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### Title

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### Permalink

<https://escholarship.org/uc/item/0fq355pq>

### Journal

Managerial and Decision Economics

### ISSN

0143-6570

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### Publication Date

2025

### DOI

10.1002/mde.70073

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Peer reviewed

## RESEARCH ARTICLE

# Platform-Induced Category Encroachment: Impact on Manufacturer's Quality Disclosure

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**Received:** 12 July 2024 | **Revised:** 10 December 2025 | **Accepted:** 12 December 2025

**Keywords:** category encroachment | distribution contract | quality disclosure | supply chain management

## ABSTRACT

This paper explores the dynamic interplay between the platform owner's category encroachment and the manufacturer's quality disclosure within a supply chain. This research uncovers a noteworthy insight: platform owner-led category encroachment negatively influences the manufacturer's inclination to disclose information about product quality. Moreover, we observe a free-rider effect on quality information disclosure by the platform, underscoring the idea that enhanced transparency in product quality information primarily benefits the platform. Notably, our findings reveal specific scenarios that create opportunities for a mutually beneficial outcome, fostering a win-win situation between the manufacturer and the platform.

## 1 | Introduction

Online shopping has become increasingly popular among consumers with the rapid development of the e-commerce platform economy. With the COVID-19 pandemic accelerating digital transformation across industries and the increasing penetration of mobile internet, consumers now exhibit a stronger preference for convenience, variety, and personalized services offered by online retailing. The optimization of platform retailing has led to a steady increase in the proportion of online retailing within the broader landscape of social retailing. According to data from China's National Bureau of Statistics, the share of online retail grew from 20.7% in 2019 to 27.6% in 2023.<sup>1</sup> This growth has been accompanied by the emergence of category encroachment phenomenon, where e-commerce platforms establish their own brands for product selling, logistic protection, and warranty services (Zhang et al. 2021). For instance, JD's own brand "Jingzao" exemplifies this trend. The proliferation of category encroachment is evident in the significant sales growth of JD's own brand, which approached 3 billion dollars in 2020, representing a 200% increase from the previous year.<sup>2</sup> Category encroachment by the platform owner induces competition for sales between the

manufacturer and the platform, which leads to both competition and co-operation between the manufacturer and the platform.

Product quality plays a crucial role in influencing consumers' purchasing decisions and impacting firms' revenues, thereby the manufacturer can counter the cannibalisation effect of the platform owner's category encroachment by aligning its quality disclosure strategy (Cheng et al. 2020). For example, in high-involvement categories such as consumer electronics and cosmetics, where consumers are highly sensitive to product quality and authenticity, credible disclosure of product quality can become a key differentiator for manufacturers. To address consumer uncertainty regarding product quality, manufacturers employ various methods to disclose quality information, including collaborating with third-party certification bodies (e.g., ASTM International and Nielsen) and offering free samples (e.g., Estée Lauder, Lancôme, and Dove). However, quality information disclosure activities entail costs, prompting manufacturers to evaluate whether the benefits of such disclosures outweigh the associated expenses. In practice, it is noteworthy that many manufacturers (e.g., HUAWEI, Apple, and P&G, Nestle) adopt two distribution contracts when selling their

products on e-commerce platforms. For instance, HUAWEI operates its JD self-owned flagship store (Reselling) on JD.com and its official flagship store (Agency Selling) on Tmall.com. These dual-channel strategies reflect not only pricing or logistics considerations, but also signal different levels of control over branding, customer data, and quality disclosure behaviors. Interestingly, manufacturers employ distinct quality disclosure strategies under different distribution contracts (Wu et al. 2023).

Numerous studies have examined the relationship between category encroachment and quality disclosure strategies (Huang et al. 2020; Sun et al. 2023; Guan et al. 2019). However, few works have investigated the impact of platform owners' category encroachment on manufacturer quality disclosure on distribution contracts. This paper seeks to address this gap in the literature by exploring the interactions between platform category encroachment and manufacturer quality disclosure under diverse distribution arrangements, including reselling and agency selling. In the study most related to our work, (Wu et al. 2023) emphasize the effect of upstream quality disclosure on downstream entry in a market where the platform owner are entering retail market, sharing a common manufacturer with the incumbent retailer. Motivated by these above cases, this paper aims to explore the strategic landscape of platform owners' category encroachment in relation to manufacturers' quality disclosure across diverse distribution contracts. The investigation seeks to address the following key questions:

- What influence does the platform owner's category encroachment exert on the manufacturer's disclosure of quality information under different distribution contracts, and how does it alter the transparency of quality information?
- How does category encroachment affect manufacturer and platform revenues?
- Could the interaction between the platform owner's encroachment strategy and the manufacturer's disclosure strategy lead to a win-win situation?

To address these questions, this paper formulates four gaming scenarios: the RN model (Reselling-No Entry), the RE model (Reselling-Entry), the AN model (Agency Selling-No Entry), and the AE model (Agency Selling-Entry). By analyzing the interaction between the platform owner's category encroachment and the manufacturer's quality disclosure under two distribution contracts, we compare the equilibrium solutions across the four scenarios. Our analysis yields the following main conclusions: (1) Category encroachment by the platform owner weakens incentives for the manufacturer to disclose quality information in both distribution contracts. The manufacturer's incentive to disclose quality information in the reselling is higher when agency fees are high, whereas the manufacturer's incentive to disclose quality information in the agency selling is higher when agency fees are low. Platform category encroachment intensifies competition between the platform's private label and the manufacturer's product. In both reselling and agency models, this reduces the manufacturer's expected return from quality disclosure, as the platform may prioritize or promote its own brand. However, the relative strength of the manufacturer's incentive to disclose is shaped by the fee structure: In reselling, the platform bears demand risk and sets the retail price. The

manufacturer's relative gain from quality disclosure increases since a higher wholesale price does not reduce its profit margin proportionally. In contrast, in agency selling, the manufacturer controls the price and pays a fee per transaction. When agency fees are low, the marginal benefit of disclosure is higher, since the manufacturer retains more surplus from quality-induced demand. (2) The manufacturer does not always benefit from lower disclosure costs. However, the platform owner benefits from the free-rider effect of product quality information and consistently prefers higher information transparency. Lower disclosure costs increase the likelihood that both high- and low-quality manufacturers will choose to disclose. However, the platform can free-ride on the quality disclosure, using it to attract consumers and improve transaction efficiency without directly bearing the cost of signaling, which can harm the manufacturer. (3) In certain cases, strategic choices by the platform owner and manufacturer can lead to a win-win situation. When the platform calibrates its private label strategy and pricing policies appropriately, and the manufacturer responds with truthful disclosure, both parties can benefit.

In this study, our contribution to theoretical and practical insights is in three aspects. First, we theoretically explore the interaction between platform owner category encroachment and manufacturer quality disclosure under different distribution contracts. Our theoretical findings enrich the current research on e-commerce platform operations. Second, win-win situations for both manufacturer and platform owner are found to maintain a healthy competitive relationship for the first time in combination of different selling modes (reselling or agency selling) and category encroachment decisions (encroach or not). Finally, we introduce a hybrid selling model. It is worth noting that our findings indicated that no one selling model is strictly superior to the others.

This paper comprises seven main sections. Section 1 provides an overview of the research background, delineates the research questions, and highlights the main contributions of the study. In Section 2, a comprehensive literature review is presented. Section 3 elucidates the supply chain structure, including the main parameters, functions, and decision sequence. The equilibrium solutions in four scenarios, along with the mathematical analysis of each scenario, are systematically organized in Section 4. Section 5 critically examines the impact of platform owner category encroachment. Furthermore, Section 6 extends the research scope by introducing a hybrid model. Finally, Section 7 offers a concise summary of the main findings and presents practical recommendations. Detailed proofs are provided in the appendices for reference.

## 2 | Literature Review

The literature related to this paper encompasses two primary directions: category encroachment on platform and quality disclosure.

The rapid development of the platform economy has led to an abundance of categories on platforms, making category encroachment on platforms a common occurrence. Extensive research has investigated various aspects of category

encroachment on platforms. Some scholars have delved into the motivations behind platform encroachment (Li et al. 2021; Parker and Van Alstyne, 2018), while others have highlighted its impact on market dynamics, including direct competition with third-party sellers (Zhu and Liu, 2018; Li et al. 2021). Some scholars focus on the platform owner's category encroachment strategy. Research such as (Li et al. 2023) established a dynamic signaling game model in which the platform owner observed the manufacturer's sales signals in the first stage and made category encroachment on the manufacturer with high sales potential (HM) in the second stage. An interesting phenomenon was that this encroachment prompted the HM to disguise itself as a manufacturer with low sales potential (LM) to evade platform owner encroachment, thereby aggravating information asymmetry. Moreover, studies like (Wei and Xu, 2022) investigated the interaction and timing of platform owners' category encroachment and manufacturers' self-operating channel opening. They found that the self-operating channel as an anti-entry approach to the platform owners' category encroachment was effective in some scenarios. Research by (Li et al. 2021) examined how the platform owner's category encroachment impacted the manufacturer's optimal selling mode choice and summarised the conditions under which the two sales models were chosen. It is worth noting that following the rise of live-streaming e-commerce, the manufacturer's channel strategy has become more complex. It not only needs to balance between traditional agency and resale models, but also must decide between new business models such as vertically integrating live-streaming MCNs or collaborating with them. These decisions also profoundly impact the manufacturer's dependence on and control over platform channels (Liu et al. 2025). Research by (Li et al. 2024) explored how a national brand (NB) seller's new product introduction strategy affected the co-opetition relationship between the two players considering the existence of a platform owner's category encroachment. They showed that new product introduction as a fight strategy may cause a win-win situation for the NB seller and the platform. Notably, (Sun et al. 2023) examined supplier selection and quality disclosure decisions for category encroachment by the platform owner. They noticed that the ratio of the cost per unit quality of the inside supplier's product relative to that of the platform owner's category encroached product served a significant role. In practice, category encroachment by the platform owner can cannibalise the market share of the manufacturer selling the product on the platform, affecting the manufacturer's quality disclosure strategy. In particular, when the manufacturer sells through hybrid channels such as live-streaming e-commerce, its product quality disclosure strategy becomes more dynamic and complex. This may involve multiple choices, including honest disclosure, deceptive promotions, or collusion with influencers, which directly impacts its competitive position and long-term credibility when facing platform encroachment (Zhao et al. 2025; Zhang et al. 2025). However, few studies have examined the interaction between platform owner's category encroachment and manufacturer's quality disclosure strategy.

Numerous studies have investigated quality disclosure strategies, with a focus on various aspects such as different sales models (Wang et al. 2021; Pei and Li, 2023), information

access channels (Markopoulos and Hosanagar, 2018; Hong et al. 2021), disclosure techniques (Zhang et al. 2024; Xu and He, 2021; Shi et al. 2022), free-rider issues (Yuan et al. 2022; Wang et al. 2021), and disclosure formats (Guo, 2009; Li et al. 2021; Jiang et al. 2023). Many scholars have focused on manufacturer's quality disclosure strategy on e-commerce platforms. For instance, research by (Guan et al. 2019) investigated a manufacturer's voluntary disclosure strategy when it can encroach on e-commerce platform's operations by selling directly to final consumers. They found that the establishment of a direct sales channel ultimately leads to a higher level of information transparency in the supply chain. Similarly, (Huang et al. 2020) delved the interplay between a manufacturer's quality disclosure and channel encroachment. They showed that there exists a U-shaped pattern between the manufacturer's payoff and the disclosure cost. Recent research further reveals that in the digital economy era, live-streaming e-commerce—as a key direct-sales and interactive channel—has profoundly reshaped quality disclosure strategies through its unique information exchange model. For instance, manufacturers or live-streamers must decide disclosure levels and pricing within agency or self-operated models, while disclosure costs, revenue-sharing mechanisms, and platform intervention all nonlinearly impact supply chain members' profits and strategic choices (Ma and Shuai, 2024). Additionally, as a crucial tool for disclosing quality and environmental information, eco-labels—whether industry- or government-issued—interact with e-commerce platforms' sales models (resale or agency) to jointly influence the manufacturer's disclosure incentives, product environmental credentials, and ultimate profitability (Yao et al. 2025). Our paper came to the unanimous conclusion. They also found the increase of the encroachment cost always hurts the manufacturer. However, these studies do not specifically address the interplay between platform owner's category encroachment and manufacturer's quality disclosure under different distribution contracts.

While many studies have looked into “category encroachment” and “quality disclosure strategies”, few have studied how platform owners' category encroachment affects manufacturer quality disclosure. This paper aims to fill this gap by exploring how platform category encroachment impacts manufacturer quality disclosure under different distribution contracts, like reselling and agency selling. We illustrate the detailed comparison of this paper with the literature in Table 1. Unlike previous research, our study looks at how platform category encroachment affects manufacturer quality disclosure across different distribution contracts. We also examine when the platform owner might decide to encroach on categories at different quality levels and discuss situations where both platform and manufacturer benefit. Our findings offer theoretical insights for the platform owner and practical guidance for businesses, highlighting how distribution channels can influence manufacturer's quality disclosure when platform owner encroaches on categories.

### 3 | Model Formulation

This study constructs a supply chain consisting of a manufacturer (m), a platform (s), and consumers. The manufacturer opens the selling channel on the platform, and there are two

**TABLE 1** | Comparison of the present study with previous studies.

| Authors             | Quality disclosure | Category encroachment by |                | distribution contract       |                              |
|---------------------|--------------------|--------------------------|----------------|-----------------------------|------------------------------|
|                     |                    | Manufacturer             | Platform owner | Reselling or Agency selling | Reselling and Agency selling |
| (Sun et al. 2023)   |                    |                          |                |                             |                              |
| (Li et al. 2021)    | ✓                  |                          | ✓              | ✓                           |                              |
| (Huang et al. 2020) |                    |                          |                |                             |                              |
| (Guan et al. 2019)  |                    |                          |                |                             |                              |
| (Cui, 2019)         | ✓                  | ✓                        |                | ✓                           | ✓                            |
| (Li et al. 2024)    |                    |                          |                |                             |                              |
| (Li et al. 2023)    | ✓                  |                          | ✓              | ✓                           |                              |
| (Wei and Xu, 2022)  |                    |                          | ✓              | ✓                           | ✓                            |
| (Li et al. 2021)    |                    |                          | ✓              | ✓                           |                              |
| Our paper           | ✓                  |                          | ✓              | ✓                           | ✓                            |

types of distribution contracts between the platform and the manufacturer, including reselling and agency selling. The manufacturer is responsible for disclosing product quality information. The platform owner can choose whether or not to make category encroachment, and we assume that the quality level of products provided by the manufacturer and the platform is the same. All firms are risk neutral.

### 3.1 | Problem Setup

We consider four different models, namely RN (Reselling-No entry), RE (Reselling-Entry), AN (Agency selling-No entry), and AE (Agency selling-Entry) models. In the agency selling, We set  $r$  as the commission fee that the manufacturer pay the platform on its revenue. In practice, the commission fee is charged by the platform, including JD.com and Amazon. Thus, we assume that  $r$  is exogenous, which is widely applied in many platform research(cf. Abhishek et al. 2015; Geng et al. 2018; Qin et al. 2021). The important parameters and variables in the model are organized in Table 2.

Assume the following conditions: (1) The manufacturer's quality disclosure strategy is shown as  $d_R$ ,  $d_R = 0$  for no disclosure and  $d_R = 1$  for active quality disclosures. (2) The paper assumes a uniform distribution of the quality level  $m$  from 0 to 1 ( $m \sim U[0, 1]$ ) (cf. Wu et al. 2023). This distribution is known to all parties, but only firms have exact knowledge of  $m$  before selling to consumers. At purchase, consumers perceive the quality as  $\tilde{m}$ . If quality information is disclosed, consumers perceive the true quality ( $\tilde{m} = m$ ); otherwise, they perceive an expected quality ( $\tilde{m} = \bar{m}$ ). (3) When the platform owner decides to encroach, the cost of category encroachment is denoted as  $I$ , and the coefficient of substitution between two products in the same category is denoted as  $b$ , where  $0 < b < 1$ . (4) For simplicity in calculations and analyses, the production cost and product are set to zero (cf. Zhang, 2019). This assumption does not affect the managerial insights. (5) To avoid the

**TABLE 2** | Basic parameters and decision variables.

| Notation           | Quantity                                                                 |
|--------------------|--------------------------------------------------------------------------|
| Basic parameters   |                                                                          |
| $c$                | The quality disclosure cost                                              |
| $I$                | The category encroachment cost                                           |
| $r$                | The revenue sharing ratio when the manufacturer adopts an agency selling |
| $b$                | The coefficient of substitution of two products in the same category     |
| $m$                | The real product quality                                                 |
| $\bar{m}$          | The expected quality                                                     |
| $\tilde{m}$        | The perceived quality by the consumer                                    |
| $\hat{m}$          | The threshold quality for the manufacturer to disclosure product quality |
| $d_R$              | The indicator of manufacturer's quality disclosure strategy              |
| Decision variables |                                                                          |
| $w$                | The wholesale price                                                      |
| $q_m$              | The quantity of the original product (Reselling/agency selling)          |
| $q_s$              | The quantity of the encroached product                                   |

uninteresting scenario where the manufacturer consistently fails to disclose information, the cost of quality disclosure is set as  $c < \frac{3}{32}$  (cf. Wu et al. 2023).

Assume that the price of the original product under reselling/agency selling is  $p_m$  and the price of the encroached product is  $p_s$ . For RN and AN models, the consumer's utility function is  $U(q_m) = \tilde{m}q_m - \frac{q_m^2}{2} - p_m q_m$ , and the associated inverse demand function of the product is  $p_m = \tilde{m} - q_m$ . For RE and AE models, the consumer's utility function is  $U(q_m, q_s) = \tilde{m}(q_m + q_s) - \frac{1}{2} \times (q_m^2 + 2bq_m q_s + q_s^2) - p_m q_m - p_s q_s$ . The associated demand functions are  $p_m(q_m, q_s) = \tilde{m} - q_m - bq_s$  and  $p_s(q_m, q_s) = \tilde{m} - q_s - bq_m$ , respectively. Those inverse demand functions are widely used in the literature; see, for example (Cao et al. 2019; Guan and Chen, 2017).

### 3.2 | Timeline

Figure 1 illustrates the game sequence. In stage 1, the manufacturer decides on the distribution contract on the platform, including reselling and agency selling. In stage 2, the platform owner decides whether to make the category encroachment. In stage 3, the manufacturer undertakes quality information disclosure. Stage 1, stage 2 and stage 3 belong to the firm's strategic decision. Depending on the entrant's different choice, the following four subgames occur from stage 4 onward.

- In the reselling (R), if the platform owner does not engage in category encroachment (N), the manufacturer decides the wholesale price in stage 4, then the platform decides the selling quantity of original products in stage 5.
- In the reselling (R), if the platform owner engages in category encroachment (E), the manufacturer decides the wholesale price in stage 4, and the platform needs to decide

the selling quantity of original products and encroached products simultaneously in stage 5.

- In the agency selling model (A), if the platform owner does not engage in category encroachment (N), the manufacturer decides the selling quantity of original products in stage 5.
- In the agency selling model (A), if the platform owner engages in category encroachment (E), the platform decides the selling quantity of encroached products, and the manufacturer decides the selling quantity of original products simultaneously in stage 5.

## 4 | Model Analysis

In this section, we organize the equilibrium solutions under the four models, study the manufacturer disclosure strategy and the platform category encroachment strategy under the four models, and finally compare the threshold condition under different models. We organize the equilibrium solutions of four models, as shown in Table 3.

### 4.1 | RN Model

In the RN model, the manufacturer resells the product on the platform without category encroachment. The manufacturer decides whether to make quality disclosure. The manufacturer's and platform's profit functions are

$$\pi_m = wq_m - d_R c \quad (1)$$

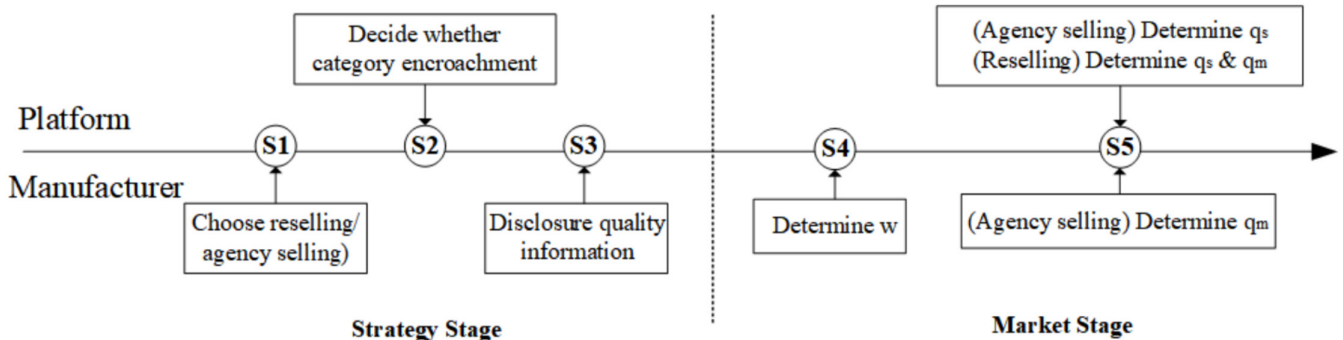


FIGURE 1 | The sequence of events.

TABLE 3 | Equilibrium solutions.

| Quantity | Model                           |                                           |                                 |                                                                                                          |
|----------|---------------------------------|-------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------|
|          | RN                              | RE                                        | AN                              | AE                                                                                                       |
| $w$      | $\frac{\tilde{m}}{2}$           | $\frac{(1-b)\tilde{m}}{2}$                | $\frac{\tilde{m}}{2}$           | —                                                                                                        |
| $q_m$    | $\frac{\tilde{m}}{4}$           | $\frac{\tilde{m}}{4(1+b)}$                | $\frac{\tilde{m}}{4}$           | $\frac{(b-2)\tilde{m}}{-4+2b^2(1+r)}$                                                                    |
| $q_s$    | —                               | $\frac{(2+b)\tilde{m}}{4(1+b)}$           | —                               | $\frac{(-4+2b(1+r)+b^2(1+r))\tilde{m}}{-8+4b^2(1+r)}$                                                    |
| $\pi_m$  | $\frac{\tilde{m}^2}{8} - d_R c$ | $\frac{(1-b)\tilde{m}^2}{8(1+b)} - d_R c$ | $\frac{\tilde{m}^2}{8} - d_R c$ | $\frac{(-2+b)^2\tilde{m}^2(-1+r)}{8(-2+b^2(1+r))} - d_R c$                                               |
| $\pi_s$  | $\frac{\tilde{m}^2}{16}$        | $\frac{(5+3b)\tilde{m}^2}{16(1+b)} - I$   | $\frac{\tilde{m}^2}{16}$        | $\frac{\tilde{m}^2(16(1+r)-16b(1+r)+b^4(1+r)^2+4b^3(1+4r+3r^2)-4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} - I$ |

$$\pi_s = (\tilde{m} - q_m - w)q_m. \quad (2)$$

We can derive the optimal wholesale price and sales quantity by backward induction as

$$w^{\text{RN}} = \frac{\tilde{m}}{2} \quad (3)$$

$$q_m^{\text{RN}} = \frac{\tilde{m}}{4}. \quad (4)$$

The profit functions at equilibrium for both the manufacturer and the platform are

$$\pi_m^{\text{RN}} = \frac{\tilde{m}^2}{8} - d_R c \quad (5)$$

$$\pi_s^{\text{RN}} = \frac{\tilde{m}^2}{16}. \quad (6)$$

Note that if the manufacturer does not disclose the product quality, then  $\tilde{m} = \frac{\hat{m}}{2}$ . The threshold quality for the RN model can be obtained as follows: the manufacturer's revenue under non-disclosure is  $\pi_m = \frac{\tilde{m}^2}{8} = \frac{\hat{m}^2}{32}$ , and the manufacturer's revenue under disclosure is  $\pi_m = \frac{\hat{m}^2}{8} - c$ , at which point the threshold quality is  $\hat{m}_R^{\text{N}} = \frac{4\sqrt{6c}}{3}$ . The manufacturer withholds product quality information when  $m < \hat{m}_R^{\text{N}}$  and discloses it otherwise. The proof is presented in the Appendix A.1. Therefore, the manufacturer's and platform's ex-ante profits are

$$\Pi_m^{\text{RN}} = \int_0^{\hat{m}_R^{\text{N}}} \frac{(\hat{m}_R^{\text{N}})^2}{32} dm + \int_{\hat{m}_R^{\text{N}}}^1 \left( \frac{m^2}{8} - c \right) dm = \frac{1}{24} + \frac{32}{9} \sqrt{\frac{2}{3}} c^{\frac{3}{2}} - c \quad (7)$$

$$\Pi_s^{\text{RN}} = \int_0^{\hat{m}_R^{\text{N}}} \frac{(\hat{m}_R^{\text{N}})^2}{64} dm + \int_{\hat{m}_R^{\text{N}}}^1 \frac{m^2}{16} dm = \frac{1}{48} - \frac{2}{27} \sqrt{6} c^{\frac{3}{2}} \quad (8)$$

**Corollary 1.** In the RN model, when  $c \in (0, \frac{27}{512})$ ,  $\frac{d\Pi_m^{\text{RN}}}{dc} < 0$ ; when  $c \in (\frac{27}{512}, \frac{3}{32})$ ,  $\frac{d\Pi_m^{\text{RN}}}{dc} > 0$ ;  $\frac{d\Pi_s^{\text{RN}}}{dc} < 0$ . (Appendix B)

From Corollary 1, it is clear that the platform's ex-ante benefit decreases strictly in the disclosure cost, that is, the platform is benefiting from higher-quality information transparency. Because the platform does not need to bear the quality disclosure cost, there is a free-rider effect on quality disclosure. The manufacturer's ex-ante benefit firstly decreases in the disclosure cost, and then increases in the disclosure cost. that is to say, there is a U-shaped relationship between the manufacturer's ex-ante benefit and the disclosure cost. Similar to (Huang et al. 2022). For the manufacturer, at lower levels of disclosure costs (higher transparency of information), the disclosure cost has a more significant impact on the manufacturer's earnings, and the manufacturer's benefit and the disclosure cost are negatively correlated. However, the higher disclosure cost does not always harm the manufacturer's benefit. When the disclosure cost is high (low transparency of information), the manufacturer could hide quality information, resulting in higher perceived

quality by consumers, which can lead to more demand for the original product.

## 4.2 | RE Model

In the RE model, the manufacturer resells the product on the platform and the platform makes category encroachment. The manufacturer decides whether to make quality disclosure. The manufacturer's and platform's profit functions are

$$\pi_m = wq_m - d_R c \quad (9)$$

$$\pi_s = (\tilde{m} - q_m - bq_s - w)q_m + (\tilde{m} - q_s - bq_m)q_s - I. \quad (10)$$

We can derive the optimal wholesale price and sales quantity by backward induction as

$$w^{\text{RE}} = \frac{(1-b)\tilde{m}}{2} \quad (11)$$

$$q_m^{\text{RE}} = \frac{\tilde{m}}{4(1+b)} \quad (12)$$

$$q_s^{\text{RE}} = \frac{(2+b)\tilde{m}}{4(1+b)} \quad (13)$$

The manufacturer's and platform's equilibrium profit functions are

$$\pi_m^{\text{RE}} = \frac{(1-b)\tilde{m}^2}{8(1+b)} - d_R c \quad (14)$$

$$\pi_s^{\text{RE}} = \frac{(5+3b)\tilde{m}^2}{16(1+b)} - I. \quad (15)$$

Similar to the idea shown in Section 4.1, the threshold quality for the RE model can be obtained as follows: the manufacturer's revenue under non-disclosure is  $\pi_m = \frac{(1-b)\tilde{m}^2}{8(1+b)} = \frac{(1-b)\hat{m}^2}{32(1+b)}$ , the manufacturer's revenue under disclosure is  $\pi_m = \frac{(1-b)\hat{m}^2}{8(1+b)} - c$ , at which point the threshold quality is  $\hat{m}_R^{\text{E}} = \frac{4\sqrt{6c(1+b)(1-b)}}{3(1-b)}$ . The manufacturer withholds product quality information when  $m < \hat{m}_R^{\text{E}}$  and discloses it otherwise. The proof is presented in the Appendix A.2. Therefore, the manufacturer's and platform's ex-ante profits are

$$\begin{aligned} \Pi_m^{\text{RE}} &= \int_0^{\hat{m}_R^{\text{E}}} \frac{(1-b)(\hat{m}_R^{\text{E}})^2}{32(1+b)} dm + \int_{\hat{m}_R^{\text{E}}}^1 \left( \frac{(1-b)m^2}{8(1+b)} - c \right) dm \\ &= \frac{1-b}{24(1+b)} + c \left( -1 + \frac{32\sqrt{\frac{2}{3}}(1+b)c}{9\sqrt{c-b^2c}} \right) \end{aligned} \quad (16)$$

$$\begin{aligned} \Pi_s^{\text{RE}} &= \int_0^{\hat{m}_R^{\text{E}}} \frac{(5+3b)(\hat{m}_R^{\text{E}})^2}{64(1+b)} dm + \int_{\hat{m}_R^{\text{E}}}^1 \frac{(5+3b)m^2}{16(1+b)} dm - I \\ &= \frac{2\sqrt{\frac{2}{3}}(5+3b)c\sqrt{c-b^2c}}{3(-1+b)^2} + \frac{(5+3b)(9 - \frac{128\sqrt{6}(c-b^2c)^{\frac{3}{2}}}{(1-b)^3})}{432(1+b)} - I \end{aligned} \quad (17)$$

**Lemma 1.** In the reselling model, the manufacturer discloses quality when the platform owner does not encroach, if  $m \geq \hat{m}_R^N = \frac{4\sqrt{6c}}{3}$ . The manufacturer discloses quality when the platform owner engages in encroachment, if  $m \geq \hat{m}_R^E = \frac{4\sqrt{6c}}{3} \times \sqrt{\frac{1+b}{1-b}}$ . Clearly, we have  $\hat{m}_R^E > \hat{m}_R^N$ . (Appendix B)

Lemma 1 identifies the manufacturer's quality disclosure strategy faced with the platform's category encroachment strategy under the reselling model. We derive both threshold quality including  $\hat{m}_R^N$  and  $\hat{m}_R^E$  which are indifference points of the manufacturer' non-disclosure and disclosure. Compared to the case that the platform does not have category encroachment, the incentive for the manufacturer to disclose quality information becomes lower when the platform makes category encroachment, that is,  $\hat{m}_R^E > \hat{m}_R^N$ . This is because category encroachment intensifies the market competition and harms the manufacturer's revenue. To weaken the profit reduction, the manufacturer's motivation to disclose product quality information decreases. In addition, the difference between the two quality thresholds shows a positive correlation with the substitution coefficient  $b$  and the disclosure cost  $c$ . Along with the increase of the substitution coefficient and the disclosure cost, the manufacturer's motivation to disclose is more deeply affected by the platform encroachment.

**Lemma 2.** In the reselling model, the platform owner engages in encroachment only if  $I \leq I_R^* = \frac{1}{24} \left( \frac{2+b}{1+b} \right) + \frac{2}{27} \sqrt{6c}^{\frac{3}{2}} \left( 1 - \frac{(5+3b)\sqrt{1-b^2}}{(1-b)^2} \right)$ . (Appendix B)

Lemma 2 shows that the platform will make category encroachment only if the benefit from the encroachment is greater than the cost to be paid. Here, we obtain the threshold cost of the platform category encroachment under the reselling model, and the platform can adopt the category encroachment only when the cost is lower than this threshold cost. We further find a negative correlation between the threshold and the product substitution coefficient  $b$  and the disclosure cost  $c$ , that is,  $\frac{\partial I_R^*}{\partial b} < 0$ ,  $\frac{\partial I_R^*}{\partial c} < 0$ . When the substitutability coefficient increases, the platform gains less through encroachment. According to Lemma 1, with the higher disclosure cost, the manufacturer's quality disclosure is negatively affected by the encroachment, which also leads to the platform being more cautious in deciding whether to encroach or not.

**Corollary 2.** In the RE model, when  $c \in \left( 0, \frac{27(1-b)}{512(1+b)} \right)$ ,  $\frac{\partial \Pi_m^{\text{RE}}}{\partial c} < 0$ ; when  $c \in \left( \frac{27(1-b)}{512(1+b)}, \frac{3}{32} \right)$ ,  $\frac{\partial \Pi_m^{\text{RE}}}{\partial c} > 0$ ;  $\frac{\partial \Pi_s^{\text{RE}}}{\partial c} < 0$ . (Appendix B)

Similar to the RN model, the platform's ex-ante benefit benefits from higher information transparency. The platform's ex-ante benefit decreases in disclosed cost strictly, and there is a free-rider situation for the platform as well. The relationship between the manufacturer's ex-ante benefits and the disclosure cost also shows a U-shaped relationship. Unlike the RN model, the threshold cost affecting changes in the manufacturers' ex-ante benefit is different  $\left( \frac{27(1-b)}{512(1+b)} \right)$ . In the RE model, the threshold cost is related to the competition intensity generated by the platform category encroachment.

### 4.3 | AN Model

In the AN model, the manufacturer sells the product under the agency model on the platform and the platform does not category encroachment. The manufacturer decides whether to make quality disclosure. The manufacturer's and platform's profit functions are

$$\pi_m = (1-r)(\tilde{m} - q_m)q_m - d_R c \quad (18)$$

$$\pi_s = r(\tilde{m} - q_m)q_m \quad (19)$$

We can derive the optimal wholesale price and sales quantity by backward induction as

$$q_m^{\text{AN}} = \frac{\tilde{m}}{2} \quad (20)$$

The manufacturer's and platform's equilibrium profit functions are

$$\pi_m^{\text{AN}} = \frac{(1-r)\tilde{m}^2}{4} - d_R c \quad (21)$$

$$\pi_s^{\text{AN}} = \frac{r\tilde{m}^2}{4} \quad (22)$$

The threshold quality for the AN model can be obtained as follows: the manufacturer's revenue under non-disclosure is  $\pi_m = \frac{(1-r)\tilde{m}^2}{4} = \frac{(1-r)\hat{m}_A^N}{16}$ , the manufacturer's revenue under disclosure is  $\pi_m = \frac{(1-r)\tilde{m}^2}{4} - c$ , at which point the threshold quality is  $\hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$ . The manufacturer withholds product quality information when  $m < \hat{m}_A^N$  and discloses it otherwise. The proof is presented in the Appendix A.3. Therefore, the manufacturer's and platform's ex-ante profits are

$$\begin{aligned} \Pi_m^{\text{AN}} &= \int_0^{\hat{m}_A^N} (1-r) \frac{(\hat{m}_A^N)^2}{16} dm + \int_{\hat{m}_A^N}^1 \left( (1-r) \frac{m^2}{4} - c \right) dm \\ &= \frac{1-r}{12} + c \left( -1 + \frac{32c}{9\sqrt{3}\sqrt{c-cr}} \right) \end{aligned} \quad (23)$$

$$\begin{aligned} \Pi_s^{\text{AN}} &= \int_0^{\hat{m}_A^N} \frac{r(\hat{m}_A^N)^2}{16} dm + \int_{\hat{m}_A^N}^1 \frac{rm^2}{4} dm \\ &= \frac{r(9+9(-2+r)r-16\sqrt{3}c\sqrt{c-cr})}{108(-1+r)^2} \end{aligned} \quad (24)$$

**Corollary 3.** In the AN model, when  $r \in (0, \frac{1}{9})$ ,  $\frac{\partial \Pi_m^{\text{AN}}}{\partial c} < 0$ ; when  $r \in (\frac{1}{9}, 1)$  and  $c \in \left( 0, \frac{27(1-r)}{512} \right)$ ,  $\frac{\partial \Pi_m^{\text{AN}}}{\partial c} < 0$ ; when  $r \in (\frac{1}{9}, 1)$  and  $c \in \left( \frac{27(1-r)}{512}, \frac{3}{32} \right)$ ,  $\frac{\partial \Pi_m^{\text{AN}}}{\partial c} > 0$ ;  $\frac{\partial \Pi_s^{\text{AN}}}{\partial c} < 0$ . (Appendix B)

Under the AN model, there exists a clear negative correlation between the platform's ex-ante benefit and the disclosure cost. Increased transparency in quality information leads to higher platform benefits, akin to the scenario in the RN model where the platform benefits from the free-rider effect. The relationship between the manufacturer's ex-ante benefit and the disclosure cost is affected by the commission ratio. When the commission ratio is low, the relationship between the manufacturer's ex-ante benefit and the disclosure cost is negative. When the commission ratio is high, the relationship is U-shaped. That is, at lower commission ratio, the manufacturer benefits more from higher quality information transparency, whereas the low quality information transparency may be more favorable to the manufacturer when the manufacturer faces higher agency fees. Since the manufacturer is more likely to choose to hide quality information to reduce costs under higher commission ratios and higher disclosure costs.

#### 4.4 | AE Model

In the AE model, the manufacturer sells the product under agency model on the platform and the platform makes category encroachment. The manufacturer decides whether to make quality disclosure. The manufacturer's and platform's profit functions are

$$\begin{aligned} \Pi_s^{\text{AE}} &= \int_0^{\hat{m}_A^E} \frac{(\hat{m}_A^E)^2(16(1+r) - 16b(1+r) + b^4(1+r)^2 + 4b^3(1+4r+3r^2) - 4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} dm \\ &\quad + \int_{\hat{m}_A^E}^1 \frac{m^2(16(1+r) - 16b(1+r) + b^4(1+r)^2 + 4b^3(1+4r+3r^2) - 4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} dm - I \\ &= (-16(1+r) + b(16(1+r) + b(4 - b^2(1+r)^2 - 4b(1+r)(1+3r) + 4r(5+3r))) \\ &\quad \times (-9((2-b)(1-r))^3 + 32\sqrt{6}(c(-1+r)(-2+b^2(1+r)))^{\frac{3}{2}}) \times C(b, r) - I, \end{aligned} \quad (32)$$

$$\pi_m = (1-r)(\tilde{m} - q_m - bq_s)q_m - d_R c \quad (25)$$

$$\pi_s = r(\tilde{m} - q_m - bq_s)q_m + (\tilde{m} - q_s - bq_m)q_s - I \quad (26)$$

We can derive the optimal wholesale price and sales quantity by backward induction as

$$q_m^{\text{AE}} = \frac{(b-2)\tilde{m}}{-4+2b^2(1+r)} \quad (27)$$

$$q_s^{\text{AE}} = \frac{(-4+2b(1+r)+b^2(1+r))\tilde{m}}{-8+4b^2(1+r)} \quad (28)$$

The manufacturer's and platform's equilibrium profit functions are

$$\pi_m^{\text{AE}} = \frac{(-2+b)^2\tilde{m}^2(-1+r)}{8(-2+b^2(1+r))} - d_R c \quad (29)$$

$$\pi_s^{\text{AE}} = \frac{\tilde{m}^2(16(1+r) - 16b(1+r) + b^4(1+r)^2 + 4b^3(1+4r+3r^2) - 4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} - I. \quad (30)$$

The threshold quality for the AE model can be obtained as follows: the manufacturer's revenue under non-disclosure is

$\pi_m = \frac{(-2+b)^2\tilde{m}^2(-1+r)}{8(-2+b^2(1+r))} = \frac{(-2+b)^2\hat{m}_A^E(-1+r)}{32(-2+b^2(1+r))}$ , the manufacturer's revenue under disclosure is  $\pi_m = \frac{(-2+b)^2\hat{m}_A^E(-1+r)}{8(-2+b^2(1+r))} - c$ , at which point the threshold quality is  $\hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r))(1-r)}}{3(2-b)(1-r)}$ . The manufacturer withholds product quality information when  $m < \hat{m}_A^E$  and discloses it otherwise. The proof is presented in the Appendix A.4. Therefore, the manufacturer's and platform's ex-ante profits are

$$\begin{aligned} \Pi_m^{\text{AE}} &= \int_0^{\hat{m}_A^E} \frac{(-2+b)^2(\hat{m}_A^E)^2(r-1)}{32(-2+b^2(1+r))} dm \\ &\quad + \int_{\hat{m}_A^E}^1 \left( \frac{(-2+b)^2m^2(r-1)}{8(-2+b^2(1+r))} - c \right) dm \\ &= \frac{1}{216} \left( \frac{9(-2+b)^2(-1+r)}{-2+b^2(1+r)} \right. \\ &\quad \left. + 8c \left( -27 + \frac{32\sqrt{6}\sqrt{c(-1+r)(-2+b^2(1+r))}}{(-2+b)(-1+r)} \right) \right) \end{aligned} \quad (31)$$

where function  $C(b, r) = (432(-2+b^2(1+r))^2((2-b)(1-r))^3)^{-1}$ .

**Lemma 3.** In the agency selling model, the manufacturer discloses quality information when the platform owner does not encroach, if  $m \geq \hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$ ; the manufacturer discloses quality information when the platform owner engages in encroachment, if  $m \geq \hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r))(1-r)}}{3(2-b)}$ . Here, when  $3+2r < \frac{4}{b}$ ,  $\hat{m}_A^N < \hat{m}_A^E$ ; otherwise,  $\hat{m}_A^N \geq \hat{m}_A^E$ . (Appendix B)

These two quality thresholds ( $\hat{m}_A^N$  and  $\hat{m}_A^E$ ) are threshold qualities (indifference points) of the manufacturer's non-disclosure and disclosure in the agency selling model. This is roughly the same as under reselling, where the difference between the two quality thresholds is related to the substitution coefficient  $b$  and the sharing ratio  $r$ . However, the magnitude of two quality thresholds is different under different conditions. When the agency fee is high and the product's competitive intensity is low ( $3+2r \geq \frac{4}{b}$ ), the

manufacturer has a stronger incentive to disclose quality information when the platform makes encroachment. This is because

the product's competitive intensity is low, and the manufacturer can disclose the quality to attract more consumers and secure its revenue. When the agency fee is low and the product competitive intensity is high ( $3 + 2r < \frac{4}{b}$ ), the manufacturer has a stronger incentive to disclose quality information when the platform do not category encroachment. When the platform category encroachment is underway, there is high product competition in the market, there is quality information free-riding by the platform, and the manufacturer's profit is threatened. Therefore, the manufacturer has weaker incentives to disclose quality information when the platform encroaches.

**Lemma 4.** *The manufacturer's quality disclosure strategy is compared between the reselling and agency selling models. When the platform owner does not encroach, if  $r \geq \frac{1}{2}$ , then  $\hat{m}_A^N \geq \hat{m}_R^N$ ; otherwise,  $\hat{m}_A^N < \hat{m}_R^N$ . When the platform owner engages in encroachment, if  $r \geq \frac{2(1+b-b^2)}{4+2b^2+b^3}$ , then  $\hat{m}_A^E \geq \hat{m}_R^E$ ; otherwise,  $\hat{m}_A^E < \hat{m}_R^E$ . (Appendix B)*

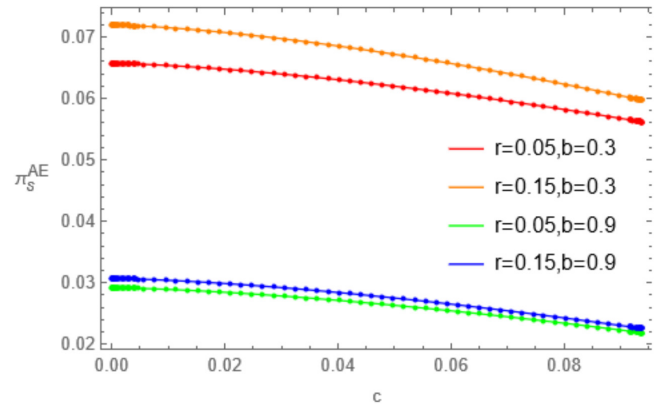
Lemma 4 shows the manufacturer's quality disclosure strategy under both reselling and agency selling models. We can obtain that the threshold quality under reselling and agency selling is related to the sharing ratio  $r$ . When the platform owner does not encroach, the manufacturer has a stronger incentive to disclose under the reselling model when  $r \geq \frac{1}{2}$ . This is because the larger  $r$  is, the less the manufacturer receives the shared benefit, which weakens its disclosure. When the platform owner makes encroachment, the manufacturer is also more likely to disclose quality in the reselling model when  $r \geq \frac{2(1+b-b^2)}{4+2b^2+b^3}$ . The threshold here is related to the product substitution coefficient, and the higher the product substitution coefficient, the smaller the threshold is.

**Lemma 5.** *In the agency selling model, the platform owner engages in encroachment only if  $I \leq I_A^* = -\frac{r(9+9(-2+r)r-16\sqrt{3c}\sqrt{c-cr})}{108(-1+r)^2} + (-16(1+r)+b(16(1+r)+b(4-b^2(1+r)^2-4b(1+r)(1+3r)+4r(5+3r))) \times (-9((2-b)(1-r)^3)+32\sqrt{6}(c(-1+r)(-2+b^2(1+r)))^{\frac{3}{2}}) \times C(b, r)$ . (Appendix B)*

Lemma 5 demonstrates the threshold cost for the platform category encroachment, which illustrates that the platform can only be profitable if the encroachment cost is lower than this threshold. Through observation and calculation, we also find that there is a complex connection between the threshold cost and the revenue sharing ratio, product substitution coefficient, and disclosure cost under the agency sales model.

**Corollary 4.** *In the AE model, when  $-1 + \frac{4\sqrt{(r-1)(-2+b^2(r+1))}}{3(b-2)(r-1)} < 0$ ,  $\frac{\partial \Pi_m^{AE}}{\partial c} < 0$ ; when  $-1 + \frac{4\sqrt{(r-1)(-2+b^2(r+1))}}{3(b-2)(r-1)} > 0$  and  $c \in (0, \frac{27(-4+b(4-b)+4r(1-b)-b^2r)}{512(-2+b^2(r+1))})$ ,  $\frac{\partial \Pi_m^{AE}}{\partial c} < 0$ ; when  $-1 + \frac{4\sqrt{(r-1)(-2+b^2(r+1))}}{3(b-2)(r-1)} > 0$  and  $c \in (\frac{27(-4+b(4-b)+4r(1-b)-b^2r)}{512(-2+b^2(r+1))}, \frac{3}{32})$ ,  $\frac{\partial \Pi_m^{AE}}{\partial c} > 0$ . (Appendix B)*

Similar to the AN model, the trend of the manufacturer's ex-ante revenue accompanied by disclosure cost includes two cases.



**FIGURE 2** | The relationship between ex-ante benefits and costs of platform.

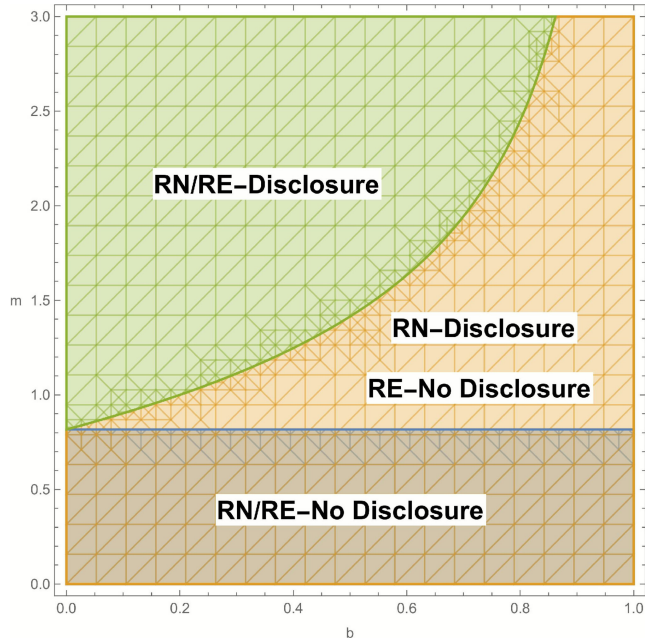
One is that when the condition  $-1 + \frac{4\sqrt{(r-1)(-2+b^2(r+1))}}{3(b-2)(r-1)} < 0$  is satisfied, the manufacturer's ex-ante revenue is negatively correlated with the disclosure cost, and the other is that when the condition  $-1 + \frac{4\sqrt{(r-1)(-2+b^2(r+1))}}{3(b-2)(r-1)} > 0$  is satisfied, there is a U-shape relationship between the manufacturer's ex-ante revenue and the disclosure cost, and the manufacturer's revenue change is more complicated. As for the platform, it is not possible to get the relationship between the platform's ex-ante benefit and disclosure cost through mathematical analysis, here we adopt the arithmetic analysis, as shown in Figure 2. We set four cases including low commission rate-low competitive intensity ( $r = 0.05, b = 0.3$ ), high commission rate-low competitive intensity ( $r = 0.15, b = 0.3$ ), low commission rate-high competitive intensity ( $r = 0.05, b = 0.9$ ), and high commission rate-high competitive intensity ( $r = 0.15, b = 0.9$ ). It can be seen from Figure 2 that the platform always benefits from higher information transparency. There is a negative correlation between the platform's ex-ante benefits and disclosure costs.

## 5 | The Impact of Category Encroachment

This article focuses on exploring changes that the platform's category encroachment will bring to various stakeholders in terms of decision-making and benefits when the manufacturer is responsible for quality information disclosure. Therefore, it is necessary to compare the profits of the manufacturer and the platform before and after platform encroachment. Platforms have an information advantage, so the encroachment cost is low for most platforms. Therefore, this section discusses the scenario that  $I \leq I^*$ . Here, we explore distinct response strategies adopted by both the platform and the manufacturer across varying quality levels, analyze the ex-post benefits associated with each strategy, and investigate the influence of platform category encroachment through a comprehensive arithmetic analysis.

(1) In the reselling model, the manufacturer's disclosure strategy is structured as depicted in Figure 3, irrespective of whether the platform owner engages in encroachment or

not (assuming  $c = \frac{1}{16}$ ). When the level of quality information is low ( $m < \hat{m}_R^N$ ), the manufacturer will not disclose quality information whether or not the platform owner makes

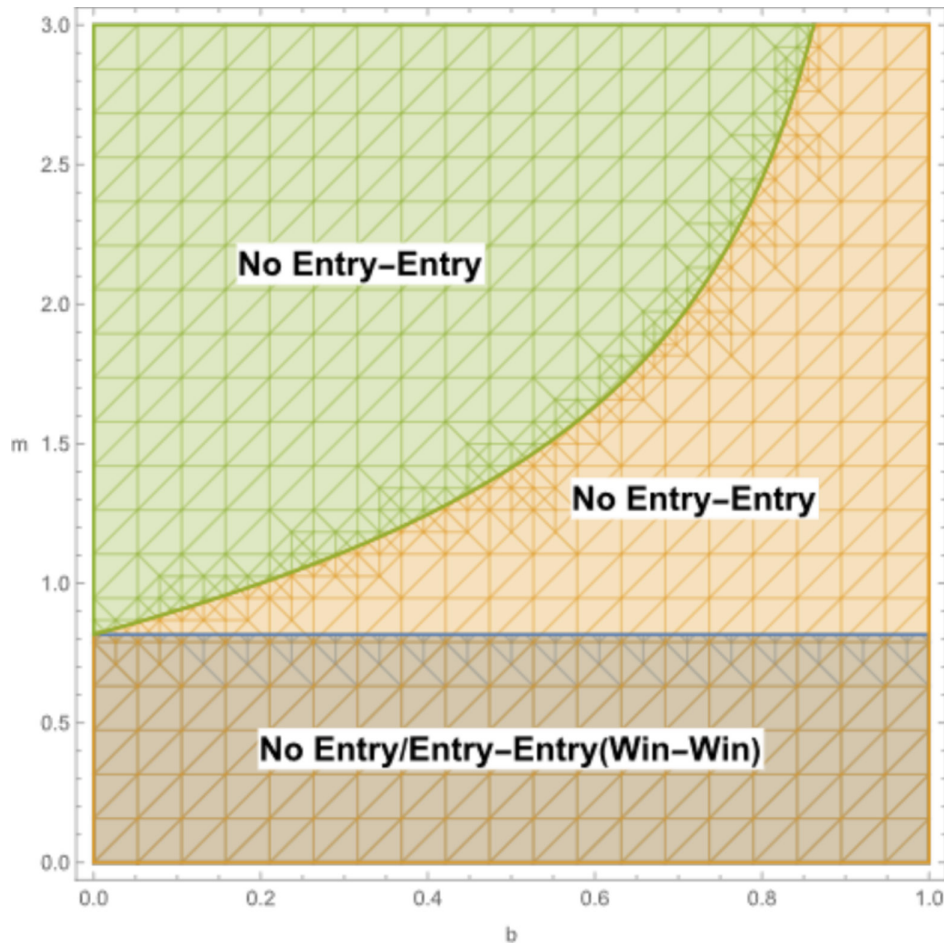


**FIGURE 3** | Integration map of the manufacturer's disclosure strategy.

category encroachment, at which time the platform owner's category encroachment will have no effect on the manufacturer ( $\pi_m^{RE} = \pi_m^{RN}$ ), while the platform is the more inclined to make encroachment ( $\pi_s^{RE} > \pi_s^{RN}$ ). When the level of quality information is intermediate ( $\hat{m}_R^N \leq m \leq \hat{m}_R^E$ ), the manufacturer will disclose quality information when the platform does not encroach and choose to hide the information when the platform makes encroachment. The manufacturer is more benefited when the platform does not encroach ( $\pi_m^{RE} < \pi_m^{RN}$ ), while the platform is more benefited when the platform makes encroachment ( $\pi_s^{RE} > \pi_s^{RN}$ ). When the level of quality information is at a high level ( $m > \hat{m}_R^E$ ), the manufacturer discloses quality information whether or not the platform owner makes category encroachment. The manufacturer benefits more when the platform does not encroach than when it makes encroachment ( $\pi_m^{RE} < \pi_m^{RN}$ ), while the platform benefits more when it makes category encroachment ( $\pi_s^{RE} > \pi_s^{RN}$ ). Figure 4 summarises the encroachment strategy preferences of the manufacturer and the platform.

**Theorem 1.** *In the reselling model,*

- The manufacturer is indifferent to the platform owner's encroachment only when the quality information is at a low level, and in other cases, the manufacturer is the one who benefits more from the platform owner's not encroaching.
- The platform is always the one who prefers the encroachment.



**FIGURE 4** | Manufacturer-platform preferred entry mode.

Therefore, when the cost of encroachment is below the threshold cost of encroachment, platform encroachment can be a win-win situation for both the manufacturer and the platform when the quality of information is at a low level. (Appendix B)

(2) In the agency selling model, the relationship between  $3 + 2r \geq \frac{b}{4}$  and  $\frac{b}{4}$  has an impact on the strategies of the manufacturer and the platform at different quality levels. We organize the disclosure strategy choices of the manufacturer in the case of  $3 + 2r \geq \frac{b}{4}$  and  $3 + 2r < \frac{b}{4}$ , as shown in Figure 5a and Figure 5b. In reality, the commission rate of most platforms is around 10%, for example, the commission rate of most products on the Amazon platform is between 8% and 15%, and the technical service fee and platform usage fee of products on the JD platform are between 2% and 11%. Due to the many factors involved in the agency selling model, the situation is more complex. Therefore, in this part, we start the discussion

with the case of  $r = 0.1$ , and the condition of  $3 + 2r < \frac{b}{4}$  is satisfied. When the level of quality information is low ( $m < \hat{m}_A^N$ ), the manufacturer will not disclose the quality information whether or not the platform owner makes category encroachment. The platform category encroachment will not affect the manufacturer's revenue ( $\pi_m^{AE} = \pi_m^{AN}$ ). There exists an investment threshold  $I_1$ , at  $I_1$ , the platform is indifferent to the encroachment. The platform prefers encroachment if  $0 < I < I_1$  ( $\pi_s^{AE} > \pi_s^{AN}$ ), and the platform prefers not encroachment otherwise if  $I_1 < I < I_A^*$ , the manufacturer-platform preferred entry mode under a low-quality level as shown in Figure 6a. When the quality information is at an intermediate level ( $\hat{m}_A^N \leq m \leq \hat{m}_A^E$ ), the manufacturer will disclose the quality information when the platform does not encroachment and hide the quality information when the platform makes encroachment. The manufacturer benefits more from the situation where the platform does not encroach ( $\pi_m^{AE} < \pi_m^{AN}$ ). The

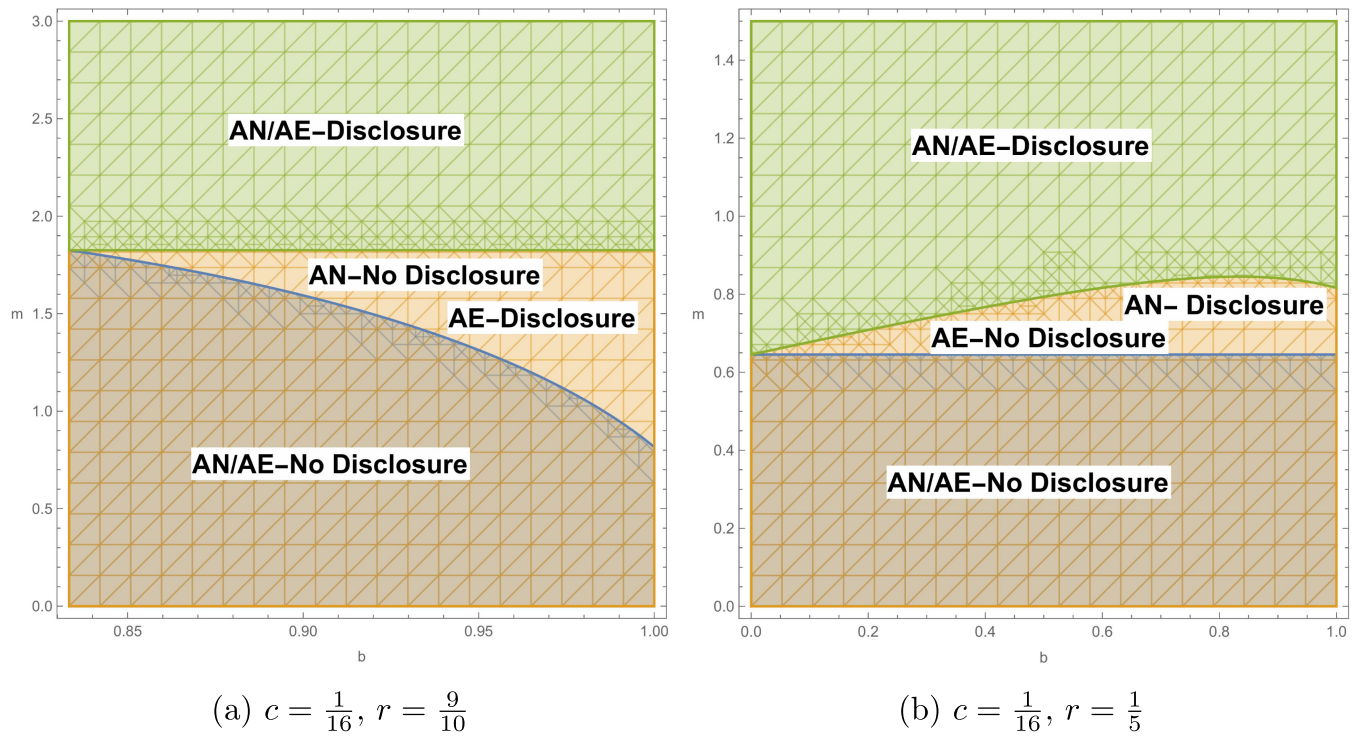


FIGURE 5 | Integration map of the manufacturer's disclosure strategy.

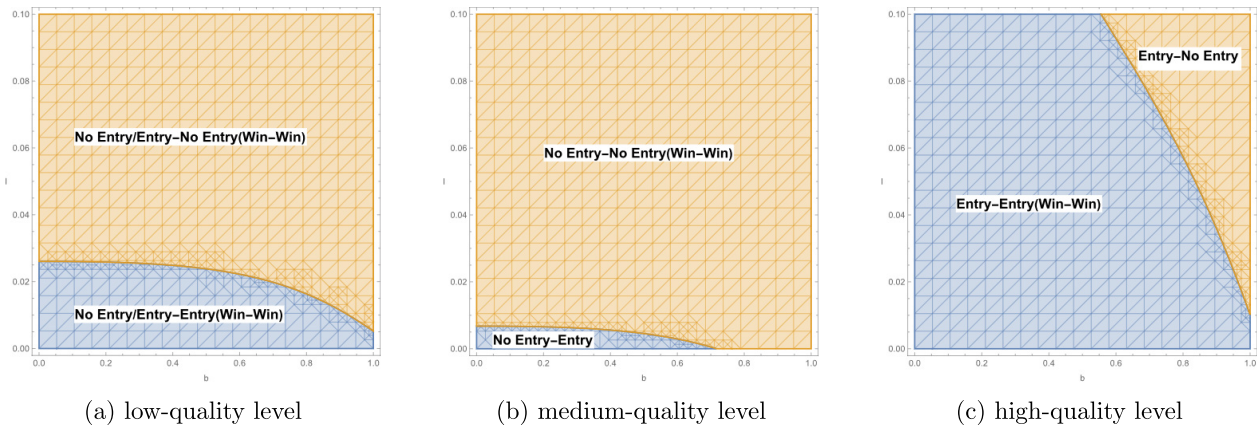


FIGURE 6 | Manufacturer-platform preferred entry mode under different quality levels.

platform's preference for the encroachment has a complex relationship with the encroachment cost, the product's competitive intensity, and other parameters, and it is not possible to summarize the regular preference. We use the arithmetic example analysis to explore the platform encroachment strategy in a particular environment, the manufacturer-platform preferred entry mode under a medium-quality level as shown in Figure 6b. When the product quality information is at a high level ( $m > \hat{m}_A^E$ ), the manufacturer will disclose product quality information both when the platform does not encroach and when it makes encroachment, in which case the manufacturer gains more in the case of platform encroachment ( $\pi_m^{AE} > \pi_m^{AN}$ ), and the platform's preference is also impossible to judge, and it is necessary to take into account a variety of factors such as encroachment cost, product competition intensity and information disclosure cost. Similar to the case of medium-product quality information, we also use arithmetic analysis in a particular context, the manufacturer-platform preferred entry mode under a high-quality level as shown in Figure 6c.

**Theorem 2.** *In the agency selling model,*

- In most cases, only when the level of quality information is low or high, the manufacturer's revenue is not compromised by the platform owner's encroachment.
- The platform can't always benefit from encroachment strategies either.

Moreover, along with rising product quality, the area in which the manufacturer and the platform can reach a win-win situation will decrease gradually. (Appendix B)

## 6 | Extension

In the previous study, we have discussed the interaction between the manufacturer's quality disclosure strategy and the platform's category encroachment strategy in both reselling and agency selling models. After investigating the sales models of JD.com and Tmall.com, we have sorted out the sales models of some brands on the two e-commerce platforms from the two categories including smart devices and cosmetics, as shown in Table 4. According to Table 4, we find that there are cases where the reselling model and the agency selling model co-occur on the same platform. Therefore, we extend the model to

a hybrid model (S), where the manufacturer sells products on the platform through both the reselling model and the agency selling model.

To facilitate the observation of the impact of platform category encroachment, this paper does not consider competition in the reselling and agency selling channels. Assume that product sales in the reselling channel are  $q_{m1}$  and product sales in the agency selling channel are  $q_{m2}$ . When the platform does not category encroachment, there exists a product in the market, in which case the manufacturer's profit is  $\pi_m = wq_{m1} + (1-r)(\tilde{m} - q_{m2})q_{m2} - d_Rc$ , the platform's profit is  $\pi_s = (\tilde{m} - q_{m1} - w)q_{m1} + r(\tilde{m} - q_{m2})q_{m2}$ . When the platform makes category encroachment, there are two products in the market. In this case, the manufacturer's profit function is  $\pi_m = wq_{m1} + (1-r)(\tilde{m} - q_{m2} - bq_s)q_{m2} - d_Rc$ , the platform's profit function is  $\pi_s = (\tilde{m} - q_{m1} - bq_s - w)q_{m1} + r(\tilde{m} - q_{m2} - bq_s)q_{m2} + (\tilde{m} - q_s - b(q_{m1} + q_{m2}))q_s - I$ . The equilibrium solution is organized in Table 5, and the proof is presented in the Appendix A.5 and A.6.

**Lemma 6.** *In the hybrid selling model, the manufacturer discloses quality information when the platform owner does not encroach, if  $m \geq \hat{m}_S^N = \sqrt{\frac{32c}{9-6r}}$ . The manufacturer discloses quality information when the platform owner engages in encroachment, if  $m \geq \hat{m}_S^E = \frac{4\sqrt{2c(16+8b^2(3+r)-b^4(3+8r+r^2))}}{\sqrt{3(48+32b(-2+r)-32r-16b^3r+16b^2(1+r)+b^4(1+r)^2)}}$  (Appendix B)*

According to Lemma 6, we can obtain the threshold quality before and after platform encroachment, and we compare the magnitude of the two threshold qualities. The results are depicted in Figure 7. We can find that in most situations the threshold disclosed quality is lower when the platform does not encroach, which suggests that the manufacturer has a stronger incentive to disclose quality information at the time. Without the free-rider effect of platform category encroachment, the manufacturer is more willing to disclose product quality.

Based on the study in Section 5, this section continues the discussion with  $r = 0.1$ , when  $\hat{m}_S^E > \hat{m}_S^N$  is satisfied. In the hybrid model, the integration of the manufacturer's disclosure strategy when facing platform encroachment is shown in Figure 8. By comparing the revenue of the manufacturer and the platform before and after the

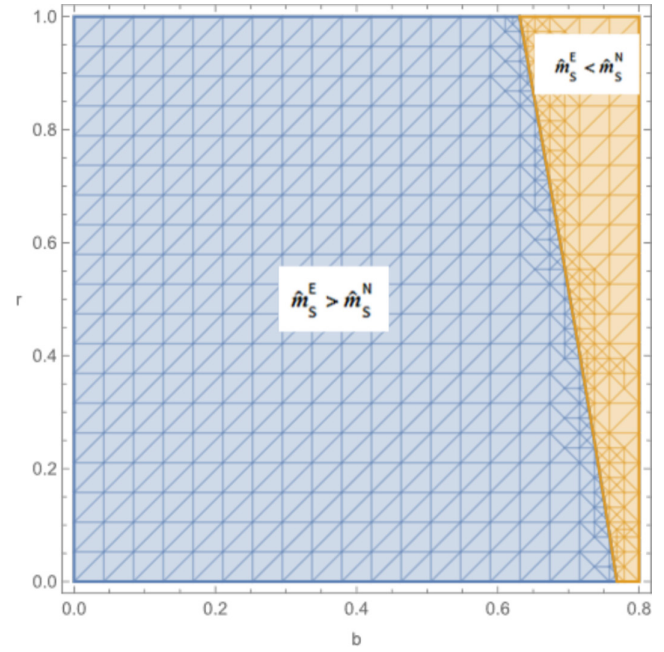
**TABLE 4** | Selling models of partial categories.

| Category     | Company       | JD.com                   | Tmall.com                |
|--------------|---------------|--------------------------|--------------------------|
| Smart device | XIAOMI        | Reselling/agency selling | Agency selling           |
|              | HUAWEI        | Reselling                | Agency selling           |
|              | DELL          | Reselling/agency selling | Agency selling           |
|              | APPLE         | Reselling                | Agency selling           |
|              | HP            | Reselling/agency selling | Agency selling           |
| Skincare     | ESTÄ'E LAUDER | Reselling                | Reselling/agency selling |
|              | CHANDO        | Reselling/agency selling | Reselling/agency selling |
|              | CLINIQUE      | Reselling                | Reselling/agency selling |

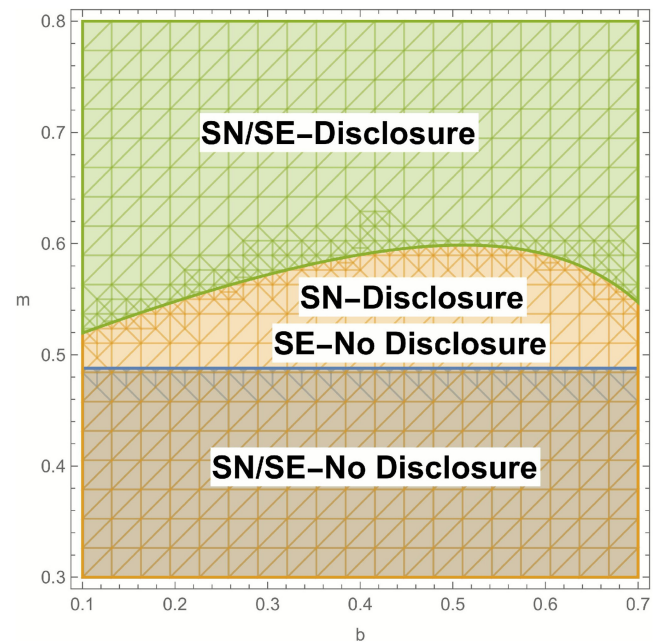
**TABLE 5** | Equilibrium solutions ( $D(b, r) = (16 - 8b^2(3+r) + b^4(3+8r+r^2))^{-1}$ ).

| Quantity | Model                          |                                                                                                                                                                                                                                                        |
|----------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | SN                             | SE                                                                                                                                                                                                                                                     |
| $w$      | $\frac{\tilde{m}}{2}$          | $(8 - 8b - 4b^2(3-r) + 12b^3 - 0.5b^4(1+10r+r^2)) \times D(b, r) \times \tilde{m}$                                                                                                                                                                     |
| $q_{m1}$ | $\frac{\tilde{m}}{4}$          | $(4 - 4b + 2b^2(1-r) + 2b^3r - 0.25b^4(1+r)^2) \times D(b, r) \times \tilde{m}$                                                                                                                                                                        |
| $q_{m2}$ | $\frac{\tilde{m}}{2}$          | $(8 - 4b - 2b^2(4+r) + 0.5b^4(1+r) + b^3(3+r)) \times D(b, r) \times \tilde{m}$                                                                                                                                                                        |
| $q_s$    | —                              | $(8 - 4b(2+r) - 2b^2(3+r) + b^3(2+7r+r^2)) \times D(b, r) \times \tilde{m}$                                                                                                                                                                            |
| $\pi_m$  | $\frac{\tilde{m}^2(3-2r)}{8}$  | $-dc + (6 - 4r - 4b(2-r) + 2b^2(1+r) - 2b^3r + 0.125b^4(1+r)^2) \times D(b, r) \times \tilde{m}^2$                                                                                                                                                     |
| $\pi_s$  | $\frac{\tilde{m}^2(1+4r)}{16}$ | $-I + (80 + 64r - 32b(3+2r) - 16b^2(8+14r+3r^2) + 16b^3(10+15r+3r^2) + 2b^4(19+82r+55r^2+6r^3) - 6b^5(11+32r+19r^2+2r^3) + b^6(15-4r-48r^2-14r^3-r^4) + b^7(3+20r+54r^2+14r^3+r^4) - 0.0625b^8(15+64r+50r^2-r^4)) \times D^2(b, r) \times \tilde{m}^2$ |

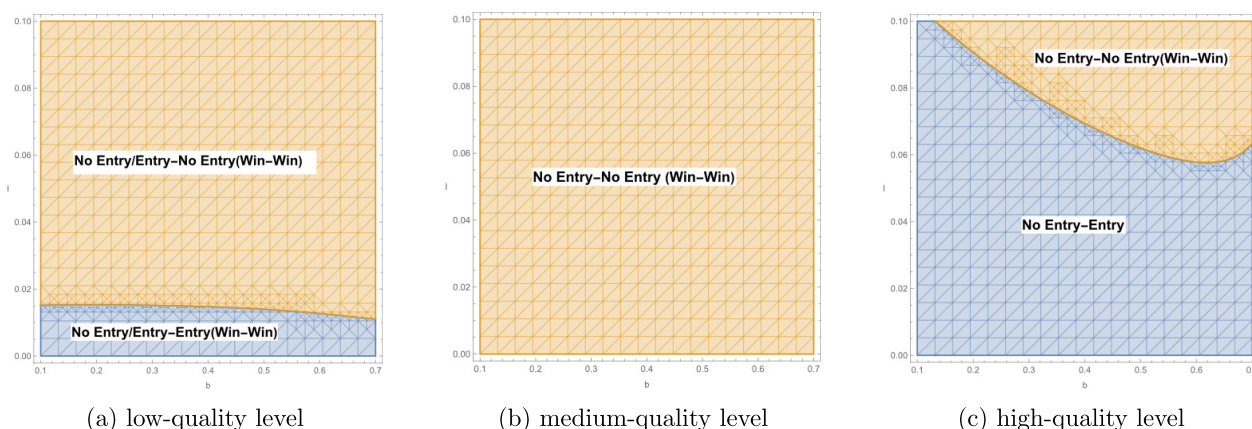
encroachment, we can get: (1) When product quality is at a lower level, the manufacturer's revenue is unchanged before and after platform encroachment ( $\pi_m^{SE} = \pi_m^{SN}$ ). The platform has different preferences for encroachment strategies for different substitution coefficients and encroachment costs, and Figure 9a illustrates the manufacturer-platform preference for the encroachment model at a low-product quality level. (2) When the product quality is at an intermediate level, both the manufacturer and the platform are more profitable when the platform does not encroach. Therefore, the manufacturer and the platform can reach a win-win situation when the platform does not encroach. Figure 9b illustrates the



**FIGURE 7** | Comparison of manufacturer's threshold disclosure quality before and after platform encroachment in the hybrid model.



**FIGURE 8** | Integration of manufacturer disclosure strategies.



**FIGURE 9** | Manufacturer-platform encroachment model preferences under different quality levels.

manufacturer-platform preference for the encroachment model at a mediate-quality level. (3) When product quality is at a high level, the manufacturer's payoff is higher when there is no encroachment, while the platform's payoff is the same as in the case of (1), and Figure 9c illustrates the manufacturer-platform preference for the encroachment model at a high-quality level.

**Theorem 3.** *In the hybrid selling model,*

- *The manufacturer's revenue is not damaged by the platform's encroachment only if the product quality is at a low level.*
- *Category encroachment is not always beneficial to the platform. Platform revenue is affected by many factors such as the substitutability of the encroaching product and the encroachment investment.*

*It is worth noting that the conditions under which the manufacturer and the platform can reach a win-win situation are becoming more and more stringent as the level of product quality increases. (Appendix B)*

## 7 | Conclusions and Managerial Insights

The ubiquitous phenomenon of category encroachment by e-commerce platform owners serves as a focal point for this paper. This paper discusses the impact of platform category encroachment on the manufacturer's and platform's decision-making in the reselling and agency selling models. In the extended section, we explore the strategic interactions between the manufacturer and the platform in the hybrid selling model.

1. In the reselling model, platform category encroachment diminishes manufacturers' motivation to disclose quality information, correlating positively with substitution coefficient and disclosure costs. In the agency selling model, disclosure motivation is intricately tied to the commission rate. In the hybrid selling model, manufacturer's incentive for quality disclosure is stronger when the platform refrains from encroachment.
2. Platform encroachment leads to platform free-riding, where increased information transparency consistently benefits the platform, while the impact on the manufacturer's

revenue remains uncertain. In the reselling model, the relationship between the manufacturer's revenue and disclosure costs follows a U-shaped pattern. In the agency model, the commission rate becomes a significant factor, with low rates favoring higher information transparency for the manufacturer, and high rates exhibiting a U-shaped relationship between manufacturer benefit and disclosure costs.

3. In the reselling model, a win-win situation between the manufacturer and the platform, post-category encroachment, occurs only when the product quality is low. In the agency-selling model, the manufacturer is not adversely affected by platform encroachment when the quality is either low or high. However, as product quality improves, the scope for a win-win situation gradually diminishes. Within the hybrid selling model, manufacturers can accommodate low-quality category encroachment by the platform. Nevertheless, as product quality increases, the potential area for a win-win situation between manufacturers and platforms gradually contracts.

This study yields several managerial insights for both platform operators and upstream manufacturers in the context of category encroachment and quality information disclosure.

First, platforms should recognize that medium-quality product categories are often not ideal targets for category encroachment. These categories are typically characterized by ambiguous consumer preferences and moderate quality sensitivity, making it harder for platform-owned brands to establish a compelling value proposition. Instead, low-quality categories (e.g., daily-use consumables) allow platforms to leverage cost-efficiency, catering to price-sensitive consumers who prioritize affordability over brand or perceived quality. High-quality categories, on the other hand, may also be viable under agency selling, particularly when platforms aim to build premium private-label brands to strengthen their reputation and brand equity.

Second, platform encroachment can lead to asymmetric disclosure incentives. In many cases, manufacturers face reduced incentives to disclose product quality when the platform itself participates in the same category and benefits from free-riding on the disclosed information. However, when the platform

refrains from entering the product category, the disclosure incentive for manufacturers is restored, allowing them to better differentiate their offerings and communicate product value to consumers.

Third, manufacturers must carefully strategize their disclosure decisions by considering factors such as: platform entry strategy (whether or not the platform introduces private-label competition), contractual form (reselling vs. agency selling), agency fee levels and disclosure costs. Understanding these dimensions allows manufacturers to better anticipate the platform's behavior and tailor their disclosure policies to preserve competitiveness.

Overall, the interplay between platform category strategies and manufacturer information policies suggests that coordination mechanisms, such as disclosure cost-sharing or quality verification schemes, may help mitigate the distortions caused by platform entry and preserve ecosystem efficiency.

This paper examines the issue of real disclosure of product quality information by the manufacturer. However, in reality, manufacturers might engage in fake quality disclosure practices, posing challenges to platform quality control management. Therefore, future research could explore the impact of platform owners' category encroachment when manufacturers involve fake quality disclosure and strategies for combating fake quality disclosure to achieve effective product quality management on platforms.

#### Author Contributions

**Jiao Zhang:** conceptualization, methodology, model analysis, visualization, writing – original Draft. **Tianjian Yang:** conceptualization, resources, supervision, writing – review. **Yu Zhang:** supervision, writing – editing.

#### Funding

The authors have nothing to report.

#### Conflicts of Interest

The authors declare no conflicts of interest.

#### Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

#### Endnotes

<sup>1</sup> <https://www.stats.gov.cn/english/Statisticaldata/yearbook/>.

<sup>2</sup> <https://www.statista.com/statistics/1011703/china-revenue-share-of-self-operated-business-of-jd/>.

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## Appendix A

### Basic Quantities of Different Models

#### A.1 | RN Model

In the RN model, the manufacturer's profit function is given by  $\pi_m = wq_m - d_R c$ , and the platform's profit function is given by  $\pi_s = (\tilde{m} - q_m - w)q_m$ . The optimal quantity  $q_m$  depend on the given wholesale price  $w$ , which can be expressed as  $q_m(w) = \frac{m-w}{2}$ . Then, the manufacturer determines the wholesale price to maximize its profits. By plugging  $q_m(w)$  into  $\pi_m$ , we have optimal wholesale price  $w = \frac{m}{2}$ . By substituting  $w$  into  $q_m(w)$  and both firm's profit functions, we obtain  $q_m = \frac{\tilde{m}}{4}$ ,  $\pi_m = \frac{\tilde{m}^2}{8} - d_R c$ , and  $\pi_s = \frac{\tilde{m}^2}{16}$ .

By solving equation  $\frac{\tilde{m}^2}{32} = \frac{\tilde{m}^2}{8} - c$  directly, we obtain  $\hat{m}_R^N = \frac{4\sqrt{6c}}{3}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_R^N$  and disclose it otherwise.

#### A.2 | RE Model

In the RE model, we have

$$\begin{aligned}\pi_m &= wq_m - d_R c \\ \pi_s &= (\tilde{m} - q_m - bq_s - w)q_m + (\tilde{m} - q_s - bq_m)q_s - I.\end{aligned}$$

Similar to the RN model, we obtain  $w = \frac{(1-b)\tilde{m}}{2}$ ,  $q_m = \frac{\tilde{m}}{4(1+b)}$ ,  $q_s = \frac{(2+b)\tilde{m}}{4(1+b)}$ ,  $\pi_m = \frac{(1-b)\tilde{m}^2}{8(1+b)} - d_R c$ , and  $\pi_s = \frac{(5+3b)\tilde{m}^2}{16(1+b)} - I$ . By solving equation  $\frac{(1-b)\tilde{m}^2}{32(1+b)} = \frac{(1-b)\tilde{m}^2}{8(1+b)} - c$  directly, we obtain  $\hat{m}_R^E = \sqrt{\frac{32(1+b)}{3(1-b)}}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_R^E$  and disclose it otherwise.

#### A.3 | AN Model

In the AN model, we have

$$\begin{aligned}\pi_m &= (1-r)(\tilde{m} - q_m)q_m - d_R c \\ \pi_s &= r(\tilde{m} - q_m)q_m\end{aligned}$$

Similar to the RN model, we obtain  $q_m = \frac{\tilde{m}}{2}$ ,  $\pi_m = \frac{(1-r)\tilde{m}^2}{4} - d_R c$ , and  $\pi_s = \frac{r\tilde{m}^2}{4}$ . By solving equation  $\frac{(1-r)\tilde{m}^2}{16} = \frac{(1-r)\tilde{m}^2}{4} - c$  directly, we obtain  $\hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_A^N$  and disclose it otherwise.

#### A.4 | AE Model

In the AE model, we have

$$\begin{aligned}\pi_m &= (1-r)(\tilde{m} - q_m - bq_s)q_m - d_R c \\ \pi_s &= r(\tilde{m} - q_m - bq_s)q_m + (\tilde{m} - q_s - bq_m)q_s - I\end{aligned}$$

Similar to the RN model, we obtain

$$\begin{aligned}q_m &= \frac{(b-2)\tilde{m}}{-4+2b^2(1+r)} \\ q_s &= \frac{(-4+2b(1+r)+b^2(1+r))\tilde{m}}{-8+4b^2(1+r)} \\ \pi_m &= \frac{(-2+b)^2\tilde{m}^2(-1+r)}{8(-2+b^2(1+r))} - d_R c \\ \pi_s &= \frac{\tilde{m}^2(16(1+r)-16b(1+r)+b^4(1+r)^2+4b^3(1+4r+3r^2)-4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} - I\end{aligned}$$

By solving equation  $\frac{(-2+b)^2\tilde{m}^2(-1+r)}{32(-2+b^2(1+r))} = \frac{(-2+b)^2\tilde{m}^2(-1+r)}{8(-2+b^2(1+r))} - c$  directly, we obtain  $\hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r))(1-r)}}{3(2-b)(1-r)}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_A^E$  and disclose it otherwise.

#### A.5 | SN Model

In the SN model, we have

$$\begin{aligned}\pi_m &= wq_{m1} + (1-r)(\tilde{m} - q_{m2})q_{m2} - d_R c \\ \pi_s &= (\tilde{m} - q_{m1} - w)q_{m1} + r(\tilde{m} - q_{m2})q_{m2}\end{aligned}$$

Similar to the RN model, we obtain  $w = \frac{\hat{m}}{2}$ ,  $q_{m1} = \frac{\hat{m}}{4}$ ,  $q_{m2} = \frac{\hat{m}}{2}$ ,  $\pi_m = \frac{\hat{m}^2(3-2r)}{8} - d_R c$ , and  $\pi_s = \frac{\hat{m}^2(1+4r)}{16}$ . By solving equation  $\frac{\hat{m}^2(3-2r)}{32} = \frac{\hat{m}^2(3-2r)}{8} - c$  directly, we obtain  $\hat{m}_S^N = \sqrt{\frac{32c}{9-6r}}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_S^N$  and disclose it otherwise.

## A.6 | SE Model

In the SE model, we have

$$\begin{aligned}\pi_m &= wq_{m1} + (1-r)(\tilde{m} - q_{m2} - bq_s)q_{m2} - d_R c \\ \pi_s &= (\tilde{m} - q_{m1} - bq_s - w)q_{m1} + r(\tilde{m} - q_{m2} - bq_s)q_{m2} \\ &\quad + (\tilde{m} - q_s - b(q_{m1} + q_{m2}))q_s - I\end{aligned}$$

Similar to the RN model, we obtain

where function  $D(b, r) = (16 - 8b^2(3+r) + b^4(3+8r+r^2))^{-1}$ .

By solving equation

$$\begin{aligned}w &= (8 - 8b - 4b^2(3-r) + 12b^3 - 0.5b^4(1+10r+r^2)) \times D(b, r) \times \tilde{m} \\ q_{m1} &= (4 - 4b + 2b^2(1-r) + 2b^3r - 0.25b^4(1+r^2)) \times D(b, r) \times \tilde{m} \\ q_{m2} &= (8 - 4b - 2b^2(4+r) + 0.5b^4(1+r) + b^3(3+r)) \times D(b, r) \times \tilde{m} \\ q_s &= (8 - 4b(2+r) - 2b^2(3+r) + b^3(2+7r+r^2)) \times D(b, r) \times \tilde{m} \\ \pi_m &= -d_R c + (6 - 4r - 4b(2-r) + 2b^2(1+r) - 2b^3r + 0.125b^4(1+r)^2) \times D(b, r) \times \tilde{m}^2 \\ \pi_s &= -I + (80 + 64r - 32b(3+2r) - 16b^2(8+14r+3r^2) + 16b^3(10+15r+3r^2) \\ &\quad + 2b^4(19+82r+55r^2+6r^3) - 6b^5(11+32r+19r^2+2r^3) + b^6(15-4r-48r^2-14r^3-r^4) \\ &\quad + b^7(3+20r+54r^2+14r^3+r^4) - 0.0625b^8(15+64r+50r^2-r^4)) \times D^2(b, r) \times \tilde{m}^2,\end{aligned}$$

$$\begin{aligned}\frac{\hat{m}^2(48 + 32b(-2+r) - 32r - 16b^3r + 16b^2(1+r) + b^4(1+r)^2)}{32(16 - 8b^2(3+r) + b^4(3+8r+r^2))} &= \\ \frac{\hat{m}^2(48 + 32b(-2+r) - 32r - 16b^3r + 16b^2(1+r) + b^4(1+r)^2)}{8(16 - 8b^2(3+r) + b^4(3+8r+r^2))} - c\end{aligned}$$

We obtain  $\hat{m}_S^E = \frac{4\sqrt{2c(16+8b^2(3+r)-b^4(3+8r+r^2))}}{\sqrt{3(48+32b(-2+r)-32r-16b^3r+16b^2(1+r)+b^4(1+r)^2)}}$ . Accordingly, the manufacturer withholds the quality information if  $m < \hat{m}_S^E$  and disclose it otherwise.

## Appendix B

### Proofs of Lemmas, Corollaries, and Theorems

**Proof of Corollary 1.** In the RN model, the ex-ante benefit of the manufacturer is

$$\Pi_m^{\text{RN}} = \int_0^{\hat{m}_R^N} \frac{(\hat{m}_R^N)^2}{32} dm + \int_{\hat{m}_R^N}^1 \left(\frac{m^2}{8} - c\right) dm = \frac{1}{24} + \frac{32}{9} \sqrt{\frac{2}{3}} c^{\frac{3}{2}} - c.$$

We can get:

$$f_1(c) = \frac{d\Pi_m^{\text{RN}}}{dc} = \frac{-9 + 16\sqrt{6c}}{9}$$

Let  $f_1(c) = 0$ , we can get:  $c^* = \frac{27}{512}$ . For  $c \in [0, c^*]$ ,  $f_1(c) < 0$ , and for  $c \in (c^*, \frac{3}{32}]$ ,  $f_1(c) > 0$ .

The ex-ante benefit of the platform is

$$\Pi_s^{\text{RN}} = \int_0^{\hat{m}_R^N} \frac{(\hat{m}_R^N)^2}{64} dm + \int_{\hat{m}_R^N}^1 \frac{m^2}{16} dm = \frac{1}{432} (9 - 32\sqrt{6c^{\frac{3}{2}}})$$

We can get:

$$\frac{d\Pi_s^{\text{RN}}}{dc} = -\frac{1}{3}\sqrt{\frac{2c}{3}} < 0$$

**Proof of Lemma 1.** The threshold quality under RN and RE models are  $\hat{m}_R^N = \frac{4\sqrt{6c}}{3}$  and  $\hat{m}_R^E = \frac{4\sqrt{6c}}{3} \times \sqrt{\frac{1+b}{1-b}}$ .

Thus we have:

$$\hat{m}_R^E - \hat{m}_R^N = \frac{4\sqrt{6c}}{3} \times \left( \sqrt{1 + \frac{2b}{1-b}} - 1 \right) > 0$$

**Proof of Lemma 2.** In RN and RE models, the platform's ex-ante revenue are

$$\begin{aligned} \Pi_s^{\text{RN}} &= \frac{1}{432} (9 - 32\sqrt{6c}^{\frac{3}{2}}) \\ \Pi_s^{\text{RE}} &= \int_0^{\hat{m}_R^E} \frac{(5+3b)(\hat{m}_R^E)^2}{64(1+b)} dm + \int_{\hat{m}_R^E}^1 \frac{(5+3b)m^2}{16(1+b)} dm - I \\ &= \frac{2\sqrt{\frac{2}{3}}(5+3b)c(\sqrt{c-cb^2})}{3(-1+b)^2} + \frac{(5+3b)(9 - \frac{128\sqrt{6}(c-cb^2)^{\frac{3}{2}}}{(1-b)^3})}{432(1+b)} - I \end{aligned}$$

We can get:

$$I_R^* = \frac{1}{216} \left( 9 + \frac{9}{1+b} + 16\sqrt{6c} \left( \sqrt{c - \frac{(5+3b)\sqrt{c(1-b^2)}}{(b-1)^2}} \right) \right)$$

And only when  $I < I_R^*$ , the platform will make category encroachment.

**Proof of Corollary 2.** In the RE model, the ex-ante benefit of the manufacturer is

$$\begin{aligned} \Pi_m^{\text{RE}} &= \int_0^{\hat{m}_R^E} \frac{(1-b)(\hat{m}_R^E)^2}{32(1+b)} dm + \int_{\hat{m}_R^E}^1 \left( \frac{(1-b)m^2}{8(1+b)} - c \right) dm \\ &= \frac{1-b}{24(1+b)} + c \left( -1 + \frac{32\sqrt{\frac{2}{3}}(1+b)c}{9\sqrt{c-b^2c}} \right) \end{aligned}$$

We can get:

$$f_2(c) = \frac{\partial \Pi_m^{\text{RE}}}{\partial c} = -1 + \frac{16\sqrt{\frac{2}{3}}\sqrt{2c(1-b^2)}}{3\sqrt{3}(1-b)}$$

Therefore, the root of  $f_2(c)$  is given by  $c^* = \frac{27(1-b)}{512(1+b)}$ . For  $c \in [0, c^*)$ ,  $f_2(c) < 0$ ; when  $c \in (c^*, \frac{3}{32}]$ ,  $f_2(c) > 0$ .

The ex-ante benefit of the platform is

$$\begin{aligned} \Pi_s^{\text{RE}} &= \int_0^{\hat{m}_R^E} \frac{(5+3b)(\hat{m}_R^E)^2}{64(1+b)} dm + \int_{\hat{m}_R^E}^1 \frac{(5+3b)m^2}{16(1+b)} dm - I \\ &= \frac{2\sqrt{\frac{2}{3}}(5+3b)c\sqrt{c-b^2c}}{3(-1+b)^2} + \frac{(5+3b)\left(9 - \frac{128\sqrt{6}(c-b^2c)^{\frac{3}{2}}}{(1-b)^3}\right)}{432(1+b)} - I \end{aligned}$$

We can get:

$$\frac{\partial \Pi_s^{\text{RE}}}{\partial c} = -\frac{\sqrt{\frac{2}{3}}(5+3b)\sqrt{(1-b^2)c}}{3(-1+b)^2} < 0$$

**Proof of Corollary 3.** In the AN model, the ex-ante benefit of the manufacturer is

$$\begin{aligned}\Pi_m^{\text{AN}} &= \int_0^{\hat{m}_A^N} (1-r) \frac{(\hat{m}_A^N)^2}{16} dm + \int_{\hat{m}_A^N}^1 \left( (1-r) \frac{m^2}{4} - c \right) dm \\ &= \frac{1-r}{12} + c \left( -1 + \frac{32c}{9\sqrt{3}\sqrt{c-cr}} \right)\end{aligned}$$

Here, we can get:

$$\begin{aligned}f_3(c) &= \frac{\partial \Pi_m^{\text{AN}}}{\partial c} = -1 + \frac{16\sqrt{c(1-r)}}{\sqrt{3}(3-3r)} \\ \frac{\partial^2 \Pi_m^{\text{AN}}}{\partial c^2} &= \frac{8(1-r)}{\sqrt{3}(3-3r)\sqrt{c(1-r)}} > 0\end{aligned}$$

Clearly,  $f_3(c)$  is a monotonically increasing function in  $c$  with  $f_3(0) = -1$  and  $f_3(\frac{3}{32}) = \frac{3(1-r)-2\sqrt{2(1-r)}}{3(r-1)}$ . Therefore, when  $f_3(\frac{3}{32}) < 0$ ,  $f_3(c) < 0$  for all  $c \in [0, \frac{3}{32}]$ . When  $f_3(\frac{3}{32}) > 0$ , the root of  $f_3(c)$  is given by  $c^* = \frac{27(1-r)}{256}$ . In this case,  $f_3(c) < 0$  for  $c \in (0, c^*)$  and  $f_3(c) > 0$  for  $c \in (c^*, \frac{3}{32})$ .

The ex-ante benefit of the platform is

$$\begin{aligned}\Pi_s^{\text{AN}} &= \int_0^{\hat{m}_A^N} \frac{r(\hat{m}_A^N)^2}{16} dm + \int_{\hat{m}_A^N}^1 \frac{rm^2}{4} dm \\ &= \frac{r(9+9(-2+r)r-16\sqrt{3}c\sqrt{c-cr})}{108(-1+r)^2}\end{aligned}$$

We can get:

$$\frac{\partial \Pi_s^{\text{AN}}}{\partial c} = -\frac{2r\sqrt{c-cr}}{3\sqrt{3}(-1+r)^2} < 0.$$

**Proof of Lemma 3.** The threshold quality under AN and AE models are  $\hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$  and  $\hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r))(1-r)}}{3(2-b)(1-r)}$ .

We can get:

$$\begin{aligned}&\hat{m}_A^E - \hat{m}_A^N \\ &= \frac{4 \left( -2\sqrt{c-cr} + b\sqrt{c-cr} + \sqrt{2}\sqrt{c(-1+r)(-2+b^2(1+r))} \right)}{\sqrt{3}(-2+b)(-1+r)}\end{aligned}$$

Clear, when  $3+2r < \frac{4}{b}$ ,  $\hat{m}_A^N < \hat{m}_A^E$ ; when  $3+2r \geq \frac{4}{b}$ ,  $\hat{m}_A^N \geq \hat{m}_A^E$ .

**Proof of Lemma 4.** The threshold quality under RN, AN, RE, and AE models are  $\hat{m}_R^N = \frac{4\sqrt{6c}}{3}$ ,  $\hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$ ,  $\hat{m}_R^E = \sqrt{\frac{32(1+b)}{3(1-b)}}$ , and  $\hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r))(1-r)}}{3(2-b)(1-r)}$ .

We can get:

$$\hat{m}_A^N - \hat{m}_R^N = -\frac{4\left(\sqrt{2}\sqrt{c}(-1+r) + \sqrt{c-cr}\right)}{\sqrt{3}(-1+r)}$$

$$\hat{m}_A^E - \hat{m}_R^E = 4\sqrt{\frac{2}{3}}\left(\frac{\sqrt{c-b^2c}}{-1+b} + \frac{\sqrt{c(-1+r)(-2+b^2(1+r))}}{(-2+b)(-1+r)}\right)$$

when the platform does not encroach,  $\hat{m}_A^N \geq \hat{m}_R^N$  when  $r \geq \frac{1}{2}$ , otherwise,  $\hat{m}_A^N < \hat{m}_R^N$ ; when the platform encroaches,  $\hat{m}_A^E \geq \hat{m}_R^E$  when  $r \geq \frac{2(1+b-b^2)}{4+2b^2+b^3}$ , otherwise,  $\hat{m}_A^E < \hat{m}_R^E$ .

**Proof of Lemma 5.** In the AN model, the platform's ex-ante revenue is

$$\Pi_s^{\text{AN}} = \int_0^{\hat{m}_A^N} \frac{r(\hat{m}_A^N)^2}{16} dm + \int_{\hat{m}_A^N}^1 \frac{rm^2}{4} dm$$

$$= \frac{r(9+9(-2+r)r-16\sqrt{3c}\sqrt{c-cr})}{108(-1+r)^2}$$

In the AE model, the platform's ex-ante revenue is

$$\Pi_s^{\text{AE}} = \int_0^{\hat{m}_A^E} \frac{(\hat{m}_A^E)^2(16(1+r)-16b(1+r)+b^4(1+r)^2+4b^3(1+4r+3r^2)-4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} dm$$

$$+ \int_{\hat{m}_A^E}^1 \frac{m^2(16(1+r)-16b(1+r)+b^4(1+r)^2+4b^3(1+4r+3r^2)-4b^2(1+5r+3r^2))}{16(-2+b^2(1+r))^2} dm - I$$

$$= (-16(1+r)+b(16(1+r)+b(4-b^2(1+r)^2-4b(1+r)(1+3r)+4r(5+3r)))$$

$$\times (-9((2-b)(1-r))^3) + 32\sqrt{6}(c(-1+r)(-2+b^2(1+r)))^{\frac{3}{2}} \times C(b, r) - I,$$

where function  $C(b, r) = (432(-2+b^2(1+r))^2((2-b)(1-r))^3)^{-1}$ .

We can get:

$$I_A^* = -\frac{r(9+9(-2+r)r-16\sqrt{3c}\sqrt{c-cr})}{108(-1+r)^2}$$

$$+ (-16(1+r)+b(16(1+r)+b(4-b^2(1+r)^2-4b(1+r)(1+3r)+4r(5+3r)))$$

$$\times (-9((2-b)(1-r))^3) + 32\sqrt{6}(c(-1+r)(-2+b^2(1+r)))^{\frac{3}{2}} \times C(b, r)$$

And only when  $I \leq I_A^*$ , the platform will make category encroachment.

Where function  $C(b, r) = (432(-2+b^2(1+r))^2((2-b)(1-r))^3)^{-1}$ .

**Proof of Corollary 4.** In the AE model, the ex-ante benefit to the manufacturer is

$$\Pi_m^{\text{AE}} = \int_0^{\hat{m}_A^E} \frac{(-2+b)^2(\hat{m}_A^E)^2(r-1)}{32(-2+b^2(1+r))} dm + \int_{\hat{m}_A^E}^1 \left(\frac{(-2+b)^2m^2(r-1)}{8(-2+b^2(1+r))} - c\right) dm$$

$$= \frac{1}{216} \left( \frac{9(-2+b)^2(-1+r)}{-2+b^2(1+r)} + 8c \left( -27 + \frac{32\sqrt{6}\sqrt{c(-1+r)(-2+b^2(1+r))}}{(-2+b)(-1+r)} \right) \right)$$

Hence, we can get:

$$f_4(c) = \frac{\partial \Pi_m^{\text{AE}}}{\partial c} = -1 + \frac{16\sqrt{\frac{2}{3}}\sqrt{c(-1+r)(-2+b^2(1+r))}}{3(-2+b)(-1+r)}.$$

Clearly,  $f_4(c)$  is a monotonically increasing function in  $c$  with  $f_4(0) = -1$  and  $f_4(\frac{3}{32}) = \frac{4\sqrt{(r-1)(b^2(1+r)-2)}}{3(b-2)(r-1)} - 1$ . Therefore, when  $f_4(\frac{3}{32}) < 0$ ,  $f_4(c) < 0$  for all  $c \in [0, \frac{3}{32}]$ . When  $f_4(\frac{3}{32}) > 0$ , the root of  $f_4(c)$  is given by  $c^* = \frac{27(-4+b(4-b)+4r(1-b)-b^2r)}{512(-2+b^2(r+1))}$ . In this case, for  $c \in [0, c^*]$ ,  $f_4(c) < 0$ , and for  $c \in (c^*, \frac{3}{32}]$ ,  $f_4(c) > 0$ .

*Proof of Theorem 1.* In the reselling model, it is known that  $\hat{m}_R^N = \frac{4\sqrt{6c}}{3}$  and  $\hat{m}_R^E = \sqrt{\frac{32(1+b)}{3(1-b)}}$ , from which we obtain: (1) When  $m < \hat{m}_R^N$ , the manufacturer chooses not to disclose quality information when the platform is not invasive and chooses not to disclose quality information when the platform is invasive. (2) When  $\hat{m}_R^N < m < \hat{m}_R^E$ , the manufacturer chooses to disclose quality information when the platform is not invasive and chooses not to disclose quality information when the platform is invasive. (3) When  $m > \hat{m}_R^E$ , the manufacturer chooses to disclose quality information when the platform does not intrude and chooses to disclose quality information when the platform intrudes.

Next, we explore the impact of platform invasion behavior under different levels of quality information. (1) When  $m < \hat{m}_R^N$ , if the platform does not intrude, the ex-post benefit of the manufacturer and the platform is  $\pi_m^{\text{RN}} = \frac{(\hat{m}_R^N)^2}{32}$ ,  $\pi_s^{\text{RN}} = \frac{(\hat{m}_R^N)^2}{64}$ . If the platform intrudes, the ex-post benefit of the manufacturer and the platform is  $\pi_m^{\text{RE}} = \frac{(1-b)(\hat{m}_R^E)^2}{64(1+b)}$ ,  $\pi_s^{\text{RE}} = \frac{(5+3b)(\hat{m}_R^E)^2}{64(1+b)} - I$ . This can be obtained by calculating and comparing the profits of the manufacturer and the platform before and after the encroachment:  $\pi_m^{\text{RN}} = \pi_m^{\text{RE}}$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} = \frac{2(1+b)c}{3(1-b)} - I > 0$  (because  $0 < I \leq I^*$ , when  $I = I^*$ ,  $\pi_s^{\text{RE}} > \pi_s^{\text{RN}}$ ). As a result, there is no difference in the manufacturer's returns before and after the invasion, whereas the platform prefers the invasion scenario. (2) When  $\hat{m}_R^N \leq m \leq \hat{m}_R^E$ , if the platform does not intrude, the ex-post benefit to the manufacturer and the platform is  $\pi_m^{\text{RN}} = \frac{m^2}{8} - c$ ,  $\pi_s^{\text{RN}} = \frac{m^2}{16}$ . If the platform intrudes, the ex-post benefit to the manufacturer and the platform is  $\pi_m^{\text{RE}} = \frac{(1-b)(\hat{m}_R^E)^2}{32(1+b)}$ ,  $\pi_s^{\text{RE}} = \frac{(5+3b)(\hat{m}_R^E)^2}{64(1+b)} - I$ . This can be obtained by calculating and comparing the profits of the manufacturer and the platform before and after the invasion:  $\pi_m^{\text{RE}} - \pi_m^{\text{RN}} = \frac{4c}{3} - \frac{m^2}{8} < 0$  (Since the difference in manufacturer's profit before and after the invasion is negatively correlated with  $m$ , therefore, when  $m = \hat{m}_R^N$ ,  $\pi_m^{\text{RE}} - \pi_m^{\text{RN}} = 0$ ; when  $m = \hat{m}_R^E$ ,  $\pi_m^{\text{RE}} - \pi_m^{\text{RN}} < 0$ ),  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} = \frac{(5+3b)c}{6(1-b)} - \frac{m^2}{16} - I > 0$  (Analyze the same ideas as above. When  $m = \hat{m}_R^N$ , and if  $I = 0$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} > 0$ , and if  $I = I^*$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} > 0$ ; When  $m = \hat{m}_R^E$ , and if  $I = 0$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} > 0$ , and if  $I = I^*$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} > 0$ ). As a result, the manufacturer prefers the no-encroachment, while the platform prefers the encroachment. (3) When  $m > \hat{m}_R^E$ , if the platform does not intrude, the ex-post benefit to the manufacturer and the platform is  $\pi_m^{\text{RN}} = \frac{m^2}{8} - c$ ,  $\pi_s^{\text{RN}} = \frac{m^2}{16}$ . If the platform intrudes, the ex-post benefit to the manufacturer and the platform is  $\pi_m^{\text{RE}} = \frac{(1-b)m^2}{8(1+b)} - c$ ,  $\pi_s^{\text{RE}} = \frac{(5+3b)m^2}{16(1+b)} - I$ . This can be obtained by calculating and comparing the profits of the manufacturer and the platform before and after the encroachment:  $\pi_m^{\text{RE}} - \pi_m^{\text{RN}} = -\frac{bm^2}{4(1+b)} < 0$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} = \frac{(2+b)m^2}{8(1+b)} - I > 0$  (due to  $0 < I \leq I^*$ , when  $I = I^*$ ,  $\pi_s^{\text{RE}} - \pi_s^{\text{RN}} > 0$ ).

*Proof of Theorem 2.* In the agency selling model, it is known that  $\hat{m}_A^N = \sqrt{\frac{16c}{3(1-r)}}$  and  $\hat{m}_A^E = \frac{4\sqrt{6c(2-b^2(1+r)(1-r))}}{3(2-b)(1-r)}$ , from which we obtain: when  $\frac{4}{b} \leq 3 + 2r$ , (1) When  $m < \hat{m}_A^E$ , the manufacturer chooses not to disclose quality information when the platform is not invasive and chooses not to disclose quality information when the platform is invasive. (2) When  $\hat{m}_A^E < m < \hat{m}_A^N$ , the manufacturer chooses not to disclose quality information when the platform is not invasive and chooses to disclose quality information when the platform is invasive. (3) When  $m > \hat{m}_A^N$ , the manufacturer chooses to disclose quality information when the platform does not intrude and chooses to disclose quality information when the platform intrudes. when  $3 + 2r < \frac{4}{b}$ , (1) When  $m < \hat{m}_A^N$ , the manufacturer chooses not to disclose quality information when the platform is not invasive and chooses not to disclose quality information when the platform is invasive. (2) When  $\hat{m}_A^N < m < \hat{m}_A^E$ , the manufacturer chooses to disclose quality information when the platform is not invasive and chooses not to disclose quality information when the platform is invasive. (3) When  $m \geq \hat{m}_A^E$ , the manufacturer chooses to disclose quality information when the platform does not intrude and chooses to disclose quality information when the platform intrudes.

Next, we explore the impact of platform invasion behavior under different levels of quality information. Since there are more factors associated with the platform profit change, the platform profit change is analyzed by arithmetic example, and we focus on the mathematical analysis of the manufacturer's profit change. In the case of  $3 + 2r < \frac{4}{b}$ , (1) When  $m < \hat{m}_A^N$ , if the platform does not intrude, the ex-post benefit to the manufacturer is  $\pi_m^{\text{AN}} = (1-r)\frac{(\hat{m}_A^N)^2}{16}$ , if the platform intrudes, the ex-post benefit to the manufacturer is  $\pi_m^{\text{AE}} = \frac{(-2+b)^2(\hat{m}_A^E)^2(r-1)}{32(-2+b^2(1+r))}$ . This can be obtained by calculating and comparing the profits of the manufacturer before and after the encroachment:  $\pi_m^{\text{AE}} = \pi_m^{\text{AN}}$ . As a result, there is no difference in the manufacturer's earnings before and after the encroachment. (2) When  $\hat{m}_A^N < m < \hat{m}_A^E$ , if the platform does not intrude, the ex-post benefit to the manufacturer is  $\pi_m^{\text{AN}} = (1-r)\frac{m^2}{4} - c$ , if the platform intrudes, the ex-post benefit to the manufacturer is  $\pi_m^{\text{AE}} = \frac{(-2+b)^2(\hat{m}_A^E)^2(r-1)}{32(-2+b^2(1+r))}$ . This can be obtained by calculating and comparing the profits of the manufacturer before and after the encroachment:  $\pi_m^{\text{AE}} - \pi_m^{\text{AN}} = \frac{4c}{3} + \frac{m^2(r-1)}{4} < 0$  (At this point there is a negative correlation between the manufacturer's profit margin and  $m$ . When  $m = \hat{m}_A^N$ ,  $\pi_m^{\text{AE}} - \pi_m^{\text{AN}} = 0$ ). As a result, the manufacturer prefers a no-encroachment. (3) When  $m \geq \hat{m}_A^E$ , if the platform does not intrude, the ex-post benefit of the manufacturer is  $\pi_m^{\text{AN}} = (1-r)\frac{m^2}{4} - c$ , if the platform intrudes, the ex-post benefit of the manufacturer is  $\pi_m^{\text{AE}} = \frac{(-2+b)^2m^2(r-1)}{8(-2+b^2(1+r))} - c$ . This can be obtained by calculating and comparing the profits of the manufacturer before and after the encroachment:  $\pi_m^{\text{AE}} - \pi_m^{\text{AN}} = -2c - \frac{m^2(r-1)}{4} + \frac{(-2+b)^2m^2(r-1)}{8(-2+b^2(1+r))} > 0$  (At this point there is a positive correlation between the manufacturer's profit margin and  $m$ , when  $m = \hat{m}_A^E$ ,  $\pi_m^{\text{AE}} - \pi_m^{\text{AN}} > 0$ ). As a result, the manufacturer prefers the encroachment.

**Proof of Lemma 6.** In SN and SE models, the solution idea is the same as RN, and we can get:  $\hat{m}_S^N = \sqrt{\frac{32c}{9-6r}}$ ,  $\hat{m}_S^E = \frac{4\sqrt{2c(16+8b^2(3+r)-b^4(3+8r+r^2))}}{\sqrt{3(48+32b(-2+r)-32r-16b^3r+16b^2(1+r)+b^4(1+r)^2)}}$ .

*Proof of Theorem 3.* For the hybrid selling model, we have  $\hat{m}_S^N = \sqrt{\frac{32c}{9-6r}}$  and  $\hat{m}_S^E = \frac{4\sqrt{2c(16+8b^2(3+r)-b^4(3+8r+r^2))}}{\sqrt{3(48+32b(-2+r)-32r-16b^3r+16b^2(1+r)+b^4(1+r)^2)}}$ . Thus, we obtain: when  $r = 0.1$ ,  $\hat{m}_S^N < \hat{m}_S^E$ , (1) when  $m \leq \hat{m}_S^N$ , the manufacturer opts to conceal quality details regardless of whether the platform faces category encroachment or not. (2) when  $\hat{m}_S^N \leq m \leq \hat{m}_S^E$ , the manufacturer discloses quality information when the platform does not category encroachment and hides quality information when the platform makes category encroachment. (3) when  $m > \hat{m}_S^E$ , the manufacturer reveals quality information irrespective of whether the platform experiences category encroachment.

Next, we analyze the impact of platform invasion behavior on different levels of quality information. (1) When  $m < \hat{m}_S^N$ : There is no difference in manufacturer's earnings before and after encroachment. Without intrusion:  $\pi_m^{SN} = \frac{c}{3}$ . With intrusion:  $\pi_m^{SE} = \frac{c}{3}$ . (2) When  $\hat{m}_S^N < m \leq \hat{m}_S^E$ : Manufacturer prefers no category encroachment. Without intrusion:  $\pi_m^{SN} = -c + \frac{7}{20}m^2$ . With intrusion:  $\pi_m^{SE} = \frac{c}{3}$ . (3) When  $m > \hat{m}_S^E$ : Manufacturer prefers no category encroachment. Without intrusion:  $\pi_m^{SN} = -c + \frac{1}{16}(-1 + m^2(6-4r))$ . With intrusion:  $\pi_m^{SE} = \frac{m^2(48+32b(-2+0.1)-3.2-1.6b^3+16b^2(1+0.1)+b^4(1+0.1)^2)}{8(16-8b^2(3+0.1)+b^4(3+0.8+0.1^2))} - \frac{1}{16} - c$ .