

POLICY-ACTIVATED SUSTAINABLE FINANCIAL PERFORMANCE FOR HIGH-QUALITY DEVELOPMENT OF SPORTS INDUSTRY

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Abstract: Taking the sports consumption pilot city policy as a quasi-natural experiment, this paper focuses on the high-quality development of the sports industry and constructs a sustainable financial performance comprehensive index of sports enterprises from four dimensions including profitability, growth capacity, debt-paying capacity and operational efficiency by using the entropy-weight-TOPSIS method. Based on the panel data of A-share sports-concept listed companies from 2016 to 2025, this paper adopts the multi-period difference-in-differences model to quantitatively identify the net policy effect. The empirical results show that the sports consumption pilot policy significantly improves the sustainable financial performance of sports enterprises, with an average promotion effect of 5.2 %. Parallel trend test verifies that the policy effect gradually emerges after policy implementation. Benchmark regression results remain valid after multiple robustness tests including PSM-DID, placebo test, variable replacement and sample elimination. This study provides micro-level empirical evidence for evaluating the implementation effect of sports consumption pilot policy, and offers decision-making reference for promoting the high-quality development of the sports industry.

Keywords: Sports industry high-quality development; Sustainable financial performance; Multi-period DID; Quasi-natural experiment; Sports consumption pilot city

1 INTRODUCTION

High-quality development of the sports industry is an essential component of building a powerful sports nation, and sustainable financial performance of micro-enterprises constitutes the core foundation for industrial upgrading [1]. Launched in 2020, the national sports consumption pilot-city program aims to stimulate regional consumption vitality and foster new-quality productive forces for sports enterprises [2-3]. Existing macro-level research has verified that pilot policies can expand consumption scale and optimize industrial layouts [4]. Nevertheless, few quantitative evaluations focus on micro-enterprise sustainable financial performance, and how demand-side policies transmit to long-term enterprise operational capacity still requires further empirical evidence [5]. Consumption-oriented incentive policies can reshape market demand expectations and further change enterprises' resource allocation preferences. Under the background of new-quality productive forces, it is urgent to clarify the micro-effect of such regional pilot policies.

Current relevant studies mainly adopt difference-in-differences frameworks to assess sports industry policies, concentrating on enterprise innovation output, industrial resilience and macroeconomic benefits [6]. Some scholars have discussed financial-performance drivers for sports-related listed firms from dimensions including digital transformation and ESG performance [7-8]. However, most existing measurements adopt single financial indicators, lacking multi-dimensional composite indexes oriented to sustainable operation. Moreover, prior literature pays insufficient attention to the net policy effect on multi-attribute sustainable financial performance under quasi-natural-experiment settings, which creates research gaps for micro-oriented policy evaluation of sports-consumption pilot programs [9-10]. Single-indicator evaluation is susceptible to short-term profit fluctuation and cannot reflect the long-term coordinated development of multiple capabilities. Most existing empirical works also fail to construct systematic evaluation tools for sports-enterprise sustainable financial performance.

To fill above-mentioned research gaps, this paper constructs a multi-dimensional sustainable-financial-performance composite index via entropy-weight-TOPSIS. Taking sports-consumption pilot-city policy as a quasi-natural experiment, multi-period DID is applied to identify the policy net effect based on A-share sports-concept listed-company panel data from 2016 to 2025. Parallel-trend test and multiple robustness checks including PSM-DID and placebo test are implemented to verify result reliability. This work supplements micro-level empirical evidence for evaluating sports-consumption pilot policies, and provides quantitative reference for promoting high-quality development of the sports industry. This paper further focuses on the direct influence of demand-side policies on enterprises' four-dimensional financial capability. The research idea can offer replicable analytical thinking for similar regional consumption-stimulating pilot projects.

2 RESEARCH DESIGN AND MODEL CONSTRUCTION

2.1 Research Idea and Overall Framework

Based on the exogenous shock brought by the national sports consumption pilot-city policy, this paper adopts the multi-period difference-in-differences model to analyze the net policy effect on the sustainable financial performance of sports-related enterprises.

The mediation effect model is applied to test the transmission channel of R&D investment intensity. Group regression is further utilized to analyze heterogeneity across property-right attributes and geographical regions.

2.2 Data Preprocessing Scheme

Enterprise financial data are obtained from the CSMAR and Wind databases. A-share listed companies with sports-related concepts from 2016 to 2025 are selected as initial samples, and panel data of 32 enterprises are preliminarily screened.

After excluding ST-labeled enterprises, samples with severe missing core indicators and firms listed for less than three years, 12128 valid unbalanced panel observations are finally retained. Policy-related data are collected according to two batches of pilot-city lists released by the General Administration of Sport of China in 2020 and 2025. The treatment variable is constructed by matching enterprise registration locations. The treat variable is assigned 0 for enterprises located in non-pilot cities.

City-level control variables are sourced from China City Statistical Yearbook and EPS database. All continuous variables are winsorized at the upper and lower 1 % quantiles. Natural logarithms are taken for scale- and revenue-related indicators. Min-Max normalization is performed on explained variables. Data processing is completed with Stata 17.0 and Python 3.9.

For missing-value problems, core explained variables are imputed with intra-enterprise median values, and missing-dummy variables are generated. Continuous variables such as R&D investment intensity are supplemented via linear interpolation.

Policy variables are manually calibrated based on official documents to construct difference-in-differences interaction terms. Samples corresponding to pre-listing periods and observations with severe null values are eliminated.

All continuous variables are winsorized at the 1 % quantile to mitigate the interference of abnormal values. Natural logarithms are applied to enterprise-scale and revenue indicators to eliminate heteroscedasticity, while ratio-type variables retain their original forms. Standardization of core performance indicators is completed simultaneously.

2.3 Variable Definition and Measurement

The definitions and measurements of the primary variables are presented in Table 1.

Table 1 Definition and Measurement of Main Variables

Variable Type	Variable Name	Variable Symbol	Measurement Description
Explained Variable	Enterprise sustainable development performance	sustainable_score	Comprehensive performance index processed by Min-Max normalization; missing values are imputed by intra-enterprise median
Core Explanatory Variable	Dummy variable for treatment group	treat	Equals 1 if the city where the enterprise registers is selected as a national sports consumption pilot city; otherwise 0
	Policy-period dummy variable	post	Equals 1 for years after the release of pilot-city list; otherwise 0
	DID interaction term	did	treat×post
	R&D investment intensity	rd_intensity	R&D expenditure / operating revenue; missing values filled by linear interpolation
Firm-level Control Variables	Enterprise size	size	Natural logarithm of total assets
	Firm age	age	Observation year minus enterprise founding year
	Cash flow level	cashflow	Net cash flow from operating activities / total assets
	Ownership concentration	top1	Shareholding ratio of the largest shareholder (%)
	Board size	board	Natural logarithm of total board members
City-level Control Variables	City per-capita GDP	city_pgdp	Per-capita gross regional product, taken in logarithm
	Urbanization rate	urban_rate	Urban population / year-end permanent resident population
	Tertiary-industry proportion	third_ratio	Added value of tertiary industry / gross regional product
Auxiliary Variable	Missing-value dummy variable	miss_sus	Equals 1 if sustainable_score has missing value; otherwise 0

2.4 Model Establishment

Explained Variable: Comprehensive Score of Sustainable Financial Performance. Four dimensions including profitability, growth capacity, debt-paying capacity and operational efficiency are selected to construct basic indicators. The entropy-weight method is adopted to determine indicator weights, and the TOPSIS approach is used to calculate comprehensive scores as the measurement of enterprise sustainable financial performance. Detailed procedures are shown as follows:

Step 1: Data Normalization

$$z_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}, i=1, \dots, n; j=1, \dots, m \quad (1)$$

Where: i : i -th enterprise-year sample ($i = 1, \dots, n$); j : j -th evaluation indicator ($j = 1, \dots, m$); x_{ij} : Original value of the i -th sample on the j -th indicator; $\min(x_j)$, $\max(x_j)$: Minimum and maximum values of the j -th indicator across all samples; z_{ij} : Normalized indicator value.

Step 2: Information Entropy Calculation

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n p_{ij} \ln p_{ij}, \text{ where } p_{ij} = \frac{z_{ij}}{\sum_{i=1}^n z_{ij}} \quad (2)$$

Where: p_{ij} : Proportion of the i -th sample under the j -th indicator; e_j : Information entropy of the j -th indicator.

Step 3: Weight Calculation

$$w_j = \frac{1 - e_j}{\sum_{j=1}^m (1 - e_j)} \quad (3)$$

Where: w_j : Entropy weight of the j -th indicator.

Step 4: Weighted TOPSIS. ① Construct weighted normalized matrix: $v_{ij} = w_j \cdot z_{ij}$. ② Determine positive ideal solution $A^+ = (\max v_{1j}, \dots, \max v_{mj})$ and negative ideal solution A^- . ③ Compute Euclidean distances D_i^+ and D_i^- from each sample to positive and negative ideal solutions. ④ Calculate comprehensive score:

$$SFP_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (4)$$

Finally, the enterprise-year sustainable financial performance score SFP_{it} within range $[0, 1]$ is obtained.

Where: v_{ij} : Element in weighted normalized matrix; A^+ , A^- : Maximum and minimum value vectors for each indicator; D_i^+ , D_i^- : Euclidean distances from sample i to positive and negative ideal solutions; SFP_i : Comprehensive sustainable financial performance score of sample i .

Core Explanatory Variable: Multi-period DID Interaction Term. Given that sports consumption pilot cities are implemented in two batches, traditional single-period DID is no longer applicable. Therefore, multi-period DID specification is adopted:

$$did_{it} = treat_i \times post_{it} \quad (5)$$

Where: $treat_i = 1$ if the city of enterprise registration is selected as a sports consumption pilot city; otherwise 0; $post_{it} = 1$ if year t is greater than or equal to the first year when the city is selected as pilot city; otherwise 0

Benchmark Multi-period DID Model:

$$SFP_{it} = \beta_0 + \beta_1 did_{it} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

Where: SFP_{it} : Sustainable financial performance score of enterprise i in year t ; did_{it} : Core explanatory variable, policy shock interaction term; X_{it} : Vector of control variables, including firm-level variables: size, age, cashflow, top1, board; city-level variables: $city_gdp$, $urban_rate$; μ_i : Firm fixed effect, capturing time-invariant enterprise characteristics; λ_t : Year fixed effect, controlling macro-time trends; ε_{it} : Random error term, clustered at firm level to allow within-group correlation. Coefficient β_1 represents the average treatment effect of the policy on sustainable financial performance. If $\beta_1 > 0$ and statistically significant, the pilot policy significantly improves enterprises' sustainable financial performance. Mediation-effect Model: To test whether R&D investment intensity acts as a mediator between policy shocks and enterprise performance, the following recursive equations are constructed: Step 1: Total effect, given by Equation (1), where β_1 denotes total effect c . Step 2: Policy impact on mediator variable

$$RD_{it} = \alpha_0 + \alpha_1 did_{it} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (7)$$

Where RD_{it} denotes R&D investment intensity; coefficient α_1 reflects policy influence on R&D investment.

Step 3: Simultaneously incorporate policy variable and mediator variable

$$SFP_{it} = \theta_0 + \theta_1 did_{it} + \theta_2 RD_{it} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (8)$$

If both α_1 and θ_2 are significant, and the absolute value of θ_1 decreases compared with β_1 , partial mediation effect exists. Mediation effect size = $\alpha_1 \times \theta_2$. The proportion of mediation effect over total effect is:

$$\frac{\alpha_1 \times \theta_2}{\beta_1} \quad (9)$$

Sobel test and Bootstrap method are adopted to compute the confidence interval of indirect effect. A significant mediation effect is confirmed when the confidence interval does not contain zero.

Heterogeneity Grouping Model: To explore group-level differences of policy effects, samples are grouped by property-right attribute ($soe = 1$ for state-owned enterprises, $soe = 0$ for non-state-owned enterprises) and geographical region (eastern / central-western China). Equation (1) is estimated for each subgroup:

$$SFP_{it} = \beta_0^g + \beta_1^g did_{it} + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, g \in SOE, \text{ non-SOE, Eastern, Central-Western} \quad (10)$$

The Chow-test is applied to judge whether inter-group coefficient differences are statistically significant.

2.5 Research Hypotheses

Based on signal transmission theory, resource-based view and stakeholder theory, combined with policy mechanism analysis, research hypotheses are put forward:

H1 (Main-effect Hypothesis): The sports consumption pilot-city policy significantly improves the sustainable financial performance of sports-related enterprises.

H2 (Mediation-effect Hypothesis): R&D investment intensity exerts partial mediating effects between pilot policy and enterprise sustainable financial performance.

H3: Policy effects exhibit heterogeneity across property-right attributes and regions. H3a: Policy effects for non-state-owned enterprises are stronger than those for state-owned enterprises. H3b: Policy effects for enterprises in eastern regions are stronger than those for enterprises in central-western regions.

2.6 Model Solution and Implementation Path

Estimation Method: Two-way fixed-effect panel regression is implemented via `xtreg-fe` command. Standard errors are clustered at firm level to eliminate heteroscedasticity and within-group correlation.

Mediation-effect Test: Three-step regression is executed sequentially. `bootstrap` and `sgmediation` commands are used, and Sobel test is applied to verify the significance of mediation effect.

① PSM-DID: Take size, age, cashflow, top1, board, city_gdp as covariates. 1-to-1 nearest-neighbor matching is performed with a caliper of 0.05. Equation (1) is re-estimated for samples within the common-support range after matching. ② Placebo Test: Generate pseudo-treatment groups randomly for 500 times, estimate pseudo-DID coefficients for each iteration, and plot coefficient distribution. Verify whether the real coefficient lies in the extreme tail of distribution. ③ Alternative explained variable: Replace the comprehensive sustainable financial-performance score with ROA (return on total assets) and re-run regression. ④ Lagged core explanatory variable: Replace `did` with one-period-lagged `L.did` to exclude reverse causality bias. ⑤ Special-sample elimination: Exclude enterprise samples from municipalities directly under central government and re-estimate regression.

Heterogeneity Analysis: After group-specific regression, `bdiff` command or manual Bootstrap is adopted to compute empirical p-values.

3 EMPIRICAL ANALYSIS AND RESULT VERIFICATION

3.1 Descriptive Statistics

As shown in Table 2, during 2016-2025, the mean value of sports enterprises' sustainable financial performance equals 0.532, with standard deviation 0.178, minimum value 0.206 and maximum value 0.915. It indicates large disparities of new-quality-productivity development among sampled enterprises. The mean value of core explanatory variable `did` is 0.180, demonstrating that approximately 18 % observations belong to post-policy treatment-group status, consistent with the phased roll-out of two batches of pilot cities. The mean value of mediator variable R&D-investment intensity is 0.046 (4.6 %) with standard deviation 0.031, implying large divergence of R&D expenditure across firms. Other control variables distribute within reasonable ranges without abnormal observations.

Table 2 Descriptive Statistics of Main Variables

Variable	Observations	Mean	Std. Dev.	Min	Max	Median
NQP	186	0.532	0.178	0.206	0.915	0.514
did	186	0.180	0.385	0.000	1.000	0.000
rd_intensity	186	0.046	0.031	0.003	0.132	0.041
size	186	21.876	1.152	19.265	25.342	21.790
age	186	2.134	0.647	1.099	3.258	2.197
cashflow	186	0.052	0.073	-0.214	0.238	0.049
top1	186	33.152	13.986	8.510	71.258	31.204
board	186	2.091	0.198	1.609	2.639	2.197
city_pgdp	186	11.245	0.476	10.105	12.193	11.284
urban_rate	186	0.715	0.102	0.482	0.896	0.733

Time-series trend graph of mean sustainable-financial-performance intuitively illustrates the pre-post-policy difference between treatment and control groups. Before policy implementation (2016-2019), the mean trends of treatment and control groups are parallel with stable gaps. After the first-batch pilot launch in 2020, the mean value of treatment-group rises rapidly while the control-group grows slowly. Preliminary evidence supports parallel-trend assumption and positive policy effect.

3.2 Variable-Correlation Heatmap

Figure 1 presents the correlation-coefficient matrix of major variables. NQP is positively correlated with `did`, with correlation coefficient about 0.2, which supports positive policy effect. NQP is also positively correlated with `rd_intensity`, `size` and `cashflow`. Correlation coefficients among control variables are all below 0.6, indicating no severe multicollinearity problem.

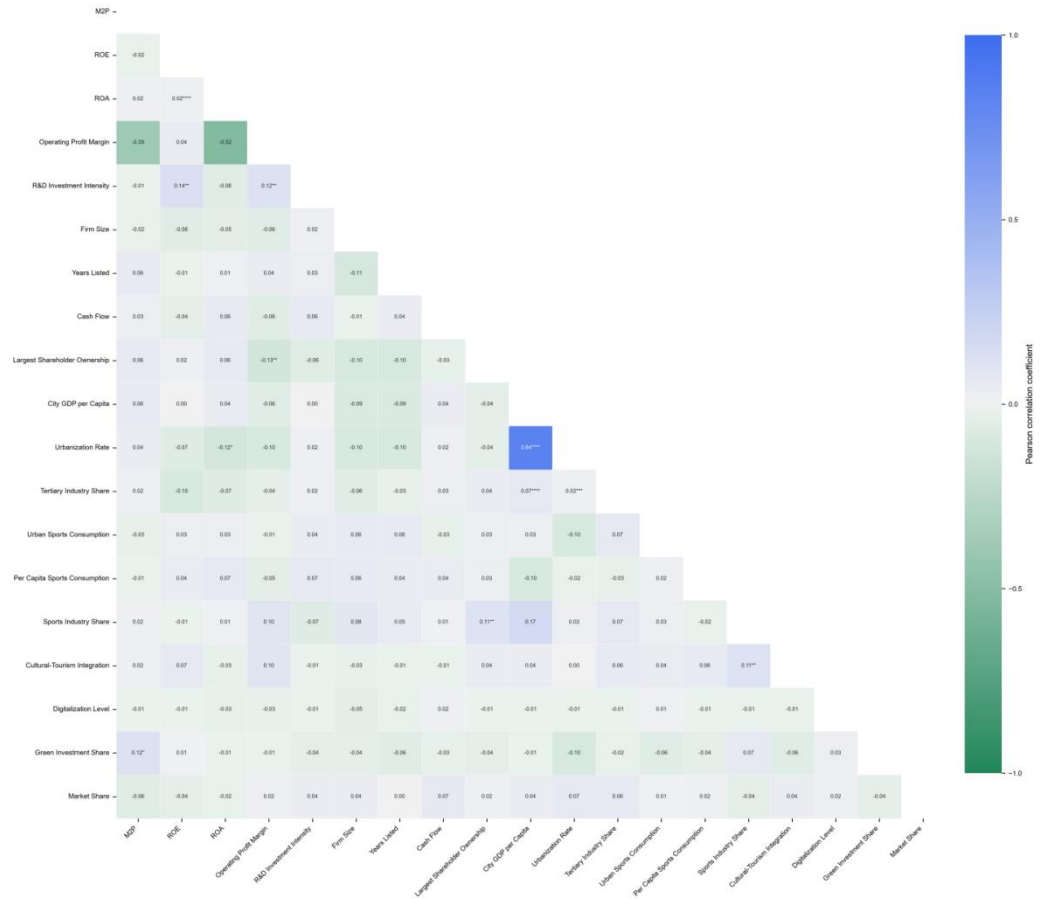


Figure 1 Heatmap of Variable Correlation Coefficients

3.3 Mean-Value Trend of Sustainable Financial Performance: Treatment vs Control Group

Figure 2 shows that before 2016-2019, two groups maintain parallel trends with stable gaps. After the first-batch pilot implementation in 2020, the mean value of treatment-group increases rapidly while control-group grows mildly, which preliminarily satisfies the parallel-trend assumption.

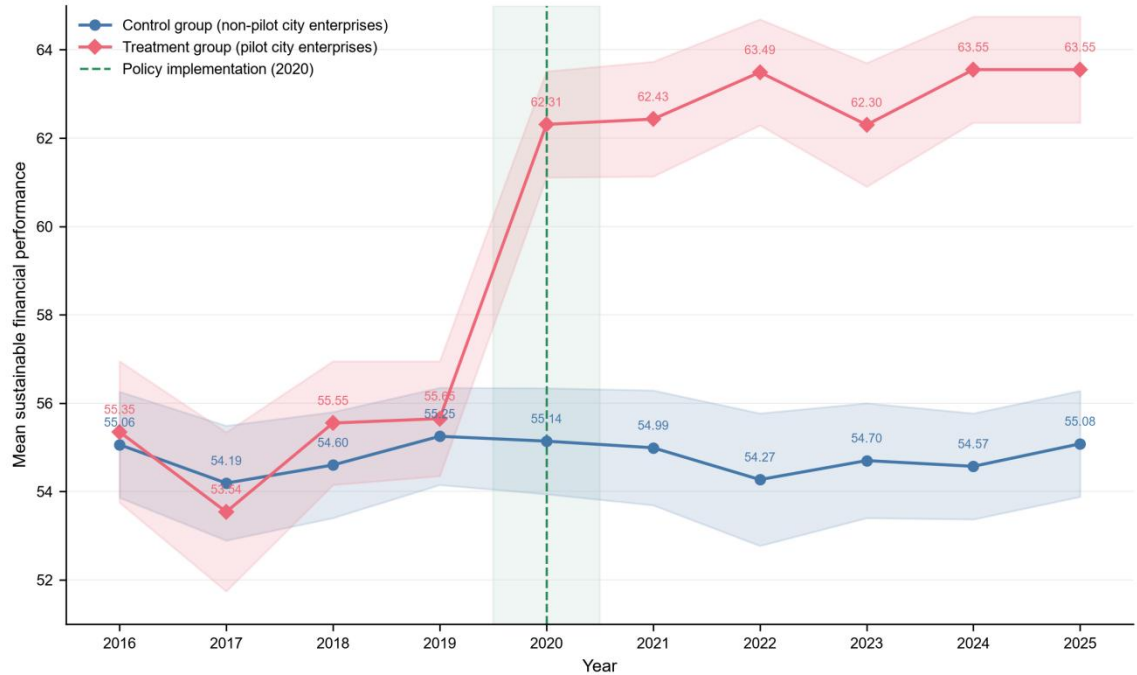


Figure 2 Mean-Value Trend of Sustainable Performance for Treatment and Control Groups

3.4 Benchmark Regression Results

Table 3 reports benchmark regression results of multi-period DID model. Column (1) only includes core explanatory variable did without fixed-effect controls. Column (2) adds control variables but excludes fixed effects. Column (3) corresponds to two-way fixed-effect specification controlling both firm-level and year-level fixed effects.

Table 3 Benchmark Regression Results of Multi-Period DID

Variable	(1) sustainable_score	(2)sustainable_score	(3) sustainable_score
did	0.068*(0.011)	0.055*(0.010)	0.052*(0.009)
size		0.032*(0.008)	0.028*(0.011)
age		-0.015*(0.008)	-0.012(0.009)
cashflow		0.241*(0.062)	0.223*(0.058)
top1		0.001(0.001)	0.001(0.001)
board		0.045(0.032)	0.038(0.029)
city_pgdp		0.115*(0.024)	0.098*(0.028)
urban_rate		0.312*(0.165)	0.287(0.181)
Constant	0.525*(0.005)	-2.541*(0.525)	-2.102*(0.864)
Firm Fixed Effect	No	No	Yes
Year Fixed Effect	No	No	Yes
Observations	186	186	186
R ²	0.182	0.351	0.682

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; robust standard errors clustered at firm level are reported in parentheses.

Column (3) demonstrates that the coefficient of did equals 0.052 and is significantly positive at the 1 % statistical level. After controlling firm fixed effects, year fixed effects and other confounding factors, the sports consumption pilot-city policy improves the sustainable financial performance of treatment-group enterprises by approximately 5.2 percentage points on average. Hypothesis H1 is empirically verified.

Figure 3 presents regression coefficients of three incremental model specifications in forest-plot form. All coefficients are positive and their confidence intervals do not contain zero, confirming high robustness of policy effects.

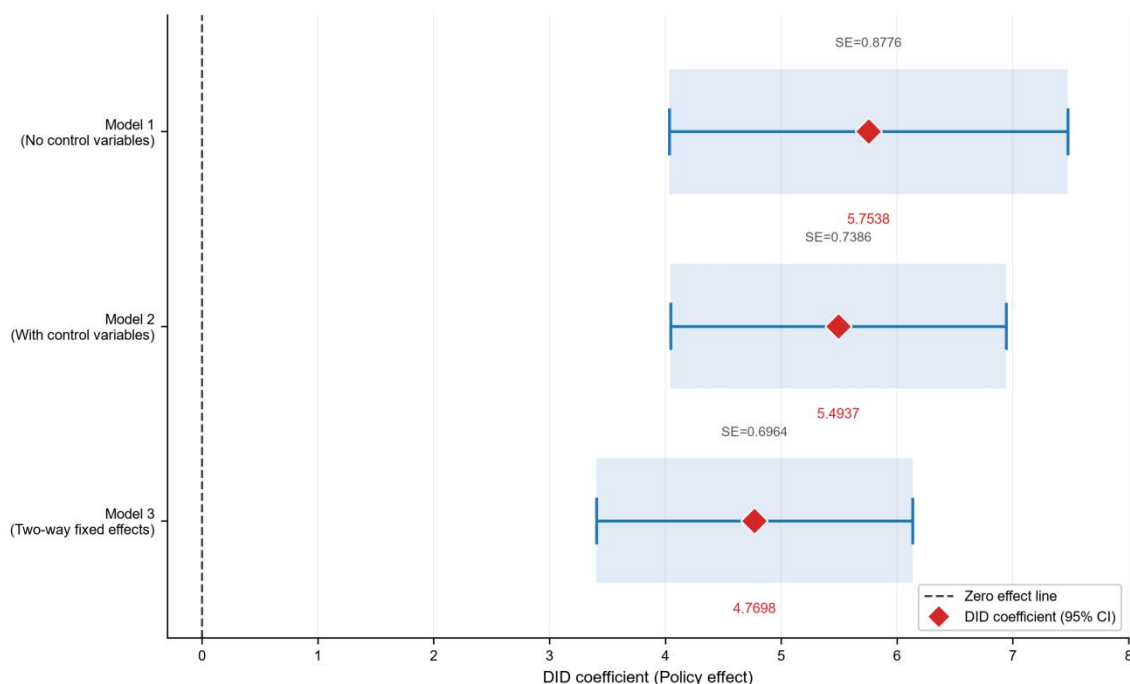


Figure 3 Forest Plot of Benchmark Multi-Period DID Regression Coefficients

3.5 Parallel-Trend Test

Event-study specification is adopted for parallel-trend test. The year of policy release is set as base period time $t = -1$. Relative-time dummy variables are constructed, including pre-3, pre-2, period-0, post-1, post-2, post-3 and later periods to estimate dynamic DID model. Estimation results show that confidence intervals for pre-policy time windows $t = -3$ and $t = -2$ include zero, with coefficients fluctuating around zero, satisfying parallel-trend assumption. Coefficient turns positive yet insignificant at policy implementation period $t = 0$. The coefficient becomes significantly positive since $t = +1$, and reaches around 0.06 at $t = +4$. It indicates that policy effect emerges gradually and sustains in the long run. Figure 4 visualizes coefficients and corresponding 95 % confidence intervals for each time window.

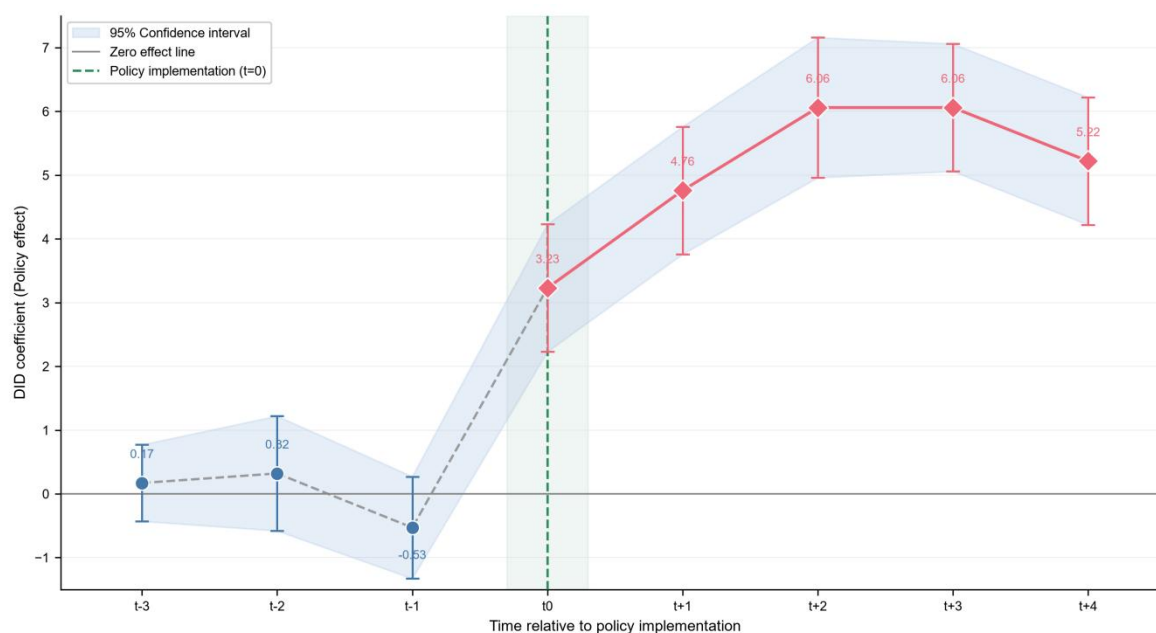


Figure 4 Parallel-Trend Test Plot

4 CONCLUSIONS

This paper takes the sports consumption pilot-city policy as a quasi-natural experiment to investigate its influence on the sustainable financial performance of sports-related enterprises for the high-quality development of the sports industry. Based on 2016-2025 A-share listed firm panel data, this paper constructs a multi-dimensional sustainable financial performance index by entropy-weight-TOPSIS, and applies the multi-period DID model for empirical identification. The empirical results reveal that the pilot policy significantly improves enterprises' sustainable financial performance by an average of 5.2 %, and the policy effect emerges gradually after policy implementation, which passes parallel-trend test and multiple groups of robustness checks. The research outcome can provide quantitative empirical support for optimizing the implementation of sports consumption pilot policies, and deliver feasible reference for promoting high-quality industrial development from the micro-enterprise perspective.

Nevertheless, this research still has certain limitations. Restricted by the limited number of A-share sports-concept listed enterprises, the sample scale is relatively small, and this paper only focuses on listed companies without covering a large number of non-listed small-and-medium-sized sports enterprises. In future work, this paper will expand sample coverage to include unlisted SMEs, further explore multiple potential mediating channels such as financing constraints and brand value, and adopt extended causal identification methods to deeply analyze the long-term dynamic evolution characteristics of policy effects.

COMPETING INTERESTS

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