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Identification of Carrying Capacity of the Market And Synthesis of a Cellular Communication Company Price Strategy

Abstract

The purpose of the work is to develop the optimum price strategy for the cellular communications services company. This is achieved by establishing a new price structure based on the identification of the capacity of the market segment for the sale of cellular communication services.

Keywords: system dynamics, growth model, price strategy, management, carrying capacity, market, communication services, cumulative sales

Introduction

The task of analyzing existing experimental data and building growth models to illustrate the cumulative growth of sales volumes of goods and services, has wide ranging implications to be considered in various areas – from the spread of epidemics to the detail of the procedures used during the complete life-cycle of the sale of a product [1,4].

The task of defining the carrying capacity of the researched market segment and synthesis the optimum price strategy for a business functioning in a competitive market during a given period of time, is a mechanism which plays a significant role in the information gathered together to make management decisions [2,3].

The first part of the article describes a model built on the basis of a dynamic system, relating to the services adoption process of the cellular communications company on the competitive market. The model includes information about the popularity of the services of the cellular communications company. Such popularity provides the growth of the subscriber base in the initial stages, when the number of subscribers is much less than potential. Advertising, dumping etc. can create such popularity. In the second part of the article, the method of constructing an growth model with a first-order differential equation is described. The approach taken is suitable for describing processes of sales where goods are distributed rapidly during the initial stages (when the number of people who have taken an interest in the new services and products on offer is small compared with the actual carrying capacity of the market sector). The result of the first-order differential equation will be incorrect if it is used to describe the adoption process of services onto the market with low initial speed of distribution. The third part of the article is devoted to describing a way of applying a second-order differential equation resulting in the same type of curves but taking into account different external circumstances. In both cases (first-order and second-order) methods are described and illustrated for identifying the capacity of the market segment at which the services are aimed. The task of establishing the optimal pricing strategy for the company is also formulated, thus providing a means for maximum income when the communication services enter the market.

1. Model of distribution of cellular communications operator services on the competitive market

Fig. 1. shows a model of a dynamic system illustrating the distribution of cellular communication company services on the competitive market. It is based on John D. Sterman's approach [4]. The total adoption rate is the sum of adoptions resulting from "word of mouth" and adoptions resulting company advertising, communicating services advertising and any other external influences. Adoptions from "word of mouth" are formulated exactly as in the logistic innovation diffusion model or Bass diffusion model [4]. The probability that a potential users will adopt as the result of exposure to a given amount of advertising and the volume of advertising and other external influences each period are constant.

When growth process begin, positive feedbacks depending on the installed base are absent because there are no or only a few users of the company. Initial growth is driven by other feedbacks outside the boundary of the simple logistic models.

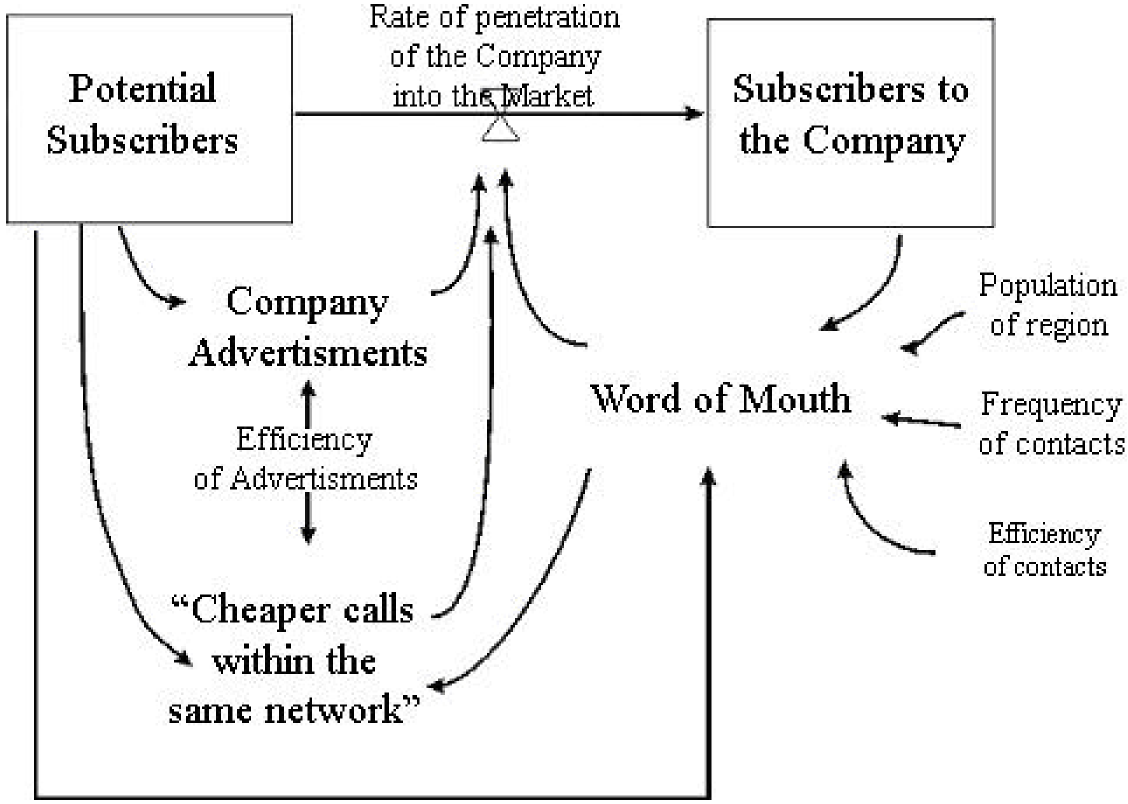

Figure 1. Model of adoption of services of a company into the market

Existing subscribers of the company, having found out about satisfactory services available, spread the information among unaware people. As a result of such contact there is "word of mouth" and there is a probability that new subscriptions will be made. This probability (the efficiency of the distribution of “word of mouth”) depends on the important principle of estimating appropriate costs for the services of the cellular communication operator. For example, the cost of calls made within the network of the same operator is cheaper than those calls made to destinations outside of the network (i.e. for calls between relatives, friends and immediate family it is cheaper to use one communication company).

An important factor influencing the rate at which customers subscribe, is the informing of potential subscribers of the services available. For this purpose, advertising is used.

2. First dynamic growth model

It has already been stated that there are two possible scenarios in the realization of sales, one with a high initial rate of sales, and one with a low initial rate of sales. From real data available on sales volumes of services belonging to various price categories, the cumulative total sales volume for a length of time on the competitive market (Fig. 1) follows [4] a sales process that can be described by the first-order differential equation:

$$T\frac{dx}{dt}+x=a_P\ ,\quad a_P\in L\ , \tag{1}$$

where $x(t)$ – cumulative sales of the services; a_P – estimation of the potential market carrying capacity for the services, taking into account issues specific to the socio–economic factors of the region; T – time constant, which depend on fractional growth rate; L – interval estimate of the market carrying capacity.

Fig. 2 shows real data curves for sales volumes within various price categories with a high initial rate of distribution. These can be approximated to a high degree of accuracy by the result of a differential equation (1).

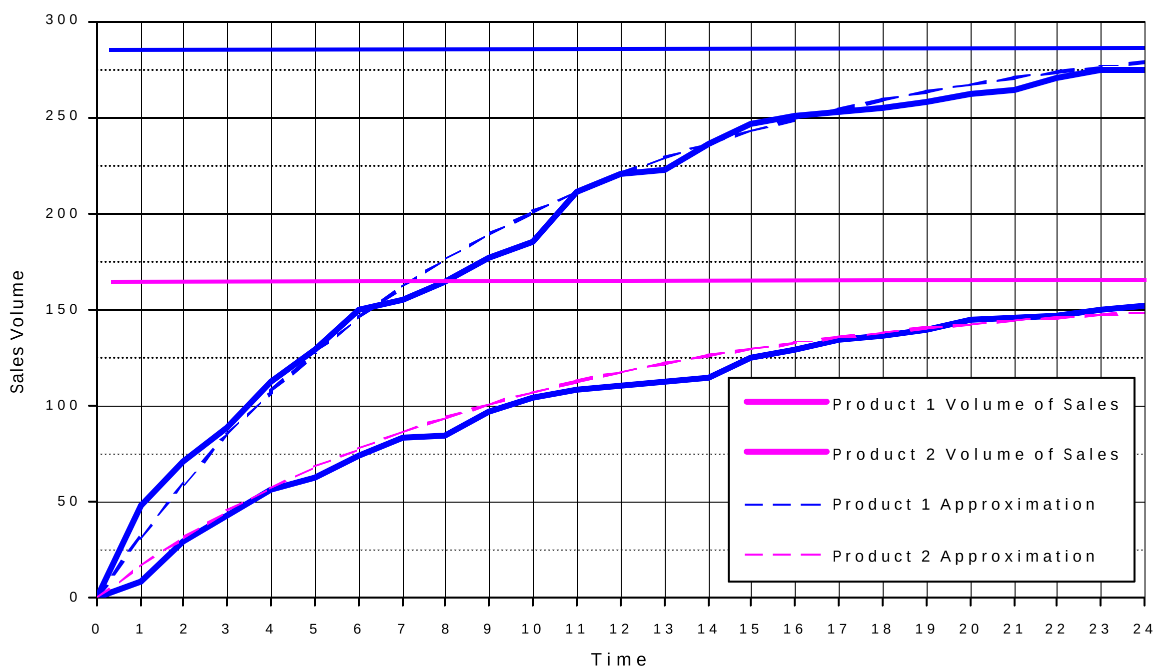

Figure 2. Increasing sales volumes

Suppose that we have point evaluation of parameter a_P. In this case $x_\infty = x_P$ and appropriate cumulative sales curve on time interval $[0, T_1]$ presented on figure 3. In other cases ($x_\infty > x_P$ or $x_\infty < x_P$) firm will have the smaller received proceeds in an outcome of non–optimum planning of price policy.

Price strategy of the company [2,3] solved from the following optimization problem:

$$F(a_P) = \int_0^{T_1} s(a_P) \cdot x(a_P, t) dt \to \max_{a_P \in L}, \qquad (2)$$

where $F(a_P)$ – income from the sale of goods and services by the company; $s(a_P)$ - function of the cost of the goods, based on the attitude of a certain target audience towards the goods and the affordability of the goods by a given a segment of the population.

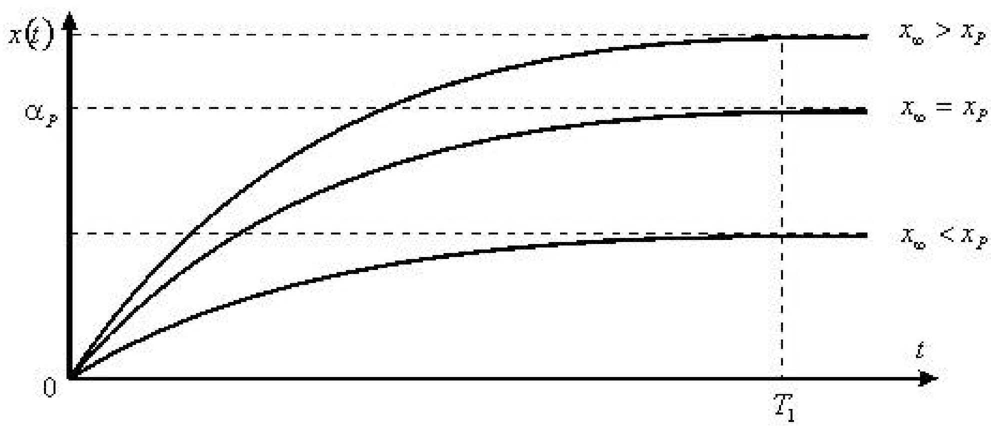

Figure 3. Estimated capacity of the market sector

If the value of a_P set as a criterion for the result of condition (2) is estimated at its extreme (asymptote) in relation to the capacity of the market segment, a_P, the company's income is maximized. The function of $s(a_P)$ depends on the level of competition within the researched market segment and the target consumers; whether or not the goods are essential (higher or lower purchase priority), social and economic indices of the region, advertising etc. When the change of parameter a_P over time is omitted from (2) we get:

$$F(a_P) = a_P s(a_P) \left(T_1 + T \left(\exp(-\frac{T_1}{T}) - 1 \right) \right) \to \max_{a_P \in L}. \qquad (3)$$

The use of asymptotic values produces the type of function shown in Fig. 4 and hence the function of cost $s(a_P)$. Therefore, the result of the one–dimensional optimisation (3) task, chosen specifically for the price bracket on the market to which the goods and services are to be directed, will allow for the company to receive maximum income from sales activities.

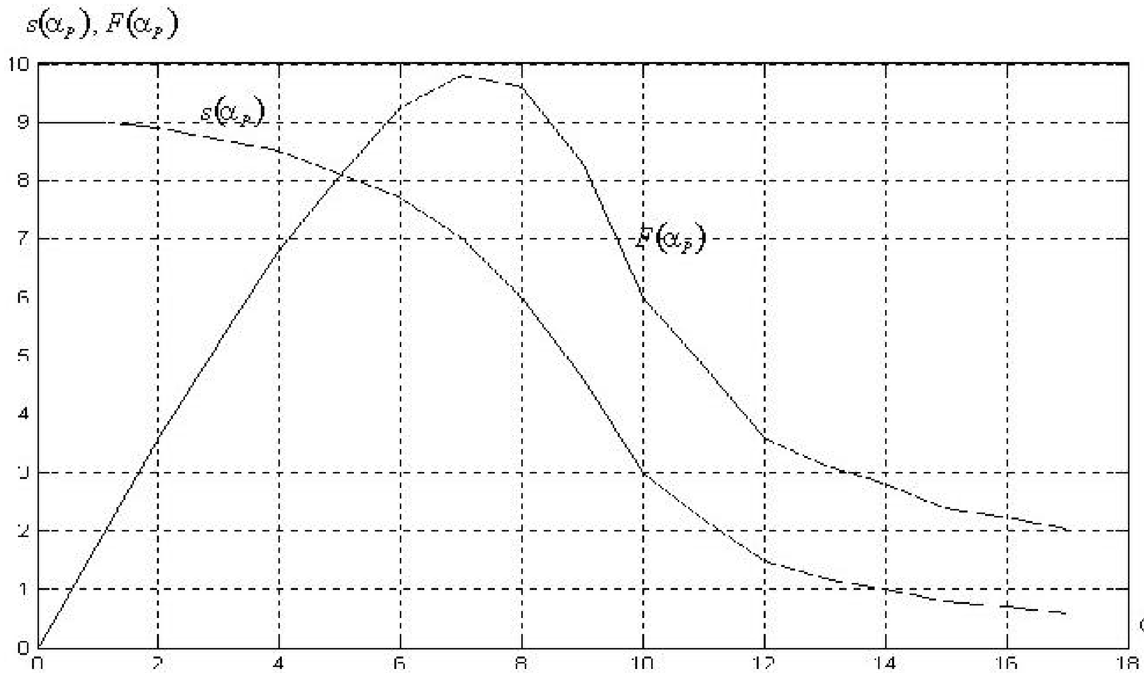

Figure 4. Relationship between price and potential capacity of the market segment

3. Second dynamic growth model

In practice there are various possibilities affecting the growth of volume of communication services sales with differing initial rates of distribution of the product on the market. The first model of cumulative sales volumes (Fig. 2.) is not applicable to the S-shaped curve (Fig. 7) of total volume of sales. In this case we should use a second-order differential equation:

$$T^2 \frac{d^2x}{dt^2} + 2xT\frac{dx}{dt} + x = a_P \,, \quad a_P \in L \,, x > 1, \tag{4}$$

where T, x - constants, relating to the curve of the cumulative increase in total volume of sales of services (Fig.5, 6). Unlike the first–order differential equation (1), equation (4) offers more possibilities to look to available experimental data and thus increase the accuracy of the approximations. This results in a more exact determination of the course and capacity of the market for the goods.

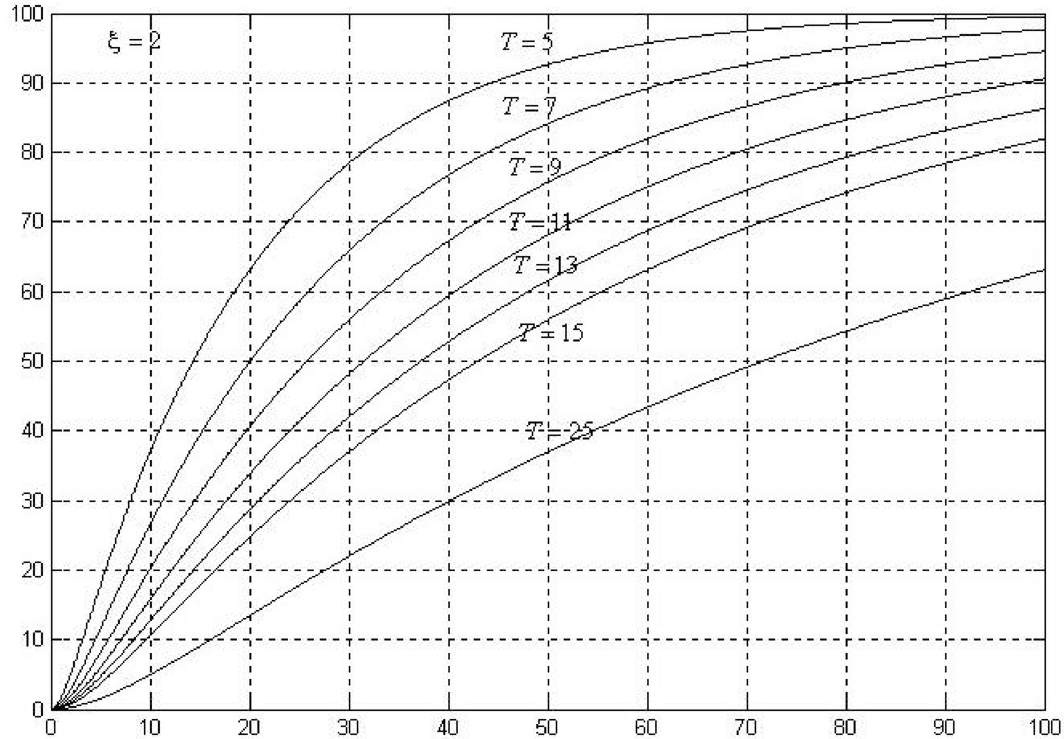

Figure 5. Influence of parameter T on curve of function $x(t)$

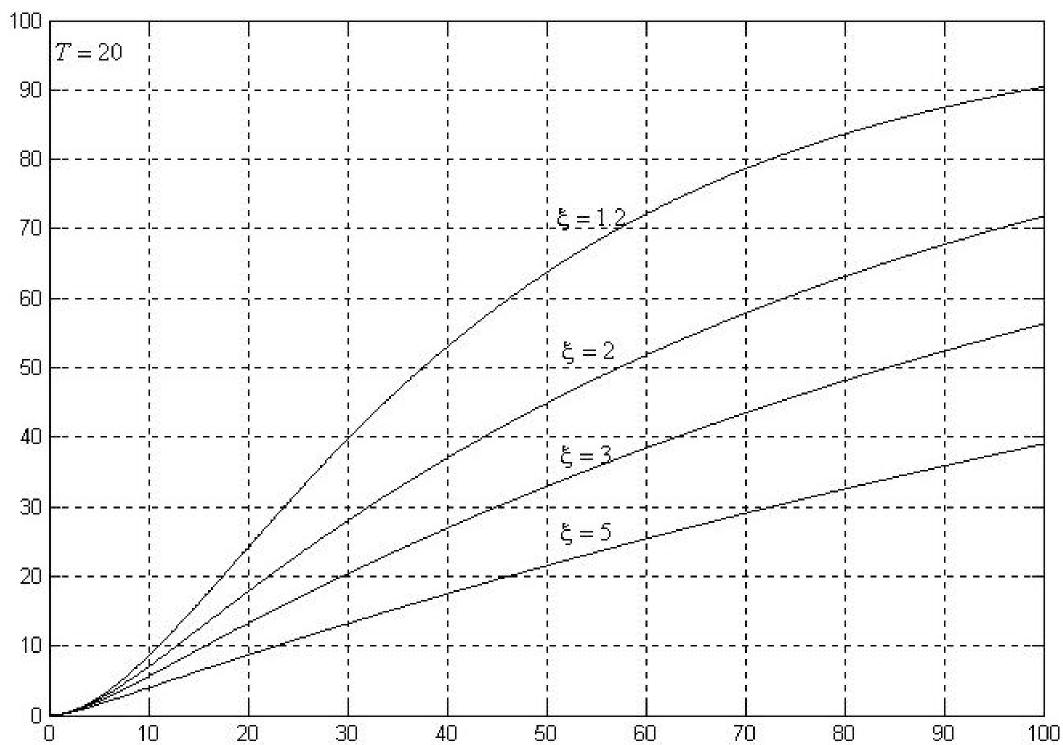

Figure 6. Influence of parameter x on curve of function $x(t)$

Fig. 7 illustrates the approximation of the real company statistical data for cumulative volume of services sales at a low initial rate of distribution (i.e. when the number of people who have purchased the goods is low compared with the capacity of the market). This is the result of the differential equation (4) with zero values entered for the derivative and function $x(t)$.

Such approximation of experimental data, assuming an S-shaped curve of distribution of services to potential consumers [4], as well as the content of Fig. 2, allows us to estimate the capacity, a_P, of the market segment at which the goods are directed. This method also enables us to forecast the demand for the goods despite the uncertainty of some factors. As new sales take place, the sales data will correlate to the market research more and more.

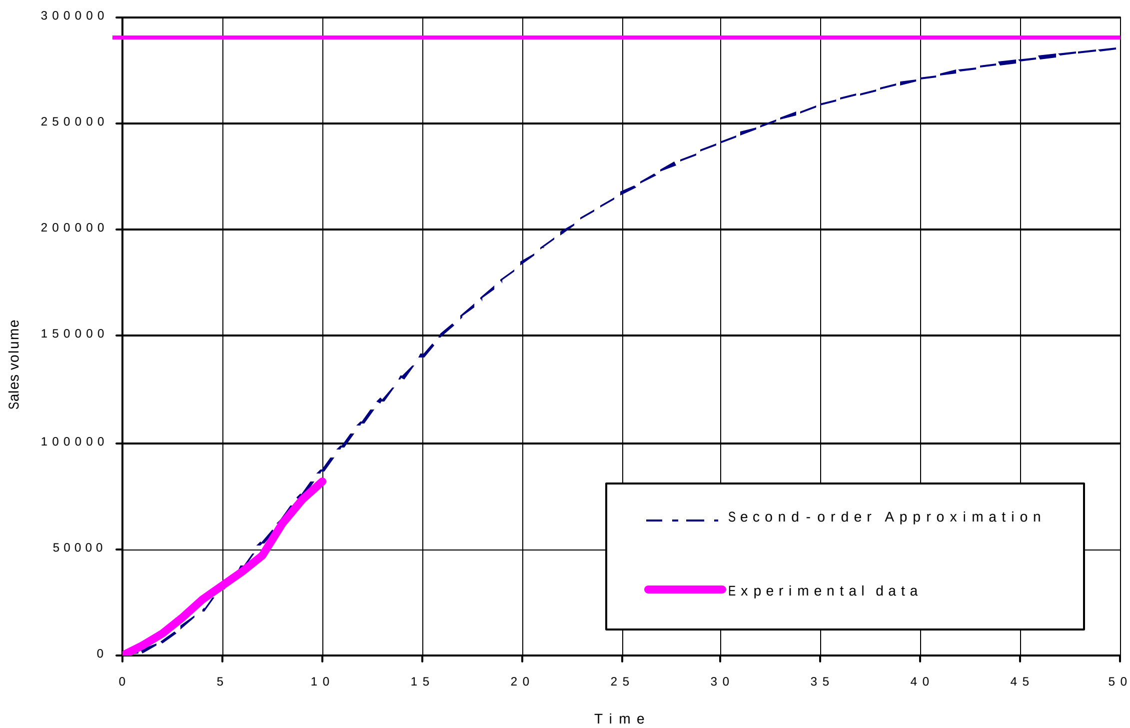

Figure 7. Cumulative sales volumes of the goods on the market

As in the case where the sale of goods is described by a first–order differential equation, for S-shaped curve distribution of an innovation on the market it is also analytically possible to utilise function (2)

$$F(a_P) = a_P s(a_P)(T_1 - C_1 - C_2 + C_1 \exp(l_1 T_1) + C_2 \exp(l_2 T_1)) \to \max_{a_P \in L} . \qquad (5)$$

It should be noted that the problem of one-dimensional analytical optimisation (5) can only be written down and solved under the condition that the analytical function, $s(a_P)$ is the cost of the goods based upon the target audience at which sales are focussed. A function of type $s(a_P)$ can change during the sale of goods along with changes to the social and economic indices of the region, resulting from changes to the level of competition from other companies selling the same product, consumer status and the influence of other factors.

If the price of the product is determined beforehand, or for some reason a specific value of $s(a_P)$ is assumed (Fig.4), this will enable an estimate to be made of the size of the prospective market, but the result of optimisation exercise (3) or (5) will be insignificant. If the company is at the stage of creating a price strategy for the presentation of an innovation on the market, then the function $s(a_P)$ is the key to establishing the optimum pricing policy for the company, which for the product in question, will result in maximum income from sales.

All data in the paper based on real volumes of cellular services sales from one of the Southern–Ural communication company of Russia.

Conclusion

This work has presented a model of a dynamic system, describing the process of distributing a cellular network operator's services in a competitive market. Two models of cumulative volumes of sales of communication services are considered by way of first-order and second-order differential equations. A method of shaping an optimum pricing strategy for companies is described, as is the process of identifying the size of the market. Numerical results of the modelling are established and comparison is made with real experimental data on the volumes of sales of communication services in a competitive market.

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