

# **Econometric Model for Analysing the Structural Funds Absorption at NUTS2 Regional Level Sectoral Operational Programme Transport**

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## **Abstract:**

The Sectoral Operational Programme - Transport (SOPT) is one of seven operational programmes under the "Convergence" Objective. Through increasing and improving the quality of investment in physical capital, it aims at speeding up the convergence of Romania by improving conditions for growth and employment. The present paper presents an Autoregressive Conditional Heteroskedasticity (ARCH) model for analyzing the absorption of structural funds, under the Sectoral Operational Program Transport in Romania. The basic idea of the presented model, due to the lack of consistent time-series for the structural funds absorption process, is to use a specific model with a mix input. This mix input takes into consideration data related to the pre-accession period and to the first monitoring exercise of structural funds absorption. The main conclusion of the study is that the presented model might be used for future analyses concerning the absorption of structural funds in Romania.

## **Key words:**

econometrics, modelling, NUTS2, structural funds, operational programmes

## **1. Introduction**

The European Union has a strategy to reduce disparities between the regions of Europe. This is called the Cohesion policy and it uses as instruments for its implementation the so called Structural Funds. The implementation of the funds will cover 7 years from beginning 2007 to the end 2013, which is called the programming period.

The Structural Funds constitute the most important financial instrument at EU level for social and economical development from 2007 to 2013. In many European regions they represent the most important source of public funding. The Structural Funds constitute over 35% of EU budget and 43 billion euros annually.

Structural funds can shape all national policies in many countries, especially those on the convergence objective (those regions under 75% of the EU GDP average). The actions funded with Structural Funds will take place at all levels - national, regional and local. Therefore, the recently approved regulations can be a major driver for a change in European societies.

The Structural Funds are managed through a de-centralised system. This means that once the agreement on the financial allocation and the type of activities to be funded is signed between the European Commission and the Governments of the EU Member States, the national authorities have much freedom in the management of the Funds.

## **2. Sectoral Operational Programme Transport - Objectives**

The Strategic Objective of the Romanian National Strategic Reference Framework (NSRF) for 2007-2013 addresses promotion of competitiveness, development of basic infrastructure and development and effective use of human resources, with a view to reducing the social and economic development disparity between Romania and EU member states.

The principal objective for the transport sector in the NSRF focuses on the provision of an adequately developed, modern and sustainable infrastructure, appropriately maintained, facilitating the safe and efficient movement of persons and goods nationally and within Europe and contributing positively and significantly to the economic development of Romania. The transport sector in the NSRF is fully consistent with, and promotes the Lisbon and Gothenburg strategies of growth, jobs and sustainable development.

As it is stated in The European Economic and Social Cohesion Policy, defined under Article 158 of the European Union Treaty, aims at reducing disparities between the levels of development of the various regions and identifying the additional help needed to assist the least developed regions. In meeting these objectives, and in particular that of fostering real convergence, the actions supported with the limited resources available to cohesion policy should be concentrated on promoting sustainable growth, competitiveness and employment as set out in the renewed Lisbon strategy.

The Sectoral Operational Programme - Transport (SOPT) is one of seven operational programmes under the "Convergence" Objective. Through increasing and improving the quality of investment in physical capital, it aims at speeding up the convergence of Romania by improving conditions for growth and employment.

The SOPT is the instrument that elaborates upon the objectives of the National Strategic Reference Framework (NSRF), establishing priorities, goals and the allocation of funds for development of the transport sector in Romania. The total budget of the SOPT over the programming period 2007 – 2013 is estimated at about 5 billion Euro, which represents about 23% of the overall budget of structural operations for Romania over the said period. Out of these, 4,010 million Euro represent the Community financial support, while national co-financing will amount to about 995 million Euro. The Community funding will be provided the Cohesion Fund and the European Regional Development Fund.

### **Global Objective of SOPT**

The objective of the Sectoral Operational Programme – Transport (SOPT) is to promote a transport system in Romania, which will facilitate safe, fast and efficient movement of persons and goods with appropriate level of service at European standards, nationally, Europe-wide and between and within Romanian regions.

### **Specific objectives SOPT**

i. Promote international and transit movements of people and goods in Romania by providing effective connections of the port of Constanta, as well as Greece, Bulgaria and Turkey, with the EU through the modernization and development of the relevant TEN-T priority axes.

ii. Promote effective movement of persons and goods among Romanian regions and their transfer from the hinterland to priority axes by modernizing and developing national and TEN-T networks.

iii. Promote the development of a balanced transport system of modes, based on the respective competitive advantage of each, by encouraging the development of rail, waterborne and intermodal transport.

iv. Promote sustainable development especially by minimizing adverse effects of transport on the environment and improving safety.

In order to achieve the objective of the SOPT it is proposed to allocate the relevant EU and State funds for transport towards the implementation of the following priority axes:

1. Modernization and development of TEN-T priority axes.
2. Modernization and development of the national transport infrastructure outside the TEN-T priority axes.
3. Upgrade the railway passenger rolling stock on the national and TEN-T railway networks.

4. Sustainable development of the transport sector.
5. Technical Assistance.

### 3. Research Methodology and Paper Review

For performing the analysis, an Autoregressive Conditional Heteroskedasticity (ARCH) models has been developed, based on the block diagram presented in Figure 1. Such models are specifically designed to model and forecast conditional variances. The variance of the dependent variable is modeled as a function of past values of the dependent variable and independent, or exogenous variables. ARCH models were introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis. See Bollerslev, Chou and Kroner (1992) and Bollerslev *et al.* (1994) for recent surveys. Another relevant characteristic for the scope of this paper is that such models provide a stable behaviour in the case of systems characterized by a high degree of volatility or non-determination (in the sense that there are exogeneous variables with hard to be predicted evolution). In a classical approach, a GARCH (1,1) model is characterized by the following set of equations:

$$y_t = x_t' \gamma + \varepsilon_t \quad (1) \quad \sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (2)$$

where the mean equation given in (1) is written as a function of exogenous variables with an error term. Since  $\sigma_t^2$  is the one-period ahead forecast variance based on past information, it is called the conditional variance. The conditional variance equation specified in (2) is a function of three terms:

$\omega$  - the mean;

$\varepsilon_{t-1}^2$  - news about volatility from the previous period, measured as the lag of the squared residual from the mean equation - the ARCH term;

$\sigma_{t-1}^2$  - last period's forecast variance - the GARCH term.

The (1,1) in GARCH(1,1) refers to the presence of a first-order GARCH term (the first term in parentheses) and a first-order ARCH term (the second term in parentheses). An ordinary ARCH model is a special case of a GARCH specification in which there are no lagged forecast variances in the conditional variance equation.

ARCH models in EViews are estimated by the method of maximum likelihood under the assumption that the errors are conditionally normally distributed. For example, for the GARCH(1,1) model, the contribution to the log likelihood from observation  $t$  is:

$$l_t = -\frac{1}{2} \log(2\pi) - \frac{1}{2} \log \sigma_t^2 - \frac{1}{2} \left( y_t - x_t' \gamma \right)^2 / \sigma_t^2 \quad (3) \quad \sigma_t^2 = \omega + \alpha \left( y_{t-1} - x_{t-1}' \gamma \right)^2 + \beta \sigma_{t-1}^2 \quad (4)$$

There are two alternative representations of the variance equation that may aid in the interpretation of the model:

- If we recursively substitute for the lagged variance on the right-hand side of (2), we obtain the conditional variance as a weighted average of all of the lagged squared residuals:

$$\sigma_t^2 = \frac{\omega}{1-\beta} + \alpha \sum_{j=1}^{\infty} \beta^{j-1} \varepsilon_{t-j}^2 \quad (5)$$

- We see that the GARCH(1,1) variance specification is analogous to the sample variance, but that it down-weights more distant lagged squared errors.

- The error in the squared returns is given by  $v_t = \varepsilon_t^2 - \sigma_t^2$ ; Substituting for the variances in the variance equation and rearranging terms we can write our model in terms of the errors:

$$\varepsilon_t^2 = \omega + (\alpha + \beta) \varepsilon_{t-1}^2 + v_t - \beta v_{t-1}. \quad (6)$$

- Thus, the squared errors follow a heteroskedastic ARMA(1,1) process. The autoregressive root which governs the persistence of volatility shocks is the sum of  $\alpha + \beta$ . In many applied settings, this root is very close to unity so that shocks die out rather slowly.

Equation (16.2) may be extended to allow for the inclusion of exogenous or predetermined regressors,  $z$ , in the variance equation:

$$\sigma_t^2 = \omega + \alpha \varepsilon_t^2 + \beta \sigma_{t-1}^2 + \pi z_t. \quad (7)$$

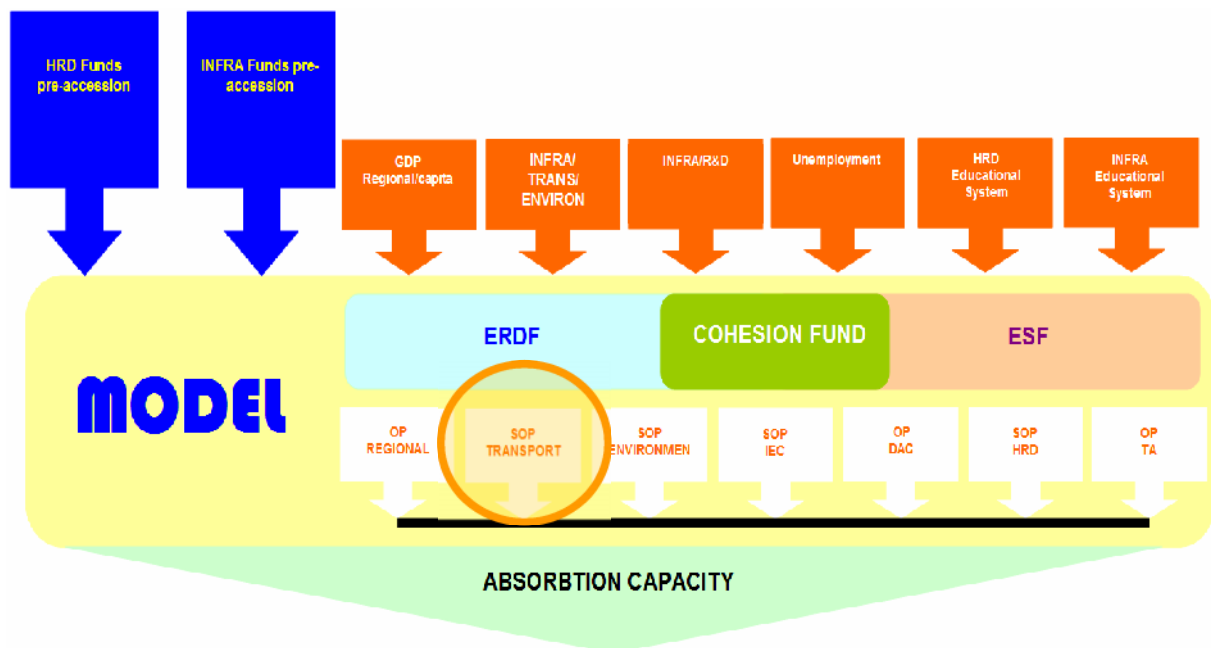
The  $x$  in equation (2) represents exogenous or predetermined variables that are included in the mean equation. If we introduce the conditional variance into the mean equation, we get the ARCH-in-Mean (ARCH-M) model (Engle *et al.*, 1987):

$$y_t = x_t' \gamma + \sigma_t + \varepsilon_t. \quad (8)$$

A variant of the ARCH-M specification uses the conditional standard deviation in place of the conditional variance. In this case, due to high dynamic of the variables flow, it was chosen a set of constant regression factors, hence preventing the increase of the hyper-reactivity of the model.

#### 4. Results & Conclusions

The basic idea of the current model, due to the lack of consistent time-series for the structural funds absorption process, is to use a specific model with a mix input. This mix input takes into consideration data related to the pre-accession period and to the first monitoring exercise of structural funds absorption. Under this approach the time interval for the combined process raises from 3 to 10 years. Fig. 1 presents the structural model used for performing the analysis. The results obtained after running the model are presented below, for each of the eight NUTS2 Development Regions in Romania.



**Fig. 1 The structural model used**

# a) South NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:56

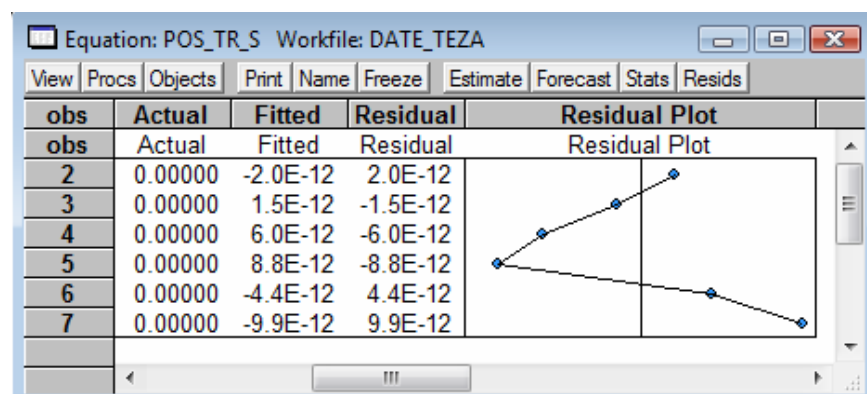
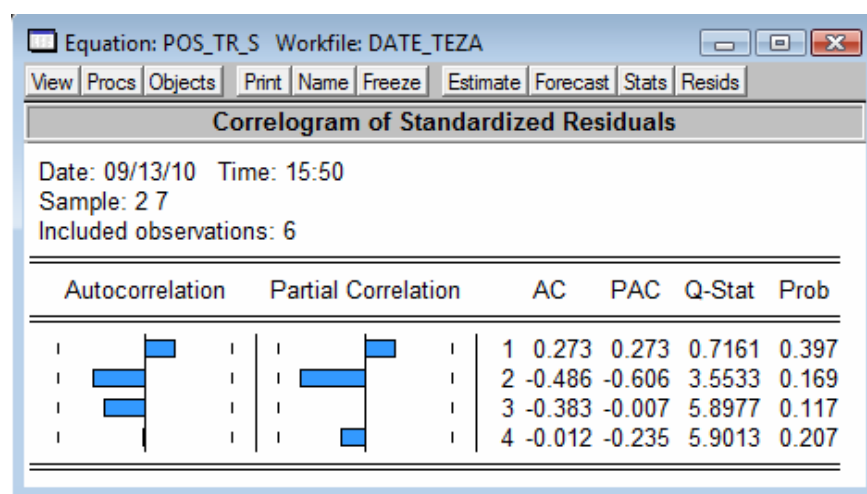
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(1,1))-(C(1)\*LOG(POS\_TR\_V\_X(1,1)\*POP\_REG(1,1)  
\*PIB\_REG(1,1))+C(2)\*LOG(INFRA\_PRE\_S(-1)\*PIB\_REG(1,1))  
+C(3)\*LOG(POS\_TR\_V\_X(1,1)\*DR\_PRE\_S(-1)\*DRM\_PRE\_S(-1)  
\*DRDENS\_PRE\_S(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.368479	0.006346	58.06349	0.0000
C(2)	-2.33E-11	6.26E-05	-3.72E-07	1.0000
C(3)	1.74E-10	0.000130	1.34E-06	1.0000
C(4)	2.57E-23	4.06E-05	6.33E-19	1.0000
C(5)	0.150000	9.145937	0.016401	0.9869
C(6)	0.600000	24.81258	0.024181	0.9807
Akaike info criterion	-46.72563	Sum squared resid		2.37E-22
Schwarz criterion	-46.93387	Log likelihood		146.1769
Durbin-Watson stat	1.030639			



## b) South West NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:44

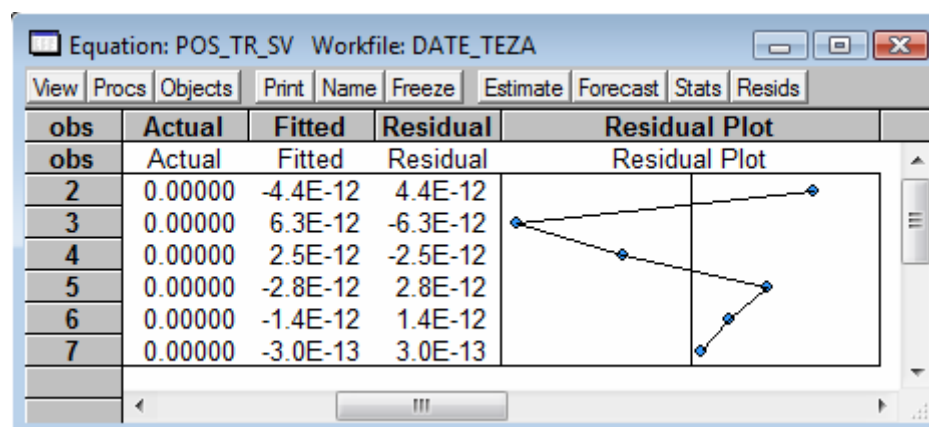
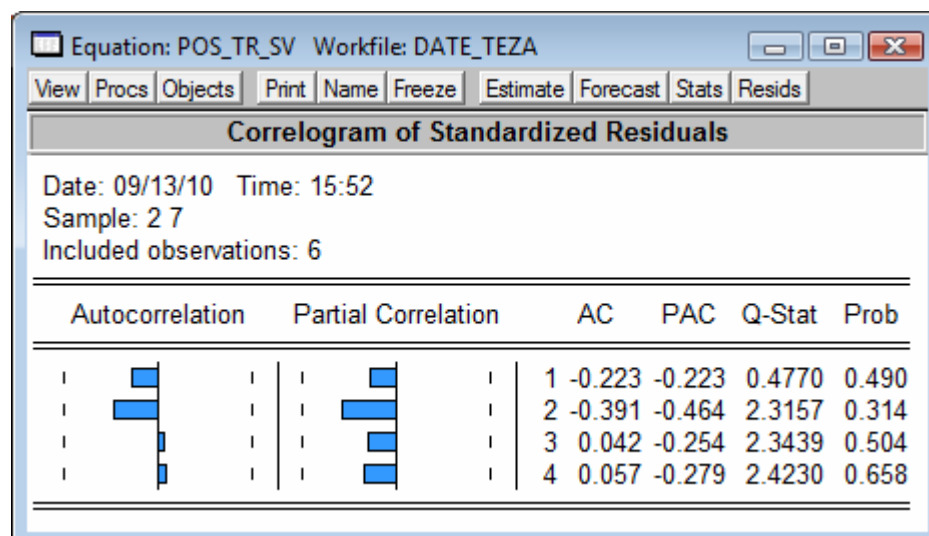
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(2,1))-(C(1)\*LOG(POS\_TR\_V\_X(2,1)\*POP\_REG(2,1)  
 \*PIB\_REG(2,1))+C(2)\*LOG(INFRA\_PRE\_SV(-1)\*PIB\_REG(2,1))  
 +C(3)\*LOG(POS\_TR\_V\_X(2,1)\*DR\_PRE\_SV(-1)\*DRM\_PRE\_SV(  
 -1)\*DRDENS\_PRE\_SV(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.366813	0.015279	24.00708	0.0000
C(2)	3.73E-11	6.65E-05	5.62E-07	1.0000
C(3)	-8.36E-11	0.000557	-1.50E-07	1.0000
C(4)	8.24E-24	1.21E-05	6.84E-19	1.0000
C(5)	0.150000	11.88765	0.012618	0.9899
C(6)	0.600000	47.76459	0.012562	0.9900
Akaike info criterion	-47.68070	Sum squared resid		7.61E-23
Schwarz criterion	-47.88894	Log likelihood		149.0421
Durbin-Watson stat	2.132298			



### c) South East NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:44

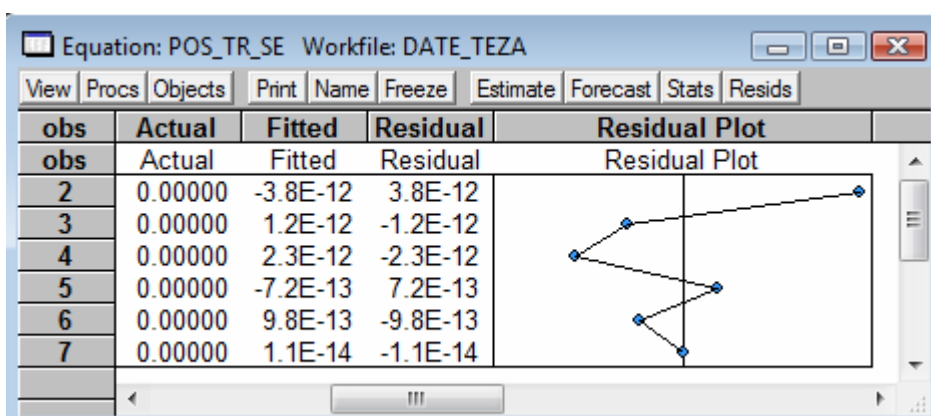
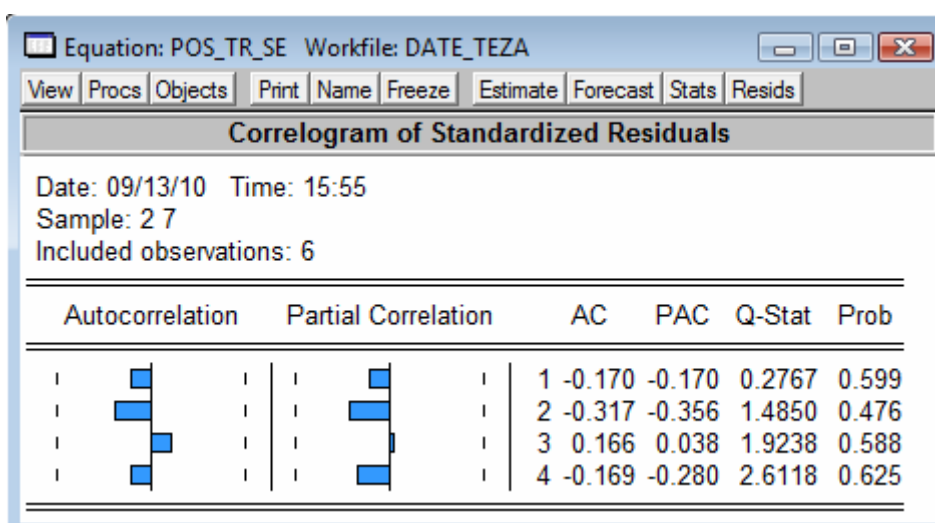
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(3,1))-(C(1)\*LOG(POS\_TR\_V\_X(3,1)\*POP\_REG(3,1)  
 \*PIB\_REG(3,1))+C(2)\*LOG(INFRA\_PRE\_SE(-1)\*PIB\_REG(3,1))  
 +C(3)\*LOG(POS\_TR\_V\_X(3,1)\*DR\_PRE\_SE(-1)\*DRM\_PRE\_SE(-1)\*DRDENS\_PRE\_SE(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.396547	0.005061	78.34954	0.0000
C(2)	2.05E-12	1.48E-05	1.39E-07	1.0000
C(3)	2.51E-11	0.000190	1.32E-07	1.0000
C(4)	2.48E-24	4.08E-05	6.08E-20	1.0000
C(5)	0.150000	5.661589	0.026494	0.9789
C(6)	0.600000	18.15551	0.033048	0.9736
Akaike info criterion	-48.86242	Sum squared resid		2.29E-23
Schwarz criterion	-49.07066	Log likelihood		152.5873
Durbin-Watson stat	1.731558			



#### d) West NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:50

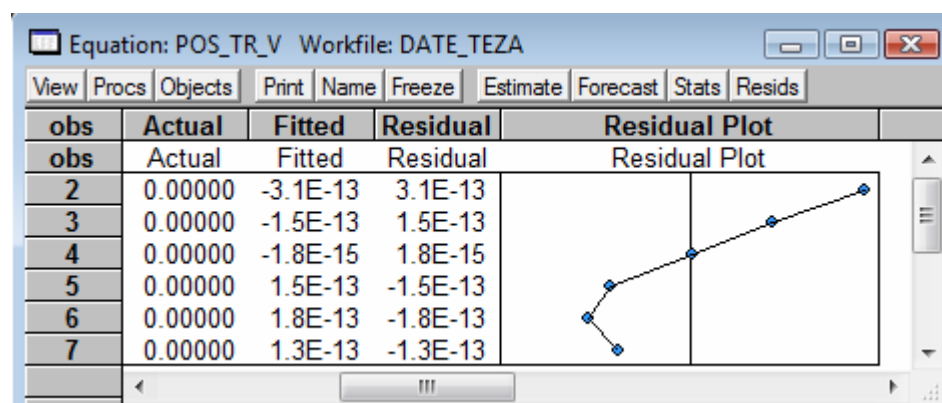
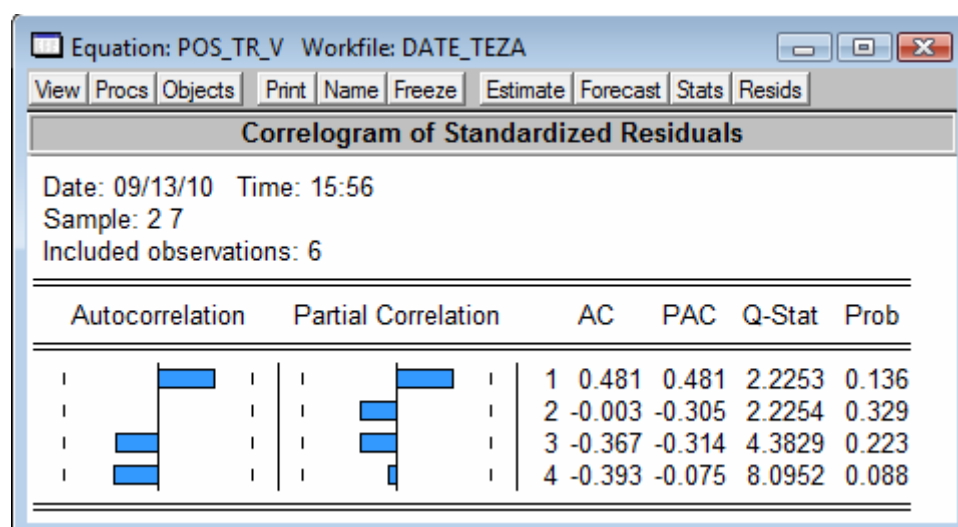
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(4,1))-(C(1)\*LOG(POS\_TR\_V\_X(4,1)\*POP\_REG(4,1)  
 \*PIB\_REG(4,1))+C(2)\*LOG(INFRA\_PRE\_V(-1)\*PIB\_REG(4,1))  
 +C(3)\*LOG(POS\_TR\_V\_X(4,1)\*DR\_PRE\_V(-1)\*DRM\_PRE\_V(-1)  
 \*DRDENS\_PRE\_V(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.361929	0.003549	101.9780	0.0000
C(2)	-8.50E-13	0.000275	-3.09E-09	1.0000
C(3)	0.000000	0.000164	0.000000	1.0000
C(4)	2.09E-26	0.000195	1.07E-22	1.0000
C(5)	0.150000	20.28552	0.007394	0.9941
C(6)	0.600000	17.41252	0.034458	0.9725
Akaike info criterion	-53.65712	Sum squared resid		1.93E-25
Schwarz criterion	-53.86536	Log likelihood		166.9714
Durbin-Watson stat	0.386975			



# e) North West NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:50

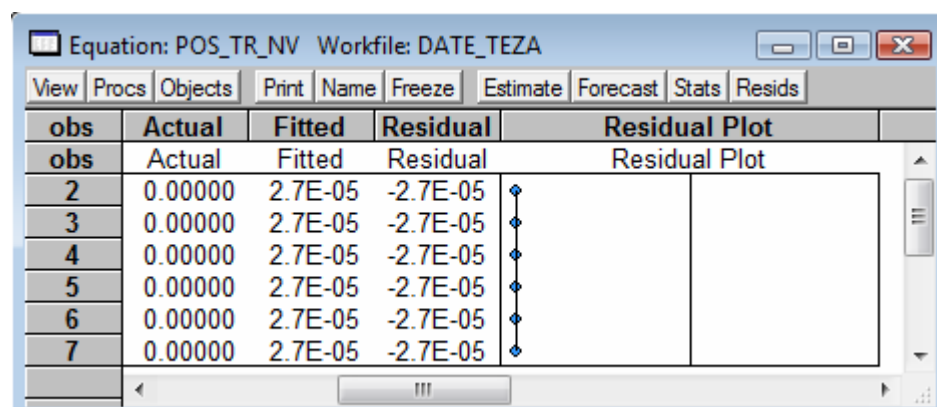
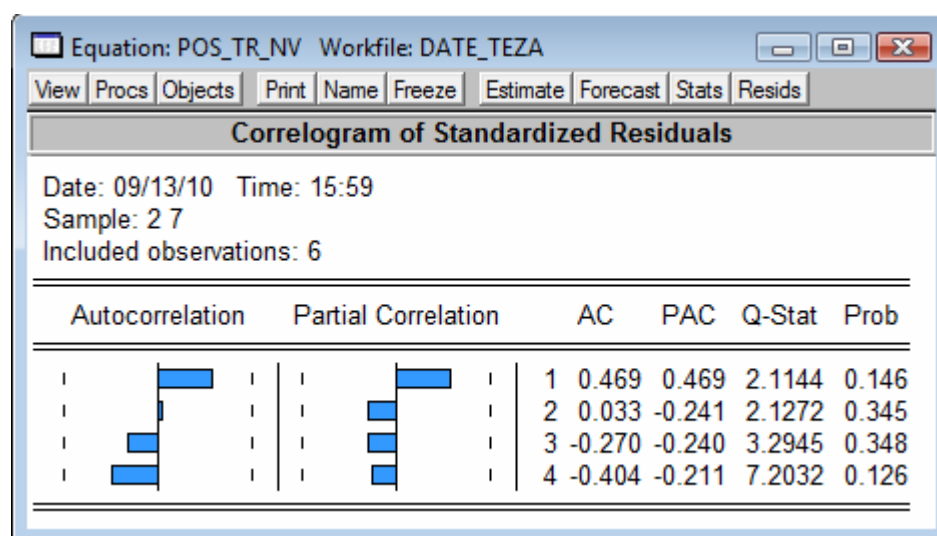
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(5,1))-(C(1)\*LOG(POS\_TR\_V\_X(5,1)\*POP\_REG(5,1)  
 \*PIB\_REG(5,1))+C(2)\*LOG(INFRA\_PRE\_NV(-1)\*PIB\_REG(5,1))  
 +C(3)\*LOG(POS\_TR\_V\_X(5,1)\*DR\_PRE\_NV(-1)\*DRM\_PRE\_NV(  
 -1)\*DRDENS\_PRE\_NV(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.362568	0.002676	135.5142	0.0000
C(2)	-2.55E-11	4.36E-05	-5.85E-07	1.0000
C(3)	1.71E-10	9.69E-05	1.76E-06	1.0000
C(4)	8.40E-24	1.62E-05	5.19E-19	1.0000
C(5)	0.150000	3.654766	0.041042	0.9673
C(6)	0.600000	9.169022	0.065438	0.9478
Akaike info criterion	-47.68721	Sum squared resid		7.76E-23
Schwarz criterion	-47.89545	Log likelihood		149.0616
Durbin-Watson stat	2.538461			



# f) North East NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:51

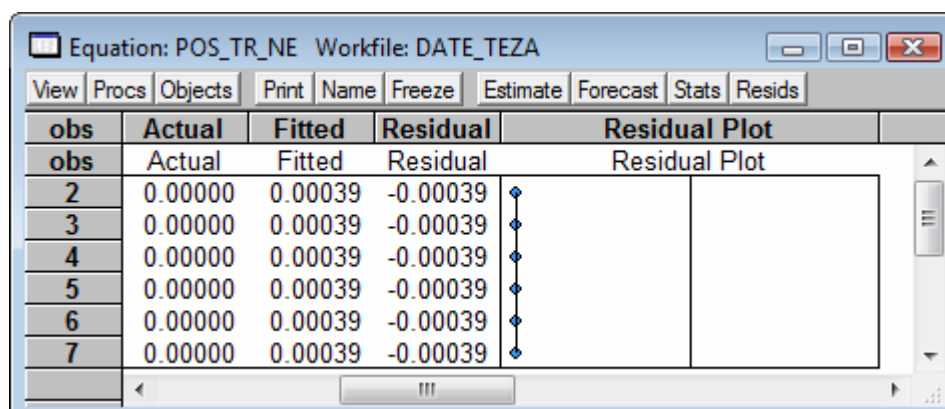
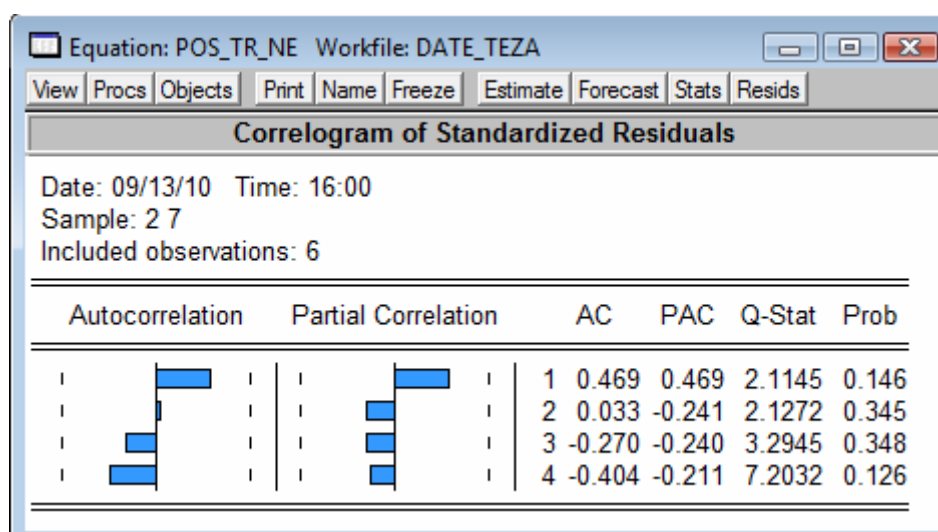
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(6,1))-(C(1)\*LOG(POS\_TR\_V\_X(6,1)\*POP\_REG(6,1)  
\*PIB\_REG(6,1))+C(2)\*LOG(INFRA\_PRE\_NE(-1)\*PIB\_REG(6,1))  
+C(3)\*LOG(POS\_TR\_V\_X(6,1)\*DR\_PRE\_NE(-1)\*DRM\_PRE\_NE(  
-1)\*DRDENS\_PRE\_NE(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.375420	0.037519	10.00606	0.0000
C(2)	-3.16E-11	0.000910	-3.47E-08	1.0000
C(3)	2.69E-10	0.000266	1.01E-06	1.0000
C(4)	2.66E-23	0.000108	2.46E-19	1.0000
C(5)	0.150000	5.752053	0.026078	0.9792
C(6)	0.600000	143.2961	0.004187	0.9967
Akaike info criterion	-46.72470	Sum squared resid		2.45E-22
Schwarz criterion	-46.93294	Log likelihood		146.1741
Durbin-Watson stat	1.003939			



# g) Centre NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/11/10 Time: 20:58

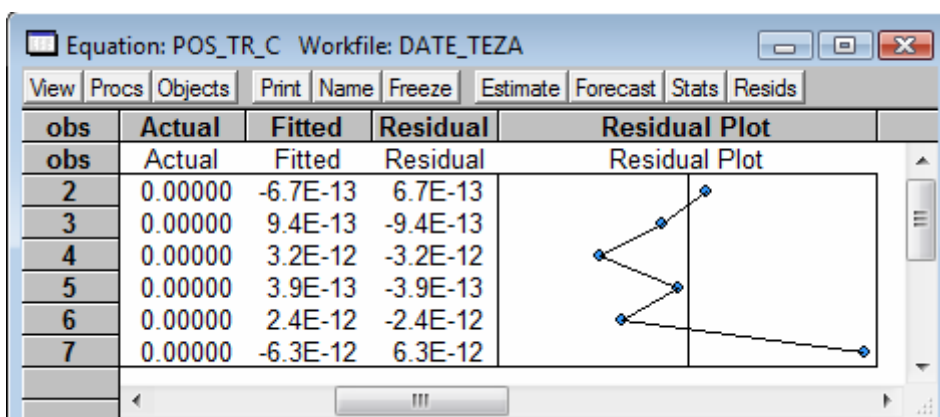
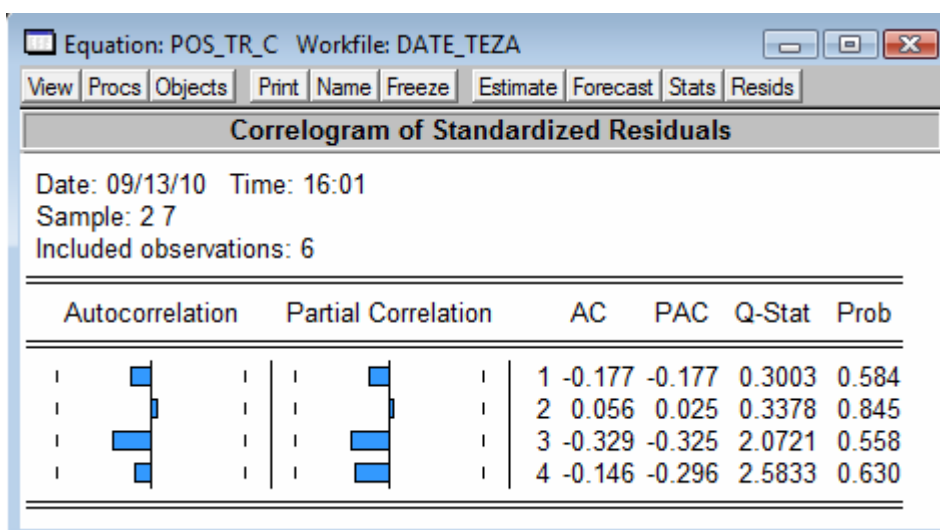
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(7,1))-(C(1)\*LOG(POS\_TR\_V\_X(7,1)\*POP\_REG(7,1)  
\*PIB\_REG(7,1))+C(2)\*LOG(INFRA\_PRE\_C(-1)\*PIB\_REG(7,1))  
+C(3)\*LOG(POS\_TR\_V\_X(7,1)\*DR\_PRE\_C(-1)\*DRM\_PRE\_C(-1)  
\*DRDENS\_PRE\_C(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.373636	0.003003	124.4072	0.0000
C(2)	-1.62E-11	5.22E-05	-3.11E-07	1.0000
C(3)	1.25E-10	5.44E-05	2.29E-06	1.0000
C(4)	6.14E-24	1.70E-05	3.61E-19	1.0000
C(5)	0.150000	7.748704	0.019358	0.9846
C(6)	0.600000	8.954040	0.067009	0.9466
Akaike info criterion	-48.19395	Sum squared resid		5.66E-23
Schwarz criterion	-48.40219	Log likelihood		150.5819
Durbin-Watson stat	1.669265			



## h) Bucharest-Ilfov NUTS2 Region

Dependent Variable: Implicit Equation Estimated by GMM

Method: ML - ARCH

Date: 09/13/10 Time: 16:04

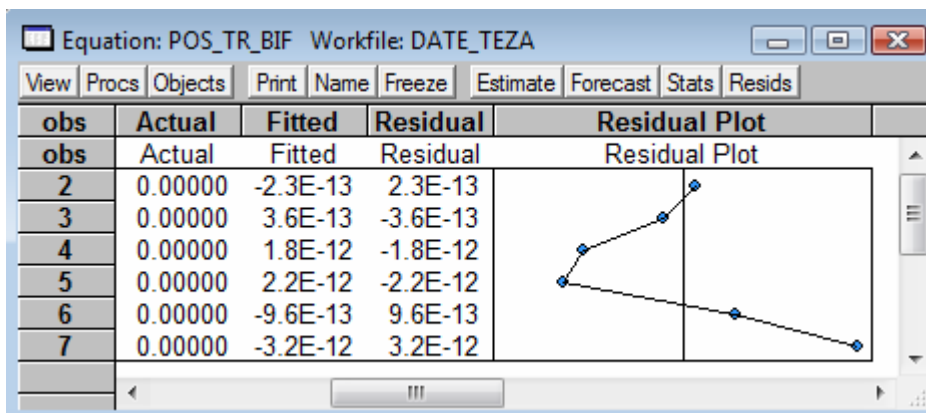
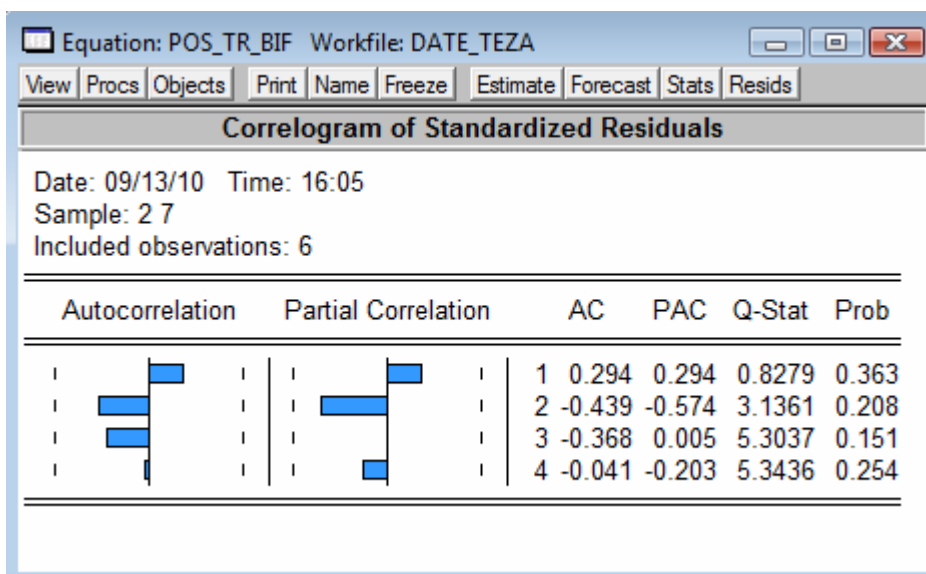
Sample(adjusted): 2 7

Included observations: 6 after adjusting endpoints

Convergence achieved after 1 iterations

LOG(POS\_TR\_P\_X(8,1))-(C(1)\*LOG(POS\_TR\_V\_X(8,1)\*POP\_REG(8,1)  
\*PIB\_REG(8,1))+C(2)\*LOG(INFRA\_PRE\_BIF(-1)\*PIB\_REG(8,1))  
+C(3)\*LOG(POS\_TR\_V\_X(8,1)\*DR\_PRE\_BIF(-1)\*DRM\_PRE\_BIF(-1)\*DRDENS\_PRE\_BIF(-1)))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.368585	0.005110	72.13626	0.0000
C(2)	-1.43E-11	0.000137	-1.04E-07	1.0000
C(3)	4.21E-11	7.06E-05	5.96E-07	1.0000
C(4)	2.09E-24	2.27E-05	9.18E-20	1.0000
C(5)	0.150000	9.197808	0.016308	0.9870
C(6)	0.600000	18.08575	0.033175	0.9735
Akaike info criterion	-49.25466	Sum squared resid		1.93E-23
Schwarz criterion	-49.46290	Log likelihood		153.7640
Durbin-Watson stat	0.901415			



The significance of all variables used in the model are here below mentioned:

ABS_POSTRANS_P	- time serie with payments for SOPT
ABS_POSTRANS_V	- time serie with contracted amounts for SOPT
DR_PRE	- time serie length of roads
DRDENS_PRE	- time serie density of roads
DRM_PRE	- time serie lengths of modernized roads
INFRA_PRE	- time serie pre-accession funds INFR type
PIB_REG	- GDB/capita at the level of development regions
POP_REG	- number of inhabitants at the level of development regions

The following set of conclusions has been depicted:

- Due to the differences in magnitude order of several variables it was considered a logarithmic scale in order to facilitate the convergence process. A very peculiar task was to slightly modify the values of time-series in cases when the same value for two consecutive years appeared, hence to eliminate the overflow errors.
- All models converge, but present a quite high degree of volatility. This is explained both by the limited number of observations and by the impossibility of modelling some external factors (e.g. political factors, audit with putting SOPT on standby etc.).
- All applied statistical tests (Akaike, Schwarz, Durbin-Watson) and the corresponding correlograms present normal values and shapes.
- It is very much sensitive to asses the quality of the absorption process at regional level. However, a ranking, under these assumptions, in terms of efficiency of absorption the funds via SOPT is presented.
- The model might be used for future analyses concerning the absorption of structural funds in Romania.
- The model could be refined by introducing supplementary variables and could be also serve as a powerful instrument in developing future strategies for absorbing the structural funds in Romania, to have better programming exercises in the future.

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