

Regression Model Used in Analyzing the Effect of Foreign Direct Investment on Economic Growth

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Abstract FDI definitely influence economic growth. While analyzing the link between FDI and economic growth, we bear in mind that investments influence economic growth. Empirical studies reveal that FDI effect upon economic growth is positive. Studies show that there is a link between the two variables, although, due to the influence of other factorial variables, economic growth can be significant at times. In this paper, I have analyzed the link between the variable Foreign Direct Investment, considered to be factorial, and economic growth, the resultative variable. The quantitative study has been done with econometric models that can be used also to predict economic trends. That is why I have used the simple and multiple linear regression models.

Key words Variable, FDI (foreign direct investment), GDP (gross domestic product), simple and multiple linear regression model, parameter

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1. Introduction

The foreign direct investment is a major source of foreign funds for all countries, irrespective of its development level. The intense periods of economic growth are characterized by the process of attracting some important FDI flows (Lipsey, 2000). Studies reveal the influence of foreign direct investment upon economies, and this stimulates economic growth. The effect of foreign direct investment also depends on the economic potential of the country, regulations on the foreign direct investment, the way in which these investments build up, as new investment or foreign capital increase.

Table 1. The causality link between economic growth and foreign direct investment

Authors	Purpose of the research	Results and conclusions
Bloomstrom, Lipsey and Zajan, 1994	FDI effects upon economic growth	Positive but depends on revenue per capita in the host country
Balasubramanyam, Salisu and Sapsford, 1996		Positive if the country has an export-oriented strategy and negative if the country has a substitution import-oriented strategy
De Mello, 1997		Positive, for countries with high revenue
Borensztein, Gregorio and Lee, 1998		Positive, but depends on education level
Bosworth and Collins, 1999		Positive
Carkovic and Levine, 2002		Positive, if economies have developed financial markets
Bengoa and Sanchez – Robles, 2003		Positive, but depends on economic conditions in the host country
Alfaro, 2003		Effect depends on investments : Positive for production, Negative for primary sector, and Non-conclusive for Services sector
Hansen and Rand, 2004		Positive
Kholdy and Sohrabian, 2005		No effect

Source: Moraru C. (2013), *Investițiile străine directe și creșterea economică în România*, Economie teoretică și aplicată Volume XX, No. 5(582), p. 126

Table 1 shows a brief presentation of the studies on the causality link between economic growth and foreign direct investment (Moraru, 2013).

Econometric models help understanding the economic relations and taking decisions on economic evolution. Econometrics uses elements of economic mathematics and statistics, emphasizing two opposite trends in approaching economy: “theory only” and “facts only” (Albu, 2003). The first economic approach focuses only on the effects of the deductions made in hypothetical systems about certain economic phenomena, the second focuses on the improvement and development of the economic data collection and recording system. Actually, there is an inter-conditioning relation between the two, since the confirmation of theoretical hypotheses results only by using a series of data, and the interpretation of the practical studies results requires a theoretical basis.

2. Methodology of research

To analyze the impact of the foreign direct investment upon economic growth in Romania, I have used a set of complex macroeconomic models. In my research, I have analyzed the phenomenon with econometric models that can be used to predict the evolution of an economic system, the simple and multiple linear regression model (Anghelache and Anghel, 2014).

With these models we can establish values of parameters of the macroeconomic models, depending on values of other macroeconomic indicators considered to be independent variables (explicative) or depending on the evolution of the factor time.

In this economic analysis, we must find the relation between two or several variables, by using two statistical techniques:

- *correlation* shows how strong is the link between the analyzed variables;
- *regression* explains and allows to predict the value of one factor in relation to the other(s).

Simple regression aim is to highlight the relationship between a dependent variable explained (endogenous, score) and an independent variable (explanatory, exogenous factor predictors) (Andrei and Bourbonais, 2008).

The simple regression model (unifactorial regression model) is defined through a mathematical relation built up in the context of economic theory, which implies that the economic phenomenon as effect is the result of the cumulated action of two categories of factors:

- one main factor that is essential;
- all the other factors can be considered non-essential, with randomly occurred action or constant action, invariable upon the economic phenomenon as effect. These influences are collected in the resultative variable.

The simple regression model can be transcribed mathematically as follows:

$$Y = f(x) + \varepsilon \quad (1)$$

In a simple regression econometric model, the relation between the resultative variable (Y) and the causal variable (X) can be described by a function as follows:

$$y_i = b + a \cdot X_i + \varepsilon_i \quad (2)$$

Where:

- y_i – resultative characteristic (explained);
- x_i – factorial characteristic (explanatory);
- ε_i – residual variable.

The hypotheses underlying the regression model that helps analyzing the effect of FDI upon economic growth are the following:

- I_1 : the data series are not affected by measurement errors;
- I_2 : the residual variable has zero mean;

I_3 : the dispersion of the residual variable is invariable in time, namely it has the property of homoscedasticity;

I_4 : the residues are not self-correlated;

I_5 : the factorial (explicative) variable is not correlated with the residual variable;

I_6 : the errors of the model are usually distributed according to a distribution of zero mean and σ^2 dispersion.

To estimate the *parameters of a linear regression model* we can use the method of the least squares, or the maximum Likelihood method. According to the least squares method, the estimation of the parameters is based on the condition that the sum of the squares of the differences between the real value and the value estimated through the regression model should be minimal:

$$F(\hat{\alpha}, \hat{\beta}) = \min \sum_{t=1}^n (y_t - \hat{y}_t)^2 = \min \sum_{t=1}^n (y_t - \hat{b} - \hat{a} \cdot x_t)^2$$

$$\hat{a} = \frac{\left| \begin{array}{c} n \quad \sum y_t \\ \sum x_t \quad \sum (x_t \cdot y_t) \end{array} \right|}{\left| \begin{array}{c} n \quad \sum x_t \\ \sum x_t \quad \sum x_t^2 \end{array} \right|}$$

$$\hat{b} = \bar{y}_t - \hat{a} \cdot \bar{x}_t \tag{3}$$

This stage requires extremely complicated calculations, and a very long time. To make the expert's work easier, specialized IT applications have been created, that allow estimating the parameters of the model and the validation of the results obtained. One of the IT programs used to solve econometric aspects is Eviews, which I have used in this research.

3. Results

To reflect the correlation between the evolution of the FDI and the GDP – the main macroeconomic result indicator, I have used a set of data for 2004 – 2014 (table 2).

Table 2. GDP evolution and FDI evolution between 2004-2014

Year	PIB	ISD
2004	61404,0	15040,0
2005	80225,6	21885,0
2006	98418,6	34512,0
2007	125403,4	42770,0
2008	142396,3	48798,0
2009	120409,2	48827,0
2010	126746,4	51414,0
2011	133305,9	53723,0
2012	133511,4	57851,0
2013	144253,5	59958,0
2014	150230,1	60198,0

The influence of the FDI upon the GDP can be revealed with the simple linear regression model, in which the GDP is the resultative variable, and the FDI is the explicative variable. Here is such a model:

$$GDP = a + b \text{ FDI} \tag{4}$$

In a first stage, with Eviews (Andrei *et al.*, 2008), I analyzed the evolution of the two indicators during that period of time, in terms of diagrams and descriptive statistics (figure 1).

As seen in the diagrams, the evolution of the two indicators is similar. Both the GDP and the balance of the FDI have a significant increase in 2008, and remain at a relatively constant level.

The graphical representation of the correlation between the two indicators, done with Eviews, reveals that there is a strong linear link, with an ascending slope, between the GDP and the FDI.

Based on these aspects, we can conclude that there is a strong connection between the balance of the FDI and the GDP. FDI is considered therefore to be a major method to increase the GDP.

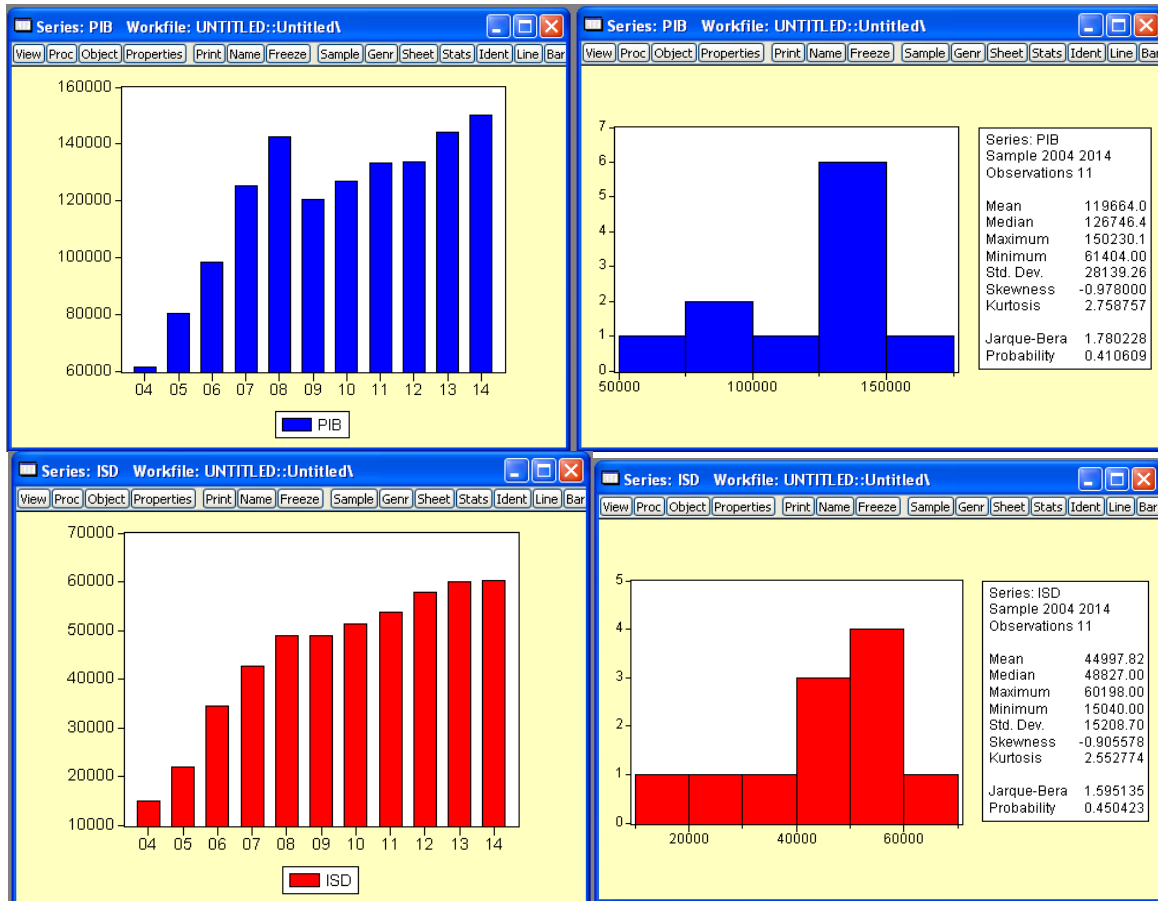


Figure 1. Evolution of indicators

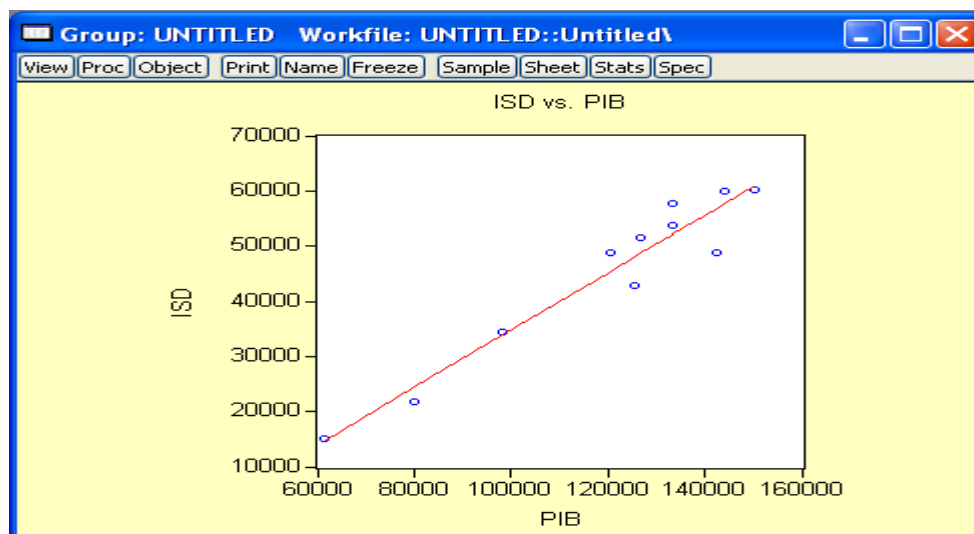


Figure 2. ISD vs. PIB

The two series have been processed with Eviews, and the parameters have been estimated with the least squares method. The results are shown below (figure 3).

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39299.27	7616.263	5.159914	0.0006
ISD	1.785970	0.161100	11.08610	0.0000

R-squared	0.931767	Mean dependent var	119664.0
Adjusted R-squared	0.924186	S.D. dependent var	28139.26
S.E. of regression	7747.962	Akaike info criterion	20.91121
Sum squared resid	5.40E+08	Schwarz criterion	20.98356
Log likelihood	-113.0117	F-statistic	122.9017
Durbin-Watson stat	1.622238	Prob(F-statistic)	0.000002

Figure 3. Least squares method

Based on the parameters obtained (a and b), the regression model becomes:

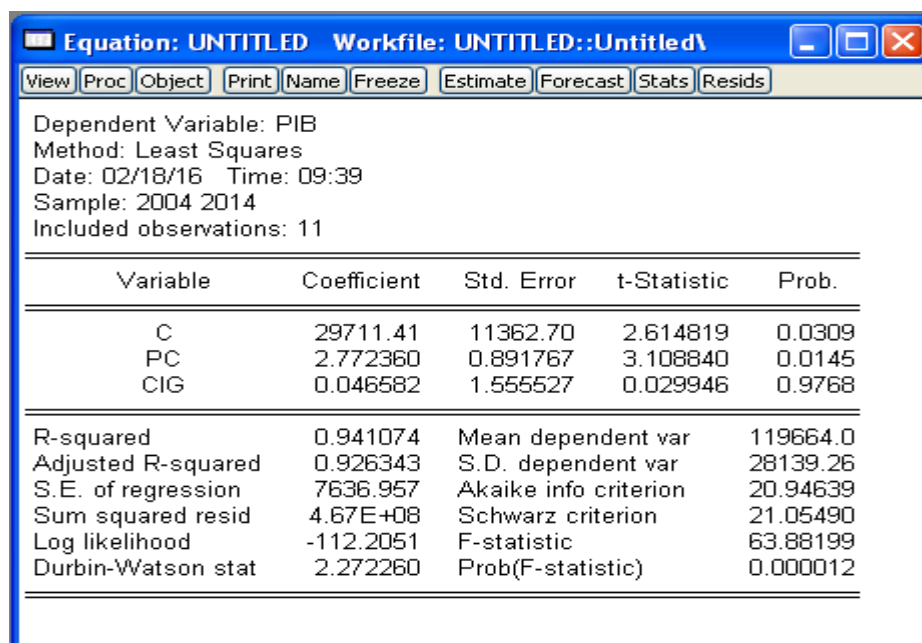
$$\text{GDP} = 39299.27 + 1.78 \text{ FDI}$$

As seen, the influence of the FDI on the GDP is significant, and this is explained by the realities in our country for each *leu* attracted as FDI, GDP can increase with 1.78 *lei*. To note however that a high value of the free term indicates the existence of other significant factors of influence contributing to the ascending evolution of the GDP in Romania. The probability of this econometric model is very high. The values of the tests R^2 (0.93) and R^2 adjusted (0.92) are close to 1, while the value of test Prob (F-statistical) is 0.000002, much below the significant threshold of 5%. Based on these elements, we can say that the simple linear regression model is accurate and can be successfully used in economic analyses. I further on developed the analysis, by using a multiple regression model that uses as explicative variables, the two components of the FDI, capital participation and intragroup loans, between 2004 – 2014.

obs	PIB	PC	CIG
2004	61404.00	12007.00	3033.000
2005	80225.60	17490.00	4395.000
2006	98418.60	27016.00	7496.000
2007	125403.4	31501.00	11269.00
2008	142396.3	34892.00	13906.00
2009	120409.2	35646.00	13181.00
2010	126746.4	35580.00	15834.00
2011	133305.9	37081.00	16642.00
2012	133511.4	39393.00	18458.00
2013	144253.5	40700.00	19258.00
2014	150230.1	43243.00	16955.00

Figure 4. Components of the FDI, capital participation and intragroup loans, between 2004 – 2014

The data have been analyzed with the same IT application, by using the least squares method in order to estimate the parameters of the multiple regression model. Here are the results:



Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	29711.41	11362.70	2.614819	0.0309
PC	2.772360	0.891767	3.108840	0.0145
CIG	0.046582	1.555527	0.029946	0.9768

R-squared	0.941074	Mean dependent var	119664.0
Adjusted R-squared	0.926343	S.D. dependent var	28139.26
S.E. of regression	7636.957	Akaike info criterion	20.94639
Sum squared resid	4.67E+08	Schwarz criterion	21.05490
Log likelihood	-112.2051	F-statistic	63.88199
Durbin-Watson stat	2.272260	Prob(F-statistic)	0.000012

Figure 5. Least Squares method

The multiple regression model resulted can be written as such:

$$\text{GDP} = 29,711.41 + 2.77 \text{ PC} + 0.04 \text{ CIG}$$

As seen, the influence of capital participation on the GDP is very important; each monetary unit increase generates an increase of 2.77 monetary units in the GDP. The influence of the intragroup loans is also positive but much weaker (only 0.04 monetary units increase in the GDP for each 1 leu invested). The validity of this model is highly accurate, the value of the test R^2 is 0.94, and test R^2 adjusted in 0.92.

4. Conclusions

The analyses performed with regression models lead to the conclusions that FDI may generate economic growth. Romania must continue the consolidation of its economy by implementing investments strategies that provide confidence in the Romanian business environment and in the national development plan. This requires improvement of the Romanian legislative and fiscal frameworks. The implementing, in the near future, of a coherent strategy to attract foreign investors and to stimulate their activity in Romania is a measure that may lead to a healthy economic growth for the Romanian economy.

References

1. Albu L.-L. (2003). *Modelarea și evaluarea impactului investițiilor directe, naționale și internaționale asupra pieței muncii și evoluției macroeconomice din România*, Institute for Economic Prognosis of the Romanian Academy (Institutul de Prognoză Economică al Academiei Române), Bucharest;
2. Albu L.-L. (2006). *Structura modelului și stadiul realizării acestuia*, International Conference: Macromodelul trimestrial al economiei românești, National Commission for Economic Forecasting, Romanian Center for Economic Policies, September, Bucharest;
3. Andrei, T., Bourbonnais, R. (2008). *Econometrie* Economic Publishing House, Bucharest;
4. Andrei, T., Stancu, S., Iacob, A.I., Tușa, E. (2008). *Introducere în econometrie utilizând Eviews*, Economic Publishing House, Bucharest;
5. Anghelache, C. (2015). *România 2015. Starea economică în continuă creștere*, Economic Publishing House, Bucharest;

6. Anghelache, C., Anghel, M.G. (2014). *Modelare economică – concept, teorie și studii de caz*, Editura Economică, București;
7. Anghelache, C. (2013). *Elemente de econometrie teoretică*, Artifex Publishing House, Bucharest;
8. Anghelache, C., Anghel, M.G., Manole, Al. (2015). *Modelare financiar-monetară și informatică*, Artifex Publishing House, Bucharest;
9. Borensztein, E., DeGregorio, J., Lee, JW. (1988). *Howdoes Foreign Investment Affect Growth?*, Journal of International Economics;
10. Bonciu F. (2003). *Investițiile străine directe*, Lumina Lex Publishing House, Bucharest;
11. Ciupagea C. (2000). *Economic and Econometric Models for Romania*, IEM Publishing House, Bucharest;
12. Dobrescu E. (2006). *Macromodels of the Romanian Market Economy*, Economic Publishing House, Bucharest;
13. Lipsey, R. (2000). *Inward ISD and economic growth in developing countries, Transnational Corporations*”, vol. 9, no. 1, April 2000;
14. Moraru, C. (2013). *Investițiile străine directe și creșterea economică în România*, Economie teoretică și aplicată, Volumul XX, No. 5(582), pp. 123-133;
15. Walsh, Carl, E.; Stiglitz, Joseph E. (2005). *Economie*, Economic Publishing House, Bucharest;
16. Zaman, Gh., Vasile, V. (2006). *Aspecte ale eficienței macroeconomice a investițiilor străine directe în România*, Theoretical and Applied Economics, Asociația Generală a Economisților din România - AGER, vol. 4 (4(499)(su)), 65-88, June;
17. Dincă (Nicola), Z., Baltac, A.G., (2014). *The evolution of direct foreign investments in Romania, in the context of globalization*, Romanian Statistical Review – Supplement no 4, vol., no 4, pp. 201-206;
18. <http://www.insse.ro/>
19. http://www.keysfin.com/#!/Pages/Investitiile_straine_in_Romania
20. <http://www.bnr.ro/>