

Application of Financial Mathematics in Marketing Trend Analysis

Tianmeng Xiao, Yuqing Huang

School of International Trade and Economics, Central University of Finance and Economics, Beijing,
102206

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Abstract: With the continuous expansion of the impact of the new economic era, China's competition in marketing is intensifying. If an enterprise wants to have a place in the fierce competition, it must continue to reform and innovate marketing strategies and establish advancing with the times. Marketing concept, actively learning new marketing methods to adapt to the continuously changing and changing market environment, so as to promote enterprises to improve their economic benefits and seek a better development path. This article takes Shanghai Liangxin Electric Co., Ltd. as an example. In the new economic era, the importance of marketing, marketing strategies, and marketing development were explored, and the company's business situation in the next three years was analyzed. The data was checked and processed using python, and the company was 2015 according to the ring-by-month analysis. -In 2017, each item of the balance sheet, profit statement and cash flow statement was analyzed for a quarter-on-quarter change, and then the financial statements of Shanghai Liangxin Electric Co., Ltd. were forecasted. The forecast results show that the company's return on equity in the next three years, Several indicators, such as total asset turnover rate and total asset return rate, have increased, indicating that companies areTo three years of operation it is getting better.

1. Data inspection and preprocessing

First, I used python to check and analyze all the data on a monthly basis. It was found that the data at 06:00 on March 30th was missing, and the data at 17:00 on September 27th was incorrect. This is because the measured data has a significant time correlation, and Taking into account the actual meaning behind the data, the missing and abnormal data can be predicted from the previously measured data, and the time interval between the data is small, and it is less affected by periodic changes. There are no irregular changes and large fluctuations. In this case, a simple time series moving average method is used for prediction [1] to correct and repair abnormal and missing data.

Let the observation sequence be $M_t^{(1)}$, Take the number of items of the moving average N . A simple moving average calculation formula is:

$$M_t^{(1)} = \frac{1}{N}(y_{t-1} + \dots + y_{t-N}) + \frac{1}{N}(y_t - y_{t-N}) = M_{t-1}^{(1)} + \frac{1}{N}(y_t - y_{t-N}) \quad (1)$$

When the basic trend of the prediction target fluctuates above and below a certain level, a simple moving average method can be used to build a prediction model:

$$\hat{y}_{t+1} = M_t^{(1)} = \frac{1}{N}(\hat{y}_t + \dots + \hat{y}_{t-N+1}), t = N, N+1, \dots \quad (2)$$

Its prediction standard error is:

$$S = \sqrt{\frac{\sum_{t=N+1}^T (\hat{y}_t - y_t)^2}{T - N}} \quad (3)$$

The average value of the most recent n-period series is used as the prediction result of each future period. Generally, the value range of n is: $5 \leq N \leq 200$, Compare the prediction errors of several models, take n as 5, and get the prediction results for repair.

2. Trend analysis of financial statements

2.1 Analysis of changes in balance sheet items

After analyzing and processing the data, the following figure shows the percentage change of each item in Shanghai Liangxin's balance sheet, as shown in the following figure:

Projects	Amount of each year (Yuan)			Percentage change from month to month	
	2015 year	2016 year	2017 year	2016 year	2017 year
Current assets =					
Monetary fund	217,557,649.71	196,066,195.32	125,504,172.51	-9.88%	-35.99%
Note receivable	202,694,264.34	244,727,212.35	273,283,917.80	20.74%	11.67%
Accounts receivable	80,321,703.21	78,454,462.53	104,618,311.82	-2.32%	33.35%
Advance payment	1,268,047.43	1,007,810.18	827,872.11	-20.52%	-17.85%
Interest receivable	657,575.01	4,268,562.04	6,773,041.12	549.14%	58.67%
Other receivables	3,304,294.26	3,934,341.52	5,602,699.14	19.07%	42.41%
Inventory	158,611,979.66	153,636,561.17	188,696,937.24	-3.14%	22.82%
other current assets	90,000,000.00	630,887,612.74	672,633,374.70	600.99%	6.62%
Total current assets	754,415,513.62	1,312,982,757.85	1,377,940,326.44	74.04%	4.95%
Non-current assets =					
Long-term equity investment	2,197,874.75	3,691,875.48		67.97%	-100.00%
Investment real estate		42,194,025.12	39,414,919.60		-6.59%
Fixed assets	250,916,204.83	243,545,459.09	245,468,029.32	-2.94%	0.79%
Construction in progress	105,060,246.04	181,400,636.06	225,161,910.79	72.66%	24.12%
Intangible assets	59,748,041.34	59,334,368.69	60,169,052.05	-0.69%	1.41%
questionnaire			23,625,037.17		
Long-term prepaid expenses	24,273,217.28	24,067,009.31	29,446,513.67	-0.85%	22.35%
deferred tax assets	2,498,650.66	2,851,433.44	4,071,717.95	14.12%	42.80%
Other non-current assets	33,189,854.40	21,473,406.51	28,285,908.14	-35.30%	31.73%
Total non-current assets	477,884,089.30	578,558,213.70	655,643,088.69	21.07%	13.32%
Total assets	1,232,299,602.92	1,891,540,971.55	2,033,583,415.13	53.50%	7.51%

Figure 1. Percentage change of each item of Shanghai Liangxin's balance sheet

(1) Analysis of asset change trends

According to the data in the above table, from the perspective of total assets, the total assets of Liangxin Electric showed an upward trend from 2015 to 2017. The total assets in 2016 increased by 53.50% compared with 2015, and the total assets in 2017 were compared with 2016. Increased by 7.51%, the percentage change from the previous month decreased sharply. From the perspective of the composition of total assets, the current year-on-year growth and change of current assets from 2015 to 2017 was larger than that of non-current assets. In 2016, current assets increased by 558,567,244.23 million yuan from 2015. Assets increased by 64,957,568.5900002 yuan compared with 2016, mainly due to the year-on-year changes in interest receivables and other current assets of 549.14% and 600.99% in 2016. In addition, bills receivable and other receivables all increased, in 2017 The increase in interest receivables and other current assets decreased, and the month-on-month change decreased significantly. In addition, the average amounts of bills receivable, accounts receivable, other receivables, and inventories increased. It increased by RMB 100,674,124.4 in 2015, an increase of 21.07% month-on-month, mainly due to the long-term equity investment of enterprises, construction in progress, deferred income tax assets, a larger increase than in 2015; non-current assets in 2017 Compared with 2016, it increased by 77,084,875.0 yuan, an increase of 13.32% from the previous quarter. The company's construction in progress and deferred income tax assets continued to rise. In addition, the amount of fixed assets, intangible assets, long-term deferred expenses, and other non-current assets This year has seen an increase. Liangxin Electric's current assets are much larger than non-current assets, indicating that Liangxin Electric's assets are in good condition and its asset structure is more reasonable.

(2) Analysis of debt change trend

From the above chart, it can be seen that from the perspective of the total liabilities, the chain changes in 2016 and 2017 are small. The total liabilities increased by 5.25% in 2016 and the total debt growth in 2017 decreased to 1.88%, indicating that Liangxin Electric's compensation The debt capacity is strong and has been improved, and the financial risk is reduced. From the perspective of

the debt structure, current liabilities increased by 15.44% compared to 2015 in 2016 and decreased to 0.19% in 2017, mainly due to accounts payable in 2016, Advance receipts, payable employees' salaries, and taxes payable all increased compared to 2015, while the accounts payable, advance receipts, tax payable, and dividends payable of enterprises in 2017 all decreased compared to 2016. Liangxin Electric 2015 -In 2017, there were no short-term borrowings, long-term borrowings, and non-current liabilities due within one year, and the debt ratio was extremely low. On the one hand, Liangxin Electric had a strong solvency, and on the other hand, it also led to a reduction in the role of financial leverage.

(3) Analysis of changes in owner's equity

From the data in the chart above, it can be seen that from the perspective of the total owner's equity, the owner's equity increased by 70.50% in 2016 from the previous month, and the chain's growth in 2017 fell sharply to 8.73%. The year-on-year increase is 124.53%. In addition, the company's capital reserve, surplus reserve and undistributed profits have all increased. The company's inventory shares have decreased by 52.78% month-on-year. In 2017, the stock capital of Liangxin Electrical Appliances still increased significantly. Compared with 2016, the chain increased by 102.59%, but at the same time, the company repurchased a large number of stocks, the inventory shares increased by 188.67%, the company's capital reserve decreased, the surplus reserve and undistributed profits increased, and the chain change remained unchanged. Large, so the change in the owner's equity of Liangxin Electric decreased significantly in 2017, to a certain extent, indicating that companies need to improve their ability to create return on investment for shareholders.

2.2 Analysis of changes in income statement items

Table 1 Momentum Changes of Major Financial Indicators in the Income Statement

project	Amount for each year (yuan)			Percent change from the previous month	
	2015 year	2016 year	2017 year	2016 year	2017 year
Operating income	1013049182.73	1225771,405.37	1452048270.46	21.00%	18.46%
Operating cost	639596444.84	766390326.17	891207563.98	19.82%	16.29%
operating profit	139554232.95	170897668.22	219891047.40	22.46%	28.67%
sales expense	113588086.06	148211700.53	182457767.82	30.48%	23.11%
Management fees	116038808.40	141064749.67	178528158.46	21.57%	26.56%
Financial expenses	-3086109.49	-3436728.96	-307853.79	11.36%	-91.04%
Income tax	23591853.38	28594646.89	35411977.71	21.21%	23.84%
Net profit	125135537.65	162196209.67	210200079.90	29.62%	29.60%

From the data in the table above, it can be seen that the net profit of Liangxin Electric increased year by year from 2015 to 2017, and both increased in 2016 and 2017. The net profit in 2016 increased by 29.62% compared to 2015, and compared with 2016. The growth rate was 29.60% month-on-month, and the two-month month-on-month growth was relatively stable, indicating that Liangxin Electric's profitability is still strong. The chain-money growth of Liangxin Electric in 2017 was lower than that in 2016, although the operating income continued to increase in these three years. However, the growth rate in 2017 was relatively small, and the month-on-month change in operating costs in 2017 was also lower than in 2016. Therefore, the company's net profit continued to grow, and the operating profit in the year-on-year change in 2017 also increased.

According to the data in the above table, the sales and management expenses of Liangxin Electric continued to rise in 2016 and 2017, and the percentage change from the previous month also changed relatively smoothly. The financial costs of it changed greatly. In 2016, the financial expenses of Liangxin Electric compared to 2015. Increased 11.36%, compared with the increase in sales expenses and management expenses, but its financial expenses decreased significantly in 2017, compared with the chain change in 2016, a significant decrease, showing a negative value. In this

year, Liangxin Electric's operating cost increase may be reduced. Related to this, it can be seen that Liangxin Electric's profitability is still strong.

2.3 Analysis of changes in cash flow statement items

Table 2. Monetary Changes of Main Financial Indicators of the Cash Flow Statement

project	Amount for each year (yuan)			Percent change from the previous month	
	2015 year	2016 year	2017 year	2016 year	2017 year
Subtotal of cash inflows from operating activities	1196726455.93	1408205696.45	1275549843.57	17.67%	-9.42%
Subtotal of cash outflows from operating activities	1029045277.25	1185753011.55	1104247906.22	15.23%	-6.87%
Net cash flow from operating activities	167681178.68	222452684.90	171301937.35	32.66%	-22.99%
Subtotal of cash inflows from investing activities	658670101.94	663233618.26	1713478096.13	0.69%	158.35%
Subtotal of cash outflows from investing activities	803588163.16	1338949901.43	1890554477.11	66.62%	41.20%
Net cash flows from investing activities	-144918061.22	-675716283.17	-177076380.98	366.27%	-73.79%
Subtotal of cash inflows from financing activities	5275361.00	494909604.25	39672880.00	9281.53%	-91.98%
Subtotal of cash outflows from financing activities	30315838.01	64746523.75	104150295.25	113.57%	60.86%
Net cash flow from financing activities	-25040477.01	430163080.50	-64477415.25	-1817.87%	-114.99%

(1) Analysis of cash flow changes in operating activities

According to the data in the above chart, from the perspective of the net cash flow generated by operating activities, the net cash flow generated by Liangxin Electric's operating activities in 2015-2017 showed an inverted "v" shape characteristic of rising first and then decreasing, 2016 The net cash flow generated from operating activities increased by 54771506.22 yuan compared with 2015, an increase of 32.66% month-on-month, and the net cash flow generated by operating activities decreased from 51,150,747.55 yuan in 2017 compared to 2016, and the month-on-month change significantly decreased to -22.99%. The annual subtotal of cash inflows and subtotals of operating activities both increased to a certain extent, which was the main reason for the year-on-year increase in the net cash flow from operating activities. In 2017, the cash inflows and outflows of operating activities of the company both declined, and The cash inflow from operating activities changed by -9.42% month-on-month, which was larger than the cash outflow from operating activities. Among them, the cash received from selling goods and providing labor services fell sharply, and the cash paid for purchasing goods and receiving labor services also fell significantly. The monthly changes in cash paid for employees and taxes and fees paid have increased significantly, so the cash flow generated from operating activities in 2017 Net greatly reduced.

(2) Analysis of the change trend of cash flow from investment activities

According to the data in the above table, it can be seen that the net cash flow generated by investment activities in 2016 increased by 366.27% compared to 2015, which is a larger range, mainly because the cash outflow of investment activities increased more than the cash inflows of investment activities, and the amount of outflow was far Much greater than the amount of cash inflows. In this year, the net cash recovered from disposal of fixed assets, intangible assets and other long-term assets increased the most month-on-month, but its growth base was small. Cash paid for investment, other payments and investment activities Relevant changes in the cash chain have increased, and the base is large, so the net cash flow generated by investment activities has changed from -144,918,061.22 to -675,716,283.17. The net cash flow generated by investment activities in

2017 has decreased to -73.79%, a large decrease, mainly due to the sub-total change in cash inflows from investment activities increased significantly to 158.35%, while the month-on-month increase in cash outflows from investment activities decreased compared to the month-on-month increase in 2016. In 2017, companies made investments The cash received for income and other cash related to investment activities increased significantly, while the cash paid for investment changed It is 0, so the net cash flow generated by the investment activities of the company in 2017 decreased significantly.

(3) Analysis of cash flow changes in financing activities

According to the data in the above table, it can be seen that the net cash flow generated by financing activities in 2015 was -25,040,477.01, and its quota in 2016 became 430,163,080.50, a month-on-month change of -1817.87%, a larger range, mainly due to the substantial increase in cash received from absorbing investments. As a result, the amount of cash inflows from financing activities was much larger than the amount of cash outflows from financing activities. In 2017, the net cash flow generated by Liangxin Electric's financing activities changed to -64,477,415.25, a chain change of -114.99%, mainly due to the company's absorption of investment income during the year. The cash received has fallen sharply, and the cash paid for distribution of dividends, profits or interest payments has increased significantly, resulting in lower cash inflows from financing activities than cash outflows.

It can be seen that the trend analysis of various financial indicators in different years and the gap between adjacent years can be roughly seen through the trend analysis, which provides an analytical basis for internal management personnel to improve business management and external investors to conduct value evaluation.

3. Financial Statement Forecast

3.1 Forecast Sales Revenue

The sales forecast of Shanghai Liangxin Electric Co., Ltd. is shown in the following table:

Table 3. Sales forecast of Shanghai Liangxin Co., Ltd.

years	20X5	20X6	20X7	20x8E	20X9E	20X10E
sales growth rate	18.39%	21.00%	18.46%	10%	10%	10%
Sales income (ten thousand)	101304.92	122577.14	145204.83	159725.31	175697.84	193267.62

3.2 Forecasting marketing deadlines

3.2.1 Establishment of Ridge Regression Model

In order to determine the company's forecast period, a ridge regression [2,3], a biased estimation regression method dedicated to collinear data analysis, is essentially an improved least squares estimation method. It is more practical and reliable to obtain regression coefficients at the cost of loss of some information and reduced accuracy. The fitting of ill-conditioned data is stronger than the least square method. It is the most commonly used method for regression analysis of discomfort. A regularization method.

The least square method commonly used in regression analysis is an unbiased estimate. For a well-posed problem, X Usually full rank $X\theta = y$. Using the least square method, define the loss function as the square of the residual, and minimize the loss function as $\|X\theta - y\|^2$.

The above optimization problem can be solved by the gradient descent method, or it can be directly solved by the following formula

$$\theta = (X^T X)^{-1} X^T y \tag{4}$$

when X When the columns are not full rank, or when the linear correlation between some columns is relatively large, $X^T X$ The determinant is close to 0, i.e. $X^T X$ Close to singularity, the

above problem becomes an ill-posed problem. At this time, the calculation $(X^T X)^{-1}$ The time error will be very large, and the traditional least square method lacks stability and reliability.

In order to solve the above problem, we need to convert the ill-posed problem into a well-posed problem: we add a regularization term to the above loss function and become $\|X\theta - y\|^2 + \|\Gamma\theta\|^2$ Where, definition $\Gamma = \alpha I$, then:

$$\theta(\alpha) = (X^T X + \alpha I)^{-1} X^T y \quad (5)$$

In the above formula, I Is the identity matrix. With α Increase, $\theta(\alpha)$ Each element $\theta(\alpha)$ The absolute values of θ_i The deviation is also getting bigger. α Towards infinity, $\theta(\alpha)$ Tend to 0. Among them, $\theta(\alpha)$ Follow α The trajectory changed by the change is called the ridge trace. There are a lot of options in the actual calculation. α Value, make a ridge plot, and see which value the graph becomes stable at, then determine α It's worth it.

Ridge regression features: 1, Ridge regression is a supplement to least squares regression, it loses unbiasedness in exchange for high numerical stability, so as to obtain higher calculation accuracy; 2, usually the regression coefficient of the Ridge regression equation The significance and accuracy are often significantly higher than ordinary regression, and have great practical value in studies with colinearity problems and more morbid data.

Take the Ridge regression model and use Python to normalize the required data. Combined with Shanghai Liangxin Electric Co., Ltd., determine that the financial forecast is based on 2017 and the forecast period is 3 years.

4. Key financial assumptions

Based on the financial assumptions of Shanghai Liangxin Co., Ltd.'s income statement and assets and liabilities, the following table is obtained.

Table 4. Major financial assumptions of Shanghai Liangxin Co., Ltd.

	20X5	20X6	20X7	20X8E	20X9E	20X10E
Sales revenue growth rate	18.39%	21.00%	18.46%	10%	10%	10%
Cost of sales ratio	63.14%	62.52%	61.38%	62.24%	62.24%	62.24%
<u>Selling and administrative expenses</u> Sales revenue	22.67%	23.60%	24.86%	23.84%	23.84%	23.84%
<u>Depreciation and amortization</u> Sales revenue	1.62%	2.16%	2.25%	2.05%	2.05%	2.05%
Short-term borrowing rate	6%	6%	6%	6%	6%	6%
Long-term borrowing rate	10%	10%	10%	10%	10%	10%
Average income tax rate	15%	15%	15%	15%	15%	15%
<u>Operating cash</u> Sales revenue	21.48%	16.00%	8.64%	14.61%	14.61%	14.61%
<u>Other operating current assets</u> Sales revenue	28.39%	26.77%	26.47%	27.10%	27.10%	27.10%
<u>Operating current liabilities</u> Sales revenue	28.81%	27.50%	23.30%	26.21%	26.21%	26.21%
<u>Operating long-term assets</u> Sales revenue	41.50%	40.04%	36.84%	39.18%	39.18%	39.18%
<u>short-term loan</u> Net operating assets	0	0	0	0	0	0
<u>Long term loan</u> Net operating assets	0	0	0	0	0	0

Note: Because Liangxin Electric did not have short-term borrowings and long-term borrowings in its 2015-2017 balance sheet, its short-term borrowings / net operating assets and long-term borrowings / net operating assets are both 0 [4].

5. Conclusion

Since Liangxin Electric had less debt in 2015-2017 and did not have short-term borrowings and long-term borrowings, its financial liabilities are expected to be zero in the next three years, and its solvency will remain high.

Table 5. Main forecast indicators of Shanghai Liangxin Co., Ltd.

index	2017 year	2018 year	2019	2020
Turnover ratio of current assets	1.09	2.40	2.40	2.40
Total asset turnover	0.74	1.83	1.83	1.83
Gross profit margin	38.62%	38%	38%	38%
Return on equity	12.97%	18%	18%	18%
Roa	10.72%	18%	18%	18%

(1) Analysis of operating capacity

In the next three years, Liangxin Electric's current asset turnover rate and total asset turnover rate will increase compared to 2017, and the increase rate will be larger, indicating that the company's ability to generate operating income in the next three years will increase, and the overall use efficiency of assets will improve.

(2) Profitability analysis

Liangxin Electric's sales gross profit margin in the next three years will change little, almost in a linear trend, indicating that the company's profitability in the next three years will be relatively stable and there will be no huge fluctuations. This may be due to the company's less debt and no long-term Borrowing and short-term borrowing are caused by less operating costs, so the profitability of the company is higher. The return on shareholders' equity and the return on total assets of the enterprise will rise in the next three years, indicating that the company's ability to create returns for shareholders has increased.

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