Scientific Research Publishing

iBusiness, 2023, 15, 321-330
https://www.scirp.org/journal/ib
ISSN Online: 2150-4083
ISSN Print: 2150-4075

Optimization Approach to Asset and Capital Structure of Companies

Erdenebat Munkhdalai[1*], Enkhbayar Jamsranjav[2], Oyuntsetseg Luvsandash[3], Gantulga Garamdorj[4]

[1]Business school, National University of Mongolia, Ulaanbaatar, Mongolia
[2]School of Information Technology and Electronics, National University of Mongolia, Ulaanbaatar, Mongolia
[3]Business School, National University of Mongolia, Ulaanbaatar, Mongolia
[4]Accounting Department, University of Finance and Economics, Ulaanbaatar, Mongolia
Email: *erdenebat.m@num.edu.mn

How to cite this paper: Munkhdalai, E., Jamsranjav, E., Luvsandash, O., & Garamdorj, G. (2023). Optimization Approach to Asset and Capital Structure of Companies. *iBusiness, 15,* 321-330.
https://doi.org/10.4236/ib.2023.154023

Received: October 18, 2023
Accepted: December 26, 2023
Published: December 29, 2023

Abstract

Optimizing a company's asset and capital structure has a positive effect on reducing capital costs and increasing the use of assets. In this paper, we consider the optimization problem of a company's asset and capital structure. The proposed model is formulated as a fractional programming problem. The problem was solved numerically on "Mat-lab" using data from Mongolian mining companies. Numerical results are provided.

Keywords

Asset Structure, Capital Structure, Net Working Capital, Mongolian Mining Companies

1. Introduction

Optimizing the structure of assets is an important and complex task of financial management. The optimal asset structure is to identify working capital and non-current assets and their financing, and to ensure liquidity, solvency financial stability. This paper deals with optimizing asset and capital structure based on the relation between assets and capital by their financial ratios and characteristics.

The trade-off relationship between asset structure, capital structure and management of profitability and liquidity of asset structure provides a new research direction for us to study how to optimize enterprise asset structure (Titman, 1983).

This is confirmed by the following studies. Capital contributes to the optimal

asset structure (Koralun-Bereźnicka, 2013). Optimal asset allocation affects capital structure through leverage (Campello & Giambona, 2013). This shows that the optimal structure of assets and capital affects each other. High levels of non-current assets negatively affect the solvency and liquidity of assets. This will negatively affect profitability. Therefore, optimizing the amount of non-current assets is the basis for the long-term sustainability of business operations. A company with efficient working capital management can increase profitability by reducing financial costs, even if it increases the amount of capital. This suggests that working capital needs to be financed as low-interest sources as possible and that for companies, having a proper working capital structure can increase efficiency. Too much-working capital increases costs, while too little has the disadvantage of reduced solvency. Researchers such as Gebrehiwot and Wolday have argued that effective management of working capital increases the efficiency of an organization through the proper management and maintenance of working capital (Gebrehiwot & Wolday, 2006). According to Afza and Nazir, "Effective working capital management is an integral part of an enterprise's strategy and creates value for shareholders" (Afza & Nazir, 2008), so effective working capital management improves profitability and thus increases business value. Therefore, companies are always trying to maintain the optimal level of working capital to increase their value (Deloof, 2003). Researchers (Deloof, 2003), (Koralun-Bereźnicka, 2013), (Schilling, 1996), (Lind et al., 2012) views on working capital suggest that "the main purpose of working capital management is to determine the appropriate amount of working capital components, reduce the associated costs, and increase the company's efficiency." The structure of a company's assets and capital varies depending on the country and industry, but it is preferable that working capital be greater than short-term liabilities. It can have a positive impact on profitability by improving solvency ratios and thereby reducing costs associated with working capital and current liabilities. The paper is organized as follows. Section 2 is devoted to the optimization model of asset and capital structure.

2. Net Working Capital Problem Formulation

We introduce the following notations and variables for asset and capital structure. (**Table 1**)

The following assumptions follow from the financial statements of a company.

The sum of variables is equal to one.

$$x_1^A + x_2^A + x_3^A + x_4^A = 1 \tag{1}$$

$$y_1^L + y_2^L + y_3^L = 1 \tag{2}$$

Current assets (sum of cash, receivables, inventories and expenses) are greater than current liability.

$$x_1^A + x_2^A + x_3^A > y_1^L \tag{3}$$

Non-current assets shall be more than long-term liability.

Table 1. Notations and variables.

Assets	Notation	Variables	Liabilities and Owner's equity	Notation	Variables
Cash	A_1	x_1^A	Current liability	L_1	y_1^L
Receivable	A_2	x_2^A	Long term liability	L_2	y_2^L
Inventory	A_3	x_3^A	Equity	E	y_3^L
Non-current assets	A_4	x_4^A			
Total assets	A	100%	Total resource	L + E	100%

$$x_4^A > y_2^L \tag{4}$$

Non-current assets shall be more than current assets.

$$x_1^A + x_2^A + x_3^A < x_4^A \tag{5}$$

Cash Ratio (υ_1): It shows the sufficiency of the entity's marketable securities and cash to pay current liabilities. It shows the sufficiency of the entity's marketable securities and cash to pay current liabilities. Denote by υ_1 cash ratio. Then υ_1 is determined as the ratio:

$$\upsilon_1 = \frac{x_1^A}{y_1^L} \tag{6}$$

Quick Ratio (υ_2): It indicates whether it the possible to repay current liabilities based on the collection of receivables in addition to cash and liquid securities. υ_2 is defined as follows:

$$\upsilon_2 = \frac{x_1^A + x_2^A}{y_1^L} \tag{7}$$

Current Ratio (υ_3): Ration of the total current assets and current liabilities, which shows how current liabilities are secured by current assets. Then υ_3 is defined in the following.

$$\upsilon_3 = \frac{x_1^A + x_2^A + x_3^A}{y_1^L} \tag{8}$$

Specific gravity of non-current assets (υ_4): It shows holding specific gravity of non-current assets from the total assets. υ_4 is given by the following formula:

$$\upsilon_4 = \frac{x_4^A}{x_1^A + x_2^A + x_3^A + x_4^A} \tag{9}$$

Equity to assets ratio (υ_5): It defines ability to operate independently from external sources with its own funding. υ_5 is defined by the following formula.

$$\upsilon_5 = \frac{y_3^L}{x_1^A + x_2^A + x_3^A + x_4^A} \tag{10}$$

Debt to Equity Ratio (υ_6): It shows the debt per 1 tugrik of owner's equity. In business sectors other than the financial sector, it is preferable to have less than 1.

$$\text{Debt to Equity Ratio} = \frac{\text{Total debt}}{\text{Owner's equity}}$$

In other words,

$$\upsilon_6 = \frac{y_1^L + y_2^L}{y_3^L} \tag{11}$$

Debt to assets ratio (υ_7): It indicates how much of the company's total assets are financed by external sources.

$$\text{Debt to assets ratio} = \frac{\text{Total debt}}{\text{Total assets}}$$

This means that:

$$\upsilon_7 = \frac{y_1^L + y_2^L}{x_1^A + x_2^A + x_3^A + x_4^A} \tag{12}$$

Long-term debt-to-equity ratio (υ_8): High ratio means that the company has the high financial risk.

$$\text{Long-term debt-to-equity ratio} = \frac{\text{Long term liability}}{\text{Equity}}$$

It can be expressed as:

$$\upsilon_8 = \frac{y_2^L}{y_3^L} \tag{13}$$

Each of variables of the specific gravity shown in Table 1 is expressed in terms of υj and other parameters. Now we can write down the above formulas as:

$$x_1^A = \frac{y_3^L - \upsilon_5\left(x_2^A + x_3^A + x_4^A\right)}{\upsilon_5} \tag{14}$$

$$x_1^A = \upsilon_1 y_1^L \tag{15}$$

$$x_2^A = \upsilon_2 y_1^L - x_2^A = \upsilon_2 y_1^L - \upsilon_1 y_1^L \tag{16}$$

$$x_3^A = \upsilon_3 y_1^L - x_2^A - x_1^A = \upsilon_3 y_1^L - \upsilon_2 y_1^L + \upsilon_1 y_1^L - \upsilon_1 y_1^L = \left(\upsilon_3 - \upsilon_2\right) y_1^L \tag{17}$$

$$x_3^A = \frac{y_1^L + y_2^L - \upsilon_7\left(x_1^A + x_2^A + x_4^A\right)}{V_7} \tag{18}$$

$$x_4^A = \frac{V_4 x_1^A + \upsilon_4 x_2^A + \upsilon x_3^A}{1 - \upsilon_4} \tag{19}$$

$$y_2^L = \upsilon_8 y_3^L \tag{20}$$

$$y_3^L = \upsilon_5\left(x_1^A + x_2^A + x_3^A + x_4^A\right) \tag{21}$$

Also, the variable y_1^L can be expressed by υ_5, υ_6 and V_8 ratios in the following.

$$y_1^L = \frac{y_3^L}{x_1^A + x_2^A + x_3^A + x_4^A}\left(\frac{y_1^L + y_2^L}{y_3^L} - \frac{y_2^L}{y_3^L}\right)$$

$$y_1^L = \upsilon_5\left(\upsilon_6 - \upsilon_8\right) \tag{22}$$

We can express variables x_4^A via variables x_1^A, x_2^A, x_3^A, y_1^L and υ_4 as follows:

$$\begin{aligned} x_4^A &= \frac{\upsilon_4\left(x_1^A + x_2^A + x_3^A\right)}{1-V_4} = \frac{\upsilon_4\left(\upsilon_1 y_1^L + \upsilon_2 y_1^L - \upsilon_1 y_1^L + \upsilon_3 y_1^L - \upsilon_2 y_1^L\right)}{1-V_4} \\ &= \frac{\upsilon_4\upsilon_3 y_1^L}{1-\upsilon_4} = \frac{\upsilon_3\upsilon_4\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4} \end{aligned} \tag{23}$$

Using Formulas (15)-(17), we compute a value of y_3^L as:

$$\begin{aligned} y_3^L &= \upsilon_5\left(x_1^A + x_2^A + x_3^A + x_4^A\right) \\ &= \upsilon_5\left(\upsilon_1 y_1^L + \upsilon_2 y_1^L - \upsilon_1 y_1^L + \upsilon_3 y_1^L - \upsilon_2 y_1^L + \frac{\upsilon_3\upsilon_4\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \\ &= \upsilon_5\left(\upsilon_3 y_1^L + \frac{\upsilon_3\upsilon_4\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \\ &= \upsilon_5\left(\upsilon_3\upsilon_5\left(\upsilon_6 - \upsilon_8\right) + \frac{\upsilon_3\upsilon_4\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \\ &= \upsilon_5\left(\frac{\upsilon_3\upsilon_5\left(\upsilon_6 - \upsilon_8\right)\left(1-\upsilon_4\right) + \upsilon_3\upsilon_4\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \\ &= \upsilon_5\left(\frac{\upsilon_3\upsilon_5\left(\upsilon_6 - \upsilon_8\right)\left[1-\upsilon_4 + \upsilon_4\right]}{1-\upsilon_4}\right) \\ &= \upsilon_5\left(\frac{\upsilon_3\upsilon_5\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \end{aligned}$$

$$y_3^L = \frac{\upsilon_3\upsilon_5^2\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4} \tag{24}$$

The variable y_2^L is expressed by υ_8 and y_3^L as:

$$y_2^L = \upsilon_8 y_3^L$$

$$y_2^L = \upsilon_8\left(\frac{\upsilon_3\upsilon_5^2\left(\upsilon_6 - \upsilon_8\right)}{1-\upsilon_4}\right) \tag{25}$$

If we substitute x_2^A and x_3^A into $x_2^A + x_3^A$ then we obtain:

$$x_2^A + x_3^A = x_2^A = \upsilon_2 y_1^L - x_1^A + \upsilon_3 y_1^L - x_2^A - x_1^A =$$

$$x_2^A + x_3^A = \upsilon_2 y_1^L - \upsilon_1 y_1^L + \upsilon_3 y_1^L - \upsilon_2 y_1^L + \upsilon_1 y_1^L - \upsilon_1 y_1^L = \left(\upsilon_3 - \upsilon_1\right) y_1^L$$

Now we substitute y_1^L into the last expression:

$$x_2^A + x_3^A = \left(\upsilon_3 - \upsilon_1\right)\upsilon_5\left(\upsilon_6 - \upsilon_8\right) \tag{26}$$

If we substitute Formula (24), (23) and (25) into (14) then we get an expression of x_1^A:

$$x_1^A = \frac{\dfrac{\upsilon_3\upsilon_5^2(\upsilon_6-\upsilon_8)}{1-\upsilon_4} - \upsilon_5\left[(\upsilon_3-\upsilon_1)\upsilon_5(\upsilon_6-\upsilon_8) + \dfrac{\upsilon_3\upsilon_4\upsilon_5(\upsilon_6-\upsilon_8)}{1-\upsilon_4}\right]}{\upsilon_5}$$

$$x_1^A = \frac{\left(\dfrac{\upsilon_5(\upsilon_6-\upsilon_8)\left[\upsilon_3\upsilon_5 - \upsilon_3\upsilon_5 + \upsilon_1\upsilon_5 + \upsilon_3\upsilon_4\upsilon_5 - \upsilon_1\upsilon_4\upsilon_5 - \upsilon_3\upsilon_4\upsilon_5\right]}{1-V_4}\right)}{V_5}$$

Simplify the above expression to get the following expression:

$$x_1^A = \upsilon_5(\upsilon_6-\upsilon_8)\upsilon_1 \tag{27}$$

The sum $x_1^A + x_2^A$ is simplified as follows:

$$x_1^A + x_2^A = V_1y_1^L + V_2y_1^L - V_1y_1^L = V_2y_1^L$$

or

$$x_1^A + x_2^A = \upsilon_2\upsilon_5(\upsilon_6-\upsilon_8) \tag{28}$$

x_3^A has the form:

$$x_3^A = \frac{\upsilon_5(\upsilon_6-\upsilon_8) + \upsilon_8\left(\dfrac{\upsilon_3\upsilon_5^2(\upsilon_6-\upsilon_8)}{1-\upsilon_4}\right) - \upsilon_7\left(\upsilon_2\upsilon_5(\upsilon_6-\upsilon_8) + \dfrac{\upsilon_3\upsilon_4\upsilon_5(\upsilon_6-\upsilon_8)}{1-\upsilon_4}\right)}{\upsilon_7},$$

$$x_3^A = \frac{\dfrac{\upsilon_5(\upsilon_6-\upsilon_8)\left[1-\upsilon_4+\upsilon_3\upsilon_5\upsilon_8 - \upsilon_2\upsilon_7(1-\upsilon_4) - \upsilon_3\upsilon_4\upsilon_7\right]}{1-\upsilon_4}}{\upsilon_7},$$

$$x_3^A = \frac{\upsilon_5(\upsilon_6-\upsilon_8)\left[1-\upsilon_4+\upsilon_3\upsilon_5\upsilon_8 - \upsilon_2\upsilon_7 + \upsilon_2\upsilon_4\upsilon_7 - \upsilon_3\upsilon_4\upsilon_7\right]}{(1-\upsilon_4)\upsilon_7}. \tag{29}$$

Net working capital (NWC): It shows the amount of fixed resources used to finance working capital.

$$\text{Net working capital} = \text{Current assets} - \text{Current liability}$$

$$\text{NWC} = x_1^A + x_2^A + x_3^A - y_1^L$$

The goal of working capital management is to maximize the net working capital. Denote NWC by f, then it has the following expression:

$$\begin{aligned}\text{NWC} = f = {} & \upsilon_5(\upsilon_6-\upsilon_8)\upsilon_1 + (\upsilon_2-\upsilon_1)\upsilon_5(\upsilon_6-\upsilon_8) \\ & + \frac{\upsilon_5(\upsilon_6-\upsilon_8)\left[1-\upsilon_4+\upsilon_3\upsilon_5\upsilon_8 - \upsilon_2\upsilon_7 + \upsilon_2\upsilon_4\upsilon_7 - \upsilon_3\upsilon_4\upsilon_7\right]}{\upsilon_7(1-\upsilon_4)} \\ & - \upsilon_5(\upsilon_6-\upsilon_8)\end{aligned}$$

or

$$f = \frac{\upsilon_5(\upsilon_6-\upsilon_8)\left[1-\upsilon_4+\upsilon_3\upsilon_5\upsilon_8 - \upsilon_3\upsilon_4\upsilon_7 - \upsilon_7 + \upsilon_4\upsilon_7\right]}{\upsilon_7(1-\upsilon_4)} \tag{30}$$

$$\upsilon_4 = 1-\upsilon_3\upsilon_5(\upsilon_6-\upsilon_8)$$

$$\upsilon_7 = \upsilon_5 * \upsilon_6$$

$$\upsilon_5 = 1 - \upsilon_7$$

$$\upsilon_4 = \frac{1-\upsilon_5}{\upsilon_5}$$

Taking into account (30) we can simplify NWCF as follows:

$$\tilde{f} = \frac{\upsilon_5(\upsilon_6 - \upsilon_8)\left[1 - \upsilon_4 + \upsilon_3\upsilon_5\upsilon_8 - \upsilon_3\upsilon_4\upsilon_7 - \upsilon_7 + \upsilon_4\upsilon_7\right]}{\upsilon_7(1-\upsilon_4)} \to \max \tag{31}$$

We are using the objective function (31) to determine the optimal amount of assets and capital structure of Mongolian mining companies.

As of the TOP 40 mining companies of the world, other indications from the turnover ratios are "good" in terms of median and average values for each of the ratios set out in the Model Methodology for Analyzing the Financial Statements of Business Entities (Ministry of Finance Mongolia, 2015) and it leads to the conclusion that those companies source structure and capital management is optimized.

The standard (Table 2) deviation of the TOP 40 mining companies of the world is significantly lower than mining companies of Mongolia, indicating that these companies maintain a stable capital and resource structure over a long period of time.

The functional limitation conditions for achieving the net working capital target are selected as follows based on the financial stability and capital structure of the mining companies of Mongolian TOP 40 companies.

Based on the financial statements of Mongolian mining companies using Table 3 we can define the lower and upper bound for variables $\upsilon_j\left(j = \overline{1,8}\right)$.

$$9.23 \geq \upsilon_3 \geq 1.49$$

Table 2. Standard deviations on financial ratios between Mongolia and the world's TOP-40 mining companies.

№	Ratios	World TOP-40	Mongolian mining companies
1	Cash Ratio (υ_1)	0.13	2.402634
2	Quick Ratio (υ_2)	0.15	6.177571
3	Turnover ratio (υ_3)	0.21	9.466798
4	Specific gravity of non-current assets (υ_4)	0.01	0.243357
5	Equity to assets ratio (υ_5)	0.05	0.529773
6	Debt to Equity Ratio (υ_6)	0.18	10.58154
7	Debt to assets ratio (υ_7)	0.05	0.529773
8	Long-term debt-to-equity ratio (υ_8)	0.02	0.365345

Table 3. Functional limitation conditions for NWC.

No	Ratios	Minimum	Maximum
1	Turnover ratio (υ_3)	1.49	9.23
2	Specific gravity of noncurrent assets (υ_4)	0.48	0.72
3	Independent coefficient (υ_5)	0.14	0.67
4	Debt to equity ratio (υ_6)	0.70	6.42
5	Specific gravity of debt (υ_7)	0.33	0.86
6	Long-term debt to equity ratio (υ_8)	0.16	0.53

Table 4. Optimal solutions of ratio.

Variables	Ratio	Value
υ_3	Current ratio	1.755778
υ_4	Specific gravity of non-current assets	0.715415
υ_5	Equity to assets ratio	0.588235
υ_6	Debt to equity ratio	0.7
υ_7	Debt to assets ratio	0.411765
υ_8	Long-term debt to equity ratio	0.424456

Table 5. Optimal structure of asset source of Mongolian Mining Companies (%).

Asset	Optimal Structure	Liabilities and Owner's equity	Optimal structure
Current assets	28.46	Current liabilities	16.21
Non-current assets	71.54	Long term liabilities	24.97
		Owner's equity	58.82
Total assets	100.00	Total Source	100.00

Source: Researcher's calculation.

$$\begin{gathered} 0.72 \geq \upsilon_4 \geq 0.48 \\ 0.67 \geq \upsilon_5 \geq 0.14 \\ \upsilon_6 \geq \upsilon_8 \\ 6.42 \geq \upsilon_6 \geq 0.70 \\ \upsilon_4 \geq \upsilon_5 \upsilon_8 \\ 0.53 \geq \upsilon_8 \geq 0.16 \end{gathered} \tag{32}$$

Problem (31)-(32) is fractional programming and belongs to a class of global optimization.

Numerical Results

Now NWC maximization Problem (31)-(32) is solved numerically on "Matlab" based data of Mongolian mining companies.

Using the above results (Table 4) we can calculate optimal structure of assets.

Looking at the results of Table 5, it is clear that the working capital (28.46 percent of the total capital) of the mining company is less than the non-current capital. From the optimal amount of working capital (28.46%), using equation (29), the maximum amount of inventory is calculated to be 15.49% of total assets. Using the maximum amount of inventory and substituting it into equation (26), the maximum amount of receivables is calculated to be 6.16%. Working capital is defined as the sum of cash, receivables, and inventory, and the minimum amount of cash is determined to be 6.81%. Using the optimal value calculated by us for asset and resource management means that Mongolian mining companies will have good solvency and be able to use their assets effectively, as well as have less financial dependence on others.

3. Conclusions

Capital contributes to the optimal asset structure. Therefore, we propose a fractional programming problem to optimize the asset and capital structure. Companies can use this model of asset and capital structure optimization in their operations. We have optimized the asset and source optimal structure of Mongolian mining companies through function streaming to working net capital purposed value. Numerical results explain that the current assets (28.46% of total assets) of mining companies are lower than non-current assets, this situation is considered as the mining sector's diversity.

The objective function results also show the potential maximum value of receivables value from liquid assets should be 6.16%, inventory maximum value to be 15.49%, minimum value of monetary assets to be 6.81%. Mongolian mining companies operate with a deficiency of monetary assets, private mining sector company's receivables value and inventory value are more than optimal value, in outcome they will need to focus on these kinds of assets.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Afza, T., & Nazir, M. S. (2008) Working Capital Management Policies of Firms: Empirical Evidence from Pakistan. *Pakistan Journal of Commerce and Social Sciences, 1,* 18-30.

Campello, M., & Giambona, E. (2013) Real Assets and Capital Structure. *The Journal of Financial and Quantitative Analysis, 48,* 1333–1370. https://doi.org/10.1017/S0022109013000525

Deloof, M. (2003) Does Working Capital Management Affet Profitability of Belgian Firms? *Journal of Business Finance and Accounting, 30,* 573-588. https://doi.org/10.1111/1468-5957.00008

Gebrehiwot. A., & Wolday, A. (2006) Micro and Small Enterprises (MSEs) Finance in Ethiopia: Empirical Evidence. *Eastern Africa Social Science Research Review, 22,* 63-86.

https://doi.org/10.1353/eas.2006.0002

Koralun-Bereźnicka, J. (2013) How Does Asset Structure Correlate with Capital Structure? —Cross-Industry and Cross-Size Analysis of the EU Countries. *Universal Journal of Accounting and Finance, 1,* 19-28. https://doi.org/10.13189/ujaf.2013.010103

Lind, L., Pirttila, M., Viskari, S., Schupp, F., & Karri, T. (2012) Working Capital Management in the Automotive Industry: Financial Value Chain Analysis. *Journal of Purchasing & Supply Management, 18,* 92-100. https://doi.org/10.1016/j.pursup.2012.04.003

Ministry of Finance Mongolia (2015) *Model Methodology for Analyzing the Financial Statements of a Business Entity or Organization.*

Schilling, G. (1996) Working Capital's Role in Maintaining Corporate Liquidity. *TMA Journal, 16,* 4-7.

Titman, S. (1983) The Effect of Capital Structure on a Firm'S Liquidation Decision. *Journal of Financial Economics, 3,* 137-151. https://doi.org/10.1016/0304-405X(84)90035-7