The automatic stabilizer of the fiscal revenue in Romania

Theaching assistant, PhD Candidate Saierli Olivia Anne-Marie
Lecturer, PhD Candidate Şerban (Boiceanu) Corina
Tibiscus University Timişoara, Romania

Abstract:

As the macroeconomic literature on automatic stabilization tends to focus on taxes we want to study the relationship between GDP and fiscal revenue for Romania during 1990-2008 using a simple linear regression model. First we determine the parameters of the model, and then we establish the intensity of the correlation model using some of the indices of regression. In the last part of this paper we verify the linear model considered statistically by using the Helmert test, Durbin-Watson test, Student test and Fisher test.

Key words: fiscal revenue, G.D.P, automatic stabilizers, regression model, indices of correlation

1. Introduction

The close bond between the level of GDP and fiscal revenues has been studied a lot in economic literature, but, in this paper, we want to determine an empirical relationship expressing the specific form of this bond for Romania. Although the study covers a short period of time for the econometrics computation, it is very important in terms of socio-economic changes that occurred in our country, hoping to provide important information for future estimation of this correlation to help a better planning of public finances in Romania.

We try to elaborate the model starting from the GDP structure which is expressed by the production of a country (Y):

$$Y = C + I + G$$

where:

- I represents the private investment,
- G represents the public expenditure
- C represents the private consumption and can be decomposed into a fixed part b and a

willingness to use depended and the disposable income after tax collection $Y_d = Y - T$:

$$C = b + c \cdot (Y - T).$$

We obtain the structure of GDP expressed by elements of budgetary balance (*G*), public expenditure (*T*) , public revenues from taxes and fees and the level of private investment (*I*) :

$$Y = \frac{1}{1+c} \cdot (b - c \cdot T + I + G).$$

Because the macroeconomic literature on automatic stabilization tends to focus on taxes, we consider the public expenditure and other investments to be constant and we will obtain a simplified model.

So, we will try to establish a correlation between GDP and fiscal revenues.

2. The regression analysis

In this paper, the economic data used in modeling are taken from the IMF Country report- Romania 2006, 2009, and they have been recalculated.

We will try to establish a correlation between G.D.P and fiscal revenues.

We can observe from figure 1.1. that when the fiscal revenues increase, then the GDP increases too and backward. Therefore, we can find a regression model to characterize the bond between the two variables.

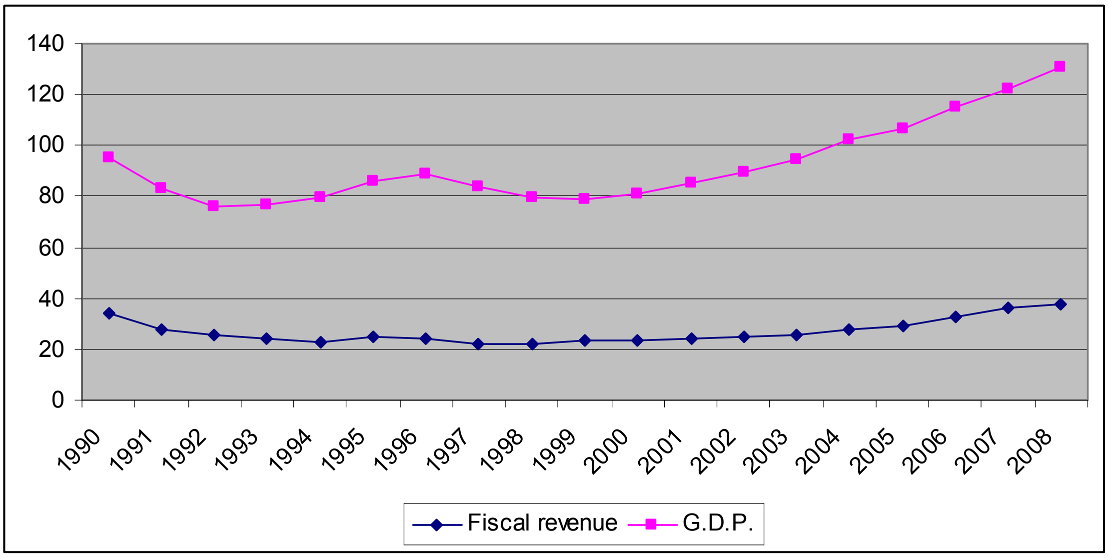

Figure 1.1. The evolution of fiscal revenues and G.D.P from 1990 – 2008

To choose the correct regression function, first we performed the *correlogram* or the *correlation plot* based on a rectangular coordinate system. On the abscissa there are the values of fiscal revenues, and on the ordered the values of GDP. So that, based on the correlogram, we use a linear model to study this economic phenomenon (see fig. 1.2.).

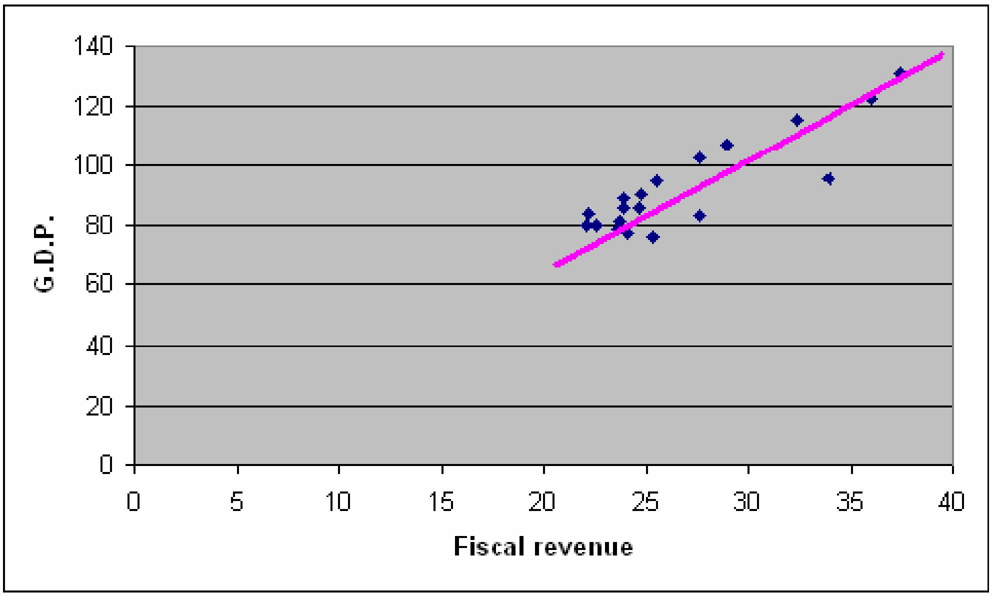

Figure 1.2. The correlogram of the study model

The linear regression model is given by the formula:

$$y_i = a + b \cdot x_i + \varepsilon_i,\ i = \overline{1,n},$$

where x represents the exogenous variable, y represents the endogenous variable and ε represents the residual variable.

Next, we want to estimate the parameters of the linear regression model. For that we use *ordinary least squares method*, which obtains parameter estimates that minimize the sum of squared residuals $\sum_{i=1}^{n} \varepsilon_i^2 = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$ (where $\hat{y}_i$ represents the estimate values of the endogenous variable). Thus, we resolve the linear system:

$$\begin{cases} n \cdot \hat{a} + \hat{b} \cdot \sum_{i=1}^{n} x_i = \sum_{i=1}^{n} y_i \\ \hat{a} \sum_{i=1}^{n} x_i + \hat{b} \cdot \sum_{i=1}^{n} x_i^2 = \sum_{i=1}^{n} x_i \cdot y_i \end{cases}$$

and we obtain the parameter estimates $\hat{a} = 11.57752$, $\hat{b} = 3.010754$.

Interpretation of parameters

The parameter $\hat{a} = 11.57752$ represents the value of the GDP if the result is not influenced by the fiscal revenues (i.e. $x = 0$).

The parameter $\hat{b} = 3.010754$, called the *regression coefficient*, represents the slope of the regression straight-line, that is, if the fiscal revenues increase by a million RON then the G.D.P increases by a harsh 3 million RON.

3. The correlation analysis of quantitative variables

To characterize the intensity of the statistical bound for the linear model considered, we compute the following *indices of correlation*:

a) *The linear correlation coefficient* is given by

$$r_{xy} = \frac{n \cdot \sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{\sqrt{\left[n \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x\right)^2\right] \cdot \left[n \sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right]}} = 0.883443.$$

Because $0.75 \leq r_{xy} = 0.883443 \leq 0.95$, then there is a strong bond between the fiscal revenues and the GDP. Furthermore, the sign of the linear correlation coefficient indicates that between the two variables there is a direct bond (that we have already seen in figure 1.1.).

b) *The coefficient of determination* is given by $R = r_{xy}^2 = 0.780472$.

This means that 78.05% of GDP variations are due to variation in fiscal revenues, the remaining 21.95% are the effect of non-essential or uncontrollable factors.

c) *The correlation ratio* is given by $R_{xy} = \sqrt{1 - \frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}}$.

In this case (the case of simple linear correlation model), the correlation ratio is equal to the correlation coefficient module, i.e. $R_{xy} = |r_{xy}|$

In conclusion, between the GDP and the fiscal revenues there exists a strong and direct linear bond.

4. The statistical verification of the linear model considered

A first verification consists in determining and interpreting ***the standard errors generated by the model***. Standard errors are deviations of estimated values from actual values. They are:

- *Standard error of the model*, given by $s_\varepsilon = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-2}} = 7.761458$.

Because the standard error of the model is less than each value of the real variable y (i.e. less than each value of GDP), then the model approximates correctly the studied economic reality.

- *Standard errors of the model parameters*, given by

$$s_a = s_\varepsilon \cdot \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n \cdot \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}} = 10.55144, \quad s_b = s_\varepsilon \cdot \sqrt{\frac{n}{n \cdot \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}} = 0.387273$$

Because $s_a = 10.55144 < |\hat{a}| = 11.57752$ and $s_b = 0.387273 << |\hat{b}| = 3.010754$, then the estimated values of the parameters are approaching their real values.

For the model to be correctly done statistically, it has to check the condition of normality of the residual variable ε, which is present in the initial hypothesis formulation. It can be checked using several tests, but the most commonly used is the ***Helmert test*** (χ^2).

Thus, we formulate the null hypothesis under which the residual variable is normally distributed and we determine the computed value of the test as $\chi_c^2 = 77.5578827$. From the statistical tables relating χ^2 test for a confidence level of 99 %(i.e. $\alpha = 0.01$) and for $n-1=18$ degrees of freedom we determined its critical value as $\chi_t^2 = 36.191$. As $\chi_c^2 > \chi_t^2$ we conclude that the null hypothesis is rejected and the residual variable is not normally distributed. In this situation we need to make some correction of the model, either in the sense of introducing other factors of influence in the model (which is true because GDP is influenced not only by fiscal revenues) or to increase the volume of data that is analyzed (i.e. values considering GDP and fiscal revenues before 1990).

Another hypothesis that can be checked is the autocorrelation of the residual variable. This test is done using the ***Durbin-Watson test***.

Thus, we formulate the null hypothesis under which the residual variable is auto correlative and we determine the computed value of Durbin-Watson test as

$$d = \frac{\sum_{i=2}^{n}(\varepsilon_i - \varepsilon_{i-1})^2}{\sum_{i=1}^{n}\varepsilon_i^{\,2}} = 0.27166, \text{ where } \varepsilon_i = y_i - \hat{y}_i .$$

From the statistical tables relating Durbin-Watson test for a confidence level of 95% ($\alpha = 0.05$), $n = 19$ and $k = 1$ (where k represent the number of exogenous variables) we determined its critical values as $d_L = 1.18$ and $d_U = 1.40$.

Now, comparing the critical value to the computed one, we observe that $d < d_L$. This means that the hypothesis of auto correlation of the residual variable is accepted and the model should be corrected. We expect such a result based on the conclusions of the Helmert test.

By applying a correction algorithm we obtain the following corrected model:

$$\hat{y}_i = 14.5323 + 3.047841 \cdot x_i, \text{ for } i = \overline{1,n} .$$

To get the model above, first we compute the parameter r which represents the slope of the regression straight-line using the formula:

$$r = \frac{\sum_{i=1}^{n}\varepsilon_i \cdot \varepsilon_{i-1}}{\sum_{i=1}^{n}\varepsilon_i^2} = 0.675939 .$$

The value of r is known and we can adjust the linear regression so that its parameters are efficient. The correction algorithm involves the use of a generalized difference method, leading to a model where the residual variable values are independent one from the other.

To get the parameters for the corrected model, we will apply the method of *ordinary least squares* for the equation:

$$y_i^* = a \cdot (1-r) + b \cdot x_i^* + u_i,$$

where $y_i^* = y_i - r \cdot y_{i-1}$, $x_i^* = x_i - r \cdot x_{i-1}$, $u_i = \varepsilon_i - \varepsilon_{i-1}$.

We can also check if the parameters obtained through the application of the *ordinary least squares method* are consistent using the ***Student test***. We formulate the null hypothesis under which the estimate parameters $\hat{a}, \hat{b}$ are not significantly different from zero and we determine the computed value of Student test as

$$t_a = \frac{|\hat{a}|}{s_a} = 8.138824988,\ t_b = \frac{|\hat{b}|}{s_b} = 8.845659134.$$

From the statistical tables relating Student test for a confidence level of 95% ($\alpha = 0.05$) and for $n-1=18$ degrees of freedom we have determined its critical value as $t_t = 2.445$. Since $t_a, t_b > t_t$ then there is a 95% probability that the null hypothesis is rejected and we can say that the model is statistically correct (i.e. the estimate parameters are significant).

Another way to test the statistical corrected model is the ***Fisher test*** for checking the variation of the endogenous variable. This test establishes the model ability to reconstruct the empirical values of endogenous variables using the estimated values.

We establish the null hypothesis under which the spreading of the estimated values of endogenous variables due to the influence of exogenous variables does not differ significantly from spreading to the same values due to chance. We determinate the computed value of Fisher test as:

$$F_c = \frac{s_{y/x}^2}{s_\varepsilon^2} = 6.320128,$$

where $s_y^2 = \frac{\sum_{i=1}^{n} (y_i - \bar{y})^2}{n-1}$, $s_{y/x}^2 = \frac{\sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2}{n-1}$, $s_\varepsilon^2 = s_y^2 - s_{y/x}^2$.

From the statistical tables relating Fisher test for a confidence level of 95% ($\alpha = 0.05$), for 1 and 18 degrees of freedom we determined its critical value as $F_t = 4.414$. Since $F_c > F_t$ there is a 95% probability that the null hypothesis is rejected and we can say that the fiscal revenues have a significant influence on the GDP

5. Conclusion

Based on the above statistical tests we conclude that the simple linear model proposed in this paper describes with 95% probability the dependency relationship between GDP and fiscal revenues in Romania. However, we have to bear in mind that the model was obtained on a small number of data and took into account only one of the components of GDP (considering the others as a constant factor) and also not taking into account other random factors which in fact may have an important influence on the outcome.

To develop an automatic stabilizer model of the fiscal revenue all factors from the GDP equation should be taken into account, which disrupts the econometric computation.

Our goal was to demonstrate that in Romania, during the development of market economy and EU accession there has been a strong bond between GDP and fiscal revenues as in other EU countries.

Reference

1. Anghelescu C., Badea S. G., Capanu I., Wagner P., *Bazele statisticii teoretice şi economice*, Editura Economică, Bucureşti, 2005;
2. Chilărescu C., Ciocîrlă O., Preda C., Şipoş C., Surulescu N., *Bazele Statisticii. Teoria Probabilităților*, Editura Universității de Vest, Timişara, 2002;
3. Constantin Ghe., Surulescu C., Zaharie D., *Lecții de statistică descriptivă I – III*, Editura Universtității de Vest
4. Fernandes M., *Statistics for Business and Economics, Venus Publishing ApS, 2009;*
5. Pecican E., *Econometrie*, All Edition, Bucureşti, 1994;
6. Pindyck R. S. Rubinfeld ., D. L, *Econometrics Models and Economic Forecasts*, Fourth Edition, McGraw-Hill, 1998;
7. Petruş A., *Introducere în statistica socială*, Editura Paralela 45, Piteşti, 2005;

8. Şipoş C., Preda C., *Statistică Economică*, Editura Mirton, Timişoara, 2004;
9. Stock J. H.,. Watson M. W, *Introduction to Econometrics*, Addison-Wesley, 2003;
10. www.imf.org - IMF Country report- Romania n06/1692006,and nr.09/183 /2009.