The Deviation Degree of Investment Level of Sports Industry in China—A Case Study of Listed Sports Companies

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Abstract

The purpose of this paper is to study the degree of deviation from the level of investment in China's sports industry. Subjects of this paper are 39 companies engaged in the sports industry of China and listed in Shanghai or Shenzhen stock market, and a two-tier Stochastic Frontier Approach (SFA) model was built to study their panel data from 2007 to 2021 and figure out the influence of financing constraints and agency costs on the deviation of investment level of these subjects. The results suggest that: Both financing constraints and agency costs have a significant impact on the investment level of subjects, and the influence degree of financing constraints is slightly higher; on average, under the combined effect of financing constraints and agency costs, the investment level of subjects is 1.72% lower than the optimal investment level; the influence of financing constraints and agency costs on the deviation of investment level of subjects varies with the year, overall speaking, the influence of financing constraints is larger; for subjects of different property ownership types, there are differences in the degree of deviation of their investment level from the optimal investment level; compared with non-state-owned companies, the state-owned companies are more likely to have insufficient investment. The policy and practical recommendation of this paper is: Government should reduce financing constraints by means of optimizing relevant legal provisions and regulating the tax rates.

Keywords: Listed Sports Companies; Two-Tier Stochastic Frontier Approach (SFA) Model, Financing Constraints; Agency Costs.

Introduction

Achievements in the sports field are reflections of national strength and a powerful country is the foundation of a prosperous sports industry. In recent years, the Chinese government and the Communist Party led by Chairman Xi Jinping have continued to promote the development of sports industry and deepen industrial reform in the country. In September 2019, the General Office of the State Council of China issued the *Opinions on Promoting National Fitness and Sports Consumption to Propel High-quality Development of Sports Industry*, which clearly states that efforts must be made to provide guarantee for developing sports industry and making it a pillar industry of the national economy. In the report of the 20th National Congress of the Communist Party of China, Chairman Xi Jinping called on the people to participate in the Fitness-for-All programs, and he pointed out that we need to invest efforts in sports for youth, for mass, and for competitions, and build China into a powerful country in the sports field. Thus, sports industry is utterly important for the development of China.

Listed sports companies are the most important link in the entire industry chain of sports and they play a crucial role in holding various sports events and investing in the sports industry. Shao et al. (2022) argue that listed sports companies in China are facing some common problems such as inefficient investment and financing, which has limited the high-quality development of sports industry in the country to a certain extent. For these reasons, the average investment efficiency of China's sports industry is only 65%. In view of these matters, we cannot help wondering how far does the investment level of listed sports companies in China deviate from the optimal investment level? According to the Principal-agent Theory, financing constraints lead to insufficient investment while agency costs lead to excessive investment, then will the combined effect of the two drag down or push up the investment level of listed sports companies? Will the deviation degree of investment level change over time or differ according to the ownership of the companies? Research on these problems is meaningful for listed sports companies to take measures to prevent the investment from being insufficient or excessive, so this paper incorporates financing constraints and agency costs into a same research framework based on two-tier SFA (i.e. two-tier Stochastic Frontier Approach, which is a method for efficiency estimation using stochastic frontier production functions.) and builds a model to measure the said deviation degree of investment level of Chinese listed sports companies, in the hopes of providing a piece of useful evidence for the sports industry to save investment resources.

The rest of this paper is structured as follows: the second part is literature review; the third part is the research design of this paper; the fourth part is the two-tier SFA empirical study of this

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paper; the fifth part is the conclusion of this paper.

Literature Review

Shao and Wang (2018) and (Pereira et al., 2022) adopted the heterogeneous SFA model and took sports concept listed enterprises as an example to quantitatively measure the investment efficiency level of China's sports industry. They point out that the sports industry is an emerging force in the development of market economy in modern society, but its development has to rely on financial support. Existing studies have explored a few aspects and situations of listed sports companies, such as Li et al. (2020) and (Abdulnabi et al., 2022) measured the financial support efficiency of listed sports companies, Cai and Zhang (2019) assessed the financial risks of listed sports companies, Liu et al. (2017) studied the capital structure of listed sports companies, and Huang and Fan (2020) discussed the risk prevention of overseas sports industry investment.

Moreover, scholars Zhang and Mu (2021) and (Morán et al., 2024) took the data of 136 listed real estate enterprises in China from 2012 to 2019 as samples to build a two-tiered SFA model and explore the alienation of investment behavior of real estate enterprises. They summarize that the deviation from "optimal" investment level has two situations: excessive investment and insufficient investment. In China, the market allocation of financial resources may fail from time to time, coupled with the low diversity and high cost of financing of sports companies in the country for a long time, as a result, the investment behavior of sports companies is greatly limited by financing constraints. Sevim (2021) and (Al-Tamimi, 2022) studied the operating financial statements and financial risks of sports clubs during COVID-19 's pandemic. The research of Buch et al. (2014) and (Ho & Bautista, 2022) shows that financing constraints have a significant negative influence on the investment behavior of companies; in addition to financing constraints, the investment behavior of listed companies is also affected by agency costs. Lian and Su (2009) and (Abumalik & Alqahtani, 2024) discovered that financing constraints, agency costs, and cash flow sensitivity are closely related to each other. Wang and Song (2014) and (Saleh & AlAli, 2022) found that the cash flow held by managers would restrict their investment behavior. Fama and Jensen (1983) stated that there is a conflict of interest between operators and shareholders. Jensen and Meckling (1976) believes that operators may use the free cash flow of company to make excessive investment for their own benefit.

In summary, listed sports companies may change their investment behavior due to financing constraints and agency costs, and both can cause the investment level of listed sports companies to deviate from the optimal level. When sports companies make their investment decisions, financing constraints and agency costs are factors they cannot ignore. Compared with previous studies, the novelty of this paper lies in integrating financing constraints and agency costs into the same framework at the same time to measure the degree of overinvestment and underinvestment in China's sports industry.

Research Design

Research Method

By drawing on the studies of Gaynor and Polachek (1994), Kumbhakar and Parmeter (2009) and Polachek and Yoon (1996), this paper built a model for measuring the deviation of investment level of listed sports companies. Core mechanism of this model is that, under the precondition that a given sample has an optimal investment level, due to existence of financing constraints and agency costs, on the one hand, agency costs can lead to excessive investment thereby pushing up the investment level of listed sports companies; on the other hand, financing constraints can lead to insufficient investment thereby dragging down the investment level of listed sports companies; the final investment level of listed sports companies is the result of the two-tier actions of financing constraints and agency costs. By calculating the strength of the action of the two, the deviation degree of the investment level of listed sports companies could be measured.

Assuming: during a typical market competition, the investment level of listed sports companies is affected by financing constraints and agency costs, then the investment level ($invt$) can be written as:

$$invt = \underline{invt} + \eta\left(\overline{invt} - \underline{invt}\right) \quad (1)$$

Where, $\underline{invt}$ represents the minimum investment level allowed by a listed sports company; $\overline{invt}$ represents the maximum investment level could be afforded by the listed sports company; $\eta(0\leq\eta\leq1)$ measures the influence intensity of agency costs during the formation of investment level of listed sports company, the higher the influence intensity, the closer the η value to 1, therefore, $\eta\left(\overline{invt} - \underline{invt}\right)$ reflects the deviation degree caused by agency costs during the formation of investment level of the listed sports company.

To exhibit the actions of both agency costs and financing constraints on the investment level of listed sports companies in the model, Formula 1 needs to be decomposed. Under the condition that the sample feature x is given, the optimal investment level spontaneously formed by the market is $\mu(x)=E(\theta|x)$, and it satisfies

$\underline{invt} \le \mu(x) \le \overline{invt}$, wherein θ actually exists but cannot be known (This efficient matching game problem has been analyzed in many foreign studies (e.g., Acemoglu and Shimer (2000); Flinn (2006), etc.), but they are basically set to be known or to obey a certain distribution. Since it is difficult to find an "optimal" level of investment a priori, this paper assumes that it is not known as a priori but exists objectively.). $\mu(x) - \underline{invt}$ represents the degree of deviation caused by agency costs during the formation of investment level of listed sports companies; $\overline{invt} - \mu(x)$ represents the degree of deviation caused by financing constraints during the formation of investment level of listed sports companies (Bhatti et al., 2022; Osborne & Rubinstein, 1990). According to the definition of deviation degree, Formula 1 can be re-written as:

$$invt = \mu(x) + [\underline{invt} - \mu(x)] + \eta[\overline{invt} - \mu(x)] - \eta[\underline{invt} - \mu(x)]$$
$$= \mu(x) + \eta[\overline{invt} - \mu(x)] - (1-\eta)[\mu(x) - \underline{invt}] \quad (2)$$

According to Formula 2, agency costs can increase investment level, the increment is $\eta[\overline{invt} - \mu(x)]$; similarly, financing constraints can decrease investment level, and the decrement is $(1-\eta)[\mu(x) - \underline{invt}]$.

Formula 2 indicates that the investment level of listed sports companies consists of three parts: $\mu(x)$ represents the optimal investment level formed by market under the condition that the sample feature x is given; $\eta[\overline{invt} - \mu(x)]$ represents the increment of investment level caused by agency costs; $(1-\eta)[\mu(x) - \underline{invt}]$ represents the decrement of investment level caused by financing constraints. The net deviation of investment level of listed sports companies caused by the joint action of the two is:

$$ND = \eta[\overline{invt} - \mu(x)] - (1-\eta)[\mu(x) - \underline{invt}] \quad (3)$$

Formula 3 measures the combined effect of agency costs and financing constraints during the formation of investment level of listed sports companies, if ND<0, then it indicates that the influence of financing constraints is greater than that of agency costs, in the end, the investment level will go down; if ND>0, then it indicates that the influence of agency costs is greater than that of financing constraints, in the end, the investment level will go up.

Within the analysis framework of Formula 3, financing constraints exert a negative effect on the deviation of investment level, and the effect of agency costs is positive, the final investment level is the result of the combined action of the two, this is a typical two-tier SFA model which can be written as:

$$invt_i = \mu(x_i) + \xi_i, \xi_i = w_i - u_i + v_i \quad (4)$$

Where, $\mu(x_i)=x_i'\delta$, $x_i$represents the eigenvector of the sample, δ represents the parameter vector to be estimated; w_i represents the increment of investment level caused by agency costs, and there is $w_i = \eta_i[\overline{invt_i} - \mu(x_i)] \ge 0$; u_i represents the decrement of investment level caused by financing constraints, and there is $u_i = (1-\eta_i)\left[\mu(x_i) - \underline{invt_i}\right] \ge 0$;$v_i$ is the random disturbance term in the common sense.

In order to estimate the deviation caused by parameter vector δ in the model and by agency costs and financing constraints at the same time, this paper adopted the maximum likelihood estimation method to estimate Model 4. According to the setting of Model 4 and the above analysis, both disturbance terms w_i and u_i have single-tier distribution feature, so in this paper, it's assumed that they both obey the exponential distribution, that is, u_i~$i.\ i.\ d.\ Exp(\sigma_u, \sigma_u^2)$, w_i~$i.\ i.\ d.\ Exp(\sigma_w, \sigma_w^2)$ (The study of Kumbhakar et al. (2009) showed that the use of different distribution assumptions did not have a substantial effect on the results, so the exponential distribution, which has the simplest form, is used in this paper.). For disturbance term v_i, assuming: v_i obeys the normal distribution v_i~$i.\ i.\ d.\ N(0, \sigma_v^2)$, and v_i, u_i, w_i are independent of each other and are independent of sample feature x_i, then the probability density function of hybrid disturbance term $\xi_i$can be derived as follows:

$$f(\xi_i) = \frac{exp(a_i)}{\sigma_u+\sigma_w}\Phi(c_i) + \frac{exp(b_i)}{\sigma_u+\sigma_w}\int_{-h_i}^{\infty}\phi(z)dz = \frac{exp(a_i)}{\sigma_u+\sigma_w}\Phi(c_i) + \frac{exp(b_i)}{\sigma_u+\sigma_w}\phi(h_i) \quad (5)$$

where, $\phi(\cdot)$and $\Phi(\cdot)$are respectively the probability density function and the cumulative distribution function of standard normal distribution, other parameters were set as follows:

$$a_i = \frac{\sigma_v^2}{2\sigma_u^2} + \frac{\xi_i}{\sigma_u}; b_i = \frac{\sigma_v^2}{2\sigma_w^2} - \frac{\xi_i}{\sigma_w}; h_i = \frac{\xi_i}{\sigma_v} - \frac{\sigma_v}{\sigma_w}; c_i = -\frac{\xi_i}{\sigma_v} - \frac{\sigma_v}{\sigma_u}$$

For a sample containing n observed values, its logarithmic likelihood function can be written as:

$$ln\,L\,(X;\theta) = -n\,ln(\sigma_u + \sigma_w) + \sum_{i=1}^{n} ln[\,e^{a_i}\Phi(c_i) + e^{b_i}\Phi(h_i)] \quad (6)$$

where, $\theta = [\beta, \sigma_v, \sigma_u, \sigma_w]'$. By maximizing the logarithmic likelihood function, the maximum likelihood estimates of all parameters could be attained.

Since this paper focuses on the deviation of investment level caused by financing constraints and agency costs, the conditional distributions of u_i and w_i need to be derived, respectively denoted as $f(u_i|\xi_i)$ and $f(w_i|\xi_i)$, then there are:

$$f(u_i|\xi_i) = \frac{\lambda\, exp(-\lambda u_i)\Phi(u_i/\sigma_v + h_i)}{\Phi(h_i) + exp(a_i - b_i)\Phi(c_i)} \quad (7a)$$

$$f(w_i|\xi_i) = \frac{\lambda\, exp(-\lambda w_i)\Phi\left(\frac{w_i}{\sigma_v} + c_i\right)}{exp(b_i - a_i)[\Phi(h_i) + exp(a_i - b_i)\Phi(c_i)]} \quad (7b)$$

where, $\lambda = \frac{1}{\sigma_u} + \frac{1}{\sigma_w}$. Based on the conditional distributions given in Formula (7a) and Formula (7b), the conditional expectations of u_i and w_i during the formation of investment level could be attained, and the estimation formulas of the two formulas are:

$$E(1 - e^{-u_i}|\xi_i) = 1 -$$

$$\frac{\lambda}{1+\lambda}\frac{\left[\Phi(h_i)+exp(a_i-b_i)\,exp\left(\frac{\sigma_v^2}{2}-\sigma_v c_i\right)\Phi(c_i-\sigma_v)\right]}{\Phi(h_i)+exp(a_i-b_i)\Phi(c_i)} \quad (8a)$$

$$E(1-e^{-w_i}|\xi_i)=1-$$

$$\frac{\lambda}{1+\lambda}\frac{\left[\Phi(c_i)+exp(b_i-a_i)\,exp\left(\frac{\sigma_v^2}{2}-\sigma_v h_i\right)\Phi(h_i-\sigma_v)\right]}{exp(b_i-a_i)[\Phi(h_i)+exp(a_i-b_i)\Phi(c_i)]} \quad (8b)$$

Further, the net deviation ND of the investment level caused by the combined effect of financing constraints and agency costs can be expressed as:

$$ND=E(1-e^{-w_i}|\xi_i)-E(1-e^{-u_i}|\xi_i)=E(e^{-u_i}-e^{-w_i}|\xi_i) \quad (9)$$

One thing should be pointed out here is that parameter σ_u only exists in a_i and c_i, and σ_w only exists in b_i and d_i, so they are recognizable. Therefore, in follow-up verification, it's not necessary to assume the relative size of the deviation of investment level caused by agency costs and financing constraints in advance, and it's entirely determined by the estimation results of the model (Lu et al., 2011). In this paper, the sfa2tier command in stata is used to estimate Model 4. This model mainly adopts the method of maximum likelihood estimation, which can estimate the influence degree of overinvestment and underinvestment on the investment level of China's sports industry at the same time, so as to judge the actual level of investment efficiency of China's sports industry.

Sample Selection and Data Source

Drawing on the practice of Tian et al. (2022), in this paper, several companies engaged in the sports industry of China and listed in Shanghai or Shenzhen stock market were taken as subjects of this study, and all subjects were processed according to following standards: (1) The main business of the subject is within eleven categories specified by the *National Sports Industry Statistical Classification*; (2) Companies with an income from sports business activities accounting for less than 50% of the total corporate revenue were excluded. After that, 39 listed sports companies were chosen as subjects, and their panel data from 2007 to 2021 was drawn from the CSMAR database (China Stock Market & Accounting Research Database), after deleting missing values, a total of 381 observed values were attained, as shown in Appendix.

Variable Selection

In this paper, the explained variable is the investment level of subjects (ln_invt), referring to the investment expenditure expectation model of Richardson (2006), the calculation method of investment level here is: calculating the value of (expenditure of fixed assets, intangible assets and other long-term assets)/total assets, and then taking the natural logarithm of this value; in terms of control variables, referring to previous research paper, this paper selected the following variables that can affect the investment level of subjects: growth rate of business profit (profit_grow); growth rate of main business income (income_grow); return on assets (roa); return on equity (roe); liabilities to assets ratio (lev); cash stock (cash), the calculation method is: monetary capital/total assets; company size (size), its value is the natural logarithm of total assets; annual return on stock (return); company age (ln_age), the calculation method is: calculating the value of "research time - company establishment time", and then taking the natural logarithm of this value; company age when listing (ln_list), the calculation method is: calculating the value of "research time - company listing time", and then taking the natural logarithm of this value; share balance (share_b); board size; proportion of independent directors (ind_r); proportion of shares held by the largest shareholder (topone); Herfindahl-Hirschman Index 5 (hhi5). At the same time, two dummy variables Year and Industry were added to control the influence of the two on regression results, Table 1 lists the above variables. The conceptual framework of this paper is shown in Figure 1.

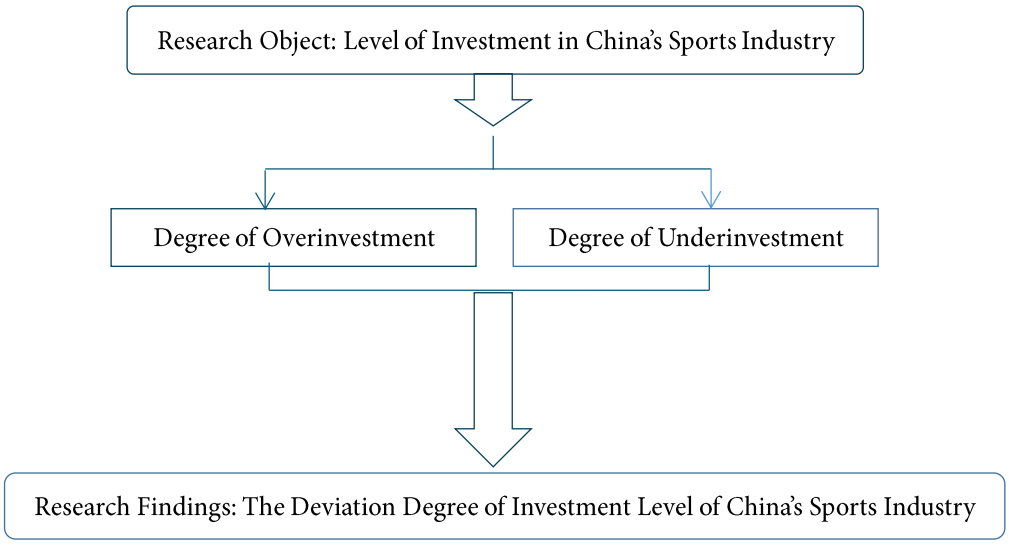

Figure 1: The Conceptual Framework of This Paper.

Table 1

Statistical Results of Variables

Variable	N	mean	sd	min	p50	max	Cited by previous scholars
ln_invt	381	-3.971	1.533	-8.952	-3.759	-1.414	Zhang et al. (2021)
profit_grow	381	-0.633	4.632	-31.09	0.004	8.289	Li et al. (2020)
income_grow	381	0.135	0.426	-0.66	0.078	2.34	Zhang et al. (2021)
roa	381	0.036	0.061	-0.221	0.035	0.179	Li et al. (2020)
roe	381	0.067	0.123	-0.446	0.067	0.374	Li et al. (2020)
lev	381	0.437	0.199	0.098	0.452	0.853	Zhang et al. (2021)
cash	381	0.19	0.126	0.015	0.158	0.556	Zhang et al. (2021)
size	381	22.056	1.209	19.109	22.073	24.701	Liu et al. (2017)
return	381	0.075	0.576	-0.627	-0.11	3.168	Zhang et al. (2021)
ln_age	381	2.825	0.415	1.386	2.89	3.497	Shao et al. (2022)
ln_list	381	2.143	0.937	0	2.398	3.296	Wang (2023)
share_b	381	0.583	0.539	0.017	0.404	2.098	Tian et al. (2022)
boardsize	381	8.751	1.931	5	9	15	Wang (2023)
ind_r	381	0.365	0.043	0.3	0.333	0.5	Shao et al. (2022)
topone	381	0.364	0.143	0.113	0.358	0.676	Shao et al. (2022)
hhi5	381	0.17	0.109	0.023	0.153	0.457	Wang (2023)

Note: For detailed calculation process of indexes please refer to the CSMAR database (China Stock Market & Accounting Research Database).

Table 2

Regression Analysis Results of Factors Affecting the Investment Level of Listed Sports Companies

ln_invt	model 1	model 2	model 3	model 4
profit_grow	0.030	0.035*	0.022	0.019
	(1.435)	(1.701)	(1.165)	(0.999)
income_grow	-0.268	-0.086	-0.236	-0.321**
	(-1.492)	(-0.473)	(-1.568)	(-1.970)
roa	5.787	6.105*	-0.203	-0.666
	(1.541)	(1.691)	(-0.063)	(-0.201)
roe	-3.654*	-3.721**	0.08	-0.231
	(-1.909)	(-2.031)	(0.05)	(-0.139)
lev	0.663	-0.051	1.042*	0.874*
	(1.289)	(-0.103)	(1.898)	(1.809)
cash	1.047	0.504	1.245**	1.255**
	(1.616)	(0.825)	(2.009)	(1.992)
size	-0.056	-0.147**	-0.054	0.068
	(-0.762)	(-2.218)	(-0.802)	(0.819)
return	-0.154	-0.025	-0.183*	-0.113
	(-1.196)	(-0.204)	(-1.772)	(-0.773)
ln_age	-0.387*	-0.832***	-0.091	0.256
	(-1.743)	(-4.726)	(-0.478)	(1.137)
ln_list	-0.525***	—	-0.418***	-0.483***
	(-5.004)	—	(-4.125)	(-4.570)
share_b	-0.104	0.093	-0.022	0.215
	(-0.351)	(0.323)	(-0.076)	(0.837)
boardsize	0.138***	0.125***	0.151***	0.138***
	(2.973)	(2.924)	(3.531)	(3.359)
ind_r	3.236	3.597*	1.918	1.87
	(1.596)	(1.92)	(1.169)	(1.157)
topone	-1.495	0.296	-3.938	-2.867
	(-0.436)	(0.091)	(-1.296)	(-0.985)
hhi5	0.346	-1.346	3.797	3.106
	(0.092)	(-0.382)	(1.181)	(0.987)
_cons	-2.756	-0.565	-3.572	-6.649***
	(-1.354)	(-0.274)	(-1.582)	(-2.662)
industry_dum	—	—	yes	yes
year_dum	—	—	—	yes
N	381	381	381	381
r2_a	0.171	—	—	—
Log likelihood	—	-666.688	-600.507	-590.74

Note: ***, ** and * represent the t-test is significant at the levels of 1%, 5% and 10%, respectively, t values are given in parentheses; model 2: In Model 2, variable "ln_list" was removed, otherwise the model could not converge.

The difference between model 1, model 2, model 3 and model 4 is that the variables of model 1 and model 2 are the same, but OLS is used for estimation in model 1, MLE is used for estimation in model 2, industry dummy variables are added in model 3 based on the variables of model 1 and model 2, and two-tier SFA is used for model 3's estimation, and annual dummy variables are added in model 4 based on variables of model 3. And two-tier SFA is also used for model 4's estimation. The reason for selecting the four models for estimation is to select the one with the largest likelihood ratio for the subsequent variance decomposition and deviation degree measurement. This is consistent with the research method of Lu et al. (2011).

In Table 2, model 1 adopted OLS estimate, model 2 adopted MLE estimate, and models 3 and 4 adopted MLE estimate under two-tier stochastic frontier. model 3 added a dummy variable Industry on the basis of model 2, and model 4 added a dummy variable Year on the basis of model 3. In this paper, model 4 with the largest Log likelihood was taken as the benchmark model for subsequent variance decomposition.

Estimation results of model 4 suggest that income growth rate and company age when listing have significant negative effects on investment level; liabilities to assets ratio, cash stock, and board size have significant positive effects on investment level.

Variance Decomposition

Table 3

Deviation of Investment Level Caused by Agency Costs and Financing Constraints

	Meaning of the variable	Symbol	Coefficient of measurement
Influence mechanism of deviation	Random error term	σ_v	0.4458
	Deviation caused by agent costs	σ_w	0.7500
	Deviation caused by financing constraints	σ_u	0.8023
Variance decomposition	Total variance of random terms	$\sigma_v^2 + \sigma_u^2 + \sigma_w^2$	1.405
	Proportion of effect on deviation in total variance	$\frac{\sigma_u^2 + \sigma_w^2}{\sigma_v^2 + \sigma_u^2 + \sigma}$	85.85%
	Proportion of effect on deviation caused by agency costs	$\frac{\sigma_w^2}{\sigma_u^2 + \sigma_w^2}$	46.63%
	Proportion of effect on deviation caused by financing constraints	$\frac{\sigma_u^2}{\sigma_u^2 + \sigma_w^2}$	53.37%

This paper measured the deviation of investment level of listed sports companies caused by agency costs and financing constraints, and the results are shown in Table 3. The results shown in Table 3 indicate that the deviation caused by agency costs and financing constraints has significant impact on the investment level of listed sports companies, and the deviation caused by the effect of financing constraints is slightly higher than that caused by agency costs, and the comprehensive effect caused by the two on investment level is negative, $E(w\text{-}u)= \sigma_w\text{-}\sigma_v$=0.7500-0.8023=-0.0523, which means that overall speaking the comprehensive deviation caused by the two will result in an investment level that is slightly lower than the "optimal" investment level. At the same time, the total variance ($\sigma_v^2+\sigma_u^2+\sigma_w^2$) of the part *invt* cannot explain is 1.405, of which 85.85% is contributed by the deviation caused by agency costs and financing constraints; in the total effect on investment level, the proportion of deviation caused by agency costs is 44.63%, and the proportion of deviation caused by financing constraints is 55.37%. The results of variance decomposition suggest that, both agency costs and financing constraints have certain effect during the formation of the investment level of listed sports companies, and the effect of financing constraints is slightly higher. This may be due to the fact that there is still a certain degree of market failure in the allocation of financial resources in China, and the business philosophy, innovation capacity and service level are not yet adapted to the requirements of high-quality economic development, thus leading to the deviation of investment in China's sports industry from the optimal level. To analyze the net deviation of investment level caused by agency costs and financing constraints and the respective deviation caused by either of them, this paper further performed single-tier effect estimation on the two.

Estimation of Deviation of Investment Level Caused by Agency Costs and Financing Constraints

This part mainly studies the deviation of investment level of listed sports companies respectively caused by financing constraints or agency costs, namely $E(u|\xi)$ and $E(w|\xi)$, the corresponding estimates are given by Formulas (8a) and (8b), and their meaning is the percentage of deviation

from the optimal investment level $\widehat{invt} = x_i^{'\hat{\beta}}$ caused by the two during the formation of investment level of listed sports companies. The estimation results are shown in Table 4.

Table 4

Net Deviation Caused by Agent Costs and Financing Constraints

Variable	Average (%)	Standard Deviation (%)	Q1 (%)	Q2 (%)	Q3 (%)
Agency costs: $\hat{E}(1-e^{-w}\|\xi)$	42.85	17.85	28.98	35.03	49.90
Financing constraints: $\hat{E}=(1-e^{-u}\|\xi)$	44.57	18.94	29.61	37.07	53.83
Net deviation: $\hat{E}=(e^{-w}-e^{-u}\|\xi)$	-1.72	33.36	-24.85	-2.04	20.29

Note: Q1, Q2, and Q3 are respectively the 1st, 2nd, and 3rd quartile, namely the 25, 50, and 75 percent, same below.

The estimation results in Table 4 suggest that, on average, the deviation caused by agency costs makes the investment level higher than the optimal investment level by 42.85%, while the deviation caused by financing constraints makes the investment level lower than the optimal investment level by 44.57%, finally, their joint action makes the investment level lower than the optimal investment level by 1.72%. The last three columns (Q1-Q3) of Table 4 show detailed distribution characteristics of the deviation caused by financing constraints and agency costs, indicating that there are differences in the degree of deviation caused by the two during the formation of investment level of listed sports companies. At the 1st quartile(Q1), the investment level is lower than the optimal investment level by 24.85%, while at the 3rd quartile (Q3), the investment level is is 20.29% higher than the optimal investment level, this means that, with the increase of investment level, the effect of agency costs is stronger during the formation of investment level of listed sports companies.

In this paper, the distribution characteristics of the deviation caused by agency costs, the deviation caused by financing constraints, and the net deviation caused by the two were plotted into histograms, as shown in Figure 2, Figure 3 and Figure 4.

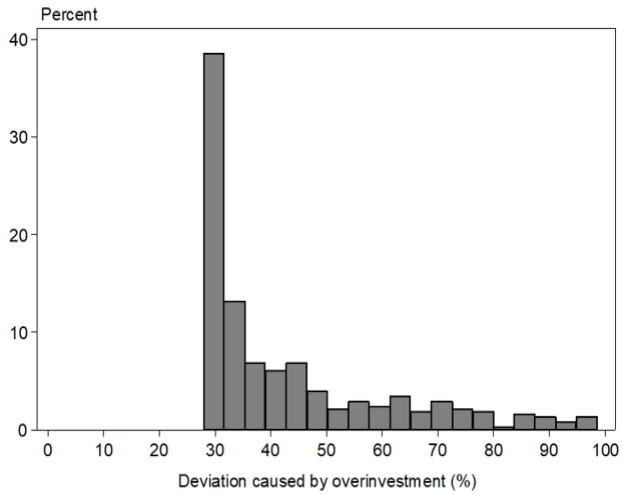

Figure 2: Deviation of Investment Level Caused by Agency Costs.

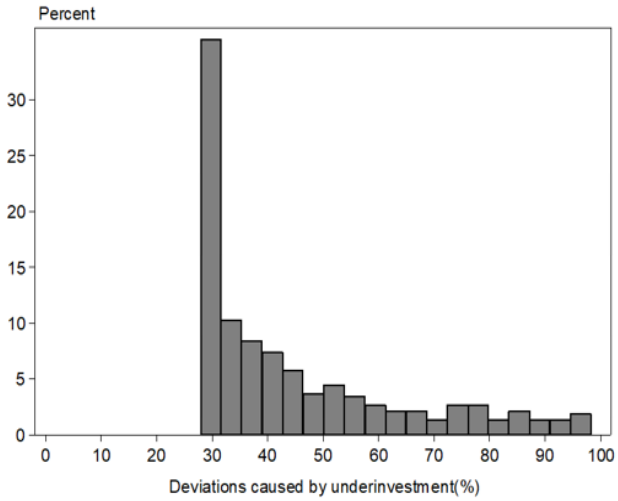

Figure 3: Deviation of Investment Level Caused by Financing Constraints.

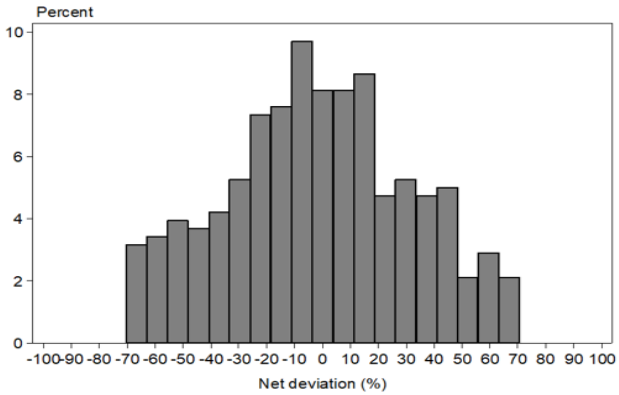

Figure 4: Net *Deviation.*

Figures 2-4 clearly show the distribution characteristics of the deviation caused by agency costs, the deviation caused by financing constraints, and the net deviation caused by the combined action of the two. According to Figure 2 and Figure 3, for the deviation caused by agency costs and the deviation caused by financing constraints, both have a tail extending to the right, indicating that only a small number of companies are significantly affected by agency costs or financing constraints. According to the distribution characteristics of net deviation shown as Figure 4, it's not that financing constraints are in the dominant position in all listed sports companies, statistics show that for about

52.76% of the listed sports companies, their investment level has been dragged down, and it also means that for about 47.24% of the listed sports companies, their investment level has been pushed up. This may be because China's listed sports enterprises are faced with a series of problems of low investment and financing efficiency. The overall operation efficiency of the sports industry is low, and the lack of investment efficiency is common, which restricts the high-quality development of the sports industry to a certain extent.

Net Deviation Caused by Agency Costs and Financing Constraints in Different Years

Table 5

Net Deviation of Investment Level Caused by Agent Costs and Financing Constraints in Different Years

Year	Mean (%)	Standard deviation (%)	Q1 (%)	Q2 (%)	Q3 (%)
2007	-1.88	30.64	-25.73	-7.71	23.83
2008	0.59	35.65	-24.07	-1.08	34.00
2009	0.73	37.40	-24.61	-8.64	27.82
2010	-1.54	28.97	-17.34	-3.55	16.93
2011	-0.94	34.14	-19.49	-4.58	19.72
2012	-4.44	34.08	-20.46	3.32	17.90
2013	-1.06	34.22	-21.41	-2.63	14.27
2014	-6.28	34.18	-37.80	-1.79	20.92
2015	-3.58	32.38	-26.22	-1.31	30.14
2016	-3.81	34.55	-32.74	1.58	19.67
2017	-1.34	35.32	-15.22	-4.39	26.51
2018	-1.69	33.91	-25.54	-1.55	18.78
2019	-0.56	38.43	-32.71	-5.72	38.76
2020	-1.02	30.05	-21.73	-1.67	13.39
2021	0.29	33.11	-23.10	-2.81	25.25

Due to the possible heterogeneity in listed sports companies in different years, to compare the comprehensive effect of agency costs and financing constraints on the net deviation of investment level in different years, statistics were made for each year, and the net deviation of different years is shown in Table 5.

Estimation results in Table 5 show that between 2007 and 2021, the net deviation of investment level caused by agency costs and financing constraints in different years is heterogeneous. On average, in 12 out of the 15 years, the deviation caused by financing constraints is greater, only in three years, the deviation caused by agency costs is larger. This may be due to different economic circumstances in different years. Therefore, overall speaking, the deviation of investment level caused by financing constraints is greater than that caused by agency costs; besides, Q1-Q3 also show this trend, as investment level increases, the effect of agency costs during the formation of investment level of listed sports companies is stronger. The heterogeneity of Q1-Q3 is similar to the results of Lu et al. (2011).

Deviation Caused by Agency Costs and Financing Constraints to Companies With Different Ownership Types

Due to the possible heterogeneity in listed sports companies with different ownership types, because different ownership types of companies operating environment are different, to compare the deviation of investment level caused by agency costs and financing constraints to companies with different ownership types, statistics were made respectively for state-owned companies and non-state-owned companies, and the results are shown in Table 6.

Table 6

Deviationof Investment Level Caused by Agency Costs and Financing Constraints to Companies with Different Ownership Types

	Variable	Mean (%)	Standard deviation (%)	Q1 (%)	Q2 (%)	Q3 (%)
Non-state-owned	Agency costs: $\hat{E}(1-e^{-w}\|\xi)$	43.45	18.60	29.38	35.37	52.27
	Financing constraints: $\hat{E}=(1-e^{-u}\|\xi)$	43.49	17.55	29.2	36.68	51.17
	Net deviation: $\hat{E}=(e^{-w}-e^{-u}\|\xi)$	-0.03	32.80	-21.79	-1.31	23.07
State-owned	Agency costs: $\hat{E}(1-e^{-w}\|\xi)$	42.11	16.93	28.68	34.60	48.76
	Financing constraints: $\hat{E}=(1-e^{-u}\|\xi)$	45.88	20.47	29.84	37.60	56.61
	Net deviation: $\hat{E}=(e^{-w}-e^{-u}\|\xi)$	-3.77	34.02	-27.93	-3.00	18.92

The results shown in Table 6 suggest, regardless of state-owned or non-state-owned listed sports companies, overall

speaking, the deviation of investment level caused by financing constraints is greater than that caused by agency costs. Especially in state-owned companies, the insufficient investment caused by financing constraints is more serious, which has resulted in an investment level 3.77% lower than the optimal level. The findings that companies with different ownership have heterogeneity are similar to the findings of Zhang et al. (2021).

Research Conclusions

This paper built a model for measuring the deviation of investment level of listed sports companies caused by agency costs and financing constraints based on two-tier SFA and used it to measure the data of a few sample companies, then the following conclusions were drawn: The deviation of investment level caused by agency costs and financing constraints has an important impact on the formation of investment level of listed sports companies. The deviation caused by financing constraints is slightly higher than that caused by agency costs, together, their combined effect on the investment level of listed sports companies is -0.0523, indicating that the investment level of listed sports companies is lower than the optimal investment level under the joint action of the two; when analyzing the single-tier effect of agency costs and financing constraints, it is found that, on average, the deviation caused by agency costs makes the investment level 42.85% higher than the optimal level, and the deviation caused by financing constraints makes the investment level 44.57% lower than the optimal level, and the final result is the investment level of listed sports companies is 1.72% lower than the optimal level. Analysis of quartile further shows that as the investment level increases, the effect of agency costs during the formation of investment level of listed sports companies is stronger. Moreover, statistics suggest for about 52.76% of listed sports companies, their investment level has been dragged down, while for 47.24% of them, their investment level has been pushed up; annual analysis shows that from 2007 to 2021, the net deviation of investment level caused by agency costs and financing constraints in different years is heterogeneous. But on the whole, the deviation caused by financing constraints is greater; ownership analysis shows that, regardless of state-owned or non-state-owned companies, the deviation of investment level caused by financing constraints is larger than that caused by agency costs; especially in state-owned companies, the under-investment caused by financing constraints is even more serious.

The research results of this paper revealed that, although the under-investment caused by financing constraints has a great impact on listed sports companies, the over-investment caused by agency costs is also a problem cannot be ignored, therefore, listed sports companies should make efforts to reduce agency costs by improving their information disclosure system and production and operation management system; to promote healthy and stable development of the sports industry, government should reduce financing constraints by means of optimizing relevant legal provisions and regulating the tax rates. Future studies can study the specific factors that affect financing constraints and agency costs in China's sports industry, and study how to effectively reduce the negative impact of financing constraints and agency costs on investment levels.

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Appendix

List of listed sports companies (subjects)

id	name	id	name	id	name
000529	GHKG	002694	GDKJ	600158	ZTCY
000558	LYTY	002701	ARJ	600287	JSST
000652	TDGF	002832	BYLF	600637	DFMZ
000839	ZXGA	002858	LSSC	600679	SHFH
000935	SCSM	002899	YPS	600749	XZLY
002081	JTL	300005	TLZ	600768	NBFB
002105	XHJK	300043	XHYL	600814	HZJB
002181	YCM	300162	LMGD	600826	LSGF
002346	TZGF	300291	HLBN	600881	YTJT
002395	SXGF	300526	ZQGF	601718	JHJT
002400	SGJT	300651	JLTY	603129	CFDL
002486	JLJ	600052	DWSD	603558	JSJT
002489	ZJYQ	600060	HXYX	603908	MGD