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A Quasi-Natural Experiment on How National-Fitness Policy Shapes Digital Sports Industrial Growth: Evidence from Difference-in-Differences and Regression Discontinuity Designs

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Abstract. Against China's mass-sports-advancement context, the national-fitness policy package constitutes a top-down strategic initiative responding to evolving public sports demands. Beyond enhancing public sports service efficiency and optimizing industrial structures within the sports sector, this policy set fosters favorable institutional conditions supporting digital transformation across sports-related businesses. Taking the 2014 strategic upgrade of national fitness as an exogenous policy shock, this study constructs a composite metric for digital sports industry performance using balanced panel data covering 30 Chinese provincial-level jurisdictions over 2010-2024. A two-way fixed-effects difference-in-differences estimator is deployed to quantify the causal influence exerted by national-fitness interventions on digital sports industrial expansion. Multiple validation strategies including regression discontinuity design based on time cutoff, placebo permutation tests and alternative proxy indicators are adopted for robustness assessment. This paper further explores cross-provincial heterogeneous policy responses as well as underlying transmission logics. Estimation outputs indicate that national-fitness strategic interventions effectively expand the scale of digital-sports-related industries and facilitate business-model iteration and renewal. Policy gains demonstrate noticeable geographical divergence, whereby eastern provinces reap substantially larger positive policy spillovers. Mechanism examinations uncover three intermediate channels: stimulating residents' fitness-oriented market demands, promoting digital-intelligent upgrading of sports service scenarios, and accelerating sports-consumption structural shifts. These empirical findings offer actionable references for designing future fitness-oriented digital policy frameworks, bridging inter-regional developmental gaps in digital sports, and cultivating sustainable smart-sports consumption markets.

Keywords: National-Fitness Strategic Initiative, Digital Sports Industry, Industrial Expansion, Difference-in-Differences, Quasi-Natural Experiment

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1. Introduction

Digital sports emerges as an innovative industrial format derived from deep integration between digital technological capabilities and sports economic activities [1]. Its business scope encompasses smart venue operation and maintenance modules, online fitness service delivery, smart sports-equipment manufacturing, as well as web-streamed sports event broadcasting. It has become a core yardstick for evaluating high-quality developmental performance of modern-era sports industries. Since national fitness was formally elevated to national-strategy status in 2014, Chinese regulatory authorities have rolled out successive supporting measures aimed at digitally renovating public sports service systems and encouraging the online migration of mass fitness activities [2]. Such policy arrangements generate considerable institutional dividends for digital-sports-relevant industries.

Existing scholarly literature can be sorted into two major strands. One strand investigates how national-fitness interventions reshape traditional sports industries and residents' physical-activity patterns [3]. The other strand discusses how standalone digital-technology applications empower sports-sector development [4]. Nevertheless, few existing works treat national-fitness strategic adjustments as exogenous policy shocks and adopt quasi-experimental econometric techniques to identify causal associations between this policy initiative and digital-sports-sector evolution. Empirical exploration concerning policy transmission pathways and cross-regional heterogeneous effects still remains insufficient. To fill such research gaps, this paper integrates difference-in-differences (DID) and regression discontinuity design (RDD) empirical frameworks to unpack the inner logics of policy influence. It compensates quantitative-analysis deficiencies within prior studies and delivers empirical insights supporting digital-transformation progress across China's sports industries.

2. Theoretical mechanism and research hypotheses

2.1. Mechanism of action

2.1.1. Demand expansion effect

National-fitness policy portfolios sponsor mass-oriented public sports events, upgrade local sports-infrastructure hardware, and disseminate scientific physical-activity knowledge to general residents [5]. These measures lift public fitness awareness and help citizens build stable exercise routines. Gradually, fitness-related consumer demands shift away from offline physical premises toward online service channels [6]. Such market shifts drive growing supply of digital-sports commodities, including fitness mobile applications, household intelligent fitness apparatus, and on-demand virtual workout courses, which directly enlarges overall market capacity of the digital sports industry.

2.1.2. Digital transformation of sports venues

Building a complete public fitness service system compels local administrative bodies to fix existing bottlenecks within sports-infrastructure construction. Local authorities push forward intelligent retrofitting of sports facilities by launching online reservation modules and constructing fitness big-data platforms [7]. Digital-tool adoption improves resource-allocation efficiency and

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reconstructs public-sports service delivery patterns, which further broadens industrial boundaries for digital-sports-related businesses.

2.1.3. Consumption-upgrading effect

Continuous national-fitness advocacy shapes residents' sports-consumption inclinations and restructures household consumption compositions [8]. Apart from conventional tangible sports merchandise, emerging consumption patterns such as online membership subscription, paid sports-event streaming access, and digital fitness service procurement capture rising market shares. These newly-formed revenue streams create extra profit sources for digital-sports enterprises and underpin scalable industrial development.

2.2 Research hypotheses

H1: The national-fitness strategic initiative generates statistically significant positive causal effects that accelerate digital-sports-industry expansion.

H2: Industrial-promotion outcomes triggered by national-fitness interventions feature regional heterogeneity; policy implementation effectiveness in eastern provinces surpasses that observed in central and western jurisdictions.

H3: The national-fitness strategic initiative facilitates digital-sports-industry advancement through three indirect routes: enlarging fitness-market demands, realizing digital-intelligent transformation for sports scenarios, and advancing sports-consumption upgrading.

3. Research design

3.1 Sample selection and data sources

Balanced panel samples cover 30 Chinese provincial-level administrative units from 2010 to 2024. Samples of the Xizang Autonomous Region, Hong Kong, Macao and Taiwan are excluded considering data accessibility constraints and inconsistent statistical caliber. Raw data materials are collected from China Statistical Yearbook, Statistical Yearbook of China's Sports Industry, Report on China's Digital Economy Development, official information released by the General Administration of Sport of China, and annual statistical bulletins published by provincial statistical administrations [9].

3.2 Variable definition

Dependent variable: Digital-sports-industry developmental level (DigitalSport). A multi-dimensional composite evaluation index is constructed via the entropy-weight approach. Three sub-indicators are incorporated: operating revenue of digital-sports service sectors, authorized digital-technology patents within sports-related domains, and total output value from intelligent sports-equipment manufacturing. Higher index readings correspond to superior developmental status for local digital-sports industries.

Key explanatory variable: policy interaction term $Treat_i \times Post_t$. Year 2014 serves as the exogenous policy cutoff marking national-fitness strategic upgrade. $Post_t$ functions as time dummy: assigned value 1 for observations in 2014 and subsequent years, and 0 for pre-policy periods. Treatment group and control group are divided according to provincial sports-industry foundational conditions plus local policy-enforcement intensity.

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Control variables: regional gross domestic product, total internet broadband access subscribers, residents' per-capita disposable income, proportion of tertiary-industry added value within regional GDP, aggregate added value of sports industries, and urbanization ratio.

Mechanism variables: residents' fitness-participation rate, quantity of intelligent sports venues, and residents' per-capita sports expenditure.

3.3 Model specification

3.3.1. Benchmark two-way fixed-effects DID model

$$DigitalSport_{it} = \beta_0 + \beta_1 Treat_i \times Post_t + \sum \beta_j Control_{jit} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where i denotes province identifier and t denotes year identifier; μ_i represents province-specific fixed effects; λ_t denotes year fixed effects; core coefficient β_1 captures average treatment effect brought by national-fitness strategic interventions; ε_{it} represents stochastic error term.

3.3.2. Regression discontinuity design (RDD) model

Year 2014 is designated as policy cutoff point. A local-polynomial regression-discontinuity specification is built to account for time-varying trends. This framework tests whether noticeable jumps emerge for digital-sports-industry development metrics around policy breakpoint, mitigating estimation bias induced by inherent long-run industrial growth momentum. The concrete model is shown below:

$$DigitalSport_{it} = \alpha_0 + \alpha_1 Break_t + f(year) + \sum \alpha_j Control_{jit} + \mu_i + \varepsilon_{it} \quad (2)$$

$Break_t$ is cutoff dummy variable, taking value 1 for 2014 and later years while 0 for preceding periods; $f(year)$ stands for polynomial function of time variable, used to capture temporal evolutionary tendencies.

4. Empirical results and analysis

4.1 Benchmark regression results

Two-way fixed-effects DID estimation outputs reveal that the coefficient of policy interaction term is positive and statistically significant at the 1 % significance level, which lends empirical support to Hypothesis H1. To put it concretely, provinces belonging to treatment groups witness more remarkable improvement in digital-sports-industry performance after policy implementation compared with control-group counterparts. Among control variables, coefficients for internet-infrastructure conditions, resident disposable-income level and regional economic scale remain significantly positive. This finding demonstrates improved digital-infrastructure conditions and residents' purchasing capacity provide solid backing for digital-sports-industry advancement.

4.2 Robustness check

Firstly, RDD estimation identifies a statistically significant upward jump of composite digital-sports-industry index around the 2014 policy breakpoint, proving industrial expansion mainly originates from policy interventions rather than spontaneous industrial evolution, hence validating

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baseline regression reliability. Secondly, placebo permutation tests are implemented by randomly reshuffling policy-launch timing and reassigning treatment-control-group membership. After repeated resampling and regression iterations, mean estimated coefficients converge toward zero, excluding interference risks stemming from random confounding factors. Thirdly, core empirical conclusions still hold after substituting dependent-variable proxy indicators, shortening sample time horizon, and removing observations from pandemic-impacted years.

4.3 Heterogeneity analysis

The full sample is split into eastern, central and western subgroups to conduct grouped regressions. Estimation outputs indicate policy-interaction coefficients for eastern subsample carry larger magnitude and higher statistical significance, while policy-driven promotional effects stay relatively limited within central-western regions. Such regional gaps can be explained as follows: eastern provinces own mature digital-infrastructure foundations, highly market-oriented sports sectors and robust resident purchasing power. These advantages lower conversion costs when translating national-fitness policy impulses into market-available digital-sports products and consumer spending, amplifying overall policy effectiveness. In contrast, central-western regions suffer from inadequate digital-sports supporting facilities and low-efficiency policy-transmission chains, which is consistent with Hypothesis H2. Further subgroup regressions based on internet-development levels indicate provinces equipped with sounder digital infrastructure obtain stronger policy-driven industrial-empowerment dividends.

4.4 Mechanism test

Residents' fitness-participation rate, quantity of intelligent sports venues and per-capita sports expenditure are separately set as explained variables for mechanism regressions [10]. Regression outputs suggest national-fitness strategic interventions effectively lift public physical-activity participation rate, expand supply scale of smart sports venues and boost per-capita sports outlay. When three mechanism variables are incorporated into baseline econometric specification, core policy coefficient drops moderately yet still maintains statistical significance. This outcome verifies effectiveness of three transmission channels: demand expansion, digital-intelligent upgrading for sports scenarios and sports-consumption upgrading. Accordingly, Hypothesis H3 gains solid empirical support.

5. Conclusion

5.1 Research findings

First, the national-fitness strategic initiative delivers significant positive causal impacts on digital-sports-industry expansion and acts as a key policy driver facilitating digital transformation within sports-related sectors. Second, policy-enabled industrial empowerment displays obvious regional divides: digital-sports industries in eastern provinces harvest far larger policy spillovers than those in central-western areas. Third, national-fitness-oriented policies promote high-quality scale expansion of digital-sports industries via three functional pathways: unlocking public fitness-market potential, realizing intelligent-technology-driven sports-scenario upgrading, and activating digital-sports-consumption markets. Among these channels, demand expansion constitutes fundamental market-growth foundations; digital-intelligent renovation enriches

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market-side product supply; consumption-pattern upgrading realizes commercial returns for relevant market participants.

5.2 Policy recommendations

First, refine top-level institutional frameworks for digital-development undertakings within national-fitness governance systems. Integrate smart-venue construction-operation modules, online public fitness service supplies, and sports-digital-platform regulatory mechanisms into local national-fitness performance-assessment systems, so that policy spillovers can precisely fuel digital-sports-industry advancement.

Second, scale-up digital-sports-oriented infrastructure construction across central-western jurisdictions. Under unified provincial planning frameworks, facilitate the trickle-down of digital-sports resources to county-level and township-level administrative units. Mitigate bottlenecks concerning smart-fitness venues and network hardware facilities, compress cross-regional digital-sports developmental gaps, and unlock latent fitness-consumption potential among local residents.

Third, enrich diversified application scenarios for digital-sports-related consumption. Encourage market entities to foster innovative business formats including online sports tournaments, intelligent fitness hardware equipment, and sports-themed short-video intellectual properties. By doing so, a positive industrial circulation can be constructed: "release of public fitness demands — supply of digital-technology-empowered products — realization of sports-consumption value".

Fourth, build complete regulatory systems targeting digital-sports industries, accelerate interdisciplinary-talent cultivation programs, and guide industrial entities toward standardized and high-quality developmental trajectories.

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