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THE ECONOMICAL MODELLING OF THE RETAIL GOODS TURNOVER

Abstract

Economic-mathematical models of the volume of the retail goods turnover' s dependence on various factors were constructed: investments into retail goods turnover, the monthly average nominal salary, monetary incomes of the population, industry and agriculture production, and also their contribution to retail goods turnover were calculated.

Key words:

Retail goods turnover, investments into retail goods turnover, industrial output sold, agriculture production, the monthly average nominal salary, monetary incomes of the population, econometrical models, logs, Aitken's model, method of tool variables.

JEL: E22, E24, C02.

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Problem statement. Retail goods turnover of the enterprises is one the main componet of gross national product. According to the source [10, p. 273] retail goods turnover of the enterprises is defined as a volume of consumer goods sold to the population by the retail trading network and by the network of a hotel and restaurant economy by all operating enterprises, and also by industrial, transport and others the non commercial enterprises and households directly to the population through enterprise cash desk. Besides, in retail goods turnover sale through a trading network to establishments, the organizations and the enterprises of the food stamps to the groups of the population served by them (in sanatoria, child care centers, hospitals, etc.) is included. As shown in the author's research [2, p. 108] the increase in volume of retail goods turnover on 1% led to the increasement in gross national product on 0,946%. This factor specifies that it is an inadequate place of retail goods turnover's development in dynamics of the gross national product, as in the developed countries this factor is higher. Because of that connection there is a necessity to reveal the laws of various factors influence on intensity of retail goods turnover dynamics in the conditions of stable development of economy development for the purpose of possible use those predictive indicators for working out the measures of a state policy.

The analysis of the last researches and publications. Article theme concerns a problem, which in economic researches is depicted insufficiently. To make this research the methods of correlation and regression analysis have been used. It is necessary to notice, that such researches have been depicted partly only in works [1, p. 627–634, 2, p. 107–110, 3, p. 473–479; 4, p. 50–56, 5, p. 130–136].

The purpose and task of the research. The objective of this research is the calculation of investments influence's efficiency into retail goods turnover on its volumes and revealing the dependence of retail goods volume turnover on the monthly average nominal salary, monetary incomes of the population, expenses on acquisition of the goods and services and the volumes' contribution of the realized industrial output and agriculture production in retail goods turnover on the basis of the constructed economic-mathematical models.

Statement of the basic material. For research the statistical data 2001–2010 years were given (tab. 1 see) [8, p. 52, 54, 68, 72, 9, p. 46, 79; 10, p. 37, 105, 106, 108, 139, 204, 206, 273, 385, 389].

To construct the econometrical models the independent (factorial) variable X is used and have been representing the investments' volumes into retail goods turnover, the monthly average nominal salary, monetary incomes of the population, expenses on acquisition of the goods and services, volumes of the industrial output sold, volumes of production of agriculture and hunting. The productive variable Y was chosen to represent the enterprises' retail goods turnover vol-

umes. Calculations were done by MS Excel program. In tab. 2 the basic and most statistically significant econometrical models are shown. The other models with smaller coefficient of determination R^2 are not represented.

I. Models of retail goods turnover's intensity on investments into it.

Investments positively influence the development of national economy and are actual especially in the conditions of the budgeted deficit and the crisis situation in Ukraine. Apparently from tab. 1 during 2001–2008 years there was a growth in the retail goods turnover volumes of the enterprises in 7,2 times and in the investments enclosed in it into 23,4 times. In 2009 due to an economic crisis in Ukraine in comparison with 2008 there was a decrease in retail goods turnover (in basis prices) on 6,5% and the investments enclosed in it on 31,6%. In 2010 the investment decreased for 16,3% in comparison with previous year and the retail goods turnover increased in comparison with 2008 on 13,8%.

Table 1

Statistical data of the economical indicators for 2001–2011 in the actual prices, million hrv.

Years	Retail goods turnover of the enterprises[1]	Investments in the retail goods turnover[2*]	The monthly average nominal salary[3], hrv.	Monetary incomes of the population[4]	Expenses on the acquisition of the goods and services[5]	Volume of the realized industrial output[6]	Volume of the agriculture and hunting[7] production
2001	34417	417	311,08	109391	77846	210842,7	65218
2002	39691	637	376,38	185073	153589	229634,4	65253
2003	49993	950	462,27	215672	180703	289117,3	64780
2004	67556	1473	589,62	274241	222270	400757,1	83900
2005	94332	2556	806,19	381404	306769	468562,6	92540
2006	129952	4301	1041,44	472061	385691	551729,0	95730
2007	178233	7632	1351	623289	510023	717076,7	109985
2008	246903	9750	1806	845641		917036,0	152210
2009	230955	6670	1906	894286		806551,0	153800
2010	280890	5581	2239	1101175		891170,0	184900
2011	346498		2633	1251005			

Data are presented according to the sources:[1] [10, p. 273];
[2] [10, p. 204];
[3] [10, p. 389];
[4] [10, p. 385];
[5] [8, p. 52, 54];
[6] [9, p. 46; 10, p. 25, 37, 105, 106];
[7] [9, p. 46, 10, p. 25, 139].
* Since 2001 volumes of investments are presented according to classification of types of the economical activity.

Table 2

Statistically significant economical and mathematical models of the retail goods volumes turnover dependence Y_t on the various factors X_t

2001–2010	R^2	2001–2008	R^2
I. X_t – Investments into retail goods turnover			
а) $Y_t = 35056 + 25{,}08X_t$	0,794	a) $Y_t = 30972 + 21{,}41X_t$	0,987
б) $Y_t = 4498 + 49{,}83X_t - 0{,}002X_t^2$	0,850	b) $Y_t = 29429 + 22{,}76X_t - 0{,}0001X_t^2$	0,987
в) $Y_t = 495{,}7X_t^{0{,}682}$	0,941	c) $Y_t = 754{,}6X_t^{0{,}618}$	0,992
		d) Model of the distributed log $Y_t = 42033 + 28{,}52X_{t-1}$	0,971
		e) Generalized Aitken's model $Y_t = 29519 + 22{,}07X_t$	0,9999
II. X_t – The monthly average nominal salary			
а) $Y_t = -9793 + 133{,}6X_t$	0,994	a) $Y_t = -15763 + 143{,}4X_t$	0,997
б) $Y_t = -10872 + 135{,}9X_t - 0{,}0001X_t^2$	0,994	b) $Y_t = -4658 + 114{,}01X_t + 0{,}014X_t^2$	0,999
в) $Y_t = 60{,}22X_t^{1{,}100}$	0,997	c) $Y_t = 45{,}82X_t^{1{,}144}$	0,998
III. X_t – Monetary incomes of the population			
а) $Y_t = -4255 + 0{,}274X_t$	0,990	a) $Y_t = -12259 + 0{,}302X_t$	0,992
б) $Y_t = -7893 + 0{,}291X_t - 1\times10^{-8}X_t^2$	0,990	b) $Y_t = 750 + 0{,}226X_t + 8\times10^{-8}X_t^2$	0,995
в) $Y_t = 0{,}185X_t^{1{,}026}$	0,983	c) $Y_t = 0{,}148X_t^{1{,}044}$	0,969
IV. X_t – Expenses on acquisition of the goods and services*			
		a) $Y_t = -7819 + 0{,}353X_t$	0,977
		b) $Y_t = 14940 + 0{,}153X_t + 3\times10^{-7}X_t^2$	0,992
		c) $Y_t = 0{,}667X_t^{0{,}940}$	0,922
V. X_t – Industrial output realized/sold			
a) $Y_t = -50009 + 0{,}338X_t$	0,971	a) $Y_t = -38038 + 0{,}302X_t$	0,986
		b) $Y_t = -7791 + 0{,}164X_t + 1\times10^{-7}X_t^2$	0,994
		c) $Y_t = 0{,}002X_t^{1{,}348}$	0,989
		d) Model of the distributed log $Y_t = -55127 + 0{,}62X_{t-3}$	0,9718
		e) Model with tool variables $Y_t = -1178 + 1{,}62Y_{t-1} - 0{,}04X_t$	1
VI. X_t – Volume of the agriculture and hunting production			
a) $Y_t = -92095 + 2{,}128X_t$	0,961	a) $Y_t = -121316 + 2{,}483X_t$	0,957
		b) $Y_t = -16922 + 3{,}477X_t + 5\times10^{-6}X_t^2$	0,960
		c) $Y_t = 3\times10^{-7}X_t^{1{,}348}$	0,933
		d) Model with tool variables $Y_t = -9453{,}7 + 1{,}39Y_{t-1} + 0{,}07X_t$	0,9988

* Data for 2001–2007.

Intensity of retail goods turnover on volumes of the investments enclosed in it can be represented by linear, quadratic and power practically functional dependences (tab. 2 see, *I a–c*).

On the basis of the constructed models the quantitative analysis was made [1,p. 479-483]. For average productivity of investments or investment return the relation is taken $\frac{f(x_t)}{x_t} = A_{1t}$, And for investment capacity – reciprocal variable $A_{2t} = \frac{1}{A_{1t}}$. The first derivative of function Y' is a marginal productivity of the retail goods turnover's volume. The approached value of the marginal productivity shows on what size the volume of retail goods turnover will increase at increasement in volume of investments at unit. According to the linear model made for data 2001–2008 years the marginal productivity was 21,41, so at increasement in investments at unit of the retail goods turnover volume (in the actual prices) rose on 21,41 units. During 2001–2010 years the marginal productivity increased to 25,08 units, but, as this model's determination coefficient R^2 was significant, but it was essential lower (0,794), so this volume of marginal productivity deserved on less degree of trust.

The calculated size of investment return A_{1t} shows the tendency to decreasement from the period beginning in 2001 till the end of the period in 2008 with 82,53 to 25,32 units and, accordingly, growth of investment capacity A_{2t} on 0,012 to 0,039 units. In 2009 investment return grown to 34,63 units, in 2010 – to 50,33 units. Considering, that investments into retail goods turnover since 2009 have started to decrease, during the given period it is possible to explain growth of investment return by displacement or delay of retail goods turnover volume concerning the investments enclosed in it.

Elasticity E_x of the goods turnover volume to investments defines the relative change of the productive indicator at change of factorial one on 1%.

Factor of elasticity, which is calculated for various models, also was in range of 0,62–0,71 (%) for the period of 2001–2008 and 0,68–0,74 (%) for the period of 2001–2010 years and specified on its insufficient growth with time and its spending character of investments involved in the retail goods turnover.

Let's investigate the linear function, as the most economically efficient model of (tab. 2 see, *Ia*) the dependences of the retail goods turnover's volume on the investments' volume enclosed in it, constructed for statistical period of 2001–2008 years in the conditions of stable development of economy. Estimations of the model's parameters were estimated by the method of the least squares 1MLS [2, p. 107–108, 6, p. 85–105, 7, p. 52–56]. Check of the application's correctness 1MLS has shown, that a) $\sum_{t=1}^{8} U_t \approx 0$, so consequently $M(U) = 0$;

b) $\sum_{t=1}^{8} X^T \cdot U = -0{,}000011 \approx 0$ was the independent variable that was not connected with the rests; c) the empirical value of the Durbin Watson critical values $DW_{эмп} = 2{,}22$, therefore we have used $DW_{эмп} = 4 - 2{,}22 = 1{,}78$. For $n = 8$ and the set level of trust $\beta = 0{,}95$ its top critical border was $DW_2 = 1{,}33$, and for $\beta = 0{,}99$ – $DW_2 = 1{,}00$ and, as, $DW_{эмп} > DW_2$ –the autocorrelation of the rests was absent for the high degrees of trust to the results [6, p. 170–176, 2, p. 108–109]. Model research on the heteroscedasticity [2, p. 108; 6. 150–153, 7, p. 116–117] by the parametrical test of Goldfeld–Quandt (for small sets of supervision) has shown, that $R^*_{эмп} = 401{,}27$. According to the tables of *F*-distributions for the chosen level of trust $\beta = 0{,}95$, freedom degrees $\nu_1 = \nu_2 = 1$ the critical value of criteria equals $F_{кр} = 161$, for trust level $\beta = 0{,}99$ $F_{кр} = 4{,}052$. As $R^*_{эмп} > F_{кр}$, than with high degree of trust it could be asserted, that sample was the heteroscedastic

It also proves by the non-parametric Goldfeld–Quandt's test (fig. 1) on which values of the rests were represented u_i after the supervision X_i has been arranged.

The importance of the model's parameters was checked on *t*-criteria:

$$t_j = \frac{|\hat{a}_j|}{S_{\hat{a}_j}}, \qquad (1)$$

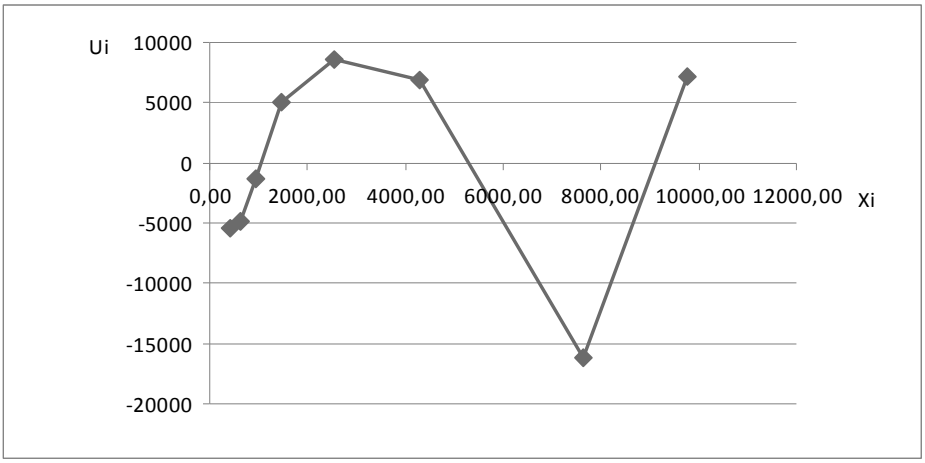
where $\hat{a}_j$ – Value of model's parameter, $S_{\hat{a}_j}$ was the standard error of the model's parameter estimation. The calculated $t_j = t_{эмп}$ criteria has been compared with the tabular *t*-criteria ($t_{кр}$) on the chosen level of trust β and $n - m$ is freedom degrees, where n – is the sample's volume, m – number of model's parameters. If it were $t_{эмп} > t_{кр}$, than that model parameters would be significant or accurate.

From the tables of Students distribution test we have found the numbers of the freedom's degrees of $\nu = 6$ and trust level $\beta = 0{,}95$, $t_{кр} = 1{,}943$, for $\beta = 0{,}99$ $t_{кр} = 3{,}143$.

Model parameters were significant, because of the residual dispersion was $S_u^2 = 85951122{,}13$ and standard errors were $S_{a_0} = 4769{,}05$, $S_{a_1} = 0{,}9999$, so the meaning of t-criteria equaled: $t_{a_0} = 6{,}494$, $t_{a_1} = 21{,}409$.

Figure 1

The non-parametrical Goldfeld–Quandt's test



When there is the presence of the heteroscedasticity and the absence of the rests' autocorrelation the generalized method of the least squares (Aitken's method) for the calculation of model's parameters was used [6, p. 159–161, 7, p. 122–125], the estimation's operator looks like:

$$\vec{A} = (X^T V^{-1} X)^{-1} X^T V^{-1} \vec{Y}, \quad (2)$$

where $\vec{A}$ is a vector of the estimated parameters, X – matrix of the observed values of independent variables, X^T – transposed matrix, $\vec{Y}$ – vector of the observed values of a dependent variable, V – the symmetric positively certain matrix, which diagonal elements depend on the chosen hypothesis concerning a dispersion of the rests [6, p. 156-157]. The absolute values of the rests of the model constructed on 1MLS were used as the elements of the Matrix V.

The dispersion of casual deviations is estimated by the formula:

$$S_u^2 = \frac{1}{n-k-1} U^T V^{-1} U, \quad (3)$$

where n – sample volume, k – quantity of independent variables, U – vector of the model's rests, and the matrix of dispersions and co-variance is estimated by the formula:

$$D^2(\vec{A}) = S_u^2 (X^T V^{-1} X)^{-1} \qquad (4)$$

The specified model looks like (tab. 2 see, *I h*):

$$\hat{Y}_t = a_o + a_1 X_t = 29518{,}56 + 22{,}07 X_t \,;\; R^2 \approx 1.$$

The residual dispersion of the model is $S_u^2 = 9275{,}52$, the standard errors of model's parameters estimations are equal to $S_{a_0} = 2939{,}9034$, $S_{a_1} = 0{,}85$, the empirical *t*-relation for parameter a_0 equals $t_0 = 10{,}04$, for a_1 – $t_1 = 25{,}87$. Thus, as $t_0 > t_{кр}$, $t_1 > t_{кр}$, than at high level of trust the value of model's parameters is significant.

In the model the determination coefficient $R^2 \approx 1$, which specifies that the given linear dependence between the retail goods turnover and the investments enclosed in it was practically function and was calculated by the Aitken's method.

It is necessary to consider, that the effect from the investments influence on the retail goods turnover's volume does not occur immediately but through some period of time, with time delay (log). We use the mutual correlation function $r(\tau)$ to justify a time log or logs [6, p. 216–217]:

$$r(\tau) = \frac{(n-\tau)\sum_{t=1}^{n-\tau} y_t \cdot x_{t+\tau} - \sum_{t=1}^{n-\tau} y_t \cdot \sum_{t=1}^{n-\tau} x_{t+\tau}}{\sqrt{\left[(n-\tau)\sum_{t=1}^{n-\tau} y_t^2 - \left(\sum_{t=1}^{n-\tau} y_t\right)^2\right] \cdot \left[(n-\tau)\sum_{t=1}^{n-\tau} x_{t+\tau}^2 - \left(\sum_{t=1}^{n-\tau} x_{t+\tau}\right)^2\right]}} \qquad (5)$$

The greatest value $r(\tau)$ by the module (is closer to unit) defines the shift in time or a time log. The range $r(\tau)$ at various values τ was calculated and it was represented in tab. 3 and also shown on fig. 2.

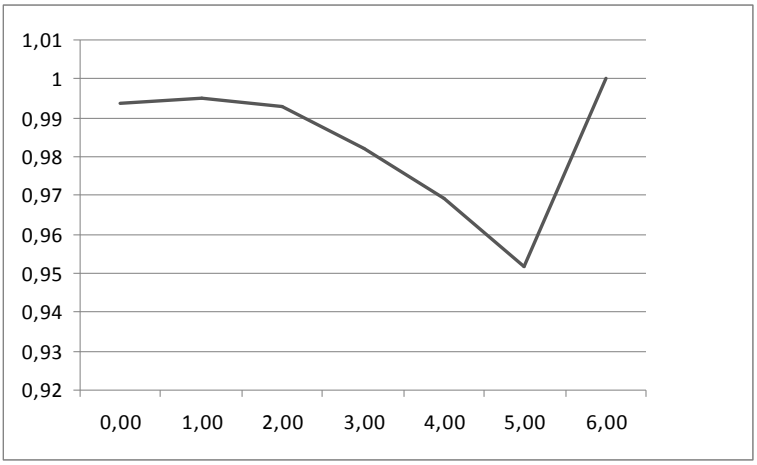
Table 3

The calculated value of the mutual correlation function $r(\tau)$ for the investments into retail goods turnover

τ	0	1	2	3	4	5	6
r_τ	0,993518259	0,994815995	0,992651093	0,982172643	0,969128263	0,951696917	1

Figure 2

The mutual correlation function diagram, based on the time range (the investment into the retail goods turnover)



Apparently from fig. 2 and tab. 3, the greatest mutual value correlation function $r_\tau = 0{,}994816$ accepts at $\tau = 1$, so that in a year after the investment was made it was obvious to expect the greatest gain of retail goods turnover. The dynamic model of the distributed log in that case will be such:

$$\hat{Y}_t = a_0 + a_1 X_{t-1}, \quad (6)$$

where $\hat{Y}_t$ – volume of retail goods turnover during the period *t*; X_{t-1} – investments into the period $t-1$.

The estimation of model's parameters was made by 1MLS. Thus the hypothesis was accepted that the rests were non-auto correlated and were normally distributed. As the greatest log $\tau = 1$, that initial data have been reduced to one supervision, and in time range of the retail goods turnover's volume the first supervision was rejected and in the time investments' range the last one. The model of the distributed log looks like (see tab. 2, *Id*):

$$\hat{Y}_t = 42033 + 28{,}52 \cdot X_{t-1}, \; R^2 = 0{,}971.$$

Check of the model's parameters on *t*-criteria shows, that the estimations of its parameters are authentic at high level of trust, are not displaced, as at

$S_u^2 = 197543860{,}8$, $S_{a_0} = 7752353$, $S_{a_1} = 2{,}199$, the empirical values *t*-criteria are equal to $t_{a_0} = 5{,}42$, $t_{a_1} = 12{,}97$.

The model of the distributed log shows, that the increase in investments at unit in previous year leads to the increasement in retail goods turnover in the current year on 28,52 units, that is more than by the model 1MLS.

From the economic point of view the model of the distributed log in which the greatest influence of investments in it is obvious to expect in a year after the investments were involved is the most accurate and also can be used for the prognosis in the conditions of the stable development of the economy.

2. The governmental policy of the population incomes growth (the monthly average salary in hryvnas) in complex influenced on the economy as a whole and on the retail goods turnover in particular, which were reflected in the models *II a–c*, *III a–c* (see tab. 2). Linear model *II a* of the retail goods turnover's dependence on the monthly average nominal salary for the period of 2001–2008 years is adequate according to Fisher's *F*-criteria and its parameters are authentic, as for a residual dispersion $S_u^2 = 15372331{,}3$ and standard errors of parameters a_0, a_1, $S_{a_0} = 275032$, $S_{a_1} = 2{,}82$, the empirical values of *t*-criteria are equal to $t_{a_0} = 5{,}73$, $t_{a_1} = 5{,}90$. According to this model the increasement in the monthly average salary of Ukrainian citizens at one hryvna increases the retail goods turnover within Ukraine on 143,4 hryvnas. Elasticity of the monthly average nominal salary for linear model is 1,15 (%), for the power model 1,14 (%). During the period of the 2001–2010 years the limiting productivity were 133,6 hrv., elasticity were 1,08–1,1 (%). It indicates on the deterioration of an economic situation in Ukraine after 2008.

In tab. 4 and fig. 3 the values of the calculated $r(\tau)$ – functions were resulted and that testified, that time shift of the retail goods turnover's volume depending on the nominal salary was absent, as mostly all the Ukrainian citizens salary was used in the retail goods turnover on payment of the food and industrial goods during the current year.

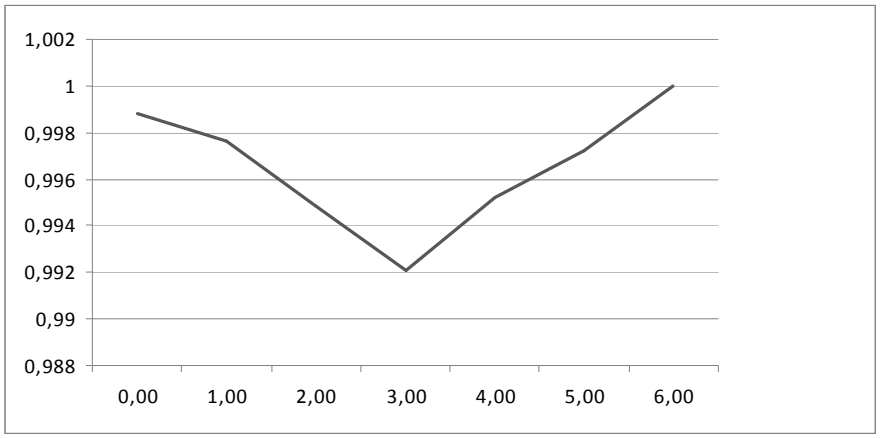
Table 4

The calculated value of the mutual correlation function $r(\tau)$ for the average nominal salary

τ	0	1	2	3	4	5	6
r_τ	0,998843831	0,997643865	0,994860584	0,992108688	0,995204517	0,9971987	1

Figure 3

The mutual correlation function diagram, based on the time range (the monthly average nominal salary)



3. *Models of the retail goods turnover dependence on monetary incomes of the population* (Tab. 2, *III a–c*).

The parameters of the linear model *III a* constructed for the period of 2001–2008 years were significant, as for a residual dispersion $S_u^2 = 52020782$ and standard errors $S_{a_0} = 4960{,}53$, $S_{a_1} = 0{,}011$, the critical values *t*-criteria were equal to $t_{a_0} = 2{,}47$, $t_{a_1} = 27{,}59$. For $\beta = 0{,}95$ parameter a_0 was essential, for $\beta = 0{,}99$ parameter a_0 was insignificant, and in the conclusions' formation haven't been used.

According to the linear model of the retail goods turnover's dependence on monetary incomes of the population the increase in monetary incomes of the population at unit (one million hrv.) leads to the growth in retail goods turnover at 0,302 units (0,302 million hrv.). As follows about 70% of all incomes are spend on savings and acquisitions of the goods not through a trading network of the enterprises. From the period of 2001–2010 years the share of the consumer goods sales which are made on territory of Ukraine through a trading network, that belonged to the physical persons – entrepreneurs and in the market places has grown from 25 to 35,6% [10, p. 287]. Elasticity for linear model was 1,12 (%) and 1,04 (%) – for the power.

In tab. 5 and fig. 4 the correlation function that has two maxima's on $\tau = 1$ and $\tau = 4$ is represented. The first peak represents the purchases for which the population saves its incomes. It can be the goods of not too high cost for the consumer. In Four years the second peak shows the income savings on the purchases' acquisition, which are essential for the consumer.

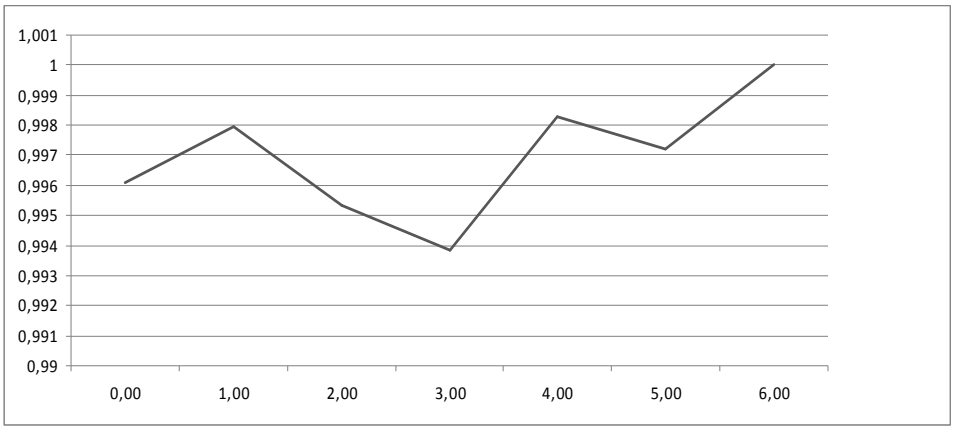
Table 5

The calculated value of the mutual correlation function $r(\tau)$ for the monetary incomes of the population

τ	0	1	2	3	4	5	6
r_τ	0,996082051	0,997979326	0,99531329	0,993817404	0,998295283	0,997205432	1

Figure 4

The mutual correlation function diagram, based on the time range (monetary incomes of the population)



4. *Dependence's models of the acquisition of the goods and services' expenses* (Table. 2, *IV a–c*). Apparently from the linear model for data of 2001-2007 years (*IV a*) the increase in expenses at acquisition of the goods and services at unit (1 million hrv.) leads to the growth in the retail goods turnover at 0,353 units (million hrv.), so approximately 65% of the expenses on acquisition of

the goods and services are circulating not through a trading network of the enterprises. Parameter of the linear model a_1, on which base such conclusion was made, was significant for the high levels of trust β, as for the residual dispersion $S_u^2 = 64068059{,}25$ and its standard errors $S_{a_1} = 0{,}022$, the empirical value was $t_{a_1} = 16{,}08$. The value of parameter a_0 was not authentic for high values β, but it didn't influence on the given conclusion.

5. *Investments' efficiency of the industry's production in retail turnover* (Table 2, *V a–e*). According to the paper [10, p. 105] the volume of the realization of an industrial output (works, services) is defined at the price of the sold and shipped for the enterprise's boarder finished goods (the executed works, services) that are stated in documents (including production (works, services) under the barter contract), which were issued on the basis for calculations with buyers (customers) except for the indirect taxes (value added tax, the duty, etc.). The production (works, services) is recognized as realized after the official papers' registration irrespective of the payments' receipt for it.

Similarly to the previous points the linear model of the dependence of the retail goods turnover volume on the volume of realized production of the industry was analyzed in detail. The check of the correctness of 1MLS application shown, that: a) $\sum_{t=1}^{8} U_t \approx 0$, and consequently $M(U) = 0$; b) $\sum_{t=1}^{8} X^T \cdot U = -0{,}000011 \approx 0$ was the independent variable that was not connected with the rests; c) the empirical Durbin Watson critical values was – $DW_{эмп} = 1{,}13$, for $n = 8$ and the set level of trust $\beta = 0{,}95$ Its lower critical boarder was $DW_1 = 0{,}76$, the top critical border $DW_2 = 1{,}33$ and, as, $DW_1 < DW_{эмп} < DW_2$, that it was impossible to make any conclusions about the autocorrelations of the rests. For $\beta = 0{,}99$ is $DW_2 = 1{,}00$ and, sj, $DW_{эмп} > DW_2$ – the autocorrelation of the rests was absent for the high degrees of results' trust. Model research on the heteroscedasticity by the parametrical test of Goldfeld–Quandt shown, that $R^*_{эмп} = 19{,}28$ and as $R^*_{эмп} < F_{кр}$, it could be asserted, that heteroscedastisity was absent. The sample is gomoscedastic for $\beta = 0{,}95$ and for $\beta = 0{,}99$ is geteroskedastic.

According to the linear model the growth of the realized industrial output on unit leads to the growth of the retail goods turnover on 0,302 units. The elasticity of the retail goods turnover depending on the realized production was 1,35–1,36 (%) and that specifies on the accumulative character of the process.

As the doubts are occurring because of the reasons of the possible rests' autocorrelation's occurrence, and, accordingly, and adequacy of the constructed

1MLS linear model, we will calculate the mutual correlation function $r(\tau)$ by the formula (5).

The calculated value $r(\tau)$ at various values τ is resulted in tab. 6 and is also represented on fig. 5.

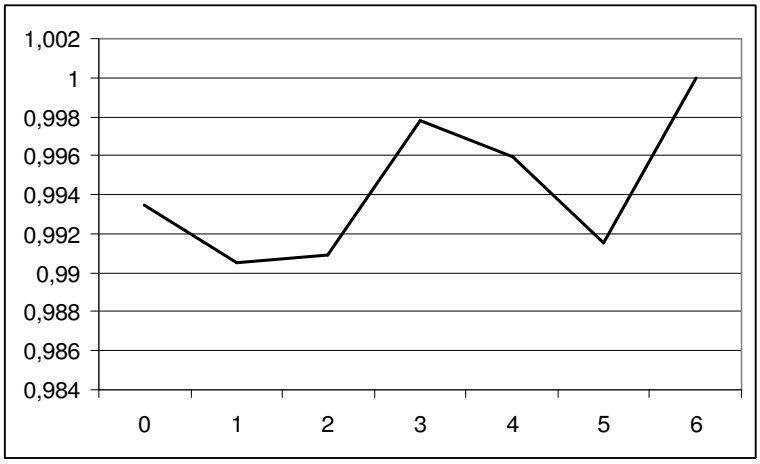
Table 6

The calculated value of the mutual correlation function $r(\tau)$ for the volume of the realized industrial output

τ	0	1	2	3	4	5	6
r_τ	0,993502576	0,990536251	0,9909311302	0,997843411	0,995910703	0,991535138	1

Figure 5

The mutual correlation function diagram, based on the time range (the realized/ sold industrial output)



Apparently from fig. 5 and tab. 6, the greatest mutual correlation function value $r_\tau = 0{,}99808035$ accepts at $\tau = 3$, thus in three years period from the beginning of an industrial output realization it is obvious to expect the maximum growth of the retail goods turnover. This log coincides with a log in three years,

on which the maximum growth of the realized industrial output volume from the period on the investments' beginning in it is observed [5, p. 135–136]. The dynamic model of the distributed log in that case is such:

$$\hat{Y}_t = a_0 + a_1 X_{t-3}$$

where $\hat{Y}_t$ – is a volume of the retail goods turnover during the period t; X_{t-3} – volume of the realized production of the industry during the period $t-3$.

The estimation of the model's parameters was made by 1MLS. Thus the hypothesis was accepted that the rests were non auto correlated and were normally distributed. As the greatest log $\tau = 3$, than the initial data have been reduced to three supervision, and in the time range of the realized production's volume first three supervision were rejected, and in the time range of investments the three last were exclude. The model of the distributed log looked like:

$$\hat{Y}_t = -55127{,}41 + 0{,}62 \cdot X_{t-3},\ R^2 = 0{,}9718,$$

Thus on 97% the variation of the retail goods turnover volume could be explained by the variation in the realized production's volumes of the industry. The growth of the realized industrial output's volumes on unit in current year leads to the growth of the retail goods turnover on 0,62 units in three years after it, thus in twice more than in the model without a log. As $DW_{эмп} = 2{,}77 > 2$, than for the hypothesis' check on negative autocorrelation we should accept value $DW_{эмп} = 1{,}23$ $(4 - 2{,}77 = 1{,}23)$ and its comparison with the tabular $DW_2 = 1{,}142$ for the high degree of trust $\beta = 0{,}99$ indicates on the absence of the rests. Check of the importance of the model's parameters according to *t*-criteria shows that estimations of its authentic parameters at high level of trust are not displaced and there is no autocorrelation of the rests in the model.

If there is the lag explanatory variables in the econometric model, in the right part of the model among such variables would appears the log dependent variable $y_{t-\tau}$. With its appearance the explanatory models' variables become scholastic. Some other models, which are used in the terms of absence of the total representation about the object and its inertness, cause the occurrence of lag values of the dependent variable in the model's right part. In this case the method of the tool variables, which is used, for an estimation of the model's parameters with casual explaining variables is applied [6, p. 221, 232–242, 7, p. 137–140]. A vector $\vec{A}$ of the estimations of the structural parameters is defined by the formula:

$$\vec{A} = (Z^T X)^{-1} Z^T \vec{Y} \qquad (7)$$

The dispersion of the rests is calculated by the formula:

$$S_u^2 = \frac{1}{n-k-1} U^T U, \qquad (8)$$

And the matrix of the dispersion and co-variance of the of structural parameters estimations has the form:

$$D^2(\vec{A}) = S_u^2 (Z^T X)^{-1} (Z^T Z)(Z^T X)^{-1}. \qquad (9)$$

Let's estimate the models' parameter by the application of the of tool variables' method $Y_t = a_0 + a_1 Y_{t-1} + a_2 X_t$. For this purpose we will use such tool variables Z_1 and Z_2, thus $Z_1 = X_{t-1}$, $Z_2 = X_t$.

Let's construct the vector $\vec{Y}$ of the dependent variable' supervision Y_t, the matrix X of the explaining variables' supervision Y_{t-1} and X_t, and also the matrix Z of supervision of the tool variables Z_1 and Z_2:

$$\vec{Y} = \begin{bmatrix} y_2 \\ y_3 \\ \dots \\ y_n \end{bmatrix}, \; X = \begin{bmatrix} 1 & y_1 & x_2 \\ 1 & y_2 & x_3 \\ \dots & \dots & \dots \\ 1 & y_{n-1} & x_n \end{bmatrix}, \; Z = \begin{bmatrix} 1 & x_1 & x_2 \\ 1 & x_2 & x_3 \\ \dots & \dots & \dots \\ 1 & x_{n-1} & x_n \end{bmatrix}. \qquad (10)$$

The model looks as:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 X_t = -1177{,}88 + 1{,}62 Y_{t-1} - 0{,}04 X_t, \; R^2 \approx 1{,}00.$$

The Durbin Watson critical value is $DW_{эмп} = 1{,}14$. For $n = 7$, $k = 2$ (Quantity of variables) and $\beta = 0{,}95$ $DW_1 = 0{,}467$, $DW_2 = 1{,}896$; for $\beta = 0{,}99$ $DW_1 = 0{,}294$, $DW_2 = 1{,}676$, and, thus, $DW_1 < DW_{эмп} < DW_2$, thus it is impossible to make any conclusions about the autocorrelations.

As for $S_u^2 = 25197617{,}9$, $S_{a_1} = 0{,}00016391$, $S_{a_2} = 5{,}63149 \cdot 10^{-5}$, $t_{a_1} = 10000$, $t_{a_2} = 711$, therefore according to *t*-criteria the values of the parameters a_1 and a_2 are essential, and value of parameter a_0 is insignificant.

6. *Retail goods turnover volumes dependence on the volumes of production in agriculture and hunting* Looks like it is presented in tab. 2 *VI a–d*.

We investigate the linear econometrical model that is: $Y_t = -121316 + 2{,}48 X_t$, $R^2 = 0{,}957$.

The Durbin Watson critical value is $DW_{эмп} = 1{,}90$, the top boarder of the criteria $DW_2 = 1{,}332$ for $\beta = 0{,}95$ and $DW_2 = 1{,}003$ for $\beta = 0{,}99$. Thus as

$DW_{эмп} > DW_2$, than the autocorrelation is absent for the high degrees of trust to the results.

Model research on geteroscedasticity has shown, that $R^* = 6{,}11$. For $\beta = 0{,}95$ $F_{крит} = 161$ and, as, $R^* < F_{крит}$, thus the geteroscedasticity is absent. For $\beta = 0{,}99$ $F^*_{крит} = 4{,}052$ and, as $R^* > F_{крит}$, thus the geteroscedasticity is present.

According to the linear model *VI a* it follows, that the increase in the volumes of the agriculture and hunting production for the unit led to increase in the retail goods turnover at 2,48 units. It approximately in 8 times more, than for the industry production. Elasticity of the retail goods turnover depending on the volumes of the agriculture and hunting production is 2,15% for the linear model and is higher that the elasticity of the retail goods turnover depending on the volumes of the realized industrial.

In tab. 7 and on fig. 6 the correlation function is presented, which shows, that between manufacture of the agricultural production and its realization in retail sale there is not displacement. So all the agricultural production is realized in retail sale in current year.

Application of the tool variables' method has led to such model:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 X_t = -9453{,}67 + 1{,}39 Y_{t-1} + 0{,}07 X_t,\ R^2 = 0{,}9988.$$

According to the model $S_u^2 = 10438463$, $S_{a_1} = 4{,}8322810^{-5}$, $S_{a_2} = 6{,}5314 \cdot 10^{-5}$, the empirical values of *t*-criteria are equal $t_{a_1} = 28778$, $t_{a_2} = 1072$.

Thus, according to the Students' *t*-criteria the models' parameters a_1 and a_2 are authentic with high degree of trust. The parameter a_0 is not authentic.

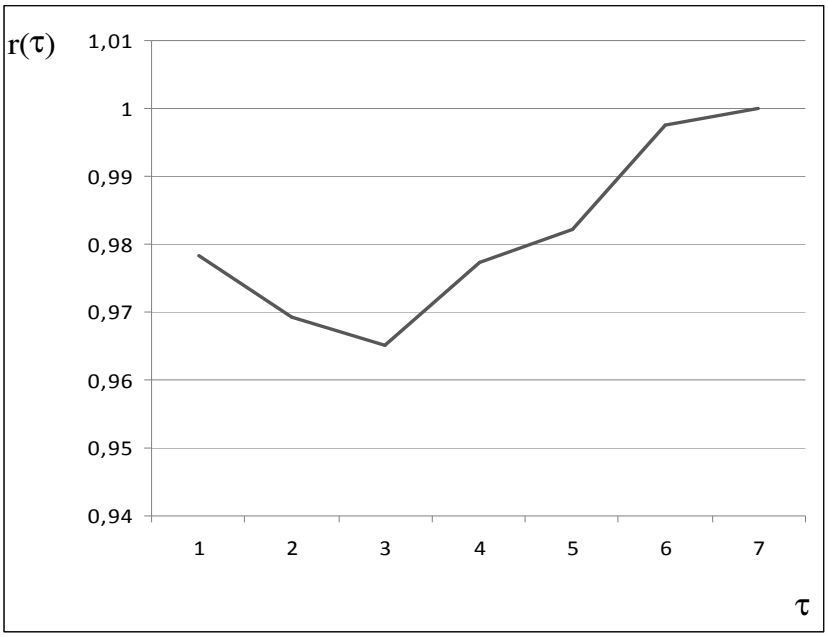
Table 7

The calculated value of the mutual correlation function $r(\tau)$ for the volume of the agriculture and hunting production

τ	0	1	2	3	4	5	6
r_τ	0,978173181	0,969158812	0,965195801	0,977339734	0,982106507	0,997556017	1

Figure 6

The mutual correlation function diagram, based on the time range (the agriculture and hunting production)



Conclusions. The models of the dependence of the retail goods turnover on the investments enclosed in it, the monthly average nominal salary, monetary incomes of the population, industry and agriculture production were constructed and on their basis the efficiencies of the influence of the various business factors on retail goods turnover were calculated and grounded. It was shown, that in 2009 in Ukraine the crisis phenomena began although in 2010 some positive tendencies to the economical growth occurred. The constructed econometrical models allow us to predict the retail goods turnover in the conditions of the stable economical development with the purpose of the efficient state policy regulation.

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