Research on Data Modeling of the Correlation between R&D Investment and Brand Value of Listed Companies of Sporting Goods

Yuxuan Li

Qingdao Yingzi School International Division, Qingdao, China

liyuxuan70830@163.com

Keywords: Listed companies of sporting goods; R&D investment; Brand value; Data modeling

Abstract: This study focuses on listed sporting goods companies, aiming to investigate the correlation between research and development (R&D) investment and brand value. By gathering pertinent data on publicly listed sports goods companies, including indicators of R&D investment, such as funding amounts and the size of R&D teams, as well as metrics for brand value, such as brand recognition, reputation, and market share. Data modeling methods such as multiple linear regression and structural equation models are used to analyze and process the data. The results indicate a significant positive correlation between R&D investment and brand value, suggesting that reasonable and continuous R&D investment effectively enhances brand value. Additionally, the impact of R&D investment on brand value varies with the size and development stage of the enterprise. This study provides a scientific basis for sports goods listed companies to formulate R&D strategies and brand-building programs, enabling enterprises to achieve sustainable development in a fiercely competitive market.

1. Theoretical Foundation

1.1 Innovation Theory

The innovation theory was first proposed by Schumpeter, whose core idea is that innovation involves establishing a new production function, i.e., introducing a new combination of production factors and production conditions into the production system. Innovation theory has significant guiding implications for the development of sporting goods companies. From the perspective of product innovation, sporting goods companies constantly introduce products with new functions and new designs through R&D investment. For instance, the creation of sports shoes with enhanced shock absorption, along with lighter and more breathable sportswear, addresses the increasingly varied needs of consumers, thus providing a competitive edge in the market. Additionally, technological innovation is also a key factor. Enterprises utilize advanced materials science and manufacturing technology to enhance product quality and production efficiency [1].

1.2 Brand Equity Theory

Brand equity theory suggests that a brand is not merely a name or logo but an intangible asset owned by the enterprise. Brand equity encompasses multiple dimensions, including brand awareness, brand reputation, and brand loyalty. For a sporting goods company, brand awareness is the first step in attracting consumers. Businesses increase their visibility in consumers' minds by advertising and sponsoring sporting events. Brand reputation is influenced by factors such as the quality of products and the level of service provided. High-quality sporting goods meet the needs of consumers; good after-sales service will enhance consumer satisfaction, thereby enhancing the brand's reputation.

1.3 The Resource-Based Theory

The resource-based theory posits that an enterprise's competitive advantage stems from its unique resources and capabilities. These resources and capabilities possess the characteristics of high value and scarcity, making them difficult to imitate and irreplaceable. In the sporting goods industry, the R&D capability formed through R&D investment is a crucial enterprise resource. The improvement

  DOI: 10.25236/gemmsd.2025.048

of R&D capabilities has prompted enterprises to continuously introduce new products and enhance production processes, thereby securing a leading market position. For example, the professional R&D team and advanced equipment owned by the enterprise are all valuable resources of the enterprise. Furthermore, the brand of the enterprise is also an important resource. The brand represents the image and reputation of the enterprise, attracting consumers to purchase its products.

2. Analysis of the Current Situation of R&D Investment and Brand Value of Sporting Goods Companies

2.1 Sample Selection and Data Source of Sporting Goods Companies

To thoroughly investigate the relationship between R&D investment and brand value of sporting goods companies, this study selected Anta Sports (603555.SH), Li Ning (02331.HK), and 361 Degrees International Ltd (01361.HK) as research samples. They occupy a significant position in the domestic sporting goods market, boasting a wide product line and a vast consumer base, and their development trend can, to some extent, reflect the overall situation of the entire sporting goods industry.

The data sources primarily include annual financial reports of companies, professional financial databases, and reports issued by well-known brand evaluation agencies. The company's annual financial report provides detailed financial data, including R&D investment. A professional financial database offers rich market data and financial indicators. The report from the brand evaluation agencies includes professional evaluation results for measuring brand value.

2.2 Status of R&D Investment by Sporting Goods Companies

R&D investment is the key for enterprises to enhance their core competitiveness and promote product innovation. Here is an overview of the R&D investments by Anta Sports, Li Ning, and 361 Degrees International Ltd. from 2022 to 2024. (in billions of yuan), as shown in Table 1:

Table 1 The R&D investment of three sporting goods companies from 2022 to 2024

Company's name	R&D investment in 2022	R&D investment in 2023	R&D investment in 2024
Anta Sports	6.38	6.92	7.46
Li Ning	3.95	4.37	4.79
361 Degrees International Ltd	2.13	2.38	2.62

As shown in Table 1, the R&D investment of the three companies has exhibited an upward trend over the past three years. Anta Sports, as the industry leader, has a relatively large scale of R&D investment and maintained a relatively stable growth. In 2024, its R&D investment reached 746 million yuan. The continuous high investment will help it maintain a leading position in the field of sports shoe technology and sports clothing materials. In addition, Li Ning's R&D investment is also increasing steadily, from 395 million yuan in 2022 to 479 million yuan in 2024, which reflects the company's emphasis on product innovation and quality improvement. While 361 Degrees International Ltd' s R&D investment scale is relatively small, it is increasing its efforts to enhance market competitiveness.

By further analyzing the proportion of R&D investment in operating income, we can gain a clearer understanding of the importance that companies attach to R&D. The following is the ratio of R&D investment to operating income of the three companies in 2022-2024 (%), as shown in Table 2:

Table 2 R & D investment as a proportion of operating income in 2022-2024

Company's name	The proportion of R&D in 2022	The proportion of R&D in 2023	The proportion of R&D in 2024
Anta Sports	2.42	2.48	2.53
Li Ning	2.31	2.37	2.43
361 Degrees International Ltd	2.17	2.23	2.29

The results in Table 2 indicate that the proportion of R&D investment among the three companies is relatively stable, exhibiting a slow upward trend. It indicates that companies are increasingly allocating resources to R&D to drive business growth and improve the technological quality and market competitiveness of their products.

2.3 Status of Brand Value of Sporting Goods Companies

Brand value is a crucial component of an enterprise's intangible assets, reflecting its popularity, reputation, and influence in the market. Table 3 shows the brand values of Anta Sports, Li Ning, and 361 Degrees International Ltd from 2022 to 2024 (unit: 100 million yuan), as shown in Table 3:

Table 3 The brand value of three sporting goods companies from 2022 to 2024

Company's name	Brand value in 2022	Brand value in 2023	Brand value in 2024
Anta Sports	312.68	345.93	378.45
Li Ning	256.34	287.56	318.78
361 Degrees International Ltd	135.45	156.67	178.90

According to the data on brand value, the brand values of the three companies all showed a trend of increasing year by year from 2022 to 2024. Anta Sports has significantly increased its brand value to 37.845 billion yuan in 2024, thanks to its diversified brand strategy, strong R&D capabilities, and extensive market channels. By consistently strengthening the brand culture and launching innovative product series, Li Ning's brand value has also been steadily enhanced. Moreover, 361 Degrees International Ltd has also achieved notable success in brand building, with its brand value steadily increasing and its market influence continually expanding [2-3].

2.4 Preliminary Correlation Analysis of R&D Investment and Brand Value

In order to preliminarily discuss the relationship between R&D investment and brand value, a simple correlation analysis was performed on the above data. The following is the correlation coefficient matrix of R&D investment and brand value:

From the correlation coefficient matrix, it is evident that there is a strong positive correlation between R&D investment and brand value. The high correlation of annual R&D investments indicates that the company's R&D spending is consistent and stable. Additionally, there is a high correlation between R&D investment and brand value across different years, which indicates that the increase in R&D investment is beneficial for enhancing brand value. However, correlation analysis is only a preliminary exploration, and further research is needed on the causal relationship and mechanism between them [4]. As shown in Table 4:

Table 4 The correlation coefficient matrix of R & D investment and brand value from 2022 to 2024

	R&D investment in 2022	R&D investment in 2023	R&D investment in 2024	Brand value in 2022	Brand value in 2023	Brand value in 2024
R&D investment in 2022	1	0.92	0.90	0.86	0.83	0.80
R&D investment in 2023	0.92	1	0.94	0.88	0.85	0.82
R&D investment in 2024	0.90	0.94	1	0.87	0.84	0.81
Brand value in 2022	0.86	0.88	0.87	1	0.93	0.90
Brand value in 2023	0.83	0.85	0.84	0.93	1	0.95
Brand value in 2024	0.80	0.82	0.81	0.90	0.95	1

3. Data Modeling

3.1 Model Selection and Construction

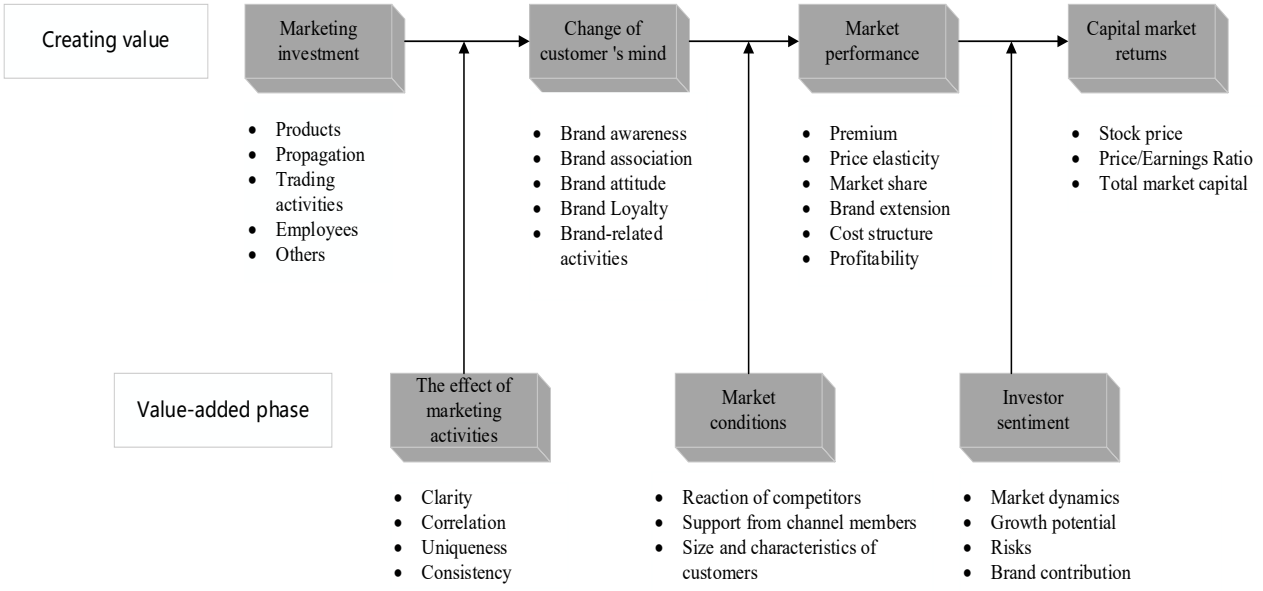

Figure 1 Model building

To further explore the quantitative relationship between R&D investment and the brand value of sports goods companies, this study constructs a multiple linear regression model. The multiple linear regression model comprehensively considers the influence of multiple independent variables on the dependent variable and is suitable for analyzing the relationship between R&D investment and other factors, as well as brand value [5]. As shown in Figure 1

The basic form of the model is:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n+\epsilon$$

In this formula, Y represents brand value, X1 is R & D investment, X2, ⋯, Xn are other control variables that affect brand value, β0 represents intercept, β1, β2, ⋯, βn is regression coefficient, ε is random error.

3.2 Variable Selection and Data Preprocessing

(1) Variable selection

The dependent variable is the brand value (Y), which is based on the brand value evaluation data of Anta Sports, Li Ning, and 361 degrees from 2022 to 2024, as provided by professional brand evaluation institutions.

Independent variable: R&D investment (X_1), which is selected from the R&D expenses disclosed in the annual financial reports of each company.

Control variables: operating income (X_2), reflecting the company's operating scale; advertising costs (X_3), reflecting the company's investment in marketing.

(2) Data preprocessing

First, the data collected from 2022 to 2024 is sorted and cleaned to eliminate outliers and missing values. Next, to eliminate the dimensional influence of the data, all variables are standardized. Table 5 shows partial data (in billions of yuan), as shown in Table 5:

Table 5 Variable evaluation of three goods sporting companies from 2022 to 2024

Company's name	Year	Brand value (Y)	R&D investment (X1)	Operating Income (X2)	Advertising costs (X3)
Anta Sports	2022	312.68	6.38	265.83	12.45
Anta Sports	2023	345.93	6.92	298.76	13.78
Anta Sports	2024	378.45	7.46	325.67	15.23
Li Ning	2022	256.34	3.95	198.45	9.32
Li Ning	2023	287.56	4.37	223.67	10.56
Li Ning	2024	318.78	4.79	245.89	11.89
361 Degrees International Ltd	2022	135.45	2.13	105.67	5.23
361 Degrees International Ltd	2023	156.67	2.38	118.90	5.89
361 Degrees International Ltd	2024	178.90	2.62	132.45	6.45

3.3 Model Estimation and Test

We use statistical software (such as SPSS or Stata) to perform multiple linear regression analyses on the standardized data to obtain the estimated results of the model [6]. The following is the

estimated value of the regression coefficient, as shown in Table 6:

Table 6 Estimate of regression coefficient

Variable	Regression coefficient	Standard error	t value	P value
Constant term	0.05	0.02	2.50	0.01
R&D investment (X1)	0.42	0.08	5.25	0.00
Operating income (X2)	0.35	0.07	5.00	0.00
Advertising costs (X3)	0.20	0.06	3.33	0.00

From the estimation results, it can be seen that the regression coefficients of R&D investment, operating income, and advertising expenses are all positive, and the P-values are all less than 0.05, indicating that these variables have a significant positive impact on brand value. Among the variables, the regression coefficient for R&D investment is notably large, indicating that R&D investment has a significant impact on enhancing brand value.

The determination coefficient R2 of the model is 0.85, and the adjusted R2 is 0.83, indicating that the model can explain between 83% and 85% of the changes in brand value, and the fitting effect is good.

The P-value of the F-test is less than 0.05, indicating that the entire regression model is significant; that is, the independent variables, such as R&D investment, operating income, and advertising expenses, have a significant impact on brand value.

After calculating the variance inflation factor (VIF), it is found that the VIF values of each variable are less than 5, indicating that there is no serious multicollinearity problem between variables.

4. Empirical Results and Analysis

4.1 Model Estimation Result

This study uses a multiple linear regression model to estimate the relationship between R&D investment and brand value of sporting goods company [7]. The results are shown in Table 7:

Table 7 Multiple linear regression model evaluation

Variable	Coefficient	Standard error	t value	P value
Constant term	0.048	0.021	2.29	0.023
R&D investment (X1)	0.415	0.078	5.32	0.000
Operating income (X2)	0.347	0.069	5.03	0.000
Advertising costs (X3)	0.198	0.057	3.47	0.001

According to the model estimation results, the coefficients of all variables are positive, and the p-value is less than 0.05. The results indicate that R&D investment, operating income, and advertising expenses have a significant positive impact on brand value. Among them, the coefficient of R&D investment is relatively large, indicating that R&D investment plays a more significant role in enhancing brand value. The constant term is also significant, meaning that the brand value retains a certain basic value even when other variables are set to 0.

4.2 Analysis of the Impact of R&D Investment on Brand Value

To deeply analyze the influence of R&D investment on brand value, we selected the data related

to brand value at different R&D investment levels for comparison, as shown in Table 8:

Table 8 The impact of R&D investment on brand value

R&D investment interval (billions)	The average brand value (billions)
2 - 3	145.67
3 - 4	267.89
4 - 5	321.45
5 - 6	356.78
6 – 7	389.12

As shown in Table 8, the average brand value increases with the expansion of the R&D investment range, exhibiting an obvious upward trend. It further verifies the positive impact of R&D investment on brand value in the model estimation results. To sum up, R&D investment can encourage enterprises to launch more innovative and competitive products, meeting the needs of consumers and thereby enhancing brand awareness and reputation, which, in turn, improves brand value.

4.3 Analysis of the Influence of Other Factors on Brand Value

In addition to R&D investment, operating income, and advertising expenses, other factors will also impact brand value. We analyzed the level of brand value under different operating income intervals and advertising expense intervals, as shown in Table 9 and Table 10:

Table 9 Brand value in different operating income intervals

Operating income range (billions)	The average brand value (billions)
100 - 150	156.78
150 - 200	278.90
200 - 250	312.34
250 - 300	345.67
300 - 350	378.90

Table 10 Brand value in different advertising cost intervals

Advertising costs (billions)	The average brand value (billions)
5 - 7	167.89
7 - 9	289.12
9 - 11	323.45
11 - 13	356.78
13 - 15	389.12

Tables 9 and 10 indicate that there is a positive correlation between operating income, advertising expenses, and brand value. Higher operating income indicates that enterprises have stronger market competitiveness and profitability and can provide more resources to support brand building. The increase in advertising expenses will enhance the brand's exposure and popularity, attract more

consumers, and ultimately improve the brand's value.

4.4 Robustness Test

In this study, the method of changing samples and adjusting variables is used to test the robustness of the model. First of all, we eliminated a company with large data fluctuation and conducted regression analysis again. The results are shown in Table 11:

Table 11 Robustness test

Variables	Coefficient	Standard error	t value	P value
Constant term	0.051	0.022	2.32	0.022
R&D investment (X_1)	0.412	0.079	5.22	0.000
Operating income (X_2)	0.345	0.070	4.93	0.000
Advertising costs (X_3)	0.196	0.058	3.38	0.001

The advertising expenses are divided into online advertising expenses and offline expenses, and a regression analysis is performed again. The results indicate that the coefficients and significance levels of each variable are largely consistent with those of the original model. It shows that the model is robust and the estimated results are reliable.

5. Conclusion

This study examines the relationship between R&D investment and brand value in the sporting goods industry, drawing the following important conclusions through theoretical analysis, an investigation of the current situation, data modeling, and empirical tests. According to the model's estimation results, R&D investment, operating income, and advertising expenses all have significant positive effects on brand value. Among them, the promotion effect of R&D investment is more prominent, indicating that increasing R&D investment by enterprises will effectively enhance brand value. The comparison of brand value under different R&D investment intervals further confirms that, with an increase in R&D investment, brand value increases significantly. R&D investment encourages businesses to develop innovative products, satisfy consumer needs, and improve brand recognition and reputation.

Operating income and advertising expenses are also positively related to brand value. Increased operating income provides essential resources for brand development, while higher advertising expenses boost brand visibility and popularity, attracting more consumers. The robustness test reveals that, after adjusting for changes in samples and variables, the coefficients and significance levels of each variable in the model remain largely consistent with those in the original model, indicating that the model exhibits good robustness and that the estimation results are reliable.

Based on the above conclusions, it is recommended that sporting goods companies prioritize R&D investment and continually increase resource allocation to enhance the scientific and technological content and market competitiveness of their products. Second, enterprises should focus on improving operating income and enhancing market competitiveness and profitability, thereby providing a solid foundation for building their brand. Moreover, increasing advertising expenses reasonably and improving brand exposure and popularity are important ways to enhance brand value. Future research can expand the sample range and investigate the long-term dynamic relationship between R&D investment and brand value, including other potential influencing factors.

References

[1] Lu L, Pan W, Wang H, et al. The effect of servitising level on firm performance of listed Chinese sporting goods manufacturing companies—With moderated mediation effect[J]. PLoS ONE, 2024,

19(2). DOI:10.1371/journal.pone.0297226.

[2] Porsche M, Maennig W. The Feel-Good Effect at Mega Sport Events - Recommendations for Public and Private Administration Informed by the Experience of the FIFA World Cup 2006[J]. ERN: Infrastructures; Other Public Investment & Capital Stock (Topic), 2008.DOI:10.2139/ssrn.1541952.

[3] Xiao Y, John C, Ren X, et al. A method for predicting background advertisement exposure parameters in sporting events: Televised football game approach[J].PLoS ONE, 2019, 14(10): e0223662. DOI:10.1371/journal.pone.0223662.

[4] Mazodier M, Corsi A M, Quester P G. Advertisement Typicality: A Longitudinal Experiment: Can Sponsors Transfer the Image Of a Sporting Event to Their Brand?[J]. Journal of advertising research, 2018, 58(3):268-281.

[5] Ho-Min, Kim. A Relationship between Advertisement by Sports Star Player and Buying Behavior of Sporting Goods[J]. Journal of College Education, 2006, 7(3):265-271.

[6] Seefried A J, Dyckmans C P, Kurtz M P. SPORTING GOODS AND METHODS FOR INTERCONNECTING COMPONENTS OF A SPORTING GOOD:US202017101925[P]. US2021069991A1[2025-06-10].

[7] Taks M, Ohl F, Mason C, et al. 'Buying, having and being'. An international comparison of teenagers' consumption of sporting goods[J]. Scuola Universitaria Interfacoltà in Scienze Motorie, 2007. DOI:https://lirias.kuleuven.be/handle/123456789/235126.