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Financial Early Warning Model Based Short Selling Product Design - Pharmaceutical Industry

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Abstract: *Due to the continued impact of the global new crown epidemic, the current investment in the pharmaceutical track is exceptionally hot, and the demand for high-yield fund products in the pharmaceutical industry has arisen, while its accompanying risks have further increased. In this paper, 18 financial indicators were initially selected from five dimensions, and the Mann-Whitney test was used to eliminate variables that were not significantly different between ST companies and financially normal companies. 7 variables were finally identified for inclusion in the model by combining the principles of indicator selection and stepwise regression method, and finally the financial warning model based on annual reports was obtained through logistic regression and its effect was back-tested. The P-values of all companies are calculated using the financial warning model, after which six companies in the top 10 and bottom 10 of the P-values that can finance and finance securities are selected and their returns during the investment period are t-tested, and it is found that significant positive returns can be obtained during the holding period by short selling stocks, and relevant financial products can be designed accordingly.*

Keywords: *Short selling; Financial Alert Model; Fund Products*

1. Product Name and Definition

Product Name: New Spring Short Selling Fund

The "New Spring" is an innovative way to help companies avoid risks and make their wealth flow like a spring.

The "New Spring Short Selling Fund" is a product of the current financing and financing business in China. Financing and financing is also known as "securities credit trading", which means that a qualified securities company requires investors to provide collateral[1], and then the investors borrow funds from the securities company to achieve the purpose of purchasing securities (financing and financing) or borrowing securities and at the same time achieve the target of offering securities (financing and financing). The fund is set up for the pharmaceutical sector and the stocks in the pool are selected with the help of a financial alert model. The financial warning model is essentially a discriminatory model that analyzes and judges the financial position of a company through its financial indicators.

2. Product Design Background

Financing and securities financing refers to leveraged borrowing to buy stocks (financing) or leveraged borrowing to sell stocks (securities financing), of which securities financing business is short selling. As an important innovation in the history of finance, financing and financing securities first originated in the U.S., but lagged behind in China. on October 5, 2008, the China Securities Regulatory Commission started the pilot financing and financing securities, and in March 2010, with the approval of the State Council, China officially implemented the financing and financing securities business. At the beginning of the policy implementation, there were only 6 securities companies and 90 tradable stocks. In the following years, financing and financing securities have become more and more popular among the public and their policies have become more and more mature. wind data shows that as of March 2022, the balance of China's financing and financing securities has reached 167282058 billion yuan, the specific scale trend is shown in Figure 1. With the rapid development of the capital market, the business scale of financing and financing securities will be further enhanced in the future.

The advent of credit trading has allowed investors to not only invest in securities that are expected to

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rise in price, but also to short-sell securities that are expected to fall. Thus, the use of financial warning models provides a viable and effective way to invest in bearish securities. The financial early warning model can predict the risk of the enterprise in advance or warn the enterprise in the first time when it encounters the risk, investors will pay more attention to the financial situation of the enterprise after receiving the warning and adjust their investment strategies in time, while the business operators not only judge the degree of impact on themselves based on the financial information of listed companies, but also strengthen the level of financial management and avoid financial losses by applying the financial early warning system. The current research on financial early warning model has been more perfect, and this paper, based on the reference of previous research results, constructs a new financial early warning model to achieve the purpose of investment stock selection, and then designs a short selling fund product related to it.

3. Product Necessity Analysis

Currently, the pharmaceutical track continues to be hot due to the continued impact of the global new crown epidemic, especially the pharmaceutical manufacturing industry, which has been maintaining a high growth trend. According to the National Bureau of Statistics, the annual revenue of China's pharmaceutical manufacturing industry in 2021 was 2,928.85 billion yuan, an increase of 17.83% year-on-year. At the same time, the export of pharmaceutical manufacturing industry has also increased significantly due to the continued seriousness of the epidemic situation overseas, which has led to a great increase in the export demand for epidemic prevention material products. 24.3% year-on-year growth in the export delivery value of pharmaceutical manufacturing industry in the first two months of 2022, 7.4% higher than the industrial average. Meanwhile, in terms of data from listed companies, the pharmaceutical and biological sector continued to maintain a stable performance[3].

The future development of the pharmaceutical industry is bound to be a top priority in China, and the demand for high-yielding fund products for the pharmaceutical industry has emerged accordingly, while its accompanying risks, such as industry policy risk, the risk of less-than-expected development of innovative drugs and the risk of less-than-expected performance, have further increased. Therefore, it is necessary to establish a financial warning model-based short-selling fund product for the pharmaceutical industry.

4. Product Feasibility Analysis

In terms of the short-selling mechanism, according to the "Measures for the Administration of Securities Company Financing and Financing Business", the short-selling business refers to the situation where an investor does not hold the actual stock and makes a judgment that the market price will fall in the future, then he can borrow the stock from the securities company and sell it, and then buy the stock and return it to the securities company after the stock price falls. Moreover, a large number of domestic and foreign scholars have found that the short selling mechanism does not lead to the decline of the stock market, but helps to increase the stability of the stock market, so this trading mechanism has its rationality and legitimacy[4].

In terms of product design, in Part V of this paper, the P-values of 64 companies are calculated by establishing a financial warning model based on annual reports, and then six companies with high and low P-values, i.e., ST companies and normal companies, are selected for financing and financing, and the t-test is conducted on their short-selling returns.

5. Short-selling fund product design and simulation

5.1 Sample design and indicator selection

(1) Sample Design

This paper takes listed companies in China's A-share pharmaceutical sector as the research object, and takes whether listed companies are specially treated for financial reasons (ST) as the basis for judging corporate financial crisis, and selects 16 companies that are ST from 2015-2021 as the sample, while 48 financially normal companies are selected as the auxiliary pair in a ratio of 1:3, for a total sample of 64 companies. The principle of selection is that the two types of companies have similar total asset size and similar main business.

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(2) Indicator selection

The selection of financial early warning indicators is particularly important for the effectiveness of the application of financial early warning models. The selection of early warning indicators in this paper follows the principles of comprehensiveness, complementarity and predictability

Based on the previous research results and the characteristics of the medical industry, this paper initially selects 18 important financial indicators, including 15 financial indicators that reflect the solvency, operating ability, profitability and development ability of listed companies and 3 financial indicators per share that investors are more concerned about [5], as shown in Table 1.

Table 1: List of Financial Metrics

Evaluation Content	Evaluation Indicators	Indicator Code	Indicator calculation formula
Solvency	Current Ratio	X1	Current assets/current liabilities
	Quick Ratio	X2	(Current assets - inventories)/current liabilities
	Gearing ratio	X3	Total liabilities/total assets
	Equity ratio	X4	Total liabilities/total owner's equity
Business Capability	Inventory turnover rate	X5	Operating income/average inventory balance
	Accounts Receivable Turnover Ratio	X6	Net credit receipts/average balance of accounts receivable
	Fixed asset turnover rate	X7	Net revenue from main business / Average total fixed assets
	Current asset turnover ratio	X8	Net revenue from main business / Average total current assets
	Total assets turnover ratio	X9	Net income from main business / Average total assets
Profitability	Return on Assets	X10	Net Profit / Average Total Assets
	Total net asset margin	X11	Net profit / Average total assets
	Return on Net Assets	X12	Net Income / Shareholders' Equity Balance
Development capacity	Total assets growth rate	X13	(Total assets at the end of the year - Total assets at the beginning of the year) / Total assets at the beginning of the year
	Net profit growth rate	X14	(Net income for the period - Net income for the previous period)/Net income for the previous period
	Owner's equity growth rate	X15	(Total owner's equity for the current period - Total owner's equity for the previous period)/ Total owner's equity of the previous period
Per Share Metrics	Earnings per share	X16	Net Income / Total Equity
	Capital surplus per share	X17	Ending value of capital surplus / Total equity
	Net cash flow per share	X18	Net cash flow/total equity

All indicator data in this paper are obtained from Wind, and all data are pre-processed before further indicator selection. In order to eliminate the influence of inflation factors on the data, 2013 was used as the base period, and the CPI index for the calendar years 2014-2020 was used to calculate the inflation rate and adjusted the data with it. After that, by comparing and analyzing ST companies with financially normal companies, it is found that the model possesses better prediction effects when the financial conditions of the two types of listed companies have significant differences. Therefore, this paper firstly performs the Mann-Whitney test on the 18 financial indicators initially screened, eliminating variables with significance greater than 0.05, i.e., eliminating indicators that do not differ significantly between the two types of companies. The original hypothesis H_0 of this test is the variables that do not differ significantly between ST companies and financially normal companies, and the alternative hypothesis H_1 is the variables that differ significantly between ST companies and financially normal companies, and the results are shown in Table 2.

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Table 2: Results of the Mann-Whitney test

Variable code	Variables	Significance	Decision-making
X1	Current Ratio	0.03103	Reject the original hypothesis
X2	Quick Ratio	0.00026	Reject the original hypothesis
X3	Gearing ratio	0.00397	Reject the original hypothesis
X4	Equity ratio	0.00940	Reject the original hypothesis
X5	Inventory turnover rate	0.01438	Reject the original hypothesis
X6	Accounts Receivable Turnover Ratio	0.02827	Reject the original hypothesis
X7	Fixed asset turnover rate	0.00000	Reject the original hypothesis
X8	Current asset turnover ratio	0.00000	Reject the original hypothesis
X9	Total assets turnover ratio	0.00000	Reject the original hypothesis
X10	Return on Assets	0.00000	Reject the original hypothesis
X11	Total net asset margin	0.00000	Reject the original hypothesis
X12	Return on Net Assets	0.00000	Reject the original hypothesis
X13	Total assets growth rate	0.00000	Reject the original hypothesis
X14	Net profit growth rate	0.00630	Reject the original hypothesis
X15	Owner's equity growth rate	0.00190	Reject the original hypothesis
X16	Earnings per share	0.00000	Reject the original hypothesis
X17	Capital surplus per share	0.16332	Reject the original hypothesis
X18	Net cash flow per share	0.13218	Reject the original hypothesis

The test results indicate that capital stock per share and net cash flow per share are not significant between the two types of companies. When these two variables are excluded, the remaining 16 variables are tested for correlation coefficients, and the results show that there is a more serious problem of multicollinearity between some of the variables. In order to reduce the multicollinearity among the samples, this paper firstly judges whether it is suitable for principal component analysis by KMO test, and the results show that the value of KMO is less than 0.7, which is not suitable for principal component analysis[6]. Therefore, this paper combines the principle of index selection and stepwise regression method to further screen the appropriate variables, and theoretically, variables with p-value less than 0.05 are included in the model. However, considering that both current asset turnover rate and inventory turnover rate are important indicators to judge the business ability of enterprises, and the two indicators can play a complementary role to each other, so although the significance of the variable current asset turnover rate cannot pass the test, but based on the practical significance, we still choose to retain it in the end, and the regression results are shown in Table 3.

Table 3: Stepwise regression results

Models	Standardization factor	Standard error	t	Significance	Lower limit of the 95% confidence interval for B	The upper 95% confidence interval of B
X4	-0.0207	0.0082	-2.54	0.012	-0.0367	-0.0047
X5	-0.0008	0.0004	-2.24	0.025	-0.0015	-0.0000
X8	0.0069	0.0200	0.34	0.732	-0.0325	0.0462
X12	0.1523	0.0588	2.59	0.010	0.0368	0.2679
X13	0.1337	0.0549	2.44	0.015	0.0258	0.2416
X15	-0.0789	0.0216	-3.66	0.000	-0.1213	-0.0365
X16	0.1587	0.0254	6.25	0.000	0.1088	0.2086
Constants	0.6811	0.03497	19.48	0.000	0.6123	0.7498

The variables finally selected as the financial early warning model in this paper are equity ratio(X_4), inventory turnover(X_5), current assets turnover(X_8), return on net assets(X_{12}), total assets growth rate($X13$), owner's equity growth rate(X_{15}) and earnings per share(X_{16}), a total of seven financial indicators.

After the indicators were determined, the variance inflation factor (VIF) was used to test for multicollinearity, and the test results are shown in Table 4. From the test results, it can be obtained that the VIF values of the seven variables are less than 5, and there is no significant multicollinearity among the variables, which can prove the reasonableness of the indicator selection.

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Table 4: VIF test results

Variables	VIF
X4	1.10
X5	1.09
X8	1.10
X12	1.30
X13	1.50
X15	1.59
X16	1.22

5.2 Binary LOGISTIC regression

(1) Model Construction

After selecting the variables through the above process, the analysis was conducted using companies that were ST during 2015-2021, and the time when the companies fell into financial distress was year T. The data of year T-1 was used for both ST companies and financially normal companies, i.e., the data of variables from 2014-2020 to establish the financial warning model based on annual reports. Firstly, ST companies are labeled as "1", which indicates a higher probability of loss, and financially normal companies are labeled as "0", which means a lower probability of loss. Then, the logistic regression analysis of the seven variables was conducted using SPSS software, and the regression results are shown in Table 5.

Table 5: logistic regression results

Variables	Coefficient	Standard error	P
X4	-0.1142	0.0833	0.171
X5	-0.0140	0.0096	0.198
X8	0.0032	0.0011	0.005
X12	0.6049	0.6228	0.331
X13	1.5512	0.6240	0.013
X15	-1.2774	0.4249	0.003
X16	1.3589	0.2901	0.000
Constants	0.2768	0.2662	0.298

Accordingly, the financial warning model based on annual reports can be expressed as:

$$\log\frac{P}{1-P} = 0.2768 - 0.1142X_4 - 0.0140X_5 + 0.0032X_8 + 0.6049X_{12} + 15512X_{13} \\ -12774X_{\mathrm{K}} + 13589X_{16} \quad (1)$$

(2) Model Testing

Using the above financial early warning model to backtest the financial data of 64 sample companies from 2014 to 2020, *P=0.5* was used as the basis for judging whether an enterprise is likely to have a financial crisis, and when *P>0.5*, it is considered that the probability of the enterprise having a financial crisis is higher, and when *P<0.5*, it is considered that the enterprise is more likely to be in a normal financial state. The results of the test show that the backtesting rate of the model is 82.3%, and the overall model effect is good, and the test results are shown in Table 6.

Table 6: Model test results

Category	Actual number	Number of correct backtests	Percent correct	Overall correct rate
ST Corporation	16	12	75.0%	82.3%
Financially sound company	48	45	89.6%	

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5.3 T-test of short-sale return on financing securities

Hypothetical premise: In the forecast period 2021, the P-value is calculated using the previous year's annual report data, after which the P-values are sorted from largest to smallest, and six companies in the top 10 and bottom 10 that can be financed and financed are selected, and a short sale of the financing is established six months before the next year's annual report is published, i.e., November 10, and the stock is bought on the nearest trading day on May 10 of the following year to return the securities. Given that it takes some time for the company's financial information to be reflected in the stock price, the short sale is chosen on the 10th trading day after the annual report is uniformly reported. In order to simplify the calculation, this paper does not take into account the fees, stamp duty and interest of the financing process, and only calculates the return on net assets due to the change in share price [7].

Based on the hypothesis, the annualized weighted average return R1 for companies with higher P-values and R2 for companies with lower P-values were calculated separately for each period, and then t-tests were conducted for R1 and R2, and the test results are shown in Table 7.

Table 7: T-test results

Prediction period	Holding period	R_1	R_2	T-test results
2021	6 Months	19.29%	0.72%	Ha: mean (diff)<0 Pr(T<t) = 0.9889 Ha: mean (diff)>0 Pr(|T|>|t|) = 0.0111
		13.48%	2.33%	
		18.00%	-0.26%	

Based on the results of the t-test, it can be seen that *Pr(|T|>|t|) = 0.0111*, which is much smaller than 0.05, and the return on short selling in ST companies is expected to be significantly higher than that of financially normal companies, and the difference between the returns of the two types of listed companies is significantly non-zero. Therefore, using the financial warning model for short selling investment has a more stable positive return, and relevant financial products can be designed accordingly[8].

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