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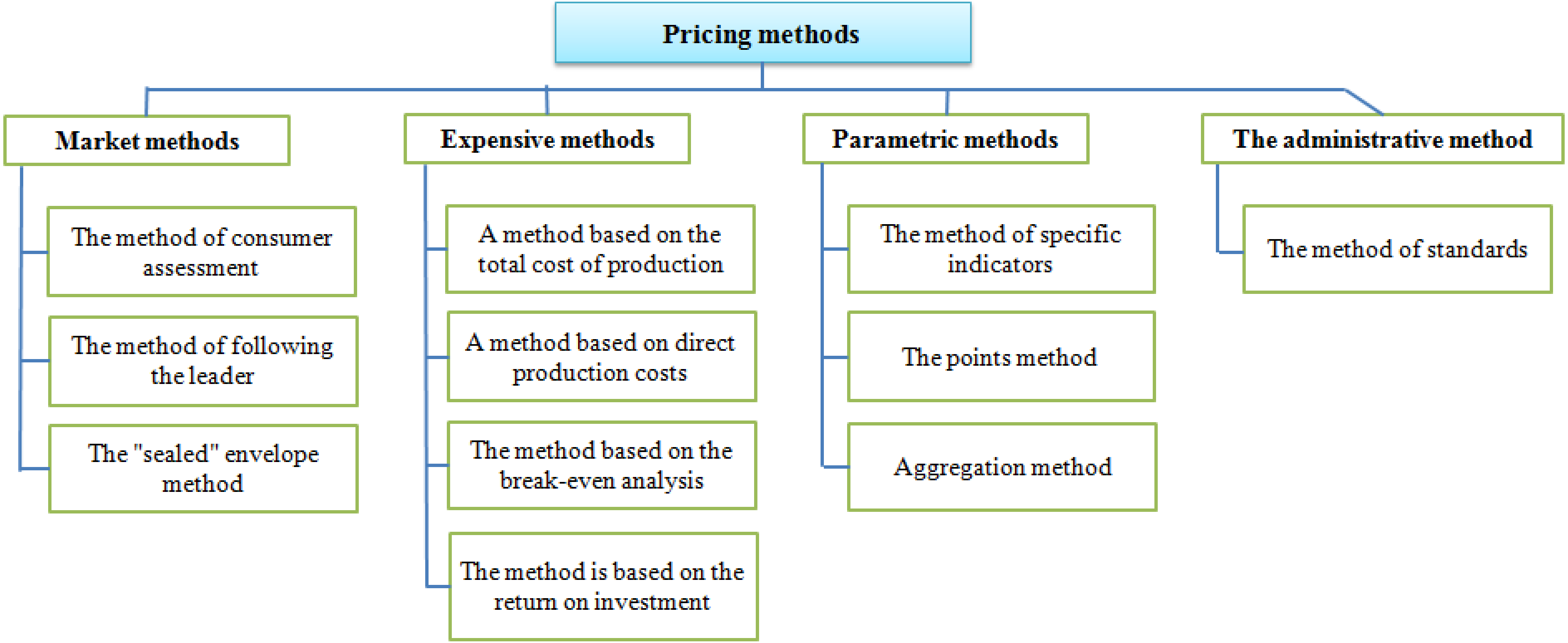
The Role of the Mathematical Modeling in the Analysis of Market Price Conditions

MUTOVKINA Nataliya

Department of “Accounting and Finance”, Tver State Technical University, Tver, 170023, Russia

Correspondence author, e-mail: letter-boxNM@yandex.ru

Introduction



Mathematical models allow you to predict the development of economic systems, and mathematical models of supply and demand give you to calculate the equilibrium market price. The knowledge of which allows companies operating in the market to optimize their activities.

Research objectives

The study aims to analyze the effectiveness of mathematical pricing models in modern market conditions. The study considers a demand-driven pricing model and a cobweb pricing model.

The study's novelty lies in comparing the effectiveness of the applied models and recommendations for their inclusion in the pricing methodology of an economic entity. The entity in the study is a farm poultry meat and sells through its retail store.

The practical task solved in the study is to achieve the optimal price for poultry meat in this company.

Types of Pricing Models

Demand-Driven Pricing Model

$$\frac{\Delta Q}{Q} = -\frac{\Delta P}{P} \quad (1)$$

$$E_{P-AVC} = \frac{P - AVC}{P} \cdot E = 1 \quad (2)$$

$$\frac{\Delta Q}{Q} = -\frac{\Delta P}{P} \cdot \frac{P}{P - AVC} \quad (3)$$

$$E_P^D = \frac{\Delta Q / Q_1}{\Delta P / P_1} = \frac{(Q_2 - Q_1)/Q_1}{(P_2 - P_1)/P_1} \quad (4)$$

Table 1. Recommendations on price changes to maximize revenue and profit

	$E_P^D < 1$	$E_P^D = 1$	$1 < E_P^D < \frac{P}{P-AVC}$	$E_P^D = \frac{P}{P-AVC}$	$E_P^D > \frac{P}{P-AVC}$
To maximize revenue	raise	save	reduce	reduce	reduce
To maximize profits	raise	raise	raise	save	reduce

Cobweb Pricing Model

$$y_t^D = a_0 + a_1 p_t \quad (5)$$

$$y_t^S = b_0 + b_1 p_{t-1} \quad (6)$$

$$y_t^D = y_t^S \quad (7)$$

$$p_t = \frac{b_1}{a_1} \cdot p_{t-1} + \frac{(b_0 - a_0)}{a_1} \quad (8)$$

$$p^* = \frac{b_1}{a_1} \cdot p^* + \frac{(b_0 - a_0)}{a_1} \quad (9)$$

$$p^* = \frac{c}{1 - b_1/a_1} \quad (10) \qquad c = \frac{b_0 - a_0}{a_1}$$

1. If $\alpha = \left|\frac{b_1}{a_1}\right| < 1$, then for $t \to \infty$ $p_t \to p^*$.

2. If $\alpha = 1$, then at $t \to \infty$, p_t fluctuates near the equilibrium value.

3. If $\alpha > 1$, then at $t \to \infty$, the price will deviate from its equilibrium value more and more.

Modeling the Search for an Equilibrium Price

Demand-Driven Pricing Model

Table 2. Calculations to determine the selective demand function for chicken drumstick

Price per 1 kg, rub.	Frequency	Inverse cumulative frequency	Cash receipts, rub.	Variable costs, rub.	Earnings, rub.	Elasticity coefficients	Coefficients *P/(P-AVC)*
300	4	100	30 000	24 600	5 400	-	5.56
320	5	96	30 720	23 616	7 104	0.6	4.32
340	14	91	30 940	22 386	8 554	0.8	3.62
360	18	77	27 720	18 942	8 778	2.6	
380	33	59	22 420	14 514	7 906	4.2	
400	18	26	10 400	6 396	4 004	10.6	
420	5	8	3 360	1 968	1 392	13.8	
440	3	3	1 320	738	582	13.1	

The optimal price for profit turned out to be the price of 360 rubles, which corresponds to 8 778 rubles of profit.

In the range from 340 to 360 rubles, the average elasticity is more than one (modulo) but less than the coefficient $\frac{P}{P-AVC}$; so when the price increases in this range, revenue begins to decrease, but profit continues to grow. From 360-380 rubles, the elasticity coefficient is noticeably higher than the coefficient $\frac{P}{P-AVC}$, so both revenue and profit are reduced. Accordingly, we can recommend a retail price of 360 rubles per kilogram of goods.

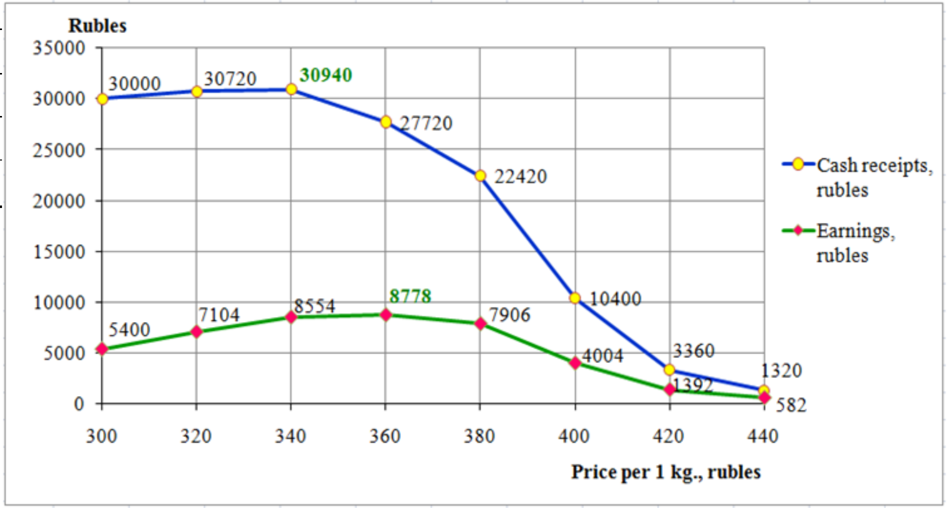


Figure 1. The prices of achieving maximum revenue and maximum profit

Cobweb Pricing Model

Table 3. Initial data for building a cobweb model

No. of change	Price per 1 kg, rub.	The volume of demand, kg	The volume of supply, kg
1	300	512	223
2	320	425	284
3	340	383	313
4	360	362	328
5	380	328	346
6	400	313	362
7	420	284	383
8	440	223	425

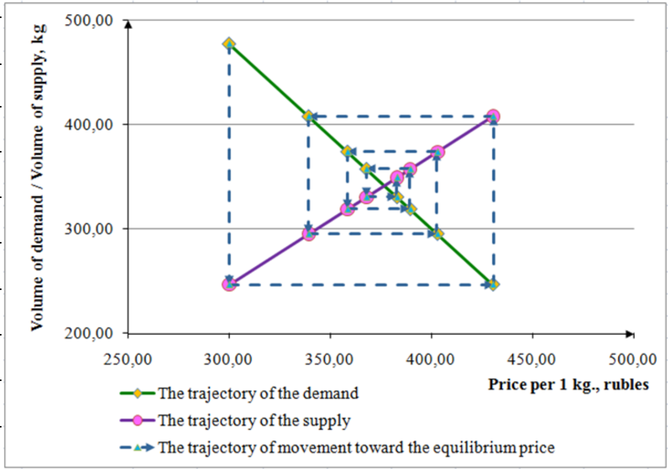
The equilibrium price was 376.84 rubles, which is higher than the 16.84 rubles than the result obtained using the demand-oriented model.

$$y^D = 1007.6 - 1.8p \quad (11)$$

$$y^S = -123.8 + 1.2p \quad (12)$$

Table 4. Calculations for modelling

Price	The trajectory of the demand	The trajectory of the supply	The trajectory of movement toward the equilibrium price
300.00	477.272	246.583	477.272
300.00	477.272	246.583	246.583
430.51	246.583	407.701	246.583
430.51	246.583	407.701	407.701
339.36	407.701	295.173	407.701
339.36	407.701	295.173	295.173
403.02	295.173	373.765	295.173
403.02	295.173	373.765	373.765
358.56	373.765	318.875	373.765
358.56	373.765	318.875	318.875
389.61	318.875	357.211	318.875
389.61	318.875	357.211	357.211
367.92	357.211	330.436	357.211
367.92	357.211	330.436	330.436
383.07	330.436	349.136	330.436
383.07	330.436	349.136	349.136



Features and Disadvantages of the Models

Each model has its features and disadvantages. The advantages of both models are their simplicity, visibility, and modeling capabilities in almost any computing software environment.

The disadvantage of the demand-driven model is the subjectivity of respondents’ responses. Respondents’ opinions may change over time. In addition, there is no guarantee that each respondent answered honestly during the survey. Another disadvantage is the initial assumption that each respondent will buy one kilogram of goods.

The disadvantage of the cobweb model is that it considers the influence of only two factors and does not take other.

Nevertheless, it should be recognized that each of the considered models is effective under certain conditions. The demand-driven pricing model is effective when sales are of a new product; there is still no information about the volume of supply and demand. The cobweb model shows, on the contrary, good results if this information is known. Both models are based on statistical data but on different indicators.

The models proposed in the work allow us to analyze the process of establishing an equilibrium price for goods and services in a competitive market. With the help of the developed models, entrepreneurs can make informed decisions about the prices of goods and services and create an effective pricing policy for their enterprises.

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