Modelling of management of herd behavior of consumers at sales markets based on reflexive approach

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Abstract: The model of management of herd behavior of consumers in the product markets based on a reflexive approach have been proposed and substantiated. The model of reflexive management of herd behavior of consumers at product sales markets takes into account the impact on the decision-making process by consumers of information about the number of consumers who have already bought the product. The likelihood of manifestation of herd behavior by a consumer is based on such characteristics as individual personality characteristics, awareness, limited time for making a decision. The proposed model can be used to get the required number of customers, increase volume of sales and generate additional financial profit based on low-cost methods of reflexive management. Promising areas of research have been identified.

Key-Words: reflexive management, consumer behavior, management of herd behavior of consumers, reflexive models, consumer irrationality, product sales market.

1 Introduction

The relevance of research in the field of behavioral economics was emphasized by the scientific community by awarding the 2002 Nobel Prize to the researcher of irrational consumer behavior Kahneman D. and Tversky A. for the study of the formation of judgments and decision-making in conditions of uncertainty [1], and also in 2017 to Thaler R. for identifying a way to influence the process of making group and individual decisions [2].

Among modern researchers, the issues of managing herd behavior of consumers in their works are considered by Kahneman D., Tversky A. [1], Thaler R. H., Sunstein C. R. [2], Soros G. [3], Barden F. [4], Klyucharev V. [5], Voronovitsky M. M [6, 7, 8], Turlakova S. S. [9, 10, 11], Breer W. W. [12], Chkhartishvili A. G. [13], Lepa R. N. [14], Chirkova E. V. [15], Strelets I. A. [16], Svetlov K. V. [17].

However, today many issues related to the methods and models of herd behavior management for its practical regulation and forecasting of demand for products at the markets remain insufficiently studied.

There is a hypothesis that there is a way to persuade the consumer to buy the proposed product (good or service), influencing the factors on which the manifestation of his herd behavior depends. In particular, informing the consumer about the result of the decision to purchase the product by the majority of other consumers and / or authority, in the presence of low awareness and / or limited time to take a decision.

2 Problem Formulation

Herdness is inherent in man as a biological being and its manifestations are found in all spheres of life, including the economy. In markets herd behavior is a case of irrational consumer behavior and is expressed in the fact that the consumer decides to buy the product, imitating the decisions of most other consumers or the leader / authority of opinions. Herd behavior arises due to the fact that the consumer wants to avoid risks in a situation of uncertainty and increase their own confidence in getting what they want [4]. Examples of consumer behavior in the markets are mass withdrawals of deposits from banks, the emergence of financial bubbles at financial markets, spontaneous purchases under the influence of advertising incentives ("Black Friday") and other similar sales. It is proved that the irrationality of economic agents is natural, and therefore predictable and manageable [1].

In 2017 behavioral economist Thaler R. received the Nobel Prize for formulating the theory of pushing – the ability to influence the process of group and individual decisions through positive reinforcement

and, as it were, indirect guidance [2]. The most well-known and method of indirect information influence at management theory is the method of reflexive management [18, 19]. Reflexive management means the transfer of the original parcels by the subject of management, on the basis of which the object will make a decision in the necessary way. This approach makes it possible in the course of management to take into account the peculiarities of consumer thinking and, accordingly, to influence the line of their behavior.

The ability to predict and manage irrational behavior opens new opportunities for companies to fight for consumer favor in today's competitive environment, accelerate the pace of development and innovation at markets. Therefore, it is important to modeling the management of herd behavior of consumers at the markets, which can be used as a marketing tool to increase demand for a particular product or group of products.

3 Problem Solution

Suppose there is a market in which products A are sold, where there are many consumers N who are ready to meet their needs by purchasing product A. Specific consumer from the set N denote as H_i, where $i = \overline{1, N}$.

Determining the number of consumers N is similar to determining the capacity of a market in which actual sales data and current demand data based on marketing research, open source information, or specialized queries can be used.

In order to start managing consumer behavior, the subject of management (SM) needs to specify the purpose of management. To do this, the SM determines the need to sell products A at a price of W in the amount of AW. This can be determined by the following factors:

1. Encouraging the earliest possible sale of the purchased batch of products to release the funds spent on its acquisition.
2. Encouraging buyers to buy a product that is no longer in good demand or expires.
3. Increasing sales of goods in order to meet or exceed the indicators of the existing sales plan, etc.

Assume that there are 2 types of agents among consumers: agents of the first type tend to buy the product regardless of its advertising, agents of the second type in the absence of reflexive management (eg, advertising) are not inclined to buy the product. Denote $Q \in [0; 1]$ - the share of agents of the first type, $1 - Q$ - the share of agents of the second type, n_1 - number of consumers per share Q, n_2 – number of consumers per share $1 - Q$.

The set of possible actions of each agent consists of two actions: a (accept) corresponds to the purchase of goods or services, and action r (reject) – refusal to purchase a product or service. We assume that the agents of the second type with probability $p(Q)$ to choose the action of a.

Based on the management model of Chkhartishvili A. G. [13], we will develop a modified model in accordance with the concept of reflexive management of herd behavior of consumers at the market.

If the decision result of the first type of agents Q is common knowledge, then the agents expect that it is the Q agents who will acquire the product, and in fact observe that the product will be acquired by $x(Q)$ agents.

$$x(Q) = Q + (1 - Q)p(Q) \ (1)$$

Due to the fact that this influence is evident - consumers see that the product tends to buy more people than they imagined. $\forall Q \in [0; 1] Q \leq x(Q)$

The subject of management, which applies the reflexive management, forms in the agents of the second type the idea Q_2 of the value of the parameter Q – the share of agents who tend to buy the product without the presence of the reflexive management influence.

Given that agents are unaware of manipulation by the center (SM), they expect to see Q_2 agents purchase the product. In fact, after the reflexive management influence it will be acquired:

$$x(Q, Q_2) = Q + (1 - Q)p(Q_2) \ (2)$$

Thus, SM performs reflexive management by transmitting information about the number of consumers who have already chosen the product, which increases the likelihood of herd behavior in other consumers and inclines them to make decisions in favor of purchasing product A.

Reflexive influence forms a structure of consumer awareness that leads to a change in their decision-making model and inclines them to make decisions prepared in advance by the managing party. Thus, the presented model reflects the ability of SM to reflexively manage the decision-making process and the manifestation of herd behavior by potential consumers at the market.

The determination of the share of agents of the first type Q is based on data on actual sales of products and the number of customers n_1 for a certain period of time before the application of any reflexive management or management.

$$Q = (n_1 * 100\%)/N \ (3)$$

After determining the share of consumers of each type, we calculate the result of consumer decision-making before the beginning of reflexive management influence. To do this, determine the probability $p(Q)$.

We assume that $p(Q)$ – does not fall on [0; 1] a function such that $p(r) = \varepsilon, p(a) = 1 - \partial$, where ε and ∂ are constants belonging to a unit segment, such that $\varepsilon \leq 1 - \partial$.

Meaningfully ε corresponds to the fact that some agents of the second type are "wrong" and, even if they believe that all other agents have a second type, they buy the product. The constant ∂ characterizes in some sense the tendency of agents to the manifestation of herd behavior due to reflexive influence. Where $\partial = 0$ it means a consumer prone to influence, $\partial = 1$ - an independent consumer who is not prone to herd behavior due to influence. The individual case $\varepsilon = 0$, $\partial = 1$ corresponds to independent agents of the second type who refuse to purchase the product.

To understand what proportion of consumers of product A is prone to the manifestation of herd behavior, it is necessary to conduct a marketing study of the target audience of product A. All costs for the study of the target audience and determine its characteristics are denoted as z_1.

General characteristics of the target audience of consumers, such as age, gender, place of residence, etc., are collected from free analytics services (eg, Google Analytics) or on the basis of collected data from the customer base of SM.

To calculate the probability of acquisition $p(Q_2)$ product A share of consumers 1-Q after the implementation of reflective management influences use the method of questionnaires of a sample of many consumers of the target audience of the product. Thus we determine the tendency of the consumer to imitate someone else's opinion, which is the opposite of ∂ and expressed as the coefficient of inheritance K_i^{1-Q}, where i is the ordinal number of the consumer being interviewed, from the share of consumers $1 - Q$.

Coefficient of propensity to imitate K_i^{1-Q} will consist of the following identified consumer qualities that need to be identified:

1. The level of emotional instability, en_i^{1-Q}.
2. The level of introversion, in_i^{1-Q}
3. Level of conformism, kn_i^{1-Q}
4. Level consumer awareness / experience, d_i^{1-Q}

5. Estimation of time allotted for decision-making, v_i^{1-Q}

To determine the required parameters in this study, it is recommended to use a multifactorial questionnaire of Kettel's personality [20].

The obtained survey results are normalized into parameters, including individual consumer characteristics $en_i^{1-Q}, in_i^{1-Q}, kn_i^{1-Q} \in [0; 1]$ that are equivalent in importance to each other in terms of influence on the manifestations of imitation in consumer behavior in markets, and external factors that are also equivalent to each other and relate to the assessment of the probability of error prediction of reward (risk) $d_i^{1-Q} \in [0; 1], v_i^{1-Q} \in [0; 1]$. These parameters, consisting of individual characteristics of the consumer and external factors form the overall coefficient of imitation of the consumer $K_i^{1-Q} \in [0; 1]$, which will be calculated by the formula:

$$K_i^{1-Q} = 0.5 \left(\frac{1}{3} en_i^{1-Q} + \frac{1}{3} in_i^{1-Q} + \frac{1}{3} kn_i^{1-Q} \right) + 0.5 \left(\frac{1}{2} d_i^{1-Q} + \frac{1}{2} v_i^{1-Q} \right) \ (4)$$

The inverse of the propensity to imitate is the tendency to maintain one's opinion and maintain independence from reflexive management. What for a particular consumer is calculated as:

$$\partial_i^{1-Q} = 1 - K_i^{1-Q} \ (5)$$

And the calculation for the entire share of consumers surveyed:

$$\partial = \frac{1}{n_3} \sum_{i=1}^{n_3} \partial_i^{1-Q} \ (6)$$

Where n_3 - the number of consumers from the share $1 - Q$ who took part in the survey.

We will form the value ε as making the wrong decision in spite of the currently formed error of prediction of remuneration.

Based on the obtained parameters, using the scientific method of extrapolation of the sample results, the SM can take the calculated value $p(Q_2)$

$$p(Q_2) = 1 - \partial \ (7)$$

Then, according to (2), we calculate the predicted result of consumer decision-making in the market after reflexive managerial influence.

To form a reflexive managerial influence, SM engages a thought leader through material incentives. Material incentives may include direct payment under a contract for the provision of

advertising services, barter, discounts, bonuses, etc. The cost of attracting an opinion leader is denoted as z_2.

In order to correctly identify the opinion leader for use in promoting a particular product, it is necessary that the target audience of consumers of the product and the target audience of the opinion leader coincide. Show business stars, experts and bloggers can be thought leaders. The task of SM is to choose a leader with the maximum coverage of the target audience of buyers of goods.

To do this, the SM can use ready-made search services, setting the necessary parameters of the target audience (for example, TrendHero), conduct its own research of audiences of various opinion leaders or use a method of questioning a sample of many consumers of the target audience.

The promotion channel of the advertising campaign is chosen according to the activity of the audience of the chosen opinion leader or several promotion channels are used, in which the most active audience of consumers is A.

The total cost $z(Q, Q_2)$ for the introduction of the concept of reflexive management of herd behavior of consumers at the market of products is calculated as the sum of the costs for determining the characteristics of the target audience Z_1 and attracting the opinion leader Z_2 according to the formula:

$$z(Q, Q_2) = z_1 + z_2 \qquad (8)$$

If the income of the center is proportional to the share of agents who buy the product, and the cost of introducing reflexive management: $z(Q, Q_2)$ is a non-decreasing function Q_2, the target function of the center (the difference between income and expenses) in the absence of reflexive management is 0, and if available reflexive management:

$$F(Q, Q_2) = NWx(Q, Q_2) - z(Q, Q_2) \qquad (9)$$

Therefore, the influenceiveness of reflexive management can be defined as the difference between $F(Q, Q_2)$ and $x(Q)$, and the task of reflexive management can be written as

$$F(Q, Q_2) - NWx(Q) \to \max_{Q_2} \qquad (10)$$

Consider the constraints for problem (10).

The first restriction: $Q_2 \in [0; 1]$, and $Q_2 \geq Q$. This means that reflexive management influence will not be appropriate and advertising costs will not pay off if a sufficient proportion of agents acquire the product in the absence of reflective management influence.

The second restriction $Q_2 \in [0; 1]$ means that agents of the second type must observe the value of the share of agents who buy the product, not less than they were told by the center:

$$x(Q, Q_2) \geq Q_2 \qquad (11)$$

Substituting (2), we obtain:

$$Q + (1 - Q)p(Q_2) \geq Q_2 \qquad (12)$$

Therefore, the optimal stable solution of the reflexive management problem will be the solution of the maximization problem (10) under constraint (12).

$$\begin{cases} F(Q, Q_2) - NWx(Q) \to \max_{Q_2} \\ Q + (1 - Q)p(Q_2) \geq Q_2 \end{cases} \qquad (13)$$

where the function $F(Q, Q_2)$ takes into account the result of the decision-making by consumers $x(Q, Q_2)$ after the reflexive management action.

If we understand stability as a complete coincidence of the results expected and observed by agents (that is required performance (12) as equality), then the only stable reflexive management will be a message from the SM that all consumers are consumers of the first type, that is $Q_2 = 1$.

During the reflexive influence, the subject of management will also transmit information to consumers at the market of products for which it is $d_i^{1-Q} \to 0$ - consumer awareness decreases, and $v_i^{1-Q} \to 1$ - the consumer becomes limited in time to make a decision to purchase the product

For this opinion leader, a technical task for advertising is formed, which provides for the transfer of information about the number of consumers who have already bought a product, limited time to make a decision and the need for high competence to make an independent decision ("difficulty").

Reflexive management influence will be carried out by means of an advertising campaign with the involvement of an opinion leader on the target audience of consumers of products A, which consists of consumers of type Q and 1-Q.

After application of reflexive management influence it is necessary to carry out fixing of the actually received data among which can be: fixing of the received phone calls, messages, appeals to office, site visits. Further work with the customer call received as a result of reflexive management

remains with the sales department. The percentage of customers who make an actual purchase after leaving their request depends on the competence of the sales team.

In the event of a new need to increase sales of goods, the company-seller can use the proposed model (13) of reflexive management of herd behavior of consumers at the market again.

4 Conclusion

Thus, using the modeling the reflexive management of consumer behavior at markets, it will take into account the peculiarities of herd behavior of consumers and push the object of management (buyer) to make the decision necessary for the subject of management (seller).

The model of reflexive management of herd behavior of consumers at the product sales markets is developed on the basis of the model of information management of Chkhartishvilli and refined using the factors obtained as a result of the analysis that affect the likelihood of a consumer showing herd behavior. The model of reflexive management of herd behavior of consumers at product sales markets takes into account the impact on the decision-making process by consumers of information about the number of consumers who have already bought the product. The likelihood of manifestation of herd behavior by a consumer is based on such characteristics as individual personality characteristics, awareness, limited time for making a decision. The using of the model of reflexive management of herd behavior of consumers at product sales markets as a marketing tool allows the selling company to get the required number of customers, increase volume of sales and generate additional financial profit based on low-cost methods of reflexive management.

A promising area of research is the implementation of the presented model of reflexive management of herd behavior of consumers at the market.

References:

[1] Kahneman D., Tversky A., Prospect theory: An analysis of decision under risk, *Econometrics,* №47, 1979, pp.313-327.

[2] Thaler Richard H., Sunstein Cass R., *Nudge: Improving Decisions about Health, Wealth, and Happiness*, Yale University Press, 2008.

[3] Soros G., *The new paradigm for financial marketers: The credit crisis of 2008 and what it means*, Philadelphia: Public Affairs, 2008.

[4] Barden F. *Hacking marketing*, M: Myth, 2014.

[5] Klyucharev V., Zubarev I., Shestakova A., Neurobiological mechanisms of social influence, *Experimental Psychology*, No. 4, 2014, pp. 20–36

[6] Voronovitsky M. M., Tsvetkov V. A., Mechanisms of herd behavior of market participants, *ENSR*, №3 (66), 2014, pp. 17-36.

[7] Voronovitsky M. M., Model of herd behavior in the formation of demand, *Journal of Economics and Mathematical Methods (EMM)*, vol. 45, №1, 2009, pp. 101-109.

[8] Voronovitsky M. M., Herd behavior with Bayesian choice and linear sequence of interaction, *Journal of Economics and Mathematical Methods (EMM),* vol. 46, №. 1, 2010, pp. 92-103.

[9] Turlakova S. S., Causes of herd behavior in the economy, *Theoretical economics,* №6 (12), 2012.

[10] Turlakova S. S., *Reflexive management of herd behavior at enterprises: concept, models and methods: monograph*, NAS of Ukraine, Institute of Industrial Economics, Kiev, 2020.

[11] Turlakova S. S., Tools for reflexive management of herd behavior of agents in enterprises, *Economic management: theory and practice: Coll. Science. pr. - K: IEP NASU*, 2017, pp. 133-149.

[12] Breer V. V., Models of conformal behavior. Part 2, *Mathematical models. Management problems*, №2, 2014, pp. 2-17.

[13] Chkhartishvili A. G., *Theoretical and game models of information management*, M.: ZAO PMSOFT, 2004.

[14] Lepa R. N, Solodukhin S. V., Analysis of the influence of the theory of information cascades and herd behavior of agents on the formation of financial bubbles, *Industrial economic,* № 4 (56), 2011, pp. 256-262.

[15] Chirkova E. V., Sociological and economic theories of group behavior and their applicability to explain herd behavior in financial markets, *Corporate finance*, №2, 2010, pp. 16-26.

[16] Strelets I. A., Information cascades as a threat to the security of the information space, *Economics. Entrepreneurship. Environment,* Vol. 2, № 54, 2013, pp. 73-76.

[17] Svetlov K. V., Herd behavior in the stock market: analysis and forecasting, *Economics and mathematical methods*, vol.. 55, № 2, 2019, pp. 81-97.

[18] Turlakova S. S., Shumilo Y. N., Approaches to managing herd behavior of consumers in the markets, *Scientific Bulletin of the Donbass State Engineering Academy*, №2 (20) E, 2016, pp.186-191.

[19] Lepa R. N., Shumilo Y. N., Herd behavior as a consequence of the irrationality of consumers in the markets, *Bulletin of Economic Science of Ukraine*, №2 (4th quarter), 2016, pp.111-113.

[20] Kapustina A.N., *R. Kettell's multifactorial personal methodology*, SPb, 2001.