O P E R A T I O N S R E S E A R C H A N D D E C I S I O N S

No. 3–4
DOI: 10.5277/ord1203-0402 2011

Krzysztof PRZYBYSZEWSKI*
Monika RZESKA**
Honorata SOSNOWSKA**

COGNITIVE PROPERTIES OF APPROVAL VOTING. AN EXPERIMENTAL APPROACH

The paper summarizes two series of experiments demonstrating the cognitive properties of approval voting. The former series is devoted to mental processes induced in decision makers who use the method of approval voting. Based on cognitive effort, the use of choice strategies is presented in this paper. The observations of respondents show that most of them use relatively effortless strategy of eliminating alternatives and attributes. Few respondents use more sophisticated methods. The other series of experiments analyses the number of alternatives chosen in approval voting. It appears that the average number is not constant, even for similar votes but it depends on the subject of voting. The number of chosen alternatives and the subjective significance of the scope of voting are negatively or positively correlated in the case of special votes. The analyzed experiments show that the cognitive properties of approval voting have a diverse structure.

Keywords: *experiments, approval voting, cognitive properties*

1. Introduction

The aim of this paper is to present some results describing certain mental processes connected with approval voting. Approval voting was introduced by Brams and Fisburn in 1982 [3]. Voters choose the alternatives they approve of. Each voter may choose none, one or more alternatives from the list. The number of voters who have chosen any given alternative is computed, and the alternative with the highest score wins. This method is used by many scientific societies and the Security Council of the United Nations (in 1996, for example, to narrow the list of potential candidates for Secretary General). Voters may vote

*Kozminski University, 03-301 Warsaw, ul. Jagiellońska 59, Poland; e-mail: crispy@alk.edu.pl
**Warsaw School of Economics, 02-554 Warsaw, al. Niepodległości 162, Poland; e-mail addresses: monikaa@op.pl, honorata@sgh.waw.pl

for more than one candidate, so they may express their opinion better in the case where they treat some candidates identically or almost identically. Approval voting is a subject of a campaign presenting its advantages over other voting procedures (see the Internet *Approval Voting Home Page* [2]). The simplicity of the method is especially stressed.

The problem of how methods of voting are connected with the mental processes of voters arises when different voting methods are used. It is known that different voting methods lead to different results. The theoretical approach (e.g. [11, 12] has been confirmed by the results of Laslier and Van der Straeten's experiment [7, 8] in the case of presidential elections in France and Przybyszewski and Sosnowska [14] in the case of the presidential election in Poland in 2005. These experiments show that not all common opinions on the properties of approval voting are empirically confirmed. It is assumed [2] that approval voting increases voter turnout. However, the results of the Polish experiment are different. During the pre-election poll, respondents were asked about their willingness to participate in elections in both the traditional majority system and in a system with approval voting. The declared turnout was greater in the case of the traditional system. So, the theoretical properties do not always hold in practice. The pre-election poll for the 2011 parliamentary elections gave similar results. In this paper, we consider two groups of properties of approval voting, the complexity of mental processes and the dependence of the number of chosen alternatives on a subjective measure of the importance of a choice. The former group of properties is connected with the assumed simplicity of the method. The latter is, on the other hand, connected with the real reasons behind the use of multiple selections. The analysis of some common opinions about approval voting (usually formulated only informally) is common for both groups and is the subject of the paper.

The paper is constructed as follows: Section 2 describes two experiments connected with the complexity of mental processes. One experiment considers the cognitive effort connected with three different voting methods. This part is based on the paper by Malawski et al. [9]. The other experiment analyses which choice strategies (fragmentary methods used during the process of choice) are used. Experiments on the origins of the variation in the number of chosen alternatives are presented in Section 3. This section is based on the papers by Kozińska and Sosnowska [5, 6]. Section 4 contains the conclusions.

2. Cognitive properties – choice of the head of a Dean's Office

Two experiments were conducted upon a common cover story – the choice of the head of a Dean's Office. The method of process tracing was used [10, 13, 17].

The data – a list of alternatives and their attributes – were presented in the form of an information board/matrix (Table 1). There were 13 candidates, listed in rows and 14 attributes, listed in columns. The information on the candidates was given in rows and the attributes were listed in columns. The participants were informed that their task would be to vote for anonymous candidates applying for the position of the manager of a Dean's Office using the data from the information matrix.

Table 1. Basis for the information matrix presented to the subjects

No.	Age	Gender	Qualification	English	Russian	Other	Proffesional experience	Availability	Communication skills (0–5)	Reaction to stress (0–5)	Organizational skills (0–5)	Ability to work in a team (0–5)	Leadership skills(–0–5)	Dealign with new challenge (0–5)
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														

Source: [9].

Each candidate was described by a sequence of 14 characteristics presented in the form of a description or by a figure on a scale. Gender, age, education, foreign languages skills, professional experience, availability and specifications of other important characteristics were presented by description. Communication skills: ability to cope with stress, organizational skills, ability to work in a team, leadership skills, openness to new challenges, were presented by figures on a 0–5 scale. The subjects were informed that the candidates received these points during psychological tests. The subjects were also

informed that they are members of a group which was making its group decision by a strictly specified method of voting. The subjects did not contact each other.

2.1. The cognitive effort of 3 different voting methods

In the first experiment, the cognitive cost of 3 different voting methods was studied. The experiment was described in Malawski et al. [9] and this subsection is based on that paper. Three different voting methods were analyzed – the majority method, approval voting and the categorization method.

Majority rule (MAJ) chooses a single best alternative from the list of alternatives. The alternative which is chosen most frequently – i.e. by the largest number of voters – wins. It is easy to understand but may thwart popular second best candidates. Using approval voting (APP), voters choose the alternatives of which they approve. Each voter may choose none, one, two or more alternatives. The number of voters who have chosen each alternative is computed, and the alternative with the highest score wins.

Using the categorization method (CAT), each voter divides candidates into three groups – approvable, not approvable and neutral. An approvable candidate receives one point, strictly not approvable – minus one and neutral – zero. The sum of points obtained by each candidate is computed. The candidate with the highest score wins. This method is a variant of approval voting, where candidates are divided into two groups – approvable and not approvable, and lack of approval is indicated by zero points. Using the categorization method, voters may use different levels of disapproval. The strictly not approvable candidates are singled out. This method is more complicated than both the majority rule and approval voting, but voters gain an opportunity to express their opinion more precisely. We use the term "categorization method" to emphasize the psychological process of categorization connected with this method. This method is also known as "combined approval with disapproval voting (CAV)" [3], yet this term seems lengthy.

We compared the cognitive effort used under the majority rule, approval voting and the categorization method. By cognitive effort we mean the number of actions undertaken in order to acquire the information necessary to make a decision. The precise definition of cognitive effort used in this paper is connected with the experiment and will be formulated below. We formulate a hypothesis concerning the cognitive effort applied in the voting methods studied.

H1. The cognitive effort which voters put into searching and integrating the information on alternatives is different for the three voting methods.

This hypothesis was confirmed during the experiment. Results were statistically analyzed using the Kruskall–Wallis and Mann–Whitney tests. Process tracing methods (e.g. [15]) were used during the experiment.

2.2. Choice strategies

The experiment was conducted in autumn 2010 on a group of 21 undergraduate students of Warsaw School of Economics (SGH) as a part of a lecture on social choice. The students knew the majority method and approval voting. Similarly to the previous experiment, the students were informed that they were members of a group choosing the head of a Dean's Office. They were randomly divided into 2 disjoint groups. The former, $n = 5$, used the majority method. The other ($n = 16$) made their choice in two steps. First, they used approval voting. In the second step, using the majority method, they chose the best alternative from those obtained in the first step. They used the same information matrix as in the previous experiment, but this time the matrix was complete and all the information was printed on sheets of paper.

The decision process can be defined as a sequence of operations. The steps of this process, where partial choices are made, are called choice strategies [13]. You can use the strategy of elimination, according to which you decide not to consider some alternatives. You can use the comparison strategy, where you compare some pairs of alternatives. You may use the maximization of additive utility (MAU), where you assign weights to all the attributes for each alternative, add them and choose the alternative with the highest sum of weights. Choice strategies have many properties. Choice strategies with properties leading to the overall analysis of alternatives are considered to be more rational. Such properties may be compensation (tradeoff between alternatives) and contatenation (joint analysis of alternatives). The aim of the experiment was to verify whether the same choice strategies were used for both voting methods and which ones were the most popular. The following hypotheses were investigated:

H2. Different choice strategies are used for different voting methods.

H3. Less complicated strategies of choice are more popular.

We used a method based on the idea of the think-aloud method [16, 17]. The think-aloud method uses unsophisticated subjects who are instructed ''to think aloud'' all their thoughts while completing a task. These thoughts are recorded or written down during the session and analyzed by dividing them into small steps, coding and assigning them to choice strategies. Our approach was less complicated. Two observers noted what the subject said during the session. Then the coordinator divided the written material into small sections according to the operations a subject had carried out. Finally, the coordinator classified these sections as being either part of a choice strategy or other statements. The results have a preliminary character and require deeper analysis. The majority method was used by 5 subjects and approval voting by 16. In the second step, the subjects who used approval voting applied the majority method to the alternatives which had been chosen by approval voting in the first step. We obtained the following results:

The following strategies were used: Elimination of one or several alternatives. Subjects eliminated alternatives with a low score (formulated numerically or descriptively) according to certain attributes such as education. In some cases, a threshold for elimination was defined (for example BA). Complementary to elimination was choice according to certain or several attributes. In these cases, subjects decided to choose a given alternative if a certain attribute had a high enough score. We distinguish between strategies of elimination and choice because they use different mental processes. In some cases, attributes were considered to be unimportant. In many cases, similarly to the previous experiment, subjects reviewed all the alternatives or attributes. In some cases, subjects compared more than one pair of alternatives. The compensation strategy is a compromise between alternatives. Using the concatenation strategy, the attributes of alternatives are considered jointly. Using the MAU (maximization of additive utility) strategy, weights are assigned to attributes and added for each alternative. The alternative with the highest sum of weights wins.

Table 2. Use of choice strategies and their properties when applied to approval voting and majority voting

Strategies or properties	Approval voting $n = 16$	Majority voting applied to the alternatives chosen after approval voting, $n = 16$	Majority voting, $n = 5$
1. Elimination according to one attribute	51	4	10
2. Elimination according to several attributes	166	14	59
3. Defined threshold of elimination	14	0	0
4. Choice according to one attribute	1	3	1
5. Choice according to several attributes	1	4	7
6. Elimination of attributes	13	0	3
7. Review according to alternatives	6	1	1
8. Review according to attributes	1	0	1
9. Comparing all pairs of alternatives	0	0	0
10. Compensation	0	0	0
11. Concatenation	0	0	2
13. MAU	2	1	0

Source: author's work.

The strategy of elimination according to one or several attributes in several steps was the most frequently chosen strategy. This corresponds to the results of many (e.g. [18, 19]) psychological papers. Nobody compared all the pairs of alternatives. Some subjects compared a small number of alternatives. Nobody used compensation. Concatenation was used in a fragmentary form. The MAU strategy was used only once in its full version. It was used by the only person who chose only one alternative in an approval vote. MAU, as a strategy which usually chooses one alternative by maximization does not seem to be a suitable method to apply to approval voting. After the

session, the subject said that she had learned MAU during an optional lecture on decision making. On the second occasion MAU was used, a simplified form was applied: the points in the numerical part of the information matrix were used as weights. Some subjects categorized attributes using pluses and minuses as an introduction to the elimination process. Some students eliminated alternatives in a very chaotic way. In Table 2, we present the results in a synthetic form.

The results do not confirm hypothesis H2, but they do confirm hypothesis H3. The choice strategies applied to both methods are of the same type (see Table 2 and additionally Table 4). Elimination strategies were most often chosen for both methods. More complicated strategies such as MAU or comparing all pairs of alternatives, were chosen rarely or never.

2.3. Summary

The results presented in Sections 2.1 and 2.2 demonstrate that approval voting is different from other voting methods (the majority method, the categorization method) when cognitive effort is taken into account and similar to the majority method when the use of choice strategies is analyzed. Therefore, it is not possible to have a common rule for all the types of cognitive processes applied to approval voting which compares this method to other voting methods.

3. Associations between the number of chosen alternatives and the subjective importance of a choice

In this section, we analyze the question of whether the number of chosen alternatives may change and seek the source of these changes. Two series of experiments are studied. All the experiments applied the approval voting method with different subjects of choice. The experiments were conducted using students of Warsaw School of Economics as a part of a lecture course on social choice in 2009 and 2010. This section is based on two papers [5, 6].

3.1. Non-constant average number of chosen alternatives in approval voting

The number of chosen alternatives shows how voters really use the main property of approval voting, the possibility of voting for more than one alternative. Voters choose various numbers of alternatives, thus the average number of chosen alterna-

tives may be a characteristic of the vote. In the two studies connected with the presidential elections in France [7, 8] and Poland [14], the average numbers of chosen alternatives were different, 3.15 in France and 1.76 in Poland. There were 16 candidates in France and 15 in Poland. Therefore one question arises as to whether in the same society similar applications of approval voting may give different results. Table 3 presents the results of 12 experiments. Six of them were conducted by students of Warsaw School of Economics on a sample of Warsaw students, one (number 12) was conducted by students of the Koźmiński Academy (the highest ranked Polish private business university). Experiment No. 1 was conducted by TNS OBOP, the Polish branch of an international poll agency. The average number of chosen alternatives is different for different choices.

Table 3. Approval voting – the average number of choices

No.	Experiment	Number of respondents	Number of alternatives	Average number of alternatives chosen
1	presidential poll, representative sample, 2005	669	15	1.78
2	presidential poll, students, SGH, 2009	43	20	3.74
3	presidential poll, students, SGGW, 2009	30	20	2.97
4	presidential poll, students, arts, UW, 2009	31	20	3.22
5	parliamentary poll, students SGH 2009 (the same sample as in 2)	43	14	2.23
6	parliamentary poll, students, SGGW, 2009 (the same sample as in 3)	30	14	2.23
7	parliamentary poll, students, arts, UW, 2009 (the same sample as in 4)	28	14	2.25
8	properties of excursions, students, Warsaw, 2009	240	6	2.86
9	interesting lectures, students, SGH, 2009	148	12	4.06
10	prestigious professions, students, SGH, 2009	117	20	4.3
11	cell phones, students, Warsaw, 2009	164	8	2.71
12	beers, students, ALK, 2006	200	20	6.81

Source: [5].

Kozińska and Sosnowska [5, 6] meta-analyzed possible sources of these differences. They grouped the studies according to the kinds of choices made (political, social and consumer). Using a division into two kinds of choices, ‘‘political’’ and “other”, they discovered that the average number of chosen alternatives depends on the kind of choice. In Table 4, we use the following notation: LA – the dependence of the average number of chosen alternatives on the number of alternatives, LR – the dependence of the average number of chosen alternatives on the number of respondents, P – the division into political choice and other subjects of choice, PK – division into political, consumer and social choice.

Table 4. Dependence of the average number of chosen alternatives on the number of alternatives and the subject of choice

No.	Statistical analysis	Dependence on number of alternatives	Dependence on kind of choice
1	LA	no	does not apply
2	LA–LR	no	does not apply
3	LA–P	yes	yes
4	LA–PK1	yes	yes
5	P	does not apply	no

Source: [5].

The LA–P model was statistically the best; $R^2 = 0.7616$. The estimates of both parameters are statistically significant (Student *t*-test).

Table 5. Estimates of the parameters of the LA–P model

Variable	Estimate of the parameter aj	Standard error	t statistic	$Pr > \|t\|$
Constant	10.43294	0.651	20.2	0.0552
P	–20.23941	0.41907	–50.34	0.0005
LA	0.20569	0.04386	40.69	0.0011

Source: [5].

3.2. The significance of voting

The results showing that the average number of chosen alternatives may not be constant were presented in the previous section. This raises a question as to what the source of this diversity may be. There is a belief that when a choice is connected with a more serious question, then voters' preferences are strongly defined. Based on this belief, we formulated the following hypothesis.

H4. There is a negative correlation between the number of chosen alternatives and the significance of choice.

We attempt to verify whether voters choose fewer alternatives when the subject of choice is more important for them. We tested this hypothesis by a series of questionnaire studies. The respondents were students of Warsaw universities. Eight subjects of choice were analyzed: parliamentary elections (planned for the next year), the choice of a person to perform the National Anthem at EURO 2012, the choice of a place to spend free time, the choice of a tooth paste, the choice of a fast food restaurant, the

choice of a holiday destination, the choice of vodka, the choice of kinds of liquors. The subjects of choice were suggested by students, in order to be interesting to the respondents and to cover political, social and consumer kinds of choice. The respondents made their choice by approval voting and additionally marked the subjective significance of the subject of choice on a 0–10 scale (0 – unimportant, 10 – very important).

Table 6. The correlation between the number of chosen alternatives and the significance of a choice

Experiment	Number of respondents	Number of alternatives	Average number of chosen alternatives	Average significance of choice	Correlation
1. Fast foods	100	9	3.53	4.8	positive
2. Anthem	131	12	2.95	4.22	negative
3. Holidays	95	15	3.36	6.5	positive
4. Vodkas	107	10	3.57	6.39	not significant
5. Free time	113	11	4	6.11	not significant
6. Tooth pastes	120	12	3.16	6.1	not significant
7. Parliamentary elections	438	11	2.16	7.43	negative
8. Liquors	100	10	3.87	6.48	not significant

Source: [6].

The analysis of Table 6 shows that the average number of chosen alternatives does not depend on the significance of choice monotonically. For a more detailed analysis, we consider (for each subject) the correlations between two series of data – the number of chosen alternatives and the significance of a respondent's choice. We present the statistical results below. For the χ^2 and F tests see [1].

1. Fast foods. There is no dependence between the number of chosen alternatives and the significance of choice ($\chi^2 = 64.479$, p-value = 0.664). A small, statistically significant positive correlation (0.2) between the number of chosen alternatives and the significance of a choice is observed. H4 was rejected.

2. National Anthem. The Pearson correlation coefficient is (–0.187), p-value 0.0323. There is a statistically significant negative correlation between the number of chosen alternatives and the significance of a choice. Hypothesis H4 was confirmed.

3. Holidays. A small, significant positive correlation exists between the number of chosen alternatives and the significance of a choice. The Pearson correlation coefficient (0.06) is not statistically significant. H4 was rejected.

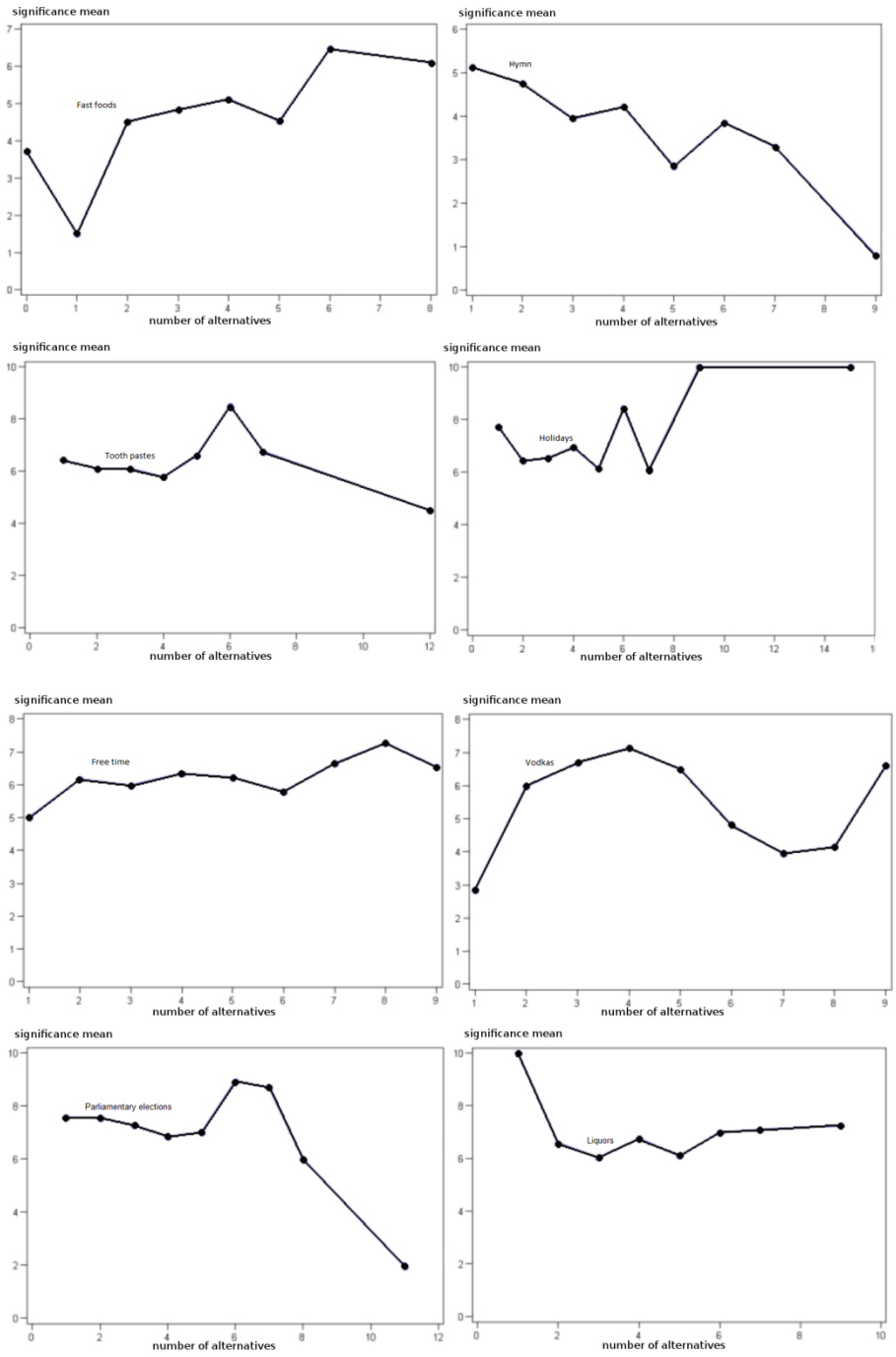

Fig. 1. Association between the number of chosen alternatives and the significance of voting. Source: [6]

4. Vodkas. The Pearson correlation coefficient is not statistically significant, so the hypothesis of a negative correlation is rejected. Some groups are too small for the χ^2 test to be accurate. H4 was rejected.

5. *Free time*. Testing at the 5% level, the χ^2 statistic indicates that it may be assumed that the variables are independent. The Pearson choice coefficient is not statistically significant, so the null hypothesis on negative correlation is rejected. H4 was rejected.

6. *Tooth-pastes*. $\chi^2 = 53.36$. There are no reasons to reject the null hypothesis of the lack of dependence between the number of chosen alternatives and the significance of choice. The correlation between these numbers is not statistically significant, thus the hypothesis H4 has to be rejected.

7. Parliamentary elections. The *F* Test ($F = 1.326$, p-value = 0.265) does not give any reason to reject the null hypothesis of the equality of the average significance of choice in groups of respondents with the same number of chosen alternatives. There is a negative, statistically significant correlation (–0.136) between the number of chosen alternatives and the significance of choice. Thus, hypothesis H4 was confirmed in this case.

8. Liquors. The correlation between the number of chosen alternatives and the significance of a choice equals 0.0653 and is not statistically significant. It may be assumed that the variables are independent. Hypothesis H4 was rejected.

Figure 1 presents the dependence between the number of chosen alternatives and the significance of a choice. The number of chosen alternatives is given on the horizontal axis and the significance of a choice on the vertical axis.

The hypothesis H4 was confirmed only in the experiments concerning parliamentary elections and the choice of a performer of the national anthem. Let us note that these choices are political and social ones. The other investigated choices were of the consumer kind. In some of those cases the opposite relation was observed.

3.3. Summary

There are no rules connected with the behavior of the number of chosen alternatives common to all situations of making a choice by approval voting. The average number of chosen alternatives is not constant. It depends on the subject of choice. The experiments confirmed that the number of chosen alternatives and the significance of choice were negatively correlated in the case of political or social subjects of choice.

This hypothesis was not confirmed in the case of consumer subjects of choice. Thus, not all the commonly held opinions on the properties of the number of chosen alternatives in approval voting are fully true.

4. Conclusions

- The main aim of the paper was to test whether some commonly held opinions on approval voting may be confirmed experimentally. The answer is positive in some cases and negative in others.
- The experiments present some reasons to claim that there is no common rule which would distinguish approval voting from other voting methods when taking into account cognitive processes.
- Approval voting is a less complex method of voting than the majority method when we consider the cognitive effort required and of similar complexity to choice strategies.
- The heart of the matter in approval choice – the number of chosen alternatives – differs depending on the subject of choice and may be positively correlated with the subjective significance of the choice in the case of consumer choices and negatively in the case of political or social choices.

Acknowledgements

The authors thank Marcin Malawski for helpful comments.

References

[1] AGRESTI A., *An Introduction to Categorical Data Analysis*, Wiley, 2007, 34–38.
[2] *Approval Voting Home Page*, http://ben.boulder.co.us/goverment/approvalvote/center.html
[3] BRAMS S.J., FISBURN P.C., *Approval Voting*, Birkhäuser, Boston, 1982.
[4] FELSENTHAL D.S., *On combining approval voting with disapproval voting*, Behavioral Sciences, 1989, 34, 53–60.
[5] KOZIŃSKA M., SOSNOWSKA H., *Varialibility of the average number of chosen alternatives in approval voting*, Studia i Materiały Polskiego Stowarzyszenia Zarządzania Wiedzą, 2010, 31, 120–127 (in Polish).
[6] KOZIŃSKA M., SOSNOWSKA H., *The average number of chosen alternatives in approval voting. Analysis of chosen experiments*, Roczniki Kolegium Analiz Ekonomicznych, 2010, 22, 117–134 (in Polish).

[7] LASLIER J.F., VAN DER STRAETEN K., *Une expérience de vote par assentiment lors de l'élection présidentielle de 2002*, Revue Française de Science Politique, 2004, 54, 99–130.
[8] LASLIER J.F., VAN DER STRAETEN K., *Alive experiment on approval voting*, Experimental Economics, 2008, 11, 97–105.
[9] MALAWSKI M., PRZYBYSZEWSKI K., SOSNOWSKA H., *Cognitive effort of voters under three different voting methods – an experimental study*, Operations Resarch and Decisions, 2010, 3–4, 1–11.
[10] MONTGOMERY H., *Decision rules and the search for a dominance structure: towards a process model of decision making*, [in:] *Analysing and Aiding Decision Processes*, P. Humphreys, O. Svenson, A. Valdi (Eds.), North Holland, Amsterdam, 1983.
[11] NURMI H., *Comparing Voting Systems*, Reidel. Publ. Co., Dordrecht, 1987.
[12] NURMI H., *On the Properties of Voting Systems*, Scandinavian Political Studies, 2007, 4, 19–32.
[13] PAYNE J.W., BETTMANN J.R., JOHNSON E.J., *The Adaptive Decision Maker*, Cambridge University Press, Cambridge, 1993.
[14] PRZYBYSZEWSKI K., SOSNOWSKA H., *Approval voting – turnout and election preferences*, [in:] *Badania operacyjne i systemowe 2006. Metody i Techni*ki, J. Kacprzyk, R. Budziński (Eds.), Akademicka Oficyna Wydawnicza EXIT, Warszawa, 2006, 153–162.
[15] REISEN N., HOFFRAGE U., MUST F.W., *Identifying decision strategies in a consumer choice situation*, Judgement and Decision Making, 2008, 3, 641–658.
[16] SOMEREN VAN M.W., BARNARD Y.F., SANDBERG J.A.C., *The think aloud method. A practical guide to modeling cognitive processes*, Academic Press, London, 1994.
[17] SVENSON O., *Differentiation and consolidation theory of human decision making: A frame of reference for the study of pre and post decision processes*, Acta Psychologica, 1992, 80, 143–168.
[18] TVERSKY A., *Elimination by aspects*, Psychological Review, 1972, 79, 281–299.
[19] WRIGHT P., *Consumer choice strategies. Simplifying vs. optimizing*, Journal of Marketing Research, 1975, 12, 60–67.