Econometric Analysis of O.U.T.A. – Organisation of Urban Transportations of Athens

Giovanis Elephtherios

Greece

CONTENTS

INTRODUCTION

In this project we will analyse specific economic factors of O.U.T.A. (Organism of Urban and Transportations of Athens. O.U.T.A. is a legal person of private law and was established in according to the law 2175/1993, as a successor of O.U.T. . (Organism of Urban and Transportations).

O.U.T. was established in according to the law 588/1977 as a full public enterprise, applicable under the principles of private economy and operational for the public benefit under the supervisor and the control of the Ministry of transportations and communications. O.U.T.A. as a maternal enterprise supervise four other companies, which they belong to O.U.T.A. There are U.T.B. (Union of thermal bushes), which concerns the control of thermal bushes, E.R.A.P. (Electric Railroad of Athens-Peraia) which took over the control of the Electric railroad of Athens and also the control of the green bushes, D.E.B.A.P. (Driven by Electricity bushes of Athens-Peraia) the driven bushes by electricity with antennas and finally the A.M.C.F. (Attica Metro company function) which company is not anything else than the company that have taken over the control of the Metro function.

In the first chapter we will analyse three models of adaptive expectations. The first model concerns the revenues, the second concerns investments and third concerns the costs.

In the second chapter we will examine, with the help of dynamic Nerlove model, the adjustment of the real revenues at the desirable level. Also the same analysis will be done with the lending and the subsidy. We will examine the O.U.T.A. at the total of the same O.U.T.A. and the total of the other four enterprises, but we will examine also each of the four other companies.

In chapter third we present simultaneous equations of revenues and investments.

Finally , in fourth chapter is being reference to the Koyck model and the Almon technique. Specifically, we will present two models, which the first concerns, revenues and investments and the second model concerns revenues and the price of tickets.

CHAPTER FIRST

Summary

In this article we will analyse two models with regard to the revenues and that is realised in the enterprises of O.U.T.A. as for the total. The first model that we examine is the model of partial adaptation, where we will find the short-run interrelation of revenues and long-run. The second model concerns the investments. The third model is reported in the costs. The two first models are reported in time period 1980 - 2002. The third model is reported in period 1983-2002.

Analysis

We suppose that revenues are connected and interpreted with the price of ticket, the number of passengers and the inflation. The model that was preferred is the logarithmic. We have:

$$\mathbf{LnR_t = \alpha_0 + \alpha_1 LnP_t + \alpha_2 LnE_t + \alpha_3 LnR_{t-1} + \alpha_4 Ln\Pi_\tau + \varepsilon_t}$$

, where

R = the revenues
Rt-1 = the revenues with a lag
R = the price of ticket
E = the number of passengers
Π = the inflation

The regression equation is

$$\mathbf{LnR_t = 3{,}28 + 0{,}557LnP_t + 0{,}954\ LnE_t - 0{,}234\ Ln\Pi_t + 0{,}460\ LnR_{t-1}}$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	3,277	3,300	0,99	0,335	
LnP_t	0,5573	0,1731	3,22	0,005	12,9
LnE_t	0,9539	0,4668	2,04	0,057	1,3
$Ln\Pi_t$	-0,2341	0,1210	-1,93	0,070	4,8
LnR_{t-1}	0,2630	0,2010	1,31	0,208	16,3

S = 0,1890 R-Sq = 95,9% R-Sq(adj) = 95,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	14,3374	3,5843	100,30	0,000
Residual Error	17	0,6075	0,0357		
Total	21	14,9449			

Durbin-Watson statistic = 2,21

The model does not present autocorrelation, but also does not present heteroscedasticity. The factor of adaptation is 1-γ = 1 - 0,2630 = 0,737. If is increased the price at one unit, then the revenues are increased at 0,557, while if is increased the number of passengers at one unit, the revenues will be increased at 0,954. We see consequently that the number of passengers influences more considerably the revenues . If that is to say is decreased price at 1 unit the income will be decreased at least, at 0,557, while if the number of passengers is decreased at one unit then the revenues will be decreased at 0,954. From the other hand, if the inflation is increased at one unit, then revenues will be decreased only at 0,234. This interrelation is also the short-run interrelation of income. We see that γ = 0,2630, that means almost 26,3% of difference between the desirable and real income are decreased in one year. The long-run interrelation will result if we divide the short-run with the factor of adaptation. We have the following model:

$$LnR_t = 12,47 + 2,11\ LnP_t + 3,62\ LnE_t - 0,889\ Ln\Pi_t$$

As it was expected the long-run elasticity of price as for revenues 2,11, is bigger than the short-run. Similarly and for the number of passengers and for the inflation.

Then we will advance in the analysis for the investments. As dependent variable is naturally the **I** that symbolizes investments. As explanatory variables we selected the revenues, the inflation and variable **I** with a lag. However, for econometric reasons, according the conception that the regression presented multicollinearity, we selected "to break" in two parts the model. Thus, we have the following models:

$$LnI_t = \alpha_0 + \alpha_1 LnR_t + \alpha_2 LnI_{t-1} + \alpha_3 Ln\,S_t + \varepsilon_t \quad (1)$$

and

$$LnI_t = \alpha_0 + \alpha_1 LnP_t + \alpha_2 LnI_{t-1} + \varepsilon_t \quad (2)$$

, where

I = the investments
I_{t-1} = the investments with a time delay
R = the revenues
R = the inflation
S = the subsidy

For the equation (1) we have the following model:

```
The regression equation is
LnIt = - 1,34 + 0,334 LnRt + 0,083 LnSt + 0,668 LnIt-1

Predictor         Coef     SE Coef          T         P       VIF
Constant        -1,341       2,793      -0,48     0,637
LnR             0,3337      0,6346       0,53     0,605       7,9
LnSt            0,0831      0,5401       0,15     0,879       4,6
LnIt-1          0,6680      0,2424       2,76     0,013       2,8

S = 0,8748      R-Sq = 66,3%     R-Sq(adj) = 60,7%
Analysis of Variance

Source            DF          SS          MS         F         P
Regression         3     27,1229      9,0410     11,81     0,000
Residual Error    18     13,7738      0,7652
Total             21     40,8967
Durbin-Watson statistic = 1,96
```

The test for autocorrelation and heteroscedasticity led us to reject their existence. The above model is the short-run interrelation of investments concerning the revenues and the subsidies and shows us the short-run elasticity of revenues and subsidies as for the investments. This is 0,334, that it says to us with few reasons, that if the revenues would increased at one unit then the investments will be increased at 0,334. From the other if the subsidies are increased at one unit, then the investments will be increased at 0,083. γ = 1-0,668 = 0,332. If the revenues and the subsidies are zero, then the autonomous investments are negative, that means the revenues and consequently the proper funds play very important role in the development of investments of enterprises of O.U.T.A.. For the subsidies we cannot claim the same conclussion, as we saw moreover precisely. The long-run interrelation is:

$$LnI_t = -4,03 + 1,006\ LnR_t + 0,25\ LnS_t$$

We analyse now the equation (2).

The regression equation is

$$LnI_t = 8,86 - 1,12\ LnP_t + 0,349\ LnI_{t-1}$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	8,863	2,392	3,71	0,002	
LnP_t	-1,1188	0,3247	-3,45	0,003	2,6
LnI_{t-1}	0,3492	0,1861	1,88	0,076	2,6

S = 0,6964 R-Sq = 77,5% R-Sq(adj) = 75,1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	31,683	15,842	32,67	0,000
Residual Error	19	9,213	0,485		
Total	21	40,897			

Durbin-Watson statistic = 2,06

Similarly the test that we made for the autocorrelation and heteroscedasticity it was negative. From that we see in the model the inflation, as it was expected, influences considerably in the development of investments. An increase of inflation at one unit leads to a reduction of investments at 1,12. γ = 1-0,349 = 0,651. We see also the long-run interrelation.

$$LnI_t = 13,6 - 1,72\ LnP_t$$

The big effect of inflation appear also from that if the inflation is zero (a fact almost improbable) the autonomous investments will be 13,6.

Now we will examine the equation of expenses.

$$LnC_t = \alpha_0 + \alpha_1 Ln\Pi_t + \alpha_2 E_t + \alpha_3 LnC_{t-1} + \varepsilon_t$$

, where

C = the costs

Π = the inflation

E = the number of labour staff

The regression equation is

$$C_t = 3,50 - 0,193 Ln\Pi_t + 0,000039 E_t + 0,728 LnC_{t-1}$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	3,500	1,782	1,96	0,068	
Π	-0,19296	0,09785	-1,97	0,067	2,7
E	0,00003912	0,00001642	2,38	0,031	1,3
$C_{t=1}$	0,7279	0,1243	5,86	0,000	3,1

S = 0,1880   R-Sq = 90,5%   R-Sq(adj) = 88,6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	5,0336	1,6779	47,49	0,000
Residual Error	15	0,5300	0,0353		
Total	18	5,5637			

Durbin-Watson statistic = 1,78

As we observe, variable E is not logarithmic, because it does not need to make it logarithmic, because it concerns absolute number, while the other variables concern pecuniary values. We observe that if the inflation is increased at 1 unit the expenses will be decreased at 0,193. This according to the economic theory is not acceptable, after the inflation decreases the value of money. However exists the theory that results from the experience of markets and the reality of economic phenomena, that explains the enterprises in period of inflation, they increase the prices with rhythm of bigger of inflation rhythm, or if the inflation decreases their profits is led to reductions of real wage of workers. From the other hand if is increased the number of workforce of O.U.T.A. at one unit the costs are increased at 0,000039. This is in effect and agrees with the economic theory, and we observe that the increase of personnel affects insignificant in the cost of enterprises of O.U.T.A. $\gamma = 0{,}272$. The long-run interrelation of costs is presented below:

$$C_t = 12{,}8 - 0{,}709 Ln\Pi_t + 0{,}000149 E_t$$

CONCLUSION

With the model of partial adaptation we saw that we can find short-run and long-run elasticities. Thus, for example, provided that the enterprise knows which effect may have the increase of price of ticket in the revenues or in the investments, it will also proceed in the proportional decisions. If the enterprise forecasts that the increase of passengers will have beneficial consequences in the revenues, then the enterprise will be supposed to proceed in energies that she will gain the consuming public, as the improvement of promotion and generally of the Marketing.

CHAPTER SECOND

Summary

In this article we will analyse with the dynamic model Nerlove aspects of economic situations and economic policy that is followed. Concretely we see when becomes the adaptation of real revenues to desirable. Equivalents and for the lending and the subsidy. We will analyse these sizes of O.U.T.A. as for the total, which means included and his affiliated companies, as U.T.B. E.R.A.P., D.E.B.A.P. , but also individually, separated each one company. The analysis is reported in time period 1980-2002.

1. Model for the investments and the revenues.

We will begin the analysis O.U.T.A. but also for his subsidiary companies, as U.T.B. E.R.A.P., D.E.B.A.P. and A.M.C.F. but also as for the total. If we remember the model of Nerlove.

$E^*_t = \alpha_o + \alpha_1 I^*_t$ (1)
$E_t - E_{t-1} = \gamma(E^*_t - E_{t-1})$, where it is in effect $0 \le \gamma \le 1$
$I^*_t - I^*_{t-1} = \delta (I_t - I^*_{t-1})$, where it is in effect $0 \le \delta \le 1$

and the final model is:
$E_t = f(I_{t-1}, E_{t-1}, E_{t-2})$,

$$E_t = \alpha_0\gamma\delta + \alpha_1\gamma\delta I_{t-1} + (2-\gamma-\delta) E_{t-1} - (1-\gamma)(1-\delta) E_{t-2} + \varepsilon t$$

, where finally it becomes

$$E_t = \beta_0 + \beta_1 I_{t-1} + \beta_2 E_{t-1} + \beta_3 E_{t-2} + \varepsilon_t$$

It results from the combination of models of partial adaptation and adjustment expectations. , where the **E** symbolizes the revenues and the **I** investments. The question that results is if we must select the linear model or the logarithmic. According to MWD test[1], that it symbolizes initial the MacKinnon, White and Davidson, we will select logarithmic. The model is:

$$\mathbf{lnM = 2,18 + 0,134\ LnI + 0,800\ LnM_{t-1} - 0,116 LnM_{t-2}}$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	2,178	1,611	1,35	0,194	
LnI	0,1345	0,1281	1,05	0,309	1,3
LnM_{t-1}	0,8003	0,2243	3,57	0,002	2,4
LnM_{t-2}	-0,1156	0,1600	-0,72	0,480	2,0

S = 0,7125 R-Sq = 64,2% R-Sq(adj) = 57,9%

1. Guzarati N. Damodar, "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995, pages 265-266.

```
Analysis of Variance

Source            DF          SS          MS         F        P
Regression         3     15,4701      5,1567     10,16    0,000
Residual Error    17      8,6300      0,5076
Total             20     24,1001

Durbin-Watson statistic = 1,85
```

From that we observe from indicator h[2] does not exist problem of autocorrelation. The variables lnM_{t-1} and lnM_{t-2} present multicollinearity, but this is reasonable. However does not exist problem of heteroscedasticity according to the ARCH test.

We have the relations:

$\alpha_0\gamma\delta = 2,18$ (1)
$\alpha 1\gamma\delta = 0,134$ (2)
$(2-\gamma-\delta) = 0,800$ (3)
$-(1-\gamma)(1-\delta) = -0,116$ (4) From the relations (3) and (4) results that $\gamma=\delta = 0,6$. The final model is:

$$lnM = 6,05 + 0,372\, LnI + 0,800\, LnM_{t-1} - 0,116 LnM_{t-2}$$

From the model we observe that if investments are increased at 1 billion, for example, then the desirable level of financing or lending will be increased at 372 millions. We see that the variables are statistically important. Apart from variable Ln (M_{t-2}), that means the investments, which O.U.T.A. realize and his affiliated companies, do not have duration higher from two years. Moreover and the cross-correlation between variable Ln (M_{t-1}) and Ln (M_{t-2}), are not important. After the γ and δ are equally with 0,6, they enough least remain the unit, it means that the adaptation of real financing to desirable, but the expectations for the adaptation of investments to a desirable level are also simultaneously realised in the maximum interval of one year.

2. Analysis for U.T.B. E.R.A.P., D.E.B.A.P

Now we will take individually also the affiliated companies of O.U.T.A. For the case of U.T.B**.** we used the Factor analysis with the method of maximum likelihood and the software Minitab. We have the final model. We observe that variable Ln (M_{t-2}) was null so that it is rejected by the model.

$$LnM = 33 + 0,102 LnI_t + 0,894 LnM_{t-1}$$

2. Statistics h result from the type: $\rho^* \sqrt{\frac{n}{1-n[\mathrm{var}(b2)]}}$, where p = 1 1/2 * d (where d is not nothing other than the price of statistics D W, n is the number of observations and var the fluctuation of factor b2, the fluctuation of factor of dependent variable, that is presented as independent with a lag. See also, Damodar N. Guzarati, Basic Econometrics, 1995, page. 605-607

We see that when the investments are increased at 1 billion, then the lending is increased at 102 millions. When $\gamma = 0{,}999$ and the $\delta = 0{,}107$, then the adaptation of real financing to desirable level is completed in one year and the expectations for the adaptation of investments to a desirable level is realised in interval of much smaller of one year. What however is in effect is opposite, that is to say $\gamma = 0{,}107$ and the $\delta = 0{,}999$. For the next companies we used the same methodology with that of U.T.B**.**

In the case of E.R.A.P., we have the model:

$$LnM = 4{,}81 + 0{,}247LnI_t + 0{,}339LnM_{t-1}$$

If investments are increased at 1 billion, then the desirable level of financing will be increased at 247 millions, $\gamma = 0{,}668$ and the $\delta = 0{,}993$.

For. D.E.B.A.P we have:

$$LnM = 6{,}32 + 0{,}671LnI_t + 0{,}519LnM_{t-1}$$

We observe that the need for financing is more intense in the case of D.E.B.A.P, after in case of increase of investments at 1 billion, the desirable level for financing is 671 millions, where $\gamma = 0{,}483$ and the $\delta = 0{,}998$.

CONCLUSION

From that we saw with the model of Nerlove, that substantially is a combination of models of partial adaptation and adjustment expectations, we accomplish to find which is the desirable level of lending in case of increase of investments. We observe, that the expectations for the adaptation of investments to a desirable level are realised in interval of one year and above, as it is reasonable, it shows that investments, which O.U.T.A. realise, are completed maximum in two years. Exists also a resemblance between in the subsidiary companies, with the exception of. D.E.B.A.P that as we saw, the desirable level of lending differs a lot and also is enough increasing concerning the level of financing of other companies.

CHAPTER THIRD

Summary

A subject that occupies the economists is the right confrontation, determination and forecast of various economic sizes and developments that they have to face. Many times the economists make errors in the determination of these sizes, that requires mathematic approach, so that we were led to an erroneous picture of reality and to the not rational decision-making. In this article we will analyse the method of simultaneous equations for the revenues and the investments that become for the total companies of O.U.T.A. which concern period 1980-2002.

Analysis

First we should approach the equation of revenues. The independent variables that can influence and interpret the revenues are the investments, the price of ticket and the number of passengers. We should stress that in all the article we analyse the logarithmic models, because these were considered more suitably. The equations that we have are:

REVENUES FUNCTION $LnR_t = \alpha_0 + \alpha_1 LnI_t + \alpha_2 LnP_t + \alpha_3 LnEt + \varepsilon_t$

INVESTMENT FUNCTION $LnI_t = \beta_0 + \beta_1 Ln R_t + \beta_2 LnR_{t-1} + u_t$

,where R = the revenues

R_{t-1} = the revenues with a lag

I = the investments

P = the price of ticket

E = the number of passengers

If we untie each one equation we will separately be led to valid results. We observe that the endogenous or dependent variable LnR_t is presented as independent or endogenous in the equation of investments. In this case we have over- identification. Beyond the conditions of interdependence that are in effect, we prove that exists over- identification with the Hausman Specification Test[3] Similarly is also in effect for the variable of investments. The final equations will be:

$$LnR_t = \Pi o + \Pi_1 LnP_t + \Pi_2 LnE_t + \Pi_3 LnR_{t-1} + \varepsilon_t$$

$$LnI_t = \Pi_4 + \Pi_5 LnP_t + \Pi_6 LnE_t + \Pi_7 LnR_{t-1} + u_t$$

3. Guzarati N. Damodar, "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995, pages 670-671.

, where $\mathbf{\Pi o} = \dfrac{\beta_o - \alpha_0}{\alpha_1 - \beta_1}$ $\mathbf{\Pi_1} = -\dfrac{\alpha_2}{\alpha_1 - \beta_1}$ $\mathbf{\Pi_2} = -\dfrac{\alpha_3}{\alpha_1 - \beta_1}$

$\mathbf{\Pi_3} = \dfrac{\beta_2}{\alpha_1 - \beta_1}$ $\mathbf{\Pi_4} = \dfrac{a_1\beta_o - \alpha_0\beta_1}{\alpha_1 - \beta_1}$ $\mathbf{\Pi_5} = -\dfrac{\alpha_2\ \beta_1}{\alpha_1 - \beta_1}$

In order to we find the final model $LnR_t = \beta_0 + \beta_1 LnI_t$ we must find the Π_1 , Π_2, Π_5, Π_6 ,

where $\beta_0 = \dfrac{\Pi_5}{\Pi_1}$ και $\beta_1 = \dfrac{\Pi_6}{\Pi_2}$

The analysis of regression for the equation of revenues is:

The regression equation is
$LnR_t = 3,43 + 0,113\ LnI + 0,830 lnP_t + 1,18 LnE_t$

Predictor	Coef	SE Coef	T	P	VIF
Constant	3,428	3,082	1,11	0,280	
LnI	0,11331	0,04182	2,71	0,014	1,6
lnP_t	0,82966	0,06440	12,88	0,000	1,7
LnE_t	1,1798	0,4840	2,44	0,025	1,1

S = 0,2138 R-Sq = 94,8% R-Sq(adj) = 94,0%

Similarly for the investments we have:

The regression equation is
$LnI = -\ 3,33 + 1,08\ LnR_t + 0,08 LnR_{t-1}$

Predictor	Coef	SE Coef	T	P	VIF
Constant	-3,329	3,019	-1,10	0,284	
LnR_t	1,0832	0,9841	1,10	0,285	13,3
LnR_{t-1}	0,084	1,002	0,08	0,934	13,3

S = 1,044 R-Sq = 49,4% R-Sq(adj) = 44,1%

$\Pi_1 = -\dfrac{0,830}{0,113 - 1,08} = 0,830/0,967 = 0,858$

$\Pi_2 = -\dfrac{1,18}{0,113 - 1,08} = 1,18/0,967 = 1,22$ Hence $\beta_0 = \dfrac{\Pi_5}{\Pi_1} = 0,926/0,858 = 1,079$

$\Pi_5 = -\dfrac{0,830 X 1,08}{0,113 - 1,08} = 0,8964/0,967 = 0,926$ and $\beta_1 = \dfrac{\Pi_6}{\Pi_2} = 1,31/1,221 = 1,07$

$\Pi_6 = -\dfrac{1,18 X 1,08}{0,113 - 1,08} = 1,2744/0,967 = 1,31$

We should mark that became control for autocorrelation with the BG test, control for heteroscedasticity with the ARCH test and control for multicollinearity with indicator VIF and we led to the reject of existence of heteroscedasticity and autocorrelation. multicollinearity is presented, but it can be insignificant after according to an other hypothesis that there is multicollinearity when the R-sq (adj) is very tall and the t-statistics very low, something that is not in effect here. Also the signs of the variables are rightly according to the economic theory. Consequently, the final model is below. We see that if investments are increased at 1 billion, then the revenues increases at 1 billion and 70 millions.

$$\mathbf{LnR_t = 1{,}079 + 1{,}07LnI_t}$$

A second, different model that we will examine is precisely more. Concretely, we will analyse precisely the same model, simply we will see the effect of all variables. The method of estimate where it will be applied is the method of least square in two stages (2sls). Initially, we will regress endogenous variable R with all exogenous variables P, E and R with a lag and we will take the appreciated prices of R. Similarly, we will also make with the variable of investments. This is also the first stage. In the second stage we will regress the R as dependent with independent variables P, E and the appreciated prices of variable of investments. From the other, we will regress the variable with the variable R with a lag and the appreciated prices of variable of R.

Appreciated prices of R	Appreciated prices of I	Appreciated prices of R	Appreciated prices of I
9,5652	8,3794	11,1247	9,9266
9,6545	8,2152	11,1171	9,5187
9,7531	8,2135	11,058	8,7773
10,0007	8,4843	11,5382	10,0933
10,1897	8,6053	11,6206	10,1338
10,393	8,7507	11,6336	10,0585
10,6376	8,9981	11,7031	10,1947
10,7462	8,8505	11,8547	10,5479
10,9755	9,3189	12,0063	10,7511
10,9059	9,1795	12,1831	11,0477
11,0859	9,4549	12,3407	11,5663

The revenues model is :

The regression equation is

$$\mathbf{LnR = 2{,}88 + 0{,}272LnI_t + 0{,}701\ LnP_t + 1{,}00LnE_t}$$

Predictor	Coef	SE Coef	T	P	VIF
Constant	2,876	2,952	0,97	0,343	
LnI_t	0,2722	0,1100	2,47	0,024	5,7
LnP_t	0,7007	0,1286	5,45	0,000	6,2
LnE_t	1,0028	0,5008	2,00	0,061	1,3

S = 0,2029 R-Sq = 95,0% R-Sq(adj) = 94,2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	14,2036	4,7345	114,97	0,000
Residual Error	18	0,7413	0,0412		
Total	21	14,9449			

Consequently if the investments are increased at one unit, and all the other factors remain constant, then the revenues will be increased at 0,272. If price is increased at 1 unit, the revenues will be increased at 0,701. These variable are accounted in pecuniary value. While variable E that expresses the number of passengers, it shows that if this number increased at 1 number, then revenues will be increased at 1. We observe that the variable R_{t-1} was not included in the equation, because we led to rejection, for the reason that existed intense cross-correlation with the other variables.

For the investments we have:

The regression equation is

$LnI_t = - 0,7 + 0,55\ LnR + 0,54\ LnP_t + 0,57\ LnE_t + 0,132\ LnR_{t-1}$

Predictor	Coef	SE Coef	T	P	VIF
Constant	-0,66	11,62	-0,06	0,956	
LnR	0,554	1,106	0,50	0,623	8,6
LnP_t	0,538	1,213	0,44	0,663	8,9
LnE_t	0,574	3,358	0,17	0,866	1,5
LnR_{t-1}	0,1318	0,3262	0,40	0,691	1,2

S = 0,9508 R-Sq = 33,1% R-Sq(adj) = 17,3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	7,5935	1,8984	2,10	0,126
Residual Error	17	15,3696	0,9041		
Total	21	22,9632			

In the last case was presented the problem of autocorrelation, that was solved with the repetitive method of Cochrane – Orcutt[4] Here we see that if the revenues are increased at one unit in the present period the investments will be increased at 0,55, while the increase of revenues of the previous period at one unit they increase investments at 0,132. If the price of ticket is increased at one unit the investments will be increased at 0,54 and if the passengers will be increased at one number the investments are increased at 0,57.

CONCLUSION

We saw that with the simultaneous equations and the suitable methodology we can solve the systems, that can give us, at the best approach for the financing situation of O.U.T.A. in his total and the possibility of taking the best decisions. Thus, in this way we can make analysis also for the affiliated companies of O.U.T.A., each one separately.

4. Guzarati N. Damodar, «Basic Econometrics», McGraw – Hill International Editions, Economic Series, Third Edition, New York 1995, σελίδες 430-433.

CHAPTER FOURTH

Summary

In this article becomes reason for the model of Koyck that will be solved with the technique of Almon. This model will help us in the finding of the direct or short-run multipliers, the intermediary multipliers and the long-run multipliers. Concretely, we will examine two models for the total of enterprises of OU.T.A. (Organisation of Urban transportation of Athens). The one will include the revenues with the investments, and the second will include the revenues with the price of ticket.

Analysis

In the first model we will take the income as the endogenous variable and the investments and investments with lags, as exogenous variables. The model has the form:

$$\mathbf{Y_t = \alpha + b_0X_t + b_1X_{t-1} + b_2X_{t-2} + b_3X_{t-3} + b_4X_{t-4} + \ldots\ldots b_nX_{t-n} + U_t}$$

,where the Y = revenues and the X the investments, and respectively the investments with lags.

$$\mathbf{Y_t = 8{,}05 + 0{,}231X_t + 0{,}131X_{t-1} + 0{,}216X_{t-2} - 0{,}135X_{t-3} + 0{,}093X_{t-4} - 0{,}211X_{t-5}}$$

Y_t	Coef	SE Coef	T	P	VIF
Constant	8,050	1,411	5,71	0,000	
X_t	0,2312	0,1178	1,96	0,076	3,7
X_{t-1}	0,1312	0,1524	0,86	0,408	5,3
X_{t-2}	0,2155	0,1496	1,44	0,177	4,3
X_{t-3}	-0,1349	0,1533	-0,88	0,398	3,4
X_{t-4}	0,0934	0,1440	0,65	0,530	2,0
X_{t-5}	-0,2109	0,1595	-1,32	0,213	1,5

S = 0,3844 R-Sq = 80,2% R-Sq(adj) = 69,4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	6,5750	1,0958	7,41	0,002
Residual Error	11	1,6258	0,1478		
Total	17	8,2008			

The factor of X_t gives us the direct multiplier, that is 0,231. This means that if in the present the investments are increased at one unit, then the evenues will be increased at 0,231. The sum of factors the X_t and X_{t-1} give us the direct multiplier that is 0,231 + 0,131 = 0,362. With few reasons this multiplier gives us the change in the mean value of revenues if the investments are increased at one unit, that in the case in question this increase of revenues is 0,362. Thus the sum of factors X_t , X_{t-1} and X_{t-2} gives us the change in the value of revenues from a increase,at one unit of investments, in the immediately next period, that is 0,231 + 0,131 - 0,135 = 0,227. However we observe that there are certain factors which present negatively signs, something that does not agree with the economic theory. The model doesn't present problems of heteroscedasticity and autocorrelation. This negatives however signs disclose the appearance of multicollinearity. This problem can be solved with the equation Koyck. The model Koyck takes into consideration the theory of Milton Friedman for the permanent income. According to this hypothesis the consumption is not associated only with the running income, but also with the significance of permanent income. The perception of permanent income is based on the incomes of past years. We immediately below present the model.

$$\mathbf{Y_t = \alpha + \beta_0 X_t + \beta_1 Y_{t-1}}$$

The regression was the following:

$$\mathbf{Y_t = 0{,}511 + 0{,}0553\, X_t + 0{,}916 Y_{t-1}}$$

From the model of Koyck[5] we know that $\beta_i = \lambda_i\, \beta_0$. After β_0= 0,0553 and λ = 0,916, we have the following transformations:

$\beta_1 = \lambda^1\, \beta_0 = (0{,}916)^1 * (0{,}0553) = 0{,}0506$.
$\beta_2 = \lambda^2\, \beta_0 = (0{,}916)^2 * (0{,}0553) = 0{,}0464$.
$\beta_3 = \lambda^3\, \beta_0 = (0{,}916)^3 * (0{,}0553) = 0{,}042$.
$\beta_4 = \lambda^4\, \beta_0 = (0{,}916)^4 * (0{,}0553) = 0{,}038$.

We can stop here, after the β_4 is already small enough. The equation will be:

$\mathbf{Y_t = 6{,}08 + 0{,}0553X_t + 0{,}0506X_{t-1} + 0{,}0464X_{t-2} + 0{,}042X_{t-3} + 0{,}038X_{t-4} + \ldots\ldots b_nX_{t-n}}$

where $\alpha = \dfrac{0{,}511}{1-0{,}916}$ With this way we resolve the problem of multicollinearity. Thus direct multiplier is 0,0553. The intermediary multiplier of the next period is 0,0553 + 0,0506 = 0,1059. The immediately multiplier of the next period is 0,0553 + 0,0506 + 0,0464 = 0,1523. The long-run multiplier is.

LR multiplier = $\beta_0 \left(\dfrac{1}{1-\lambda}\right)$ = 0,0553*(1/0,084) = 0,0553*11,9 = 0,658. Consequently if the investments are increased, in the long-run period, at one unit, then revenues will be increased at 0,658.

But however where we want to lead is the analysis of an alternative method in the models with lags and this is the technique of Almon, with that method are avoided the problems of autoregressive models. We decided to select a polynomial, for the particular case where we examine, third degree - For more details for the technique of Almon see Guzarati N. Damodar, New York 1995 and User, Volume B, Athens 2001 -. The model that we will appreciate is:

5. Guzarati N. Damodar, "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995, pages 584-602.

$$\mathbf{Y_t = \alpha + C_0 Z_1 + C_1 Z_2 + C_2 Z_3 + U_t \quad (1)}$$

,where $Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_t + X_{t-1} + X_{t-2} + X_{t-3} + X_{t-4} + X_{t-5}$

$$Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_{t-1} + 2X_{t-2} + 3X_{t-3} + 4X_{t-4} + 5X_{t-5}$$

$$Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_{t-1} + 4X_{t-2} + 9X_{t-3} + 16X_{t-4} + 25X_{t-5}$$

Finally the equation (1) will become

$$\mathbf{Y_t = 7{,}79 + 0{,}223\, Z_1 - 0{,}0545\, Z_2 - 0{,}0031\, Z_3}$$

where

$$\beta_0 = C_0\,,\ \beta_1 = (C_0 + C_1 + C_2)\ ,\ \beta_2 = (C_0 + 2C_1 + 3C_2)\ ,\ (C_0 + 3C_1 + 9C_2)$$

Therefore if we replace the prices of model in the above relations we will have the final model:

$$\mathbf{Y_t = 7{,}79 + 0{,}223X_t + 0{,}1654X_{t-1} + 0{,}101X_{t-2} + 0{,}0316X_{t-3}}$$

Consequently the direct multiplier is 0,223. The first intermediary multiplier is 0,223 + 0,1654 = 0,3884. Next is 0,223 + 0,1654 + 0,101 = 0,4894. Long-run multiplier is 0,223 + 0,1654 + 0,101 + 0,0316 = 0,521.

We continue the analysis with the second model. As dependent variable we will take the revenues and as independent we will take the price of ticket. We have the following model.

$$\mathbf{Y_t = \alpha + b_0X_t + b_1X_{t-1} + b_2X_{t-2} + b_3X_{t-3} + b_4X_{t-4} + \ldots\ldots\ b_nX_{t-n} + U_t}$$

,where the Y = revenues and the X the of ticket in base of inflation, and respectively the prices with lags..

```
The regression equation is
```

$$Y_t = 12{,}9 + 0{,}02X_t - 1{,}06X_{t-1} - 4{,}06X_{t-2} + 6{,}45X_{t-3} + 0{,}70X_{t-4} - 6{,}31X_{t-5} + 4{,}63X_{t-6}$$

(2)

Predictor	Coef	SE Coef	T	P
Constant	12,9323	0,1660	77,90	0,000
X_t	0,019	1,987	0,01	0,993
X_{t-1}	-1,057	3,794	-0,28	0,787
X_{t-2}	-4,057	4,072	-1,00	0,345
X_{t-3}	6,452	3,936	1,64	0,136
X_{t-4}	0,701	3,664	0,19	0,853
X_{t-5}	-6,314	3,383	-1,87	0,095
X_{t-6}	4,634	1,862	2,49	0,035

S = 0,1628   R-Sq = 96,6%   R-Sq(adj) = 94,0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	7	6,77256	0,96751	36,52	0,000
Residual Error	9	0,23846	0,02650		
Total	16	7,01102			

And in this case we observe, as in the first model, that signs do not agree with the economic theory. Of course, we should see if the good is flexible or inflexible. Because if it is inflexible, then the increase of price leads to increase of revenues, something that does not happen here. The income of enterprises we know that they counterbalance with the total expense of consumers. Thus, if the good has inflexible demand, then the increase of price leads to increase of total expense and reverse. If however the good has flexible demand, we know that the increase of price leads to reduction of income and reverse. Consequently, we should first find the elasticity of demand for these goods. We will regress with the method of least square the passengers, as dependent variable, that express substantially the Qd, that is the demanding quantity with the price of ticket. The model is:

$Q_d = \alpha + \beta P$

The results of regression are:

LnQ = 0,273 - 1,85 LnP

Predictor	Coef	SE Coef	T	P
Constant	0,27340	0,02085	13,11	0,000
LnP	-1,84938	0,04664	-39,65	0,000

S = 0,09947   R-Sq = 98,7%   R-Sq(adj) = 98,6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	15,557	15,557	1572,26	0,000
Residual Error	21	0,208	0,010		
Total	22	15,765			

The model presented problem of autocorrelation and was solved with the method Cochrane - Orcutt. According to the Goldfeld-Quandt test, the model does not present heteroscedasticity. We preferred the logerithmic model, after it has the advantage that gives immediately the elasticity that is not other than the coefficient of variable P. We observe that the price is -1,85, that means that the good is flexible. Hence the model (2) that we saw more, it can be also right. Nevertheless let’s see also the model Koyck.

$$\mathbf{Y_t = \alpha + \beta_0 X_t + \beta_1 Y_{t-1}}$$

The regression was the following:

$$\mathbf{Y_t = 4{,}91 + 0{,}3797\, X_t + 0{,}6065 Y_{t-1}}$$

From the model of Koyck1 we know that $\beta_i = \lambda_i\, \beta_0$. After β_0= 0,3797 and λ = 0,6065, we have the following transformations:

$\beta_1 = \lambda^1 \beta_0 = (0{,}6065)^1 * (0{,}3797) = 0{,}23$.

$\beta_2 = \lambda^2 \beta_0 = (0{,}6065)^2 * (0{,}3797) = 0{,}139$.

$\beta_3 = \lambda^3 \beta_0 = (0{,}6065)^3 * (0{,}3797) = 0{,}084$.

$\beta_4 = \lambda^4 \beta_0 = (0{,}6065)^4 * (0{,}3797) = 0{,}051$

We can stop here, after the β_4 is already small enough. The equation will be:

$$\mathbf{Y_t = 12{,}47 + 0{,}3797X_t + 0{,}23X_{t-1} + 0{,}139X_{t-2} + 0{,}084X_{t-3} + 0{,}051X_{t-4} + \ldots\ldots\ b_nX_{t-n}}$$

where $\alpha = \dfrac{4{,}91}{1-0{,}6065}$. We solved the problem of multicollinearity. Thus, the direct multiplier is 0,3797. The intermediary multiplier of the next period is 0,3797 + 0,23 = 0,6097. The immediately multiplier of the next period is 0,3797 + 0,23 + 0,139 = 0,7487. The long-run multiplier is.

LR multiplier = $\beta_0 \left(\dfrac{1}{1-\lambda}\right)$ = 0,3797*(1/0,3935) = 0,3797*2,54 = 0,96. Consequently if prices are increased, in the long-run period, at one unit, then the revenues will be increased at 0,96. We see that the price of ticket plays more decisive role in the configuration of revenues, from that affect the investments. Below we see the technique of Almon.

$$\mathbf{Y_t = \alpha + C_0 Z_1 + C_1 Z_2 + C_2 Z_3 + U_t \quad (3)}$$

,where $Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_t + X_{t-1} + X_{t-2} + X_{t-3} + X_{t-4} + X_{t-5}$

$$Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_{t-1} + 2X_{t-2} + 3X_{t-3} + 4X_{t-4} + 5X_{t-5}$$

$$Z_{i\,t} = \sum_{i=0}^{5} x_{t-1} = X_{t-1} + 4X_{t-2} + 9X_{t-3} + 16X_{t-4} + 25X_{t-5}$$

Finally the equation (3) will become

$$\mathbf{Y_t = 12{,}71 - 1{,}52\, Z_1 + 1{,}31\, Z_2 - 0{,}1836\, Z_3}$$

Where

$$\beta_0 = C_0\ ,\ \beta_1 = (C_0 + C_1 + C_2)\ ,\ \beta_2 = (C_0 + 2C_1 + 3C_2)\ ,\ (C_0 + 3C_1 + 9C_2)$$

Therefore if we replace the prices of model in the above relations we will have the final model:

$$\mathbf{Y_t = 12{,}71 - 1{,}52X_t - 0{,}3936X_{t-1} + 0{,}5492X_{t-2} + 0{,}7576X_{t-3}}$$

Consequently the direct multiplier is -1,52. The first intermediary multiplier is -1,52 - 0,3936 = -1,9136. Next is -1,52 - 0,3936 + 0,5492 = -1,3644. Long-run multiplier is -1,52 - 0,3936 + 0,5492 + 0,7576 = -0,6068. Consequently, in the long run period the revenues will be decreased by the increase of price. Consequently, the initial model did not present erroneously signs, after the good has flexible demand, that means the increase of price of ticket leads to reduction of revenues. Hence, .O.U.T.A. will be supposed to seek also another ways of competitive price. Moreover this is proved, from the unified accountant situation of group 2001-2002, where is presented loss. (See REPORT of PROCEEDINGS of PERIOD 1.1.2002 - 31.12.2002, Organism of Urban Transport Athens, TYPE GREECE LTD).

BIBLIOGRAPHY

GREEK

1. Christou, "Introduction in the Econometrics", Volume A, Publications Gutenberg, Athens 2001.
2. Christou, " Introduction in the Econometrics", Volume B, Publications Gutenberg, Athens 2001.
3. Intriligator D. M. , "ECONOMETRIC MODELS, Techniques and Applications ", Volume A, Publications Gutenberg, Athens 1982.
4. Andreas A. Kintis, "Econometrics", Volume A, Publications Gutenberg, Athens 1982.
5. John Papadimitriou, Statistics Copy 2, "Inductive statistics", Publications Observer Thessaloniki, 1989.
6. John Alkiv. Kaskarelis, "Eleven Courses of econometrics", 2nd Publication Revised, Gutenberg, Athens 2000.
7. REPORT OF PROCEEDINGS OF PERIOD 1.1.2002 - 31.12.2002, Organism of Urban Transport Athens, TYPE GREECE LTD.

FOREIGNER

1. Guzarati N. Damodar, "Basic Econometrics", McGraw - Hill International Editions, Economic Series, Third Edition, New York 1995