Simultaneous Equations Models Used in the Study of Some Issues Related to the Corruption and Performance of Services in the Public Health System

Tudorel Andrei
Academy of Economic Studies, Bucharest
Ani Matei
National School of Political Studies and Public Administration, Bucharest
Bogdan Oancea
Artifex University, Bucharest

Abstract. *This paper presents an analysis of some issues related to the corruption and performance of services in the public health. Reform of public health is a complex and lengthy process, which involves different types of institutions and individuals. In this paper, starting from a set of hypotheses, we define a simultaneous equations model to analyze some important issues related to the progress of the reform process in the public health system. This model contains equations regarding the quality of reform in the public health system, the role played by different factors in increasing of the transparency of decisions in the public health system, estimations of the influence of some factors from the public health system in increasing the health education of the population, factors related to corruption and nonacademic behavior in the public health system contributing to the implementation of the reform process in the system and improvement of the quality of the medical act. Parameters estimates have been done through procedures implemented in EViews. Applying Hausman test we compare the results for cases in which the parameters are estimated by the least squares method and the two stages least squares method.*

Key words: simultaneous equations models; public health system; reform.

JEL Codes: C30, C51, I18.
REL Codes: 10B, 10F, 13A.

1. Introduction

Reform of public health is a complex and lengthy process, which involves different types of institutions and individuals. During the transition, actions undertaken by all governments have pursued solving the current problems and not to define a new functioning philosophy of the public health system. Under these circumstances, public health system has become expensive and often unfunctional. Not a few times, inefficient solutions have been chosen for solving problems in the health system, both in terms of professional, but also economically. The networks of health services providers from Romania, currently do not respond to most needs to improve the health of the population.

In the past eighteen years, a series of measures have been undertaken to decentralize the system and to the privatization of medical services. However, currently we assist to a fragmentation of the system, which emphasize the inequality in the distribution of medical personnel and a reduction of it to certain types of medical services. We note that the number of doctors per capita in the rural area is now only 20% of those in urban areas. Another major shortcoming is related to the financing and linking it with the strategies of decentralization. Not a few times, decentralization appeared as a way of placement of the tasks from the central level to local administrations.

2. Model definition

General presentation

In the economic literature there are a number of applications of the simultaneous equations models for the analysis of the phenomena in the social field, under the condition that estimates of the parameters are obtained using data series from the application of statistical surveys. We mention in this regard Kaufmann (2002), Bai and Wei (2000), Kaufmann et al. (1999), Andrei (2008) etc. For example, the last paper quoted defines a simultaneous equations model for the analysis of some phenomena at the level of public administration. By this model four important aspects of the functioning of public administration are analyzed: the performance of institutions of central and local administration, corruption, transparency of decisions and satisfaction of employees.

The major problem using simultaneous equations models, which use data from a sample, is related to the definition of the instrumental variables list used in estimating the model parameters by applying the two stages least squares method. We point out that in the economic literature there is no uniform approach in choosing the list of instrumental variables in the simultaneous equations models used to analyze certain aspects of public administration (Bai, Wei, 2000; Kaufmann et al., 1999).

In the following, starting from a set of assumptions, we define the equations of the simultaneous equations model used to analyze some important issues related to

the progress of the reform process in the public health system.

Model assumptions

For the simultaneous equations model used to analyze the process of reform of the public health system will take into account of a series of working hypotheses, defined as follows.

Hypothesis 1. The perception of the reform by the medical staff with higher education in the public health system is viewed from the perspective of the following aspects: quality system of funding public health system, measures taken to reform the medical institutions, the quality of the decentralization of the health system, the characteristics of the medicines procurement system and the quality of employment and promotion of staff in the public health system.

Hypothesis 2. The reform process in the public health system will determine, in an average time horizon, changes in national policy of public health system viewed from the perspective of increasing the volume of public expenditure for health, the policy of national programs carried out by the health ministry and the increase of the transparency in the usage of public funds for compensate and free drugs in the primary medicine.

Hypothesis 3. The reform process should support measures increasing the public health education to prevent illness and aggravation of a disease.

Hypothesis 4. The results of the reform process are perceived by reducing the level of the corruption in the public health system.

Hypothesis 5. The process of reform should be transparent.

Hypothesis 6. Statistical data used to estimate the model parameters are obtained from the application of a questionnaire to statistical medical personnel sample.

Model equations

The models equations are defined using the above assumptions and the structure of the questionnaire applied to medical personnel.

The first equation describes the quality of reform in the public health system (RSS) depending on various characteristics which are grouped as follows: characteristics of the functioning of the institutions, such as the quality of the factors affecting the achievement of a quality medical act (CF) and the assessment of the institution and employees (CSE); ministry transparency in making decisions related to the progress of the reform process (TMS); ministry politics in the field (PDS); health education of the population (ESP); personal characteristics of the person interviewed, including the gender, age and category of medical staff. Personal characteristics are defined on the basis of variable vector VP. We define the first equation as follows:

$$RSS = f_1(CF, CSE, TMS, PDS, ESP, VP) + \varepsilon_1 \quad (1)$$

The ε_1 variable is uncorrelated with explanatory variables in the regression model, being homoscedastic. The f_1 function is a linear combination of explanatory variables. Under these conditions the regression model used to analyze the quality of the process of reform in the public health system is defined as follows:

$$RSS_i = a_0 + a_1 \times CF_i + a_2 \times CSE_i + \\ + a_3 \times TMS_i + a_4 \times PDS + a_5 \times ESP_i + \\ + a_7 \times VP + \varepsilon_{1i} \quad (2)$$

where a_7 is a line vector with the three elements, and VP is a column vector with three elements.

The second equation estimates the role played by different factors in increasing the transparency of decisions in the public health system (TMS). Moreover, the increase of the decisions transparency plays an important role in the progress of the reform process. The second equation of the model analyzes the influence of some factors in the public health decisions on transparency in the system. The following factors are taken into consideration: factors related to ministry policy in the field (PDS); the quality of the reform process (RSS); the level of corruption at the national level (COR); a series of personal characteristics of the person, such as the gender, age and category of staff (VP). The second equation is:

$$TMS = f_2(PDS, RSS, COR, VP) + \varepsilon_2 \quad (3)$$

The ε_2 variable is uncorrelated with explanatory variables in the regression model, being homoscedastic. The f_2 function is defined as a linear combination of explanatory variables. The regression model for the analysis of the quality of the reform process in the public health system is defined based on the relationship below:

$$TMS_i = b_0 + b_1 \times PDS_i + b_2 \times RSS_i + \\ + b_3 \times COR_i + b_4 \times VP + \varepsilon_{2i} \quad (4)$$

where b_4 is a line vector with the three elements, and VP is a column vector column with three elements.

The third equation estimates the influence of some factors from the public health system in increasing health education of the population. In defining this equation we start from the fact that optimizing the costs of health is not possible without direct participation of the beneficiary who is the citizen. Under these conditions, to obtain positive results and a sustainable development a national strategy is necessary to ensure public health education to prevent illness and aggravation of a disease, to request a new medical check at the end of medical treatment, etc.

This equation examines the health education of the population (ESP) depending on various factors, such as factors related to direct the behavior of patients, including a number of variables, such as the frequency of the application of a new medical control at the end of a period of treatment (PCS) and the extent to which people give sufficient importance to their health (PAC); factors related to the accessibility of the citizens to the primary, secondary and tertiary health care (ACS); factors related to decisions of the management of the Ministry of Health regarding education programs for the health of the population: the contribution of institutions such as Ministry of Health, Ministry of Education, medical units, the mass-media, to the development of the health education and prevention of illnesses among the population (DPE); the usefulness of the development of health education and prevention programs among the population (UDP). The third equation is:

$$ESP = f_3(PCS, PAC, ACS, DPE, UDP) + \\ + \varepsilon_3 \quad (5)$$

The ε_3 variable is uncorrelated with explanatory variables in the regression model, being homoscedastic. The f_3 function is defined as a linear combination of explanatory variables. The regression model for the analysis of the quality of the reform process in the public health system is defined based on the relationship below:

$$\begin{aligned} ESP_i &= c_0 + c_1 \times PCS_i + c_2 \times PAC_i + \\ &+ c_3 \times ACS_i + c_4 \times DPE + \\ &+ c_5 \times UDP + \varepsilon_{3i} \end{aligned} \quad (6)$$

The fourth equation. The corruption and nonacademic behavior from the public system, in general, and in the public health system, in particular, have an important contribution in the implementation of the reform process in the system and in the improving the quality of the medical act. This equation estimates the contribution of some factors in reducing the corruption (COR), such as the features of the reform process (RSS); the system for evaluating the quality of services (CSE); the transparency of the decisions, the accessibility of citizens to health care (TMS); changing based on the political criteria of the management personnel (SCP); the satisfaction level of the medical personnel (GSM); personal characteristics of the interviewed person (VP). The fourth equation is:

$$\begin{aligned} COR &= f_4(RSS, CSE, TMS, SCP, GSM, VP) + \\ &+ \varepsilon_4 \end{aligned} \quad (7)$$

The variable ε_4 is uncorrelated with explanatory variables in the regression model, being homoscedastic. The f_3 function is defined as a linear combination of explanatory variables. In these circumstances, the regression model is defined as:

$$\begin{aligned} COR_i &= d_0 + d_1 \times RSS_i + d_2 \times CSE_i + \\ &+ d_3 \times TMS_i + d_4 \times SCP + d_5 \times GSM + \\ &+ d_6 \times VP + \varepsilon_{4i} \end{aligned} \quad (8)$$

d_6 is a line vector with three parameters and VP is a column vector for the three variables used to evaluate certain personal characteristics.

3. Simultaneous equations model for the reform process

The general form

The simultaneous equations model is defined is the structural form as follows:

$$B \times y_i + C \times x_i = \varepsilon_i \quad (9)$$

where residuum vector has a normal repartition $\varepsilon_i \to N(0, \Omega), i = 1,..., G,$ and Ω matrix is defined as:

$$\Omega = \begin{bmatrix} \sigma_{11} \sigma_{12} \cdots \sigma_{1G} \\ \sigma_{21} \sigma_{22} \cdots \sigma_{2G} \\ \cdots \cdots \cdots \cdots \\ \sigma_{G1} \sigma_{G2} \cdots \sigma_{GG} \end{bmatrix}$$

The equations defined in our model rises a number of important issues from the public health system:

- quality of the reform of the system and its implications on the quality of medical services offered to citizens;
- the government policy in the health system and its implications on the development on medium and long term of the system;
- the level of the health education of the population in the prevention of illness and aggravation of a disease;

- the level of the nonacademic behavior in the public health system and its implications on the progress of the reform process and the quality of medical services offered to citizens.

For the estimates of the model parameters we used series of data form a statistical sample. The features of this sample are presented in the following.

Data sample

For data collection we used a two stage poll. The first stage was represented by public health units from Bucharest (hospitals, health centers, polyclinics) which were treated as primary sampling units. The second stage was represented by doctors in each primary sampling unit.

The representative sample from Bucharest consisted in 407 people, and the survey results are guaranteed with a 95% probability in circumstances where there is an error of representativeness of ± 2.5%.

The sample was divided in three categories of staff, as family doctors - 75, doctors in hospitals - 279 and doctors in polyclinics - 53.

The period of recording the information in the sample was about two weeks, these weeks being in June 2007. Thus the comparability of such responses from the individuals included in the sample was ensured, meaning that during this period there were not taken any major decisions at the Ministry of Health to change the opinion of respondents, while most people were present at the workplace.

During the research we designed a questionnaire which was structured according to eight themes presentation in Table 1. For each theme of the analysis the number of primary variables is specified in the table below. Based on the 52 questions in the questionnaire, of which 49 have been closed, were set 177 primary variables. Using primary characteristics a series of aggregated characteristics have been defined to be used in the simultaneous equations model.

Primary and aggregated variables grouped on themes

Table 1

No.	The theme	The number of primary variables	The number of aggregated variables
1.	General issues concerning the reform of the public health system	41	14
2.	Ministry policy in this area	18	5
3.	Health education of the population	18	4
4.	The analysis of the nonacademic behavior	24	7
5.	The research capacity of the public health system	24	2
6.	Characteristics of current activities	6	2
7.	Personal aspects	32	1
8.	General data	14	-
9.	Total	177	35

For questions definition of the questionnaire we took into account to the following issues: the reform measures undertaken by the ministry on health reform, the European models used in the field of performance analysis for public health systems; application of the questionnaire developed in a first form at a pilot stage; the definition of the responses to closed questions on the basis of scale of measurement correctly specified. Table 2 gives the variables used in the model.

Synthetic description of the aggregated variables used for the simultaneous equations model

Table 2

No.	Code	Aggreagted variable description	Primary variable number
1.	*RSS*	The variable is defined to measure the medical staff opinion on the quality of reform in the public health viewed from the perspective of six components: system funding, procurement of medicines, the process of decentralization, the employment and promotion of staff with medium and higher medical studies and reform measures applied to the units in which they are employed. Range of values: 1 - very poor, 2, 3, 4, 5-very good.	6
2.	*CF*	Measures the quality of the factors that contribute to a good quality medical act in the public health units. Range of values: 1-very poor, 2, 3, 4, 5 - very good.	5
3.	*CSE*	Estimates the quality of the assessment system of health services provided to beneficiaries. Range of values: 1 - unsatisfactory, 2, 3, 4 - very good.	3
4.	*TMS*	It is an aggregate variable used to estimate the ministry transparency in decision-making in the reform process. Range of values: 1 - unsatisfactory, 2, 3, 4 - very good.	2
5.	*PDS*	Aggregated variable used to asses the quality of government policy in the field of public health from the perspective of the volume of public expenditure health, the quality of national health programs run by the ministry and the transparency of funds usage for compensated and free medicines in primary medicine. Range of values: 1 - unsatisfactory, 2, 3, 4 - very good.	3
6.	*ESP*	Aggregated variable used to measure the level of public health education to prevent illness and aggravation of a disease. Range of values: 1 - most people do not give importance to prevent the occurrence or aggravation of a disease, 2, 3, 4, 5 - most of the people give importance to this.	2
7.	*COR*	Aggregated variable used to measure the level of corruption at the national level in the opinion of medical staff with higher education. Range of values: 1 - there is no corruption, 2, 3, 4, 5 - there is generalized corruption.	5
8.	*PCS*	Quantifies to what extent patients who have followed a treatment requires a new specialized consulting. Range of values: 1 - a small part of them, 2, 3, 4, 5 - with few exceptions, all patients.	2
9.	*PAC*	Variable used for an overall assessment of the extent to which people give sufficient importance to their health. Range of values: 1 - do not give sufficient importance to their health, 2, 3, 4, 5 - give great importance to health.	2
10.	*ACS*	Quantifies what is the degree of accessibility of the citizen primary, secondary and tertiary health care. Range of values:1- reduced accessibility, 2, 3, 4, 5 – high degree of accessibility.	3
11.	*DPE*	Aggregated variable used for an overall assessment of the contribution of public institutions to develop programs of health education and prevention of illnesses among the population. Range of values: 1 - unsatisfactory, 2, 3, 4 - very good.	4
12.	*UDP*	Primary variable used to assess the usefulness of health education programs and prevention among the population. Range of values: 1 - are not useful, 2, 3, 4, 5 - are very useful.	1
13.	*SCP*	Primary variable used to assess to what extent the political change of management personnel on political criteria. Range of values: 1 – changes in the leadership have not been made based on political changes, 2, 3, 4 - changing the technical staff on political criteria of is a practice.	1
14.	*GSM*	Aggregated variable defined to assess the satisfaction degree of the medical personnel. Range of values: 1 - are not happy at all, 2, 3, 4, 5 - fully satisfied.	5

The models' equations and variables

Taking into account the manner of the definition of each variable and the series of data available we define the equations of the simultaneous equations model as:

1. Regression models' equations:

$$\begin{cases} RSS_i = c(1) + c(2)\times CF_i + c(3)\times CSE_i + c(4)\times TMS_i + c(5)\times PDS + c(6)\times ESP_i + \\ \qquad c(7)\times GEN_i + c(8)\times ANI_i + c(9)\times PER_i + \varepsilon_{1i} \\ TMS_i = c(10) + c(11)\times PDS_i + c(12)\times RSS_i + c(13)\times COR_i + \\ \qquad c(14)\times GEN_i + c(15)\times ANI_i + C(16)\times PER_i + \varepsilon_{2i} \\ ESP_i = c(17) + c(18)\times PCS_i + c(19)\times PAC_i + c(20)\times ACS_i + c(21)\times DPE + \\ \qquad c(22)\times UDP + \varepsilon_{3i} \\ COR_i = c(23) + c(24)\times RSS_i + c(25)\times CSE_i + c(26)\times TMS_i + c(27)\times SCP + \\ \qquad c(28)\times GSM + c(29)\times GEN_i + c(30)\times ANI_i + c(31)\times PER_i + \varepsilon_{4i} \end{cases} \quad (10)$$

In the above model, GEN is a variable for the gender of the person, ANI for the age of the person and PER for the category of staff. All other variables are presented in Table 2.

2. The four residual variables satisfy the assumptions made for the structural form of simultaneous equations model.

3. The variables of the simultaneous equations model are divided into endogenous and exogenous, according to table 3.

Endogenous and exogenous variables of the simultaneous equations model

Table 3

Endogenous variables	Exogenous variables
RSS, TMS, ESP, COR	CF, CSE, PDS, GEN, ANI, PER, PCS, PAC, ACS, DPE, UDP, SCP, GSM, CSE

Hausman test

If the estimates of the models parameters is made using the two stage least squares method, the list of instrumental variables plays a unique role. In these circumstances the analysis of the exogenousness of the models' variables represents an important step. An important tool in this approach is the Hausman test (Hausman, 1978). The aim of this test is to verify the effectiveness and consistency of the estimators. In this sense there are defined the following two assumptions.

The first is the case when the list of instrumental variables is properly specified. The estimators for the parameter obtained by OLS, denoted by $\hat{\beta}_0$, is efficient and consistent. In this case the explanatory variables in the regression model $y = X \times \beta + u$ are not correlated with residual variables, so that $H_0: \text{cov}(u, X) = 0.$

In the second case, the list of instrumental variables is not properly specified. The estimator for the parameter β obtained by OLS, denoted by $\hat{\beta}_1$, is effective and inconsistent. Residual variables are correlated with one or more explanatory variables, so that $H_1: \text{cov}(u, X) \neq 0.$

The difference between the two estimators is $\hat{d} = \hat{\beta}_1 - \hat{\beta}_0$ and the Hausman test statistics is:

$$H = \hat{d}'(\text{var}(\hat{\beta}_1) - \text{var}(\hat{\beta}_0))^{-1}\hat{d} \rightarrow \chi^2(r) \quad (11)$$

where r is the number of the endogenous variables from the list of the explicative variables, thus of the variables $X_i, i = 1,...,r$ that satisfies $\text{cov}(u, X_i) \neq 0.$

If the statistics is greater than a predefined value, then null hypothesis is rejected, considering that in this case the second estimator gives more appropriate results.

4. Parameter estimates

We present in the following parameters estimates for the above defined simultaneous equations model obtained by EVIEWS procedures. By applying Hausman test we compare the results for the simultaneous equations model for cases in which the parameters are estimated by the least squares method (OLS) and the two stages least square method (TSLS).

RSS equation

Any reform is a complex and lengthy process. At the system level there are a number of factors acting to carry out in good conditions, but there are a number of other factors that reduce the effectiveness of measures to reform the system. To analyze the characteristics of the reform process we

propose a regression model without free term, with eight-explanatory variables. Parameters estimates are achieved through the least squares method (the results are presented in Table 4), in which case it is considered that all explanatory variables are exogenous, and the two stages least squares method, in which a series of explanatory variables are likely to be endogenous nature. To compare if the results are significant different between the two approaches we recourse to the Hausman test.

Regression model (2) features

Table 4

Dependant variable: *RSS*			
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the significance threshold**
CF	0.309	0.035	8.784 (0.000)
CSE	0.017	0.042	0.406 (0.635)
TMS	0.041	0.040	1.010 (0.313)
PDS	0.393	0.058	6.746 (0.000)
ESP	0.141	0.035	4.024 (0.000)
GEN	- 0.027	0.050	0.539 (0.590)
ANI	0.047	0.023	2.074 (0.039)
PER	- 0.042	0.026	1.649 (0.100)

The results from the above table emphasize the existence of three categories of explanatory variables included in the model:

(1) First there are the variables that explain with certainty the quality of the process of reform in the public health system. Here there are included here are: the quality of the factors that compete to achieve a good quality medical act – CF, the quality of government policy in the public health system – PDS, the quality of the assessment system of the health services – ESP, the age of person interviewed – ANI.

(2) The second category includes a number of variables that are likely to explain RSS. We include here the transparency of the decisions in the health system – TMS and the category of medical staff – PER.

(3) The third category is represented by variables that can not explain this structure of the RSS model. We include here the gender of the interviewed person – GEN and the quality of the evaluation system of health services provided to beneficiaries – CSE.

The results from the application of the two methods to the situation in which the RSS is explained in terms of explanatory variables CF, PDS, ESP, ANI and TMS are presented in Table 5.

***RSS* regression model on the following variables: CF, PDS, ESP, TMS and ANI**

Table 5

Dependant variable: *RSS*				
Source model characteristics	Square sum	Degrees of freedom	Observations number	407
Regressors	1897.9	5	F	1296.9
Residuum	117.7	402	Prob>F	0.000
Total	2015.6	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and level of significance**	
CF	0.336	0.029	11.490 (0.000)	
PDS	0.407	0.058	7.051 (0.000)	
ESP	0.170	0.033	5.208 (0.000)	
ANI	0.055	0.022	2.470 (0.014)	
TMS	0.045	0.040	1.112 (0.260)	

After applying the method of the two stages least squares to estimate the parameters of regression model we obtained the results below.

***RSS* regression model on the following variables: CF, PDS, ESP, TMS and ANI**

Table 6

Dependant variable: *RSS*				
Source model characteristics	Square sum	Degrees of freedom	Observations number	407
Regressors	1871.4	5	F	11120.5
Residuum	134.3	402	Prob>F	0.000
Total	2005.7	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
CF	0.463	0.136	3.408 (0.001)	
PDS	0.549	0.299	1.836 (0.067)	
ESP	0.178	0.070	2.536 (0.012)	
ANI	-0.094	0.128	-0.736 (0.462)	
TMS	-0.058	0.102	-0.572 (0.568)	
Instrumental variables list	CF. CSE. PDS. ANI. PER. PCS. PAC. ACS. DPE. UDP. SCP. GSM. CSE. COR. FLC. RCO. GSM. FMM			

To determine if there are significant differences between the two results we applied the Hausman statistics test based on equation (11). Hausman statistics test value equal to 25.8 shows that there are significant differences between the two categories of estimates. In these circumstances, the results presented in Table 6 are validated.

TMS equation

Ensuring transparency in carrying out decisions during the reform process in any field of activity is an important factor for its success. To analyze the transparency of the health system we take into consideration factors related to characteristics of the reform process, the quality of government policy on health, the level of corruption and nonacademic behavior inside the system, and personal characteristics such as age, staff category, etc. We present in the table below the results from the OLS estimates of the parameters model used for analyzing TMS variable:

Regression model (4) characteristics

Table 7

Dependant variable: *TMS*			
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the significance threshold**
PDS	0.758	0.067	11.359 (0.000)
RSS	0.131	0.053	2.468 (0.014)
COR	0.045	0.032	1.412 (0.159)
GEN	0.043	0.066	0.645 (0.520)
ANI	0.018	0.028	0.623 (0.533)
PER	0.013	0.033	0.396 (0.692)

These results shows three categories of factors:

(1) First there are the variables which certainly explain the transparency of decisions in the public health. We include here the quality of government policy in health system – *PDS* and the quality of reform in the public health – *RSS*.

(2) The second category includes a variable *COR* – corruption in the system,

which is likely to be included in the model with a large extent.

(3) In the third category we include a number of variables which does not explain the transparency of decisions on the system. In this category there are personal characteristics of the medical staff included in the sample: the gender of the interviewed person – *GEN*, the age of the person – *ANI* and the category of the staff – *PER*.

The second regression model is defined solely on the basis of the explanatory variables of the first and second categories of variables defined above. In the table below we show the characteristics of this model for the case when the parameters estimates are achieved through the least squares.

***TMS* regression model depending on PDS, RSS and COR**

Table 8

Dependant variable: *TMS*				
Source model characteristics	Squares sum	Degrees of freedom	Observations number	407
Regressors	1131.4	3	F	563.86
Residuum	270.2	404	Prob>F	0.000
Total	1401.6	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
PDS	0.764	0.066	11.562 (0.002)	
RSS	0.160	0.047	3.395 (0.001)	
COR	0.068	0.024	2.896 (0.004)	

After applying the two stage least squares method to estimate the parameters of regression model to obtain the results below.

***TMS* regression model depending on PDS, RSS and COR**

Table 9

Dependant variable: *TMS*				
Source model characteristics	Squares sum	Degrees of freedom	Observations number	407
Regressors	1131.4	3	F	563.86
Residuum	270.2	404	Prob>F	0.000
Total	1401.6	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
PDS	1.672	0.537	3.111 (0.0020)	
RSS	-0.372	0.383	-0.971 (0.332)	
COR	0.024	0.072	0.332 (0.740)	
Variabile instrumentale				

Using the Hausman test, whose statistics is calculated on the basis of the relationship (11), we determined if the two estimates are significant differences. We mention that the results presented in the last two tables show a number of significant differences. If in the first case all the three variables are significant in defining the model, in the second case we found out that the parameters that correspond to the variables *RSS* and *COR* are not significantly different from zero. Hausman statistics value equal to 5.28 indicates that between the two categories of estimates there are significant differences. These results confirm the endogenous character of the variables *RSS* and *COR*.

ESP equation

An important aspect of increasing the efficiency of using financial, material and human resources in the public health system is to improve the health education of the population. Therefore, in the reform process of the public health system an important issue should be the development of programs that increase health education of the population and illnesses prevention among the population. To analyze the variable used to measure the level of health education of the population we made use of a regression model with a series of explanatory variables that refer to attention given by population to the health (*PAC*), the practice of patients to ask for a new medical investigation at the end a period of treatment (*PCS*), the extent to which different institutions or organizations are involved in developing programs for health education among the population (*DPE*), the accessibility of public healthcare services (*ACS*) and the usefulness of these types of programs (*UDP*).

The table below shows the results from the application of the least squares method to estimate the models' parameters defined above for the analysis of the variable used to measure the level of health education of the population (*ESP*).

ESP regression model characteristics

Table 10

Dependant variable: *ESP*			
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**
PCS	0.084	0.038	2.200 (0.028)
PAC	0.520	0.046	11.188 (0.000)
ACS	0.040	0.035	1.123 (0.262)
DPE	0.204	0.045	4.513 (0.000)
UDP	0.009	0.025	0.373 (0.709)

Results from the table 10 show three categories of explanatory variables included in the model:

(1) First there are the variables that certainly explain the level of health education of the population. Variables included here are CAP, DPE and PCS.

(2) The second category includes a variable that is likely to be included in the model - ACS.

(3) The third category includes the UDP variable that does not explain the health education of the population.

The results obtained by the application of the two methods to the situation in which the ESP is explained in terms of explanatory variables CF, PDS, FSP, ANI and TMS are presented in Table 11.

***ESP* regression model depending on PCS, PAC, ACS and DPE**

Table 11

Dependant variable: *ESP*			
Source model characteristics	Squares sum	Degrees of freedom	Observations number 407
Regressors	1834.2	4	F 1106.3
Residuum	167.0	4032	Prob>F 0.000
Total	2001.2	407	
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**
PCS	0.086	0.038	2.288 (0.023)
PAC	0.523	0.046	11.437 (0.000)
ACS	0.046	0.031	15.467 (0.110)
DPE	0.207	0.044	4.718 (0.000)

After applying the two stages least squares method to estimate the parameters of regression model we obtained the results presented in Table 12.

***ESP* regression model depending on PCS, PAC, ACS and DPE**

Table 12

Dependant variable: *ESP*			
Source model characteristics	Squares sum	Degrees of freedom	Observations number 407
Regressors	1871.4	5	F 11120.5
Residuum	134.3	402	Prob>F 0.000
Total	2005.7	407	
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**
PCS	-0.079	0.123	-0.648 (0.517)
PAC	1.025	0.460	2.228 (0.026)
ACS	-0.132	0.237	-0.557 (0.578)
DPE	0.021	0.137	0.151 (0.880)
Instrumental variables	CF. CSE. PDS. ANI. PER. UDP		

Table 12 shows inconclusive results for this model if the parameters were estimated by the two stages least square.

COR equation

The quality of the reform in the public health system directly affects the nonacademic behavior and the corruption in the system. The existence of mechanisms that generate corruption in the system is a brake on the progress of the reform process. The regression model without the free term presented here evidence a number of factors which directly influence corruption in the system. To define the model we envisaged results from the descriptive analysis of the data series on corruption and intensity factors acting to reduce it. We took into account a number of factors, such as: the defective or incorrectly applied legal framework, the wages of medical personnel that encourage the nonacademic behavior, the pressure from the political and economic environment, the behavior of the patients, etc.

Table 13 shows the results from the application of the least squares method for the estimates of the parameters of the model used to analyze the COR variable which is defined by (8).

Regression model (8) characteristics

Table 13

Dependant variable: *COR*				
Source model characteristics	Squares sum	Degrees of freedom	Observations number	407
Regressors	43917.20	8	F	566.0
Residuum	386.96	399	Prob>F	0.000
Total	4778.16	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
RSS	-0.028	0.079	-0.354 (0.725)	
CSE	0.029	0.071	0.415 (0.679)	
TMS	0.125	0.064	1.939 (0.053)	
SCP	0.186	0.061	3.043 (0.002)	
GSM	0.758	0.091	8.357 (0.000)	
GEN	0.061	0.043	1.418 (0.157)	
ANI	0.155	0.049	3.195 (0.002)	
PER	0.320	0.040	8.021 (0.000)	

The results from Table 13 show three categories of explanatory variables included in the model:

(1) First are the variables TMS, SCP, GSM, ANI and PER whose parameters significantly differ from zero in the regression model defined above.

(2) The second category includes the variable GEN which is likely to be included in the model.

(3) The third category includes variables RSS and CSE whose parameters do not significantly differ from zero in the current regression model.

The results from the application of the two methods to the situation in which the RSS is explained in terms of explanatory variables TMS, SCP, GSM, GEN, ANI, PER are presented in tables 14 and 15.

Regression model *COR* depending on TMS, SCP, GSM, GEN, ANI, PER

Table 14

Dependant variable: *COR*				
Source model characteristics	Squares sum	Degrees of freedom	Observations number	407
Regressors	4390.9	6	F	747.9
Residuum	387.2	401	Prob>F	0.000
Total	4778.1	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
TMS	0.123	0.060	2.040 (0.042)	
SCP	0.320	0.040	8.043 (0.000)	
GSM	0.187	0.053	3.556 (0.000)	
GEN	0.761	0.088	8.615 (0.014)	
ANI	0.060	0.042	1.413 (0.150)	
PER	0.154	0.048	3.188 (0.002)	

After applying the two stages least squares method to estimate the parameters of regression model we obtained the results presented in Table 15.

Regression model COR depending on TMS, SCP, GSM, GEN, ANI, PER

Table 15

Dependant variable: *COR*				
Source model characteristics	Squares sum	Degrees of freedom	Observations number	407
Regressors	4365.8	6	F	243.0
Residuum	1200.7	401	Prob>F	0.000
Total	5566.5	407		
Explanatory variables	**Coefficient**	**Standard deviation**	**T-student statistics and the level of significance**	
TMS	0.369	0.253	1.459 (0.001)	
SCP	0.612	0.235	2.607 (0.009)	
GSM	0.384	0.313	1.226 (0.221)	
GEN	1.802	1.037	1.738 (0.083)	
ANI	-1.085	0.477	-2.272 (0.024)	
PER	0.062	0.469	-0.132 (0.895)	
Instrumental variables list	RSS. CF. CSE. PDS. ESP. PCS. DPE. FMM. ACS			

To determine if the two results are significant different we calculated the Hausman statistics test on the basis of the relation (11). Hausman statistics value equal to 9.86 indicates that between the two categories of estimates there are significant differences.

5. Conclusions

Starting from a set of assumptions, we define the equations of the simultaneous equations model used to analyze some important issues related to the progress of the reform process in the public health system.

The equations defined in our model rises a number of important issues from the public health system:

- quality of the reform of the system and its implications on the quality of medical services offered to citizens;
- the government policy in the health system and its implications on the development on medium and long term of the system;
- the level of the health education of the population in the prevention of illness and aggravation of a disease;
- the level of the nonacademic behavior in the public health system and its implications on the progress of the reform process and the quality of medical services offered to citizens.

By applying Hausman test we compare the results for the simultaneous equations model for cases in which the parameters are estimated by the least squares method (OLS) and the two stages least square method (TSLS).

For the first equation, that describes the quality of the reform process, the Hausman statistics test value equal to 25.8 shows that there are significant differences between the two categories of estimates. In these circumstances, the results presented in Table 6 are validated.

For the second equation, the one that describes the transparency of the decisions in the reform process, after we estimated the parameters using OLS and TSLS we computed the Hausman statistics test value which is equal to 5.28. The results indicate that between the two categories of estimates there are significant differences.

These results confirm the endogenous character of the variables *RSS* and *COR*.

To analyze the variable used to measure the level of health education of the population we made use of a regression model with a series of explanatory variables that refer to attention given by population to the health (*PAC*), the practice of patients to ask for a new medical investigation at the end a period of treatment (*PCS*), the extent to which different institutions or organizations are involved in developing programs for health education among the population (*DPE*), the accessibility of public healthcare services (*ACS*) and the usefulness of these types of programs (*UDP*). The results obtained in this case shows inconclusive results for this model if the parameters were estimated by the two stages least square.

To define the equation describing corruption and nonacademic behavior influence we envisaged results from a descriptive analysis of data series on corruption and intensity factors acting to reduce it. In this case too, we estimated the parameters by OLS and TSLS methods and Hausman test statistics calculated on the basis relation (11). Hausman statistics value equal to 9.86, indicates that between the two categories of estimates there are significant differences.

References

Alesina, A., Perotti, R., „The Politics of Economic Growth", *Harvard University, Cambridge, Working Paper, n⁰ 4341*, 1993, Cambridge

Andrei, T., Bourbonnais, R. (2008). *Econometrie*, Editura Economică, București

Andrei, T., Matei, A., Roșca, I. Gh. (2008). *Corupția. O analiză economică și socială*, Editura Economică, București

Baltagi, B.H. (2008). *Econometrics*, 4th Edition, Springer

Bardhan, P., „Corruption and Development: A Review of Issues", *Journal of Economic Literature*, Vol.35, n⁰ 3, 1997

Emerson, M., P., „Corruption and industrial dualism in less developed countries", *The Journal of International Trade & Economic Development*, 2002, pp. 63-76

Gupta, S., Luiz de Mello, Sharan, R., „Corruption and Military Spending", *European Journal of Political Economy*, vol. 17, 2001, pp. 749-777

Hausman, J., „Specific Tests in Econometrics", *Econometrica*, 46, 1978

Lambsdorff, J. G., „Transparency International Corruption Index. Responding to the Challenges of Corruption", *Act of the International Conference*, Milan, 19-20 November 1999, pp. 257-277

McCabe, D.L, Trevino, L.K., „Individual and contextual influences of academic dishonesty", *Research in Higher Education*, 38, 1997, pp. 379-353

McCabe, D.L., Trevino, L.K., „Academic dishonesty: Honor codes and other contextual influences", *Journal of Higher Education*, 65, 1993, pp. 520-538

Mauro, P., „Corruption and Growth", *Quarterly Journal of Economics*, Vol. 110, n⁰ 3, 1995

Mauro, P., „La corruption: causes, conséquences et recommendations", *Finance et developpement*, volume 35, nº 1, mars, 1998

Pulvers, K., Diekhoff, G.M. „The relationship between academic dishonesty and college classroom environment", *Research in Higher Education*, 40, 1999, pp. 487-498

Rumyantseva, N. L., „Taxonomy of Corruption in Higher Education", *Peabody Journal of Education*, 80(1), 2005, pp. 81-92

Rumyantseva, N. L. „Higher Education in Kazakhstan: The Issue of Corruption." *International Higher Education*, 37, 2004, pp. 24-25

Schleifer, A., Vishny, R., „Corruption", *Quarterly Journal of Economics*, 59, 1993, pp. 599-617

Teodorescu, D., Andrei, T., „Faculty and peer influences on academic integrity: college cheating in Romania", *Higher Education*, accepted, to be published, 2009