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Research Article

Mathematical Modelling of B2C Consumer Product Supply Strategy Based on Nonessential Demand Pattern

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The influence of consumer psychological effects on customer needs has become a normal state of product sales models in the consumer goods supply chain field. The literature lacks systematic research on the mechanism through which consumer psychological effects affect customer needs. On the basis of analyzing and sorting out the literature and viewpoints, this paper establishes a mathematical model to investigate how manufacturers design and plan product supply strategies based on nonessential demand patterns under three different sales models. Finally, by solving the mathematical model, the optimal production volume, the optimal commodity price, and the maximum profit that can be obtained by the manufacturer are obtained, and the correctness of the model is verified via numerical calculation. The study results explain the relationships among commodity costs, demand, and commodity pricing, which are significant for the study of consumer psychology and can further provide a beneficial reference for manufacturers in various industries.

1. Introduction

Facing the current complex domestic and international market competition environment, enterprise managers are paying increasing attention to the key factors of enterprise marketing strategy and their impact on enterprise performance, and the investigation of how to establish and improve the foundation of enterprise marketing strategy has become the focus of this research field [1]. The core of this study is the process by which an enterprise determines marketing goals and direction, formulates product marketing strategies, and finally achieves its performance goals through integration and dominance. The focus is on how companies design and plan products supply strategies for the business-to-consumer (B2C) based on the customer needs [2–4]. Therefore, satisfying customer needs is the core of an enterprise's product operation decision making. This is a philosophy with the core value of satisfying customer needs and reflecting customer initiative in enterprise marketing management. Under the guidance of this concept, all the activities of an enterprise are centered around the needs of customers, and the satisfaction of customers' needs is the secret of commercial success.

From the perspective of organizational structure, how to satisfy customer needs requires the enterprise to determine the demand characteristics behind customer needs in relation to the final consumer products, such as production, sales, and after-sales services [5]. The classic case "The Story of Wang Yongqing Selling Rice" in "Manager's Classroom" truly achieved an in-depth understanding of customer needs [6]. The case illustrates that the core key to satisfying customer needs is to find the needs behind the customer needs. At this point, what customers truly want to buy is not your product or service but that they need to use your product or service to complete a certain task or solve a certain problem. That is, according to the supply and demand relationship theory, demand is the reason for the existence of products in the commodity economy. Enterprises have an in-depth understanding of consumer preferences and consumers' needs for products and services and grasp the intensity and changes in consumers' product demand through data analysis; thus, it is very important to predict the demand intensity and quantity of products or services at different prices [7, 8].

Moreover, the progress of science and technology and the improvement of social productivity have greatly promoted the continuous growth of economic status and personal income, creating dynamic social living conditions and consumption environments [9]. On the one hand, the consumer goods market is experiencing vigorous development: the speed of product updates is accelerating, and new products are emerging in an endless stream. This phenomenon not only continuously stimulates consumers' new pursuits in consumption but also has a profound impact on customer needs [10]. In particular, in recent years, the rise and popularization of Internet+ and artificial intelligence have had widespread impacts on people's production and life, and online direct selling and live broadcast e-commerce have become emerging mainstreams in the market [11, 12]. The core reason why this new market format in the Internet plus era has shown exceptionally strong vitality is that it can effectively help consumers reduce uncertainty about products, thereby cultivating the trust of consumers with similar physical characteristics and values [13].

From the perspective of consumer psychology, demand refers to the feeling of necessity for something, the need for the actual purchase of a specific product or service, the desire of human beings to obtain a certain product or service, and the willingness to pay a certain price for it [14–17]. At present, as people's material life is becoming increasingly common, their living standards are constantly improving. To satisfy the spiritual needs of consumers and become the leading factor in consumer purchasing behavior, this paper uses a simple sales model table for the apparel industry to verify this statement.

Table 1 shows that consumer psychology has a variety of influences on clothing sales. Our further study showed that product sales in almost all sectors of the consumer goods supply chain are affected by consumer psychology. Therefore, it is important to explore how companies in the consumer goods supply chain satisfy customer needs and thereby maximize profits in a fierce market competition environment.

2. Literature Review

2.1. Relevant Research on Demand-Oriented Product Supply Chains. In the consumer goods supply chain, which involves a variety of commodities, the price of a product is an important factor affecting the purchasing behavior of consumers. At this point, customer demand played a crucial role in the pricing strategy of the product and led to the development of several classical theoretical models of customer demand, such as the single-product inventory model where the demand rate for a product is dependent on a single product shortage depending on factors such as price, time, and inventory [25] and the inventory system model with a dynamical demand model and items that allow for shortages [26]; with sales effort as a decision variable under the circumstances of demand uncertainty of the green dual-channel supply chain pricing and coordination strategy model [27]; a dual-channel supply chain pricing strategy model with green investment and sales effort when demand is uncertain [28]; under the low-price and high-price strategy, a two-stage analysis model of the profitable buy-back strategy of the original equipment manufacturer (OEM) and the independent remanufacturer (IR) [29]; a model considering the cooperative versus noncooperative game with a decision model of manufacturer-retailer membership under two different scenarios of presence and absence of discounts [30]; a dual-channel inventory model considering retailers having offline and online options to sell products [31]; and further extending and modifying Sana's production-inventory model to derive the optimal buffer inventory that minimises expected costs [32].

In these models, green product marketing in relation to corporate social responsibility has been the focus of scholars, e.g., Sana [33] finds that in green product marketing, the demand for the product depends on the sales price, carbon emissions, and CSR index when the government provides higher subsidies and lower taxes for green producers and lower subsidies and taxes for nongreen producers. Sana [34] further finds that in a given economic environment, business managers want to capture the market that offers the best green quality at a reasonable price when the profit function of manufacturers and retailers includes the cost of purchasing, selling price, and the cost of green level development, while the demand of final customers also depends on the price and quality of green products. Das Roy and Sana [35], on the other hand, found that additional investments in reducing ordering costs help buyers save more money and reduce the overall expected total cost of the entire green supply chain system. Rastpour et al. [36] identified the main criteria for green supply chain management (GSCM). De et al. [37] used the Norwegian salmon supply chain network as an example and proposed a mathematical calculation method in the form of a mixed integer linear programming model. This model aims to minimize the fuel costs of various transportation means and takes into account the constraints associated with carbon emissions, thereby addressing environmental issues. Mogale et al. [38] developed a sustainable freight network that considers an inclusive cross-dock to minimize the overall supply chain cost, including the cost of carbon emissions.

2.2. Research Gaps. These models have enriched and developed the application of demand theory in the product supply chain field and have had an enormous impact on the supply strategy research of manufacturers and retailers in designing and planning products according to customer needs. However, the paper finds that these studies are all supply chain models under uncertain demand and do not consider the relevant results of the supply chain model under the basic needs and nonbasic needs of customers. Currently, the influence of consumer psychological effects on customer needs has become a normal part of the product sales model in the consumer goods supply chain field. The literature

Table 1: Distribution of apparel industries affected by consumer psychology factors.

Ideological impact	Sources
Product recommendations for e-commerce	Xu and Cui [18]
Product images in the website	Srivastava et al. [19]
Materialistic values	Gomes et al. [20]
Environmental-psychological factors	Zhang and Dong [21]
Contemplative theatre performance	McEachern et al. [22]
Social appearance expressiveness	Sarkar and Sarkar [23]
Consumer ethnocentrism	Chakraborty and Sadachar [24]

lacks systematic research exploring the influencing mechanism of consumer psychological effects on customer demand, and there is a large theoretical gap. Therefore, it is highly important to explore how the supply chain model changes under deterministic demand.

In the consumer goods supply chain, customer demand is the core of product supply. In the product marketing process, we observe two interesting customer demand phenomena. For one, people must eat to survive. From this perspective, food is the most important material product for meeting human survival needs [39]. With the continuous improvement in social productivity, the problems associated with food and clothing have become prevalent. At present, what to eat has become a problem because people have difficulty choosing among the wide variety of foods. The second interesting phenomenon is that the original function of clothes is to keep warm; that is, they are the most important material products for meeting basic survival needs [40]. However, with the continuous improvement in social productivity, people's income has also greatly increased. At this time, people's repeat purchases of clothing no longer have a significant negative impact on their income levels and quality of life. Consumers are paying more attention to the pursuit of fashion products [41, 42]. Faced with a dazzling array of clothing, people exhibit an incredible psychological state; that is, they buy clothes when they are happy or unhappy. In these two simple life examples, customers' needs not only satisfy basic human survival needs but also enter the field of consumer psychology [43]. Especially in recent years, with the popularization of "Internet +" and artificial intelligence, new business models, such as online direct selling and live broadcast e-commerce, have become emerging business models in the "Internet +" era [44]. Scholars generally believe that convenience and hedonic motivation are important determinants of emerging shopping behaviors such as live broadcast e-commerce, and these behaviors have shown unusually strong vitality [42, 45, 46]. In essence, this is an important reflection of the influence of consumer psychology factors on consumer purchasing behavior.

Psychological factors of consumption have nothing to do with human survival needs but are the product of human beings' pursuit of higher spiritual enjoyment after satisfying their survival needs [47] and are essentially an important manifestation of the psychological processes of human beings' quest for growth and progress, happiness, mutual solidarity, awe, and self-transcendence in the further experiences of customers [45, 46] and drive value cocreation and customer willingness to pay [48], realizing the optimal trade-off between customer satisfaction and producer capabilities and customers' purposive expectations of firms [49, 50] and reflecting the nonlinear relationship between product performance and user satisfaction [51]. This type of customer demand caused by psychological factors is called "nonessential demand" and was also called false demand by Marcuse [43, 52].

This differs from existing research in that the vast majority of existing studies only consider price as a single decision variable and do not take into account the specific factor of how people choose when faced with a wide range of goods, while this paper pays more attention to the attributes of demand behind demand to explore the mechanism of the influence of consumer psychology on customer demand. The problem to be solved in this study is how manufacturers or retailers should develop appropriate product supply strategies when people's buying behavior is influenced by consumer psychology in the context of the rapid development of modern society. From the perspective of customer needs, this type of purchasing behavior belongs to the nonessential demand patterns. This paper explores how manufacturers develop accurate marketing strategies based on this demand pattern. Under the nonessential demand patterns, the manufacturer establishes a mathematical model of the relationships among product pricing, product quantity, and customer demand and obtains the optimal solution among these variables, thereby maximizing profits. The research in this paper has important implications for demand theory in the field of marketing and supply chain strategy, fills an important gap in existing demand theory, and can be applied to product supply chains in a wide range of industries with broad practical value.

3. Variables and Functions

Based on the purpose of the study, this paper proposes three hypotheses. (1) It is assumed that goods are sold directly to customers by the manufacturer. (2) It is assumed that all customers are nonbasic needs customers. (3) It is assumed that there is only one product manufacturer in the region.

3.1. Nonessential Demand Function. In an economic society, demand represents the maximum amount of goods that consumers are willing and able to purchase at various possible prices during a given period of time. At this moment, the demand quantity of this good is determined by many factors, including the price of the good itself, the income level of the consumer, the price of the good, the preferences of consumers, and the expectations of consumers regarding the price of goods. The demand function here is the mathematical relationship of the dependence relationship between the demand quantity of goods and the factors influencing the demand quantity [53].

Research over the past decades has shown that demand function modelling is very useful for understanding customer demand in commodity economies [54–58]. The demand function model can also be used as a way to establish the existence and uniqueness of the optimal solution for profit maximization of different products and can be effective in representing some of the properties of the optimal solution to find the optimal ordering strategy for the problem under consideration to achieve the best possible equilibrium between uncertain supply and demand. This is then used as a basis for economic reasoning using linear supply and demand diagrams, and finally, mathematical models of economic reasoning are applied to investigate the interaction between mathematical logic and economics [59–61]. However, although these models and results have investigated the application of customer demand in the commodity economy from various aspects, the only thing that has not been considered is the demand attributes of consumer goods, that is, the study of demand function models under the psychological effects of consumption.

In their research on demand functions, Petruzzi and Dada [62] treated demand as a random function of price. Therefore, there are two modelling approaches: the demand function of both the additive form and the multiplication form. The demand function model of the additive form represents a phenomenal demand curve, while the demand function of the multiplicative form represents an elastic demand curve [63]. Mills [64] constructed the demand function model of the additive form as $D(p,\varepsilon) = y(p) + \varepsilon$. Karlin and Cair [65] constructed the demand function model of the multiplication form as $D(p,\varepsilon) = y(p)\varepsilon$. p denotes the product retail price, $y(p)$ is a function of the price, and the random variable ε is in the range of $[A, B]$.

Meanwhile, in the model of Chen and Wang [66], it is claimed that product performance includes the practical function and the taste function, and the combination of these two functions is a complete product function. This paper assumes that a consumer's demand for a product is an essential demand; according to our definition, an essential demand should meet the basic demand of consumers. At this moment, to meet their essential demand, consumers should pay more attention to the essential functions of the product. In contrast, if consumers pay more attention to the taste function of the product than to the practical function when consumers buy a product, the demand of consumers at this moment is the nonessential demand. This study combines the additive model of the demand function by Mills [66] and the consumer product performance model of Chen and Wang [66] to build nonessential demand patterns [63, 67–71].

$$D_F = \frac{3}{2}\left(\frac{p - v p_m}{p_m(u - v)} - d_0\right)(a - bp + \varepsilon), a, b > 0, \varepsilon \in U\left(\mu, \sigma^2\right). \tag{1}$$

D_F denotes the nonessential demand function, p denotes the product price, P_m is the highest retail price of a product in the market, v means the taste function of a product, u means the practical function of a product, d_0 is the minimum value of the weight of the practical function of a product, and a and b are the coefficients of the product price. The nonessential demand patterns is not based on the price of the product to distinguish between the three different demand models, but rather on the context, motivation, and psychological factors of the consumer when purchasing the product, i.e., more consideration is given to what is the main psychological purpose of the consumer when purchasing the product, defined by the relationship between the taste value and the utility function.

This paper assumes that $F(\varepsilon)$ is the distribution function of ε, so $F(-\infty) = 0$, $F(+\infty) = 1$, and $f(\varepsilon)$ is the density function of ε. This paper sets ε as the function that has a uniform distribution in the range of $[-(a - bp), a - bp]$ and then gets the following:

$$f(\varepsilon) = \frac{1}{2(a - bp)}, \quad \varepsilon \in [-(a - bp), a - bp]. \tag{2}$$

3.2. Manufacturer's Profit Function. If the manufacturer wants to make a profit, they need to produce the products first and sell them out. The price difference between the total price of the two processes is the profit that the manufacturer can obtain. There are two sides: one is the manufacturer's per unit marginal cost of product and the total quantity of products. The second is whether the product produced by the manufacturer can be sold, or how many units of the product can be sold and how much each unit of product can be sold. Overall, when manufacturers sell their products, there are two situations: supply exceeds demand and demand exceeds supply.

The manufacturer's per unit marginal cost of product is denoted as c, the total quantity of products produced is q, and the total cost of the product produced by the manufacturer is cq. The market demand for the product is assumed to be $D(p,\varepsilon)$, and the selling price per unit is p. When a product is sold, if the market is in a condition when demand exceeds supply, the product is not enough to sell. This means that everything a manufacturer produces can be sold entirely. At this moment, the manufacturer can collect the money as pq, and the profit is $\Pi_M(p,q) = -cq + pq$, which is related to the retail price p and the total product quantity q. If the supply of the products produced by the manufacturer exceeds the market demand, that means manufacturers cannot sell all the products they produced; the greater they can sell is as much as the market demand. Meanwhile, the profit a manufacturer can make is shown as $\Pi_M(p,q) = -cq + pD(p,\varepsilon)$, ε here means the product quantity actually sold as the market changes, and it is a random variable.

By substituting equation (2) into the above two situations, the profit function of the manufacturer can be obtained as follows:

$$\prod_{M}(p,q)=\begin{cases}-cq+pq, & D(p,\varepsilon)\geq q,\\ -cq+pD(p,\varepsilon), & D(p,\varepsilon)<q.\end{cases} \tag{3}$$

Since the manufacturer's profit function is a piecewise function, it is difficult to analyze or compute, resulting in the need to transform this piecewise function into a single function that considers both cases. In this paper, it is found that manufacturer's profit is closely related to sales volume. Thus, this paper takes sales volume as a variable and combines it with the mathematical expectation formula of Schmeidler and Wakker (1994). Equation (3) is then simplified as follows:

$$\prod_{M}(p,q)=\int_{q}^{2(a-bp)}[-cq+pq]\cdot f(\varepsilon)\mathrm{d}\varepsilon+\int_{0}^{q}[-cq+pD(p,\varepsilon)]\cdot f(\varepsilon)\mathrm{d}\varepsilon. \tag{4}$$

4. A Manufacturer's Product Supply Strategy Model Based on Nonessential Demand Pattern

This paper establishes a model of a product supply strategy for individual customers in direct discount and unsold treatment under nonessential demand pattern to obtain the optimal yield q and the optimal price p when the manufacturer obtains the maximum profit. We designed variable indicators before modelling (see Table 2).

4.1. Product Supply Strategy Model under the Direct Discount Mode. In this supply model, this paper assumes that the retail price of some products produced by the manufacturer directly selling to individual customers is p. However, in the actual sale, as the supplier and the demand side negotiate with each other, the manufacturer ultimately decides to reduce the retail price by α of each product to promote sales. At this moment, if the manufacturer's production is greater than the demand, the total revenue from the sales of the product is $(p-\alpha)D_F(p,\varepsilon)$; if the manufacturer's production is less than the demand, then they can sell all the products, and the total revenue of recovery is $(p-\alpha)q$. Thus, the profit of the manufacturer can be expressed as follows:

$$\prod_{\mathrm{MF}}=\begin{cases}-cq+(p-\alpha)q, & D_F(p,\varepsilon)\geq q,\\ -cq+(p-\alpha)D_F(p,\varepsilon), & D_F(p,\varepsilon)<q.\end{cases} \tag{5}$$

Equations (1) and (2) are substituted into the equation below:

$$\prod_{\mathrm{MF}}=\int_{q}^{2(a-bp)}[-cq+(p-\alpha)q]\cdot f(\varepsilon)\mathrm{d}\varepsilon+\int_{0}^{q}[-cq+(p-\alpha)\cdot D_F(p,\varepsilon)]\cdot f(\varepsilon)\mathrm{d}\varepsilon. \tag{6}$$

After organizing, the following equation is derived:

$$\begin{aligned}\prod_{\mathrm{MF}}&=\int_{q}^{2(a-bp)}(-cq)\cdot f(\varepsilon)\mathrm{d}\varepsilon+(p-\alpha)\int_{q}^{2(a-bp)}q\cdot f(\varepsilon)\mathrm{d}\varepsilon\\&\quad+\int_{0}^{q}(-cq)\cdot f(\varepsilon)\mathrm{d}\varepsilon+(p-\alpha)\int_{0}^{q}D_F(p,\varepsilon)\cdot f(\varepsilon)\mathrm{d}\varepsilon\\&=(-cq)\int_{0}^{2(a-bp)}f(\varepsilon)\mathrm{d}\varepsilon+(p-\alpha)\left[\int_{0}^{q}D_F(p,\varepsilon)\cdot f(\varepsilon)\mathrm{d}\varepsilon+\int_{q}^{2(a-bp)}q\cdot f(\varepsilon)\mathrm{d}\varepsilon\right].\end{aligned} \tag{7}$$

Equation (8) is the expression of the nonessential demand function.

$$D_F=\frac{3}{2}\left(\frac{p-vp_m}{p_m(u-v)}-d_0\right)(a-bp+\varepsilon),\quad a,b>0,\ \varepsilon\in U\left(\mu,\sigma^2\right). \tag{8}$$

Moving $(a-bp)$ number of units to the right and also in $\varepsilon\in[0,2(a-bp)]$, one gets the following:

$$D_F(p,\varepsilon)=\frac{3}{2}\left(\frac{p-vp_m}{p_m(u-v)}-d_0\right)\varepsilon. \tag{9}$$

Table 2: Variable index design.

Symbol	Description
α	Discounted price per product in the off-invoice model
γ	Discount treatment fee per unit in the unsold treatment model
p	The product price
q	The product quantity
u	The practical function of a product
v	The taste function of a product
c	The manufacturer's per unit marginal cost of product
d_0	The minimum value of the weight of the practical function of a product
p_m	The highest retail price of a product in the market
D_F	The nonessential demand function
Π_M	Manufacturer's profit function
a	The coefficients of the product price
b	The coefficients of the product price

Substituting expression (2) of the density function $f(\varepsilon)$ of uniform distribution on the interval of $[0, 2(a - bp)]$ into equation (9), the following can be obtained:

$$\prod_{\mathrm{MF}} = (-cq)\int_0^{2(a-bp)} \frac{1}{2(a-bp)}\cdot \mathrm{d}\varepsilon + (p-\alpha)\left[\int_0^q \frac{3}{2}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right)\varepsilon \cdot \frac{1}{2(a-bp)}\mathrm{d}\varepsilon + \int_q^{2(q-bp)} q\cdot\frac{1}{2(a-bp)}\mathrm{d}\varepsilon\right]. \tag{10}$$

After calculation, one gets the following:

$$\begin{aligned}
\Pi_{MF} &= -cq + (p-\alpha)\int_0^q D_F(\varepsilon) f(\varepsilon)\mathrm{d}\varepsilon + (p-\alpha)\int_q^{2(a-bp)} q f(\varepsilon)\mathrm{d}\varepsilon \\
&= -cq + (p-\alpha)\int_0^q \frac{3}{2}\cdot\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right)\varepsilon\cdot\frac{1}{2(a-bp)}\mathrm{d}\varepsilon \\
&\quad + (p-\alpha)\int_q^{2(a-bp)} q\frac{1}{2(a-bp)}\mathrm{d}\varepsilon \\
&= -cq + (p-\alpha)\cdot\frac{3}{2}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right)\cdot\frac{1}{4(a-bp)}\left(q^2 - 0\right) \\
&\quad + (p-\alpha)q\cdot\frac{1}{2(a-bp)}\left[2(a-bp) - q\right] \\
&= (-c + p - \alpha)q + \frac{3q^2(p-\alpha)}{8(a-bp)}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right) - \frac{(p-\alpha)q^2}{2(a-bp)}.
\end{aligned} \tag{11}$$

Taking the first derivative of the above equation and setting it equal to 0, the following can be obtained:

$$\frac{\partial \Pi_{\mathrm{MF}}}{\partial q} = (-c + p - \alpha) + \frac{3q(p-\alpha)}{4(a-bp)}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right) - \frac{(p-\alpha)q}{a-bp} = 0. \tag{12}$$

Then, the following can be obtained:

$$(p-\alpha)q\left[4-3\left(\frac{p-vp_m}{p_m(u-v)}-d_0\right)\right]=4(-c+p-\alpha)(a-bp). \tag{13}$$

After calculation, the following can be obtained:

$$q=\frac{4(-c+p-\alpha)(a-bp)}{(p-\alpha)\left[4-3\left(p-vp_m/p_m(u-v)-d_0\right)\right]}. \tag{14}$$

Combined below:

$$\frac{\partial\Pi_{\mathrm{MF}}}{\partial p}=q+\frac{3q^2}{8(a-bp)}\left(\frac{2p-vp_m-\alpha}{p_m(u-v)}-d_0\right)-\frac{q^2}{2(a-bp)}+\frac{3bq^2(p-\alpha)}{8(a-bp)^2}\left(\frac{p-vp_m}{p_m(u-v)}-d_0\right)-\frac{b(p-\alpha)q^2}{2(a-bp)^2}=0. \tag{15}$$

After organization, one can get the following:

$$\begin{aligned}&\left[8b^2-\frac{3bq}{p_m(u-v)}\right]p^2+\left[-16ab+\frac{6aq}{p_m(u-v)}\right]p+\left[8a^2-4q(a-\alpha)b\right]\\&+\left[8a^2-4q(a-\alpha b)-3q(a-\alpha b)\left(\frac{vp_m}{p_m(u-v)}+d_0\right)-\frac{3aq\alpha}{p_m(u-v)}\right]=0.\end{aligned} \tag{16}$$

Then, denote

$$\begin{aligned}A_1&=8b^2-\frac{3bq}{p_m(u-v)},\\B_1&=-16ab+\frac{6aq}{p_m(u-v)},\\C_1&=8a^2-4q(a-\alpha b)-3q(a-\alpha b)\left(\frac{vp_m}{p_m(u-v)}+d_0\right)-\frac{3aq\alpha}{p_m(u-v)}.\end{aligned} \tag{17}$$

The optimal pricing p value of the manufacturer is written as follows:

$$p=\frac{-B_1+\sqrt{B_1^2-4A_1C_1}}{2A_1}. \tag{18}$$

4.2. The Product Supply Strategy Model in the Unsold Treatment Mode. Under this supply model, this study assumes that the manufacturer makes a better discount on unsold products to recover costs as soon as possible. At this moment, if the manufacturer's production is greater than the demand, the total revenue from selling the product is only $p\cdot D_F(p,\varepsilon)$, and the remaining quantity $q-D_F(p,\varepsilon)$ should be treated with a discount. For this part of the product, this study assumes that the manufacturer shall give the product a discount treatment fee per unit γ. Thus, the total revenue of the manufacturer is $pD_F(p,\varepsilon)+\gamma[q-D_F(p,\varepsilon)]$. If the manufacturer's production is less than the demand, they can sell all the products, and the total revenue from sales is pq; thus, the manufacturer's profit is as follows:

$$\Pi_{\mathrm{MF}}=\begin{cases}-cq+pq, & D_F(p,\varepsilon)\geq q,\\ -cq+pD_F(p,\varepsilon)+\gamma\left(q-D_F(p,\varepsilon)\right), & D_F(p,\varepsilon)<q.\end{cases} \tag{19}$$

Substituting equations equations (1) and (2),

$$\prod_{MF}=\int_q^{2(a-bp)}(-cq+pq)\cdot f(\varepsilon)\mathrm{d}\varepsilon+\int_0^q\left[-cq+pD_F(p,\varepsilon)+\gamma\left(q-D_F(p,\varepsilon)\right)\right]\cdot f(\varepsilon)\mathrm{d}\varepsilon. \tag{20}$$

After organization,

$$\begin{aligned}\prod_{\mathrm{MF}}&=(-cq+pq)\int_q^{2(a-bp)}f(\varepsilon)\mathrm{d}\varepsilon+(-cq)\int_0^q f(\varepsilon)\mathrm{d}\varepsilon\\&\quad+p\int_0^q D_F(p,\varepsilon)f(\varepsilon)d\varepsilon+\gamma\int_0^q\left[q-D_F(p,\varepsilon)\right]\cdot f(\varepsilon)\mathrm{d}\varepsilon\\&=(-cq)\cdot\left[\int_q^{2(a-bp)}f(\varepsilon)d\varepsilon+\int_0^q f(\varepsilon)\mathrm{d}\varepsilon\right]+pq\int_q^{2(a-bp)}f(\varepsilon)\mathrm{d}\varepsilon\\&\quad+p\int_0^q D_F(p,\varepsilon)f(\varepsilon)\mathrm{d}\varepsilon+\gamma q\int_0^q f(\varepsilon)\mathrm{d}\varepsilon-\gamma\int_0^q D_F(p,\varepsilon)f(\varepsilon)\mathrm{d}\varepsilon\\&=(-cq)\cdot\int_0^{2(a-bp)}f(\varepsilon)\mathrm{d}\varepsilon+pq\int_q^{2(a-bp)}f(\varepsilon)\mathrm{d}\varepsilon+\gamma q\int_0^q f(\varepsilon)\mathrm{d}\varepsilon\\&\quad+p\int_0^q D_F(p,q)f(\varepsilon)\mathrm{d}\varepsilon-\gamma\int_0^q D_F(p,\varepsilon)f(\varepsilon)\mathrm{d}\varepsilon.\end{aligned} \tag{21}$$

Substituting equation (2) into equation (21), one can get the following:

$$\begin{aligned}\prod_{\mathrm{MF}}&=(-cq)\cdot\int_0^{2(a-bp)}\frac{1}{2(a-bp)}\mathrm{d}\varepsilon+pq\int_q^{2(a-bp)}\frac{1}{2(a-bp)}\mathrm{d}\varepsilon\\&\quad+\gamma q\int_0^q\frac{1}{2(a-bp)}d\varepsilon+(p-\gamma)\int_0^q D_F(p,\varepsilon)\cdot\frac{1}{2(a-bp)}d\varepsilon.\end{aligned} \tag{22}$$

After integration,

$$\begin{aligned}\prod_{\mathrm{MF}}&=-cq+pq\cdot\frac{1}{2(a-bp)}\left[2(a-bp)-q\right]+\gamma q\cdot\frac{1}{2(a-bp)}(q-o)\\&\quad+\frac{p-\gamma}{2(a-bp)}\int_0^q D_F(p,\varepsilon)d\varepsilon\\&=-cq+pq-\frac{pq^2}{2(a-bp)}+\frac{\gamma q^2}{2(a-bp)}+\frac{p-\gamma}{2(a-bp)}\int_0^q D_F(p,\varepsilon)\mathrm{d}\varepsilon\\&=(-c+p)q-\frac{(p-\gamma)q^2}{2(a-bp)}+\frac{p-\gamma}{2(a-bp)}\int_0^q D_F(p,\varepsilon)\mathrm{d}\varepsilon.\end{aligned} \tag{23}$$

Substituting equation (10) into equation (23), the following can be obtained:

$$\begin{aligned}\prod_{MF} &= -cq + p\int_0^q D_F(\varepsilon) f(\varepsilon)\mathrm{d}\varepsilon + p\int_q^{2(a-bp)} q f(\varepsilon)d\varepsilon \\ &\quad + \gamma\int_0^q \left(q - D_F(\varepsilon)\right) f(\varepsilon)\mathrm{d}\varepsilon \\ &= -cq + (p-\gamma)\int_0^q \frac{3}{2}\cdot\left(\frac{p - vp_m}{p_m(u-v)} - d_0\right)\varepsilon\cdot\frac{1}{2(a-bp)}\cdot \mathrm{d}\varepsilon \\ &\quad + p\int_q^{2(a-bp)} q\cdot\frac{1}{2(a-bp)}d\varepsilon + \gamma\int_0^q q\cdot\frac{1}{2(a-bp)}\mathrm{d}\varepsilon \\ &= (-c+p)q + \frac{3q^2(p-\gamma)}{8(a-bp)}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right) - \frac{(p-\gamma)q^2}{2(a-bp)}.\end{aligned} \tag{24}$$

Taking the first derivative of this and setting it equal to 0, the manufacturer's optimal yield is q, and the following can be obtained:

$$\frac{\partial \Pi_{MF}}{\partial q} = (-c+p) + \frac{3q(p-\gamma)}{4(a-bp)}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right) - \frac{q(p-\gamma)}{a-bp} = 0. \tag{25}$$

After organization, the following can be obtained:

$$q = \frac{4(a-bp)(-c+p)}{4(p-\gamma) - 3(p-\gamma)\left(p - vp_m/p_m(u-v) - d_0\right)}. \tag{26}$$

Because

$$\frac{\partial \Pi_{\mathrm{MF}}}{\partial p} = q + \frac{3q^2}{8(a-bp)}\left(\frac{2p - vp_m - \gamma}{p_m(u-v)} - d_0\right) + \frac{3bq^2(p-\gamma)}{8(a-bp)^2}\left(\frac{p-vp_m}{p_m(u-v)} - d_0\right) - \frac{q^2}{2(a-bp)} - \frac{bq^2(p-\gamma)}{2(a-bp)^2} = 0, \tag{27}$$

after organization,

$$\left[8b^2 - \frac{3bq}{p_m(u-v)}\right]p^2 + \left[-16ab + \frac{6aq}{p_m(u-v)}\right]p + \left[8a^2 - 3q(a-b\gamma)\left(\frac{vp_m}{p_m(u-v)} + d_0\right) - \frac{3aq\gamma}{p_m(u-v)} - 4q(a-b\gamma)\right] = 0. \tag{28}$$

As

$$A_2 = 8b^2 - \frac{3bq}{p_m(u-v)},$$
$$B_2 = -16ab + \frac{6aq}{p_m(u-v)}, \quad (29)$$
$$C_2 = 8a^2 - 3q(a-b\gamma)\left(\frac{vp_m}{p_m(u-v)} + d_0\right) - \frac{3aq\gamma}{p_m(u-v)} - 4q(a-b\gamma),$$

the manufacturer's optimal pricing value p is as follows:

$$p = \frac{-B_2 + \sqrt{B_2^2 - 4A_2C_2}}{2A_2}. \quad (30)$$

5. Analysis of Numerical Examples

This paper assumes that a manufacturer plans to produce and sell an ordinary product, and the single production cost of this product is set as 50. If the production quantity is large enough, the cost is further reduced, and the current maximum retail price of this product in the market is set as 100, and then the retail price of the product sold directly to individual customers by the manufacturer should meet the requirements of $50 < p \leq 100$ to achieve profit. Therefore, our question is how manufacturers develop product supply strategies to achieve optimal profits. Meanwhile, it can be seen from the definition of nonessential demand that traditional practical functional factors cannot satisfy customer demand and that ideological factors have become the mainstream factors that increasingly influence consumer buying behavior, so nonessential demand pays more attention to the taste function of products. Therefore, to accurately understand the influencing factors of nonessential demand on the product supply chain, this paper believes that the practical efficiency parameters of the product should be lower than the taste efficiency parameters of the product. The basic parameters are set as follows: $a = 70$, $c = 50$, $d_0 = 0.2$, $b = 0.5$, $p_m = 100$, $u = 0.5$, and $v = 0.4$.

5.1. Product Supply Strategy of the Manufacturer-Individual Customer Mode under the Direct Discount Mode. In this supply model, this paper aims to examine the influence mechanism of the manufacturer's rediscount α to individual customers on the optimal yield and optimal price. This paper used Mathematica 8.0 to substitute the basic parameters into equations (12) and (15) for the solution, and numerical calculation was carried out with 0.5 increments of α within the range (0.5, 3) (see Table 3 for calculation results).

Numerical calculation shows that there are two optimal solutions that meet the constraints $50 < p \leq 100$ under the direct discount sales model. Numerical results show that the p value and q value of the two optimal solutions are both greater than 0, indicating that the production quantity and pricing are in line with the regulations of market transactions. It is proven that this model can effectively help manufacturers set the optimal price and achieve the goal of maximizing product profits.

To more accurately present the variation between the preferential value and the optimal yield and the optimal pricing, this paper used Mathematica 8.0 to transform the results of Table 3 into Figure 1. Figure 1 shows that under the supply model of a direct discount, the relationship between p and q is an inverted parabola. At this moment, the parabola shows the highest point of the upwards trend, that is, the optimal price made by the manufacturer for individual customers. According to Pukelsheim's [72] three-sigma theory, this paper defines product pricing within the range (84, 88), and the manufacturer's profit can reach the optimal level. However, if the product price is set within the range (50, 51) and the production quantity q is negative, this does not conform to the rules of commodity management. Therefore, it can be inferred that the manufacturer is losing money on the production and sales of the product at this moment and should stop the loss in time.

5.2. Product Supply Strategy of the Manufacturer-Individual Customer Mode under the Unsold Treatment Mode. In this supply model, to test the influence mechanism of manufacturers' discount handling charge γ on the optimal yield and price, this paper used Mathematica 8.0 to substitute the basic parameters into equations (25) and (27) for solving and carried out numerical calculation for γ with the increment of 1 in the range (44, 49) (calculation results are shown in Table 4).

Numerical calculation showed that under the direct discount sales mode, there is only one optimal solution that can satisfy the constraint conditions of $50 < p \leq 100$. The numerical results show that the p value and the q value of the optimal solution are greater than 0, indicating that production and pricing are in line with market trading rules. Thus, this model is proven to effectively help manufacturers establish the optimal price, achieving the goal of realizing profit maximization.

To more accurately present the variation in the discount processing cost, optimal production quantity, and optimal pricing, this paper used Mathematica 8.0 to transform the results from Table 2 into Figure 2. Figure 2

Table 3: Optimal yield and optimal price under the direct discount mode.

a	p_1	q_1	p_2	q_2
0.5	50.60	0.08	90.10	9.91
1.0	51.11	0.08	90.11	9.84
1.5	51.61	0.08	90.12	9.77
2.0	52.11	0.08	90.14	9.70
2.5	52.61	0.08	90.16	9.62
3.0	53.11	0.09	90.17	9.55

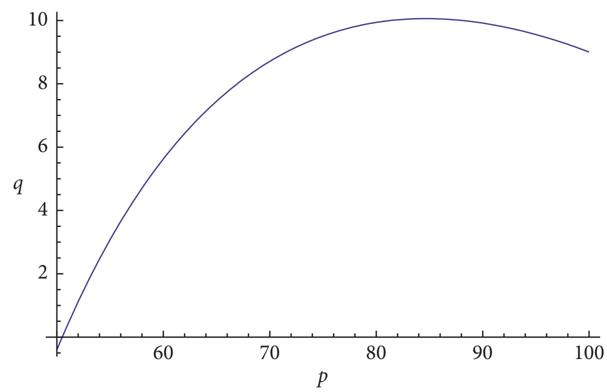

Figure 1: The changing trend diagram of optimal pricing under the direct discount mode.

Table 4: The optimal yield and optimal price under the unsold treatment mode.

γ	p	q
44	93.95	2.40
45	93.99	2.43
46	94.03	2.47
47	94.07	2.50
48	94.11	2.53
49	94.15	2.58

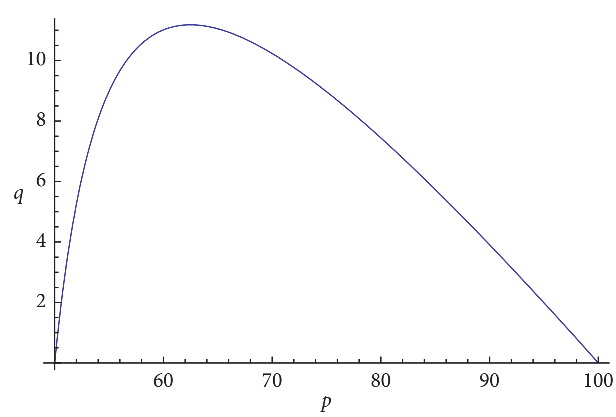

Figure 2: The changing trend diagram of optimal pricing under the unsold treatment mode.

shows that the relationship between p and q is an inverted parabola under the unsold treatment of this supply pattern. The highest point of the upwards trend in the parabola is the manufacturer's optimal pricing for individual customers. Based on the three sigma theorems of Pukelsheim [72], this paper defines product pricing in an interval of (60, 64), and the manufacturer's profits can be optimal.

6. Managerial Insights

(1) The model can guide the manufacturer to produce the most appropriate amount of goods to avoid causing the supply to exceed the demand or the supply to exceed the demand to achieve the lowest cost.

(2) The model can guide the manufacturer to set a reasonable price for the product to obtain the maximum profit.

(3) In rapidly changing market conditions, the model can effectively respond to fluctuations in consumer behavior by dividing the same product into different hierarchical levels for which targeted product sales decisions are made.

(4) Through the results of this paper, manufacturers can be reminded to always pay attention to market changes in customer demand to adjust the production quantity and pricing of products in a timely manner.

7. Conclusions

Product supply strategies under different demand modes have a major impact on supply chain management. The essence of this problem is that the manufacturer or retailer achieves the optimal profit from the product by looking for the optimal pricing and the optimal sales volume for individual and group customers under different demand patterns. The theoretical contribution of this paper is that a manufacturer's product operation decision model for individual customers is established under the nonessential demand model, and the model is solved by a numerical example. The numerical results validate the validity of the model and reveal the intrinsic mechanism of manufacturer B2C product operation decision making under the nonessential demand model.

Moreover, from the perspective of management practice, this paper proposes an optimal production volume and an optimal pricing model based on optimization theory for the manufacturer's product supply strategy for individual customers under the nonessential demand model, and the numerical results validate the validity of the model. In management practice, by substituting real product production and sales data into the model, the manufacturer can obtain the optimal production volume and optimal pricing that maximize the profit of the product. Therefore, this approach has strong theoretical significance and practical application value. Numerical results not only provide an important basis for manufacturers' product supply strategies when supply exceeds demand or when supply is less than demand but also help manufacturers make accurate products for individual customers under the circumstance of the nonessential demand mode of consumers' pursuit of taste-function sales decisions.

A limitation of this paper is that the model was created under idealized conditions, which may vary in practice. As discussed in the example of a customer buying clothes, there are seven psychological factors that influence customers' purchasing behavior: product recommendations in e-commerce, product pictures on websites, material values, environmental psychological factors, contemplative drama performance, social appearance, power and consumer ethnocentrism, each factor has different variables, leading to different results. This study will improve the model at a later stage in light of the actual situation of the specific industry in the market to obtain more practical results. In addition, in future studies, we can generalize the results to multiplicative forms of demand function models to obtain better results.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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