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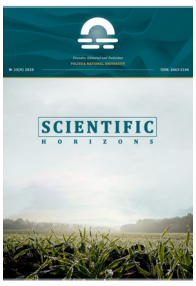

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Methodological Approaches to Forecasting Bread Prices in Ukraine

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Abstract. The article examines the current state of the bread and bakery market in Ukraine on the basis of the exponential smoothing method. An important aspect of the analysis of the bakery industry state is the issue of pricing for the number one product in Ukraine – bread and bakery products. The purpose of this study was to analyze the level of bread prices in the regional context, to identify trends and factors influencing them and to propose models on the basis of which it is advisable to make operational forecasts of bread prices. The study was performed on the basis of monitoring data of average consumer prices for wheat bread from first grade flour by months of 2017 and 2018 in the selected regions, Kyiv and Ukraine as a whole. The choice of areas is done due to their territorial location, and the choice of bread type – due to steady popularity among consumers. The dynamics of product prices, in particular in the regional aspect, was analyzed. The example of wheat bread made from first grade flour shows significant differences in the price level for these products by regions. Trends in price changes and their dependence on such factors as the price of flour, the price of gasoline A-95, wages have been identified. The expediency of using for the estimation of bread prices of models based on series of dynamics by exponential smoothing is shown. High accuracy of the received models is confirmed. The proposed approach in this study can be used by industry to construct models of product price forecasting as a benchmark for making management decisions about the real price. Performing these calculations online on a computer will provide businesses with particular advantages over their competitors, as well as the ability to plan their economic performance at the desired level

Keywords: modeling of pricing processes, exponential smoothing method, food industry, product competitiveness

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INTRODUCTION

According to Food and Agriculture Organization, in December 2019, the food price index reached a maximum of 181.7 in the last 5 years. The increase is observed in many countries around the world, as evidenced by studies in Africa, Asia and other regions [1-3]. Most often, price increases are associated with changes in oil prices [1; 3; 4-7]. Different models are being explored to identify the relationship between these metrics, including Autoregressive Distributed Lag (ARDL), A Nonlinear Autoregressive Distributed Lag (NARDL) [2; 5; 8]. For some types of products, here are recent articles on coffee price forecasts [9], soybean oil, fish and vegetables, on red chili peppers [10], using the ARIMA Models.

A. Volkov, M. Morkūnas, and V. Skvarciany [11], based on monthly data on retail prices of foodstuffs of the Lithuanian market for 2016-2018, substantiated the high efficiency of multiple regression models for forecasting prices for butter, eggs and rye bread. In particular, in the bread model, the retail price of rye bread is influenced by the volumes of bread produced, the volume of exports, the purchasing power (monthly average salary in the country) and the yield of rye. This paper examines the processes of changing the price of bread and bakery products (HBB) on the basis of the exponential smoothing method. An important aspect of the analysis of the bakery industry state is the issue of pricing for the number one product in Ukraine – bread and bakery products (BBP).

A lot of publications in the field of engineering, technology and economics are devoted to forecasting as an important function of management. It is economy where forecasting models have achieved special development and widespread use. Forecasting models and methods have been actively researched since the mid-twentieth century by both foreign and domestic specialists. Among the founders should be noted R.G. Brown [12], V.G. Kendall [13], H. Wold [14], G.E.P. Box, G.M. Jenkins [15], T. Anderson [16] and other works.

Among the Ukrainian authors, first of all, works of experts from Forecasting Institute of the NAS of Ukraine, in particular V.M. Heyets [17], should be noted. Among the publications of recent years devoted to the analysis of the bread and BBP market, the works of N.I. Kostetska [18], N.V. Navolska [19] should be noted.

In recent years, there has been a steady decline in the production of bread and HBV in Ukraine. According to the State Statistics of Ukraine, if in 2000 the output was 2646 thousand tons, in 2018 it was only 949 thousand tons (2.16 times less). Most researchers ([18; 19] etc.) associate this fact with population decline. What's more, they note the change in the structure of the population's nutrition towards consumption of other types of products. In addition, small enterprises, mini-bakeries and enterprises operating in the "shadow", whose data on production output is not recorded by the State statistics authorities, compete with the manufacturers of large and medium-sized enterprises.

The purpose of this study is to analyze the level of bread prices in the regional context, to identify trends and factors influencing them and to propose models on the basis of which it is advisable to make operational forecasts of bread prices.

MATERIALS AND METHODS

In contrast to the work discussed above, this paper focuses on the short-term forecast of bread prices using the exponential smoothing method. The study was performed on the basis of monitoring data of average consumer prices for wheat bread from first grade flour by months of 2017 and 2018 in the selected regions, Kyiv and Ukraine as a whole [1]. The choice of areas is done due to their territorial location, and the choice of bread type – due to steady popularity among consumers. The first stage examined the impact on bread prices of factors such as the price of flour of the first grade, the price of gasoline A-95 and average wages. In the second stage, forecast models were constructed on the basis of exponential smoothing method and bread price samples were presented as time series.

It is believed that through the time parameter, the time series is implicitly associated with many factors, taking into account the influence of which individually is not always possible. However, in time series most often there is autocorrelation in a series of "residues" and a certain inertia of economic processes takes place. Therefore, it is advisable to use adaptive forecasting methods for forecasting, in particular, the exponential smoothing method based on R. Brown's [12] model.

According to the classification of exponential smoothing models [20], the NN model is used in this paper, which does not take into account seasonal variations and the damping component (due to their absence). The method involves the representation of the time series y_t, $t = 1, 2, \ldots, T$, in the form of n-degree polynomial:

$$y_t = a_0 + a_1 \cdot t + \frac{a_2}{2!} \cdot t^2 + \cdots + \frac{a_n}{n!} \cdot t^n + \varepsilon_t \quad (1)$$

where ε_t – random variable; $a_0, a_1, \ldots, a_n$ – coefficients to be estimated on a sample basis.

Most often, representations of the series in the form of a linear or parabolic function are used.

Analysis of the dynamics of bread prices by months in 2017-2018 in the studied regions showed that it can best be described by a parabolic function:

$$\hat{y}_t = \hat{a}_0 + \hat{a}_1 \cdot t + \hat{a}_2 \cdot \frac{1}{2} \cdot t^2 \quad (2)$$

To test the feasibility of applying the method of exponential smoothing, the output time series for the

study objects were divided into two parts. The models were based on the first 20 observations (T=20), and the last 4 (l=1, 2, 3, 4) were used to estimate the accuracy of the forecasts.

Estimates $\hat{a}_0$, $\hat{a}_1$,$\hat{a}_2$ of the coefficients a_0, a_1,a_2 of the equation (1) for the parabolic model were determined according to the formulas [12; 21]:

$$\hat{a}_0 = 3(S_t^1 - S_t^2) + S_t^3 \quad (3)$$

$$\hat{a}_1 = \frac{\alpha}{2(1-\alpha)^2} \cdot [(6 - 5 \cdot \alpha) \cdot S_t^1 - (5 - 4\alpha)S_t^2 + (4 - 3\alpha)S_t^3] \quad (4)$$

$$\hat{a}_2 = \frac{\alpha^2}{(1-\alpha)^2} \cdot (S_t^1 - 2S_t^2 + S_t^3) \quad (5)$$

$$S_t^1 = \alpha y_t + (1-\alpha)S_{t-1}^1 \quad (6)$$

$$S_t^2 = \alpha S_t^1 + (1-\alpha)S_{t-1}^2 \quad (7)$$

$$S_t^3 = \alpha S_t^2 + (1-\alpha)S_{t-1}^3 \quad (8)$$

where S_t^1, S_t^2, S_t^3 – exponential means of the first, second and third order; α – smoothing parameter.

The initial conditions were determined according to the formulas:

$$S_0^1 = \hat{a}_{00} - \frac{1-\alpha}{\alpha} \cdot \hat{a}_{10} + \frac{(1-\alpha)(2-\alpha)}{2\alpha^2}\hat{a}_{20} \quad (9)$$

$$S_0^2 = \hat{a}_{00} - \frac{2(1-\alpha)}{\alpha} \cdot \hat{a}_{10} + \frac{(1-\alpha)(3-2\alpha)}{\alpha^2}\hat{a}_{20} \quad (10)$$

$$S_0^3 = \hat{a}_{00} - \frac{3(1-\alpha)}{\alpha} \cdot \hat{a}_{10} + \frac{3(1-\alpha)(4-3\alpha)}{2\alpha^2}\hat{a}_{20} \quad (11)$$

where $\hat{a}_{00}, \hat{a}_{10}, \hat{a}_{20}$ – estimates in the trend model obtained using the least squares (LS) method.

Predicted values $\hat{y}_{t+l}$ were determined according to the formula:

$$\hat{y}_{t+l} = \hat{a}_0 + l \cdot \hat{a}_1 + \frac{\hat{a}_2}{2!}l^2 \quad (12)$$

where l – prediction period.

An important point in forecasting $\hat{y}_{t+l}$ for l periods ahead is to determine the confidence interval within which the true value $\hat{y}_{t+l}$ should be expected. The confidence interval was determined according to the formula:

$$\hat{y}_{t+l} \pm \sigma_{t+l} \quad (13)$$

where:

$$\sigma_{t+l} = \Delta \approx S_{respr} \cdot (2\alpha + 3\alpha^2 + 3\alpha^3 \cdot l^2)^{\frac{1}{2}} \quad (14)$$

where S_{respr} is the standard deviation for absolute errors of the forecast periods.

Value α is usually selected within (0, 1). The closer α to 1, the greater the weight of the last actual values of the time series. This provides a low forecast error for the next period, but at the same time the confidence interval increases. Therefore, they are trying to determine the compromise value α at which a sufficiently high forecast accuracy for the coming periods and an acceptable confidence interval are achieved. The selection of the parameter α was performed by calculating the indicators of the model when α is changing with a certain step.

RESULTS AND DISCUSSION

Studies [22] have shown, that in recent years the level of bread products consumption per person in territorial aspect is not the same: the highest level of consumption is in Dnipro region, the lowest – in Lviv region. Amid the decline in production, bread prices are growing rapidly as evidenced by data in Table 1: for the period 2012-2018 bread had risen in price in Ukraine by more than 4 times. Prices grew at a particularly high rate in Kyiv region and in the city of Kyiv, below the national average they were in Mykolaiv region.

It could be assumed that the decrease in the level of bread consumption is due to the increase in prices for it, but this product for ordinal Ukrainian is a basic necessity, the elasticity coefficient of which is almost equal to one. Therefore, the bread price is influenced by other factors: the cost of grain and flour, and, in recent years, tariffs on energy, water, wages.

Table 1. *Consumer prices for wheat bread from first grade flour by regions and in Ukraine as a whole at the end of 2012-2018*

Consumer prices, UAH/kg, and indexes of prices by regions	Date						
	28.12.12	20.09.13	30.12.14	30.12.15	29.12.16	30.12.17	30.12.18
Dnipro region	**4.75**	**4.72**	**7.43**	**11.48**	**11.42**	**13.48**	**15.81**
Indexes to the previous year, %	100.0	99.4	157.4	154.5	99.5	118.0	117.3
Indexes to 2012, %	100.0	99.4	156.4	241.7	240.4	283.8	332.8
Kyiv region	**3.99**	**5.07**	**7.51**	**9.9**	**10.4**	**16.17**	**19.85**
Indexes to the previous year, %	100.0	127.1	148.1	131.8	105.1	155.5	122.7
Indexes to 2012, %	100.0	127.1	188.2	248.1	260.6	405.3	497.5
Lviv region	**4.62**	**4.88**	**6.67**	**10.67**	**11.21**	**13.96**	**17.71**
Indexes to the previous year, %	100.0	105.6	136.7	159.9	105.1	124.5	126.9
Indexes to 2012, %	100.0	105.6	144.4	230.9	242.6	302.2	383.3

Table 1, Continued

Consumer prices, UAH/kg, and indexes of prices by regions	Date						
	28.12.12	20.09.13	30.12.14	30.12.15	29.12.16	30.12.17	30.12.18
Mykolaiv region	**3.8**	**4.18**	**5.48**	**8.91**	**9.61**	**12.38**	**15.43**
Indexes to the previous year, %	100.0	110.0	131.1	162.6	107.8	128.8	124.6
Indexes to 2012, %	100.0	110.0	144.2	234.5	252.9	325.8	406.1
Kyiv city	**5.38**	**5.38**	**7.72**	**10.68**	**12.1**	**16.78**	**21.26**
Indexes to the previous year, %	100.0	100.0	143.5	138.3	113.3	138.7	126.7
Indexes to 2012, %	100.0	100.0	143.5	198.5	224.9	311.9	395.2
Ukraine	**4.29**	**4.78**	**6.61**	**10.36**	**10.87**	**14.19**	**17.48**
Indexes to the previous year, %	100.0	111.4	138.3	156.7	104.9	130.5	123.2
Indexes to 2012, %	100.0	111.4	154.1	241.5	253.4	330.8	407.5

If until 2012 the cost of bread was more than 75...80% dependent on the cost of flour, in 2018 the proportion of the cost of flour was already to 50 (Fig. 1, 2). A sharp increase in bread prices in 2017-2018 was also caused by the fact that the Cabinet of Ministers of Ukraine on the 1st of October 2016 canceled Resolutions No. 1548 [23] and No. 373 [24]. Those Resolutions provided for restrictions on the level of profitability of bread production weighing more than 500 grams from wheat flour of the highest, first and second grade and their mixtures, rye flour and a mixture of wheat and rye flour of simple recipes (flour, yeast, salt, water) without adding sugar, fat, other excipients, as well as bread and bakery products for diabetics. The abolition of restrictions on the level of profitability of bread production allowed enterprises to set economically reasonable prices according to expenses and with an average level of profitability [25].

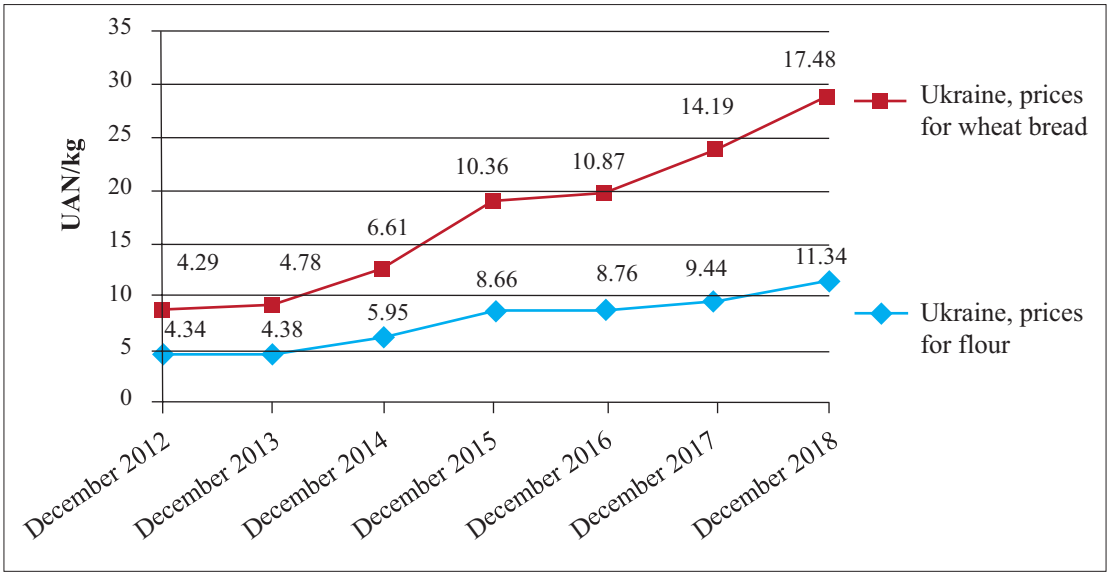

Figure 1. *Dynamics of prices for wheat bread and flour of the 1st grade in Ukraine in 2012-2018, UAH/kg*

In recent years, factors such as fuel tariffs and wages have also had a significant impact on bread prices. This is evidenced by the data of correlation analysis between the values of these indicators by months of 2017-2018 in the studied regions (Table 2).

The initial sample for these two years was formed on the basis of data from the State Statistics Committee of Ukraine precisely because during this period bread prices were more influenced by market factors, without regulatory influence from the Government.

The following notation is accepted in the Table 2: Y – the price of wheat bread, UAH/kg – function; X_1 – the price of 1st grade wheat flour, UAH/kg; X_2 – price of gasoline A-95, UAH/l; X_3 – average wage, UAH/month – factors affecting function.

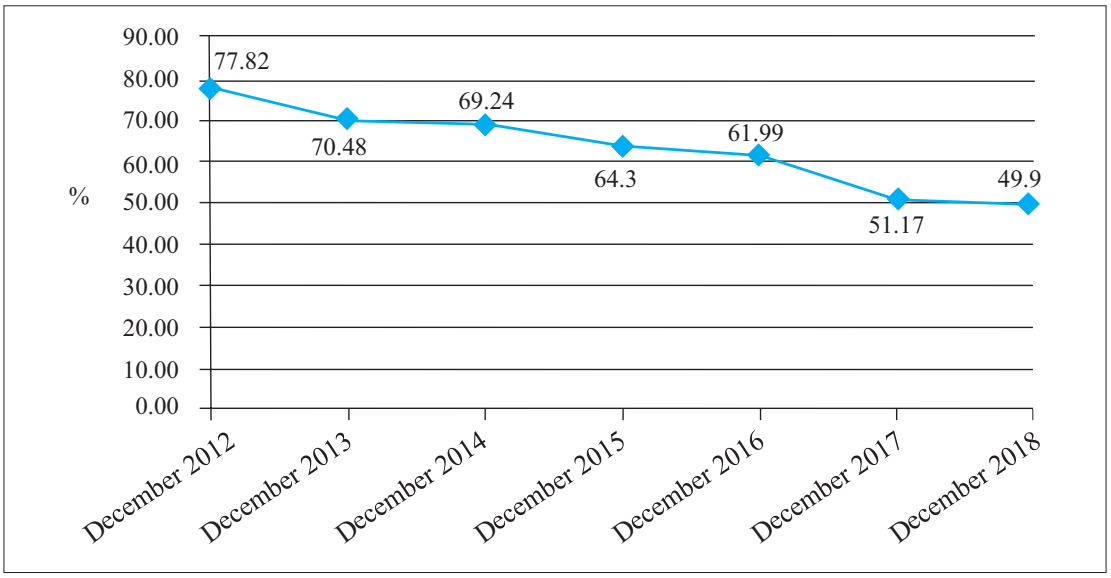

***Figure 2**. Share of the cost of the 1st grade flour in the cost of wheat bread in Ukraine, %*

***Table 2**. Matrix of coefficients of paired correlation between indicators*

	Y	X_1	X_2	X_3
		Dnipro region		
Y	1			
X_1	0.930	1		
X_2	0.927	0.796	1	
X_3	0.976	0.931	0.892	1
		Kyiv region		
Y	1			
X_1	0.955	1		
X_2	0.837	0.856	1	
X_3	0.917	0.927	0.874	1
		Lviv region		
Y	1			
X_1	0.957	1		
X_2	0.950	0.864	1	
X_3	0.937	0.910	0.834	1
		Mykolaiv region		
Y	1			
X_1	0.939	1		
X_2	0.937	0.833	1	
X_3	0.859	0.813	0.809	1
		Kyiv city		
Y	1			
X_1	0.738	1		
X_2	0.906	0.626	1	
X_3	0.901	0.791	0.832	1
		Ukraine		
Y	1			
X_1	0.979	1		
X_2	0.944	0.899	1	
X_3	0.949	0.948	0.859	1

Data of Table 2 indicates a high level of statistical relationship between function and factors. The factors themselves have a high level of communication. Therefore, it is not advisable to make price forecasts based on multiply regression models: the factors are expected to be collinear (which is confirmed by calculations) and their simultaneous use in the models will be incorrect. That is why, a sample of bread prices was presented as a time series [26-28]. It is believed that through the time parameter, the time series is implicitly associated with many factors, taking into account the influence of which individually is not always possible. However, in time series most often there is autocorrelation in a series of "residues" and certain inertia of economic processes takes place. Therefore, it is advisable to use adaptive forecasting methods for forecasting, in particular, the exponential smoothing method based on R. Brown's model.

To obtain the initial values S_t^1, S_t^2, S_t^3, trend models were constructed in Table 3. Model coefficients are estimated according to LS method.

***Table 3**. Trend models for changes in the price of wheat bread by region in 2017-2018*

Region	Type of model	Model accuracy indicators		
		S_{res}^2	R^2	E, %
Dnipro region	$\hat{y} = 12.046 + 0.106 \cdot t + 0.0018 \cdot t^2$	0.006	0.991	0.45
Kyiv region	$\hat{y} = 12.413 + 0.426 \cdot t + 0.0174 \cdot t^2$	0.118	0.953	1.60
Lviv region	$\hat{y} = 11.392 + 0.141 \cdot t + 0.0091 \cdot t^2$	0.037	0.984	1.06
Mykolaiv region	$\hat{y} = 10.445 + 0.140 \cdot t + 0.0033 \cdot t^2$	0.047	0.963	1.33
Kyiv city	$\hat{y} = 13.455 + 0.282 \cdot t + 0.0036 \cdot t^2$	0.235	0.944	2.14
Ukraine	$\hat{y} = 11.951 + 0.178 \cdot t + 0.0013 \cdot t^2$	0.012	0.991	0.65

Trend models' accuracy indicators were calculated according to the formulas:

$$S_{res}^2 = \frac{\sum_{t=1}^{T}(y_t - \hat{y}_t)^2}{T - K} = \frac{\sum_{t=1}^{T}\hat{u}_t^2}{T - K} \quad (15)$$

$$R^2 = 1 - \frac{\sum^{T}(y_t - \hat{y}_t)^2}{\sum_{t=1}^{T}(y_t - \bar{y})^2} \quad (16)$$

$$E\% = \frac{1}{T}\sum_{t=1}^{T}\left|\frac{y_t - \hat{y}_t}{y_t}\right| \cdot 100 \quad (17)$$

where – S_{res}^2 residual dispersion; T – number of observations; K – number of coefficients in the regression equation; $\bar{y}$ – arithmetic mean of y; R^2 – coefficient of determination; $E\%$ – average relative error of approximation. The closer S_{res}^2, $E\%$ to 0 and R^2 to 1, the more accurate the model is.

Fisher's F-test confirmed the statistical reliability of the models ($F_p > F_{tabl}$). As can be seen from the Table 3, the models are fairly accurate. Tables 4 and 5 show the results of calculations done according to the formulas (2-14) at the optimal value α from the position of forecast accuracy for the coming prediction periods and an acceptable level of the confidence interval.

From Tables 4 and 5 it follows that the forecast values of the price for *l*=1.2 are quite accurate. For further periods accuracy decreased. But the advantage of the method is its ability to adapt the model parameters by including new actual data in the sample and recalculating it. Predicted price values often come close to the actual from the "bottom". However, the confidence interval at the upper limit practically coincides with the real price [29]. Therefore, the final decision on pricing should be made by management, taking into account other factors as well. The Tables also show that for each region the best result was obtained at different values α. This indicates the need to carefully study the features of the original dynamic series, its structure and the selection of the best model, depending on the purpose of modeling. Considering the peculiarity of the exponential smoothing method, the aim should be to achieve high accuracy of short-term forecast for the coming prediction periods.

***Table 4**. Results of price forecasting in Ukraine as a whole, α=0.85*

$S^1{}_0$	11.920								
$S^2{}_0$	11.888								
$S^3{}_0$	11.857								
y_t	$S^1{}_t$	$S^2{}_t$	$S^3{}_t$	$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_2$	$\hat{y}_t$	y_t-$\hat{y}_t$	$\left\|\frac{y_t - \hat{y}_t}{y_t}\right\| * 100$
11.99	11.979	11.966	11.949	11.990	0.005	-0.085			
12.41	12.345	12.288	12.238	12.408	0.490	0.196	11.953	0.457	3.68

Table 4, Continued

12.67	12.621	12.571	12.521	12.671	0.279	-0.004	12.996	-0.326	2.57
12.78	12.756	12.728	12.697	12.781	0.065	-0.108	12.948	-0.168	1.31
12.87	12.853	12.834	12.814	12.870	0.055	-0.060	12.792	0.078	0.60
13.00	12.978	12.956	12.935	13.000	0.126	0.005	12.895	0.105	0.81
13.11	13.090	13.070	13.050	13.110	0.108	-0.006	13.128	-0.018	0.14
13.28	13.251	13.224	13.198	13.280	0.183	0.033	13.215	0.065	0.49
13.50	13.463	13.427	13.393	13.500	0.242	0.046	13.479	0.021	0.15
13.72	13.681	13.643	13.606	13.720	0.232	0.018	13.765	-0.045	0.33
13.98	13.935	13.891	13.849	13.980	0.274	0.030	13.962	0.018	0.13
14.19	14.152	14.113	14.073	14.190	0.206	-0.018	14.269	-0.079	0.55
14.41	14.371	14.332	14.294	14.410	0.216	-0.004	14.387	0.023	0.16
14.68	14.634	14.588	14.544	14.680	0.282	0.030	14.624	0.056	0.38
14.90	14.860	14.819	14.778	14.900	0.216	-0.017	14.977	-0.077	0.51
15.14	15.098	15.056	15.014	15.140	0.239	0.003	15.108	0.032	0.21
15.27	15.244	15.216	15.186	15.270	0.104	-0.065	15.380	-0.110	0.72
15.35	15.334	15.316	15.297	15.35	0.049	-0.060	15.342	0.008	0.05
15.49	15.467	15.444	15.422	15.490	0.140	0.014	15.369	0.121	0.78
15.68	15.648	15.617	15.588	15.680	0.208	0.041	15.636	0.044	0.28
l	y_{t+l}	$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_2$	y_{t+l}	y_{t+l}-$\hat{y}_{t+l}$	%	E% =	0.73
1	16.14	15.680	0.208	0.041	15.91	0.23	1.42		
2	16.54				16.18	0.36	2.18		
3	17.22				16.49	0.73	4.24		
4	17.48				16.84	0.64	3.66		
					S_{respr} =	0.23		E% =	2.88
		l	y_{t+l}	$\hat{y}_{t+l}$	Δ	Lower limit	Upper limit		
		1	16.14	15.91	0.56	15.35	16.47		
		2	16.54	16.18	0.79	15.39	16.97		
		3	17.22	16.49	1.06	15.43	17.55		
		4	17.48	16.84	1.35	15.49	18.19		

***Table 5**. Results of price forecasting by regions of Ukraine*

Region	l	y_{t+l}	$\hat{y}_{t+l}$	y_{t+l}-$\hat{y}_{t+l}$	$\left\|\frac{y_t-\hat{y}_t}{y_t}\right\|$, %	Δ	Lower limit	Upper limit	E%
Dnipro region α=0.60	1	14.87	14.84	0.03	0.20	0.25	14.62	15.12	
	2	15.24	15.07	0.17	1.12	0.33	14.91	15.57	
	3	15.68	15.30	0.38	2.42	0.42	15.26	16.10	
	4	15.81	15.55	0.26	1.64	0.53	15.28	16.34	
		S_{respr}=	0.15						1.35
Kyiv region α=0.60	1	17.71	17.87	-0.16	0.90	1.43	16.44	19.30	
	2	18.05	18.05	0.00	0.00	1.84	16.21	19.89	
	3	19.48	18.22	1.26	6.47	2.38	15.84	20.60	
	4	19.85	18.40	1.45	7.30	2.97	15.43	21.37	
		S_{respr}=	0.84					3.67	

Table 5, Continued

Region	l	y_{t+l}	$\hat{y}_{t+l}$	y_{t+l}-$\hat{y}_{t+l}$	$\left\|\frac{y_t-\hat{y}_t}{y_t}\right\|$, %	Δ	Lower limit	Upper limit	E%
Lviv region α=0.15	1	16.26	16.27	-0.01	0.06	0.15	16.12	16.42	
	2	16.63	16.59	0.04	0.24	0.16	16.43	16.75	
	3	17.32	16.91	0.41	2.37	0.17	16.74	17.08	
	4	17.71	17.24	0.47	2.65	0.18	17.06	17.42	
			S_{respr}=	0.25					1.33
Mykolaiv region α=0.45	1	14.53	14.38	0.15	1.03	0.16	14.22	14.54	
	2	14.78	14.73	0.05	0.34	0.19	14.54	14.92	
	3	15.01	15.11	-0.10	0.67	0.23	14.88	15.34	
	4	15.43	15.51	-0.08	0.52	0.28	15.23	15.79	
			S_{respr}=	0.12					0.64
Kyiv city α=0.30	1	19.06	19.82	-0.76	3.99	0.85	18.97	20.67	
	2	19.10	20.07	-0.97	5.08	0.95	19.12	21.02	
	3	20.90	20.32	0.58	2.78	1.10	19.22	21.42	
	4	21.26	20.57	0.69	3.25	1.28	19.29	21.85	
			S_{respr}=	0.87					3.78

To predict prices based on time series with an upward trend, the method of exponential smoothing based on the R. Brown model can be recommend. As noted in Yu.P. Lukashin [30], the positive characteristics of the model include the fact that the model requires the determination of the optimal value of only one parameter. And, what's more, the coefficients of the model are estimated according to the method of exponential smoothing in such a way as to reduce the autocorrelation in the "residues". Therefore, the model can be used in calculations on a computer, even in Excel.

CONCLUSIONS

An analysis of the dynamics of prices shows that they have been steadily increasing over the last 7 years, that is, the situation in the country is no different from world trends. The price level for these products has a significant impact on the prices of many other food products. So, research of the dynamics of changes in the prices of bread and BBP, identifying the factors of influence, construction and application of econometric models for the analysis, forecasting and management of the pricing process is a relevant task.

The proposed approach can be used by industry to construct models of product price forecasting as a benchmark for making management decisions about the real price. Performing these calculations online on a computer will provide businesses with particular advantages over their competitors, as well as the ability to plan their economic performance at the desired level.

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Методологічні підходи до прогнозування цін на хліб в Україні

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Анотація. У статті досліджується сучасний стан ринку хліба та хлібобулочних виробів в Україні на основі методу експоненціального згладжування. Важливим аспектом аналізу стану хлібопекарської промисловості є питання ціноутворення на продукт номер один в Україні – хліб і хлібобулочні вироби. Метою даного дослідження було проаналізувати рівень цін на хліб у регіональному розрізі, виявити тенденції та фактори, що впливають на них, а також запропонувати моделі, на основі яких доцільно робити оперативні прогнози цін на хліб. Дослідження виконано на основі даних моніторингу середніх споживчих цін на хліб пшеничний із борошна першого ґатунку за місяцями 2017 та 2018 років у виділених регіонах, Києві та Україні в цілому. Вибір районів обумовлений їх територіальним розташуванням, а вибір виду хліба зумовлений стабільною популярностю серед споживачів. Проаналізовано динаміку цін на продукцію, зокрема в регіональному аспекті. На прикладі пшеничного хліба, виготовленого з борошна першого сорту, видно значні відмінності в рівні цін на цю продукцію за регіонами. Виявлено тенденції зміни цін та їх залежність від таких факторів, як ціна на борошно, ціна на бензин А-95, заробітна плата. Показано доцільність використання для оцінки цін на хліб моделей на основі рядів динаміки методом експоненційного згладжування. Підтверджується висока точність отриманих моделей. Запропонований у статті підхід може бути використаний промисловістю для побудови моделей прогнозування ціни на продукцію як орієнтира для прийняття управлінських рішень щодо реальної ціни. Виконання цих розрахунків онлайн на комп'ютері дасть підприємствам певні переваги перед конкурентами, а також можливість планувати свої економічні показники на бажаному рівні

Ключові слова: моделювання процесів ціноутворення, метод експоненційного згладжування, харчова промисловість, конкурентоспроможність продукції