

Valuation Analysis of Sports Industry Stocks Based on HP-Tobit Model -- A Case Study of a Sample Data of 2430 in 2020-2021

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Abstract: Along with the growing sports industry nowadays, the corresponding stock prices of the enterprises deserve our attention, triggering our research on the evaluation as well as valuation upon the characteristics of the stock price of enterprises among this industry. This paper selects five fore-end and back-end enterprises in the sports industry, then initially make their opening and closing prices de-noised through HP filtering to form a long-term trend; Secondly, the stock prices are estimated by applying the OLS and Tobit models. After comparing with the actual values, the stock price characteristics among the two types of enterprises are summarized; After conducting heterogeneity analysis, relevant conclusions can be drawn: (1) In terms of stock prices, the fore-end enterprises are generally lower than the back-end enterprises. (2) In terms of stock price forecasts, the fore-end enterprises own more stable stock prices and slighter forecast errors; comparably, the back-end enterprises are affected by external factors. They have larger forecast errors than the fore-end enterprises. (3) The fore-end closing price impacts both fore-end and back-end sports enterprises. It is more significant for back-end enterprises as well.

1. Introduction

The sports industry is a sunrise industry that with low resources and high elasticity of demand. In the meantime, it is also known as an emerging industry, able to integrate other industries. It will insist on emerging new products, new models, and new business models, which has strong growth and sustainability. In the future, the sports industry indicates the following three trends: (1) Emerging sports have exploded with amazing growth with large potential. To illustrate, winter sports, cycling, combat, etc.; (2) there exists cross-industry integration and transformation among the sports industry, such as media, entertainment and tourism, which are complementary to the combination of sports; (3) Event IP rights are considered as the high point of competition for sports enterprises. The leading games with higher commercial value become the focus of competition. Accordingly, what are the features of diversified enterprises in the sports industry? Do their stock price fluctuations depict a certain pattern? [1]

This paper summarizes past stock valuation methodologies in conjunction with existing relevant literature and provides insight into the features within the sports industry, representative enterprises along the industry, and their businesses. In the context of COVID-19, every industry has suffered hit, and the sports industry is also confronting with same dilemmas as well. In accordance with related papers, we recognized the impact of the COVID-19 on the sports industry, not only by limiting individuals' participation in sports due to reduced exposure, but also by imposing restriction on the hosting of major events and meanwhile reducing audience booking office. These negative factors provide us with a deeper comprehension of the sports industry. We examine the stock price characteristics and predictive valuation of two various types of enterprises, respectively, from the fore-end and back-end. The significance of this study is (1) to help investors identify stocks that are severely undervalued and purchase them to bring direct economic benefits; (2) to help investors determine whether the stocks in their hands are overvalued or undervalued to decide to sell or continue to hold, and to help them lock in profits or firm up their determination to hold for higher returns; (3) to help

investors better comprehend the features of the sports industry aiming to enter the industry for investment. [2]

As for the innovation of this study, in terms of the research subject, the popular stocks involve industries mainly in military, medical and new energy. Nonetheless, the sports industry itself, as a new industry in recent years, has received national support and encouragement. In the 2022 Beijing Winter Olympic Games, winter sports have gained the attention and participation of all humanity. To specify, as for the research focus, the stock valuation requires not only an in-depth comprehension of the industry, but also the application of an excellent mathematical model for fitting, the choice of stock valuation is accordingly innovative. In addition, for the purpose of research methodology, HP filtering and OLS regression are widely used in recent years for macroeconomic trend analysis, which is full of innovation.

Besides, the reasons why we choose the sports industry as the object of study are as follows:

(1) In 2020, our sports industry accounted for 1% of total GDP. By 2025, China's sports industry is expected to double its GDP share in 2020 which has a bright prospect. This industry is both germinating as well as emerging.

(2) The selection of samples and relative data is representative. For instance, Li Ning and Anta are well-known domestic sportswear brands, and their share prices can reflect the characteristics of the domestic market in a better way.

When it comes to the focus of this study, we emphasize the post-pandemic era. As a result, we only choose the data in 2021 and further explore the reasons for stock price fluctuations based on epidemic factors.

The following sections are set up as follows: Chapter 2 is the literature review, summarizing the established valuation methods; Chapter 3 is the sports industry and research data, processing the sample data; Chapter 4 is the empirical analysis, applying the HP-Tobit model for valuation; Chapter 5 is the conclusion with corresponding policy recommendations.

2. Literature Review

2.1 Valuation of listed stock prices and risk classification

Stock price is the trading price of a stock as well as a relative concept to the value of a stock. The true meaning of stock price is the value of the enterprise's assets. While the value of the stock price is equal to the earnings per share multiplied by the Price earnings ratio. The opening price, also known as the opening market price, is the price of the first sale and purchase transaction per share of certain security after the opening of each trading day on the stock exchange. The closing price depends on the closing price of the stock market, which is the volume-weighted average price of all transactions in one minute before the last transaction of the security (including the last transaction) on that day.

The risks of stocks are divided into two major parts: systematic and non-systematic risks, including policy risks, macroeconomic cycles, international crises, major changes in exchange rates and interest rates, political and war uncertainties as well as operational risks of enterprises, etc. Common risks are as follows:

2.1.1 Interest rate risk (IRR)

Interest rate risk refers to the possibility that the actual rate of return on equity investments will deviate from the expected rate of return because of the changes in the level of market interest rates. As mentioned above, stock prices are inversely proportional to interest rates. Actually, the rise or fall of stock prices is a key factor in determining capital gains or losses and the rate of return on stock investments. Meanwhile, when the level of interest rates rises, the operating costs of the enterprise increase while the earnings decrease. Besides, it will also be influenced by stock dividends and dividend income.

2.1.2 Purchasing power risk

The nominal return of an equity investment includes the real return as well as the inflation compensation. When unanticipated inflation occurs, the real return on equity investment will deviate from the expected return. That is to say, the real purchasing power will deviate from the expected purchasing power, which is known as the purchasing power risk.

In some ways, the stock market is an efficient and susceptible market, capable of reacting rapidly to policies, news, events, data, etc. Certain stock prices can thus fluctuate significantly or interpret in extreme ways. Therefore, what are the main factors that influence stock price movements? [3]

(1) Economic factors: The stock market is directly affected by economic conditions and indicates a cyclical fluctuation. When the economy is in recession, the stock market will fall with weakness; when the economy is recovering while booming, stock prices will also rise or present a firm upward trend. Based on past experience, the stock market is often a barometer of the economic state.

(2) Political factors: Major political events such as the alternation of government, change of leaders as well as the actions of world leaders, etc., can have an impact on the price of the relevant stocks.

(3) Industry factors: variations in the industry's status among the national economy, development prospects, the impact of emerging industries, etc. can affect the price of the relevant stocks.

(4) The own factors of the enterprise: The value of the stock itself is the most basic factor in determining the stock price, which mainly depends on the enterprise's business performance, creditworthiness and accordingly the dividend payout status, development prospects, the expected level of stock returns, etc.

2.2 Conformity of the stock valuation methods

There are various methods for valuing stocks, based on multifarious perspectives such as investors' expected returns, enterprise profitability or enterprise asset values, the more commonly used ones are: dividend benchmark model, which applies to investors who wish to obtain cash flow returns from their investments; earnings standard ratio, which owns the advantage of simple calculation and accessible data collection; market-to-book ratio, which is suitable for the valuation of stocks of enterprises whose assets and liabilities consist mostly of monetary assets, such as banks and insurance enterprises. In this paper, the OLS approach is chosen to value and forecast stock prices.

Table 1. Summary of Stock Valuation Methods.

Valuation Method	Contents
Dividend Benchmark Model	Formula: stock price = expected dividend for the coming year/investor's required rate of return. This method evaluates the stock value in terms of dividend yield, allowing investors to obtain cash flow.
Profitability Standard Ratio	Formula: Price-earnings ratio = stock price/earnings per share. Investors should attach importance to the relative variations in expected P/E ratios versus historical P/E ratios, and pay attention to the size of the stock's P/E ratio versus the industry average level.
Market-to-book Ratio	Formula: Market-to-book ratio = share price/net asset value per share. The book value represents the historical cost of the shareholders' investment, and the market value stands for the comprehensive evaluation the enterprise receives for its operations.

3. Sports Industry and Research Data

3.1 Overview of the sports industry

The sports industry includes sports industry, sports peripheral industry, sports intermediary industry, and consumers. Among them, the sports propriety industry is viewed as the core of the whole sports industry, including sports competition as well as the mass fitness industry.

The development history of China’s sports industry is divided into three stages: the exploration and practice stage (1979-1991), in which China proposed the development strategy of “actively enhancing the sports industry and sports-related industries, so that they could gradually develop into one of the pillars of the national economy”, and successfully held the Asian Games in 1990; the initial development stage (1992-2001), China promoted the sports industry. During the initial development stage (1992-2001), China promoted sports reform, accelerated the industrialization of sports then established a dynamic sports management system and operation mechanism; During the accelerated development stage (2002-), China’s goal is to build a sports industry with a reasonable diversified industrial structure, focusing on sports service. The output value of sports industry and the number of employees grew with each passing year.

This paper aims to study the net valuation analysis of sports industry stocks. We divide the stocks of sports industry into two parts: fore-end and back-end. Among them, five enterprises, such as China Sports Group Industry and Contemporary Culture and Sports, as the fore-end industry, are concluded among the fields of event organization, sports brokerage, sponsorship consulting services, etc. Five enterprises, such as Li Ning and Anta Sports, as the back-end industry, are involved in the fields of R&D and sales of sports apparel and sports equipment, which directly face consumers.

A representative for-end and back-end enterprise are selected (contemporary culture and sports for the fore-end enterprise; Li Ning for the back-end enterprise) to present the top10 holders of their stocks.

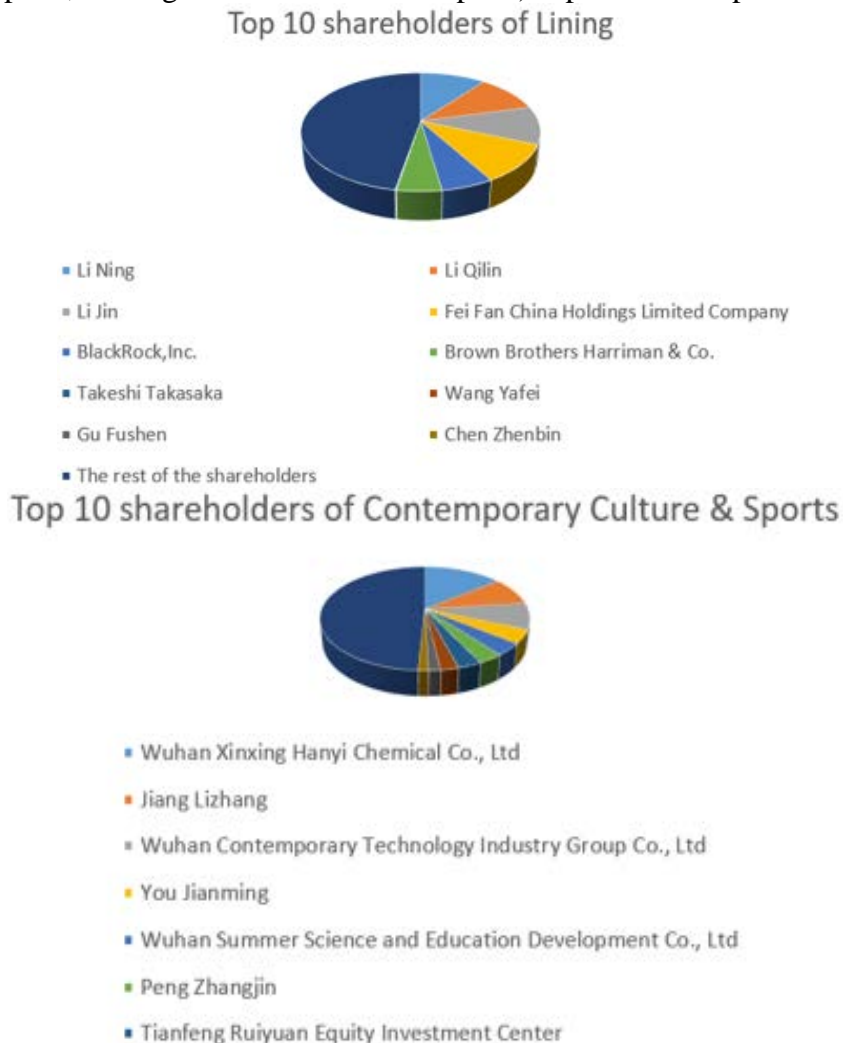


Figure 1. Li Ning and Contemporary Culture and Sports Top10 Holding Shareholders.

3.2 Research data and descriptive statistics

We obtained all trading data for a total of 10 enterprises in two main categories for the past year through wind. It includes the previous closing price, opening price, minimum, maximum, closing

price, volume, turnover amount, increase/decrease and mean price for each trading day (among which Kangrui Sports and Xingzhi Sports have been delisted). The data for these stocks are from January 4, 2021 to December 31, 2021, for a total of 243 samples excluding non-trading days.

In these samples, their mean opening prices range from 3.068 to 144.063; mean closing prices range from 3.075 to 143.589. The maximum single-day opening price of Anta Sports was 190.700 on July 16, 2021, and the maximum single-day closing price of Anta Sports was 189.700 on June 25, 2021, which indirectly indicates that, in the sports industry, Anta Sports, as a well-known domestic sports brand, has been operating well and has a great reputation among the last year. Most shareholders of the secondary market are bullish on its future development. [4]

Among them, the standard deviation of the opening price of Anta Sports is 20.503, the largest overall fluctuation; the standard deviation of the opening price of Laiyin Sports is 0.327, the smallest overall fluctuation; among the closing price, the most value situation is maintaining the same, still the largest fluctuation of Anta Sports and the smallest fluctuation of Laiyin Sports.

Table 2. Descriptive Statistical Analysis of Opening and Closing Prices of Sample Stocks.

Stock Name	Minimum	Maximum	Mean	Standard Deviation	Median	Minimum	Maximum	Mean	Standard Deviation	Median
			Opening Price	n				Closing Price	n	
China Sports Group Industry	10.350	14.300	11.953	0.761	11.860	10.210	15.120	11.974	0.780	11.860
Contemporary Culture & Sports	5.180	8.200	6.235	0.606	6.130	5.240	8.050	6.235	0.600	6.140
Laiyin Sports	2.530	3.9300	3.608	0.327	3.040	2.520	4.040	3.075	0.329	3.060
COSI	3.400	7.760	5.317	2.208	3.400	3.400	7.760	5.317	2.208	3.400
JINLING SPORTS	25.320	56.910	37.921	8.002	42.000	25.310	56.790	37.860	8.030	42.120
Li Ning	40.350	108.100	75.433	18.714	82.300	41.000	107.700	75.268	18.558	81.900
SHUA Sports	10.540	23.350	16.372	3.791	17.780	10.650	23.550	16.405	3.769	17.970
Anta Sports	110.300	190.700	144.063	20.503	137.950	109.600	189.700	143.589	20.387	137.600

4. Empirical Analysis of Stock Opening and Closing Price Forecasts for the Sports Industry

4.1 Long-term trend of stock prices in the sports industry

After obtaining the stock price data, we have to use statistical methods to de-noise the data to obtain smoother long-term trends for further application as well as analysis. Through the HP filtering method, we use python programming to remove the short-term disturbances of each enterprise over 243 trading days, that is, the pre-processing of time series data such as stock price.

Hodrick first proposed HP filtering in the analysis of the post-war socio-economics in the U.S., and later was widely used in the macroeconomic analysis of long-term trends. The HP filter is considered a High-Pass Filter, which obtains cyclical fluctuation data of different nature according to the time series data.

Assuming a time series of $Z = \{z_1, z_2, \dots, z_t\}$, periodic data of $T = \{t_1, t_2, \dots, t_t\}$, with a trend element $G = \{g_1, g_2, \dots, g_t\}$, we have $Z = T + G$. The annual parameter of λ is taken as 6.25 and the

monthly parameter as 129,600. (Ravn state that λ should vary by the fourth power of the frequency observation ratio; thus, λ should equal 6.25 for annual data and 129,600 for monthly data) [5]

The stock prices of the fore-end enterprises are less volatile, more cyclical and overall tend to be stable; the stock prices of the back-end enterprises are more volatile, not significantly cyclical and the overall trend is not stable. The images obtained are shown as below:

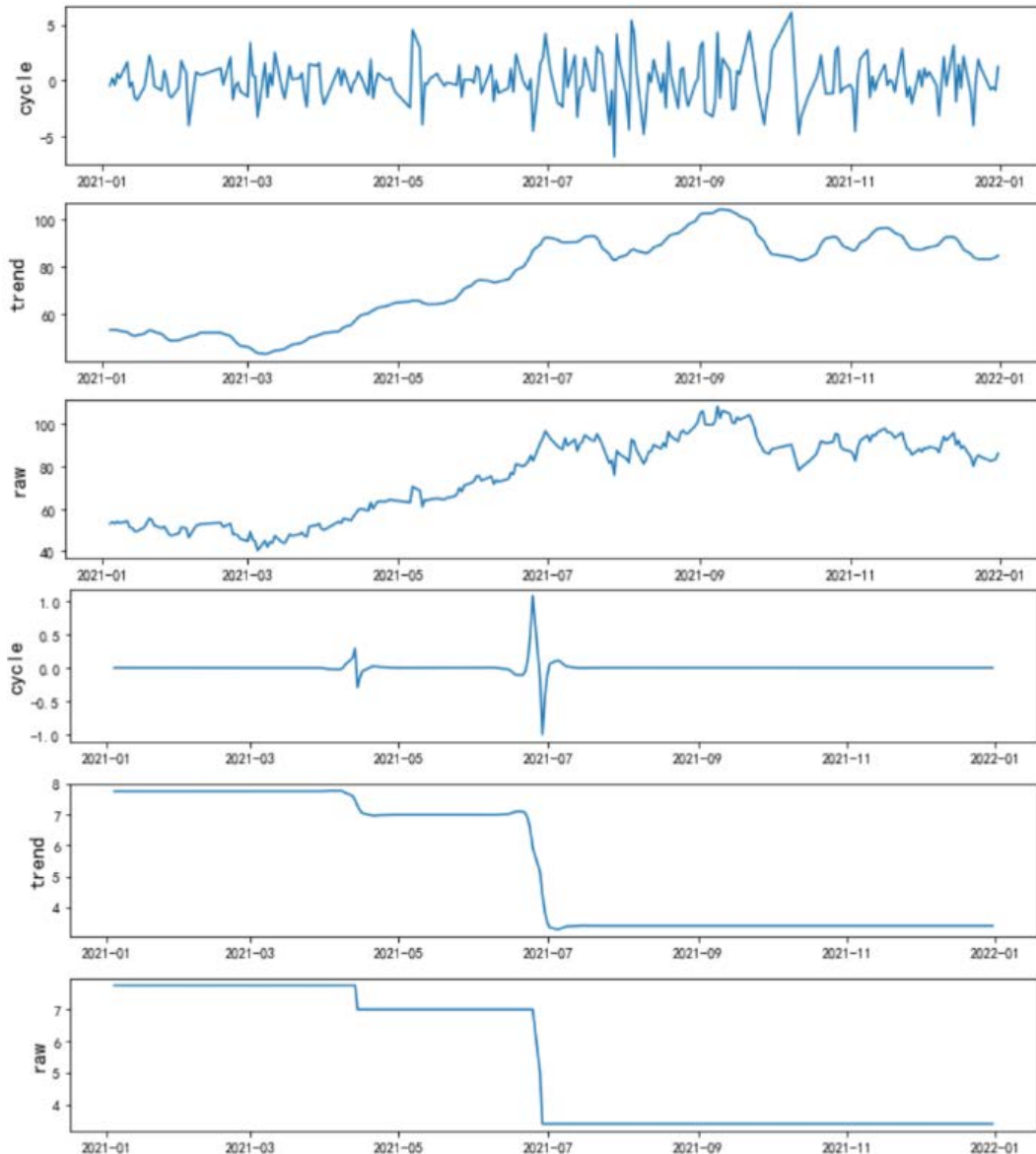


Figure 2. Long-term Trend of the Stock Price of the Selected Stock (Take the opening price as an example).

After analyzing the overall stock data, we found that stock price fluctuations are not only influenced by the external financial environment, but are also related to the size of the enterprise and the industry in which it is engaged. The more well-known and larger back-end sports industry enterprises have insignificant cyclical fluctuations. Conversely, the less well-known and smaller fore-end sports industry enterprises have apparent cyclical fluctuations.

4.2 Predictive analysis of the net value of sports industry fund units

After HP filtering analysis of the selected stock share price data, the decomposed data are fitted and predicted by OLS regression. The regression results are shown in Table 3, in which the explanatory variables are the opening and closing prices of the stocks. The features of trading days with enterprise finances are utilized as explanatory variables to build the model, so as to find the explanatory variables

with the greatest influence factors, where $x_1 \sim x_8$ correspond to Anta Sports, Contemporary Culture and Sports, JINLING SPORTS, Laiyin Sports, Li Ning, Shuhua Sports, Xingzhi Sports, COSI, and China Sports Group Industry, respectively.

The average price is the independent variable with significant effects when the Tobit regression model and the OLS model are established. Both models are significant, and the results are basically the same as well, mainly due to the setting of the left and right boundaries of the Tobit model. In the context of stock trading data, the opening price is not a variable with a fixed left-right boundary (the left-right boundary is different for each data sample), so there is more flexibility for the Tobit model as well. It would also make more sense to use the OLS model relative to other cases.

When building the OLS model with the closing price as the explanatory variable, the previous closing price while the rise and fall are the significantly influential independent variables. Tobit model is computed iteratively, obtaining Newton's method using great likelihood estimation. Under the current data conditions, the model does not gain a convergent solution and accordingly, the Tobit model fails. Given the analysis of the opening price, it is also reasonable to perform the regression with the OLS model, so that the previous closing price, the rise and fall are the variables with significant effects.

Table 3. Forecast Analysis of the Opening and Closing Prices of Stock Shares.

	Estimate	t-value	Estimate	t-value
x_1	28.583***	14.797	4.830e+01***	2.666e+14
x_2	39.308***	28.769	2.709e-13***	1.818e+00
x_3	28.775***	18.072	-1.444e-13***	-8.320e-01
x_4	0.023	1.120	-5.587e-16	-2.490e-01
x_5	-1.408***	-5.565	2.429e-15***	8.520e-01
x_6	0.749	1.156	1.999e+00	2.829e+14
x_7	0.007	0.364	1.111e-15	5.100e-01
x_8	-44.095***	-13.219	4.271e-13***	1.174e+00

The fitted ols model was applied to predict the opening and closing prices of nine stocks. The last trading day was selected for prediction as well. The prediction results of the opening price are obtained as 144.361, 12.486, 37.639, 9.252, 104.779, 26.720, 7.890, 13.328, 20.757; the prediction conclusion of the closing price are viewed as 140.747, 12.165, 38.222, 8.682, 106.950, 25.480 10.470, 12.787, and 20.933. Each stock's opening and closing prices obtained after the robustness test are the same as those forecast by OLS.

Comparing with the actual value, it is found that the biggest difference between the estimated opening price and the real value is 2.327 for Li Ning. The smallest difference between the estimated and real value is 0.294 for China Sports Group Industry. The largest difference between the estimated and true closing price is 3.785 for Anta Sports; the smallest variation among the estimated and true values is 0.065 for Contemporary Culture and Sports. It also proves that the fore-end less well-known sports industries have stable development and are less susceptible to external market factors. In contrast, the back-end well-known sports industries are subject to factors such as product quality, market supply as well as demand, which make the stock price more volatile and accordingly more challenging to predict the stock price at all. [6]

4.3 Heterogeneity test

Heterogeneity generally refers to heterogeneity among the data included in the meta-analysis. It is utilized to describe the degree of variability of effect sizes in a series of studies, while also indicating the variability among studies except for predictable chance. Seven stocks with large data were selected for heterogeneity testing (excluding Xingzhi and COSI). The previous closing price was used as the core variable. The test found that both opening and closing price data were heterogeneous ($I^2 > 50\%$) therefore could be analyzed for heterogeneity. [7]

Due to the large heterogeneity, we choose random-effects models (REM) to obtain the core variable coefficients directly. The core variable coefficients corresponding to the opening price are: 10.91, 0.17, 4.76, 0.04, 10.68, 1.30, 0.19. The core variable coefficients corresponding to the closing price are: 20.40, 0.61, 7.93, 0.32, 18.64, 3.82, 0.69.

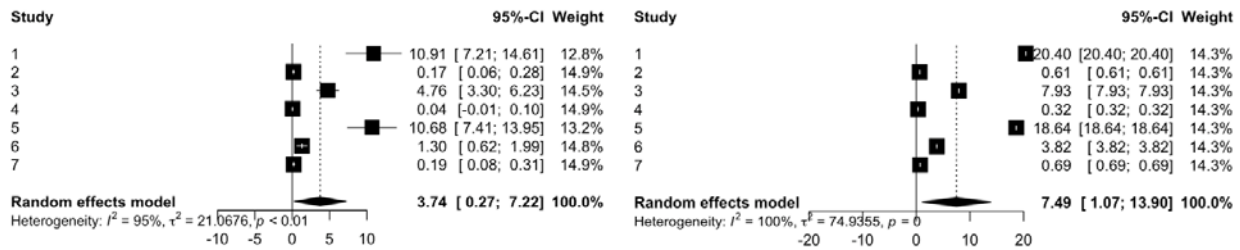


Figure 3. Heterogeneity Test of Opening and Closing Prices.

All the core coefficients are greater than 0, indicating that the previous closing price is positively correlated with the opening and closing prices, that is, the stock price situation of the previous day will have an impact on the subsequent stock price; the previous closing price increases by 1 yuan, the opening or closing price corresponds to the rise in the corresponding core variable coefficient size of the stock price, with a long-term trend of increasing, and its impact is significant for the back-end enterprises. Taking Li Ning as an example, the data above reflects that a \$1 increase in the front closing price increases its opening and closing prices by 10.91 and 20.40, respectively, representing a large impact on the back-end enterprise by the stock price of the previous day. Conversely, the back-end enterprise with CSCI is less affected by the previous day's stock price and has a long-term stable trend.

4.4 Robustness Test

Robustness test examines the robustness of the evaluation method and index interpretation ability. When some parameters are change, whether the evaluation method and index still maintain a relatively consistent and stable interpretation of the evaluation results.

WLS can eliminate heteroscedasticity problems in OLS models. After eliminating heteroscedasticity, if the positive and negative signs and significance of each variable are consistent with those in OLS model, the results are robust.

The results of robustness test are as follow:

Table 4. Robustness test table which applies OLS and WLS (part of all the samples).

Anta Sports	OLS	WLS
Pre-opening	0.4074***	0.4051***
Standard Error	0.0392	0.0394
The Maximum	0.9087***	0.9088***
Standard Error	0.0786	0.0791
The Minimum	0.6441***	0.6487***
Standard Error	0.0918	0.0918

In the case of Anta Sports, we did a robustness test for all companies. When we consider the magnitude of p, the significance and the significance of other variables are different. The strong significance of the previous closing price provides a concrete foundation for our conclusion.

5. Conclusion

In this paper, we selected the stock price information of five enterprises in each of the fore-end and back-end sports industries in 2021, including pre-opening, opening, as well as closing prices, to study the stock price changes then make forecasts. After decomposing the stochastic fluctuations using the HP filter method and using the long-term trend data as the explanatory variables, we conducted the

OLS regression and Tobit model robustness type test, finally came to the following research conclusions. [8]

(1) In terms of the size of share price, the share price of fore-end sports enterprises is mostly lower than that of back-end sports enterprises. This is because back-end sports enterprises are directly oriented to consumers. They have a broader market a visibility, resulting in better efficiency and higher share prices, while fore-end sports are engaged in organizing, not directly oriented to consumers, and have lower visibility and lower share prices as well.

(2) In terms of stock price prediction, fore-end sports enterprises have a better fit and more accurate stock price prediction, while back-end sports enterprises have a poorer fit and imprecise stock price prediction. The reason for this is that fore-end sports enterprises have more stable customers as well as operations, while back-end sports enterprises have more uncertainties that affect their stock prices.

(3) The previous closing price has an impact on both fore-end and back-end sports enterprises. It is more significant for back-end enterprises. That is, the stock price of sports enterprises has a greater influence on the stock price of the later end except for the special influencing factors.

This paper also gives corresponding policy recommendations in response to the obtained findings. [9]

(1) The excessive difference between the fore-end and back-end stock prices of sports industry enterprises is not conducive to the development of the sports industry in China. Accordingly, China should provide the nation with guidance to actively participate in sports activities and sports events to offer support and assistance to the fore-end enterprises to ensure the stable operation of the market. In the meantime, the increase in population base due to the national participation in sports activities provides a reserve force for screening future sports talents.

(2) Fore-end sports enterprises can achieve better benefits by expanding the size of the enterprise while expanding more business of the enterprise; meanwhile, they should focus on brand publicity and promotion to increase the share price after gaining the same popularity as back-end sports enterprises. To achieve stable long-term development, back-end sports enterprises should analyze market factors and combine supply and demand to stabilize share prices in the secondary market. [10]

There are certainly shortcomings in this study. Initially, the research sample of this paper is based on the fore-end and back-end of a total of 10 sports enterprises' data for the year 2021 for the interception, which may contribute to the chance of model results due to force majeure and other factors. Secondly, the model only considers the former opening price as an explanatory variable, while the external factors are considered more singularly. This paper is more of an exploration of ideas through the study of the stock valuation situation linked to diversified categories of the sports industry, which will also serve as a breakthrough for subsequent research to provide a reference for valuation studies of financial investment products.

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