



# A Research on the Management of Fake Reviews of E-commerce Platforms

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## ABSTRACT

The existence of fake reviews on online platforms has always plagued the platforms and relevant departments. This paper establishes a mathematical model for fake reviews on e-commerce platforms, and explores how to manage fake reviews scientifically and effectively by exploring the impact of fake review punishment on consumer surplus and social welfare. The results show that regulators should implement different punishment strategies depending on the type of product. For searching products, the lower penalties will increase both consumer surplus and social welfare; while for experiencing products, the higher penalties can increase both consumer surplus and social welfare.

**Keywords:** *online platform; fake reviews; supervision; punishment.*

## 1. INTRODUCTION

With the popularity of the Internet and User Generated Content, more and more consumers will read online product reviews before making purchasing decisions [3] [9] [10]. Positive online reviews can promote consumers to make purchases, thereby increasing sales and business profits. Many online shopping platform sellers take advantage of this feature to promote the generation of positive reviews by swiping orders and giving consumers rebates. For example, when consumers shop on Taobao, Pinduoduo and other platforms, they often receive discount cards with rebates sent along with the product package, but the rebates can only be obtained after consumers posted positive product reviews according to the seller's requirements. When the number of positive reviews of a product is greater than the number of positive reviews that the product can actually get or the product value reflected by the reviews is higher than its actual value, such reviews can be called fake reviews. Fake reviews are very common on online shopping platforms today, according to the Chinese Internet Data Consulting Network, between March and September 2020, Fakespot assessed 720 million reviews on Amazon.com, it found that about 42% of reviews were fake. The existence of fake reviews on online platforms has always plagued the platforms and relevant departments, in order to control the generation of fake reviews, regulatory authorities and online shopping platforms have also introduced a series of corresponding

policies to curb this phenomenon. For example, When Tmall finds that fake reviews, it will ask the merchant to delete the fake reviews and deduct store points and collect a certain deposit. JD.com will deal with violations in accordance with the "JD.com Open Platform Evaluation Management Rules". Amazon's review policy expressly prohibits compensation or claims (including free or discounted products) in exchange for creating, modifying, or publishing content. Although various e-commerce platforms and the government have introduced relevant policies to avoid fake reviews, but the phenomenon of fake reviews hasn't been banned repeatedly. Therefore, how to reasonably and effectively manage fake reviews is an urgent problem that the regulatory authorities are required to solve. This paper studying the impact of fake review supervision strategies on consumer surplus and social welfare, and explore how to manage fake review for products with different attributes (including searching products and experiencing products).

## 2. RELATED LITERATURE

Our paper is most related to the online fake reviews. Another direction is tantamount to study the impact of fake reviews on corporate strategy formulation and consumer behavior from the perspective of game theory. Dellarocas has studied companies manipulating consumers' perceptions by anonymously posting reviews to manipulate online forums to praise their products [2]. Mayzlin studied Usenet groups where consumers

discussed products and services. It is found that if the ratio of profit to manipulation cost is high enough, low-quality companies will manipulate the speech of consumers in Usenet groups more than high-quality companies [5]. Li and Xiao combined theory with laboratory experiments to examine the effect of seller's pre-commitment mechanism. Sellers can decide to offer to offer rebates to buyers before making a purchase decision to reduce the buyer's feedback reporting cost to get more feedback on the product [4]. Chen et al studied the use of conditional discount strategies by strategic sellers on online sales platforms to manipulate product reviews, and only purchasing consumers who posted positive reviews online are eligible for discounts. The results show that even if a conditional discount strategy is employed, it is not always beneficial to make fake reviews [1]. Theodoros examined the vulnerability of fake review attacks to assess the vulnerability of customer base visibility to fake review attacks. Visibility is achieved based on the features a business can cover and its position in the platform's review-based rankings. Theodoros used Yelp reviews to analyze the economic motives of companies conducting review fraud and drew relevant conclusions [6]. Uttara studied how consumers respond to potentially fraudulent reviews and how review portals can use this knowledge to design better fraud management policies and found the impact of fraudulent reviews on consumer decision-making processes increases with uncertainty in the initial assessment of product quality [7]. Wei and Xu have studied fake reviews on consumer perception decision-making, and found that it is shortsighted for store operators to benefit from manipulating reviews [8].

Different from these works, this paper divides products into two categories: searching goods and experiencing goods. Searching products refer to the fact that consumers can obtain products information on the Internet. Experiencing products refer to consumers who cannot accurately judge the performance of products value through the information they can find on the Internet, and can only draw conclusions after using them, such as health care products, clothing, etc. This paper proposes a more scientific and reasonable supervision strategy by studying the impact of the punishment of fake reviews of different categories of products on the changes of consumer surplus and social welfare. The results show that when regulators manage fake reviews, the punishment selected by the regulator is not the bigger the better, but should formulate different supervision strategies according to the type of product. For searching products, regulators should appropriately reduce rather than increase penalties to increase consumer surplus and social welfare; for experiencing products, regulators should choose larger penalties to control fake reviews.

### 3. THE MODEL

Suppose an online seller on an online platform sells a product to consumers, without loss of generality, normalize the unit cost of the product to zero, and the product has two product attributes, digital attributes and non-digital attributes. Digital attributes refer to attributes that consumers can check and obtain information on the Internet, such as product quality, color, size and so on. Non-digital attributes refer to the fact that it is difficult for consumers to obtain information on the Internet and can only be obtained the real value after used, such as the efficacy of health care products, consumers' fit with the product and so on. Assuming that the digital attributes of the product are  $x$ , and  $x \sim [0,1]$ , the non-numeric attributes are  $y$ , and  $y \sim [0,1]$ . Different products have different product value ratio of digital attributes and non-numeric attributes. Assuming that  $\theta$  is the proportion of non-digital attributes in the product, and  $\theta \in [0,1]$ . The proportion of digital attributes in the product is  $1 - \theta$ , the total product value can be expressed as

$$(1 - \theta)x + \theta y \quad (1)$$

When  $\theta$  is small, digital attributes occupy a dominant position in products, and the products are searching products, such as mobile phones; when  $\theta$  is large, non-digital attributes occupy a dominant position in products, and the products are experiencing products, such as health care products. Referring to the researching of Chen et al (2022) on fake reviews, we assume that the digital attributes of the product  $x$  are a uniform distribution, and the distribution of the non-digital attributes of the product  $y$  is unknown. When consumers make purchases on e-commerce platforms, they know the digital attributes of products. For non-digital attributes of products, although consumers do not know the specific values, they will have an estimate of their owner. After reviewing online reviews, they update their valuation of the product's non-numeric attributes and further evaluate the product's total value then decide whether to buy. Assuming that the price of the product is  $p$ , then the consumer's net utility is

$$U = (1 - \theta)x + \theta y - p \quad (2)$$

In order to attract consumers, e-commerce platform sellers will guide and control online reviews, such as providing rebates to guide consumers to post positive reviews, as well as anonymous posting, reviewing reviews and so on, to increase the number of positive reviews and improve the rate of product reviews, which makes the value of the product reflected in the online reviews higher than actual value of product. Since the digital attribute part of a product is known before consumers make a purchase, sellers only target the non-digital attribute part when making fake reviews. Suppose the exaggeration degree of non-numeric attributes caused by the seller's fake reviews is  $a$ ,  $a \in [0, \min\{\bar{a}, 1 - y\}]$  and

$\bar{a} < 1$ , because seller can't exaggerate the non-numeric attributes to 100%(perfect), there exists an upper bound  $\bar{a}$  of  $a$ , the larger the  $a$ , the higher the exaggeration degree. When consumers evaluate the value of a product through online reviews, after viewing the reviews with fake reviews, consumers believe that the utility of the product that they can obtain is

$$U' = (1 - \theta)x + \theta(y + a) - p \tag{3}$$

When sellers make false reviews to exaggerate the non-digital attributes of products, the regulatory authorities will supervise and punish merchants for false reviews. The higher the degree of exaggeration, the greater the probability of merchants being discovered. Sellers exaggerate the non-digital attributes of products will induce a cost. Suppose the cost function is  $C(a)$ , according to the researching of Dellarocas (2006), the cost function of fake reviews exaggerating the non-numeric attributes of products can be set as  $C(a) = ca^2 / 2$ , where  $c$  is a constant and  $c \in [0, 1]$ , this function reflects that sellers need to spend higher efforts to get better and better reviews. When there are fake reviews, the demands are  $D = (1 - x_1)$  where  $x_1 = (p - \theta y - a\theta) / (1 - \theta)$ . If the regulators find that the seller has fake reviews, they will punish the seller, such as paying fines. Suppose that the regulatory strength of the regulatory authority is  $\rho$  and  $\rho \in (0, 1]$ , and the punishment is  $b$ , then the merchant's profit expression is

$$\Pi = (1 + \frac{a\theta + \theta y - p}{1 - \theta})p - \frac{ca^2}{2} - \rho ab \tag{4}$$

By optimizing the merchant's profit, we can get  $a^* = (2b\rho\theta + \theta^2 y - 2b\rho - \theta^2 + \theta) / (2c - \theta^2 - 2c\theta)$ ,  $p^* = (b\rho\theta^2 - c\theta^2 y - b\rho\theta + c\theta^2 + c\theta y - 2c\theta + c) / (2c - \theta^2 - 2c\theta)$ .

#### 4. MODEL ANALYSIS

In this section, we will explore the impact of punishment intensity on the degree of seller false review exaggeration, product pricing and merchant profits, as well as consumer surplus and social welfare respectively.

**Lemma 1:** When  $0 \leq \theta < \sqrt{c^2 + 2c} - c$  and  $b < \theta(\theta y - \theta + 1) / (2\rho(1 - \theta))$ , the degree of exaggeration of fake reviews  $a^*$  decreases with the punishment  $b$ ; when  $\sqrt{c^2 + 2c} - c < \theta \leq 1$  and  $b > \theta(\theta y - \theta + 1) / [2\rho(1 - \theta)]$ , the degree of exaggeration of fake reviews  $a^*$  increases with the punishment  $b$ .

If  $\theta$  is small, the digital attribute occupies a dominant position in the product, which represent the product is a searching product. When the seller increases the degree of exaggeration, the probability of the seller being discovered by the regulatory authorities will increase. At

this time, because the digital attributes dominate the product, when the punishment is increased, although increasing the exaggerated degree of online product reviews will increase the penalty cost, increasing demand due to increased exaggeration of product online reviews which increased the profit is smaller than increased penalty costs due to increased exaggeration of product online reviews. So, in this situation, the degree of exaggeration of fake reviews decreases with the punishment. When the punishment is big enough, the seller will never exaggerate the online reviews. If  $\theta$  is large, the non-digital attributes dominate the product, the logic is the same as when is  $\theta$  small, but in this situation, the degree of exaggeration of fake reviews increased with the punishment. When the punishment is smaller enough, the seller will never exaggerate the online reviews.

**Lemma 2:** When  $0 \leq \theta < \sqrt{c^2 + 2c} - c$  and  $b < \theta(\theta y - \theta + 1) / (2\rho(1 - \theta))$ , the price decreases with the punishment; when  $\sqrt{c^2 + 2c} - c < \theta \leq 1$  and  $b > \theta(\theta y - \theta + 1) / [2\rho(1 - \theta)]$ , the price increases with the punishment.

Similar to lemma 1, if  $\theta$  is small, the digital attribute occupies a dominant position in the product. As the punishment increases, the punishment cost of the merchant will increase. From lemma 1, it can be seen that the exaggeration degree of online reviews will decrease. At this time, in order to deal with the increased punishment cost, the merchant will adopt the form of price reduction to attract consumers and increase demand. If  $\theta$  is large, the logic is the same as when is  $\theta$  small.

**Lemma 3:** No matter how big  $\theta$  is, the profit of the merchant decreases as the punishment increases.

The logic behind lemma 3 is when  $\theta$  is small, increasing the punishment will make the merchants reduce the degree of exaggeration and the price accordingly from lemma 1 and lemma 2. However, the increase in total cost is less than the increase in total profit, so the profit of merchants is reduced. When  $\theta$  is large, the increasing the punishment will make the merchants increase the degree of exaggeration and the price accordingly from lemma 1 and lemma 2, as same as the condition of  $\theta$  is small, the increase in total cost is less than the increase in total profit, so the profit of merchants is reduced.

**Lemma 4:** No matter whether  $\theta$  is large or small, the consumer surplus will decrease with the increase of the punishment intensity at first, and then will increase with the increase of the punishment intensity.

Lemma 4 reveals the effect of punishment on consumer surplus is not monotonic. When  $\theta$  is small, the product is the searching product. From Lemma 1, when the punishment increases, both the degree of exaggeration and the price will decrease. When the punishment is very

small, although the degree of exaggeration and the price will decrease as the punishment increases, the degree of exaggeration is still relatively high as the punishment is very small at this time. Therefore, in this case, the decrease in consumer surplus caused by the decrease in demand is smaller than the increase in consumer surplus caused by the decrease in price, so the total consumer surplus increases with the increase of punishment. However, when the punishment is large, the degree of exaggeration is very small at this time. Although the price of the commodity is relatively low at this time, the reduction in demand caused by the reduction in the degree of exaggeration is greater than that caused by the reduction in price. Consumer surplus increases, so when the punishment is larger, the consumer surplus decrease with the increase of the punishment. When  $\theta$  is large, non-digital attributes dominate the product, the logic is the same as when  $\theta$  is small.

**Lemma 5:** When  $\theta$  is very small, social welfare first decreases with the increase of punishment and then increases with the increase of punishment; when  $\theta$  is middle, social welfare increases with the increase of punishment; when  $\theta$  is very large, social welfare first increases with the increase of punishment and then decreases with the increase of punishment.

Lemma 5 also reveals that the impact of supervision on the total social welfare is not monotonous. When  $\theta$  is very small, from lemma 4, it can be seen that increasing the punishment will reduce the profit of the merchant and increase the consumer surplus. Because  $\theta$  is very small, when the punishment is very small, the increase of the consumer surplus is smaller than the decrease of the profit of the merchant. Therefore, the total social welfare at this time decreases with the increase of punishment. When the punishment increases to a relatively large level, the degree of exaggeration is very small and the price is also very low, so the increase in consumer surplus is greater than the decrease in the profit of merchants, so the total social welfare increases with the increase in punishment. When  $\theta$  is large, non-digital attributes dominate the product, and the product is an experiencing product. It can be obtained from lemma 4 that when the punishment is relatively small and the punishment is increased, the consumers are increasing. At this time, the total deception cost and punishment cost of the society are less than the increase of consumer surplus, so the social welfare increases with the increase of punishment intensity at this time. When the punishment is relatively large, both consumer surplus and business profit decrease, so social welfare decreases with the increase of punishment.

From lemma 4 and 5, we can conclude that for products with different attributes, regulators should not blindly increase the punishment, and should select an appropriate punishment to maintain a certain degree of false reviews, because a certain degree of positive reviews can promote consumer demand and increase

consumer surplus, while the punishment for the searching products should be smaller than the experiencing products.

## 5. CONCLUSION

In order to better promote their products, online platform sellers often exaggerate the attributes of products through false reviews such as positive reviews, which are deceptive to a certain extent. Government regulators often punish such false reviews. This paper examines the impact of government regulatory penalties on the degree of seller false review exaggeration, product pricing and profits, as well as consumer surplus and social welfare to explore how to manage fake reviews scientifically and effectively. The result show that changes in consumer surplus and social welfare are not monotonic as regulators' penalties for fake reviews increase. For products with different attributes, regulators should not blindly increase the punishment, and should select an appropriate punishment to maintain a certain degree of false reviews, because a certain degree of positive reviews can promote consumer demand and increase consumer surplus, while the punishment for the searching products should be smaller than the experiencing products. This study assumes that all consumers have the same perception ability in the face of fake reviews from sellers. However, in reality, different consumers have different perception abilities of fake reviews. Therefore, the supervision strategy considering the heterogeneity of consumers' perception ability of fake reviews is a worthy question of further study.

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