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The Binary Choice Approach of Laffer Curve

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Abstract
The paper analyzes empirically, based on "Laffer effects", in Romania's case, the relationship between tax revenues (dependent variable) and tax rates (independent variables). The analysis is based on the construction of a binary choice model (Linear Probit Model) and the data set is covering the period 1999 - 2009 (first trimester), with quarterly frequency.
The main results show that the two "Laffer effects" have a different probability of existence. If the government knows which the maximum probabilities are for each of the two effects, then he can construct a coherent tax policy arrangement that raise or decrease the tax revenues, based on flat or progressive tax systems (the tax evasion is considered to be constant).

Keyword: Tax revenues, Tax rates, Laffer curve, Effects, Probability, Probit analysis

JEL Classification: H21, H71, E62, C35

Introduction

Arthur B. Laffer, in 1974, illustrated the trade off between average tax rates and tax revenues and noted that there are always two tax rates that yield the same revenues (Wanniski, 1978). In this case, the changes in tax rates have two effects on tax revenues (Laffer, 2004). On the one hand, the arithmetic effect (if tax rates are lowered, tax revenues will be lowered by the amount of the decrease in the rate and vice versa) and, on the other hand, the economic effect (lower tax rates have positive impact on work, output or employment and increase these activities). This means that as tax rates grow continuously from zero, tax revenues increase up to some maximum after witch tax revenues fall.

In another point of view, the aggregate relationship between tax rates and tax revenues will depend on tree influences: the existence of taxes which alter the set of profit and utility of maximizing capital and labor cost; tax base depend on the degree of substitution factors owners engage between untaxed home and taxed market sectors; and the progressivity of the tax system (Edgar & McGree, 1983). Moreover, higher tax rates are associated with higher inflation rates and higher nominal interest rates (Mankiw, 1987). The public choice theory offers some evidences of "Laffer effects" in a fiscal bureaucracy optic. In this pure approach, a decrease in tax popularity will be less efficacious in terms of tax revenue (Forte, 1987).

In a tax efficiency approach, if the main objective of a government is to maximize revenues, it should not pay to much attention to this issue; it would do much better trying to make tax system as simple as possible, minimizing both incentives and possibilities for tax evasion and tax avoidance (Walewski, 1999). More, an intense tax effort by increasing the number of returns audited may also reduce net revenues. In consequence, if tax and fine rates positively influence

the level of corruption in the administration, these outcomes become more likely (Sanyal et al., 2000). In such conditions, tax authorities do not exploit their power to tax in full, which is compatible both with revenue maximizing but also fair behavior. Subjects care more for efficiency and restrict the power to tax more than in case their position (taxpayer or tax authority) is fixed in advance (Sutter & Weck-Hannemann, 2003).

Another analysis provides indirect the idea that it is never optimal for a government to operate on the downward-sloping segment of the Laffer curve (Krause, 2007). Very recent studies, argue that the relationship between the tax rate and tax revenues depends on the relevance of the "shame effect" of being detected in a corrupt transaction. In countries with a "low shame" effect, tax revenues grow as the tax rate increases. Moreover, there is a critical tax rate where the growth rate of tax revenues begins to reduce (Cerqueti & Coppier, 2009). Therefore, the researches on the causal relationship's direction between tax revenues and tax rates are conclusive and claim the connections of the same direction and the contrary one.

According to the mentioned premise, the fundamental idea is that Laffer's acquisition represents a complex phenomenon of tax revenues determined by tax rates. This one are two effects: *the arithmetic effect* (if tax rates are lowered, tax revenues will be lowered by the amount of the decrease in the rate and vice versa) and, on the other hand, *the economic effect* (lower tax rates have a positive impact on economic activities and, in consequence, on tax revenues).

To be more precise, our assumptions hypotheses are:

H_1: As tax rates increase continuously from zero, tax revenues grow up to a maximum after which tax revenues fall.

H_2: As tax rates decrease continuously from the maximum level, tax revenues grow up to a maximum after which tax revenues fall.

Summarizing, the meanings of the hypothesis' work relations are:

Table 1

The directions of the hypothesis' work relations

The trend of tax revenues	The determinant factor of tax revenues	The trend of determinant factors of tax revenues
+ (arithmetic effect) and - (economic effect)	Tax rates	+
+ (economic effect) and - (arithmetic effect)	Tax rates	-

Based on these hypotheses, the main idea of the paper is that the two "Laffer effects" have a different probability of existence; which depends on level and dynamic of tax rates.

The paper analyzes empirically, based on "Laffer effects", in Romania's case, the relationship between tax revenues (dependent variable) and tax rates (independent variables). The analysis is based on the construction of a binary choice model (Linear Probit Model) and the data set is covering the period 1999 - 2009 (first trimester), with quarterly frequency.

The rest of the paper is structured as follows: Section 2 contains the data. Section 3 presents the methodology and the empirical results. Section 4 concludes.

Data

The paper analyzes empirically, in Romania's case, the relationship between tax revenues (dependent variable) and tax rates (independent variable). The reason for choosing this country is

the fact that, during the period, Romania presents some eloquent particularities: volatility in budget deficit, radical changes in tax system, tax evasion and alternation in political governance (left-right). The data set is covering the period 1999 - 2009 (first trimester), with quarterly frequency (the data source is Eurostat).

As a novelty, for a good control of variables in the econometric estimation, we created a dummy variable (P), which represents the type of political governance (left or right) and major tax adjustments during the period.

1. The tax revenues (R) represent the absolute volume of tax revenues (direct taxes, indirect taxes and social contributions), without seasonal component, in millions euro (this indicator has been selected in euro to avoid the influence of inflation on tax revenues absolute level).

In our binary choice approach, the R becomes "The probability of tax revenues to increase" (PR):

$$PR = \begin{cases} 1, \ if \ \dfrac{R_n - R_{n-1}}{R_{n-1}} x100 > 0 \\ 0, \ if \ \dfrac{R_n - R_{n-1}}{R_{n-1}} x100 \le 0 \end{cases} \quad (1)$$

where *n* is a period (trimester).

2. The tax rate (T) illustrates the total tax revenues (direct tax, indirect tax and social contribution) as percent of gross domestic product (global tax burden), without seasonal component. For a greater relevance of the model, we have worked in dynamic, with relative variation of tax rates (DT):

$$DT(\%) = \frac{T_n - T_{n-1}}{T_{n-1}} x100 \quad (2)$$

For both of two series, the seasonal component has been corrected with Census X12, additive method. The Augmented Dickey-Fuller and Phillips-Perron tests, presented in Appendix, in Table A1, show that the series DT(%) is stationary.

3. The dummy variable (P) is 0 if the political governance is right orientated (in Romania, from 2005 to present, when is used the flat tax on revenues) and 1 if the political governance is left orientated (until 2005, has been used the progressive taxation of revenues).

The directions between PR, DT and P are as it follows:

Table 2

The expected directions of the relationship between PR, DT and P according to the working hypothesis

PR	The determinant factor of PR	The trend of determinant factor of PR
+ or -	DT	+
- or +	DT	-
+ or -	P	+
- or +	P	-

Methodology and results

The analysis is based on the construction of a binary choice model. For the first time, this type of model has been used in economy in the 1950s. The pioneer binary choice model in economic field treats the analysis of ownership of cars as a function of household income (Farrell, 1954).
In binary chioice estimation, *F(Z)* - the standardized cumulative normal distribution, gives the probability of the event occurring for any value of *Z* (Dougherty, 2007, p.262):

$$p_i = F(Z_i) \tag{3}$$

Maximum likelihood analysis is used to obtain estimates of the parameters. The marginal effect of x_i is $\frac{\delta p}{\delta x_i}$, which is best computed as:

$$\frac{\delta p}{\delta x_i} = \frac{\delta p}{\delta Z} x \frac{\delta Z}{\delta x_i} = f(Z) x \beta_i \tag{4}$$

where x_i represents the independent variables (DT and P) and β_i the independent variables coefficients.
In this case, Z is given by:

$$Z_i = PR_i = a + \beta_1 x DT_i + \beta_2 x P_i + \varepsilon_i \tag{5}$$

where α - the intercept term, ε_i - the disturbance term and *i* - the period of time (trimester).

Table A2, in Appendix, shows that, from three possible types of binary choice model (probit, logit and extreme value), the "probit" form has the lowest values of Akaike and Schwarz criterions. Based on this fact, we have selected the probit model for our approach.
In probit estimation, the marginal effect of *Z* on the probability, noted *f*(*Z*), is given by the derivative of this function with respect to *Z*:

$$f(Z_i) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}Z^2} \tag{6}$$

The marginal effect of any variable is not constant. It depends on the value of *f(Z)*, which in turn depends on the values of each of the explanatory variables. To obtain a summary statistic for the marginal effect, the usual procedure is parallel to that used in logit analysis, based on the mean values of the explanatory variables. Table A3, in Appendix, shows that from 40 included PR observations, 62.5% is 1 (the probability of tax revenues to increase) and 37.5% is 0 (contrary).

The econometric tests of the "Probit model", presented in Table A4, in Appendix, shows that the coefficients are significant at standard levels of confidence, a conclusion reinforced by the low values of the probabilities (exception the intercept term, which has been eliminated). To obtain the robust standard errors, we have used quasi-maximum likelihood method (QML) and quadratic Hill Climbing optimization algorithm.
Based on the model, the prediction values are illustrated in Table A5, in Appendix. The estimated model correctly predicts 80% of the observations (73.33% of the Dep=0 and 84% of the Dep=1

observations). Overall, the estimated equation is 17.5% points better at predicting responses than the constant probability model.

The correlogram of standardized residuals and the correlogram of standardized residuals squared show that there are not autocorrelations or partial correlations of the residuals for all considerate lags (Table A6 and A7, in Appendix). More, the Andrews and Hosmer-Lemeshow Goodness-of-Fit Tests show that the caution in order to interpret the results is minimal (Table A8, in Appendix). In conclusion, the model may be considered stabile and representative to describe, in Romania's case, the connection between PR, DT and P.

The method for identifying the effects of the DT and P on the PR consists in calculating the marginal effects with the mean values of the explanatory variables. The next table shows the marginal effects, calculated by multiplying *f(Z)* with the estimates of the coefficients of the probit regression.

Table 3

The marginal effects of the "Probit Model PR, DT and P"

Variable	Mean	β	Mean × β	f(Z)	β x f(Z)
DT	-0.102	0.261	-0.027	0.3679	0.096
P	0.575	0.746	0.429	0.3679	0.275
Total Z (PG)			0.4024615		

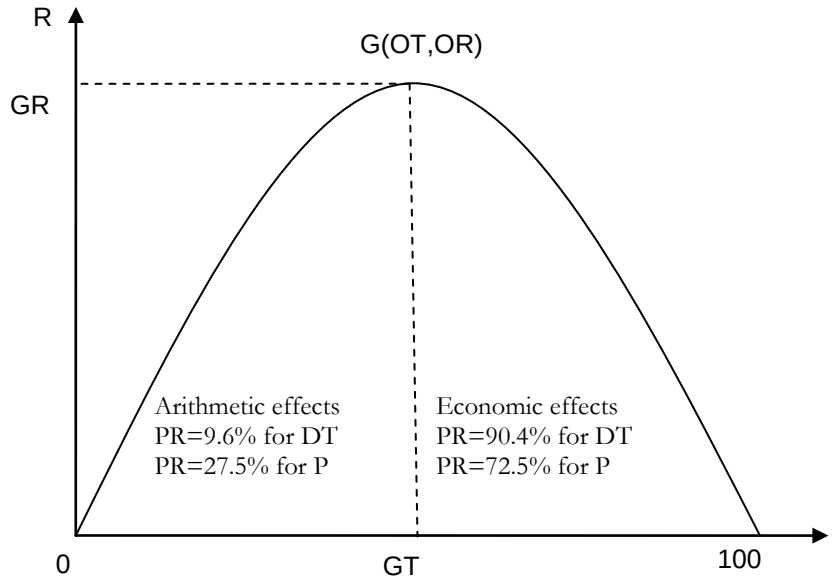
Starting from the marginal effects measured on the "probit model" built, I can identify the following remark: a one-point increase in the DT grows with 9.6% the probability of tax revenues to increase or a one-point decrease in the DT decreases with 9.6% the probability of tax revenues to increase. These facts represent the arithmetic Laffer effect. In other words, a one-point rise in the DT decrease with 90.4% the probability of tax revenues to increase or a one-point decrease in the DT grows with 90.4% the probability of tax revenues to increase. These last situations illustrate the economic Laffer effect.

More, a 1% increase in the P grows with 27.5% the probability of tax revenues to increase or a 1% decrease in the P decreases with 27.5% the probability of tax revenues to increase. Otherwise, a 1% rise in the P decreases with 72.5% the probability of tax revenues to increase or a 1% decrease in the P grows with 72.5% the probability of tax revenues to increase.

We can observe that the results confirm the conclusions of Laffer that exist two effects of tax rates on tax revenues. Moreover, the results show the existence of political governance implication in Laffer Curve.

In Romania's case, the main results show us that the two "Laffer effects" have different probabilities of existence: PR is 9.6% if DT has the same direction with PR (arithmetic effects) and 90.4% if DT has the opposed direction with PR (economic effects). More, PR is 27.5% if P has the same direction with PR and 72.5% if P has the opposed direction with PR.

In a Laffer Curve representation, the probability of the tax rate level to be situated on the right side of optimal tax rate level (GT) is bigger ≈ 90.4% for DT and 72.5% for P. Contrary, the probability of the tax rate level to be situated on the left side of optimal tax rate level (GT) is smaller ≈ 9.6% for DT and 27.5% for P (Graphic 1). G(GT,GR) represents the point of optimum tax rate (GT) that maximizes the volume of tax revenues (GR).



Graphic 1. Laffer Curve and its effects probabilities in Romania's case

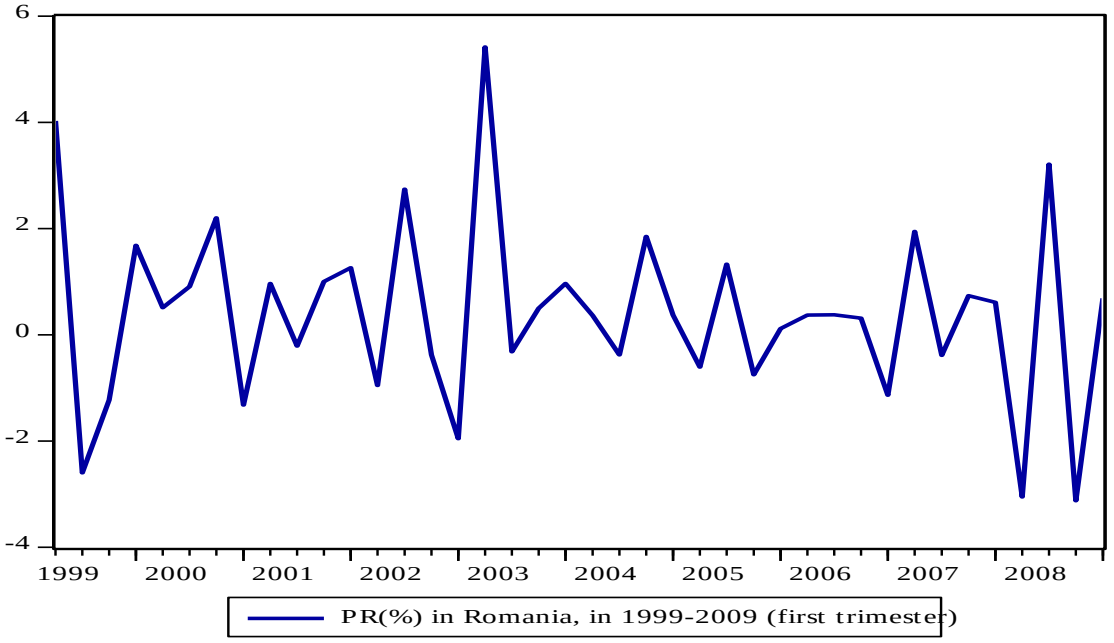
If the government knows which the maximum probabilities are for each of the two effects, then he can construct a coherent tax policy arrangement that raise or decrease the tax revenues, based on flat or progressive tax systems (the tax evasion is considered to be constant).

According PR probability, in connection with DT and P, with constant tax evasion, the arrangements can be formulated so:

(a) If the level of tax rate has a high probability to be situated on the left of the optimal tax rate (between 0% and GT), to raise the tax revenues, the government must augment the tax rate, through a progressive tax system;

(b) If the level of tax rate has a high probability to be situated on the right side of the optimal tax rate (between GT and 100%), to raise the tax revenues, the government must decrease the tax rate, through a flat tax system.

PR trend, in 1999 - 2009 (first trimester), in Romania, has a high trimester volatility (Graphic 2).



Graphic 2. The probability of tax revenues to increase, in Romania, in 1999-2009 (first trimester)

Conclusion

The main results reveal that, for maximizing the tax revenues (optimum tax level), Romanian Government must maintain the flat tax system and decrease the tax rate, with a strong control of tax evasion. The novelty of this approach is that the probit analysis of "Laffer effects" does not help to calculate the optimal level of tax rates which maximize the tax revenues, but permits to identify the direction in tax policy strategy (level of tax rates and type of taxation). Moreover, the results show the existence of political governance implication in Laffer Curve.
Our investigation has a limit: tax evasion is considered to be constant, even if it has a significant impact on tax revenues input (statistically, there is not an official data-set of tax evasion, with quarterly frequency).

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References

Arthur, L. (2004), "The Laffer Curve: Past, Present, and Future", Executive Summary Backgrounder, The Heritage Foundation, 1765:2.
Cerqueti, R. and Coppier, R. (2009), "Tax revenues, fiscal corruption and shame cost", Economic Modelling, 26(6):1239.
Dougherty, C. (2007), "Introduction to Econometrics", Third Edition, Oxford University Press, 262.
Farrell, M. (1954), "The demand for motorcars in United States", Journal of the Royal Statistical Society, A (117):171.
Feige, E. and McGree, R. (1983), "Sweden's Laffer Curve: Taxation and Unobserved Economy", Scandinavian Journal of Economics, 85(4):500.

Forte, F. (1987), "The Laffer curve and the theory of fiscal bureaucracy", Public Choice, 52:121.
Krause, A. (2007), "Dynamics of Output Growth, Consumption and Physical, Discussion Paper in Economics", University of York, 2007(10):2.
Mankiw, N. (1987), "The optimal collection of seigniorage: Theory and evidence", Journal of Monetary Economics, 20:327.
Sanyal, A., Gang, I. and Goswami, O. (2000), "Corruption, tax evasion and the Laffer curve", Public Choice, 105:61.
Sutter, M. and Weck-Hannemann, H. (2003), "Taxation and the veil of ignorance - A real effort experiment on the Laffer curve", Public Choice, 115:217.
Walewski, M. (1999), "A Short Play on the Idea of the Laffer Curve in Transition Economies", Working Paper, Center for Social and Economic Research, 175:5.
Wanniski, J. (1978), "Taxes, Revenues, and the Laffer Curve", The Public Interest, 50:1.
* * * Eurostat Database (2009), Statistical Office of the European Commission, September.

Appendix

Table A1

ADF and PP „unit root" tests for DT(%) - level

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.950927	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	
		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-13.12367	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

Table A2

Akaike and Schwarz criterions of binary choice model "PR, DT and P"

Info criterion	Binary choice model		
	Probit	Logit	Extreme value
Akaike info criterion	0.905261	0.911678	1.034728
Schwarz criterion	0.989705	0.996122	1.119172

Table A3

The PR quarterly frequencies in 1999-2009 periods

			Cumulative	
Value	Count	Percent	Count	Percent
0	15	37.00	15	37.50
1	25	62.00	40	100.00

Table A4

The econometric tests of the "Probit Model PR, DT and P"

Dependent Variable: PR

Variable	Coefficient	Std. Error	z-Statistic	Prob.
DT	0.261179	0.069584	3.753460	0.0002
P	0.746124	0.339450	2.198034	0.0279
Mean dependent var	0.625000	S.D. dependent var		0.490290
S.E. of regression	0.379208	Akaike info criterion		0.905261
Sum squared resid	5.464351	Schwarz criterion		0.989705
Log likelihood	-16.10522	Hannan-Quinn criter.		0.935793
Avg. log likelihood	-0.402631			
Obs with Dep=0	15	Total obs		40
Obs with Dep=1	25			

Table A5

The prediction values of PR base on the model

Dependent Variable: PR

	Estimated Equation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P(Dep=1)<= C	11	4	15	0	0	0
P(Dep=1)>C	4	21	25	15	25	40
Total	15	25	40	15	25	40
Correct	11	21	32	0	25	25
% Correct	73.33	84.00	80.00	0.00	100.00	62.50
% Incorrect	26.67	16.00	20.00	100.00	0.00	37.50
Total Gain*	73.33	-16.00	17.50			
Percent	73.33	NA	46.67			

Gain**

Table A6

The correlogram of standardized residuals of the "Probit Model PR, DT and P"

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.102	-0.102	0.4524	0.501
. |** |	. |** |	2	0.274	0.266	3.7745	0.151
.*| . |	.*| . |	3	-0.124	-0.083	4.4701	0.215
. | . |	. | . |	4	0.063	-0.026	4.6538	0.325
.*| . |	. | . |	5	-0.089	-0.036	5.0370	0.411
. |** |	. |** |	6	0.258	0.254	8.3275	0.215
.*| . |	.*| . |	7	-0.125	-0.076	9.1209	0.244
. | . |	.*| . |	8	0.063	-0.101	9.3317	0.315
.*| . |	. | . |	9	-0.059	0.039	9.5175	0.391
. | . |	. | . |	10	-0.043	-0.051	9.6209	0.474

Table A7

The correlogram of standardized residuals squared of the "Probit Model PR, DT and P"

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	-0.037	-0.037	0.0605	0.806
. |*. |	. |*. |	2	0.155	0.154	1.1185	0.572
. | . |	. | . |	3	0.006	0.017	1.1203	0.772
. |** |	. |** |	4	0.227	0.209	3.5247	0.474
.*| . |	. | . |	5	-0.060	-0.051	3.6965	0.594
. | . |	.*| . |	6	-0.036	-0.107	3.7593	0.709
. | . |	. | . |	7	-0.024	-0.023	3.7886	0.804
. | . |	. | . |	8	-0.023	-0.055	3.8159	0.873
. | . |	. | . |	9	0.027	0.064	3.8556	0.921
. | . |	. |*. |	10	0.020	0.069	3.8770	0.953

Table A8

The Andrews and Hosmer-Lemeshow Goodness-of-Fit Tests of the "Probit Model PR, DT and P"

Dependent Variable: PR

	Quantile of Risk		Dep=0		Dep=1		Total	H-L
	Low	High	Actual	Expect	Actual	Expect	Obs	Value
1	0.0009	0.0255	4	3.96776	0	0.03224	4	0.03251
2	0.0930	0.1701	3	3.49883	1	0.50117	4	0.56761
3	0.2269	0.3529	2	2.79740	2	1.20260	4	0.75602
4	0.3534	0.5467	2	2.30899	2	1.69101	4	0.09781
5	0.6235	0.6460	1	1.44236	3	2.55764	4	0.21218
6	0.6478	0.7294	2	1.23690	2	2.76310	4	0.68154
7	0.7542	0.8325	1	0.82620	3	3.17380	4	0.04608
8	0.8327	0.9084	0	0.52015	4	3.47985	4	0.59790
9	0.9539	0.9862	0	0.11796	4	3.88204	4	0.12155
10	0.9969	1.0000	0	0.00375	4	3.99625	4	0.00375
		Total	15	16.7203	25	23.2797	40	3.11694

H-L Statistic:	3.116	Prob. Chi-Sq(8)	0.9268
Andrews Statistic:	15.162	Prob. Chi-Sq(10)	0.1263