiod for firms that had relatively lower revenue to capitalization ratios. These results appear to be inconsistent with theory, since companies having lower revenue to capitalization ratios would be subject to greater risk and should experience greater profitability during good business periods as a reward. Therefore, the analysis suggests that the mining and processing industry was pursuing low revenue to capitalization projects without acceptable returns.

Conclusions

The most significant findings in this study related to the extremely significant negative debt - profitability relationships found. Correlation coefficients on an 18 year basis were $-.93$ and $-.94$, depending on whether total assets or capitalization was used for standardization. The very high correlation coefficient values may have also been partly the result of concurrent, but probably not independent, debt increase and business condition trends. The linearity of the 18 year relationship was also very interesting. There was no apparent deviation from a straight line. The slope did not decrease at higher debt levels which would be expected if risk from high debt levels increases capital costs and lowers profitability. The mining and processing industry group possibly did not have debt levels sufficiently high to observe the very negative impact of higher debt levels.

These results do not support the debt irrelevance hypothesis. Apparently, any amount of debt has a negative impact on income for the mining and processing industry.

Another significant relationship found was the debt - firm size variable pair. Correlation analysis showed that the pair was

statistically significant and directly related only during the 1966-1977 and 1972-1977 subperiods.

The capital intensity ratio was significantly related to the net income as a ratio with capitalization (CNNI) but not to total assets. The capital intensity ratio was also found to be directly related to debt during the 18 year period. This suggests that firms having a higher revenue to capitalization ratio have a tendency to hold more debt. Capital intensity, which is only one of several factors that account for the risk encountered by this industry, was found to be an important financial factor.

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