An analysis on the investment demand dependence relative to GDP and the interest rate for Romania during 2001-2011

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Abstract. In this paper, we have investigated the dependence of investment demand based on GDP and the real interest rate in Romania during 2001-2011. After determining the regression equation, an apparently surprising conclusion is that if an increase of 1% of GDP leads to an increase in investment of 0.45%, in the case of the real interest rate, the results contradict the classical theory. Thus, an increase in the real interest rate seems to attract an increase in the investment process.

Keywords: investment demand, GDP, interest rate, regression

JEL Classification: R12

1 Introduction

The purpose of this paper is to statistically analyze the dependence of investment demand based on GDP and the real interest rate in Romania during 2001-2011.

For accuracy and adequacy of calculations, we have reduced the existing data (GDP, the investment demand) using GDP deflator at the level of year 2000. We also determined the real interest rate taking into account the consumer price indices in the mentioned period.

2 The investment demand depending to the GDP and the real interest rate

In this section we shall investigate the dependence of investment demand to GDP and the interest rate. For data consistency calculations we will report all computations to the level of year 2000.

Considering the GDP deflator for year n: $GDP_{deflator,n}=\frac{\text{nominal GDP}_n}{\text{real GDP}_n}$ we first compute the cumulative deflator for the year n relative to 2000:

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$$GDP_{cumulative\ deflator,n} = \frac{GDP_{cumulativedeflator,n-1}}{GDP_{deflator,n}} = \frac{1}{\prod_{k=1}^{n} GDP_{deflator,n}}$$

where $GDP_{deflator,2000}=1$.

Table no.1

Year	Deflator GDP-România ($GDP_{deflator,n}$)	Cumulative Deflator-România ($GDP_{cumulative\ deflator,n}$)
2000	1.443	1
2001	1.374	0.727802038
2002	1.234	0.589790954
2003	1.24	0.475637867
2004	1.15	0.413598145
2005	1.123	0.368297547
2006	1.108	0.332398508
2007	1.13	0.294157971
2008	1.116	0.263582412
2009	1.065	0.247495222
2010	1.036	0.238895002
2011	1.071	0.223057892

Source: The World Bank

Also let the consumer price index (IPC) for the year n: IPC_n and π_n - the inflation.

Table no.2

Year	$IPC_n=1+\pi_n$
2001	1.345
2002	1.225
2003	1.153
2004	1.119
2005	1.09
2006	1.065
2007	1.0484
2008	1.0785
2009	1.0559
2010	1.0609
2011	1.0579

Source: Romanian National Institute of Statistics

Considering the nominal interest rate rd, we first calculate the real interest rate (without inflation): $r=\frac{rd-\pi_n}{1+\pi_n}$.

Table no.3

Year	The nominal interest rate (rd)	The real interest rate (r)
2001	0.3880	0.03197
2002	0.2847	0.04873
2003	0.1884	0.03070
2004	0.2027	0.07480
2005	0.0959	0.00541
2006	0.0844	0.01822
2007	0.0746	0.02499
2008	0.0946	0.01493
2009	0.0933	0.03542
2010	0.0667	0.00547
2011	0.0625	0.00435

Source: Romanian National Institute of Statistics

Let now consider GDP for the period 2001-2011:

Table no.4

Year	GDP (current mil. lei) Y
2001	117945.8
2002	152017.0
2003	197427.6
2004	247368.0
2005	288954.6
2006	344650.6
2007	416006.8
2008	514700.0
2009	501139.4
2010	522561.1
2011	578551.9

Source: Romanian National Institute of Statistics

Considering the cumulative deflator, we get:

Table no.5

Year	GDP (mil. 2000-lei) Y
2001	85841.2
2002	89658.3
2003	93904.0
2004	102310.9
2005	106421.3
2006	114561.3
2007	122371.7
2008	135665.9
2009	124029.6
2010	124837.2
2011	129050.6

Also, let the investment demand for the period 2001-2011:

Table no.6

Year	Investments (current mil. lei) I
2001	26186.2
2002	33446.1
2003	43370.2
2004	58551.4
2005	67286.6
2006	91188.3
2007	128858.7
2008	160896.9
2009	127137.4
2010	129761.9
2011	166675.7

Source: Romanian National Institute of Statistics

At the level of 2000-currency, the situation is as follows:

Table no.7

Year	Investments (mil. 2000-lei) I
2001	19058.4
2002	19726.2
2003	20628.5
2004	24216.8
2005	24781.5
2006	30310.9
2007	37904.8
2008	42409.6
2009	31465.9
2010	30999.5
2011	37178.3

The research question consists to search the dependence of investment demand from GDP and the level of real interest rate in comparable prices for the year 2000.

Let therefore the regression equation:

$$I=i_Y Y+i_r r+I_0,\ i_Y\in(0,1),\ i_r\in\mathbf{R},\ I_0\in\mathbf{R}$$

where:

- I – the investment demand;
- Y – GDP;
- r – the interest rate;
- i_Y – the rate of investments, $in_Y \in (0,1)$;
- i_r – a factor of influence on the investment rate;
- I_0 – additive constant (*representing the demand for investments in the absence of added value and financial mechanisms*)

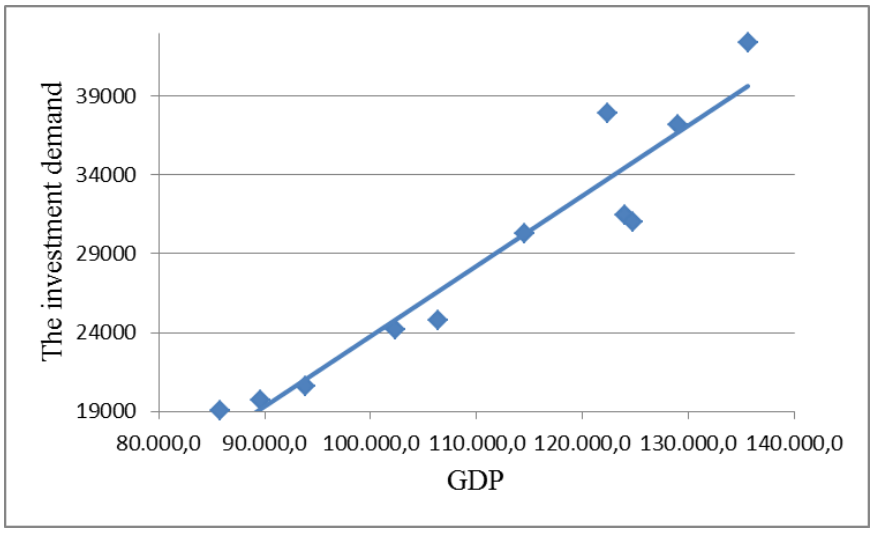

Fig.1 - The dependence of the investment demand from GDP

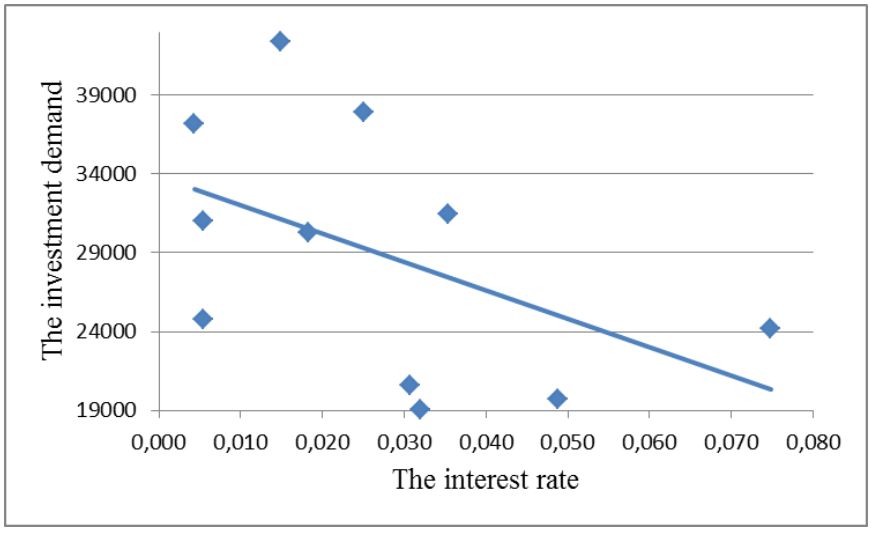

Fig.2 - The dependence of the investment demand from the interest rate

The regression analysis provides the following results:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.955310033
R Square	0.912617259
Adjusted R Square	0.890771574
Standard Error	2630.272137
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	578035314.6	289017657.3	41.77562995	5.83046E-05
Residual	8	55346652.13	6918331.516		
Total	10	633381966.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept (I_0)	-21887.21846	7182.99069	-3.04708991	0.015891138	-38451.22469	-5323.212224
X Variable 1 (Y)	0.452727206	0.057401351	7.887047991	4.83678E-05	0.320359455	0.585094958
X Variable 2 (r)	10832.54613	45971.81255	0.235634523	0.81963646	-95178.64372	116843.736

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*Standard Residuals*
1	17321.74463	1736.625096	0.738176805
2	19231.4321	494.7751398	0.210311099
3	20958.28276	-329.7733626	-0.140174784
4	25241.99309	-1025.24267	-0.435793748
5	26351.2208	-1569.731106	-0.667236179
6	30175.14453	135.7103096	0.057685567
7	33784.49717	4120.316623	1.751398254
8	39694.12042	2715.472518	1.154249603
9	34648.04812	-3182.149047	-1.352616994
10	34689.21639	-3689.747004	-1.568378611
11	36584.58676	593.7435036	0.252378987

The regression analysis revealed the following:

- For the number of data N=11 and the number of degrees of freedom k=1 (the number of independent variables), the Durbin-Watson test provides the values[3]: dl=0.93 and du=1.32, and the Durbin-Watson value statistic: $d=\frac{\sum_{i=2}^{n}(e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2}$ (where e_i are residues derived from regression) is d=1.394.

  Because $d \in (du, 4-du)$ follows that the errors are uncorrelated.

- The empirical correlation coefficient ρ (multiple R) is 0.955, while the critical value of the correlation coefficient for N=11 and a significance threshold of 95% is r_c=0.602. Because $\rho > r_c$ follows that a linear dependence between variables may exist.

- Significance F=0.000058 (*which means the probability that the regression equation cannot explain the evolution of the endogenous variable – the phenomenon having links purely random*) is much smaller than α=0.05. From the econometric theory it is known that if Significance F<α then the null hypothesis H0 is rejected with probability 1-α=0.95, so it is possible that at least one regression coefficient to be different from 0. In this case, we can consider this requirement met.
- The values P-value are an essential indicator for the revealing the variables which significantly influencing the process if they are less than α=0.05. Thus, for the coefficient of the independent variable Y we have P-value=0.000048<0.05 and for the coefficient of the independent variable r we have P-value=0.8196>0.05. For the remainder we have P-value=0.01589<0.05.
- The intervals [Lower 95%,Upper 95%] representing the confidence intervals where are the coefficients, are for the independent variable Y: [0.3204;0.5851], for the independent variable r:

  [-95178.6437;116843.7360] and for the remainder: [-38451.2247;-5323.2122]. Because 0 not belonging at the appropriate intervals for Y and remainder, implies that for a higher probability of 0.95 their coefficient belong to their respective ranges. A further analysis confirms that the coefficient of r belongs in the interval [22.2910;21642.8013] with a probability greater than 0.18.
- The regression equation is thus:

$$I=0,4527Y+10832,5461r-21887,2185$$

From these data, it appears that at an increase in GDP of 1 billion lei, the investment increases by 452.7 million lei. Also, an increase in the real interest rate by 1% leads to higher investment with 108.32 million at the level of 2000.

[3] Savin N.E., White, Kenneth J., The Durbin-Watson Test for Serial Correlation with Extreme Sample Sizes or Many Regressors, Econometrica, Vol.45, No.8, 1977, pp.1989-1996

It also should be noted that R Square=$\frac{SPE}{SPT}$ =0.9126 shows that the demand for investments is explained at the rate of 91.26% of GDP development and the real interest rate.

3 Conclusions

The above analysis shows that for Romania there is a paradoxical fact. If an increase of 1% of GDP leads to an increase in investment of 0.45%, in the case of real interest rate, the results contradict the classical theory. Thus, the increase in the real interest rate seems to attract an increase in the investment process.

The explanation could be that operators have not sufficient information or those official does not present a highly trust relative to the projected rate of inflation and hence the real interest rate cannot be expected. Therefore, the investments follows their natural course, being very little influenced by the real interest rate. Moreover, the above analysis cannot be sure of a positive value of factor of influence on the investment rate than the extremely low probability of about 0.18.

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