Marketing Case: Effect of Advertising and Quality of the Goods on the Amount of Sales

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Abstract. This paper attempts to quantify the influence of various factors in marketing. Here is examined the relationship between the funds invested in advertising, the quality of the advertised product and sales over time. A simulation was made through Markov's chains, in which sales depend on both advertising and consumer opinion. In the short term, an intensive advertising campaign increases sales, but over time, product quality is crucial.

Keywords: Advertising, Marketing, Markov Chains, Modeling.

1 Introduction

According to [1, 2], marketing should be a "philosophy of business management" because through it the organization achieves its goals. In a narrow sense, marketing aims to make a profit for the organization by satisfying market needs. In a broad sense, the purpose of marketing is to "identify and respond to human and social needs" [3].

In classical marketing theory, the 4Ps approach [4, 5] is popular, describing the four main lines of action: product, price, promotion, and place. In [5] is focused on the so-called relationship marketing: the process of creating, maintaining and strengthening strong, value-laden relationships with customers and other stakeholders.

Today, during the Fourth Industrial Revolution, the concept of marketing is changing. Some authors suggest modifications to the 4Ps approach [6, 7], including marketing services and other guidelines. According to other researchers, the new approach 4C [8] containing the guidelines Consumer (or Client), Cost, Convenience, Communication is relevant nowadays.

Modern retailers use artificial intelligence [9, 10] to do marketing – creating an accurate profile of the consumer and his desires by trying to guess his needs. The most commonly used tools are data mining, deep learning, OLAP analysis and others.

Detailed models of marketing management are shown in [10].

The present work aims to find easy and convenient tools for modeling the processes in the field of marketing management. Appropriate models would be useful for both researchers and students of economics and management.

2 Model proposition

2.1 Analytical models of investment

This paper examines two factors that play an important role in the sale of goods:

- Spending on advertising – the more money spent on advertising, the more likely the potential consumer to learn about it and buy it;
- Quality of the product – if a product is quality, it makes it free advertising [5]. Customers and merchants share their opinions through social networks, consumer associations and more. If the product is purchased periodically, and consumers are not satisfied, the next time consumers will seek external opinion and choose another product.

Suppose two companies A and B produce the same product. There are a limited number of potential users (customers) in need of this product. The difference between these companies is that:

- Company A produces a lower quality product than Company B, but spends much more on advertising;
- Conversely, Company B relies on the quality of its product but invests significantly less in its advertising.

Similar class of problems are often modeled with Markov chains [12]. A random process has a Markov property if the conditional distribution of the probability of the future states of the process at given current and past states depends only on the current state and does not depend on the past ones. A process that has the Markov property is called a Markov process [13].

A model describing the competitive situation in which the two companies find themselves is shown in Fig.1. In this case that is a semi-Markov process [13], because the intensity of the transitions is not constant over time. State C models the potential users of the product and states PA and PB mean that the consumers have purchased a product of the respective company, respectively. The intensity of the transitions from state C to the other two states depends on two components and is calculated by:

$$\beta_i = \lambda_i C + \mu_i P_i \quad (1)$$

where:

C – condition describing a limited number of potential buyers of the product offered by both companies;

P_A and P_B – buyers from C have purchased the product of Company A or Company B;

λ – the intensity of transitions from state C to state Pi, directly related to advertising costs;

μ – the intensity of the transitions from state C to state Pi, directly related to the opinion and feedback of the customers about the quality of the product.

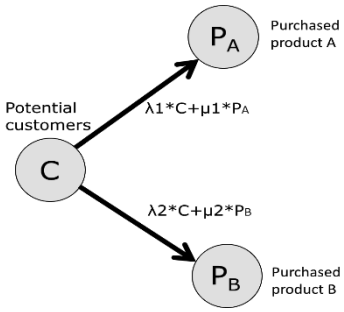

Fig. 1. Markov chain, describing the competition of two companies for product sale. It is important to note that Company A spends more on advertising and Company B offers a better product.

The system of Kolmogorov differential equations [14] describing the Markov chain from Fig.1 is:

$$\begin{cases} \frac{dC}{dt} = -(\lambda_1 + \lambda_2)C - \mu_1 P_A - \mu_2 P_B \\ \frac{dP_A}{dt} = \lambda_1 C + \mu_1 P_A \\ \frac{dP_B}{dt} = \lambda_2 C + \mu_2 P_B \\ C + P_A + P_B = const \end{cases} \quad (2)$$

3 Model simulation

MS Excel offers a convenient and easy approach for simulating systems of differential equations [15,16]. If a small enough step Δ is chosen and the equality $\frac{\Delta s}{\Delta t} = \frac{ds}{dt}$ is valid. In practice, it can be selected in a different range, varying in a very large range – from seconds to days. In the case of Fig. 2 Δ is one day. A condition for the end of the simulation is the exhaustion of position C (i.e. its value is negative), since the transitions specified by (1) cannot take place.

10000								
Time	R1	R2	I1	I2		F begin	F1	F2
0	0.01	0.003	0.001	0.05	0	10000	1	1
1	0.01	0.003	0.001	0.05	1	9998	3	2
2	0.01	0.003	0.001	0.05	2	9995	102.983	32.094
3	0.01	0.003	0.001	0.05	3	9864.923	203.035983	63.6837
4	0.01	0.003	0.001	0.05	4	9733.2803	301.888249	96.462654
5	0.01	0.003	0.001	0.05	5	9601.6491	399.52294	130.485628
6	0.01	0.003	0.001	0.05	6	9469.9914	495.938954	165.814856
7	0.01	0.003	0.001	0.05	7	9338.2462	591.134808	202.515573
8	0.01	0.003	0.001	0.05	8	9206.3496	685.108404	240.656091
9	0.01	0.003	0.001	0.05	9	9074.2355	777.857009	280.307944
10	0.01	0.003	0.001	0.05	10	8941.835	869.377221	321.546048

Fig. 2. Solving a system of differential equations with MS Excel (sample data).

3.1 Model with limited number of potential buyers

At Fig. 3 are shown simulation results for 10000 potential customers. It is assumed that Company A has an advertising intensity $\lambda_1 = 0.01$ and a product impact $\mu_2 = 0.001$. Accordingly, Company B has an advertising intensity $\lambda 2 = 0.003$ and a product impact $\mu 1 = 0.05$.

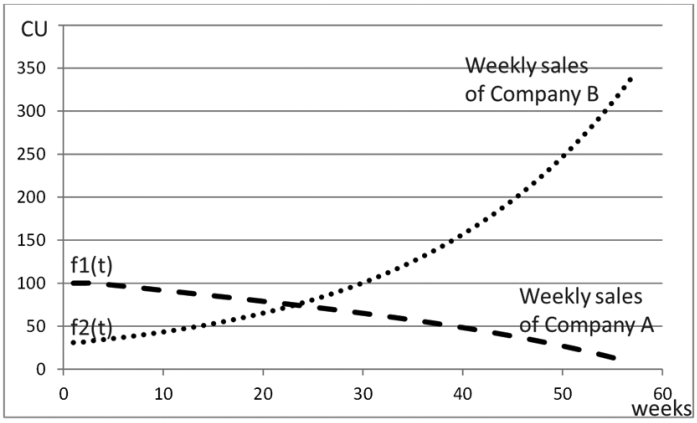

Fig. 3. Daily sales of both companies in current units [CU]. Note that Company A started with higher sales, but over time, Company B overtook it.

The total sales for the whole period are given in Fig. 4.

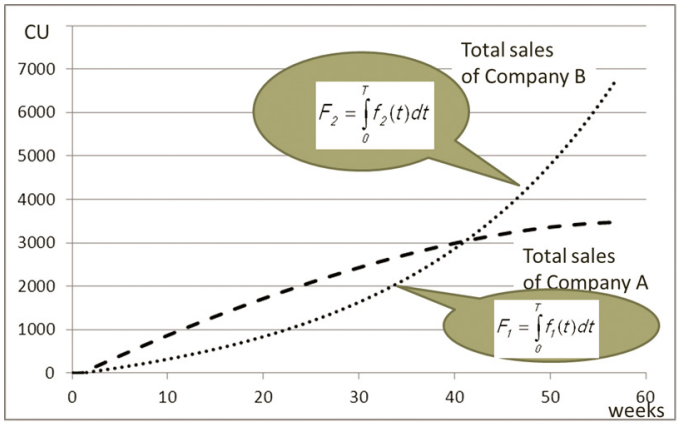

Fig. 4. Total sales volume of both companies.

3.2 Model with unlimited number of potential buyers

Assuming that the number of potential customers is very large, that is, they are practically inexhaustible. Company A's sales will depend only on the effect of its advertising campaign and will increase linearly. In this case, the coefficient only coefficient has a sense and μ not matters. On the other hand, Company B will increase its customers exponentially and the schedule of purchases is determined by the coefficient μ (Fig. 5).

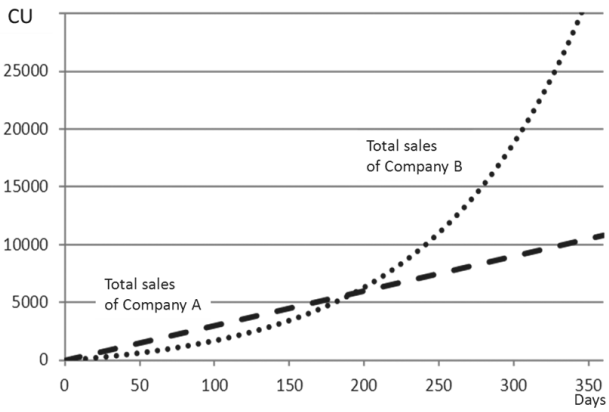

Fig. 5. Total sales volume of both companies at unlimited number of customers.

3.3 Model for goods used and purchased periodically

A model of the product that is purchased periodically by consumers is shown at Fig. 6. There is a cycle (an arc of from positions P to position C is added). The coefficient β models the intensity of product repurchase.

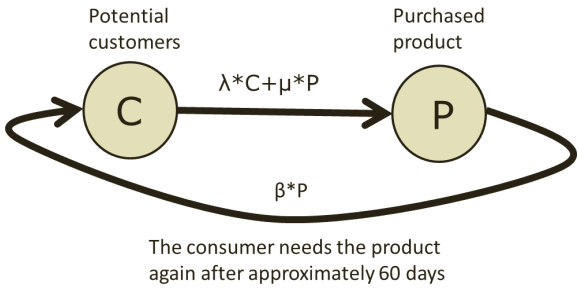

Fig. 6. Graph describing the situation of periodic need for a product.

The corresponding system of differential equations describing Fig. 6 is:

$$\begin{cases} \frac{dP}{dt} = \lambda C + \mu P - \beta P \\ \frac{dC}{dt} = \beta P - (\lambda C + \mu P) \\ P + C = const \end{cases} \tag{3}$$

The solution of (3) at (λ = 0.04, μ = 0.05 and β = 0.0015) is shown in Fig. 7. The initial fluctuations associated with the product life cycle decrease with time.

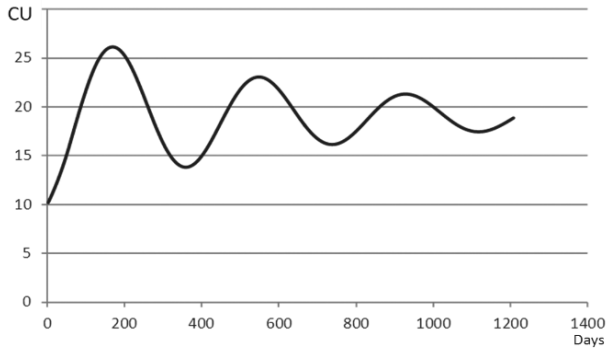

Fig. 7. Fluctuations in daily sales related to the product use cycle.
The simulations were made at λ = 0.04, μ = 0.05 and β=0.0015.

The situation given in Fig. 7 explains by the following logic. When a new product appears on the market with a limited number of buyers, initially there are

fluctuations determined by the duration of its use. Gradually, these fluctuations decrease as the use cycles of different users diverge. Over time, it obtains a stable level of daily sales.

4 Conclusion

A model is proposed in the article and a simulation tool is chosen. Displayed results have similarity with reality. The proposed approach provides qualitative and quantitative assessments of key factors in marketing on which the sale of commercial goods depends. Of course, the model may include more features mentioned above approaches 4P or 4C. Based on the research, the following conclusions can be concluded:

- The funds paid for advertising are crucial in promoting a new product;
- If the product is of poor quality, customers will buy it once and subsequently it will not be bought;
- Unscrupulous companies do this: they constantly make new brands to sell low-quality products, emphasizing aggressive and massive advertising;
- It is possible to profit from the sale of aggressively advertised product of low quality in the presence of a large (unlimited) market;
- The best advertisement for a product is its quality.

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