Analysis strategic behavior subjects of management in the property management problem

Alekseev A.O., Spirina V.S., Andronova A.A.
(Perm National Research Polytechnic University, Perm)

The managers' strategic behavior of commercial real estate in a competitive environment is discussed. Here is an optimal agent's strategy, where his rival's strategy and environmental conditions are known. Sensitivity analysis was made by using the methods of game theory. A game example is shown in very simple presentations, where the participants are simply two agents that differ in a reflection level. It is indicated that a theoretically predicted behavior of management entities of shopping centers and the importance of experimental study of people's strategic behavior are possible to determine mathematically. The novelty is that at allocation costs of the Manager for the development and promotion of shopping centers, the strategies of managers are resistant to each other's actions, in contrast to changes in the external environment is shown.

Keywords: Shopping and Entertainment Complexes, Commercial Real Estate, Property Management, Experimental Economy, Game Theory.

The problem of managing commercial real estate, in particular shopping and entertainment complexes, has a high degree of uncertainty [1, 2]. The external source of this uncertainty is consumer preferences that affect the choice of visiting a shopping and entertainment complex [3-6]. In addition, high uncertainty is associated with the complexity of forecasting the results of management and business activities. Increasing competition and increasing territorial concentration of commercial real estate makes the information on the current and projected attendance of the property consumers for effective management of real estate and business activities on the basis of the commercial object visiting [7, 8]. A mathematical statement of management problem of shopping centers is given in [9].

Internal factors that describe a shopping center for buyers, may include: x_1 – area, x_2 – assortment of goods, x_3 – transport accessibility, x_4 – aesthetic parameter, x_5 – specials and discounts, x_6 – quality of goods, x_7 – availability of brands and x_8 – measures (here you'll find statistics acquired in the course of a sociological (marketing) study on the shopping centers of Perm [10], when respondents were requested to evaluate how important they found each of the parameters of shopping centers).

The above-mentioned internal factors that describe shopping centers, may include manageable and non-manageable factors on tactic and operating levels.

In a discrete case, the total number of agent strategies will be determined by formula (1):

$$N = \prod_{m \in [1;M]} n_m , \qquad (1)$$

where m – criterion (factor) index number to be managed by an economic entity; M – the total number of manageable criteria (factors); n_m – maximal number of options for changing the criterion m.

Let us consider an example where the strategy of economic entities of a shopping and entertainment complex (SEC) depends on four options for the cost of changing the four managed criteria (table 1).

The quality of the object for this case will be calculated using a geometric weighted model:

$$Q = \prod_l Q_l(\chi_l)^{q_l} \tag{2}$$

Table 1. An example of how to allocate cost options to manage four criteria

Options for allocating management costs	*advertising /brands*	*aesthetic appearance*	*quality of goods*	*events*
	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_3}$	$\mathbf{X_4}$
CF1	40	0	100	25
CF2	60	120	200	40
CF3	90	250	300	55
CF4	120	500	400	70

In this case ($\forall m$: $n_m = n = 4$), the number of strategies of each economic subject will be determined by formula:

$$N = n^M = 4^4 = 256\ . \tag{3}$$

Despite such a not so great number of options, to find an optimal distribution of funds to manage shopping centers is far from being trivial, and for a decision maker it is cognitive complex. An optimal solution for the problem of management of shopping centers is such a distribution of economic entities' funds for a change in manageable factors to provide their maximal personal profit [9].

Below (Fig.1) you'll find an optimal strategy of the economic entity of shopping centers upon a profit-maximization criterion when the second agent's strategy is known and the consumer level is specified. The consumer level is specified, on the one hand, by a portion of visitors who shop in the shopping centers (conversion ratio – μ, Eng. *Customer Conversion Ratio*), and, on the other hand, by an average purchase sum to be paid by the visitors of shopping centers (average bill – *Ar*). These factors describe environmental changes. However, for the purpose of the study dedicated to the strategic behavior of rival entities, the environmental effect is ignored, and the consumer level is regarded as constant. Examples how the optimal strategy of management entity of shopping centers is dependent on the changing environment are given in [11].

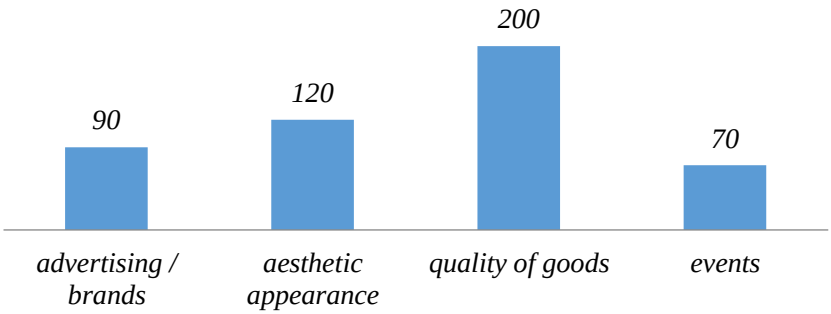

Fig. 1. Optimal first agent's strategy

Note for Figure 1: at $\mu=0.1$, the purchase is effected by each 10th visitor of the shopping center; *AR* – 0.5 c.u.; the quality of rival shopping center (*Q*) – 0.663, at a relative scale [0;1].

In this paper, we illustrate an example of the solution of the game-theoretic problem in the simplest formulations, where the participants in the game are two players that manage the competitive SECs and their strategies are determined by the costs of their development.

In a situation where the player does not know the opponent's strategy, it is suggested to search for strategies according to the concept of the maxmin (or also called maximum guaranteed result (MGR)). This situation is typical for players with the first rank of strategic reflection. The second rank of reflection means that the player calculates his Best Response (BR), knowing the opponent's strategy. The third rank of reflection means that the player uses the strategy corresponding to Double Best Response (DBR), with the known opponent's Best Response [12]. Comparative analysis strategies obtained based on these concepts is presented in Table 2.

Table 2. Matrix of strategies of players in the formulation of a game with two managers when using profit as an objective function

Strategies		**2nd player**		
		MGR2	BR*2*	DBR*2*
1st player	*MGR1*	151 (MGR1)	151 (MGR1)	151 (MGR1)
		151 (MGR2)	151 (BR2(MGR1))	151 (DBR 2(BR1(MGR2)))
	BR1	151 (BR1(MGR2))	151 (BR1(MGR2))	151 (BR1(MGR2))
		151 (MGR2)	151 (BR2(MGR1))	151 (DBR2(BR1(MGR2)))
	DBR1	151 (DBR1(BR2(MGR1)))	151 (DBR1(BR2(MGR1)))	151 (DBR1(BR2(MGR1)))
		151 (MGR2)	151 (BR2(MGR1))	151 (DBR2(BR1(MGR2)))

The solution game-theoretic formulation of two SEC players-managers shows that with an increase in rank of reflection, the players share the same strategies (Table 2). It is important to note that the solution depends on the level of consumption, which in this study deliberately not investigated.

In Table 2 the player's choice of strategy 151 corresponds to: an increase in advertising costs – 90 th.r., costs for aesthetic appearance – 120 th.r., costs for the quality of goods – 200 th.r. and increase the cost of events up to 70 th.r.

Thus mathematically possible to determine the theoretically predicted behavior of the SEC managers and becomes relevant experimental study of strategic behavior through a series of business games. An experimental study of the above problem in the form of a business simulation game will make it possible to find out – to which strategy the people will come.

In despite of preliminary character of the experiments two aspects were found: players were able to find the optimal allocation without using the decision support system in a fairly short period of time (see Figure 2 and Table 3), in other words, players came to a theoretically predicted strategy; the optimal strategy, in turn, was resistant to the actions of the opponent, and therefore the players did not change their strategies, which led to a very rapid completion of the experiments.

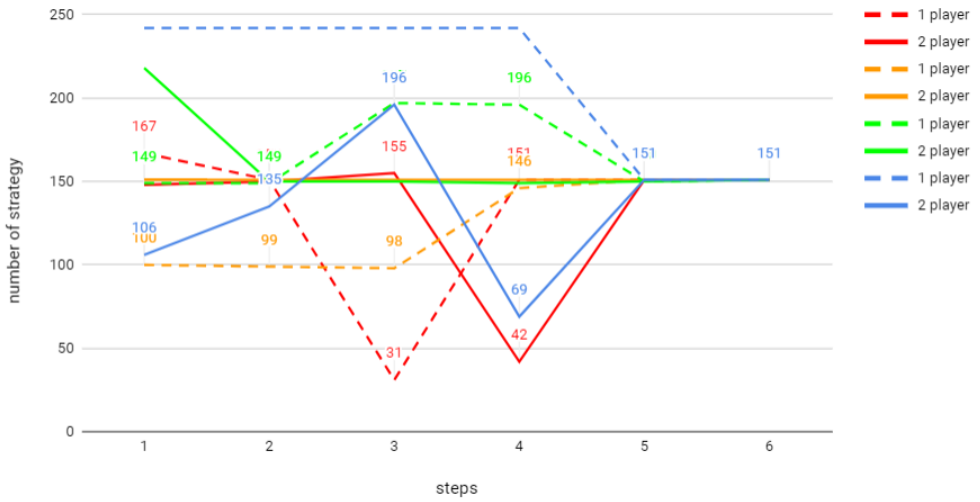

Fig. 2. Results of a preliminary experiment.

Note for Figure 2: In the figure preliminary results of a game of 4 groups of students (on 2 players in everyone) are presented. In other groups, similar results have turned out.

Table 3. Matrix of strategies of players in the formulation of a game with two managers when using profit as an objective function

Groups	**Players**	**Steps**					
		1	***2***	***3***	***4***	***5***	***6***
1-st group	*1-st player*	167	151	31	151	151	151
	2-nd player	148	150	155	42	151	151
2-nd group	*1-st player*	100	99	98	146	151	151
	2-nd player	151	151	151	151	151	151
3-rd group	*1-st player*	149	149	197	196	150	151
	2-nd player	218	150	150	149	150	151
4-th group	*1-st player*	242	242	242	242	151	151
	2-nd player	106	135	196	69	151	151

The resistance of the optimal strategy is explained by the experimental assumptions, including the values of used parameters of the costs to development and promotion SEC (see table 1) and about the type of cost functions. As it turned out, the costs are too large a change step and when the opponent tries to attract additional consumers to itself, the player's costs for their preservation in its SEC

exceed the expected economic effect, determined by the product of the average check (AR) on the number of visitors (n_j) and the conversion rate (μ). This fact makes necessary for additional theoretical study of the SEC management problem with different cost functions.

References:

1. Applebaum W. Can Store Location be a Science? Economic Geography, 1965, no. 41, pp. 234-237.
2. Arrow K.J. Social choice and individual values. Chicago: Univ. of Chicago, 1951.
3. Baudrillard J. The consumer society: Myths and structures. Sage 53, 1998.
4. Belk R. W. Situational variables and consumer behavior. Journal of Consumer research, 1975, vol. 2(3), pp. 157-164.
5. Chebat J.-C., Michon R., Haj-Salem N. and etc. The effects of mall renovation on shopping values, satisfaction and spending behavior. Journal of Retailing and Consumer Services, 2014, no. 21(4), pp. 610–618.
6. Falk P., Campbell C. (ed.). The shopping experience. Sage 52, 1997.
7. Foteringham A.S. A New Set of Spatial Interaction Models: The Theory of Competing Destinations. Environment and Planning, 1983, no. 15, pp. 15-36.
8. Galbraith J. K. Rational and irrational consumer preference. The Economic Journal, 1938, no. 48(190), pp. 336-342.
9. Alekseev A.O., Spirina V.S., Korgin N.A. Management technology for a commercial property item with account of consumer preferences // Large systems management. Issue 62. M.: Institute of Control Sciences of Russian Academy of Sciences, 2016. pp.124-168.
10. Spirina V.S., Alekseev A.O. Simulation and forecasting of commercial property traffic based on the estimation of its commercial appeal (in case of shopping centers) // Current economic and right problems. – 2015. – №1(33). – pp. 209–217.
11. Spirina V.S. Rationale for accounting the strategic behavior of lessees in the commercial property management // News of Higher educational institutions. Investments. Construction. Real estate. – 2017. – Vol.7, № 3. – pp. 42-52.
12. Goubko M., Novikov D. Game-theoretical Models and Methods of the Organizational Systems Control Theory, Game Theory and Management. Collected abstracts of papers, presented in the International Conference "Game Theory and Management", Gradual School of Management, SPbU. – 2008. – 140 p.

Alexander Alekseev, Perm National Research Polytechnic University, Perm, Cand. of Sci. in Economics, Associate Professor, Civil Engineering Faculty, Department of Construction Engineering and Materials Science (alekseev@cems.pstu.ru).

Varvara Spirina, Perm National Research Polytechnic University, Perm, Cand. of Sci. in Economics, Associate Professor, Civil Engineering Faculty, Department of Construction Engineering and Materials Science (spirina@cems.pstu.ru).

Alexandra Andronova, Perm National Research Polytechnic University, Perm, postgraduate student, Faculty of Civil Engineering, Department of Construction Engineering and Materials Science (for-c.a@yandex.ru).