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The use of dynamic econometric models in estimating the production volume of small business

Uzbekistan

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Abstract. *This article aims to analyze the state of events and processes that may occur in the future in the production volume of small businesses in Surkhandarya region based on econometric modeling, in which the GNP and the relationship between the volume of small business production are evaluated scientifically based on quantity and quality, proposals and recommendations are developed.*

Key words*: GDP, small business, small business production volume, time series, Almon model, lag value*

Introduction

The importance of using dynamic econometric models evaluating the impact of small business in ensuring the social and economic development of the region is high. Not all models based on time variation are dynamic econometric models. The term "dynamic" characterizes not the entire period during which the model is being built, but each moment of time t separately.

If the econometric model takes into account the values of the variables related to the current and previous moments at a given moment of time, and if this model reflects the dynamics of the studied variables at each moment of time, it is considered as dynamic.

Almon's method or Almon's lag are used to estimate the uncertain coefficients of the lag-distributed model. This method can be used in models characterized by a polynomial lag structure and a finite lag value (L):

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \cdots + \beta L_{xt} - L + \varepsilon_t \qquad (1)$$

The lag structure is determined graphically when reflecting the dependence of the parameters of the factor variables on the value of the lag.

Almon method algorithm is implemented in several steps.

The essence of the Almon method is as follows:[1]

1) dependence of the coefficients on the j lag value for the factor variable b_j is approximated by a polynomial function:

a) first class $b_j = c_0 + c_1 j$;

b) secondary $b_j = c_0 + c_1 j + c_2 j^2$;

c) Third level $b_j = c_0 + c_1 j + c_2 j^2 + c_3 j^3$;

g) Polynomial function of degree k in the general case:

$$b_j = c_0 + c_1 j + c_2 j^2 + \cdots + c_{3k} j^{3k} \qquad (2)$$

Almon proved that it is much easier to calculate the values of the coefficients *cj* (j=0,P) than to find the values of the βj coefficients directly.

[1] Yeliseeva I.I. Ekonometrika. M.: Finance and statistics. -2003.-S. 299-301

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2) Each coefficient of the model (1) can be expressed as follows:

$$b_0 = c_0;$$
$$b_1 = c_0 + c_1 \ldots + c_k;$$
$$b_2 = c_0 + c_1 + 4c_2 + \cdots + 2^k c_k;$$
$$b_3 = c_0 + 3\,c_1 + 9c_2 + \cdots + 3^k c_k;$$

…

$$b_l = c_0 + l\,c_1 + l^2 c_2 + \cdots + j^k c_k \qquad (3)$$

We replace the obtained expressions into the model for b_j coefficients:

$$y_t = a + c_0 \cdot x_t + (c_0 + c_1 + \cdots + c_k) \cdot x_{t-1} + (c_0 + 2 \cdot c_1 + 4 \cdot c_2 + \cdots + 2^k \cdot c_k) \cdot x_{t-2} + (c_0 + 3 \cdot c_1 + 9 \cdot c_2 + \cdots + 3^k \cdot c_k) \cdot x_{t-3} + \cdots + (c_0 + l \cdot c_1 + l^2 \cdot c_2 + \cdots + l^k \cdot c_k) \cdot x_{t-l} + \varepsilon_t \qquad (4)$$

3) We apply the method of regrouping the participants to the obtained result:

$$y_t = a + c_0 \cdot (x_t + x_{t-1} + x_{t-2} + \cdots + x_{t-l}) + c_1 \cdot (x_{t-1} + 2 \cdot x_{t-2} + 3 \cdot x_{t-3} + \cdots + l \cdot x_{t-l}) + c_2 \cdot (x_{t-1} + 4 \cdot x_{t-2} + 9 \cdot x_{t-3} + \cdots + l^2 \cdot x_{t-l}) + \cdots + c_k \cdot (x_{t-1} + 2^k \cdot x_{t-2} + 3^k \cdot x_{t-3} + \cdots + l^k \cdot x_{t-l}) + \varepsilon_t \qquad (5)$$

4) After the c_j coefficient, we define the sums in parentheses as new variables:

$$z_0 = x_t + x_{t-1} + x_{t-2} + \cdots + x_{t-l} = \sum_{j=0}^{l} x_{t-j};$$

$$z_1 = x_{t-1} + 2 \cdot x_{t-2} + 3 \cdot x_{t-3} + \cdots + l \cdot x_{t-l} = \sum_{j=l}^{l} j \cdot x_{t-j};$$

$$z_2 = x_{t-1} + 4 \cdot x_{t-2} + 9 \cdot x_{t-3} + \cdots + l^2 \cdot x_{t-l} = \sum_{j=l}^{l} j^2 \cdot x_{t-j} \qquad (6)$$

……

$$z_k = x_{t-1} + 2^k \cdot x_{t-2} + 3^k \cdot x_{t-3} + \cdots + l^k \cdot x_{t-l} = \sum_{j=l}^{l} j^k \cdot x_{t-j}$$

We can make the model look like this:

$$y_t = a + c_0 \cdot z_0 + c_1 \cdot z_1 + c_2 \cdot z_2 + \cdots + c_k \cdot z_k + \varepsilon_t \qquad (7)$$

The results of dynamic series application show that Almon's model is the most convenient method for solving tasks of econometric modeling of the relationship between GNI and the volume of small business production.

The preliminary statistics for modeling are presented in the table below.

Table 1

Dynamics of GDP and small business production volume of Surkhandarya region

Years	t	Y-GDP, bln. soum	Production volume of regional small business	X_{t-1}	X_{t-2}	X_{t-3}	X_{t-4}	Z_0	Z_1

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			(billion soums) X						
2002	1	165,8	64,8278						
2003	2	261,8	124,0932	-	-	-	-	-	
2004	3	395,1	175,8195	-	-	-	-	-	
2005	4	489,8	217,961	-	-	-	-	-	
2006	5	573,2	249,342	217,961	175,8195	124,0932	64,8278	582,7015	1201,190
2007	6	724,4	310,04	249,342	217,961	175,8195	124,0932	767,2157	1709,095
2008	7	981,5	606,57	310,04	249,342	217,961	175,8195	953,1657	2165,888
2009	8	1220,9	780,16	606,57	310,04	249,342	217,961	1383,9132	2846,523
2010	9	1531,5	1029,17	780,16	606,57	310,04	249,342	1946,1073	3920,786
2011	10	1836,7	1285,69	1029,17	780,16	606,57	310,04	2725,9333	5649,352
2012	11	3394,7	2434,00	1285,69	1029,17	780,16	606,57	3701,5801	8110,759
2013	12	5217,1	3850,22	2434,00	1285,69	1029,17	780,16	5529,013	11213,50
2014	13	6436,4	4775,81	3850,22	2434,00	1285,69	1029,17	8599,0777	16691,96
2015	14	7436,4	5510,37	4775,81	3850,22	2434,00	1285,69	12345,7185	24921,00
2016	15	9213,2	6863,83	5510,37	4775,81	3850,22	2434,00	16570,4009	36348,64
2017	16	11114,4	8524,74	6863,83	5510,37	4775,81	3850,22	21000,235	47612,88
2018	17	12179,6	9500,09	8524,74	6863,83	5510,37	4775,81	25674,76	57886,76
2019	18	14404,4	11307,45	9500,09	8524,74	6863,83	5510,37	30399,0392	69182,56
2020	19	18674,9	14939,92	11307,45	9500,09	8524,74	6863,83	36196,1208	83337,20
2021	20	22393,5	17511,72	14939,92	11307,45	9500,09	8524,74	44272,2068	100154,0
2022	21	24912	19207,15	17511,72	14939,92	11307,45	9500,09	53259,179	119314,2

Using the above data, the calculation of the relationship between the volume of small business production and GDP in Surkhondarya region was carried out using the “Finding a solution” application of the Excel electronic processor (Table 2).

Table 2

Regression analysis in Excel for the relationship between GDP and small business production volume in Surkhandarya region

Indicator	*Results*

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R is plural	*0,999*
R is a square	*0,992*
Normalized R-squared	*0,990*
Standard error	*789,053*
F	*525,3529*
Coefficient (Y_1)	896,03
Coefficient (Z0)	2.96
Coefficient (Z1)	-2.18
Coefficient (Z2)	0.39
Standard error (Y_1)	297.6786
Standard error (Z0)	1.44108
Standard error (Z1)	1.432508
Standard error (Z_2)	0.28978
t-statistics (Y_1)	3.01007
t-statistics (Z_0)	2.054616
t-statistics (Z_1)	-1.52212
t-statistics (Z_2)	1.32965
Tracking	*17*

According to Table 2, the parameters of the initial values of the distributed lag are:

$\hat{y} = 896{,}03 + 2{,}96 \cdot z_0$-$2{,}18 \cdot z_1 + 0{,}39 \cdot z_2$; $R^2 = 0.992$

Using the regression coefficients found for the variables $z_i, i = 0{,}1{,}2$ we find the regression coefficient of the initial model:

b_0=2.96, b_1=1.17, $b_2 = 0.14$, $b_3 = -0.11$, $\sum = 4.56$,

The distributed lag value looks like this:

$$\hat{y} = 896{,}03 + 2{,}96 \cdot x_t + 1.17 \cdot x_{t-1} + 0.14 \cdot x_{t-2} - 0.11 \cdot x_{t-3} + \varepsilon_t$$

$R^2 = 0.992$

The analysis of this model shows that the volume of small business production this year is 1 billion. Increase to UZS sum after 3 years the average size of GNP (2.96 + 1.17 + 0.14 - 0.11) = 4.2 billion. Leads to an increase of sum.

Now we determine the relative coefficient of regression:

$$\beta_0 = \frac{2{,}96}{4{,}56} = 0{,}65;\ \beta_1 = \frac{1{,}17}{4{,}56} = 0{,}26\ ;\ \beta_2 = \frac{0{,}14}{4{,}56} = 0{,}031;\ \beta_3 = \frac{-0{,}11}{4{,}56} = -0{,}024$$

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Almost the main part of the effect of the factor on the result, i.e. 65 percent, takes place in the first L lag year.

The average lag L of this model is:

$$\tau = 0{,}64912280 + 0{,}256578947 \cdot 1 + 0{,}030701754 \cdot 2 - 0{,}02412280 \cdot 3 = 1{,}14242377$$

The average increase in the volume of small business production in Surkhandarya region will have an effect on the growth of GDP after 1.14 years.

The built model shows that there is a close relationship between the studied factors. This shows that the importance of using time series in planning and forecasting the GNP and small business production volume of Surkhandarya region is high.

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