Research on the Impact of Anchor Types on E-commerce Product Pricing and Quality Decision-Making

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Abstract: *In the operation of the live-streaming e-commerce supply chain, a thorough exploration of the impact of e-commerce channel quality control levels, consumer quality perception, and situational awareness on manufacturers' choices of live-streaming models, as well as how to maximize manufacturers' profits, holds significant strategic value. This paper focuses on a supply chain system consisting of manufacturers, live-stream hosts, and live-stream e-commerce platforms, constructing a game-theoretical analysis model that incorporates quality control levels, platform quality supervision intensity, and consumer sensitivity to product quality. Utilizing this model, an in-depth analysis is conducted on two modes: sales by human hosts and sales by virtual hosts, discussing how they influence the pricing mechanisms and quality-related decision-making within the live-streaming e-commerce supply chain. The analysis reveals that as consumer sensitivity to manufacturers' quality control capabilities and the regulatory power of live-streaming e-commerce platforms increases, both manufacturers and platforms can achieve higher profit returns under these two modes. This study aims to uncover the specific effects of different host types on key decision variables within the e-commerce ecosystem, providing more precise strategic guidance for industry participants.*

Keywords: *live-streaming e-commerce; quality control level; Nash game model; host type*

Introduction

In recent years, the live-streaming e-commerce economy has rapidly developed, leading consumers into new consumption models and fields: live-streaming sales have become a primary means of attracting economic activity, resulting in intense competition among live-streaming e-commerce platforms. However, the "Interim Measures for the Management of Network Live-Streaming Marketing" points out that the quality control of goods and services in live-streaming marketing is concerning. Due to the long chains, multiple entities, and complex legal relationships involved in live-streaming platforms, some operators in live-streaming marketing display neglect and a sense of complacency regarding product and service quality issues. As one of the means to attract consumers, live-stream hosts, manufacturers, and live-streaming e-commerce platforms interact and constrain each other. Therefore, this paper constructs an e-commerce live-streaming supply chain system composed of a manufacturer, a host, and a live-streaming e-commerce platform, exploring three influencing factors: quality control level, consumer quality perception, and situational awareness[1]. A comparison is made between AI hosts and traditional human hosts regarding the manufacturers' quality control levels and the impact of different host types on manufacturers' pricing and host type selection, aiming to provide valuable references for manufacturers to achieve maximum profits.

1. Research Background

The report of the 20th National Congress of the Communist Party of China proposed the prosperity of the "contactless economy," highlighting that breakthroughs and innovations in a new generation of digital technologies are driving the e-commerce industry to upgrade from traditional e-commerce to new e-commerce. Based on this, it was clearly stated that live-streaming platforms must improve their control over product quality to ensure long-term development in this new domain and should promptly implement relevant quality control measures. Against this backdrop, many manufacturers have chosen to introduce virtual hosts to replace human hosts for live-streaming sales. Firstly, the extremely low cost of digital hosts significantly reduces operating expenses compared to traditional live hosts, as digital

hosts do not require salaries or benefits. Secondly,[2,3]digital live-streaming offers strong stability, unaffected by emotional instability or character breakdowns, ensuring consistent live-streaming effectiveness. Additionally, digital hosts can provide uninterrupted 24-hour live-streaming, offering businesses more opportunities for product display. Most importantly, manufacturers can maintain relatively greater control, meeting consumer demands for product quality.

2. Theoretical Analysis

Live-streaming e-commerce has rapidly emerged as a typical new business model in China's digital economy, characterized by its enjoyable shopping atmosphere, intuitive content format, and real-time face-to-face interaction. In this model, [4,5]hosts play a crucial role, as their outstanding expressiveness and approachability can attract a large audience, leading to increased traffic and higher conversion rates. Therefore, this article will analyze the impact of quality control levels, consumer quality perception, and on-site perception on manufacturers' pricing decisions and live-streaming mode selection within the e-commerce live-streaming supply chain composed of manufacturers, live-streaming platforms, and consumers.

2.1 The Impact of Manufacturers' Quality Control Costs on Their Pricing Decisions

With the rapid development of live-streaming e-commerce, an increasing number of manufacturers are choosing to showcase and sell products on live-streaming platforms. In this process, manufacturers need to focus not only on production costs and market demand but also on how quality control costs influence their pricing decisions. On one hand, manufacturers must consider the quality control costs incurred during the production process. To attract the interest of a wide range of consumers, manufacturers must commit to improving product quality and fundamentally optimizing product characteristics, thereby enhancing consumer trust and loyalty, which in turn promotes sales growth and overall profit levels. [6]On the other hand[7], with the continuous improvement of artificial intelligence technology, the use of virtual hosts for live streaming has become widespread. There is a significant difference in hiring costs between virtual hosts and traditional human hosts. If manufacturers spend excessively on host marketing costs, this will likely lead to a reduction in quality control costs. In pursuit of greater profits, manufacturers will probably increase product prices to gain direct benefits, which may result in a phenomenon of "high price, low quality." The "Action Plan for Further Improving the Quality of Products, Projects, and Services (2022–2025)," issued in November 2022, emphasizes the need to urge platform enterprises to strengthen quality control and traceability of products sold and promoted via live streaming, and to assume legal responsibilities for product and service quality assurance, as well as food safety guarantees. This requires collaborative efforts from manufacturers, live-streaming platforms, and the government.

2.2 The Impact of Consumer Perceived Value on Manufacturers' Pricing Decisions

With rising household incomes, consumers increasingly prioritize product quality when making purchases, shifting from a "price is king" mentality to one of "quality above all." This keen insight into quality profoundly influences manufacturers' pricing strategies. Consumers' preference for high-quality products drives manufacturers to focus on producing quality goods to meet market demand, thereby increasing sales. Consequently, when setting product prices, manufacturers must fully consider consumers' sensitivity to product quality. Additionally, as the end of the supply chain, consumers impose new demands on manufacturers and live-streaming e-commerce platforms. Manufacturers need to carefully consider pricing issues while strictly controlling product quality based on consumer quality sensitivity. The degree of consumer sensitivity to product quality directly impacts manufacturers' pricing decisions. If consumers have a strong preference for high-quality products, manufacturers may choose to produce high-quality goods and set correspondingly high prices. Conversely, they may opt to produce lower-quality products. [8]Moreover, considerations regarding the live-streaming platform's random monitoring and commission rates are essential; only by continuously improving product quality can stable long-term development in the e-commerce economy be ensured.

3. Problem Discussion and Model Construction

3.1 Problem Discussion

In-depth exploration of the live-streaming e-commerce supply chain system necessitates consideration of a complete system composed of core members: manufacturers, hosts, and live-streaming e-commerce platforms. Within this system, manufacturers not only bear the responsibility for product production but also must rigorously control the overall quality of products, ensuring that they meet high-quality standards from the source. Meanwhile, the live-streaming e-commerce platform plays a crucial role in the supply chain, responsible for conducting thorough product quality inspections before items are listed to ensure that all products sold on the platform comply with established quality standards, thereby providing consumers with a safe and reliable shopping environment to gain their trust and support. Based on manufacturers' different choices, live-streaming formats are divided into two types: human host live streaming and virtual host live streaming (denoted as H and A, respectively). Human host live streaming refers to manufacturers or platforms hiring professional hosts to sell products at a price of p^H using designated official accounts, while paying a certain percentage of the total product profit, g, as commission to the platform, along with remuneration, f, to the human host. At this point, the manufacturer's product quality control level is c^H. Virtual host live streaming refers to manufacturers creating AI hosts or collaborating with technology companies that possess AI technology to shape a unique AI host image based on brand characteristics, establishing a new live-streaming model of "virtual AI host + virtual scene" to sell products at a price of p^A. They also pay a certain percentage of commission, g, to the platform, and there may be fixed technology cooperation costs, s, at which point the manufacturer's product quality control level is c^A. Based on the above analysis, this study proposes the hypothesis that manufacturers will choose the type of host based on the core consideration of "profit maximization."

3.2 Model Construction

This paper sequentially establishes the Nash equilibrium models for the scenarios in which manufacturers use human anchors and those in which they use AI anchors. It also compares and analyzes the two scenarios.

3.2.1 Human Anchor Scenario

Manufacturers enter into agreements with human anchors, commissioning them to sell products produced by the manufacturers on live streaming platforms. Manufacturers pay human anchors a commission rate of f; in turn, human anchors must pay the live streaming platform a commission rate of g, based on the commission rate paid by the manufacturers. According to the assumptions of the Nash equilibrium model, both manufacturers and the live streaming platform make simultaneous decisions regarding the quality level and price of the products, aiming to maximize their respective profits. Considering the differences in interactivity between human anchors and AI anchors, the human anchor's sense of presence coefficient is set to l_1. A model is established based on the aforementioned assumptions and relevant hypotheses.

The demand function is as follows:

$$D^H = a - b * p^H + e * c^H + l_1$$

The profit function of the live streaming platform is as follows:

$$\pi_P^H = f * g * D^H * p^H \quad (1)$$

The profit function of the manufacturer is as follows:

$$\pi_M^H = (1 - g) * D^H * p^H - k * (c^H)^2/2 \quad (2)$$

By substituting the demand function into (1) and (2), and taking the first-order partial derivatives with respect to p^H and c^H, and then solving the resulting equations simultaneously, the equilibrium solutions can be obtained as follows:

$$p^{H*} = \frac{k(a + l_1)}{2bk + e^2g - e^2 + e^2fg}$$

$$c^{H*} = \frac{-(e(a + l_1)(g + fg - 1))}{2bk + e^2g - e^2 + e^2fg}$$

$$\pi_P^{H*} = \frac{bfgk^2(a+l_1)^2}{(2bk+e^2g-e^2+e^2fg)^2}$$

$$\pi_M^{H*} = \frac{-k(a+l_1)^2(e^2fg(fg+2g-2)+e^2(g-1)^2+2bk(g-1))}{2(2bk+e^2g-e^2+e^2fg)^2}$$

To ensure that the equilibrium solutions are meaningful, it is necessary that:

$$-k(a+l_1)^2(e^2fg(fg+2g-2)+e^2(g-1)^2+2bk(g-1)) > 0$$

3.2.2 AI Anchor Scenario

Manufacturers obtain the technology for AI anchors through collaboration with relevant companies, enabling the use of AI for live streaming on platforms. In this case, manufacturers only need to pay a fee of (g) to the live streaming platform, while also incurring the acquisition cost of the AI anchor, denoted as (s). Considering the differences in interactivity between human anchors and AI anchors, the AI anchor's sense of presence coefficient is set to l_2. A model is established based on the aforementioned assumptions and relevant hypotheses.

The demand function is as follows:

$$D^A = a - b * p^A + e * c^A + l_2$$

The profit function of the live streaming platform is as follows:

$$\pi_P^A = g * D^A * p^A \quad (3)$$

The profit function of the manufacturer is as follows:

$$\pi_M^A = (1-g) * D^A * p^A - k * (c^H)^2/2 - s \quad (4)$$

By substituting the demand function into (3) and (4), and taking the first-order partial derivatives with respect to p^A and c^A, and then solving the resulting equations simultaneously, the equilibrium solutions can be obtained as follows:

$$p^{A*} = \frac{k(a+l_2)}{2bk+2e^2g-e^2}$$

$$c^{A*} = \frac{-e(2g-1)(a+l_2)}{2bk+2e^2g-e^2}$$

$$\pi_P^{A*} = \frac{bgk^2(a+l_2)^2}{(2bk+2e^2g-e^2)^2}$$

$$\pi_M^{A*} = \frac{-k(a+l_2)^2(\frac{1}{2}e^2(2g-1)^2+bk(g-1))}{(2bk+2e^2g-e^2)^2} - s$$

To ensure that the equilibrium solutions are meaningful, it is necessary that:

$$-k(a+l_2)^2(\frac{1}{2}e^2(2g-1)^2+bk(g-1)) - s(2bk+2e^2g-e^2)^2 > 0$$

3.2.3 Comparative Analysis

(1) Analyzing the impact of consumer quality sensitivity coefficient (e) on manufacturers' choice of live streaming method.

Under reasonable assumptions and constraints, within a certain range, even as the consumer quality sensitivity coefficient increases, the profits obtained by manufacturers when choosing human anchors will always exceed those obtained when selecting AI anchors. As the consumer quality sensitivity coefficient increases, the advantages of choosing human anchors become increasingly evident; however, once a certain threshold is surpassed—when consumers become excessively critical of quality—the advantage of choosing human anchors diminishes, making the distinction between choosing human and AI anchors negligible.

(2) Analyzing the impact of manufacturers' quality cost coefficient (k) on their choice of live streaming method.

Within a certain range, as the quality cost coefficient increases—indicating that manufacturers are actively investing more in quality—the advantages of choosing human anchors for live streaming will

gradually diminish. This means that the costs manufacturers incur for quality control will increasingly offset the impact of their choice of live streaming method. However, under the current assumptions, within a certain range, the profits obtained from using human anchors will always exceed those obtained from using AI anchors.

(3) Analyzing the impact of the costs (s)ncurred by manufacturers to acquire AI anchors on their choice of live streaming method.

As the costs for manufacturers to acquire AI anchors increase, the advantages of using AI anchors for live streaming will gradually diminish, showing a clear linear negative correlation between manufacturers' profits and the costs of acquiring AI anchors. Manufacturers should strive to reduce the acquisition costs of AI; however, as AI technology matures, these acquisition costs will further decrease, leading manufacturers to increasingly choose AI anchors.

(4) Analyzing the impact of changes in the AI virtual anchor's sense of presence coefficient(l_2) on manufacturers' choice of live streaming method.

As the AI virtual anchor's sense of presence coefficient increases, the ability of manufacturers to generate profits will also improve. However, under the current assumptions, the performance of AI anchors must significantly surpass that of human anchors for manufacturers to choose the AI anchor method for live streaming.

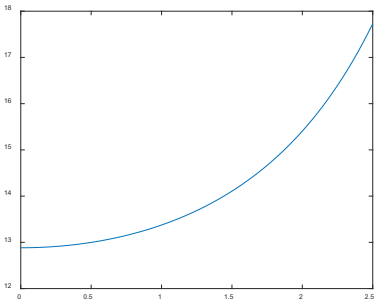
In summary, with the advancement of AI technology, the interactivity and intelligence of AI anchors will further improve. Additionally, as AI technology becomes more open-source and widespread, the costs of acquiring AI anchors will decrease, leading manufacturers to increasingly choose AI anchors.

3.3 Numerical Simulation Analysis

As noted above, the equilibrium profits for manufacturers under the human anchor model and the AI virtual anchor model are now subjected to differential analysis.

(1) Analyzing the impact of consumer quality sensitivity coefficient (e) on manufacturers' choice of live streaming method.

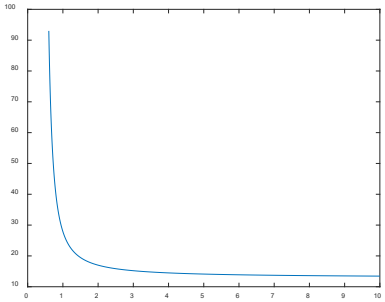
a=30;b=2;f=0.2;g=0.25;k=5;s=10;l1=1;l2=0.5;



Analysis reveals that, under reasonable market expectations and assumed conditions, as consumer sensitivity to product quality continues to rise, the difference in equilibrium profits between the human anchor model and the AI virtual anchor model exhibits significant nonlinear growth. The advantages of human anchors become increasingly prominent with the increase in the consumer quality sensitivity coefficient (e), and the profits that manufacturers can obtain by choosing human anchors consistently exceed those gained from selecting AI virtual anchors.

(2) Analyzing the impact of manufacturers' quality inspection cost coefficient (k) on their choice of live streaming method.

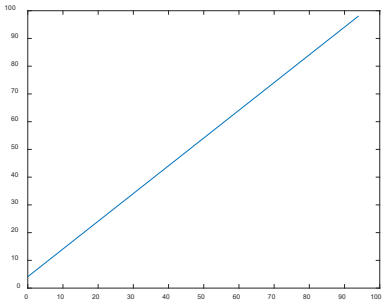
a=30;b=2;f=0.2;g=0.25;s=10;l1=1;l2=0.5;e=1.5;



Analysis reveals that, within a certain range, as the quality cost coefficient (k) increases—indicating that manufacturers are actively investing more in quality—the advantages of choosing human anchors for live streaming will gradually diminish. This means that the costs incurred by manufacturers for quality control will increasingly offset the impact of their choice of live streaming method. Under this assumption, the profits obtained from using human anchors will consistently exceed those obtained from using AI virtual anchors.

(3) Analyzing the impact of the costs (s) incurred by manufacturers for purchasing AI anchors on their choice of live streaming method.

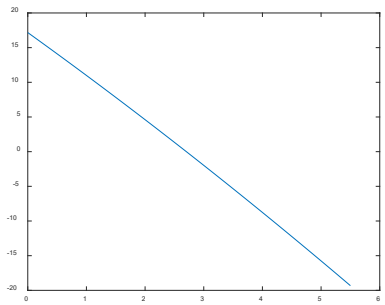
a=30;b=2;f=0.2;g=0.25;k=5;l1=1;l2=0.5;e=1.5



Analysis reveals that as the costs (s) for manufacturers to acquire AI virtual anchors gradually increase, the advantages of using AI virtual anchors for live streaming will diminish. There is a clear linear negative correlation between manufacturers' profits and the costs of acquiring AI virtual anchors. Manufacturers should strive to reduce the acquisition costs of AI virtual anchors. Although under the current assumptions, the profit potential for manufacturers using AI virtual anchors is not optimistic, as AI technology matures, the costs of acquiring AI virtual anchors will further decrease, leading manufacturers to favor AI virtual anchors.

(4) Analyzing the impact of changes in the AI virtual anchor's sense of presence coefficient (l_2) on manufacturers' choice of live streaming method.

a=30;b=2;f=0.2;g=0.25;k=5;l1=1;e=1.5;s=10



Analysis reveals that as the AI virtual anchor's sense of presence coefficient increases, manufacturers' ability to generate profits will also improve accordingly. However, under the current scenario, the performance of AI virtual anchors must significantly surpass that of human anchors to encourage manufacturers to favor the use of AI virtual anchors for live streaming.

In summary, with the advancement of AI technology, the interactivity and intelligence of AI virtual anchors will further improve. Additionally, as AI technology becomes more open-source and widespread, the costs of acquiring AI virtual anchors will decrease, leading manufacturers to increasingly favor AI virtual anchors.

4. Conclusions and Implications

4.1 Conclusions

This paper constructs a supply chain game model involving one manufacturer and one live streaming platform. It analyzes the profits obtained by manufacturers when choosing to use human anchors versus AI virtual anchors for live streaming. Under reasonable assumptions, the following conclusions are drawn through data simulation analysis:

(1) Within a certain range, as the consumer quality sensitivity coefficient increases, the advantages of choosing human anchors become more pronounced.

(2) Within a certain range, as the quality cost coefficient increases—indicating that manufacturers are actively investing more in quality—the advantages of using human anchors for live streaming will gradually diminish compared to choosing AI virtual anchors.

(3) As the costs for manufacturers to acquire AI anchors increase, the advantages of using AI anchors for live streaming will gradually decrease.

(4) As the AI virtual anchor's sense of presence coefficient increases, manufacturers' ability to generate profits in the AI virtual anchor scenario will also improve.

4.2 inspiration

4.2.1 Upgrading AI Technology and Focusing on User Experience

Artificial intelligence technology is in a rapid development phase; however, the current technological level remains immature. Continuous investment in research and development is necessary to enhance the technical capabilities of AI anchors in areas such as voice synthesis, emotional recognition, and language understanding. Improving the interaction experience between users and AI anchors will increase user participation and loyalty while meeting the needs of different users and target groups, thus fostering a fan economy. Efforts should be made to provide users with a live streaming experience akin to offline shopping, showcasing product quality, appearance, and more, to enhance consumers' sense of presence and attract them to make purchases. As technology continues to advance and AI becomes more open-source, the costs associated with using AI anchors will gradually decrease, allowing for broader application of AI anchors in e-commerce live streaming.

4.2.2 Manufacturers Enhancing Product Quality Control

Strengthening quality control is crucial for manufacturers. Low-quality or defective products can harm users, severely impact brand reputation and user trust, and diminish the influence of anchors, ultimately weakening consumer loyalty. Improving quality control and enhancing product quality are key factors in boosting product competitiveness. High-quality products can increase customer satisfaction, enhance user experience, and promote the long-term development of the brand.

4.2.3 Government Strengthening Regulation and Standards to Promote Healthy Industry Development

Due to the numerous stakeholders involved in live streaming and the challenges in tracing accountability, relevant government departments should enhance industry regulation from the source, raising entry barriers and formulating corresponding policies and regulations. This includes urging live streaming platforms to strengthen content control, supervising manufacturers to improve product quality management, and optimizing the market environment to create a green and harmonious shopping experience for consumers. Additionally, the government should provide policy support for the e-commerce live streaming industry, encouraging rational consumer behavior and fostering cooperation to promote the development of the virtual live streaming industry.

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