Econometric modeling and forecasting the development of the postal service in Uzbekistan

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Abstract. This article is devoted to econometric modeling and forecasting of development of postal services in Uzbekistan. As a result of digitization and optimization of postal services using the VAR and ARDL models with 2SLS, the number of post offices, the number of postmen closely associated with it, has been shown to decrease.

1 Introduction

Any research on the strategic development of an enterprise is based on econometric modeling. Therefore, a lot of research in this area has been done in foreign and domestic scientific work.

D.W.Caves [1] proved that postal services are associated with transportation costs based on econometric models. In world practice, it has been found that the development of transport, especially air transport, has a high impact on the development of postal services.

In 2005, B.A.Graf, then vice president of FedEx, one of the world's largest postal services gigs. The article notes that the most important factors for postal services are speed and accuracy. This requires that postal services be digitized in an optimized way at a time when information is rapidly evolving [2].

2 Methods

VAR and ARDL models in the research process,2SLS model, Dickey-Fuller (DF) test,ADF test,trend method, grinding method, STATA program and others were used.

3 Results and Discussion

During our study, VAR and ARDL models with 2 SLS We will optimize the number of suppliers of postal services by modeling the strategic activities of postal services of

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Uzbekistan.
In our study we use the following model:

$$y = \alpha_0 x_1^{\alpha_1} x_2^{\alpha_2} \tag{1}$$

If we logarithmize both sides of this equation, the equation looks like this:

$$lny = ln\alpha_0 + \alpha_1 lnx_1 + \alpha_2 lnx_2 \tag{2}$$

We hypothesize that the number of post offices depends on the number of postmen delivering mail, and the number of postmen depends on the required postal services, and that their change is linked from year to year, not from year to year. This concept is defined by the lag in econometrics, i.e., the calculation of changes in the previous year's step. The correlation represents the need to apply the VAR model . VAR (vector auto regression) model, which also includes lags of the resulting sign. The ARDL model (autoregressive distributed lag) is a model in which factor lags are also involved.
According to our hypothesis, there are two equations, the first equation is the relationship between the number of parcels (y_1) and the number of couriers (y_2) based on the VAR model, the second equation depends on the number of couriers (y_2) and the demand for postal services. The ARDL model is created. The first equation is generated using the second equation regression results, which represents the 2 SLS model in econometrics. Thus, based on our hypothesis, the following system of equations is formed:

$$\begin{cases} lny_1 = \beta_0 + \beta_1 \sum_{i=1}^{n} ln\hat{y}_{1ti} + \beta_2 \sum_{i=1}^{n} ln\hat{y}_{2ti} + \varepsilon \\ lny_2 = \alpha_0 + \alpha_1 \sum_{i=1}^{n} ln\hat{y}_{2ti} + \alpha_2 \sum_{i=1}^{n} x_{ti} \end{cases} \tag{3}$$

In the model we can identify the outcome and factor characters involved.

Table 1. Information on the variables involved in the study

№	Name of indicators	Unity	Variables	Status in the model
1	Number of delivery points for postal services	s	The resulting character	Y1
2	Including in rural areas	s	Factor character	X1
3	Number of postmen delivering mail	person	The resulting character	Y2
4	Shipments	Thousands	Factor character	X2
5	Letters, envelopes, cards	millions	Factor character	X3
6	Newspapers and magazines	millions	Factor character	X4
7	Money transfers	Thousands	Factor character	X5
8	Pension payments	millions	Factor character	X6
9	Telegrams	Thousands	Factor character	X7
10	Mail sent by air	tons	Factor character	X8

We begin our study by examining the indicators for stationary. In the scientific literature, nonstationary periodic series are also referred to as "integrated processes". The degree of integration of a series is determined by how many times it needs to be differentiated to make it stationary. Thus, stationary rows are "zero-degree integrated" and are abbreviated as I (0). Once a series becomes stationary after differentiation, it is called first-order integrated and is denoted by I (1). In general, periodicseries dif stationary after times differentiated, dis called degree integrated and is denoted as I (d).

In this case, Y $_t$ and X $_t$ - I (1) level integrated,ε_{1e} ваε_{1e} is independent and averaged “0” and is uniformly distributed with constant variance. Also, the value of at least α_1 ваα_2 one of the coefficients must be different from zero. Both equations are balanced because both sides of the equation are equally integrated. Agar, $Y_t = \upsilon + \beta x_t$ if the equation Y $_t$ and X $_t$ determine the long-term relationship between the variables,$(Y_{t-1} - \upsilon + \beta x_t)$the degree of deviation from the equilibrium position,α_1 ваα_2 and the coefficients reflect the power of the economic system to strive for equilibrium.

Because cointegration link verification requires a degree of integration of variables, the degree of integration is determined for each variable before cointegration tests. The Dickey-Fuller (DF) test is used for this [3, 4-10]. This test was developed by Dickey and Fuller, is based on equation (4) and is called the "Unit Root Test":

$$\Delta Lny_t = \delta Lny_{t-1} + u_t \tag{4}$$

or

$$Lny_t = (1+\delta)Lny_{t-1} + u_t \tag{5}$$

In general checking of indicators for stationary is carried out in three ways. The graph method is autocorrelation correlogram and ADF test.

study , the STATA program was selected and all work was carried out in this program. First, graphs and integrated cases of the resulting symbols were formed.

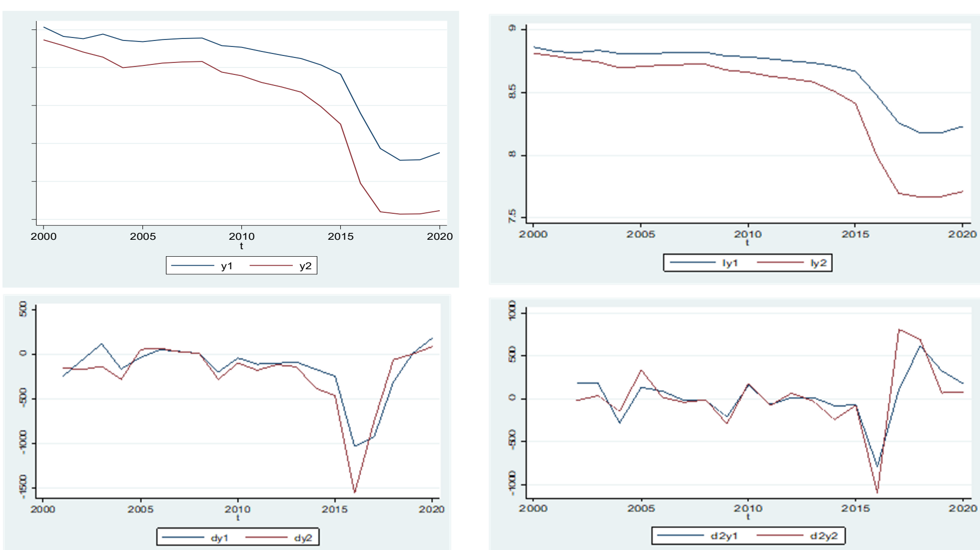

Fig. 1. The resulting character change dynamics

As can be seen from Fig. 1.y $_1$and y$_2$are non-stationary, in particular, the number of sections and postmen providing postal services tends to decrease, did not become stationary in the first integrated state, and in our opinion there is stationary in the second-order integrated indicators.

We check this condition by means of a korelagram, if in the korelogram all the lags are located in the confidence interval, a strong stationary is represented.

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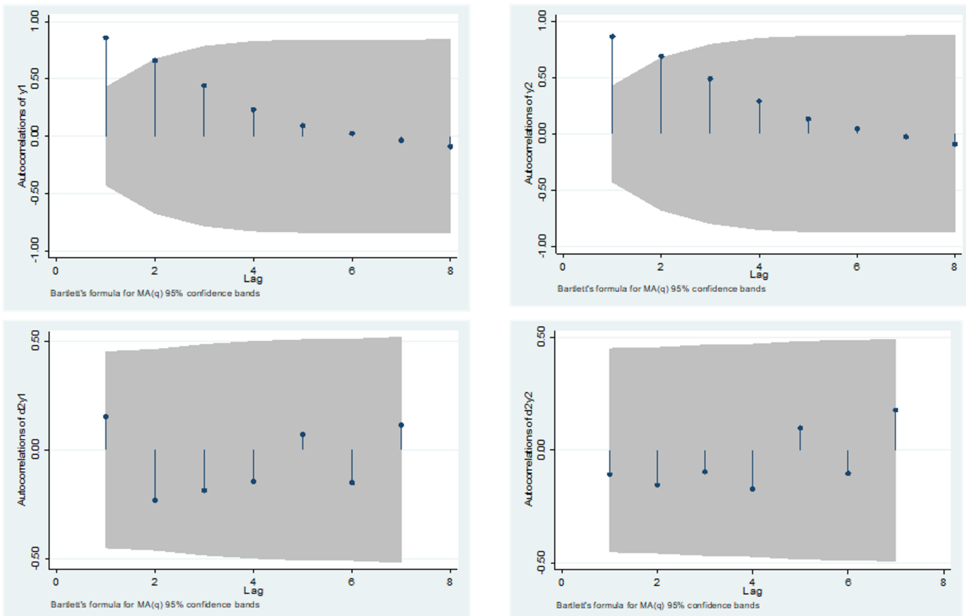

Fig. 2. Chorelogram of the resulting characters

Figure 2 clearly shows the presence of stationary in the second-order integrated case.

Table 2. ADF test results

Variable	ADF statistics	Critical values 10%	Probably	Decision
Y1	0.615	-2.630	0.98	Unitrootavailablenot
Y2	0.502	-2.630	0.98	Unitrootavailablenot
Variabledegree difference	ADF statistics	Critical values 10%	Probably	Decision
Dy1	-1.90	-2.630	0.32	Unitrootavailablenot
Dy2	-2.331	-2.630	0.16	Unitrootavailablenot
D2y1	-3.433	-2.630	0.0099	Unitrootavailable
D2y2	-4.449	-2.630	0.0002	Unitrootavailable

2 show that the hypothesis “there is no unit root” for all variables was rejected in the 1%, 5%, and 10% confidence ranges. As a logical continuation of the analysis, the hypothesis that the variables have a “secondary root” was tested, and it was concluded that all three variables were level 1 integrated.
If all indicators are non-stationary and become stationary after first-order integration, then the VAR and ARDL models are selected by selecting an alternative lag.
STATA program, we have developed more than 30 models, in which x4, x5, x6, x7, x8 have been found to have a strong impact on optimizing the number of post offices, digitization and optimizing the number of postmen. All model results are presented in the appendix, using the ARDL method in selecting the most optimal model we used.

```
. reg lny2 lag2lnx2 laglnx3

      Source |       SS           df       MS      Number of obs   =        19
-------------+----------------------------------   F(2, 16)        =      5.59
       Model |  1.33602662         2  .668013312   Prob > F        =    0.0145
    Residual |  1.91370268        16  .119606417   R-squared       =    0.4111
-------------+----------------------------------   Adj R-squared   =    0.3375
       Total |   3.2497293        18  .180540517   Root MSE        =    .34584

------------------------------------------------------------------------------
        lny2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lag2lnx2 |  -.9425568   .3321193    -2.84   0.012    -1.646618   -.2384954
     laglnx3 |  -1.206912   .6463086    -1.87   0.080    -2.577025    .1632008
       _cons |   15.76729    2.30026     6.85   0.000     10.89096    20.64363
------------------------------------------------------------------------------
```

Fig. 3. Optimal model results

This is optimal the model includes factor x 2 and x3 factor characters. The model looks like this:

$$lny_2 = -0.94L.3lnx_2 - 1.2L.lnx_3 + 15.05 \quad (6)$$

Proves that the number of postmen can be reduced by 1.2 % after one year.
Based on our hypothesis, we relate the regression results of this model to the number of parcels delivering mail, i.e., we use the 2SLS model.

```
. reg lny1 laglny1 lny2fit

      Source |       SS           df       MS      Number of obs   =        19
-------------+----------------------------------   F(2, 16)        =    139.17
       Model |  1.01761233         2  .508806164   Prob > F        =    0.0000
    Residual |  .058495144        16  .003655946   R-squared       =    0.9456
-------------+----------------------------------   Adj R-squared   =    0.9388
       Total |  1.07610747        18  .059783748   Root MSE        =    .06046

------------------------------------------------------------------------------
        lny1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     laglny1 |   .9512949   .0741156    12.84   0.000     .7941769    1.108413
     lny2fit |   .1438155   .0614447     2.34   0.033     .0135584    .2740725
       _cons |    -.81916   .5764469    -1.42   0.174    -2.041173    .4028529
```

Fig. 4. Optimal model results

$$lny_1 = 0.95L.lny_1 + 1.4ln\hat{y}_2 - 0.81 \quad (7)$$

According to the model, a 1% increase in the number of postmen would lead to a 1.4% increase in the number of parcels. Both models were validated based on t-test, F-test, and Akayke Schwartz criteria. Our study, based on our hypothesis, is fully modeled:

$$lny_2 = -0.94L.3lnx_2 - 1.2L.lnx_3 + 15.05 \quad (8)$$

$$lny_1 = 0.95L.lny_1 + 1.4ln\hat{y}_2 - 0.81 \quad (9)$$

Based on these models, we determine the forecast values for 2022 -2026 years.
In general, several forecasting methods are used in time series. There are MAPE, MAD, and MSD indicators that represent error quality in determining the optimal type of forecasting methods. These indicators measure the error between the values of the forecasting methods and the data provided. MAPE to the results of the forecasting method is the average of the sum:

$$MAPE = \frac{\sum \frac{|e_t|}{Y_t}}{n} \quad (10)$$

MAD represents the average of absolute errors:

$$MAD = \frac{\sum |e_t|}{n} \quad (11)$$

MSD absolute errorssquares represents the average:

$$MAD = \frac{\sum |e_t^2|}{n} \quad (12)$$

In the forecasting methods used, the method with the lowest results, which explains their reliability, is the most optimal forecasting method, and the forecast indicators calculated on the basis of this optimal method are more accurate.

For our study, we use three trend methods and one grinding method to determine the forecast values. The main reason for this is that the indicators are non-stationary and there is a trend factor in their change. Of the trend methods, linear, quadratic, and exponential are acceptable. Holt Winter seasonal , one of the grinding methods , covers the trend, seasonality and level of grinding, which means that this method is one of the advantages.

Grinding methods are determined on the basis of levels, the degree is from 0 to 1. Three types of grinding are widely used in scientific research, including exponential grinding, Double exponential grinding , and Holt Winter seasonal grinding. Only in the exponential grinding method αdetermines the degree of grinding of the method, this method is characterized as follows:

$$\hat{x} = \alpha x_t + \alpha(1-\alpha)x_{t-1} + \alpha(1-\alpha)^2 x_{t-2} + .. \quad (12)$$

Double exponential grinding, Holt Winter seasonal grinding types are represented in the same way.
Equation (13) with (t-1) and multiplying both sides by (1- α) gives the following equation:

$$(1-\widehat{\alpha)}x_{t-1} = \alpha(1-\alpha)x_{t-1} + \alpha(1-\alpha)^2 x_{t-2} + \alpha(1-\alpha)^3 x_{t-3} + .. \quad (14)$$

By equating the thirteenth equation from Equation (14), we obtain the following equation:

$$\widehat{x_t} = (1-\widehat{\alpha)}x_{t-1} + \alpha x_t 0 << \alpha_1 \quad (15)$$

This equation is the final equation of exponential grinding and is the $\widehat{x_t}$actual level of the forecast values .x_t Given that factor x2 and x3 are involved in our model, we first analyze these indicators.

Table 3. O mil characters prognoz methods

№	Types of forecast models	MAPE	MAD	MSD
	1	2	3	4
1	X2 = 65.3019 + 1.37169 * t	18.85	13.84	220.73
2	X2 = 52.4866 + 4.71481 * t - 0.151960 * t ** 2	16.91	12.22	196.06
3	X2 = 101.594 + 0.0301456 * t – 0.00118726 * t ** 2	18.83	14.61	228.18
4	Smoothing ConstantsAlpha (level) 0.6 Gamma (trend) 0.2 Delta (seasonal) 0.2	15.71	11.11	194.82
5	X 3 = 12.6267 + 0.163377 * t	9.5	1.3	2.4
6	X 3 = 9.90812 + 0.872563 * t - 0.0322357 * t ** 2	7.4	1.0	1. 4
7	X 3 = 12.4077 * (1.01295 ** t)	9.4	1.3	2.5
8	Smoothing ConstantsAlpha (level) 0.5 Gamma (trend) 0.3Delta (seasonal) 0.4	5.6	0.8	1.3

Holt Winter grinding method was found to be the most optimal method for forecasting for both factor marking because MAPE, MAD, MSD quality indicators representing forecast errors achieved less results than other models. We can also check this condition on a graphical basis.

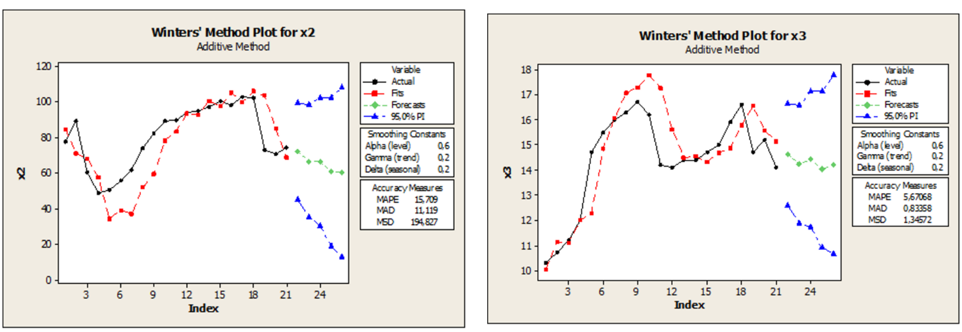

Fig. 5. Appearance of model factor symbols based on the Holt Winter grinding method

Another advantage of the Holt Winter grinding method is that it is possible to determine both pessimistic and optimistic forecast values through this forecast. This means that the effects of the current pandemic have been taken into account. We know that under the influence of the pandemic, postal services will expand.

Table 4. O mil characters prognoz values

№	Years	Forecast	Optimistic	Pessimistic
	1	2	3	4
	X2 for factor character			
1	2022 y	72.2673	99.509	45.0252
2	2023 y	66.6677	97.939	35.3968
3	2024 y	66.3795	102.544	30.2146
4	2025 y	60.7799	102.400	19.1599
5	2026 y	60.4917	107.935	13.0486
	X2 for factor character			
6	2022 y	14.6203	16.6626	12.5781
7	2023 y	14.2264	16.5707	11.8822
8	2024 y	14.4137	17.1248	11.7025
9	2025 y	14.0197	17.1398	10.8996
10	2026 y	14.2070	17.7636	10.6504

4 Conclusions

Based on our research, it has been established that shipments in 2022 may amount to 72.26 thousand units, and according to an optimistic theory, they can amount to 99.50 thousand units. By 2026, this figure, according to an optimistic theory, could reach 108,000, which is 34,000 more than now.

Letters, envelopes and postcards will reach 14.6 million in 2022, and according to the optimistic theory, 16.66 million. By 2026, this figure, according to the optimistic theory, will reach 17.76 million. This means an increase of 3.76 million more than at present time.

Based on these indicators, in our model, developed on the basis of improved VAR and ARDL methods of 2SLS methods, we develop forecast figures for the number of post offices and the number of postmen for 2022-2026.

Table 5. Forecasts of postal services of Uzbekistan for 2022-2026

№	Years	Forecast	Optimistic	Pessimistic
	1	2	3	4
	Change in the number of postmen			
1	2022 y	1681.33	2404.93	957,722
2	2023 y	1337.40	2168,01	506,784
3	2024 y	1026.38	1986,99	65,768
4	2025 y	682.45	1787.96	423,056
5	2026 y	5 71.43	1631.61	3 88,749
	Number of post offices			
6	2022 y	3244,26	3829.08	2659,44
7	2023 y	2978.51	3649.82	2307.21
8	2024 y	2684.69	3461.06	1908.32
9	2025 y	2418.95	3312,42	1525.47
10	2026 y	2125,12	3143.61	1106.64

For the next five years, there will be a downward trend in the number of post offices and postal services, by 2026 the number of postmen will be 572, while the number of post offices will be 2125.

Based on our model, the need for digitization and optimization of all postal services has been proven.

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