



Article Mainstream Value Information Push Strategy on Chinese Aggregation News Platform: Evolution, Modelling and Analysis

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Abstract: At present, most news aggregation platforms use personalized recommendation technology to push information in China, which is likely to cause the phenomenon of information cocoons. In order to alleviate the occurrence of this phenomenon, this paper studies the issue of mainstream value information push from different perspectives, which can be used as a supplement for personalized recommendation technology to promote the diffusion of mainstream value information. First, we constructed an evolutionary game model to simulate the game process between news aggregation platforms and users. Through the results of evolutionary analysis, the news platform can be guided at a macro level to formulate mainstream value information push strategies by adjusting model parameters. Second, we conducted research on user behavior, and the results show that different user groups have different demands for mainstream value information. Third, we constructed two models from the perspective of user demands and platform revenue. Experiments show that user sensitivity to mainstream value information pushes on each page. Finally, we investigated the effect of the mainstream value information from Toutiao. The survey results are consistent with the viewpoints presented in this paper.

Keywords: information dissemination; information push; mainstream value information; governance; journalism

1. Introduction

Currently, news aggregation platforms have become the primary way for users to obtain information. News aggregation platforms are services that pull together online content such as news and videos in one place for ease of viewing on mobile devices or websites. In China, the news aggregation platforms represented by Toutiao and Tencent News rely on big data technology and recommendation algorithms to increase user stickiness by meeting the personalized needs of users, making them to gradually become media platforms with strong competitiveness. At the end of 2020, the news aggregation platform has more than 600 million active monthly users, and the penetration rate of the entire network is close to 80%. Among them, top platforms such as Toutiao and Tencent News maintain their dominant positions and can reach levels of billions MAU (Figure 1). The most significant advantages of news aggregation platforms are that they are able to achieve precise matches between users and information. Combined with the overwhelming advantage of current news aggregation platforms in the information dissemination process, these platforms determine the meaning of information, the flow of information, and the audience's response to a certain extent. The function of information is to provide a basis for personal decision-making and judgment. Therefore, news aggregation platforms have a profound impact on user value judgments and daily behavior decisions.



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Figure 1. Number of monthly active users (MAU) of leading news aggregation platforms in China in December 2020 [1].

News aggregation platforms rely on big data and intelligent recommendation technology to push preferred information to users to determine the value judgment mechanism. Commonly used recommendation algorithms for news aggregation platforms include content-based recommendations and collaborative filtering-based recommendations [2]. The former recommends information based on historical user behavior, and the latter mainly assumes that similar users have similar preferences for certain recommendations. Regardless of the recommendation algorithm that is adopted, news aggregation platforms are mainly driven by commercial profits, producing and disseminating relatively personalized information according to user demands, which means the current information strategy on news aggregation platforms is more to cater to user needs than to proceed from the perspective of public communication. Although this model caters to the individual needs of users, it weakens user attention to mainstream values and public issues, leaving users in the predicament of information cocoons and filter bubbles [3,4], and gradually excludes information that users ignore, resulting in some users having narrower and narrower horizons, fewer opportunities to access multiple pieces information, and their perception of mainstream ideology is gradually weakened.

Under the current Chinese market operation model, news aggregation platforms are rational entities pursuing commercial interests, and at the same time, they are subject to the supervision of relevant government propaganda departments. In this context, the information push strategy of news aggregation platforms must meet their profit needs and assume the responsibility of promoting mainstream ideology. From the perspective of information dissemination, its information push strategy should not only disseminate mainstream value information, promote social consensus, and provide a basis for public decision-making but also ensure that users obtain personal preference information and provide users with a more relaxed public opinion environment. News aggregation platforms under the government supervision model still face particular difficulties in disseminating mainstream ideologies: the propaganda of mainstream ideologies inevitably implies subjectivity based on the government's intentions. Suppose the government wants to push more mainstream information on the platform to promote the construction of the cognitive integration of mainstream ideologies as soon as possible; this will inevitably lead to the reduction of users' personalized preference information, which, in turn, will reduce the user stickiness of the news aggregation platform and will cause user fatigue behavior. Meanwhile, due to the limited information that can be presented on a page on a news aggregation platform, studying how to formulate strategies for the amount and content of mainstream value information on a news aggregation platform helps to ensure the economic benefits of the news aggregation platform and its promotion of mainstream ideologies.

Therefore, to address the above issues, this paper studies how Chinese news platforms push mainstream value information. The main parts of the work presented in this paper are as follows:

(1) We constructed an evolutionary game model between users and news aggregation platforms to analyze the factors that affect the dissemination of mainstream value information. Then, we derived an evolution process that can guide users to reach the desired stable state. Moreover, we found that the user's stable state is closely related to the reward coefficient, time cost coefficient, user fixed income, and platform reward cost. When the above parameters change, the evolutionary stability strategy is different. Through the results of evolutionary analysis, news platforms can be guided at a macro level to formulate mainstream value information push strategies.

(2) According to user research, we discovered the distribution characteristics of user demands and constructed two models. The user demand model can measure the user demand for mainstream value information, and the platform revenue model can calculate the revenue of mainstream value information. We try to find a reasonable solution that balances user demands and platform revenue through these two models.

(3) We simulated and verified the impact of the mainstream value information on user demand and the revenue of the platform. Through these two models, it is helpful to find a common understanding of the number of mainstream value information pushed on each page.

(4) We investigated the effect of the mainstream value information of Toutiao and found that the survey result is consistent with the viewpoints presented in this paper. According to the research content of this paper, the current information push strategy can be further improved.

The rest of this paper is organized as follows: related work is introduced in Section 2. The construction and simulation of the evolutionary game model are described in Section 3. Section 4 conducts the user behavior research and constructs the user demand model and platform revenue model. Then, we simulate and verify the impact of mainstream value information on user demand and the revenue of the platform. Section 5 presents the effect of the mainstream value information from Toutiao. Finally, conclusions are drawn in Section 6.

2. Related Work

At present, studies on information push or recommendation strategies can be roughly divided into three directions. In one direction, most studies focus on recommendation algorithms to improve the accuracy of recommendation systems to further cater to user preferences. Traditionally, researchers have studied recommendation algorithms under different aspects, such as collaborative filtering (CF) recommendations [5,6] and hybrid algorithms [7]. Some technical tools include the KNN method [8], latent Dirichlet allocation [9], and Bayesian models [10]. Over the past few years, neural network and deep learning methods have shown stunning performance in various domains. In recent years, some researchers have applied convolutional neural networks (CNN) and recurrent neural networks (RNN) in recommendation systems [11]. In addition, some advanced deep learning frameworks, such as neural collaborative filter [12], deep attention neural (DAN) [13], and graph representation [14] have also been applied. These works only try to address the issue of information overload to cater to user preferences.

In the other direction, some researchers have focused on new dilemmas caused by recommendation algorithms, such as prejudice solidification, value penetration, information cocoons, and group polarization. The concept of information cocoons was first proposed by Sunstein [15]. A high concentration of personalized information will significantly narrow user perspectives, which is not conducive to the full development of users and may even lead to an imbalance in the personal information structure. Recently, researchers have recognized the drawbacks of over-personality and are taking aggressive measures. Xu H et al. [16] take advantage of the word embedding model and a large amount of user data to analyze the relationship between social class and information cocoons. The results show that information cocoons exist widely in the daily use of news aggregation platforms. People belonging to higher social classes are more able to stride over the constraints of the information cocoon. Some studies on information cocoons primarily focus on political polarization [17,18]. Zhang J Q [19] analyzed the information dilemma formed in the actual operation of algorithmic news and analyzed how to make better use of algorithmic recommendation systems to construct a health information environment from the perspective of the human–computer relationship. Chen Z et al. [20] proposed a novel model of opinion dynamics that considers different influences and horizons for every individual, and the results show that the effect of campaigns for consciousness or education can be improved by constructing the opinion of media, which can provide a basis for policymakers in the new media age. Huang H X et al. [21] used game logic and game theory deduction to analyze the game process of commercial media and users. The present study determines that commercial media prefer unreasonable information push strategies because of their interests. However, excessive preference information not only discredits individual decision-making but may also mislead personal decision-making. Most of these studies have analyzed the impact of personalized recommendation technology on social cognitive integration and personal decision-making from a macro level. However, there is a lack of further practical solutions.

In addition, some studies have focused on the phenomenon of media fatigue, mainly social media fatigue behavior. Social media fatigue refers to internal user fatigue due to various reasons caused by using social media, which reduces the user's time spent using social media, or the user may even abandon social media platforms. Social media users have experienced fatigue in recent years, as evidenced by a decline in their active numbers. In order to study the factors that lead to media fatigue, researchers have conducted research from different perspectives. Zhang Y et al. [22] described a study that examines the factors affecting online social media fatigue faced by Chinese users on WeChat. The results show that information overload, privacy concerns, and time cost positively impact social media fatigue. Yin X et al. [23] summarized five main factors that influence users: environmental factors, personal factors, technical factors, negative emotions, and information avoidance behavior. Seo Y et al. [24] proposed a model for overcoming stakeholder social media fatigue via optimizing corporate-influencer-stakeholder relationships. At the same time, some studies have focused on the media fatigue behaviors of news platform users. Ma H et al. [25] demonstrated how statistics analyzing user fatigue could be incorporated into the ranking algorithms for personalized recommendations to reduce the impact of user fatigue. Through our investigation of the current works, as far as we know, no scholars have researched the push strategies of mainstream value information for Chinese news aggregation platforms.

As for the problem addressed in our work, information push tasks need to consider the phenomenon of information cocoons and user fatigue simultaneously. Following are the differences between our work and the related literature: (1) we constructed an evolutionary game model to simulate the game process between news aggregation platforms and users; (2) the browsing situation of mainstream value information of real users of Toutiao was investigated; (3) we constructed user demand model and platform revenue model; and (4) we investigated the effect of mainstream value information from Toutiao.

3. Evolutionary Game Modelling between News Aggregation Platforms and Users

Evolutionary game theory [26] is derived from the theory of biological evolution. It has been quite successful in explaining certain phenomena in the process of biological evolution. The research objective of this theory is to determine how a particular group changes over time. Theoretical exploration aims to understand the dynamic process of group evolution and explain why the group will reach this state and how to achieve it. Nowadays, economists use evolutionary game theory to analyze the influencing factors of

social habits, norms, institutions, or systems and explain their formation process, and they have also achieved remarkable results.

This section assumes that news aggregation platforms and users are two groups of bounded rationality. Based on evolutionary game theory, we can obtain a strategy to reach a stable state by analyzing the game process of the two groups.

3.1. Model Assumption and Parameters Setting

Under the supervision of the government in China, news aggregation platforms have the lead in formulating mainstream value information push strategies, and users have the initiative to use news aggregation platforms and to select the information that they want to see. User attitudes toward adjusting information push strategies are critical from the relationship between news aggregation platforms and users. If the strategy adjustment fails, it may cause the scale of users to shrink and may affect the economic benefits of the platform. Therefore, news aggregation platforms must ensure their own interests when adjusting their information push strategies. From the user perspective, users may give up on using the platform due to adjustments made to the information push strategy, which has no impact on users. However, using news aggregation platforms means a time cost to the users. This paper adopts evolutionary game theory to analyze the influence of the adjustment strategies for information push that are used by news aggregation platforms on user behavior. News aggregation platforms and users are two game groups, both of which are bounded, rational participants. In response to the above problems, this article makes the following assumptions:

(1) News aggregation platforms have initial users and can obtain fixed income. The platforms can choose whether to increase the push of mainstream value information, that is, {increase, do not increase}. Adopting an increased strategy may increase user media fatigue behavior, resulting in fewer platform users. If the user accepts the strategic adjustment of the news aggregation platform and does not choose fatigue behavior, then strategic adjustment can play a role at this time. News aggregation platforms can obtain additional benefits (such as government support because they push mainstream value information, etc.), as they promote the dissemination of mainstream value information.

(2) Users can choose the strategy {choose fatigue behavior, do not choose fatigue behavior}. If the users choose fatigue behavior, they do not use the news aggregation platform, and its revenue is 0. If the users do not choose fatigue behavior, the user can obtain information from the news aggregation platform, and the benefit is g, but the time cost will be incurred T. Different news aggregation platforms have different time cost coefficients φ . The larger the φ , the more time users spend obtaining information on a news aggregation platform.

(3) The profitability of news aggregation platforms depends on the number of users. At present, some top platforms such as Toutiao and Tencent News adopt various incentive measures (such as cash rewards, etc.) to encourage users to obtain information. The more users read on news aggregation platforms and the greater their contributions *S*, the more platform rewards they will receive. π is the reward coefficient. The meanings of specific parameters are shown in Table 1.

Parameters	Meanings	
r	Initial revenue of the platform.	
m	The platform adopts the additional benefits of increasing mainstream value information push strategies.	
υ	The cost of the platform for taking incentive measures.	
π	Reward coefficient for user contribution to the platform.	
φ	The cost factor for users to spend time on the platform.	
8	User's fixed income from the platform.	
S	Rewards users get from the platform.	

Table 1. Model parameters and meanings.

Based on the above assumptions and parameter settings, the payoff matrix of the news aggregation platform groups and user groups under different strategic choices can be constructed, as shown in Table 2.

Table 2. The payoff matrix.

Licors	News Aggregation Platforms		
00010	Increase (x)	Do Not Increase (1- <i>x</i>)	
Fatigue (<i>y</i>)	0, <i>r</i> − <i>v</i>	0, r	
Do not fatigue $(1 - y)$	$g + \pi S - \varphi T$, $r + m - v + \pi S$	$g - \varphi T, r$	

3.2. Evolutionary Process Analysis

In the game process, news aggregation platforms choose to increase the probability of pushing mainstream value information as x, the probability of choosing not to increase is 1-x, the probability of users choosing fatigue behavior is y, and the probability of choosing non-fatigue behavior is 1-y. According to Table 2, the expected benefits of the news aggregation platform groups and user groups under different strategic choices can be obtained. The expected benefits U_1, U_2 and their average benefits \overline{U} of the news aggregation platform adopting the "increase" and "ido not increase" strategies are (1)–(3):

$$U_1 = r - v + (1 - y)(m - \pi S)$$
(1)

$$U_2 = r \tag{2}$$

$$\overline{U} = x[(1-y)(m-\pi S) - v] + r$$
(3)

The expected benefits V_1 , V_2 and their average benefits \overline{V} of the user adopting the "ifatigue" and "ido not fatigue" strategies are (4)–(6):

$$V_1 = 0 \tag{4}$$

$$V_2 = g - \varphi T + x\pi S \tag{5}$$

$$\overline{V} = (1 - y)(g - \varphi T + x\pi S) \tag{6}$$

According to the Malthusian dynamic equation [26], the evolutionary game replicator dynamic equations between the news aggregation platform and the user are (7)–(8):

$$F(x,y) = \frac{dx}{dt}$$

= $x(U_1 - \overline{U})$
= $x(1-x)[(1-y)(m-\pi S) - v]$ (7)

$$H(x,y) = \frac{dy}{dt}$$

= $y(V_1 - \overline{V})$
= $y(1-y)(\varphi T - g - x\pi S)$ (8)

The above dynamic replicator equations represent the stable status of the evolutionary game and the dynamic convergence process to this stable status. Let (F(x,y), H(x,y)) = (0,0):

$$\begin{cases} (F(x,y) = x(1-x)[(1-y)(m-\pi S) - v] = 0\\ H(x,y) = y(1-y)(\varphi T - g - x\pi S) = 0 \end{cases}$$
(9)

The game model's local equilibrium points for the dynamic equation are (0,0), (1,0), (0,1), (1,1), and $\left(\frac{\varphi T-g}{\pi S}, 1-\frac{v}{m-\pi S}\right)$. We defined $\left(\frac{\varphi T-g}{\pi S}, 1-\frac{v}{m-\pi S}\right)$ as (A, B). The Jacobian matrix of the evolutionary game is as follows:

$$J = \begin{bmatrix} \frac{\partial F(x)}{\partial x} & \frac{\partial F(x)}{\partial y} \\ \frac{\partial H(y)}{\partial x} & \frac{\partial H(y)}{\partial y} \end{bmatrix}$$

$$= \begin{bmatrix} j_{11} & j_{12} \\ j_{21} & j_{22} \end{bmatrix}$$
(10)

$$\begin{cases} j_{11} = (1-2x)[(1-y)(m-\pi S)-v]\\ j_{12} = (1-2x)[(1-y)(m-\pi S)-v]\\ j_{21} = y(y-1)\pi S\\ j_{22} = (1-2y)(\varphi T - g - x\pi S) \end{cases}$$
(11)

Due to the fact that five local equilibrium points do not necessarily create a stable strategy for system evolution, according to the theory proposed by Friedman [27], a point is an evolutionary stable strategy that must meet the following conditions:

$$tr(J) = j_{11} + j_{22} < 0$$

$$det(J) = j_{11}j_{22} - j_{12}j_{21} > 0$$
(12)

Using Equations (11) and (12) to verify the stable status of the five local equilibrium points, we can reach the following conclusions: (1) when x > A, y = B, $\frac{dx}{dt} = 0$, $\frac{dy}{dt} = 0$, all of the x and y have stable status. (2) When y > B, x = 0 has stable status. When y < B, x = 1 has stable status. When x > A, y = 1 has stable status. When x < A, y = 1 has stable status. Regardless of the user and platform environmental factors, the news aggregation platform's choice of mainstream value information push strategy and user behavior selection will present a continuous repeated game and will finally reach a dynamic balance. The news aggregation platform will maintain the probability of A to improve, and the user will have the probability of B to the choose fatigue behavior.

3.3. Numerical Simulation and Analysis

In this part, MatlabR2016a was used for simulation. The initial value of the parameters $P=(g, s, \pi, T, \varphi, r, m, v)$ were set as (50,100,0.5,100,0.3,2,20,2). In order to analyze the influencing factors of user fatigue behavior, the experiment focused on the reward coefficient π , time cost coefficient φ , user fixed income g, and the platform's fixed reward cost v. Keeping the parameter set as P unchanged, the initial probabilities of the news aggregation platform and the user selection strategy were both 0.5. In order to visually show the change process of user fatigue behavior, the initial values of π, φ, g , and v can be adjusted, and the evolution results are shown in Figure 2:

(1) Adjust the value of π to 0.5, 1, 2. It can be seen that when the value of π increases, the user will give up the fatigue strategy faster. Therefore, the selection probability of user fatigue behavior changes inversely with the value of π . The use of continuous incentive measures by news aggregation platforms can effectively inhibit user fatigue, and at the same time, they can promote the speed of user behavior selection and decision-making and can accelerate the evolution of the system. These results are shown in Figure 2a.

(2) The time cost coefficient φ increases from 0.5 to 3. The result shows that the greater the value of φ , the greater the probability that the user will choose fatigue behavior is. When the value φ is small, the user tends to be tireless. When the user's time coefficient φ on the news aggregation platform is large, it will have a more significant impact on user expectations. Users will adopt particular self-control behaviors; that is, the probability of choosing a fatigue strategy tends to be 1. This result shows that if the platform increases the push of mainstream value information and the time needed for users to obtain preference



information increases, then the probability of users choosing fatigue behavior will increase as well. These results are shown in Figure 2b.

Figure 2. The evolution process of user fatigue behavior by adjusting different parameters: (**a**) Evolution result by adjusting the value of π , (**b**) Evolution result by adjusting the value of φ , (**c**) Evolution result by adjusting the value of g, (**d**) Evolution result by adjusting the value of v.

(3) The user's fixed income g is reflected in the content of the platform. The more significant content resources the platform provides to users, the easier it is to maintain continuous use. When the value of g is 200, the user's probability of choosing fatigue quickly drops to 0; when the value g is 50 or 100, the user has no evident tendency to give up fatigue. This result shows that if the news aggregation platform pushes too much mainstream value information, the less user preference information is obtained is more likely to affect the user's income on the platform, which will lead to a greater probability of user fatigue. These results are shown in Figure 2c.

(4) When the value of the platform reward cost v rises from 1 to 3 with a step size of 1, the probability of users choosing a behavior decreases slowly. Therefore, the more the platform pays for the cost of rewards, the more the platform's effectiveness will decrease, and the probability of the platform taking incentive measures will decrease. This result shows that if the platform reduces the push for preference information to push mainstream value information, it is equivalent to paying a cost, and the platform's attractiveness to users decreases. These results are shown in Figure 2d.

The results show that the probability of user fatigue behavior is closely related to the reward coefficient π , time cost coefficient φ , user fixed income g, and platform reward cost v. When the above parameters change, the evolutionary stability strategies are different. It can be concluded that user behavior selection is more closely related to the reward coefficient and time cost coefficient in the short term, but in the long term, user fixed income, and platform reward cost have a more obvious effect on user behavior. The higher the reward cost, the higher the probability of users choosing fatigue behavior is. It shows that the greater the cost of the platform for revenue behavior, the lower the platform's utility, which is not conducive to reaching a stable status.

Through the results of evolutionary analysis, the news platform can be guided at a macro level to formulate mainstream value information push strategies. We found that the user's stable state is closely related to the reward coefficient, time cost coefficient, user fixed income, and platform reward cost. When the above parameters change, the evolutionary stability strategy is different. Through the results of evolutionary analysis, the news platform can be guided at a macro level to formulae mainstream value information push strategies. The evolutionary game model can treat users as a group to find a balanced strategy and does not consider the diversity of users and the information capacity of each page. In order to make the mainstream value information push strategy more operational, we can further analyze the problem from the perspective of user demand and platform revenue.

4. User Demand Model and Platform Revenue Model

New aggregation platforms play an essential role in promoting ideological unification and social consensus in China as an important way for users to obtain information. At present, news aggregation platforms such as Toutiao and Tencent News have opened special areas for promoting mainstream value information (such as government achievements) to ensure a certain degree of coverage of mainstream value information. According to the survey, in addition to opening a special area for mainstream value propaganda, all of the news aggregation platforms also adopt a method of putting a certain amount of mainstream value information on the top of the homepage to carry thematic propaganda at different times points so that mainstream value information can be pushed to every user. However, personalized recommendations are still used to push information on other pages, which is not conducive to disseminating mainstream value information. Some users have minor demands for mainstream value information. If they ignore the mainstream value information on the homepage, the platform will hardly recommend mainstream value information on other pages. In order to solve this problem, a simple method is to use a reasonable push strategy to push some mainstream value information on other pages, which can be used as an auxiliary means of personalized recommendation. We assume that user demands and platform revenue are two crucial factors that affect the platform's push strategy for mainstream value information. The auxiliary push strategy to be adopted needs to consider the following factors:

(1) To not affect the platform's revenue, the push strategy that is adopted must consider user demands to reduce the occurrence of user fatigue behavior.

(2) While meeting the demands of users, it is necessary to consider the revenue of mainstream value information push, which reflects the publicity effect of mainstream values.

Due to the limited information presented on a page of the news aggregation platform, studying how to formulate strategies for the amount and content of mainstream value information on the news aggregation platform helps to ensure the news aggregation platform's revenue and to promote mainstream ideology. In order to find the equilibrium value of user demands and platform revenue for mainstream value information, we can further discuss these issues by constructing models for user demands for mainstream value information and the revenue of news aggregation platforms pushing mainstream value information.

4.1. User Group Research

According to the current prevalence of news aggregation platforms in China, we selected Toutiao to analyze the demands of the user groups for mainstream value information acquisition. It can be seen from the survey that different user groups have different demands for mainstream value information. The content of the mainstream value information propaganda includes the government's governance achievements, national development strategies, the progressive nature of the CPC, and the work dynamics of national leaders. The first method is to obtain the top 50 pieces of information recently viewed by 46 users aged 20–35 and to count the amount of mainstream value information among them. This method is characterized by the group's age level, living environment, and educational level. The second method is to obtain the behaviors of 168 users between the ages of 20 and 70. This part of the data has the characteristics of a relatively large number of users and represents the diversity of the population. Statistical analysis should be performed on the first type of user data, and the K-S method should be used [28] for verification. The verification result shows that the p-value = 0.48, so the data obey the statistical law of normal distribution (Figure 3). As shown in Figure 3, we can see that most users between 20-35-years-old see 2-4 pieces of mainstream value information in the last 50 pieces of information that they browsed. This result shows that mainstream value information has not received much attention among young people.



Figure 3. Browsing status of mainstream value information for 20-35-year-olds.

For the second type of users, Figure 4 shows multiple peaks, which partially obey the normal distribution but that generally do not obey the normal distribution. The reason for this is that different user groups have different age groups, living environments, and work needs, so the demand for mainstream value information is not the same. It can be seen from Figure 4 that 27% of users have viewed 7–9 pieces of mainstream value information. Among them, users between 50–70 years old accounted for 83% of this number. This result shows that mainstream value information receives more attention among the elderly.

The above survey shows that different user groups have different demands for mainstream value information. Therefore, it is very significant for news aggregation platforms to develop mainstream value information push strategies that meet group demand. In order to adopt a common way to express the demands of different user groups for mainstream value information, we define a user demand model in the next section.



Figure 4. Browsing status of mainstream value information for 20-70-year-olds.

4.2. User Mainstream Value Information Demand Model

Through the investigation and analysis of user behavior of news aggregation platforms, we know that user demands for mainstream value information pushed by news aggregation platforms meet a particular statistical law (such as normal distribution). Because of the current market operation mode for news aggregation platforms, the service demand model can be referred to describe user demands for news aggregation platforms to push information. The CED model [29] is generally used to describe the relative changes in the average demand for services and user prices. The CED model is based on alphafair [30] utility. In the service scenario where the news aggregation platform is pushing information to users, the information displayed on the pages of the news aggregation platform is limited.

As mentioned above, the platform increases the push for mainstream value information, and the time for users to obtain preference information increases, which will increase the probability of some users choosing fatigue behavior. As such, we assume that the amount of mainstream value information on a page manifests service prices. In this paper, the relationship between the average demand of users for mainstream value information and the amount of mainstream value information on a page is expressed by the following function:

$$\overline{Q}(count) = \left(\frac{val}{count}\right)^{\sigma} \tag{13}$$

val represents the evaluation factor of the news aggregation platform, which depends on the platform's reputation, the quality of information, etc. The value *count* represents the amount of mainstream value information on a page of the news aggregation platform. At present, the size of mainstream mobile phones is generally more than 6 inches. If we consider the default font size, each page of a news platform can generally display 3–6 pieces of information depending on the information type. In the experiment, we set the value range of *count* between 0 and 6. It should be noted that the value of *count* may be less than 1. For example, if the *count* = 0.5, it means that every two pages pushes a piece of mainstream value information. As shown in Figures 3 and 4, different user groups have different demands for mainstream value information, which means different user groups have different sensitivity levels to mainstream value information. As such, the parameter σ can indicate the sensitivity of the user group to mainstream value information.

4.3. News Aggregation Platform Mainstream Value Information Revenue Model

According to Equation (13), the number of mainstream value information pushed by the news aggregation platform will affect user demands. If the amount of mainstream value information on a page meets the demands of users, it will promote the spread of mainstream value information and will bring revenue at the same time. Otherwise, it will cause user fatigue behavior. As such, the revenue of the news aggregation platform is related to user demands for mainstream value information and depends on the extent to which user needs are met. Assuming that the total number of users are *N*, the total gross revenue of the mainstream value information on each page can be described as follows:

$$Income = N \times \overline{Q}(count) \tag{14}$$

Since the push for mainstream value information on news aggregation platforms requires costs and since costs involve multiple aspects, such as operating costs, platform incentive costs, etc., we cannot make more accurate calculations. Wang Q et al. [31] proposed a logarithmic relationship between operating expenses and the network scale. As such, we assume that the operating costs of the news aggregation platform are mainly related to the number of users and the demands of those users. Therefore, it can be assumed that the cost function of the news aggregation platform to push mainstream value information is as follows:

$$Cost = \log(N \times \overline{Q}(count)) \tag{15}$$

Therefore, the revenue can be obtained according to the following function:

$$G = Income - Cost \tag{16}$$

4.4. Simulation and Analysis

According to the above definition of the mainstream value information demand model, the demand for the mainstream value information of the user group on the news aggregation platform satisfies the normal distribution. The average demand that users have for mainstream value information meets the mainstream value information demand model. Experiments can verify the impact of mainstream value information on a page on the average user demand for mainstream value information and can simulate its impact on the mainstream value information revenue for news aggregation platforms. In the experiment, the parameters and their values were defined as in Table 3:

Table 3. Parameters and meanings.

Parameters	Meanings	Value
Ν	The total number of users of the platform	1000
count	The number of mainstream value information on a page	(0,6]
val	User evaluation factors of news aggregation platform.	1, 2
σ	The user's sensitivity to the amount of mainstream value information on a page.	1.5, 3

According to the above set of parameters, take $val_1 = 1$, $val_2 = 2$, $\sigma_1 = 1.5$, $\sigma_2 = 3$ in the experiment. According to Equation (13), we can calculate the average demand of users for mainstream value information on a page. The experimental results are shown in Figure 5.

As shown in Figure 5, when *val* is given, the larger σ is, and the more sensitive the average demand for mainstream value information of users is to the number of mainstream value information on a page. As such, the parameter σ can indicate the sensitivity of the user group to mainstream value information. Meanwhile, it can reflect the different demands of different user groups for mainstream value information. Through the user demand model, we can obtain the maximum demand of users through the amount of mainstream value information. For example, we set *val* = 1 and σ = 1.5. When the *count* = 0.3, the user demand is maximum, which means users need a piece of mainstream value information approximately every three pages. We set *val* = 1 and σ = 3. When the *count* = 0.55, the user demand is at its maximum. This means that users need a piece of mainstream value information approximately every two pages.

results are consistent with the demands of the different groups of users shown in Figure 4. On each page, the user demand for mainstream value information gradually decreases with the increase of *count*. This means that blindly increasing the amount of mainstream value information will trigger user fatigue behavior. The *val* represents the evaluation factor of the news aggregation platform. The larger the value of *val*, the more popular the platform and the greater the demand for mainstream value information from users will be.



Figure 5. The relationship between user information demands and the number of mainstream value information on a page.

According to Equations (14)–(16), we can calculate the platform revenue of mainstream value information. The experimental results are shown in Figure 6. We can find the relationship between mainstream value information and revenue. Under certain conditions for other parameters, the greater the value of *val*, the greater the platform's mainstream value information revenue is. At the same time, the greater σ is, the greater the mainstream value of information revenue is. This shows that the mainstream value information revenue of different user groups is different. Figures 5 and 6 show that if the amount of mainstream value information push is reasonable, then users will have a higher demand for mainstream value information, and the platform can obtain higher revenue. For example, if *val* = 1, σ = 1.5, and *count* = 0.3, the platform's revenue is greater, which also shows that mainstream value information will achieve a good publicity effect.

From the evolution of the game between users and news aggregation platforms and Figure 6, if news aggregation platforms blindly increase the push of mainstream value information, they can increase the revenue of such information in the short term. For example, if *val* =1 and σ = 1.5 when *count* > 1, then the platform revenue gradually increases. The reason for this is that it meets the demands of some users who prefer mainstream value information and increases the amount of information that they are exposed to, but because it reduces the push for preference information, it will cause the number of users of the news aggregation platform to decrease gradually in the long term.

The *val* and σ are essential parameters for these two models. The *val* represents the quality of the news aggregation platform. It can be seen from the experiment that the greater the value of *val*, the greater the user demand for mainstream value information and the greater the revenue of mainstream value are. As such, some top news platforms such as Toutiao and Tencent News are more effective in promoting mainstream value information. It is a critical indicator that determines the amount of mainstream value information on a page.



Figure 6. The relationship between the revenue of mainstream value information and the number of mainstream value information on a page.

The purpose of the mainstream value information push strategy developed by news aggregation platforms is to strengthen user attention to the mainstream value information and public issues. Therefore, different information push strategies can be formulated according to the preferences of different user groups. The amount of mainstream value information may not require intervention for some users who prefer mainstream value information. For users who are not concerned about mainstream value information, if the government wants to promote the dissemination of mainstream value information. The platform cannot blindly increase the amount of mainstream value information. The push strategy should consider the demands of users and the revenue of mainstream value information to push a reasonable amount of mainstream value information.

5. Analysis of The Effect of Mainstream Value Information of Toutiao

At present, news aggregation platforms such as Toutiao and Tencent News all use the first two positions on the platform's homepage to push mainstream value information to report on the government's achievements, publicize mainstream values, and promote ideological unity and social consensus. Because this part of the information push location is remarkable, the push method is fixed, and the number of users affected is large, as is the amount of mainstream value information that is pushed. The impact of the push content on the promotion effect can be analyzed through the user preference for this part of the information and can further provide a basis for the push of mainstream value information.

This paper takes Toutiao as the research object and uses the number of comments as an important indicator to evaluate user attention to mainstream value information. We obtained the first two pieces of information from Toutiao from 15 January 2021 to 25 January 2021. We took a sample every 15 min to obtain a total of 1624 valid data and used data visualization methods to draw a scatter chart of the data in time series (Figure 7), which can intuitively reflect the dissemination effect of mainstream value information.

(1) As mentioned above, the user mainstream value information demand model was used to determine the relationship between the average user demand for mainstream value information and the amount of mainstream value information on a page. As shown in Figure 7, user attention to the top information is generally far greater than it is regarding second piece of information, which, to a certain extent, reflects the average demand

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that users have for mainstream value information and the amount of mainstream value information on a page that meets the demand model. This means that pushing two pieces of mainstream value information on the homepage has generally exceeded the demands of users.



Figure 7. The effect of mainstream value information on "Toutiao".

(2) The data demonstrate that the second piece of information received a high degree of attention on 18 January and 19 January. The information content included headlines such as "2020 Anti-Corruption Report" and "China's GDP exceeds 100 trillion in 2020". This fully shows that users have a high degree of attention to this type of content. As we mentioned previously when discussing the evolutionary game model above, the parameters g and φ are very important for users to reach stable points, so the content setting and how to innovate forms and expressions in the process of pushing mainstream value information to enhance attractiveness further are also essential research content for mainstream ideological communication.

(3) As shown in Figure 1, Toutiao has a large number of users in China. From the data shown in Figure 7, relatively few comments on mainstream value information are on the top of the homepage. Therefore, the publicity effect of the existing mainstream value information is limited. If users usually do not pay much attention to mainstream value information, it is still difficult to promote the spread of the mainstream ideology by simply using the homepage push method. Therefore, it is necessary to adopt supplementary means to enhance the dissemination of mainstream value information.

Based on the above analysis, news aggregation platforms should consider pushing some mainstream value information on each page of their news aggregation platform. The critical point here is that the news aggregation news platform should consider the revenue and the demands of users.

6. Conclusions

In order to study the information cocoon room problem that may be caused by personalized recommendation technology and that further promotes the dissemination of mainstream value information, this paper constructs an evolutionary game model between users and news aggregation platforms. The simulation and analysis of the evolution process concluded that the reward coefficient π , time cost coefficient φ , user fixed income *g*, and platform reward cost *v* are important factors in achieving the evolution equilibrium. Through the results of evolutionary analysis, news platforms can be guided at a macro level to formulae mainstream value information push strategies. However, the evolutionary game model does not consider the diversity of users or the information capacity of each page. According to user research, we found that different user groups have different demands for mainstream value information. Considering that the information presented on a page of the news aggregation platform is limited, we propose a user demand model and platform revenue model to guide the platform to formulate the amount of mainstream value information that would be accepted by users. The *val* and σ are essential parameters for these two models. The *val* parameter represents the quality of the news aggregation platform. The value of σ reflects the demands of the group for mainstream value information on each page is determined by these two parameters. Then, we proposed that platforms formulate different push strategies for mainstream value information for different propaganda purposes and user groups through user research and simulation experiments. Finally, we analyzed the effect of mainstream value information dissemination on Toutiao. The results of the analysis are consistent with the viewpoints presented in this paper.

There are several limitations of this study that must be acknowledged. First, we only investigated the browsing behavior of Toutiao users, so the user demands for mainstream value information are influenced differently than they are on different news aggregation platforms. Therefore, future studies should further explore user demands on other kinds of news aggregation platforms. Second, this paper suggests the number of pieces of information to be displayed on one page of the news aggregation platform. The present study does not distinguish between different types of the cell phones. For example, different cell phone sizes and font sizes may alter the results and the respective interpretations. Future studies may analyze user demands according to a specific kind of product. Third, due to the small amount of data, this paper assumes the user demand model and considers user sensitive parameters for mainstream value information σ . Future research may involve more data to fit the values of the parameters.

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