A Discriminant Analysis of the Financial Indicators of the Innovative Pharmaceutical Enterprises

Yuanyuan Zhang and Yu Jia*
School of Management, Shanghai University, Shanghai, China

*Corresponding author e-mail: luckyuan@shu.edu.cn

Abstract. This study examines the value relevance of financial indicators and pharmaceutical innovation. Discriminant analysis is used to study the difference of the financial indicators of innovative pharmaceutical enterprises and the generic pharmaceutical enterprises during the sample period between 2013 and 2017. The results show that operational capacity, debt-paying ability, growth capacity and research and development capabilities are important indicators for identifying innovative pharmaceutical companies. Investors can take these financial indicators into consideration when measuring the innovation ability of pharmaceutical enterprises.

1. Introduction
The Biomedical Sector has become a new favorite of capital market. In the first three quarters of 2018, the growth rate of biomedical sector ranked third among 28 first-class industries. The analysis of financial statements in the pharmaceutical industry is of great significance for investors to understand corporate characteristics, financial status and operating results, and make investment decisions. At the same time, innovation is the eternal theme of the pharmaceutical industry. The government has issued a number of policies to point out that it is necessary to speed up the development of medicine research and pharmaceutical industry [1]. Therefore, it is necessary to distinguish the characteristics of financial indicators between the innovative pharmaceutical companies and the generic pharmaceutical companies so that investors can understand the environment of innovative pharmaceutical industry, and then accurately receive the information content disclosed in the statements of pharmaceutical enterprises. This study starts from the seven financial indicators and establishes a relatively complete indicator inspection system.

2. Overview of the Pharmaceutical Industry Classification
The pharmaceutical industry can be simply divided into innovative drug and generic drug according to its characteristics. Among them, innovative drug has proprietary intellectual property rights and is developed for clinically unresolved problems. However, generic drug is an imitation of marketed drug in order to meet volume requirements [2]. Innovative pharmaceutical companies have the following characteristics. First, the technology is novel. The research and development of innovative drug requires the support of a number of cutting-edge technologies, all of which are leading technologies in the industry. Second, the research and development process is difficult. The data shows that only one of the 5,000 to 10,000 candidate compounds can get success and the average cost of research and development is $1 billion. Third, the profit is generous. Once the innovative drug is successfully developed, it can
enjoy exclusive market share within the patent protection period. Fourth, the traditional valuation methods are not applicable. Innovative pharmaceutical companies have no profit at the research and development stage, and they can quickly make profits once they are successful in research and development. Therefore, the traditional PE (Private Equity) valuation method is not applicable, and it depends on technological progress and potential market size of innovative drug to evaluate the value of innovative pharmaceutical companies. Generic pharmaceutical companies also have four characteristics. First, quality is prone to problems. Generic drug just imitate the chemical formula and is prone to errors in production process and other aspects. Second, the product cycle process is short. After the patent protection expires, a large number of generic drug quickly enter the market and trigger fierce competition. The products quickly enter the recession period from maturity, and the whole time is only about one year. Third, the level of profitability is low. Because the price of generic drug is low, usually only 10% of the innovative drug and the profit rate of generic drug is generally only 5% to 10%. Fourth, the competition is fierce. China is a big country of generic drug. Most pharmaceutical companies only stay in the stage of imitation, but it is easy to compete maliciously through price wars [3].

The biggest cost of innovative pharmaceutical companies stems from research and development process, and it is their biggest profit point at the same time. Therefore, the biggest difference between innovative pharmaceutical companies and generic pharmaceutical companies is the difference in the profit model brought by the research and development method, which is directly reflected in the financial indicators of enterprises. As the direction and new hotspot of the companies’ future development, the degree of innovation is an important reference standard for investors to make investment decisions. This paper uses discriminant analysis to establish a complete set of financial indicators discriminant system for pharmaceutical companies.

3. Research Methods

3.1. Sample Selection

The sample of innovative pharmaceutical companies comes from innovative pharmaceutical concept stocks in the Wind Database. By inquiring innovative pharmaceutical companies’ main business scope to exclude ST enterprises and some newly established enterprises. In the end, 13 innovative pharmaceutical enterprises were selected. In addition, generic pharmaceutical enterprises are matched from generic pharmaceutical concept stocks. The conditions for sample matching are as follows: (1) Capital size and time to market are similar. (2) The company is no-ST (no- Special Treatment). (3) The company's main business is generic drug. This paper selects the 2013-2017 data as a research sample. Finally, 13 innovative pharmaceutical companies and 13 generic pharmaceutical companies were selected, and their financial data came from the Wind Database.

3.2. Variables Selection

This paper mainly studies the differences in financial indicators between innovative pharmaceutical companies and generic pharmaceutical companies, especially the differences in research and development capability. According to the research purpose of this paper, six representative traditional financial indicators are selected to measure the asset structure, profitability, debt-paying ability, operational capability, growth capacity and cash flow of the enterprises. For research and development capabilities, the traditional financial indicators research and development expenditure is selected as the indicators to measure the research and development capability of an enterprise. At the same time, as the pharmaceutical enterprises with stronger research and development ability employ more high-tech, highly educated and high-level research and development talents, the biggest difference between knowledge-intensive industry and labor-intensive industry lies in the value that per capita investment output [4]. Therefore, according to the research and development characteristics of pharmaceutical enterprises, this paper selects the rate of return on investment per capita as the second financial indicators of profitability, which can reflect the profitability of enterprises in terms of research and development capability. Variables are shown in table 1.
Table 1. Definition of variables.

| Variable                     | Financial Indicators            | Design Formulas                                               | Variable Symbol |
|------------------------------|---------------------------------|---------------------------------------------------------------|-----------------|
| Asset structure              | Asset-liability ratio           | Total liabilities/total assets                                | LEV             |
| Profitability                | Return on equity                 | Net profit/average of equity                                  | ROE             |
|                              | Rate of return on investment per capita | Earnings before interest and taxes/gross compensation | ROP             |
| Debt-paying capability       | Liquid ratio                     | Current assets/current liabilities                             | LR              |
| Operational capability       | Total asset turnover             | Sales revenue/average of assets                               | AT              |
| Growth capacity              | Basic earnings per share         | The current net profit attributable to common shareholders/the weighted average of the outstanding common shares of the current period | EPS             |
| Cash flow                    | Sales cash ratio                 | Net cash flow from operating activities/operating income     | CSR             |
| Research and development capabilities | Research and development expenditure | Research and development expenditure /operating income | RDS             |

3.3. Regression Model
This study aims to examine the relationship between financial indicators and pharmaceutical innovation. The dependent variable is a dummy variable and there are only two cases, respectively “innovative pharmaceutical companies” and “generic pharmaceutical companies”. Therefore, this paper uses the Logistic Discriminant Model to identify financial indicators that are related to innovative pharmaceutical enterprises. Suppose the symbol TYPE indicates whether it is an innovative pharmaceutical company (if it is an innovative pharmaceutical company, the value is 1. If it is a generic pharmaceutical company, the value is 0.), the symbol P indicates the probability of the value of TYPE is 1, and the symbol X= (LEV, ROE, ROP, LR, AT, EPS, CSR, RDS) is the explanatory variable. The regression model is as the following.

\[
P = \frac{1}{1+e^{-(\beta_1 + \beta_2 \text{LEV} + \beta_3 \text{ROE} + \beta_4 \text{ROP} + \beta_5 \text{LR} + \beta_6 \text{AT} + \beta_7 \text{EPS} + \beta_8 \text{CSR} + \beta_9 \text{RDS})}}
\] (1)

4. Regression Analysis

4.1. Descriptive Statistics
Descriptive statistics are made respectively in two groups to understand the overall distribution of the samples. The results are shown in table 2.
Table 2. Descriptive statistics.

| Financial Indicators | TYPE | N  | mean | sd   | min  | max  |
|----------------------|------|----|------|------|------|------|
| ROE                  | 1    | 65 | 16.7 | 13.21| -6.15| 74.21|
|                      | 0    | 64 | 16.62| 8.69 | 5.22 | 50.91|
| LEV                  | 1    | 65 | 25.01| 17.19| 3.41 | 66.38|
|                      | 0    | 65 | 34.63| 17.47| 6.54 | 98.42|
| LR                   | 1    | 65 | 5.71 | 6.04 | 0.52 | 24.09|
|                      | 0    | 65 | 2.65 | 1.88 | 0.49 | 12.9 |
| AT                   | 1    | 65 | 0.53 | 0.25 | 0.17 | 1.43 |
|                      | 0    | 65 | 0.86 | 0.5  | 0.35 | 2.35 |
| EPS                  | 1    | 64 | 20.27| 93.51| -86.62| 215 |
|                      | 0    | 65 | 19.89| 30.17| -52.34| 105.53|
| RDS                  | 1    | 60 | 8.91 | 5.81 | 1.21 | 37.09|
|                      | 0    | 56 | 5.74 | 3.27 | 0.55 | 19.49|
| ROP                  | 1    | 65 | 269.88| 242.11| -30.22| 1139.21|
|                      | 0    | 65 | 160.91| 98.42 | 31.44| 476.29|
| CSR                  | 1    | 65 | 22.04| 13.92| -13.06| 61.37|
|                      | 0    | 65 | 14.66| 9.72 | -2.06| 37.43|

From the analysis of the mean value, if there is a small difference in the mean value of financial indicators between the two groups, it indicates that the financial indicators cannot well distinguish innovative pharmaceutical enterprises from generic pharmaceutical enterprises. As can be seen from table 2, the financial indicators with large differences are asset-liability ratio, liquidity ratio, total asset turnover ratio, rate of return on investment per capita, research and development level and sales cash ratio, while the financial indicators with small differences are return on equity and basic earnings per share.

4.2. Correlation Analysis

Before regression analysis, Spielman test was used to examine the correlation among variables. The results are shown in table 3.

Table 3. Correlation matrix.

| TYPE  | LEV   | ROE  | LR   | AT   | EPS  | CSR   | RDS   | ROP     |
|-------|-------|------|------|------|------|-------|-------|---------|
| TYPE  | 1     | -0.270*** | 1     |      |      |       |       |         |
| LEV   |       | 0.004 | -0.051 | 1     |      |       |       |         |
| ROE   |       |      | 0.326*** | -0.671*** | 0.016 |       |       |         |
| LR    |       |      |      | -0.381*** | 0.372*** | 0.485*** | -0.276*** | 1       |
| AT    |       |      |      |      | 0.140 | 0.136 | 0.039 | -0.098  | -0.084  | 1       |
| EPS   |       |      |      |      |      | 0.296*** | -0.474*** | 0.261*** | 0.453*** | -0.372*** | 0.113 | 1       |
| CSR   |       |      |      |      |      |       | 0.318*** | -0.138  | 0.067  | 0.132  | -0.310*** | 0.199** | 0.419*** | 1       |
| RDS   |       |      |      |      |      |       |       | 0.285*** | -0.382*** | 0.372*** | 0.599*** | -0.142 | 0.034  | 0.458*** | 0.033  | 1       |

*** indicates that the two variables are significantly correlated at the level of 1%.
** indicates that the two variables are significantly correlated at the level of 5%.

From table 3, we can see that the variables that are not significantly correlated to TYRE are ROE and EPS, which are consistent with descriptive statistics. If the correlation coefficient between explanatory variables is too large, it will exist serious multicollinearity, which will affect the accuracy of regression results. Generally speaking, when the absolute value of the correlation coefficient between explanatory variables is less than 0.7, multicollinearity will have little impact on the regression results.
In the table above, the absolute value of correlation coefficient of explanatory variables is 0.671 and is less than 0.7, so it has little influence on the regression results.

4.3. Correlation Analysis
All variables have completed distribution test and multicollinearity test before regression analysis. Logistic model is used for discriminant analysis, as shown in table 4.

Table 4. Regression results.

| Independent variable | Coefficient | S.E  | Sig  |
|----------------------|-------------|------|------|
| LEV                  | 0.010       | 0.022| 0.653|
| ROE                  | 0.027       | 0.045| 0.554|
| LR                   | 0.189       | 0.113| 0.094|
| AT                   | -3.122      | 1.447| 0.031|
| EPS                  | 0.007       | 0.005| 0.190|
| CSR                  | -0.021      | 0.027| 0.433|
| RDS                  | 0.113       | 0.066| 0.087|
| ROP                  | 0.002       | 0.003| 0.519|
| Constant             | -0.388      | 1.349| 0.773|

Innovative pharmaceutical company 71.4%
Generic pharmaceutical company 70.0%
Overall discrimination accuracy rate 70.7%

According to the regression results, the overall discrimination accuracy rate of the model is 70.7%. Among the 60 samples of innovative pharmaceutical enterprises, 42 samples were correctly identified and 18 samples were misjudged. Of the 56 samples from generic pharmaceutical companies, 40 samples were correctly discriminated and 16 samples were wrongly discriminated.

4.4. Modified Model
By observing the discrimination accuracy rate of single variable, it shows that discrimination accuracy rate of ROE and EPS are the lowest and not significant. The remaining variables are all significant. What’s more, the variables with the highest discrimination accuracy rate are AT and CSR. Through the multiple combinations of financial indicators and logistic regression, the discriminant accuracy rate is the highest when using the financial indicators AT, LR, EPS and RDS for discriminant analysis and the discrimination accuracy rate can reach to 75.0%. It shows the results in table 5.

Table 5. Modified regression results.

| Independent variable | Coefficient | S.E  | Sig  |
|----------------------|-------------|------|------|
| AT                   | -2.622      | 1.011| 0.009|
| LR                   | 0.173       | 0.071| 0.015|
| EPS                  | 0.009       | 0.005| 0.064|
| RDS                  | 0.112       | 0.058| 0.055|
| Constant             | -0.063      | 0.788| 0.936|

Innovative pharmaceutical company 75.0%
Generic pharmaceutical company 75.0%
Overall discrimination accuracy rate 75.0%

According to the results of regression, innovative pharmaceutical enterprises can be effectively identified by comprehensively considering the company’s operating capacity, debt paying ability, growth ability and research and development ability. Among them, the asset-liability ratio is negatively correlated with innovative pharmaceutical enterprises, and the remaining variables are positively
correlated with the discriminant results. The variables in this combination are all significant and the overall discrimination accuracy rate is 75.0%. Among the 60 samples of innovative pharmaceutical enterprises, 45 samples were correctly identified and 15 samples were misjudged. Of the 56 samples from generic pharmaceutical companies, 42 samples were correctly discriminated and 14 samples were wrongly discriminated.

Thus, the regression model equation is shown as the following.

\[ P = \frac{1}{1+e^{-(0.063+2.622AF-0.173LR-0.009EPS-0.112RDS)}} \]  \hspace{1cm} (2)

5. Conclusion

According to the above analysis, we can draw several conclusions. First, the asset-liability ratio and sales cash ratio in the past five years have not effectively distinguished between innovative pharmaceutical companies and generic pharmaceutical companies. On the contrary, the discriminant analysis based on the comprehensive application of operating ability, debt paying ability, growth ability and research and development ability can make a better distinction. Second, the development of innovative pharmaceutical companies relies more on the creativity of research and development researchers and the transformation of research and development results. Therefore, when measuring the innovation ability of enterprises, we should comprehensively consider research and development expenditures and return on human resources. The discriminant results of the multiple indicators are significantly better than the individual indicators. Third, the innovative pharmaceutical companies have better financial indicators than generic pharmaceutical companies. However, based on their high growth and highly risk characteristics, innovative pharmaceutical companies need to establish a financial risk warning system. In the future research process, scholars can continue to study on the construction of risk index model of financial indicators, so as to help investors to timely notice the risk tolerance of innovative pharmaceutical enterprises while discovering their value.

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