# Research on Price Decisions of Creative Products under Knightian Uncertainty

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*Abstract:* This paper studies the pricing of creative products that have attracted much attention in creative transactions. We constructed a utility model for consumers under Knight uncertainty conditions to analyze the impact of creative product producers providing payment information on consumer price decisions under different levels of information awareness. The research results indicate that the release of product information by producers can change consumers' judgments about the future benefits of the product in creative transactions. With the increase of information on creative products, consumers can rationally guess the price function of products, reducing the degree of uncertainty in transactions. At this point, although the producer has charged the information cost, it may not make the producer gain higher income than if he did not provide paid information from the final result. Therefore, only when both producers and consumers can obtain partial residual income can the transaction efficiency of the creative market be improved.

## 1. Research Background

Since the British economist John Howkins proposed the concept of the "creative economy" in 2001, it has gone beyond the scope of the cultural industry and rapidly expanded to the entire economic field [1]. The creative economy is characterized by the provision of products and services centered on creativity. As a new paradigm of economic development, the creative economy is becoming one of the important drivers of economic growth. With the rapid development of information technology, the suppliers, consumers and sellers of creative products and services have integrated through the network platform, which greatly improves the productivity of creative products. However, with the development of creative market, the pricing of creative products has become an important factor restricting the efficiency of creative transactions.

The core of creative products is creativity and innovation [2-4], and other scholars emphasized the novelty and uniqueness of creative products. Reasonable pricing under the market economy is the precondition of effective allocation of resources. However, the content characteristics of creative products determine the difficulty of pricing. The value judgment of creativity is highly subjective, and it is difficult for producers and consumers of creative products to reach a consensus

on their prices. Currently, the overall development of the creative industry is positive, but phenomena such as low transaction completion rates and discrepancies between prices and values are still widespread [5]. Although creativity ultimately manifests as products or services, it differs from general products in that its formation and transaction have a high degree of uncertainty. The pricing of creative products is a dynamic process, which is influenced by transaction demand, information transparency, market competition and so on. It is of great importance to promote the development of the creative industry by determining the pricing of creative products in a way that ensures producers receive corresponding benefits while consumers obtain utility that matches the price.

## 2. Theoretical Analysis

### 2.1. Characteristics of Creative Transactions

"Creativity" is the core component of creative products and is also the inherent source of value creation in the creative economy. The development of information technology has brought new opportunities to the creative economy. Information technology provides more efficient transaction platforms for creative transactions and provides opportunities for more people to participate in creative creation. The creative economy is becoming an increasingly important area of economic activity. In the current economic environment, creative transaction presents the following new features.

(1) Innovation diversity and resource diversity are integrated together. Howkins particularly emphasized the importance of innovation in defining the creative industries [1]. The development of information technology has blurred the boundaries of industries, and the cross-over of various industries is becoming increasingly deep. The innovation of the creative industry is diversified, which provides more possibilities for generating creativities. To transform creativity into products for trading, it requires collaborative efforts from different fields and industries. This collaboration helps to promote the integration of creativity with other resources. This collaboration helps drive the integration of creativity with other resources, and the higher the degree of integration, the greater the value of creativity.

(2) The demand for consuming creativity is more dispersed. Creative products are characterized by individuation, therefore the demands of consumers for similar creative products may be quite different. The development of information technology has provided diversified trading channels and various business models for creative transactions, then trading parties can search for opportunities in a broader market space. The creative trading platform utilizes the historical transaction data to deeply explore the demand of consumers, and enables the consumers to express their own needs more conveniently through the Internet, further promoting the decentralization of the demands of creative consumers.

(3) Property protection alleviates the exclusivity of creative value. Property right protection is an important guarantee for the development of the creative industry. Creative product producers find it difficult to sell their products to potential consumers with higher bids. Because the bargaining power of creative product producers is influenced by their ability to protect their creativity [6], disclosing creative information to potential consumers can pose risks to producers [7]. Information technology makes the protection of property rights easier and more efficient through new means such as digital copyright, data analysis, and tracking and supervision mechanism, which strengthens the protection of the rights and interests of both parties of creative transactions, and improves the transaction efficiency.

## 2.2. Impact of Information on Creative Transaction Pricing

In the creative trading market, the information of both parties is one of the important factors that affect the product pricing. Creativity is a form of innovative thinking and creative discovery. Before the product or service is embodied, the creative producer always has more relevant information about the quality and value of the creativity than the consumer. So, the producer has an inherent advantage in pricing. The information advantage of the producer may lead to the adverse selection and moral hazard [8], and the creative producer may exaggerate the product utility, hide the key information of the idea, and make second profit with the idea. Creative consumers may have limited transaction choices because they lack sufficient information to make an effective judgment about the value of the creative, thus making it difficult for them to obtain high-quality creative products. At the same time, in the process of creative transactions, consumers have different judgments on the value of creative products because of the differences in information acquisition channels, willingness to pay for information, and ability to understand information. Information disadvantaged consumers can only make trade decisions through public information, while consumers with information advantage can make trade decisions through additional private information. In the creative trading market, it is difficult for consumers with inferior information to judge the decision-making behavior of consumers with superior information due to lack of information. It means there is uncertainty in information-disadvantaged consumers' transaction strategies towards information-advantaged producers. This will result in limited participation in the creative trading market [9]. In conclusion, in the presence of information asymmetry, the cost and uncertainty of creative transactions increase.

Knight classified uncertainty into two categories. When there are multiple possible outcomes to an economic event and the probabilities of those outcomes are unique and known, this uncertainty is called risk. If the probabilities of those outcomes are unknown or difficult to measure, this uncertainty is called Knightian uncertainty. Easley et al. showed that Knightian uncertainty can lead to a decrease in market participation and further affect the pricing efficiency of the market [10]. Therefore, the pricing of creative products must also take into account the impact of Knightian uncertainty. He et al. found that the uncertainty in the trading market can be reduced by improving the "quality" and "quantity" of information disclosure, thereby improving the pricing capacity of the market [11]. In the creative trading market, improving the quality of information disclosure is a long-term process, which can be gradually realized by perfecting the trading mechanism and strengthening the market supervision. The nature of ideas makes creative producers cautious about the information content of the disclosure. The fees paid by consumers for additional information can compensate in advance for the decline in bargaining power of producers due to information disclosure, and change theirs pricing strategies. At the same time, the update of the information will change the probability distribution of the future income of creative products, which will have a direct impact on the product pricing. Therefore, pricing of creative products requires consideration not only of the creative product information set, but also of the variability of information set uncertainty. Based on the maximum and minimum expected utility model proposed by Gilboa and Schmeidler [12], this paper analyses the pricing of creative products.

## 3. Pricing Model of Creative Products Based on Knightian Uncertainty

### 3.1. Model Setting

Consumer perceived value refers to the utility that consumers evaluate they can gain from purchasing creative products based on their known information and knowledge. As consumers cannot get all the information about the creative product before the purchase is completed, the

expected utility can only be estimated based on the producer's judgment of the value of the creative product and t the information released to achieve the transaction.

In the initial state, all consumers in the trading market are uninformed consumers, and each consumer has very little information. Because of the asymmetric information, the consumer is in the information weak side. When there is no incremental information to judge the product value, it is difficult to directly trust the producer to evaluate the value of a creative product. At this time, they cannot conclude the transaction. Klein found that if consumers have access to critical and useful product information prior to purchasing decisions, their evaluation of the value of products will be improved [13]. Thus, in order to achieve transactions, producers are motivated to influence consumers' perception of value by releasing information.

The information released by producers consists of two parts, $I_i = \theta_i + \gamma_i$. $\theta_i$ reflects information of creative products related to consumers' future profits, $\gamma_i$ is the disturbance term contained in the information, and is not related to the future earnings situation of consumers, $\gamma_i \sim N(0, \sigma_i^2)$. $\sigma_i^2$ represents the quality of information released by producers. According to the research from Epstein and Schneider [14], $\frac{1}{\sigma_i^2}$ is defined as information quality, and the smaller $\sigma_i^2$, the greater the utility of the information released by producers on consumers. Whether the incremental information obtained by consumers through payment can be converted into expected surplus is also related to the comprehensibility of the information released by producers. Different consumers have different levels of understanding of information, and the higher the level of understanding, the greater the utility that paid information brings to consumers. Use $D$ to measure consumers' understanding of fee information, where $0 < D < 1$.

According to the research method of Easley et al. [10], the information released by producers is divided into three categories ($I_0, I_1,$ and $I_2$) based on different information content. Among them, $I_0$ represents public information, $I_1$ represents partial incremental information, $I_2$ represents complete incremental information. $I_0, I_1,$ and $I_2$ constitute the entire information of the product. All consumers can access public information $I_0$ on the trading market, while consumers need to pay corresponding costs $C_1$ and $C_2$ to obtain $I_1,$ and $I_2$. When consumers pay the cost $C_1$ they will receive information $I_0$ and $I_1$, becoming a partially informed consumer. After paying the cost $C_2$, consumers will receive information $I_0, I_1,$ and $I_2$, becoming a fully informed consumer.

Before trading creative products, consumers need to choose whether to transform into fully informed consumers or partially informed consumers, or continue to trade as uninformed consumers. Producers convert the uncertainty of demand into the uncertainty of consumer purchasing information, and consumers face the problem of Knightian uncertainty decision-making. When uninformed consumers pay the cost $C_1$ or $C_2$ to choose to become a partially informed consumer or a fully informed consumer, they can earn additional expected surplus. However, due to some informed consumers initially paying a lower cost $C_1$, $C_1 < C_2$, although both they and fully informed consumers have additional expected surplus, their levels of understanding of this additional expected surplus are different, which may be due to the inability to achieve sufficient specialization with lower investment.

Therefore, in the trading market, three types of consumers face different decision-making scenarios. Unknown consumers observe producer product valuation $V$ and information $I_0$ and use it for trading. Fully informed traders can not only observe producer product valuation $V$ and information $I_0$, but also obtain more information $I_1$ and $I_2$. Meanwhile, due to the payment of cost $C_2$ has obtained additional bargaining opportunities, so they also need to choose whether to use additional expected surplus while trading creative products. For partially informed consumers, due to the cost of payment $C_1 < C_2$, so their situation is between these two. They can observe the producer's product valuation $V$ and information $I_0$ and $I_1$. And, they also need to choose

additional expected surplus when choosing transactions. But due to the different information they have, there may be differences in the selection strategies for additional expected surplus between partially informed consumers and fully informed consumers.

In the transaction process of creative products, the initial value perceived by consumers before receiving payment information is $V_0$, then the lowest price that producers can accept for creative products is $P_a$. The maximum price that fully informed consumers are willing to pay is $P_b$. The trading price is $P^*$, $P_a \le P^* \le P_b$. $Z_i$ is the additional expected surplus obtained by consumers through paid information, and $Z_i = \frac{D}{\sigma_i^2}$. The higher the quality of information released by producers, the greater the additional expected surplus brought by paid information, and the higher the level of understanding, and the greater the additional expected surplus brought by paid information. $\delta_i$ is the correlation coefficient of $\gamma_i$ and $Z_i$, $0 < \delta_i < 1$.

## 3.2. Price Strategies of Fully Informed Consumers

By spending cost $C_2$, fully informed consumer access to information $I_0$, $I_1$, and $I_2$. At this point, consumers' value judgment of creative products changes from $V_2$ to $V_0$, with $V_2 = V_0 + I_0 + I_1 + I_2$. Then, the consumer's willingness to pay is $T_2$. The benefits obtained by fully informed consumers after the transaction: $U_2 = (V_2 - P^*)T_2 - C_2 + Z_2$. Fully informed consumers can choose their trading strategies based on the principle of maximizing utility during transactions. Since consumers use the CARA utility function with an absolute risk aversion coefficient of 1, the expected utility of fully informed consumers is expressed as:

$$E_2 = -\exp[-(E(U_2|V_0, I_0, I_1, I_2) - \tfrac{1}{2}Var(U_2|V_0, I_0, I_1, I_2))] \tag{1}$$

In this case, the objective function is

$$max\ E_2(U_2|V_0, I_0, I_1, I_2) \tag{2}$$

$$E(U_2|V_0, I_0, I_1, I_2) = (V_0 + I_0 + I_1 + I_2 - P\ *)T_2 - C_2 \tag{3}$$

$$Var(U_2|V_0, I_0, I_1, I_2) = \sigma_i^2 T_2^2 + \sigma_z^2 Z_1^2 + 2\rho\sigma_i\sigma_z T_2 Z_2 \tag{4}$$

And the solution is:

$$T_2 = \frac{V_0 + I_0 + I_1 + I_2 - P^*}{(1 - \delta^2)\sigma_i^2} \tag{5}$$

Only if $T_2 > 0$, fully informed consumers will have the willingness to purchase creative products. The information released by producers helps to improve consumers' measurement of product value. When consumers' perception of product value exceeds the minimum price $P_a$ that producers can accept, producers will receive residual income of $Z_S$, $Z_S = P^* - P_a$. At the same time, consumers will also receive residual income of $Z_C$, $Z_C = P_b - P^*$. Whether producers and consumers can obtain residual income depends on the quality and comprehensibility of the information released by producers. According to $Z_i = \frac{D}{\sigma_i^2}$, which side benefits more depends on the information which they have access to and their professional abilities.

## 3.3. Price Strategies of Uninformed Consumers

Due to not paying additional costs to obtain incremental information, uninformed consumers only own information $I_0$. Therefore, uninformed consumers fail to observe additional expected surplus, and judge the value of creative products as $V_0$. At this time, the consumer's willingness to pay is $T_0$. Assuming that the effective risk-taking coefficient of fully informed consumers is k.

When uninformed consumers recognize $k$, they will obtain incremental benefits $f_0(k)$ based on the price perception of creative products based on the behavior of informed consumers, consumers' value judgment for creative products is $V_0 + f_0(k)$. The profit obtained by uninformed consumers after the transaction is completed is $U_0$. Uninformed consumers can choose their trading strategies based on the principle of maximum and minimum expected utility during transactions. Then, the objective function is:

$$max \quad min \quad E_0(U_0|V_0, I_0) \tag{6}$$

$$E(U_2|V_0, I_0) = V_0 + f_0(k)T_0 \tag{7}$$

$$Var(U_2|V_0, I_0) = \sigma_i^2 T_0^2 \tag{8}$$

The maximum value of $f_0(k)$ is $max f_0(k)$, and the minimum value of $f_0(k)$ is $min f_0(k)$. The objective function is solved to obtain:

$$T_0 = \begin{cases} \frac{min f_0(k)}{\sigma_i^2}, min f_0(k) > 0 \\ 0, min f_0(k) \leq 0 \leq max f_0(k) \\ \frac{max f_0(k)}{\sigma_i^2}, max f_0(k) < 0 \end{cases} \tag{9}$$

Only if $T_0 > 0$, uninformed consumers will be willing to purchase creative products. They know that informed consumers will receive additional expected surplus, but they cannot accurately understand this additional expected surplus and can only speculate on its possible range. This speculation will affect the value perception of creative products among uninformed consumers. Price is the primary factor affecting the value perception of uninformed consumers. When faced with creative products with lower price, uninformed consumers have a higher acceptance of uncertainty and a lower willingness to pay fees to become informed consumers, which will increase the degree of Knightian uncertainty faced by uninformed consumers. At this point, the function $f_0(k) > 0$, and uninformed consumers will choose to purchase creative products. As prices rise, the acceptance of uncertainty by uninformed consumers decreases, and the quality of creative products and trust in producers become important factors affecting the decision-making of uninformed consumers, and an additional expectation of surplus $Z_i = \frac{D}{\sigma_i^2}$. Uninformed consumers are more likely to choose to pay fees and become informed consumers in this circumstance.

## 4. Conclusion and Enlightenment

With the development of information technology, the trading mechanism of creative products has undergone a profound transformation, and the relationship between producers, consumers and prices also presents a new characteristic. In view of the asymmetric information and the uncertainty of demands in the transaction, a great deal of research showed that the behavior of consumers is affected by the cognition of product value, and it is necessary to make price decision by synthesizing all kinds of information. This study focused on the impact of the paid information provided by the producers of creative products on the consumer's price strategies. This paper constructed the utility model of consumers under Knightian uncertainty, and analyzed the price strategies of different consumers based on it. The conclusions are as follows:

In creative transactions, that producers released product information will change the consumer's judgment of the future benefit of the product. On the one hand, consumers reduce the uncertainty of product value cognition by possessing more information, which reduces the risk of future earnings, and increases the purchase intention of risk aversion consumers. On the other hand, there is uncertainty as to whether consumers are willing to pay for obtaining incremental information,

especially if the quality of information is uncertain, which reduces the attractiveness of creative products. Paid information can provide additional added value for creative products, and the increase of consumer's information occupancy will squeeze the producer's surplus income. Although the producer charges the cost of information, the end result may not make the producer get higher income than when it does not provide the paid information. The profit of the producer comes from the completion of the transaction. The producer should fully consider the value experience of consumers in the choice of releasing information.

With the increase of product information, consumers can rationally estimate the price function of the creative product, which will narrow the interval estimation of the correlation between the information random variable and the extra expected surplus. This means that the degree of Knightian uncertainty in transactions gradually decreases, and the rate of decrease depends on the quality of the paid information. The higher the information quality, the faster Knightian uncertainty declines in the deal. Therefore, releasing high-quality information by producers can improve consumers' willingness to pay and improve the transaction efficiency of creative markets.

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