

# Modeling Decision Making with Respect to Consumer's Psychographical Portrait

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## Abstract

Decision making processes are driven by various needs. Needs determine our actions, directing us towards reducing motivational tension. This article presents developed consumer representation model. The focus is set on how, using chosen mathematical operators, we can model consumers decision making with different psychographical description. Developed approach to decision making modeling is versatile for consumers with both extremely emotional and extremely rational cognitive abilities. In the case study introduced is exemplar consumers segmentation and showed is that developed two-step procedure of obtaining the decision works.

**Keywords:** consumers choice theory, decision making, psychographical segmentation, triangular norms

## 1 Introduction

Research on mechanisms of motivational stimuli is in the scope of interest of many diverse sciences, including biology, artificial intelligence, economics and psychology. Understanding how human cognitive abilities are related to the decision making is crucial, as having appropriate knowledge would allow to control these processes. Analyzing preferences and human reactions to so called marketing communication are of interest in marketing and economics since many decades.

The objective of this paper is to present an interdisciplinary approach to modeling human behavior. Mathematical framework, which is applied is standard and well known. The originality of the idea lies in the fact that it is applied to a consumer representation model developed on the basis of two prominent theories: Maslow's need hierarchy and Lewin's field theory. Consumer representation model plus chosen operators used to describe human behavior allow to describe the whole spectrum of human decision making, including behavioral biases. Developed approach can be applied also to marketing communications research. In this article discussed is how developed model can be used to describe consumers with different psychographical portraits (a concept commonly applied in marketing). Presented are several hand-picked operators, which combined with our consumer representation model provide us with satisfactory results. Please note, that the

objective is not to describe applied, and at the same time commonly known operators, but to describe how consistent and coherent are psychological theories that lay at the background of our consumer representation model with recent marketing communications research, and how our approach can be applied to model human behavior. The originality of ideas presented in this paper lie in the fact that known theories were applied and joined together to form a consumer decision making model capable to reflect decision making process from the point of view of social sciences. Moreover, presented approach is compliant with decision making perspective present in marketing research.

The ground rule of successful marketing communication is to gather and process relevant data. As it turns out, drawing meaningful conclusions from gathered information might be aided by including psychophysical aspects of human behavior and analyzing, how it may participate in the decision making process. Hence, important questions arise: how to model consumer responses to prepared and directed (promotional) messages. Being able to understand how humans react to received information would allow to plan and execute successful promotional campaigns. In the article discussed is how consumers react at the most basic levels of motivational stimuli recognition and described is how a single decision might be taken. The explanation is supported with a model of multi-criteria consumer's decision making process based on our own consumer representation model. The article's perspective focuses on the decision making processes from the point of view of marketing communications. Described is psychographical consumer's segmentation technique. Presented is methodology of how positive preferences can be aggregated into the decision. The article is structured as follows: section 2 introduces the reader into the topic of consumer's decision making. In section 3 described is developed approach to consumer decision making modeling. In section 4 introduced is a case study, where the model is applied.

## **2 Link between marketing communications and decision making**

Psychologists indicated that susceptibility to marketing communications depends on subject's personality. One of the most often used approach to the theoretical research on motivation and behavior concerns susceptibility to various forms of marketing. Recognizing mechanisms of the decision making and skilful targeting of particular groups of consumers brings revenue.

Most scientists from the area of motivational stimuli and personality research discuss dualistic divide between emotion and reason [1], [p. 2]. Naturally, there is unequal division between the impact of emotional selves and reasonable selves on one's behavior. Our personality determines, which side of nature influences one's actions. Compartmentalizing our character into these two parts led into the understanding of behavior as a reaction to certain set of motivational stimuli. Psychologists evaluate our actions according to one's rationality. According to this scale, on the one end there is extremely rational behavior, and on the other end extremely emotional behavior. Susceptibility to marketing communications can be evaluated in exactly the same manner.

Decision making process, according to marketing specialists, is divided into four steps:

1. Need's recognition.
2. Search for information.
3. Options comparison.
4. Decision, [9] [pp. 214 - 215].

My aim was to model a general decision making process, applicable for the microeconomic theory of consumer's choice, but also, which would be valid from the point of view of marketing communications. Each of these four steps is present in developed model. This article focuses on presenting compatibility of marketer's perspective on decision making with our model. Applied are mathematical operators, with different properties, which allow to compute correct decisions, without prior knowledge, which psychographical type of consumer we are dealing with. In further parts of this paper discussed is how, with the use of developed model involved can be causality. Described is a case study of 8 consumers with different psychographical segmentation. The reason, why it is important to investigate, how one's psychological portrait influences decision making is very important. It has been shown, that knowing target's rationality type helps in choosing right marketing communication's channels and messages. Specialists developed models of psychographical segmentation of consumers, that allow them to successfully plan promotional campaigns [9] [p. 213]. Traditional demographical and geographical segmentation is now enriched with these new aspects.

### 3 Developed model

In this section discussed is developed approach. Most importantly, showed is, how this model is able to represent decision making process accordant with 4-step definition given in section 2.

Decision making is a cognitive process, which is initiated by needs recognition. Consumer is able to name motivational stimuli influencing some decision in general. Number of factors influencing a decision may be infinite, but in practice we never have to analyze infinite amount of arguments. The so called cognitive simplification process usually takes place and consumer makes the decision based on few arguments, [12] [pp. 111 - 128]. Simplification of cognitive processes is a theme thoroughly and successfully researched by H. A. Simon, [11].

Consumer representation model was built on two prominent psychological theories: Maslow's needs theory and Lewin's field theory. For detailed description of these two please refer to: [6], [7] and [8]. Most important elements of these two theories, which were inspiration for this model are following:

- humans can be represented mathematically (K. Lewin),
- this representation has to describe individual's psychophysical field: all forces influencing one's behavior (K. Lewin),
- these forces (which are in up-to-date psychology called cognitive processes and their sources) determine our decisions (K. Lewin),

- on the most prime level forces influencing our decisions can be translated into needs (A. Maslow).

Combining these information to form a model that will represent a consumer in the context of a single decision problem we obtain a vector-based model in a following form:

$$V_A = [ m_1, m_2, \dots, m_n ]$$

where  $V_A$  is a vector of needs that concerns particular decision problem. Factors  $m_1, \dots, m_n$  represent all motivational stimuli that influence discussed decision.

As was mentioned before, human beings tend to simplify cognitive processes. Therefore, though we can name plenty needs, real-life decision making process is based on a few. In order to include causality in the decision we will take into account typically 2 vectors gathering motivational stimuli. First one will contain initial evaluations of factors influencing a particular decision. It will correspond to the situation when a person considers certain purchase for the first time. These initial evaluations might be corrected, when a consumer faces a particular product. In such case constructed is second vector that corrects evaluations gathered in the first vector. If the person is undecided and considers the same product several times, more vectors can be created, but typically we will analyze two vectors. We name these two vectors as premises (initial vector) and priorities (second vector). Detailed description on chosen approach is in [3] and [4].

Numbers contained in these vectors describes consumers attitude towards certain factors influencing the decision. Information gathered in premises and priorities vectors have uncertain character. As at this point my research on consumer behavior is at the initial state, in this article analyzed are only fuzzy sets, as a framework applied to describe consumer's attitude towards certain stimuli. We say that an element  $x$  belongs to the fuzzy set  $A$  with a degree  $\mu(x)$  and denote it as the pair  $(x, \mu(x))$ . A fuzzy set  $A$  is defined as  $A = \{(x, \mu(x)) : x \in X\}$ . A fuzzy set  $A$  in the universe  $X$  is represented by the membership function  $\mu_{A,X} : X \rightarrow [0, 1]$ . Each element of premises and priorities vector describe how strongly given factor is influencing the consumer. Please note, that in future author plans to analyze also other models of uncertain information and their suitability for developed approach.

To sum up, each factor can be evaluated on the scale  $[0, 1]$ , where the greater is the value, the stronger influence has the particular factor on the decision. Such flexible scale of arguments evaluation allows to model real-life processes more accurately. To premises and priorities vectors applied is an operation of moderation. Functions, which may be applied are t-norms. Of course this is not an exclusive list. In this paper main focus is put on compatibility of presented model with decision making approach based on psychographical segmentation, not on description of functions. With the use of moderation procedure obtained is final vector, based on which performed is final decision aggregation. Again, there is plenty of aggregation operators discussed in literature, but for the purpose of model demonstration and due to space limitations in this article discussed are only t-conorms.

In order to compare how two different products satisfy one's needs it will be convenient to produce a single numeric value. This number should inform us how good is given product. In order to do so, at first included are premises, which gather general attitudes towards the decision. Then, premises are moderated with

priorities. In the frame of fuzzy logic employed can be, for example, lattice operations max and min for aggregation of information. Utilized can be also a generalized concept of the fuzzy sets connectives *union* and *intersection*. These are the mentioned before triangular norms, for short t-norms and t-conorms respectively, [5]. t-norm  $t$  and a t-conorm  $s$  are mappings  $t, s : [0, 1] \times [0, 1] \rightarrow [0, 1]$ , which satisfy conditions:

- associative, i.e.  $t(a, t(b, c)) = t(t(a, b), c)$ ,  
 $s(a, s(b, c)) = s(s(a, b), c)$  for all  $a, b, c \in [0, 1]$ ,
- commutative, i.e.  $t(a, b) = t(b, a)$ ,  $s(a, b) = s(b, a)$   
for all  $a, b \in [0, 1]$ ,
- monotonic, i.e.  $t(a, b) \leq t(c, d)$ ,  $s(a, b) \leq s(c, d)$   
for all  $a, b, c, d \in [0, 1]$  such that  $a \leq c$  and  $b \leq d$ ,
- 1 is the neutral element of t-norm and 0 is the neutral element of t-conorm,  
i.e.  $t(a, 1) = a$ ,  $s(a, 0) = a$   
for all  $a \in [0, 1]$ , [5].

If t-norm  $t$  and t-conorm  $s$  satisfy the generalized De Morgan law  $s(a, b) = 1 - t(1 - a, 1 - b)$ , they are called dual triangular norms.

Apart from some popular triangular norms, applied will be a special type of triangular norms called strict (continuous and strictly monotone) generated by additive generators. The justification of suitability of strict norms has been already discussed in [3]. Strict norms are discussed to greater extent in [2].

In order to moderate premises with priorities used are t-norms. Applying a t-norm to correct general attitudes with specific preferences towards a particular product gives a vector of moderated values. Next, in order to be able to compare the extent to which different products satisfy the need, applied are t-conorms for aggregation. The decision ranges from 0 to 1. The stronger is the result, the better this particular product fulfills consumer's needs. This article is focused only on mappings from  $[0, 1]$  to  $[0, 1]$  interval. Bipolar information processing is out of scope of this article.

In the case study applied are following t-conorms:

- max,
- probabilistic sum,
- bounded sum,
- Nilpotent maximum,
- Einstein sum,
- t-conorm generated with arc sinus function,
- t-conorm generated with tangent (argument is multiplied by  $\frac{\pi}{2}$ ),
- t-conorm generated with arc tangent hyperbolic.

Moderation is performed with t-norms dual to t-conorms listed above. Please note, that some of chosen t-conorms have the property of saturation. Different t-conorms have different tempo of saturation. Thanks to this, cognitive simplification process can be modeled.

Chosen were several popular operators. There are also other functions, which can be applied in this model. The objective of this paper is to show compatibility of presented model with marketing communications research and highlight the benefit of a 2-step procedure in this context.

In next section presented is a case study, where applied is described procedure.

## 4 Case Study

In this case study illustrated is how different consumer behaviors (analyzed in accordance with psychographical distinction known in marketing studies) might be reflected with aggregation techniques described in section 3. Case study revolves around 8 consumers facing a decision regarding a purchase of a TV. Case study is based on three different types of consumer profiles. Customers are intentionally grouped and categorized, according to common set of features, in this case according to psychographical description. Distinguished are following consumer profiles:

1. Emotional Type (EE) - profile of a person, who behaves in unexpected way. He might change his mind quickly and inconsistently with previous opinions. EE's priorities substantially differ from premises.
2. Rational Type (RR) - profile of a person, who is partially susceptible to communications. RR is not changing his mind substantially and immediately.
3. Insusceptible Type (SS) - profile of a person, who is not susceptible to stimuli arising during the phase of priorities evaluation. Insusceptible person is not changing his opinions. His premises are exactly the same as priorities.

Suggested three profiles correspond to the standard categories, describing one's susceptibility to marketing communications. It is often repeated, that susceptibility, meaning openness, sensitivity or impressionability is a feature, for which marketers fight for, [13] [p. 78]. In future author plans also to research different methodological approaches to consumers segmentation.

To be able to compare models described in section 3, used are the same arguments as premises and as priorities for all 8 consumers. Evaluations present in vectors are individual, depending on person's characteristics. Discussed are three consumers with rational attitude towards decision making, three insusceptible (or in other words stubborn) and two consumers with emotional type of personality.

For the purpose of this case study, discussed are following 5 premises (and priorities) influencing the purchase of a TV.

1. Consumer is entertained while watching TV.
2. He needs the TV for educational reasons.
3. One thinks that the TV is a nice furniture-like gadget and fits to his interiors.
4. The TV has a Wi-Fi module.
5. The TV comes with extra equipment, like stand-alone speakers.

These are common criteria, which are analyzed in the context of the decision. The character of these arguments is varied. Part of them should be more carefully

analyzed, when discussing a general decision regarding the purchase of a TV. Some are more reasonable to consider, when (after) consumer faces a particular product. In the next subsection discussed are individual premises and priorities vectors for rational, stubborn and emotional types of personalities.

#### 4.1 Consumers' vectors description

The main interest of this case study is to investigate various values of premises and priorities and the influence of this variety on the decision. Consumer's profiles are accordant with mentioned segmentation and we will see that developed approach provides results coherent with what marketing studies show. The case study is based on positive premises only. Evaluation of premises and priorities is performed separately for each consumer profile. Vectors of premises are denoted as  $P_{XX}$ , where  $XX$  is the name of consumer (case), to which this vector belongs. Vectors of priorities are named  $R_{XX}$ .

First described are vectors of premises and priorities characterizing insusceptible kind of consumers. Distinguished are three cases. First case (SS1) describes a person, who is highly convinced that he needs the TV. All evaluations of premises and priorities are equal to 0.8. Second (SS2) describes a person, who is weakly convinced, that he needs the TV. In this case all evaluations are equal to 0.2. Third example (SS3) concerns a situation, when one motivational stimuli is evaluated as very high (equal to 0.9) and all other arguments are weak. For an insusceptible person, the evaluations of all priorities are exactly the same as evaluations of premises. Below present are six vectors describing consumers SS1, SS2 and SS3.

$$P_{SS1} = [ 0.8, 0.8, 0.8, 0.8, 0.8 ]$$

$$R_{SS1} = [ 0.8, 0.8, 0.8, 0.8, 0.8 ]$$

$$P_{SS2} = [ 0.2, 0.2, 0.2, 0.2, 0.2 ]$$

$$R_{SS2} = [ 0.2, 0.2, 0.2, 0.2, 0.2 ]$$

$$P_{SS3} = [ 0.9, 0.2, 0.2, 0.2, 0.2 ]$$

$$R_{SS3} = [ 0.9, 0.2, 0.2, 0.2, 0.2 ]$$

Next, presented are vectors of premises and priorities for rational consumers. Distinguished are 3 cases: RR1, RR2 and RR3.

$$P_{RR1} = [ 0.8, 0.8, 0.8, 0.8, 0.8 ]$$

$$R_{RR1} = [ 0.9, 0.9, 0.9, 0.9, 0.9 ]$$

$$P_{RR2} = [ 0.2, 0.2, 0.2, 0.2, 0.2 ]$$

$$R_{RR2} = [ 0.1, 0.1, 0.1, 0.1, 0.1 ]$$

$$P_{RR3} = [ 0.9, 0.2, 0.2, 0.2, 0.2 ]$$

$$R_{RR3} = [ 1.0, 0.1, 0.1, 0.1, 0.1 ]$$

In the case of rational consumers, priorities do not significantly differ from premises. They might be slightly strengthened or weakened. In the case of RR1, consumer has all strong premises and slightly strengthened priorities. Consumer RR2 has all premises weak (equal to 0.2) and even weaker priorities (equal to 0.1). RR3's vector of premises contains first one strong argument and all other weak. His priorities vector contains one argument evaluated as 1.0 (he is certain that the product satisfies his needs in this criterion). All other priorities are weak, equal to 0.1.

Next, described are cases of emotional consumers (EE1 and EE2). Their behavior is very difficult to predict. Priorities vectors contain evaluations significantly different from premises evaluations. Such person is most likely to change his mind rapidly. Below visible are vectors  $P_{EE1}$ ,  $R_{EE1}$ ,  $P_{EE2}$  and  $R_{EE2}$ .

$$P_{EE1} = [ 0.8, 0.8, 0.2, 0.2, 0.2 ]$$

$$R_{EE1} = [ 0.2, 0.2, 0.8, 0.8, 0.8 ]$$

$$P_{EE2} = [ 1.0, 0.2, 0.2, 0.2, 0.2 ]$$

$$R_{EE2} = [ 0.1, 0.1, 0.1, 0.1, 0.1 ]$$

Next section discusses differences between results of the decision making procedure.

## 4.2 Results interpretation

Decision making process can be simplified to the evaluation of a single set of arguments - premises influencing given decision. In this case, we do not perform operation of moderation. Including second set of arguments evaluations - priorities vectors allows to compute results, which are more compliant with intuition. Table 1 gathers results of decision aggregation based only on premises. Table's headers contain information, which t-conorm was used to calculate particular decision.

Omitting second set of input arguments provided us with outputs based on general attitudes gathered in premises vectors. Decisions calculated for consumers with all high evaluations of premises are strong positive. It is not a surprise. This is the case of consumers SS1 and RR1. Also, when a consumer expresses at least one very strong positive attitude, saturation happens fast and computed decisions are strong positive. These are cases of RR3, SS3, EE1 and EE2. When premises are moderated with priorities and then aggregated results should be different. Change should be especially visible for EE1 and EE2, who have very volatile preferences. In cases of SS2 and RR2 (both these consumers had all premises evaluated as weak: 0.2) chosen operators provided varied decisions. Results vary from 0.2 (maximum and Nilpotent maximum) to 0.88 (arc sinus). We see that weak arguments get strengthened. This phenomena is explainable with behavioral bias, described in prospect theory.

In prospect theory explained is that preferences - or attitudes can be perceived "[...]as a function of decision weights, and it assumes that these weights do not always correspond to probabilities" [10][p. 98]. Kahneman and Tversky - authors



TABLE 1: Decisions obtained for consumers RR1, RR2, RR3, SS1, SS2, SS3, EE1 and EE2 based on premises only

consumer	maximum	probabilistic sum	bounded sum	Nilpotent maximum	Einstein sum	arc sinus	tangent	arc tangent hyperbolic
SS1	0.8	1.0	1.0	1.0	1.0	1.0	0.96	1.0
SS2	0.2	0.67	1.0	0.2	0.77	0.88	0.65	0.77
SS3	0.9	0.96	1.0	1.0	0.98	0.98	0.92	0.98
RR1	0.8	1.0	1.0	1.0	1.0	1.00	0.96	1.0
RR2	0.2	0.67	1.0	0.2	0.77	0.88	0.65	0.77
RR3	0.9	0.96	1.0	1.0	0.98	0.98	0.92	0.98
EE1	0.8	0.98	1.0	1.0	0.99	0.99	0.91	0.99
EE2	1.0	1.0	1.0	1.0	1.0	0.8	1.0	0.67

of the prospect theory, postulate that people tend to overweight small probabilities and underweight moderate and high probabilities [14][p. 179]. Translating prospect theory into developed model, means that weak evaluations of premises and priorities in the process of arguments aggregation should get strengthened. This happens for most of t-conorms, which are applied, with the exception of maximum and Nilpotent maximum. The question, which operator is most suited to model decision making, is a difficult one. Nevertheless, choosing the right function would require taking a closer look into how it aggregates small arguments. The optimal choice shall include described bias.

Next, presented are decisions obtained with a 2-step procedure, when first premises are moderated with priorities, and then the decision is aggregated. Table 2 contains results for consumers SS1, SS2, SS3, RR1, RR2, RR3, EE1 and EE2. Table's headers inform about t-conorm applied for aggregation. For moderation used were dual t-norms.

Decisions obtained for consumers with insusceptible type of personality are consistent with intuition. For cases SS1 and SS3 computed were strong positive decisions. These cases are consistent with previous results, where priorities were neglected. In a case, when a person was convinced that the purchase of the TV was practically a necessity, according to at least one argument (case SS3), the output is also strong positive. The same solid positive output concerns a case, when all arguments are fairly strong (case SS1). In case of SS2, where all premises and priorities are equal to 0.2, decisions obtained with various dual triangular norms are fairly weak. Some pairs of operators strengthen the decision, but the strength-

TABLE 2: Decisions obtained for consumers RR1, RR2, RR3, SS1, SS2, SS3, EE1 and EE2 based on premises and priorities

consumer	maximum	probabilistic sum	bounded sum	Nilpotent maximum	Einstein sum	arc sinus	tangent	arc tangent hyperbolic
SS1	0.8	0.99	1	1	1	1	0.92	1
SS2	0.2	0.18	0	0	0.51	0.24	0.43	0.12
SS3	0.9	0.84	0.8	0.9	0.92	0.81	0.84	0.83
RR1	0.8	1	1	1	1	1	0.94	1
RR2	0.1	0.1	0	0	0.34	0.16	0.31	0.06
RR3	0.9	0.91	0.9	0.9	0.94	0.85	0.91	0.91
EE1	0.2	0.58	0	0	0.75	0.74	0.7	0.6
EE2	0.1	0.17	0.1	0.1	0.37	0.31	0.59	0.15

ening effect is significantly lower. For SS2 the effect of output strengthening, when premises are moderated with priorities, is much lower than in the case, when the decision is obtained with the use of premises vector only. This is the first solid proof that involving causality is extremely important and modeling decision making has to include time flow and possibility of change of preferences. It is accordant with intuition - facing a concrete product changes consumer's perspective, not only about particular features associated with given product. The change concerns also evaluations of needs (factors). In table 2 we see relatively higher strengthening effect for t-norm/t-conorm associated with tangent generating function and for Hamacher product/Einstein sum. These pairs allow to involve behavioral bias described in the prospect theory. Some operators behave differently. For example, Lukasiewicz t-norm/bounded sum and Nilpotent minimum/Nilpotent maximum pairs of dual triangular norms lower the decision. The output in these two cases is equal to 0.

Decisions calculated for consumers, who express rational attitude towards preferences evaluation are visible in 4th, 5th and 6th rows of table 2. Rational consumer may change his mind and priorities evaluations might be different from premises. They can be either lowered - like in case RR2, or strengthened - like for RR1. Also they can be partially lowered and partially strengthened - the case of RR3. Naturally, rational consumers are also susceptible to behavioral biases. Decisions obtained for RR1, who has all premises and priorities relatively high are also very high. These results are consistent with intuition. Decisions for RR2, whose all premises are weak and priorities are even weaker are all weak too (see row 5, table 2). In the case of RR3, when one strong factor was evaluated in  $R_{RR3}$  as a certain positive (equal to 1.0) all decisions obtained using chosen dual triangular

norms are strong positive. In the cases of RR1 and RR3 results obtained based only on premises are consistent with results obtained, when applied were both premises and priorities vectors. For RR2 results obtained without moderation are too high.

Observing results for EE1 and EE2 obtained with premises moderated with priorities differ from results obtained before (without moderation). Especially for EE2 we see the lowering effect of moderation. Though  $P_{EE2}$  contains one premise evaluated as certain positive (1.0), significantly weaker priorities lower the decision. This is highly desired property. Without taking into account priorities, we neglect the disappointment of EE2 expressed with low numbers in  $R_{EE2}$ . For the case of EE1, we see mostly moderate positive decisions. This output is also compliant with intuition - all arguments in  $P_{EE1}$  and  $R_{EE1}$  are positive.

To sum up, in the article presented was a procedure of how decision making can be modeled based on developed consumer representation scheme. In the case study introduced was consumers segmentation and it was shown that described approach produces results coherent with results assumed in marketing communication studies.

## 5 Conclusions

The article presented developed approach to decision making modeling. Shown were benefits of involving causality into decision making process. Investigated were several pairs of operators, with which it was possible to compute appropriate outputs. Case study examples show, that applied operators allow to return correct decisions for various consumers profiles. Technique of premises and priorities moderation and decision aggregation allows to build a model applicable for consumers, who match different psychographical description without prior knowledge about it. Choosing certain operators allows also to include various spectrum of human behavior, including behavioral biases. Presented model of consumer's representation is very versatile, as it was built with psychological models on the background. Interdisciplinarity: joining psychology with behavioral economics into one model of consumer representation is the main advantage of presented approach.

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