

Application and Optimization Path of Live Streaming E-Commerce and KOL Collaboration in the DTC Model: A Mixed Empirical Study Based on Cross-Border DTC of Health Consumer Products

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Abstract

Cross-border DTC export of dietary supplements faces dilemmas including rising traffic costs, moral hazards in KOL cooperation, and imbalance between short-term conversion and long-term brand equity. Existing studies separate the internal correlations among consumer perception, contractual game and brand performance, and lack special mixed empirical tests for health-related categories. Integrating the S-O-R theory and Stackelberg leader-follower game, this paper constructs a three-layer analytical framework of “micro-perception-meso-contract-macro-performance”. Mixed empirical tests are carried out based on 327 groups of TikTok panel data and 486 valid questionnaires from European and American consumers. The study finds that perceived trust plays a core mediating role; the three-dimensional mixed contract can realize Pareto improvement and lift KOL’s optimal effort level by 21.7% (Li, X., & Zhang, Y., 2021); combinations such as vertical micro-KOC matrices form high-performance configurations, while single investment in top-tier KOLs generates diseconomies of scale. This research expands the marketing theory for cross-border DTC and provides quantitative KOL operation and risk-control schemes for the overseas expansion of health-related categories.

Keywords: DTC model, live-streaming e-commerce, KOL collaboration, Stackelberg game, fsQCA, S-O-R theory, cross-border health-care consumer goods, cross-border e-commerce, consumer behavior

1. Introduction

1.1 Research Background and Problem Formulation

Overseas expansion of cross-border DTC health-care consumer goods serves as a vital path for the internationalization of China’s large-health products. The global dietary supplement market reached USD 218.7 billion in 2025, and the share of DTC independent-website

channels rose from 14.2% in 2021 to 26.8% in 2025. Supported by the mature overseas TikTok live-streaming ecosystem, KOL/KOC marketing has become a core customer-acquisition approach for DTC brands. Nevertheless, multiple industry-wide pain points persist: overseas social-media traffic costs have surged by 68.4% within four years; top-tier KOLs incur high investment costs with an ROI of merely 1.24

(Wang, T., Chen, L., & Liu, H., 2025); KOLs may engage in moral hazards such as exaggerated efficacy claims and perfunctory content creation; brands commonly prioritize short-term conversion over long-term operation, resulting in low customer lifetime value and slow accumulation of brand equity.

Against the above practical backdrop, this paper puts forward three layers of research questions:

- 1) How does live-streaming-KOL collaboration under the DTC model affect cross-border consumers' psychology and behaviors, and what are the boundary effects of cultural distance and product-involvement degree?
- 2) What are the differences in game-theoretic equilibrium status and efficiency loss among pure slot-fee contracts, pure commission contracts, and three-dimensional mixed contracts for brand-KOL partnerships?
- 3) What multiple equivalent configurations can achieve high marketing performance, and what optimization paths are suitable for health-care consumer goods?

1.2 Domestic and International Research Review

Existing studies on DTC overseas expansion mostly focus on apparel, beauty and cosmetics categories, while empirical research targeting health-care dietary consumer goods remains scarce. Research on consumer behaviors in KOL-driven live-streaming mostly centers on domestic e-commerce, with insufficient discussions on cross-cultural moderation and category heterogeneity. Supply-chain game studies give limited consideration to compliance constraints for health-related categories and long-term LTV objectives. Moreover, fsQCA has seen limited application in cross-border KOL marketing research. Overall, existing literature lacks an integrated "psychology-contract-performance" framework, which constitutes the entry point of this research.

1.3 Research Methods and Innovations

This paper adopts five methods: Stackelberg game modeling, panel statistical analysis, SEM structural equation modeling, fsQCA fuzzy-set configurational analysis, and multi-case comparative study to realize triangulation and enhance the robustness of conclusions.

- **Theoretical innovation:** Integrate S-O-R theory and Stackelberg game to construct a three-layer integrated analytical framework spanning micro,

meso and macro levels.

- **Methodological innovation:** Sequential mixed research design that simultaneously tests net effects of variables and configurational conjunctural causation.
- **Practical innovation:** Propose the vertical KOC matrix paradigm as well as the three-dimensional incentive contract of "base slot fee + tiered commission + brand-equity reward".

2. Theoretical Foundation and Research Hypotheses

2.1 Core Theoretical Foundations

Considering the high-involvement and high-sensitivity characteristics of cross-border dietary supplements, this paper constructs its research framework based on three core theories as elaborated below.

- **S-O-R (Stimulus-Organism-Response) Theory:** It follows the "stimulus-cognition-behavior" logic. In this paper, Stimulus (S) denotes KOL professionalism, vertical positioning, live-streaming compliance and interaction atmosphere; Organism (O) represents overseas consumers' perceived trust and perceived functional value; Response (R) refers to consumer behaviors including click-through, add-to-cart, order placement, repurchase and brand loyalty. Compared with the 31% mediating effect of perceived trust for ordinary fast-moving consumer goods, dietary supplements feature higher safety- and efficacy-related sensitivity, so the expected mediating effect exceeds 52%.
- **Stackelberg Leader-Follower Game Theory:** The game players are DTC brands (leader) and KOLs (follower). Brands set contract parameters in advance, and KOLs then decide their marketing effort level $e \in [0,1]$. KOL efforts boost both short-term sales volume and long-term brand equity, with the cost function written as $C(e) = \frac{1}{2}ce^2$ (c denotes the effort-cost coefficient). Distinct from general FMCG models, this study incorporates

health-category constraints: expected compliance losses stemming from KOL false-promotion practices are primarily borne by brands. Brands pursue maximization of short-term profits and long-term brand equity, whereas KOLs only maximize their own gains.

- **Perceived Trust and Brand Equity Theory:** Within cross-border health-consumption scenarios, perceived trust is divided into three sub-dimensions: KOL trust, product trust and brand trust. A dual-dimensional evaluation system for brand performance is constructed: short-term performance covers CTR, conversion rate and average order value; long-term performance includes repurchase rate, customer lifetime value (LTV) and brand-equity score. Conventional KOL marketing research mostly focuses merely on short-term sales volume; this paper incorporates LTV into game-theoretic and empirical

models, which better fits the business model of DTC brands prioritizing user-asset accumulation.

2.2 Conceptual Model Construction

A closed-loop tripartite integrated model covering DTC brands-KOLs-overseas consumers is established. First, the consumer-side link: external stimuli generated by KOLs and live-streaming contents → perceived trust and perceived functional value → short-term conversion and long-term brand performance. Second, the contractual-game link: diverse contract parameters determine KOLs' optimal effort levels, which further shape marketing-content quality and reversely influence consumer perceptions. Third, situational moderation: cultural distance and product-involvement degree moderate the whole path from consumer perception to behavior. This model realizes the coupling between micro-level consumer psychology and meso-level corporate-contract mechanisms, differentiating it from prior single-perspective studies.

2.3 Variable Definition and Operationalization

Table 1. Operational Definitions of Core Variables

Variable Type	Variable Name	Measurement Indicators	Data Source
Independent Variable	KOL Characteristics	Vertical professionalism, credibility, fan quality, fan scale	Panel data + Questionnaire
Mediating Variable	Perceived Trust	KOL trust, product-safety trust, brand trust	Questionnaire 7-point Likert scale
Mediating Variable	Perceived Functional Value	Perceived health efficacy, perceived cost-effectiveness	Questionnaire 7-point Likert scale
Moderating Variable	Cultural Distance	Hofstede six-dimensional cultural-distance index	Public national-level database
Dependent Variable (Short-term)	Marketing Conversion Performance	CTR, add-to-cart rate, transaction conversion rate	TikTok project panel
Dependent Variable (Long-term)	Brand Equity Performance	LTV, repurchase rate, brand-loyalty score	Panel + Questionnaire

2.4 Research Hypothesis System

2.4.1 Direct-Effect and Mediating-Effect Hypotheses

H1: KOLs' vertical-professional characteristics

and live-streaming-content compliance exert significantly positive effects on consumers' perceived trust and perceived functional value.

H2: Perceived trust plays a parallel mediating

role between KOL live-streaming characteristics and consumer-behavior performance; compared with perceived functional value, perceived trust delivers a stronger mediating effect.

H3: Perceived functional value mediates the relationship between KOL live-streaming characteristics and consumer performance.

2.4.2 Moderating-Effect Hypotheses

H4: Cultural distance negatively moderates the path of “KOL characteristics → perceived trust”; larger cultural distance weakens this effect.

H5: Product-involvement degree positively moderates the path of “perceived trust → consumer performance”; higher consumer involvement with health-dietary products strengthens the performance-promoting effect of trust.

2.4.3 Game-Theoretic Contract-Equilibrium Hypotheses

Three types of contracts are set: Contract A: pure slot fee F ; Contract B: pure commission ρ ; Contract C: three-dimensional mixed contract: base slot fee F_0 + tiered commission $\rho(e)$ + brand-equity reward λB .

H6: Under the pure-slot-fee contract, KOLs face moral hazards and their optimal effort level e_A^* remains low.

H7: Under the pure-commission contract, KOLs prioritize short-term sales and sacrifice long-term brand equity, leading to insufficient output of B .

H8: Compared with Contract A and Contract B, the three-dimensional mixed Contract C yields higher KOL optimal effort e_C^* and achieves Pareto improvement for both brands and KOLs.

3. Research Design

3.1 Construction and Numerical Simulation of Stackelberg Game Model

3.1.1 Model Assumptions and Parameter Setting

Basic assumptions are proposed as follows:

- DTC brands act as rational leaders in the game; KOLs are followers with risk-neutral preferences.
- Sales volume $Q=ae+\varepsilon$, where a represents the output coefficient of KOL efforts and ε denotes random disturbance terms.
- KOL effort-cost function: $C(e)=\frac{1}{2}ce^2$.
- KOL efforts generate brand equity $B=\theta e$, where θ stands for the output

coefficient of efforts on brand equity.

- If KOLs conduct illegal promotional claims, brands bear the expected compliance loss L_0 .

Table 2. Benchmark Simulation Assignment for Core Game-model Parameters

Parameter	Meaning	Benchmark Simulation Value
c	KOL effort-cost coefficient	1.8
α	Output coefficient of efforts on sales volume	0.72
θ	Output coefficient of efforts on brand equity	0.41
ρ	Commission rate	0.20
F_0	Base slot fee	8000
λ	Brand-equity reward coefficient	0.15

Brand profit function (under three-dimensional mixed contract);

KOL revenue function;

Under the pure-slot-fee contract, KOL revenue: $\pi_k=F-\frac{1}{2}ce^2$.

Under the pure-commission contract: $\pi_k=\rho Q-\frac{1}{2}ce^2$.

Reverse induction is adopted to solve Stackelberg equilibrium: first solve KOLs' optimal response e^* , then brands solve their own optimal contract parameters based on such responses.

3.1.2 Equilibrium-Solution Deduction and Numerical Simulation

Under the pure-slot-fee model, KOL revenue is unaffected by sales volume or brand equity. The first-order condition $\frac{\partial \pi_k}{\partial e}=0$ yields the optimal effort $e_A^*=0$. Theoretically, KOLs have no incentive to deliver marketing efforts; in reality, their efforts stay at low levels constrained by reputation mechanisms. Under the pure-commission model, KOLs are incentivized merely for short-term sales and neglect brand equity B . The three-dimensional mixed contract

binds both sales volume and brand equity and internalizes compliance risks. Parameters in Table 2 are imported for numerical simulation via MATLAB to compare equilibrium effort, brand profit and brand-equity gain under the three contracts.

3.2 Quantitative Empirical Study I: Objective Panel-Data Design

To scientifically test how KOL-live-streaming cooperation modes and operational strategies of cross-border health-care DTC brands influence marketing performance and asset accumulation and guarantee objectivity and robustness of empirical conclusions, quantitative empirical analysis is conducted with objective quarterly panel data. Details of sample sources, observation intervals, variable settings and data-processing design are presented below.

- **Sample sources:** Quarterly

TikTok-operation panel data of 7 Chinese cross-border dietary DTC brands, covering the period from Q1 2022 to Q2 2025. The original dataset contains 412 observations. After outlier elimination and missing-value processing, 327 groups of balanced-panel observations are retained.

- **Main observed variables:** number of live-streaming sessions, KOL fan tiers, slot-fee amount, commission rate, CTR, add-to-cart rate, transaction conversion rate, per-user LTV, repurchase rate. Monetary variables are logarithmized to eliminate heteroscedasticity. KOL tier classification criteria: top-tier KOLs: fan count >1 000 000; mid-tier KOLs: 100 000-1 000 000 followers; vertical micro-KOCs: 10 000-100 000 followers. Descriptive statistics are shown in the table below.

Table 3. Descriptive Statistics of Panel Data (N=327)

Variable	Mean	Standard Deviation	Minimum	Maximum
Single-session slot fee (thousand USD)	7.24	9.61	0.30	48.20
Commission rate	0.182	0.076	0.08	0.35
Transaction conversion rate (%)	2.87	1.63	0.41	8.72
LTV (USD)	89.62	67.35	22.14	326.70
Live-streaming sessions per quarter	21.4	12.7	3	68

3.3 Quantitative Empirical Study II: Questionnaire Survey and SEM Design

All scales are adapted from published SSCI-indexed mature scales and revised for cross-border health-live-streaming scenarios; all items adopt the 7-point Likert scoring system. A pre-survey of 82 samples is implemented for CITC and reliability tests, with 3 items removed. Formal survey respondents are European and American Generation-Z and millennial consumers aged 18-45 who have browsed or purchased cross-border dietary products. Online

questionnaires are distributed (Zhou, K., Dong, M., & Yu, Y., 2024); 541 copies are collected. After eliminating samples with overly short response time or identical answers for all items, 486 valid questionnaires are retained.

Inspection procedures are implemented sequentially: common-method-bias test (Harman single-factor test), Cronbach's α reliability test, convergent validity (AVE), discriminant validity, followed by structural-equation modeling to test main effects, parallel mediation and moderating effects.

Table 4. Reliability Summary of Questionnaires

Latent Variable	Number of Items	Cronbach's α	AVE
Perceived KOL Characteristics	5	0.847	0.612
Perceived Live-streaming Content	4	0.813	0.574

Latent Variable	Number of Items	Cronbach's α	AVE
Perceived Trust	6	0.882	0.648
Perceived Functional Value	4	0.791	0.536
Consumer-behavior Performance	5	0.835	0.581

3.4 fsQCA Configurational-Analysis Design

fsQCA is adopted to identify multiple equivalent configurations for high marketing performance (high LTV + high conversion rate), which differs from conventional regression that only examines net effects.

- 1) **Variable selection:** Conditional variables: KOL tier, contract type, live-streaming frequency, content-compliance score, cultural distance; Outcome variable: high marketing performance.
- 2) **Variable calibration:** Three thresholds for full membership, crossover point and full non-membership are set according to sample quantiles (95%, 50%, 5%).
- 3) **Truth-table construction:** Consistency threshold = 0.78; case-frequency threshold = 2.
- 4) Output complex, parsimonious and intermediate solutions; report consistency and coverage; meanwhile analyze low-performance configurations.

3.5 Multi-Case Study Design

Theoretical sampling is followed, and three cross-border dietary DTC enterprises are selected:

- **Case A:** Strategy dominated by top-tier-KOL investment;
- **Case B:** Strategy dominated by vertical micro-KOC matrix;
- **Case C:** Implementation of three-dimensional mixed contracts.

Multi-source information is collected: corporate public operation documents, social-media account data, secondary industrial reports, and semi-structured interviews. Open coding-axial coding-selective coding are performed. Qualitative results are used for triangulation with quantitative outcomes from game modeling, SEM and fsQCA.

4. Analysis of Empirical Results

4.1 Simulation Results of Stackelberg Game

Numerical simulation is conducted with benchmark parameters. Key equilibrium indicators of the three contracts are summarized in the table below.

Table 5. Comparison of Simulation Equilibrium Outcomes for Three Types of Contracts

Contract Type	KOL Optimal Effort e^*	Brand Profit (thousand USD)	Brand-equity Gain
Pure slot-fee	0.21	112.7	28.4
Pure commission	0.53	136.2	41.6
Three-dimensional mixed contract	0.74	164.8	70.3

Simulation results reveal that under the pure-slot-fee contract, KOL optimal effort reaches merely 0.21 with prominent moral hazards. Although brands achieve acceptable short-term profits, brand-equity gains remain low. The pure-commission contract improves KOL efforts yet still imposes constraints on brand equity. Under the three-dimensional mixed contract, KOL optimal effort rises to 0.74,

representing a 21.7% improvement compared with the pure-slot-fee scenario. Both brand profit and brand equity are enhanced, which realizes Pareto improvement. Hypotheses H6, H7 and H8 are supported by simulation results. Boundary conditions are observed via simulation: when the KOL effort-cost coefficient c is excessively high, benefits generated by the three-dimensional contract will be offset. This indicates that such a

contract fits vertical-sector KOLs/KOCs rather than top-tier KOLs with extremely high costs.

4.2 SEM Questionnaire-Based Empirical Results

Harman single-factor test shows that the first factor explains 32.1% of total variance, below the 40% critical threshold, which suggests controllable common-method bias. All latent variables have Cronbach's $\alpha > 0.79$ and AVE > 0.5 , satisfying reliability and validity requirements.

- **Main-effect test:** KOL vertical professionalism and live-streaming-content compliance exert significant positive influences on perceived trust ($\beta = 0.512$, $p < 0.001$) and perceived functional value ($\beta = 0.327$, $p < 0.001$). H1 is validated.
- **Mediating effects:** The mediating-effect value of perceived trust equals 0.316, with 95% CI [0.223, 0.408] excluding zero. The mediating-effect value of perceived functional value is 0.142, with 95% CI [0.071, 0.216]. Within health-care-consumer-goods scenarios, perceived trust contributes far stronger mediation than perceived functional value, which supports H2.
- **Moderating effects:** Cultural distance significantly and negatively moderates the path "KOL characteristics $\rightarrow$ perceived trust" ($\beta = -0.184$, $p < 0.01$), so H4 holds. Product-involvement degree positively moderates the "perceived trust-consumer-performance" path ($\beta = 0.231$, $p < 0.001$). When consumers exhibit high product involvement, trust generates markedly amplified conversion-driving effects. This explains why marketing for dietary products cannot simply copy logics for ordinary fast-moving consumer goods.

4.3 fsQCA Configurational-Analysis Results

The intermediate solution for high marketing performance yields three equivalent configurations, with consistency of 0.812 and overall coverage of 0.647.

- **Configuration 1:** Vertical micro-KOC + high-content compliance + three-dimensional mixed contract; coverage 0.381.
- **Configuration 2:** Mid-tier KOL + high-frequency live-streaming + reward-and-constraint contracts; coverage 0.274.

- **Configuration 3:** Moderate top-tier-KOL investment + strict-content review + markets with low cultural distance; coverage 0.216.

Results confirm that no single element can produce high performance. Configurations featuring exclusive top-tier-KOL investment do not appear in high-performance solutions, verifying diseconomies of scale for standalone top-tier-KOL deployment. Panel regression demonstrates that for every 10% increase in top-tier-KOL investment, conversion rate only grows by 1.1% and LTV merely rises by 2.3% (Zhang, H., & Wu, Y., 2024), as huge slot-fee expenditures erode most profits. By contrast, configurations built upon vertical micro-KOC matrices deliver favorable consistency and coverage and prove more suitable for health-care consumer goods. Low-performance configurations indicate that the combination of "top-tier-KOL + pure-commission contract" and low-content-compliance constitutes the primary inhibitory condition set, which easily triggers false-promotion risks and short-term-traffic traps.

4.4 Heterogeneity Analysis

To further explore differentiated adaptation characteristics of core research conclusions across diverse scenarios and consumer groups and verify boundary conditions for the research model, grouped regression analysis is conducted from two dimensions: product category and consumer generation.

- 1) **Category-heterogeneity grouping:** Samples are divided into the health-dietary group and the general-FMCG overseas-expansion group. The mediating-share of perceived trust reaches 52.3% in the health-dietary group versus 30.8% in the general-FMCG group, proving that trust mechanisms carry significantly higher weight for health-related categories.
- 2) **Generation-grouped regression:** Generation-Z respondents attach greater importance to vertical authenticity of KOLs; millennial consumers are more sensitive to long-term value brought by brand-equity rewards and less susceptible to KOL-traffic glamour.

4.5 Multi-Case Comparative Results

Case A: Long-term reliance on top-tier KOLs, pure-slot-fee plus simple-commission contracts. It faces high per-session marketing costs and

volatile short-term conversion, with a repurchase rate of merely 11.3%. Multiple overseas-regulatory complaints concerning exaggerated health-efficacy claims have been filed against the brand.

Case B: Adopts vertical micro-KOC matrices and pre-release content audits. Although single-session traffic volume remains limited, the repurchase rate hits 24.7% and LTV reaches USD 14 (Liu, S., & Jiang, T., 2025).

Case C: Implements three-dimensional mixed contracts. Noticeable improvements emerge in KOL effort levels, balancing short-term sales volume and brand equity. Qualitative evidence from cases triangulates quantitative outcomes from game simulation, SEM and fsQCA.

5. Discussion of Research Findings

- 1) Empirical evidence shows that perceived trust acts as the core mediating factor in KOL marketing for cross-border health-care DTC brands. Given high risk-perception for dietary health-care products, stable conversions cannot be achieved merely through functional-value perception. KOL professionalism and content compliance constitute core prerequisites for building user trust. Within cross-cultural contexts, cultural distance weakens trust-transmission efficiency; localized content should be leveraged to optimize marketing outcomes.
- 2) Game-theoretic simulations verify that pure-slot-fee contracts and pure-commission contracts respectively give rise to KOL moral hazards and brand-equity erosion. The three-dimensional mixed contract proposed in this paper delivers performance optimization yet bears application boundaries: it fits mid-tier and vertical micro-KOLs rather than ultra-high-cost top-tier KOLs, who are only suitable for brand-awareness campaigns.
- 3) fsQCA configurational analysis confirms that marketing performance stems from multi-element synergy, and standalone top-tier-KOL investment generates diseconomies of scale. Vertical micro-KOC matrices feature high fan-matching degrees, low costs and low risks, making them well-suited for marketing of health-care consumer goods. Nevertheless, their high-performance effects can only materialize with effective

content-compliance governance.

- 4) Cultural distance significantly constrains trust transmission driven by KOLs. For markets with large cultural distance, local vertical KOCs should be prioritized. Meanwhile, product-involvement exerts positive moderating effects. High-involvement health-care consumers attach greater value to trust. Brands should prioritize trust-building instead of simple traffic procurement.
- 5) This paper revises general conclusions on KOL marketing and contracts. It validates that professionalism and compliance take priority over traffic within cross-border health-care scenarios. This study fills empirical gaps for health-category DTC overseas expansion. Compared with conventional regression, configurational analysis is more applicable for researching multi-element synergies in cross-border marketing.

6. Optimization Paths, Managerial Implications and Risk Reminders

6.1 Optimization Paths for KOL-Live-Streaming Cooperation Systems of Cross-Border Health-Care DTC Brands

Based on industry-operation pain points, failure mechanisms and empirical conclusions for cross-border health-care DTC brands, combined with overseas-regulation requirements for vertical-category exports and industrial-development characteristics, this section constructs systematic optimization paths for KOL-live-streaming cooperation systems from four dimensions: talent selection, contractual incentives, content governance and traffic links.

- 1) **KOL tiered-selection mechanism:** Establish quantitative evaluation indicators. Prioritize deployment of vertical micro-KOC matrices. Exercise prudence and impose restrictions on top-tier-KOL adoption; top-tier KOLs shall mainly serve brand-awareness promotion rather than function as regular conversion drivers. Evaluation indicators include vertical-alignment score, historical content-compliance records and fan quality; reduce weighting for absolute fan-volume metrics.
- 2) **Implementation of three-dimensional incentive contracts:** Base slot fees cover

KOLs' basic costs; tiered commissions incentivize short-term transactions; brand-equity-performance rewards tie compensation to repurchase and brand-word-of-mouth performance. Compliance-penalty clauses shall be formulated. The three-dimensional contract is explicitly more applicable for vertical KOCs and mid-tier KOLs.

- 3) **Compliance governance for live-streaming content:** Overseas regulatory requirements for health-care-product exports are stringent. Industrial statistics indicate that over 60% of compliance risks for cross-border health-care live-streaming originate from exaggerated efficacy claims and false promotion. Therefore, implement full-process governance covering pre-release content audit, real-time live-stream monitoring and post-event traceability. Strictly standardize promotional claims for dietary products to satisfy European and American food-supplement regulatory requirements and effectively mitigate brands' cross-border-export compliance risks.
- 4) **Construction of traffic-reception links:** Build traffic-flow channels connecting public-domain live-stream traffic with brand independent websites and private-domain communities. Guide precise public-domain live-stream traffic toward private-domain systems. Enhance user activity and loyalty via refined user operation, realize the transformation of short-term instant traffic into long-term LTV-driven user assets and complete the marketing closed-loop.

6.2 Implications

Drawing upon conclusions regarding marketing-closed-loop evolution, driving mechanisms and failure mechanisms for cross-border health-care DTC brands, theoretical, practical and industrial-policy implications are summarized. They enrich research findings for vertical cross-border-marketing fields and provide targeted references for brand operation, industrial regulation and policy support.

- **Theoretical implications:** This paper expands the application boundary of S-O-R theory within cross-border health-care-product contexts. It couples Stackelberg game with consumer

psychological perception and establishes the integrated "psychology-contract-performance" framework, delivering theoretical references for vertical-category cross-border marketing.

- **Practical implications:** Differentiated strategies are proposed for start-up and mature DTC brands. Start-up brands shall prioritize vertical KOC matrices plus three-dimensional mixed contracts; mature brands may allocate a small proportion of resources to top-tier KOLs for brand-awareness building.
- **Industrial-policy implications:** Empirical conclusions and operational-mechanism analyses from this research offer solid empirical evidence and decision-making references for formulating KOL-cooperation standards within the cross-border health-care-consumer-goods export sector, implementing supporting policies for Chinese health-care-brand globalization and improving cross-border-marketing compliance-regulation systems. It helps standardize industrial order and facilitates sound and long-term development of Chinese-brand cross-border sectors.

7. Research Limitations and Future Research Prospects

7.1 Research Limitations

This research still has rooms for improvement. Samples are limited to mature European and American markets, excluding high-potential emerging markets such as Southeast Asia and the Middle East, which imposes geographical-sample-coverage limitations and weakens the generalizability of conclusions. The game-theoretic model adopts static Stackelberg leader-follower game and only analyzes one-shot optimal decisions, failing to characterize strategic adjustments and dynamic evolution within long-term brand-KOL partnerships. Moreover, emerging marketing agents such as AI virtual KOLs are not covered, which restricts adaptability to contemporary new-marketing scenarios. Online questionnaire surveys also entail inherent sample biases and contextual limitations.

7.2 Future Research Prospects

Based on the above-mentioned limitations, follow-up research can be further deepened in

the following directions: construct dynamic evolutionary-game models to systematically analyze strategic-iteration rules for long-term DTC-brand-KOL cooperation; expand cross-national survey samples and conduct comparative studies across diverse regional markets to improve conclusion generalizability; further explore marketing-empowerment mechanisms of AI virtual KOLs within DTC-overseas-expansion scenarios for health-care products; incorporate practical constraints such as cross-border supply chains and overseas-compliance supervision into research frameworks to further refine relevant theoretical systems.

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