# INFORMATIC MODELS USED IN ECONOMIC ANALYSIS OF CORRELATION BETWEEN GDP AND FDI

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**Abstract**. The correlation GDP – FDI is very important because it reflects the influence that foreign direct investments have on good domestic product growth. In order to have the possibility to realize such an analysis, it is compulsory to possess a database, which should be kept and actualized, each time we consider to realize an analysis on this theme. Performing the analysis of correlation between GDP and FDI impose the use of informatics models, performed through informatics systems, able to ensure accuracy, relevance and which are represented in a coherent way. Thus, informatics systems such as Eviews and Microsoft SQL Server Analysis help us identifying correlations and representing the evolution of macroeconomic indicators, in order to establish the upcoming governmental strategies for economic recovery or exiting economic instability. In the paper, the construction and use of an informatics model in correlation analysis are presented. This article represents a useful simulation of evidencing the efficiency of using the informatics model in analyzing the macroeconomic correlations. Therewith, in this paper, the efficiency of such a model in a limited way, based on the correlation GDP – FDI, are presented.

**Key words:** Eviews, informatic model, economic correlation, GDP, FDI.

## Introduction

Nowadays, macroeconomic analysis preoccupy many researchers and analysts, not only from the economic field, but also from the governmental sector, in the context of strengthening the relation between European Union members and reducing as much as possible the existent gaps between European countries.

The following content of the article will reveal the macroeconomic evolution of Romania as member of the European Union, which develops series of actions in implementing and applying the specific regulations and norms imposed by the European Union, in order to be aligned to a wide range of requested standards. In analyzing the macroeconomic evolution of Romania, the attention will be focused on representing the correlation between the main indicators, foreign direct investments and gross domestic product by constructing and explaining the use of an informatics representation of correlation, using the actual database related to FDI and GDP.

In the Legislative Framework of International Monetary Fund, foreign direct investments are defined as: investments done on long-term by a country resident in a company – resident of another country. Long term investments suppose a long term relation, between the investor and the company, as well as a significant influence of the investor upon the management of the entity (UNCTAD, 2014).

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In this context, foreign direct investments represent the property relation of foreign companies on a range of assets in other countries (Ślusarczyk and Kot, 2012). Owners of the patrimony have all the rights of control on the use of these assets. Thus, FDI are done with the main objectives of creating productive assets, capable in returning added value. So, the main technical and juridical particularity of foreign direct investments is represented by investor right in controlling and managing all the assets owned in other countries (Brzeziński, 2011). Foreign direct investments are not a simple transfer of capitals, but refer mainly in transfer of advanced technologies, advanced managerial and organizational practices of international marketing, as well as experience in promoting its own products and services on the international market.

Therefore, FDI have a bigger impact on GDP, being considered the engine of accelerating economic growth. That's why we will limit the informatic and economic analysis on using a progressive series of data, highlighting the correlation between the influences of Foreign Direct Investments on the economic growth.

Databases represented in below are furnished by the main data owners of Romanian macroeconomic indicators: National Institute of Statistics (NIS) and National Bank of Romania (NBR). As it can be noticed at first sight (Table 1), positive sold of FDI, during the last decade triggered an easy-going trend of economic growth.

**Table 1. Evolution of GDP and FDI in the period 2003 – 2010** *(Personal representation of databases furnished by NBR and NIS)*

| MEUR | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Gross Domestic Product* | | | | | | | | | | |
| 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| 44169 | 55277 | 64553 | 77112 | 92946 | 116531 | 113450 | 118640 | 125577 | 132596 | 141685 |
| *Foreign Direct Investments* | | | | | | | | | | |
| 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| 9662 | 15040 | 21885 | 34512 | 42770 | 48798 | 49984 | 52585 | 55139 | 59126 | 59958 |

Although, the investments increased from 2008 to 2009, (Table 1), GDP registered a decrease. Significant contributions to the negative evolution of the GDP in 2009, comparatively with 2008 are given by the constructions, which recorded a decrease as well as by the section trade, cars and households appliances repair, hotels and restaurants, transports and telecommunications recording a decrease. The other branches have recorded small decreases of activity volumes. The parallel representation of indicators evolution in the last ten years reveals an obvious correlation trend for both the sold of FDI and GDP.

As per the above representation (Figure 1), we can observe that Romania had a slow, but sustainable economic growth. In parallel, foreign direct investments followed the same trend. FDI trend was determined by many factors as: the existence of an investment market, also by industrial restructuring, by the developing of production in multiple ranges of services, by an attractive legislative framework, which offered guaranties to the foreign investors (Anghelache, 2013; Dinu, 2014a,b). Also, between 2007 and 2008, the principal factor which determined the increase of foreign capitals was the privatization of some sectors of national economy.
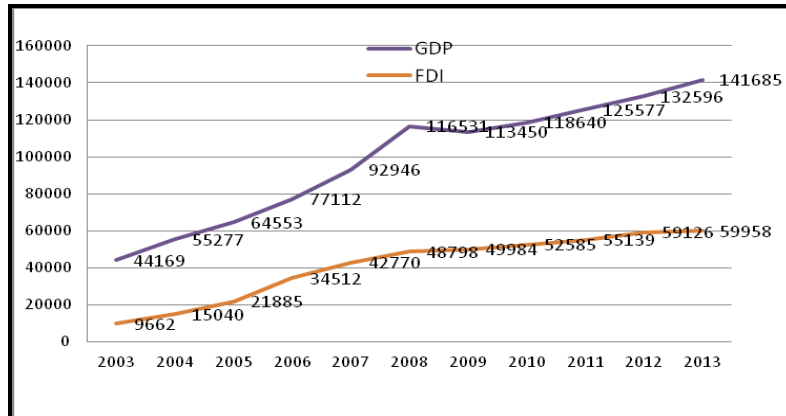


**Figure 1. Representation of FDI and GDP evolution in the period 2003 – 2013** (*Personal representation using databases furnished by NBR and NIS*)
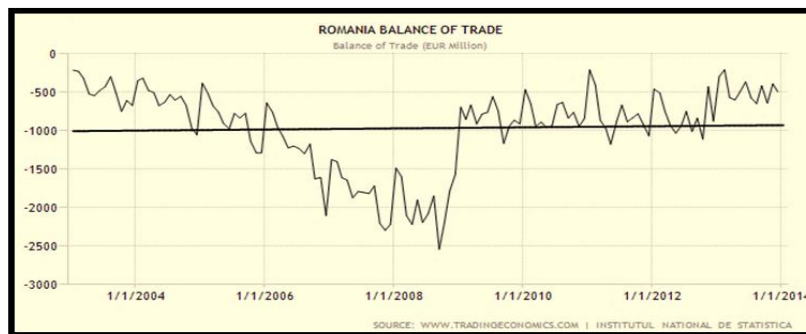


**Figure 2. Romania – balance of trade for the period 2003 – 2013** (*Source: National Institute of Statistics*)

From the above evolution of balance (Figure 2) of trade we can notice that by increasing the export volumes in last two years, Romania has achieved better results regarding the sold of balance of trade, registering at the end of 2013 the sold of – 364 MEUR , in comparison with the lowest value registered in 2009 of – 2 542 MEUR. The historical negative sold of the balance of trade, pointing – 2 542

MEUR, was the effect of a hostile economic business environment determined by the economic crisis. Current account balance evolution show a long term development of Romania and the decrease in time of its high dependency on the international market (Figure 3).
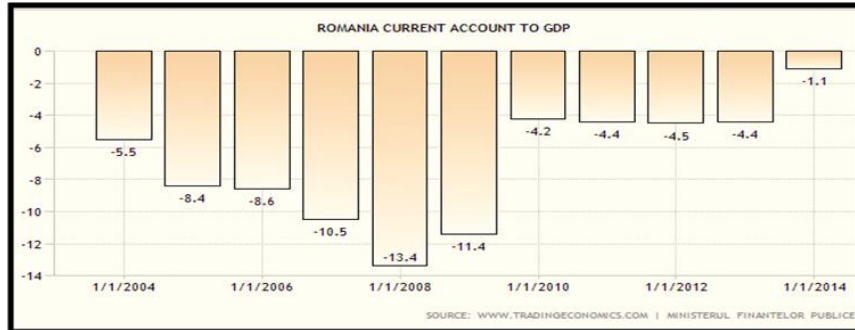


**Figure 3. Romania current account to GDP for the period 2003 - 2013** *(Source: National Institute of Statistics)*

These effects are due to a set of strategies followed constantly in order to achieve growth, even if it's an easy-going growth, but this evolution can be noticed on long-term.

In my opinion FDI had a significant impact on latest evolution of GDP in Romania, because of a wide range of reason which has determined foreign investors to develop their activity in this country. Romania is very attractive for foreign investors, mainly for the low cost of labor, the flat tax, for the high touristic potential and also because it makes part from the European Union.

A famous researcher in this domain, Richard Lipsey, explained that random periods of economic growth are correlated with the inflow of foreign direct investments (Lipsey, 2000; Anghelache et al., 3013a, b).

Analysis of correlation GDP – FDI can be done more accurately using informatics models, performed through informatics systems such as Eviews 7.2. As it will be observed informatics systems have a significant contribution in complex analysis, dealing with databases like in our case or in a wide range of analysis including multivariate random variables.

Now we will extend our analysis by showing the construction method of an informatics model in studying the correlation between GDP and investments, as well as the use of it.

In my opinion, the study of the correlations between macro-economic indicators, including the correlation between FDI and GDP justifies the design and the deployment of a multidimensional model, realized, at the physical level, as a data mart, that could be subsequently expanded to a data warehouse. The starting point of the proposed model is the idea of a unique data set, aggregated from multiple sources that become available over time, which is further capable of providing data

for analysis mechanisms. The advantages of this approach are the advantages of a database: data integrity (by compliance to unique format and business rules/integrity restrictions); assurance of correlations between various data segments (including the enforcement of referential integrity rules) etc.

As described by Kimball and Ross (2013) the key components of the data warehouse are the fact table and the dimension. While the fact table allows the storage of indicators around which, the data warehouse is normally built, the dimensions outline the characteristics of the factors that influence the achievement of indicators values (these are included as *measures* in the fact table).

For the purpose specified, the correlation between the two indicators, I propose the following design of a data warehouse. The measures are the values of the indicators, to be stored in the same fact table. The dimensions will be represented by the following criteria:

1) The *time* dimension is paramount for any data warehouse, because it allows the analysis over different periods, of the measures. The structure of the dimension is designed to store, in the fact table, values of the measures for various intervals, grouped according to the levels of the dimension: month, trimester, semester and year. Furthermore, the hierarchy (as each level is a child level of the next one), can outline, through proper analysis, the seasonal character of some correlations. Apart from other time dimensions, in this case, the dimension members should reveal the period for which the indicator was measured, not the timestamp at which the measure is included in the dataset. Therefore, a member *2014* of the *Year* level should lead to the correlation with the record in the fact table describing the value of the indicator for the year 2014;

2) A dimension is dedicated to the *indicators*, which could hold any indicator of significance. The structure of the dimension involves a *code*, the *name* of the indicator, a *description* and the *category*;

3) As the indicators measure can be provisional or partial over time, before their value become definitive, an auxiliary dimension will be included to permit the storage of these values;

4) The *Currency* dimension allows the value of the indicator to be expressed in different currencies, one likely result of this approach is the possibility to ascertain the effect of the currency exchange rate on the outcomes of the analysis, along with the impact on the evolution of various indicators;

5) The *Country* dimension provides support recording measures for more countries, and comparisons over space for the values of the indicators. Also, some indicators can be aggregated for countries belonging to a peculiar area. I ave defined the *Group* level for the possibility to allocate several countries to a specific form of multinational organization, such as the European Union.

For Romania, the official authority in charge of statistics regarding the foreign investments is the National Bank of Romania, since 2008 (according to the National Institute - INSSE). The data regarding foreign direct investments can be

detailed on many criteria but the one used in our example is the stock of FDI in the last decade.

The key data source for GDP related indicators is the National Statistics Institute, via its online database (INSSE) and the official publications. The national accounts indicators that can be used, alongside GDP, are the production of goods and services, the intermediary consumption, gross value added, taxes on products, subsidies on products, total net taxes on products (for the GDP calculation based on the production method).

Therefore, I propose model I, representing a simple linear regression model, constructed using the database presented in Figure 1, where GDP represent the dependent variable, while FDI represent the independent variable. The below model is developed through Eviews 7.2. informatic software (Figure 4).

Dependent Variable: GDP
Method: Least Squares
Date: 05/18/15   Time: 08:50
Sample: 2003 2013
Included observations: 11
GDP=C(1)+C(2)*FDI

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 23394.36 | 4409.021 | 5.306022 | 0.0005 |
| C(2) | 1.835981 | 0.099509 | 18.45035 | 0.0000 |
| R-squared | 0.974243 | Mean dependent var | | 98412.36 |
| Adjusted R-squared | 0.971381 | S.D. dependent var | | 33429.89 |
| S.E. of regression | 5655.409 | Akaike info criterion | | 20.28158 |
| Sum squared resid | 2.88E+08 | Schwarz criterion | | 20.35392 |
| Log likelihood | -109.5487 | Hannan-Quinn criter. | | 20.23598 |
| F-statistic | 340.4153 | Durbin-Watson stat | | 1.294104 |
| Prob(F-statistic) | 0.000000 | | | |

**Figure 4. Simple linear regression model representation in Eviews 7.2**

The results of database processing can be interpreted in a statistic sense. For interpreting the probability that the above model to be correct one, we use the values resulted for tests R-squared which indicate a probability of 97.42%.

The availability of the above informatics model is confirmed also, by F-statistic test results. Based on the above informatics tests, the regression model drawn by Eviews describing correlation between GDP and FDI is statistically expressed:

GDP = 1.835981 * FDI + 23 394.36                                    (1)

Therefore, a modification of 1 unit for FDI (Eq. 1), would determine the increase of GDP with 1,835981 units, highlighting that economic growth is significantly impacted by the flow of foreign direct investments and informatics models can confirm it.

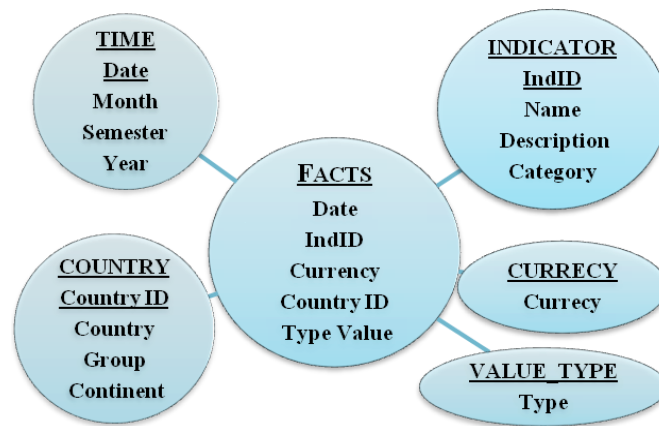I also propose model II which can be structured according to the following diagram (Figure 5):

**Figure 5. Conceptual model of the MACROIND datamart**

The physical model was implemented, and was loaded with a dataset, in order to ensure the representation of the correlation between the Gross Domestic Product and the Foreign Direct investments. The flow of data follows the general processing algorithm: database that also can be used as data staging area, then an OLAP cube in Analysis Services.

For the purpose of analyzing the correlation between the FDI and GDP, I have selected the FDI and GDP for the each year, using as structure for the database as it is represented in Figure 6, to conclude a coherent record usable for analysis. In the second example, both indicators will have their values expressed in million lei.

Based on the assumptions previously stated, a cube can be defined, whose structure can be represented in the following manner (Figure 6).
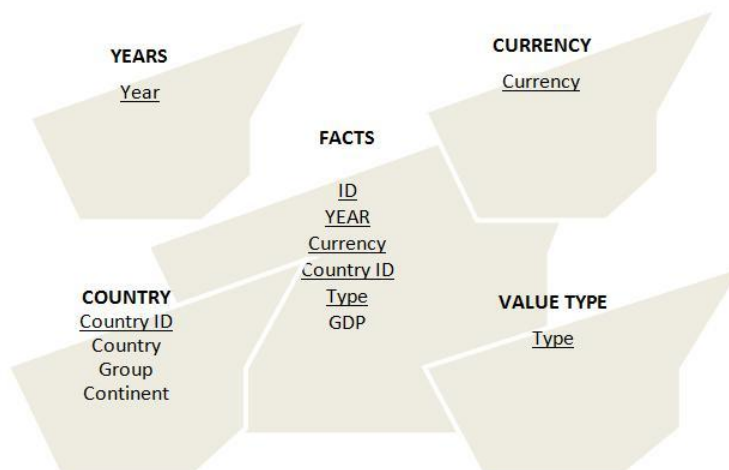


**Figure 6.Conceptual model of the MACROIND cube**

And then, data would be ready to process via an integrated tool, or exported into third party software. The proposed data mart model can be easily integrated in any RDBMS software, due to the compatibility between the model and the features of relational databases. If the RDBMS has no integrated tools for analysis, as previously stated, the data drawn from the cube can be converted in a format supported by specialized software. Also, RDMBS native tools can support any operation along the lifecycle of the multidimensional data mart. Decision support systems, such as SQL Server, are more appropriate tools for such operations.

To exemplify such possibility, both the data mart and the cube were implemented for testing purposes in relational database software, and then the datasets for the two indicators were subsequently extracted and processed using an open source software such as SOFA – Statistics Open For All (SOFA). The correlation between the two indicators can be represented using Pearson's Test of Linear Correlation, as in Figure 7.

Furthermore, the implementation of the cube in the Microsoft SQL Server Analysis Services, led to the discovery of the following regression model (data mining with Microsoft Linear Regression):

$$GDP = 1.789 * FDI + 23\ 507.53 \tag{2}$$

In the economic approach the above equation (Eq. 2), realized through the informatics system, Microsoft SQL Server Analysis Services, express that a modification of 1 unit for FDI would determine the increase of GDP with 1.789 units, highlighting that economic growth is significantly impacted by the flow of foreign direct investments and informatics models can confirm it.
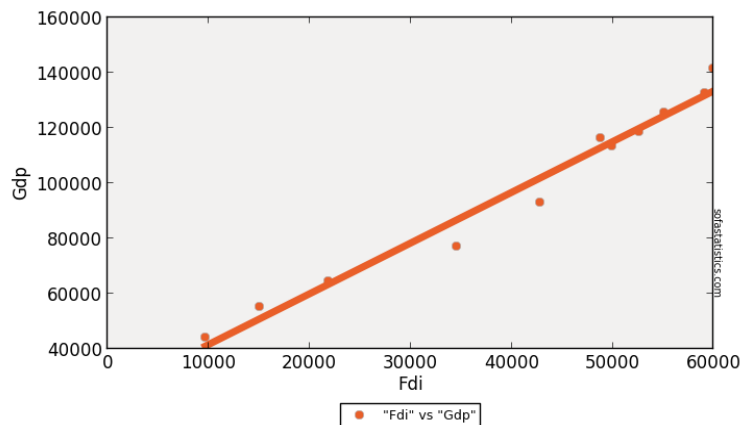


**Figure 7. Pearson's Test of Linear Correlation between FDI and GDP**

Given the fact that for the first example it was used a database which represented the evolution of GDP vs. FDI in million Euros, in the second example being implemented a database with values expressed in million lei we obtained different coefficients in the regression models, although similar.

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All informatics construction performed through different software's tests, using the database furnished by the main authorities in Romania (Figure 1), confirmed the strong correlation between the two indicators analyzed in a variety of informatics tests.

**Conclusions**

In this paper, a multidimensional data model has been proposed, for a data mart aimed at unifying various statistical data sources, data centered on the values of indicators that are considered significant for various analyses. The model is general and can be implemented in any software that supports at least relational database technology. The data drivers ensure quick loading of data into the data mart and possibility to export datasets into other software, if original data mart support system does not include certain analysis facilities the users are willing to use at a given moment in time. For more elaborate analyses, there are several instruments that can be used, some of which were exemplified in the article.

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## MODELE INFORMATYCZNE WYKORZYSTYWANE W EKONOMICZNEJ ANALIZIE KORELACJI POMIĘDZY PKB A BIZ

**Streszczenie:** Korelacja PKB-BIZ jest bardzo ważna, ponieważ odzwierciedla wpływ jaki mają bezpośrednie inwestycje zagraniczne na wzrost produktu krajowego. Aby mieć możliwość realizacji takiej analizy, obowiązkowe jest posiadanie bazy danych, która powinna być utrzymywana i aktualizowana za każdym razem, kiedy będziemy rozważać analizę na ten temat. Analiza korelacji pomiędzy PKB i BIZ wymaga wykorzystania modeli informatycznych, realizowanych za pośrednictwem systemów informatycznych, będących w stanie zapewnić dokładność, trafność i które są reprezentowane w sposób spójny. Tak więc, systemy informatyczne takie jak Eviews czy Microsoft SQL Server Analysis pomagają nam w identyfikacji korelacji i reprezentują ewolucję wskaźników makroekonomicznych, w celu ustalenia nadchodzących strategii rządowych dla odbudowy gospodarczej lub wychodzenia z gospodarczej niestabilności. W niniejszym artykule przedstawiona jest konstrukcja i wykorzystanie modelu informatycznego w analizie korelacji. Artykuł przedstawia użyteczną symulację potwierdzającą efektywność wykorzystania modelu informatycznego w analizie korelacji makroekonomicznych. W związku z tym, w niniejszym artykule zaprezentowano skuteczność takiego modelu w ograniczonym zakresie, na podstawie korelacji PKB -BIZ.

**Słowa kluczowe:** Eviews, model informatyczny, korelacja ekonomiczna, PKB, BIZ.

## 在二手國內生產總值相關性外國直接投資與經濟分析模型信息學

**摘要:**相關生產總值外商直接投資是非常重要的,因為它反映的影響,外國直接投資對國內好產品的增長。為了要實現這樣的分析的可能性,這是強制性擁有一個數據庫,應保持與現實化,每一個我們認為實現這一主題的分析時間。表演GDP和外商直接投資之間的相關分析徵收使用信息學模型,通過信息學系統進行,能確保準確性,相關性和其代表在一個連貫的方式。因此,信息系統,如Eviews確定MicrosoftSQLServer分析幫助我們識別和相關代表的宏觀經濟指標的演變,以建立經濟復甦或退出經濟不穩定即將到來的政府策略。在論文中,在相關分析的信息學模型的構造和使用介紹。本文僅代表證明使用信息學模型在分析宏觀經濟相關性的效率的有用的模擬。於是,在本文中,這樣的模型在有限的方式效率,根據相關國內生產總值     -外商直接投資,現介紹

**關鍵詞:**Eviews確定,信息學模型,經濟相關性,國內生產總值,外國直接投資