Computational Methods in Social Sciences

Vol. III, Issue 2/2015

http://cmss.univnt.ro/

contact: cmss@univnt.ro

ISSN 2344 – 1232
ISSN–L 2344 – 1232

"Nicolae Titulescu" University Publishing House

Phone: 004.021-330.90.32, Fax: 004.021-330.86.06

Calea Văcăreşti, nr. 185, Sector 4, Bucureşti, România

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Computational Methods in Social Sciences

Foreign direct investments in Romania in EU28 framework

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Abstract

Foreign direct investments flows are perceived by economic policymakers and by economic researchers as one of the key-determinants of the process of adjustment and structural modernization of emerging economies. They are also recognized in the economic literature as an important source of economic growth. This research aims to identify whether FDI can contribute to the economic growth of a country and to estimate whether the foreign investors are attracted to invest in economies that recorded successive growth rates. This approach involves the use of econometric tools and descriptive statistics to empirically support the assumptions made. Thus, for the quantitative analysis Eviews 7 and ArcGIS software tools were used. For the case study we analysed the Romanian economic situation in the current European context. First we take a look at the main evolution of foreign direct investment flows in the European Union. Subsequently we focus on the FDI flows into the Romanian economy and we test the links between these FDI flows and the economic growth process.

Keywords*: foreign direct investments, economic growth*

1. Introduction. Foreign Direct Investments and economic growth

Foreign direct investments (FDI) have been seen and still are as one of the best solutions to transform the lagging economies. These flows are helping not only the acquisition of equipment and machinery, but they also facilitate the transfer of technology, knowledge and skills from the more advanced economies. Furthermore, investments can create a chain of positive externalities by imitation and competition increases, having a large effect on an entire region, not just a few companies.

According to the neoclassical theory of growth, foreign direct investments increase the capital and the production per person, but the effects are only temporary because of the assumption of diminishing marginal returns. Foreign direct investments through cash flows does not influence long-term growth rate but only income levels. FDI can influence the long-term economic growth in the neoclassical model only through technology or through employment growth, both exogenous (UN / ECE, 2001).

Optimistic authors state that the FDI effect on growth is also through diffusion of technology and by creating dynamic comparative advantages that can lead to technological progress (Borensztein et al., 1998). FDI accelerates economic growth by supporting human capital, a factor that Romer (1990) sees as essential in R&D sector. The flow of foreign capital plays a more important role in the endogenous growth theory.

On the other hand, pessimists state that FDI flows can have a negative effect when the profits generated by investments are repatriated (Reis, 2001). The financial flow from abroad can be less favorable than national investments, by the fact that multinational companies do not reinvest profits; they don't contribute to the budget accordingly; they do not develop close ties with local firms (Firebaugh, 1992). Also increased competition leads to removal from the market of the national companies.

Campos and Kinoshita (2002), Alvaro, Chanda, Kalemli-Ozcan and Sayek (2002), Carvalho, Geert and Ionara (2010) show that FDI strongly influences a country's economy through technology. But the technology transfer is related to the level of industrialization of the country that receives the FDI: the higher the level of industrialization is, the more innovation and knowledge from multinational companies is brought.

Using data on the Romanian economy for the period 1990-2010, Clipa et.al (2013) show that a 1% increase in the stock of FDI generates an increase in GDP by 0.10%. Moreover, FDI acts on the increase of the competitiveness of exports: an increase of 1 billion lei of the stock of FDI increases exports by 0.28 billion in the next year and by 0.56 billion euros in the long term. The authors also place the short-term growth on behalf of multinational's activities, and long-term performance on the complex effects of FDI over the economy, which

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acts after the multinationals leave the local economy: imitating the multinational companies by local ones and using the same infrastructure (transport, communications, financial services); transfer of technology to local companies; business networking between local and foreign firms.

2. Romania's position in the European Union

The analysis covers the annual FDI flows and stocks in the 1997-2013 time period (2012 for the FDI stocks) for the 28 EU Member States. To provide the correct and comparable size of these indicators for each country, the values where divided to the population and annual gross domestic product.

As expected, the lowest values of the FDI stock in 1997 were located in the former communist states that had opened their doors to trade and investment only a few years earlier. FDI amounted to 98 euros per capita in Romania, 165€ (in 1998) in Bulgaria, 268€ in Lithuania, 315€ in Slovakia and 342€ in Poland. In the Czech Republic and Estonia the values for the same indicator were higher than 700€/inhabitant. For Croatia, Hungary and Slovenia there is no data on FDI stock. The highest values of FDI per capita were found in Luxembourg (€ 37.937 / inhabitant), the Netherlands (€ 7,414), Sweden (€ 4,260), the UK (€ 3,939) and France (€ 2,994).

In terms of FDI flows/capita the lowest values in 1997 were in Romania (47 euro / inhabitant), Bulgaria (53 €/ inhabitant), Italy (57 €/ inhabitant), Lithuania (87 €/ inhabitant), Czech Republic (€ 111/ inhabitant) and Poland (112 €/ inhabitant). As in the case of the FDI stock, the FDI flows values in East-European countries in 1997 are very small compared with those of states in north-central part of the European Union. The largest flows of FDI were in Sweden (1050 € / inhabitant), the Netherlands (€ 714/ inhabitant), the UK (€ 503/ inhabitant), Denmark (€ 469/ inhabitant), France (€ 378/ inhabitant). In the following years, until 2002, the lowest values of FDI were all in Romania and Bulgaria. Note that all the former communist states recorded the lowest flows of FDI in absolute terms. Those were joined by Greece, Italy and Portugal.

In 6 of the 17 years analyzed, the FDI per capita was the lowest in Romania, and in other six it had the second worst performance. To illustrate an overview of the European context we calculated the average value of FDI per capita in the European Union with 28 members. Then we calculated the average value of FDI per capita in the former communist countries, without Slovenia. The 10 countries included in the EU10 aggregation are: Bulgaria, Croatia, Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Hungary, and Slovakia. As shown in Figure 1, FDI was much lower in former communist countries than the EU average. Romania's performance in all years was less than the average EU10 states.

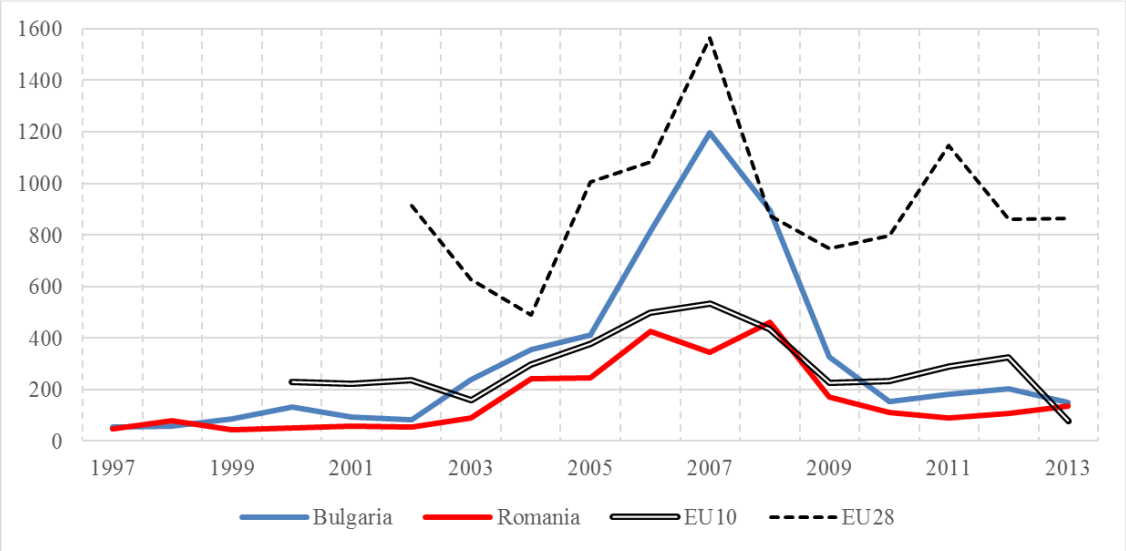

Figure 1. Evolution of foreign direct investment flows per inhabitant in Romania, Bulgaria, EU28, former communist countries (EU10[1])
Source: own computation using data from Eurostat

[1] EU10 represents the aggregation of values for: Bulgaria, Croatia, Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Hungary and Slovakia.

The evolution of Bulgaria's FDI flows was included in the analysis because it is the nearest to the economic performance of Romania and part of the same wave of EU enlargement. Bulgaria benefited from an influx of investment significantly higher than Romania. Moreover, from 2003 to 2009 FDI inflows relative to population in Bulgaria were higher than the average EU10 states. In 2005 was signed the Accession Treaty of Romania and Bulgaria to the European Union, boosting the interest of foreign companies for the two East European economies. But the changing trend in Romania was much lower than the explosive growth trend from the neighboring country. After this episode, the FDI flows reduced sharply in both countries in 2009, the year the financial crisis was felt.

According to the latest data, the foreign direct investment stock map has not changed significantly, due to the small flows in countries that already recorded low stocks of FDI per capita. In 2012 the lowest FDI stocks / capita were located in all countries belonging to the former communist bloc, plus Greece and Italy. The best performances are in the most developed countries of the UE28: Luxembourg, Ireland, Belgium, Sweden, Netherlands, Denmark and the UK. Thus, as can be seen in Figure 2, the foreign direct investment territorial pattern has not changed significantly in 2012 compared to 1998. In 2012, the FDI stock/ capita in Bulgaria was significantly higher (5153 € / capita) than in Romania (€ 2,932 / capita) due to the favorable evolution of Bulgaria.

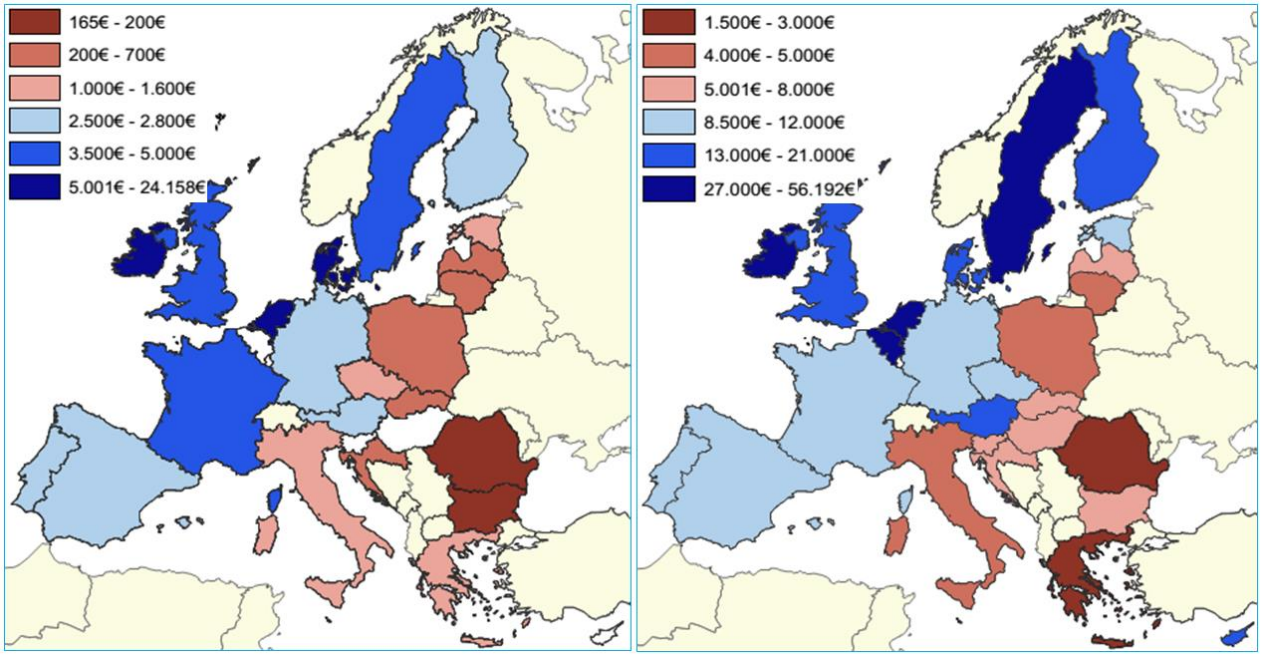

Figure 2. The stock of foreign direct investments (euro per capita) in the European Union in 1998 (left) and 2012 (right)
Source: own computation using data from Eurostat and ArcGIS software for mapping

The high coefficient of correlation (0.9) between the FDI stock and the GDP of EU countries, for all the 16 years analyzed shows that rich countries are those that have received the largest inflows of foreign capital. By adjusting the values with the number of inhabitants, the correlation is still positive but not as strong. Coefficient values vary between 0.62 and 0.84.

The analysis of the correlation between per capita FDI flows and stock of FDI per capita encounters a difficulty due to the fact that flows vary greatly from year to year while stocks fluctuate less, around an upward trend. This creates a higher fluctuation of the coefficients of correlation. Except for the years 2004 to 2006, correlation coefficients fluctuated between 0.7 and 0.93, demonstrating that large investment flows took place in states that already had accumulated a high FDI stock, ie developed countries.

A characteristic of countries in Eastern Europe is the high growth rate of FDI stock between 1997 and 2012. But this situation is mainly due to the low initial level of FDI stock in absolute terms (the lowest flows in the EU). By computing the correlation between the growth of FDI stock / capita and GDP / capita between 1998 and

2012[2] a direct link can be observed (correlation coefficient 0.74). This result shows that the countries that had the highest rates of economic growth have benefited from the highest rates of growth of the FDI stock. The least developed countries, the ones from the former communist bloc, also had the lowest levels of FDI / capita in 1998. In the following years, with the increase in production, an increased inflow of foreign direct investments has emerged. Changes in absolute terms of the two indicators are small, but relating to the initial level, the growth rates are above average. The lower the level in 1998, the higher the growth rate and vice versa. Noteworthy is the progress made by the Czech Republic and Estonia, countries that in 1998 had the highest per capita FDI stock from the former communist bloc and that have benefited from high growth rates.

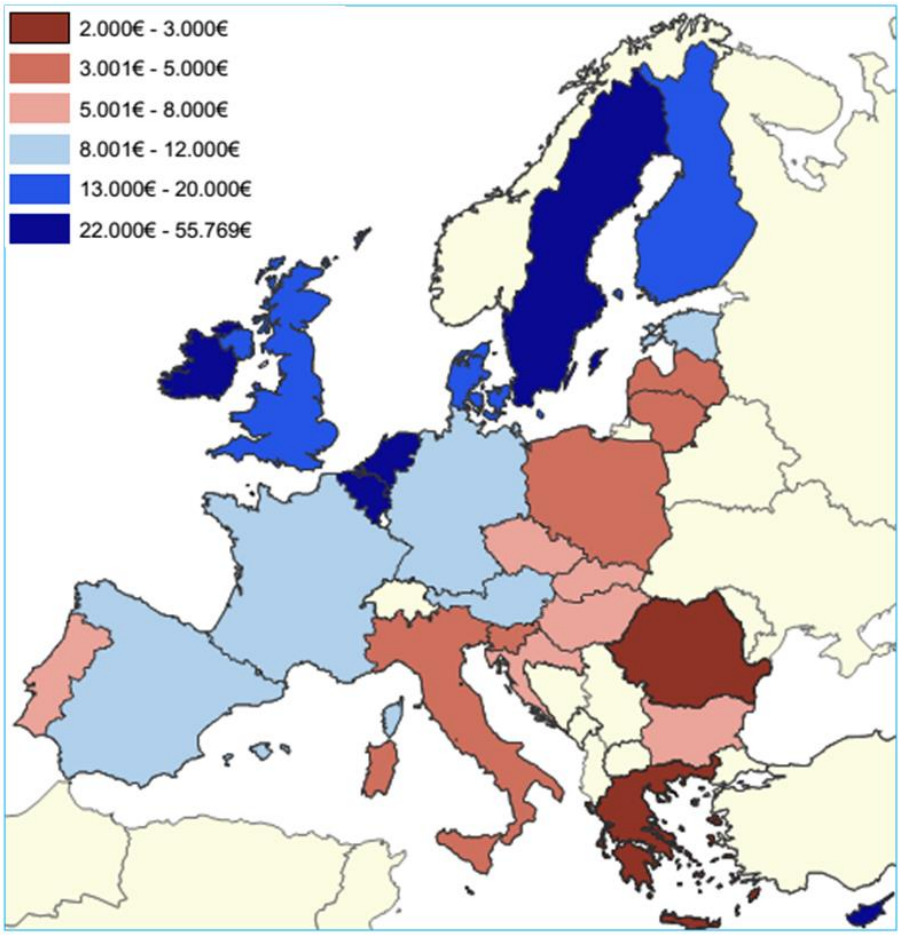

Figure 3. Flows of foreign direct investment (euro per capita) in the European Union between 1998 and 2012*
Source: own computation using data from Eurostat and ArcGIS software for mapping
Note: *For Belgium, the flow covers 2002-2012 period, for Greece 2000-2012, Croatia 1999-2012, Hungary 1999-2012, Slovenia 2001-2012, Slovakia 2000-2012.

2.1. The influence of FDI on GDP

Econometric analysis aims to study the link between FDI and the economic growth process. It consists in the linear regressions between GDP and the stock of FDI in the 28 EU Member States, for the timeframe 1997-2012. In this analysis we will test the influence of FDI on GDP and subsequent, the influence of GDP on FDI. For both sets of data the growth rate was calculated using the standard formula:

$$R = \frac{X_t - X_{t-1}}{X_{t-1}} \quad (1)$$

where R is the growth rate; Xt is either GDP per capita (in euros) or the FDI stock per capita (in euros) in year t. The stock of foreign direct investment is less available so that after calculating the growth rate remain only 378 observations for analysis.

[2] Growth index is calculated as the ratio between the values of 2012 and 1998

The first set of regressions studies the FDI influence on economic performance. The regression equation is:

$$R_{GDP} = a_0 + a_1 r_{FDI} + e \quad (2)$$

where R_{GDP} represents the GDP growth rate, A_0 is the interceptor; R_{FDI} is the growth rate of the stock of FDI per capita; a_1 is the regression coefficient that assesses the extent in which the GDP growth rate evolves depending on the FDI stock rate of growth; *e* is the error term.

The lagged effects of FDI on economic performance were also studied. The reasoning is that the flow of investment does not only produce contemporary effects (in the same year) on production. A few years may pass between the onset of the investment project and the start of production. For example, building a factory and installing the equipment requires a huge financial effort and it may take a long time before that unit starts the production.

According to the results shown in Table 1, the influence of the FDI stock on GDP is quite high. A1 coefficient has a value of 0.167, which means that an increase of one percentage point (pp) in the growth rate of the stock of FDI per capita would lift the economic growth rates with 0.167 percentage points. T test (Student) illustrates the probability coefficient to be null. In our case, the coefficient is zero with the highest degree of significance of 0.1%.

The coefficient of determination R^2 shows the extent in which the variation of the endogenous variable is due to variation of the exogenous variable. The value of 0.188 (ie 18.8%) is quite small but reasonable given the fact that the growth rate has many determinants, that are not included in the model.

These results show the contemporary influences, within the same year. Testing the time lag influences, it seems that on a one year lag the influence is stronger between the growth rate and the stock of FDI. The coefficient of the FDI stock growth rate from the previous year is higher than in the same year and the coefficient of determination is also higher. This shows that foreign direct investments have a greater impact on economic growth in the next year.

The influence is still statistically significant in the case in which the gap is increased to 2 or even 3 years. The growth rate of the FDI stock influences GDP growth rate after two years by 0.09 percentage points and 0.06 percentage points after three years. The value of the coefficient is lower than in contemporary influences or with a year gap, but also the coefficient of determination is much lower, of 5.5% for a two years gap and 2.8% for three years gap.

The FDI flows and stock are related, at least in theory, with the economic growth process. High growth rates signal higher business success and opportunities in that country, which attract the attention of foreign investors. The highest growth rates are found usually in developing countries that also have a low stock of foreign direct investment. Therefore the analysis continues with the study of the influence of the GDP growth rate on the growth rate of FDI.

The regression equation is similar to the previous one, the difference is that the endogenous variable is the growth rate of the FDI stock per capita (R_{ISD}), and the exogenous variable is the growth rate of GDP per capita (R_{PIB}):

$$R_{ISD} = a_0 + a_1 R_{PIB} + e \quad (3)$$

The results show that the influence of economic growth on foreign investments is very high. The 1.13 coefficient shows that an increase of one percentage point in the rate of GDP growth leads to an increase of 1.13 percentage points in the rate of growth of FDI stock. The coefficient higher than the one in the previous analysis is explained by the fact that FDI growth rate is much higher than GDP growth rate. The national average of the first indicator varies between 6% and 31 %, while the average growth rate of GDP per capita varies between 2% and 12 %.

At a lag of one year, the a_1 coefficient and also the R_2 coefficient have much lower values suggesting that the growth rate has a major effect on investment only in the same year. In a two-year lag the coefficient of determination is only 1.6%, and in the case of a three-year lag, the coefficient a_1 is not statistically significant.

Table 1. Regression Results

The equation	A_0	A_1	R^2
$R_{PIB} = a_0 + a_1 R_{ISD} + e$	0.028095***	0.167038***	0.188820
$R_{PIB} = a_0 + a_1 R_{ISD}(-1) + e$	0.023921***	0.174710***	0.206611
$R_{PIB} = a_0 + a_1 R_{ISD}(-2) + e$	0.035170***	0.089318***	0.055381
$R_{PIB} = a_0 + a_1 R_{ISD}(-3) + e$	0.034110***	0.063330***	0.028733
$R_{ISD} = a_0 + a_1 R_{PIB} + e$	0.093064***	1.130399***	0.188820
$R_{ISD} = a_0 + a_1 R_{PIB}(-1) + e$	0.110411***	0.591177***	0.056647
$R_{ISD} = a_0 + a_1 R_{PIB}(-2) + e$	0.112778***	0.297715**	0.016304
$R_{ISD} = a_0 + a_1 R_{PIB}(-3) + e$	0.103683***	0.190481	0.007831

Significance levels: *** - 99%; ** - 95%.

2.2. FDI at regional level in Romania

Between 2006 and 2008 foreign capital flows in Romania have reached the highest level. The major privatizations and greenfield investments have been done in that period. The maximum was reached in 2008 when FDI flows were worth 9.5 billion euros. In the coming years, amid the economic downturn and completion of large privatization, the inflow of foreign capital registered a sharp decline. FDI inflows in the last four years (2010-2013), cumulated, represent less that the value of 2006 or 2008. The level in 2011 was the lowest of all the analyzed period, even lower than the one of 2003.

Even so, net FDI inflows in 11 years are totaling 50 billion euros. The stock of foreign direct investment in 2013 was equal to 42% of the country's gross domestic product. Divided by the number of inhabitants results a value of 2995 euro /capita (figure 4).

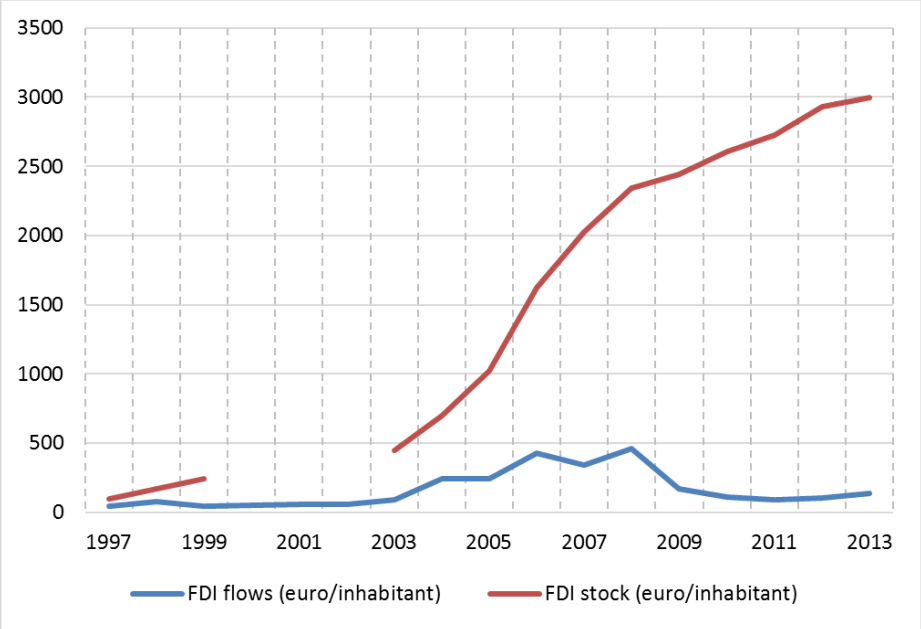

Figure 4. The dynamics of the FDI stock and flows in Romania between 1997 and 2013 (euro/inhabitant)
Source: Own calculation based on data from Eurostat

Almost half (48%) of the FDI stock is located in the industrial sector, especially in the manufacturing industry (31%). The best represented sectors are petroleum, chemicals, rubber and plastic products (5.9 percent of total FDI), the transport industry (5.7 percent), metallurgy (4.1 percent), food, beverages and tobacco (4.0 percent) and cement, glass, ceramics (2.7 percent).

Other sectors which attracted foreign investment are financial intermediation and insurances (14.2 percent of total FDI), wholesale and retail trade (11.2 percent), construction and real estate (9.8 percent), information technology and communications (6.9 percent).

The tertiary trend of the Romanian economy can be observed. The share of FDI stock in manufacturing decreased from 51 % in 2003 to 31% in 2013.

In the secondary sector, the *electrical energy, gas and water* sector expands amid the investments of foreign companies in the renewable energy, but also in the conventional energy.

Since 2004, foreigners' interest is moving on trade activities, financial intermediation and insurances (which engaged in 2007 23% of the FDI stock in the country), and construction (especially in 2008 and 2009). Figure 5 illustrates just a few activities of the national economy, as between 2007 and 2008 the methodology changes, using NACE Rev. 2 classification.

The shifting of investors' interest towards these sectors is motivated by the possibility of quick recovery of investments, high profits, or it represents strategic areas (renewable energy production) (Scutaru, 2014).

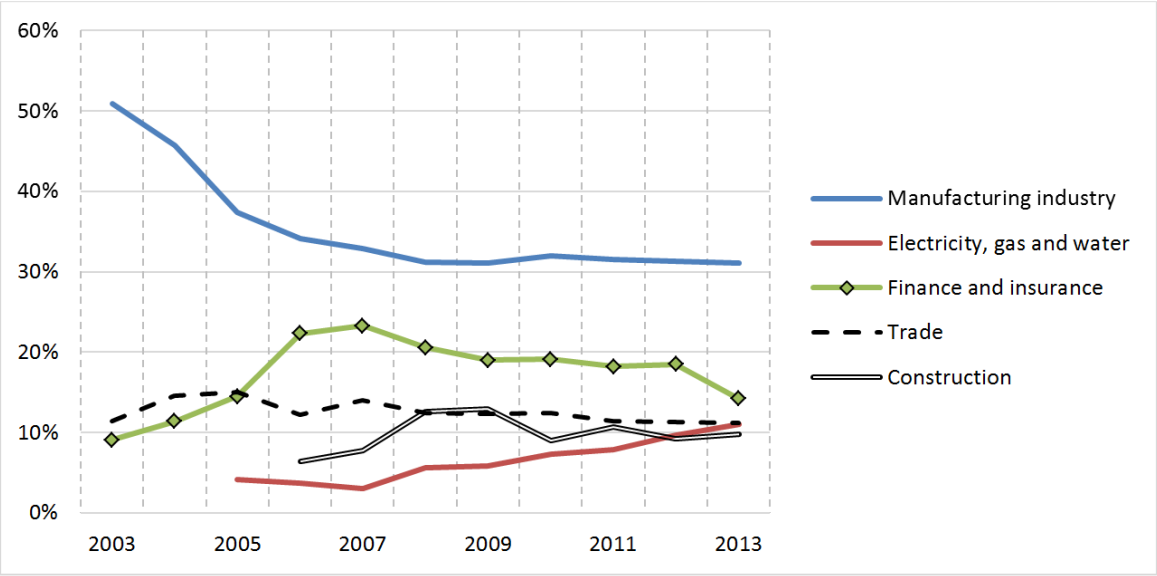

Figure 5. The distribution of foreign direct investment in manufacturing, energy, trade, construction and financial intermediation and insurance.
Source: own calculations based on data from National Bank of Romania

Given the importance of foreign capital for economic development, regional growth analysis should treat the extent to which subnational economic performance is linked to foreign direct investment.

When analyzing the distribution of foreign direct investments in the country's regions it must be taken into account a methodological aspect of data collection. Assigning the FDI to a region or other is done taking in consideration the location of the main office (headquarters) of the receiving company, which does not always correspond with the actual location of their economic activity.

Analyzing the evolution of regional allocation of FDI between 2003 and 2013 reveals that during the last decade București -Ilfov region consolidated its leadership position in attracting foreign capital.

The share of total national FDI stock increased from 54 % in 2003 to 61% in 2013. Investment flows larger than the national average were also headed to the Centru region (up from 6% to 9%) and Nord Est (up from 2% to 3 %). Disparities in terms of ability to attract foreign investors have as causes economic decline of small and medium size towns, and as well the severe impact of the economic restructuring of mono-industrial areas (Goschin et al, 2013).

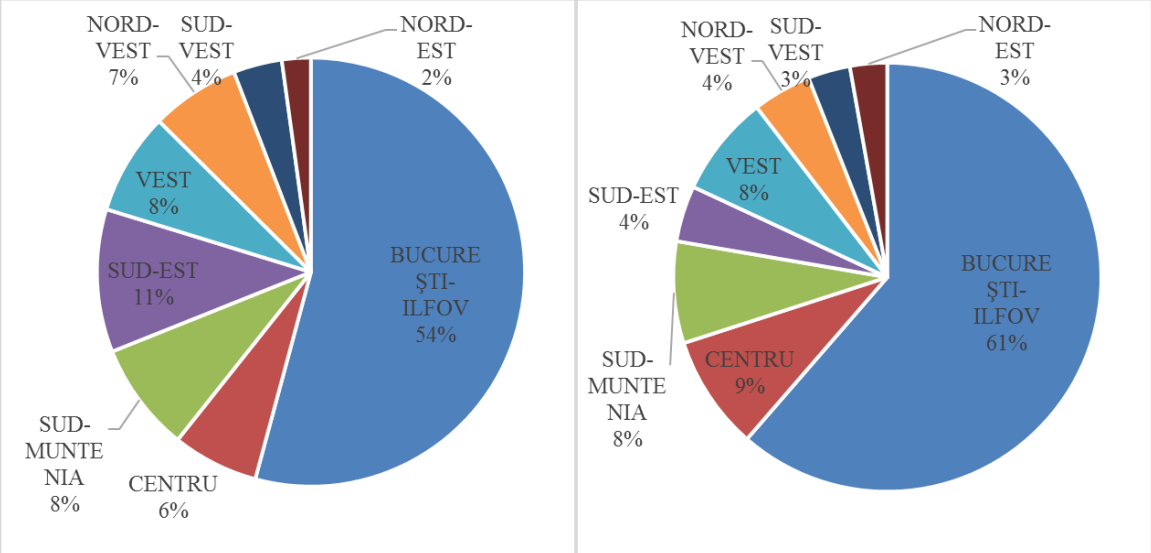

Figure 6. Distribution of FDI by region at 31 December 2003 (left) and December 31, 2013 (right)
Source: own calculations based on data from National Bank of Romania

According to Reschenhofer et al (2012), investment and regional GDP per capita are important determinants of attracting foreign capital. Many studies indicate that the market size is what weighs heaviest in the decision to locate the company and immediately after the population size, GDP per capita is a way to illustrate this feature.

Driffield and Munday (2000) stated that agglomerations attract investments, both domestic and foreign, due to lower costs of production (economies of agglomeration) and positive externalities. Infrastructure and connectivity is another reason for the decision to invest in big cities, generally better endowed in this respect than small towns.

Goschin et al (2013) study the determinants of FDI accumulation at regional level in Romania for the time period 2001-2008. The results of the econometric analysis show that the stock of FDI is positively related to foreign and domestic investments. Thus, the regions that have achieved the critical investments level, are the ones that are attracting more investment.

This result is attributed to economies of agglomeration. The authors also found that GDP per capita (indicator of economic development but also of market size) and the population density attract a greater flow of investment. This demonstrates that agglomerations are attracting investor interest.

Goschin et al (2013) show that another determinant of FDI is the technological level of the region: the FDI is higher in areas with high employment in activities intensive in knowledge while employment in sectors that are weak technologized negatively affect the flow foreign capital.

The concentration of foreign direct investments in the capital region shows that they act as a driving factor of the growing disparities. According to Zaman et . al. (2011) the decision of choosing this location depends on the attractiveness of the business environment and the infrastructure.

In 2013 most greenfield investments are also in București-Ilfov (55.6 % according to the National Bank of Romania) though the expectations would be that in this region the FDI to be accumulated in other types of investment since here is the largest cluster of companies built before 1990.

Given the fact that the developing regions are different in size in terms of territory and population, a useful methodological approach is to report the FDI stock to the the number of inhabitants. This highlights more clearly the trends of agglomeration of FDI in the capital region (figure 7).

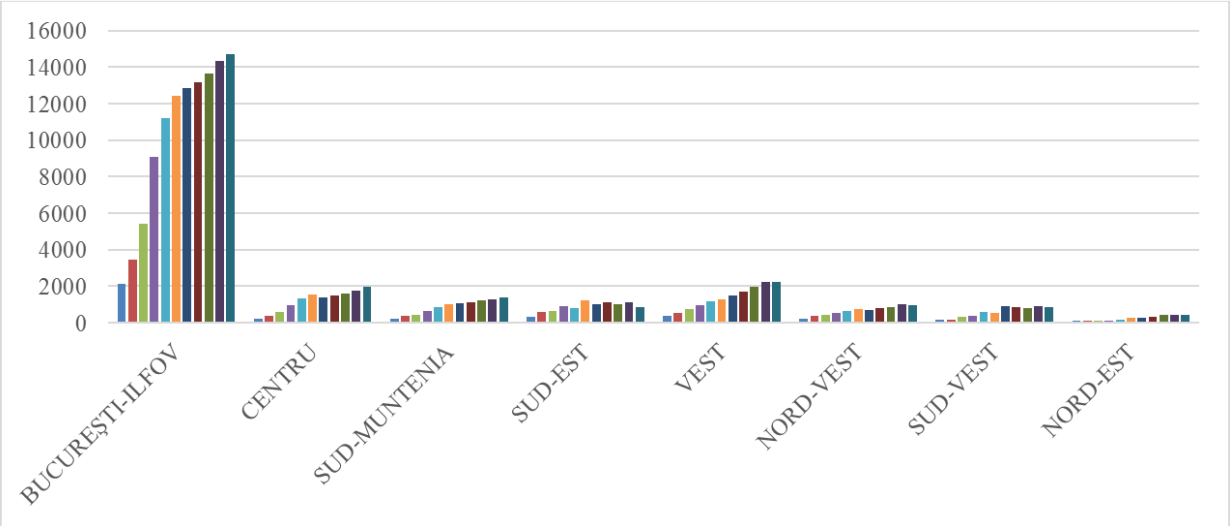

Figure 7. Foreign direct investment stocks between 2003 and 2013 (euro per inhabitant)
Source: own calculations based on data from National Bank of Romania

One of the reasons given for FDI flows to countries in Southeast Europe is the low salary levels. Goschin et al (2013) show the existence of a negative relationship, statistically significant, between the FDI and wage levels, which indicates that foreign investors are targeting locations with low labor costs. However, investment flows were much higher in București-Ilfov, region in which the wages were the highest in the country throughout the period studied. This shows that wage differences, which can be of 2:1, do not compensate for other characteristics sought by foreign companies.

At the county level, Danciu et al (2010) found a strong direct link between the per capita values of GDP and foreign capital and the number of companies with foreign participation. Foreign direct investments tend to concentrate in the most developed areas, the same where most companies are found. This reinforces the status of attraction poles of large cities, contributing to increasing the development gap between the regions of the country.

3. Conclusions

The impact of FDI on economic growth has been widely studied, many authors indicating their positive influence not only by a temporarily increase of production, but by the complex effects on the economy: the transfer of technology and knowledge from more advanced countries causes positive externalities.

The lowest values of the FDI stock in 1997 were found in the former communist states that only a few years earlier had opened their doors to trade and investment. The territorial pattern is the same in the case of FDI flows: the lowest values were found in developing countries and the largest in north central Europe, in countries with the highest level of economic development.

According to the latest available data, the lowest FDI stocks per capita are found in the former communist countries, plus Greece and Italy. A characteristic of Eastern Europe countries is the high growth rate of FDI stock between 1997 and 2012. But this situation is mainly due to low initial level of stock of FDI, in absolute terms the flows being the lowest in the EU. These countries also had the lowest levels of FDI/capita in 1998. In the following years, when production increased, also the inflow of foreign direct investments increased.

The results of the econometric analysis show that the influence of FDI stock on GDP is quite high both in the same year and one year later. An increase of one percentage point (pp) of the growth rate of the FDI stock per capita increases the economic growth rate with 0.167 percentage points that year and 0.174 pp a year later. Growing the time lag, the positive influence is still present but much weaker.

We also tested the hypothesis that high economic growth rate attracts foreign capital. The results show that the influence of economic growth on foreign investments is very high. An increase by one percentage point of GDP growth rate determines an increase of 1.13 percentage points in the rate of growth of FDI stock. The

coefficient higher than the one in the previous analysis is explained by the fact that FDI growth rate is much higher than GDP growth rate.

In European context, Romania's performance was weaker in all the years analyzed than the average of the former communist countries. In 6 of the 17 years analyzed, the FDI flows per capita were the lowest in Romania and in other six it had the second worst performance.

The flow of foreign direct investment in Romania reached high levels between 2004 and 2008, when the major privatizations and greenfield investments took place. Maximum was reached in 2008 when FDI flows worth 9.5 billion euros. In the coming years, amid the economic downturn and the completion of large privatizations, the inflow of foreign capital registered a sharp decline.

The tertiary trend of the Romanian economy can be observed from the stock of foreign direct investment. Since 2004, foreigners' interest moved on trade, financial intermediation and insurance (which engaged in 2007 23% of the country's FDI stock), and construction (especially in 2008 and 2009).

The Capital region holds a leading position in terms of attracting foreign capital. 61% of the national FDI stock is found in București-Ilfov. The next positions are held by the Centru, Vest and Sud-Muntenia regions. The least attractive areas for investors are Nord Est, Sud Vest and Sud Est. It thus appears that the regional pattern of FDI stock is very similar to the economic development of the central western and eastern, which is more favored than the east and southeast of the country.

Bucharest, alongside major cities have the highest FDI stock, although wages in these locations are the highest in the country. This shows that wage differences between regions do not compensate for the other characteristics sought by foreign companies. According to several authors, foreign capital tends to accumulate in clusters due to similar reasons for all companies that choose to locate here: the large size of markets and labor resources, infrastructure and connectivity, lower production costs (low wages compared to the developed countries), economies of agglomeration. Studies on the Romanian economy show that other determinants of FDI flows are the education and skills of the population, and previous investments (investments attract investments).

Acknowledgement

This work was cofinanced from the European Social Fund through Sectorial Operational Programme Human Resources Development 2007-2013, project number POSDRU/159/1.5/S/142115 „Performance and excellence in doctoral and postdoctoral research in Romanian economics science domain".

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Developments of regional gross domestic product and the unemployment rate in Romania during 2000-2012

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Abstract

Economic development of territorial units can be characterized by measuring the ability of producing goods and services and by measuring labor force in the area. The capacity of producing goods and services is measured by calculating the gross domestic product indicator. This article presents a comparative analysis of the evolution of regional GDP and the ILO unemployment rate at the level of the eight regions in Romania for a period of 13 years. The presented data come from the National Institute of Statistics of Romania.

Keywords: *regional gross domestic product, GDP deflator, registered unemployment, ILO unemployment, unemployment rate.*

1. Introduction

In recent years, Romania held extensive processes of economic and social changes, influenced by external and internal factors. Changes in the economic branches of activities, changes of the legislation, internal migration from the rural to urban area, emigration of some parts of the labor force, while international economic and political changes, have led to fluctuations of the main macroeconomic indicators. As shown in various books on macroeconomics, "one of the main objectives of economic policy in any country is that of full employment of labor"[1]). It is considered full employment of labor force when unemployment has an acceptable level. In national and international statistics are pursuing both the number of unemployed, and the unemployment rate. Over time, many economists have tried to highlight a link between indicators measuring unemployment and the economic indicator that summarizes the results produced within a territorial unit, the gross domestic product. This article tries to emphasize key moments in the evolution of this two macroeconomic indicators: unemployment at regional level and the regional gross domestic product, between 2000- 2012.

2. Considerations on regional GDP in the period 2000-2012

Analyzing the dynamics of GDP in the period 2000-2012 it can be seen as positive developments by 2009. After this year, lower economic growth was recorded at national level. The same trend is observed in the four macroregions. To analyze the dynamics of regional gross domestic product, the national GDP deflator was used at regional level. The distribution of GDP at counties level reveals large differences between the contributions of such administrative units in forming national GDP. The county that produce almost a quarter of the total national gross domestic product is Bucharest. The following counties, which produce around 4% of total GDP are Cluj and Constanta and the counties of Brasov, Prahova and Timis provide each about 3% of GDP.

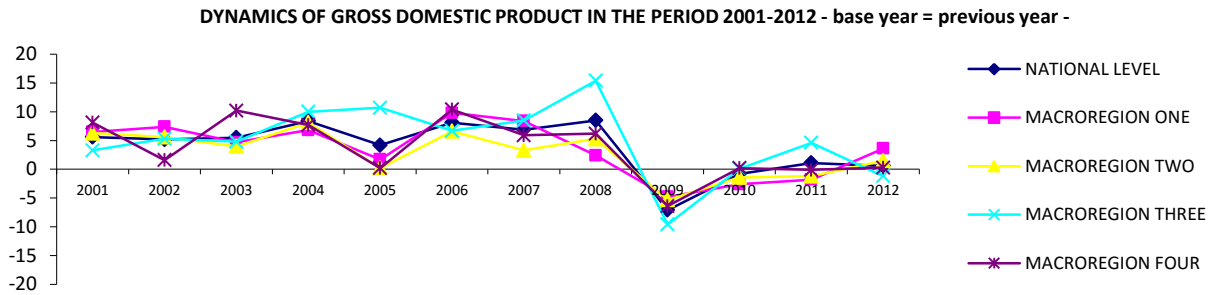

Fig. 1. Dynamics of GDP in the period 2001-2012 at national and regional level

[1] Capanu I, Wagner P, Secareanu C, *"Statistical Macroeconomy"*, Economic Editure,380, 1997, pg 66

Until 2009, GDP growth rates are positive. During this period, we notice some growth rates that exceeded 10%: in 2003 and 2006 at the Macroregion four level, and in 2004 and 2005 at the Macroregion three level. Also, we can see several inflection points, such as lowering the growth rate of GDP at the level of Macroregion three from 8.1% in 2001 to 1.6 in 2002, followed by an increase in the rate next year to 10.2% . This was due to the evolution of economic activity in the counties such: Dolj, Mehedinti, Olt and Valcea, which in 2002 produced nearly 6% of national GDP. In the year 2005, the growth rate of regional GDP from Macroregion two and Macroregion four reach up to 0.2%, then increase next year to 6.6% and 10.4%. After the 2008 financial crisis effects are felt at the level of our country. Thus, in 2009 as against the previous year, gross domestic product decreases in all regions of the country. The largest decrease, 9.6% was observed in the macroregion three, where Bucharest's gross domestic product has recorded a decrease of 13.4% percent. The data in the following years show an improvement in these indicators, showing a slight recovery of the economy.

3. Considerations on the registered unemployment rate in the regions of Romania during 2000-2012

Unemployment is a complex phenomenon that is closely related to all aspects of economic, social, political and psychological life. The number of unemployed registered at the National Agency for Employment (NAE) had a downward trend until 2008, when from the value of 403 thousand people at the end of 2008 increase sharply to 709 thousand people at the end of 2009. The registered unemployment rate follows the same trend, the 2009 level being 3.4% higher than in the previous year. The lowest registered unemployment rate is steady at Macroregion three, this being due to particularly low values of Bucharest-Ilfov region. Values above the national average of this index were recorded in Macroregion two, where Vaslui county has the highest unemployment rates, with values oscillating around 10%.

Fig. 2. Unemployment registered rate in the period 2001-2012

4. Considerations ILO unemployment rate in the regions of Romania during 2000-2012

In contrast to data of unemployed registered at the National Agency for Employment, the data obtained as recommended by the International Labour Office provides a broader picture of this phenomenon. Unemployed according to the international definition of International Labour Office (ILO) criteria, are persons aged 15-74 years who, during the reference period, simultaneously meet the following conditions: have no job and are not carrying out any activity in order to get income; are looking for a job, undertaking certain actions during the last four weeks (registering at employment agencies, or private agencies for placement, attempts for starting an activity on own account, publishing notices, asking for a job among friends, relatives, mates, trade unions a.s.o.); are available to start work within the next two weeks, if they immediately find a job. Between 2000 and 2012 in Romania, ILO unemployment rate has fluctuated between 5% and 10%. If in 2000 this indicator was 6.9%, in 2012 reached almost the same value: 6.8%. It may be noted that in 2007-2008, the values of this indicator in the regions are almost equal. Also, for this period, we can make a few observations: in Macroregion four unemployment rate was below the national level, while the unemployment rate in the Macroregion three was higher than the value of the whole country.

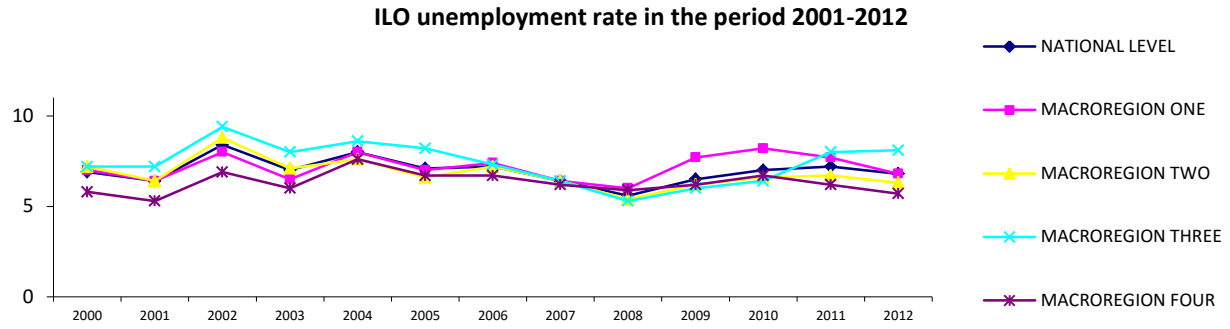

Fig. 3. ILO unemployment rate in the period 2001- 2012

4. Comparison between regional unemployment rate and regional gross domestic product in the period 2000-2012

Following the evolution of these indicators over thirteen years, we can find that in the years when the growth rate of gross domestic product declines, the unemployment rates rose. This happens in all regions. We present some graphs illustrating the connection between the evolution of unemployment and gross domestic product in the four macroregions.

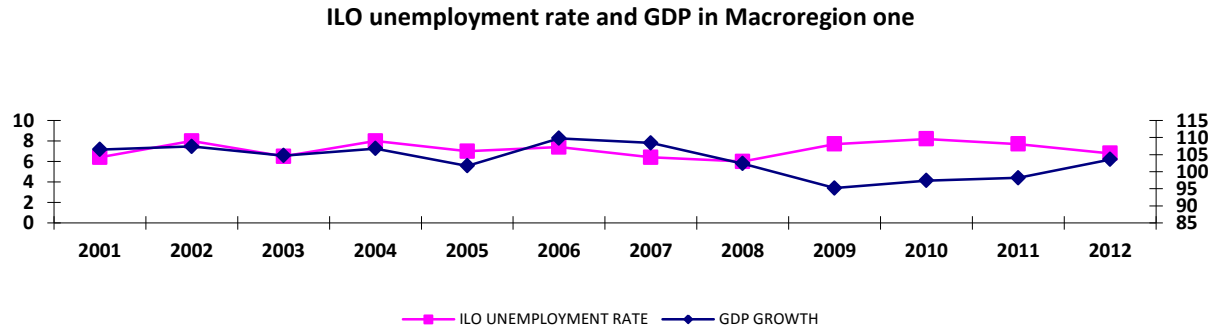

Fig.4. ILO unemployment rate and gross domestic product in Macroregion one

Fig.5. Registered unemployment rate and gross domestic product in Macroregion one

Although the registered unemployment rate values are slightly different values ILO unemployment rate, both indicators have almost the same trend. In this region we notice downward trend in unemployment in the North-West, while the Centre Region are maintained unemployment rates higher than the national level.

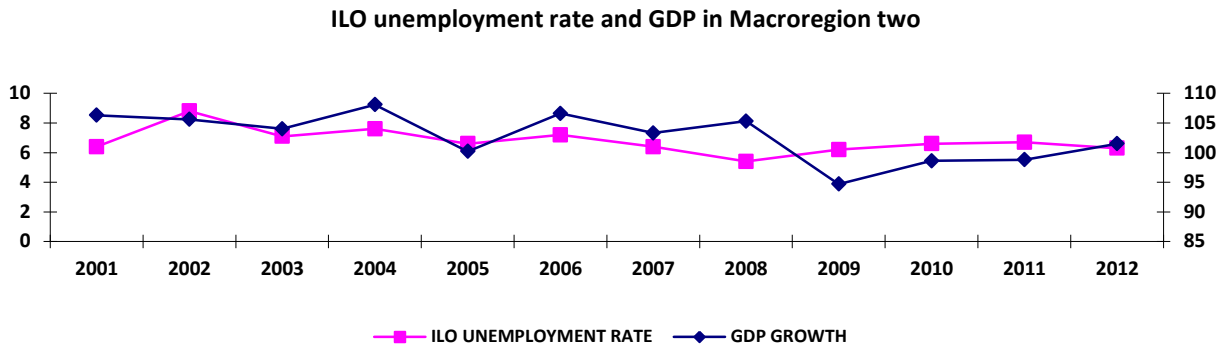

Fig.6. ILO unemployment rate and gross domestic product in Macroregion two

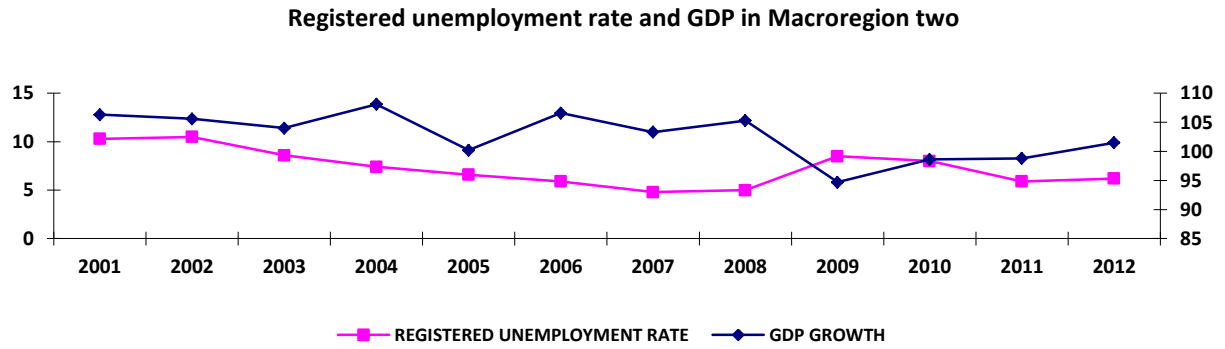

Fig.7. Registered unemployment rate and gross domestic product in Macroregion two

In Macroregion two, the registered unemployment rates are higher than those calculated according to the International Labour Office. But the downward trend until 2008 and the increasing trend after this year can be seen on both indicators.

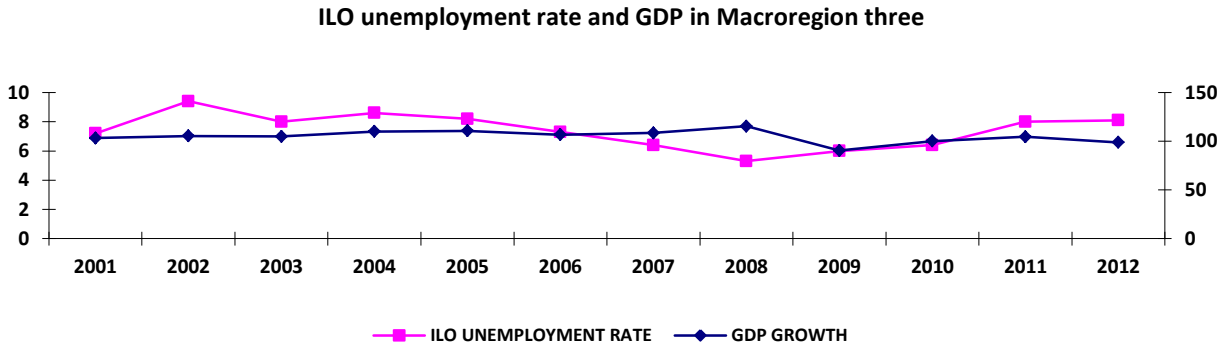

Fig.8. ILO unemployment rate and gross domestic product in Macroregion three

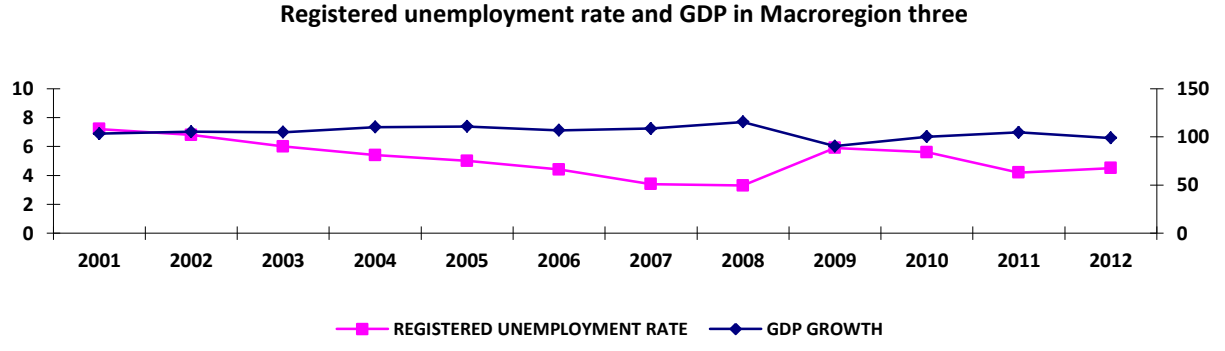

Fig.9. Registered unemployment rate and gross domestic product in Macroregion three

At this macroregion level is found in recent years a tremendous difference between the two indicators data that measure unemployment. In 2012, this difference is 4% in both regions: South - West Oltenia and West.

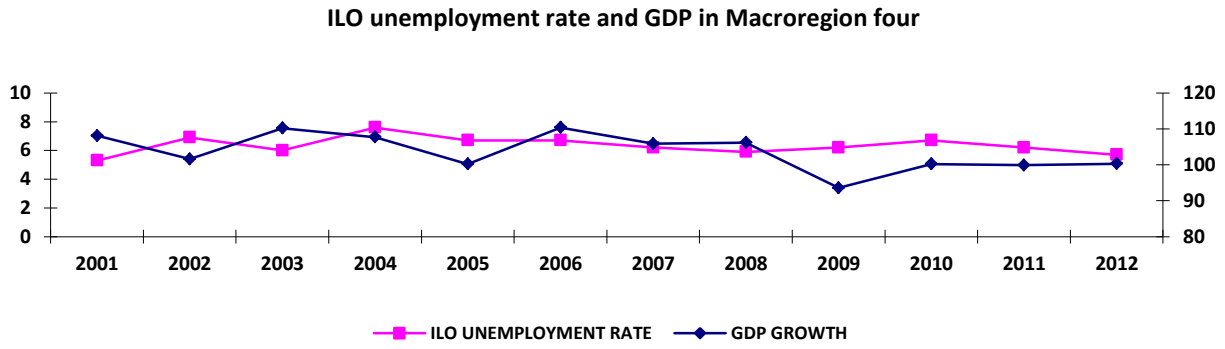

Fig.10. ILO unemployment rate and gross domestic product in Macroregion four

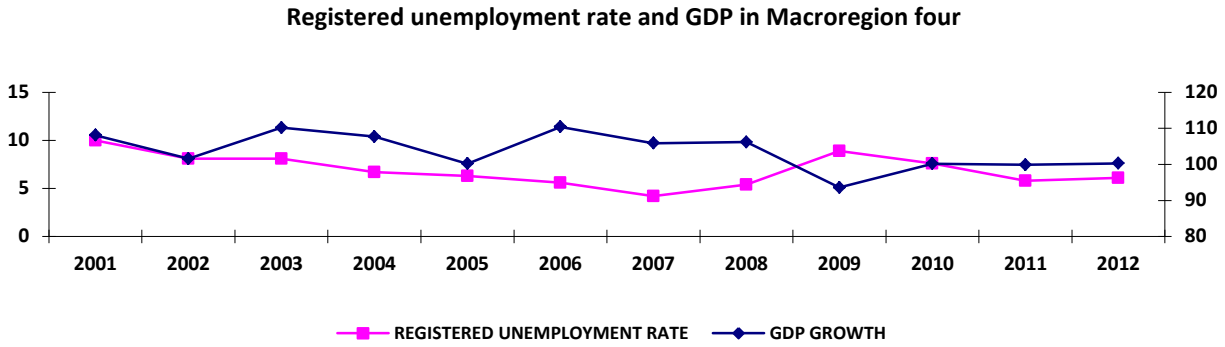

Fig.11. Registered unemployment rate and gross domestic product in Macroregion four

Evolution of the two indicators at Macroregion four captures the connection between them. The differences between the ILO unemployment rate and registered unemployment rates are much lower.

5. Conclusions

As highlighted in "Romania in figures - statistical abstract", "in the context of economic transition, Romania labor market has undergone significant changes in the volume and structure of the main indicators of labor". Thus, there was a process to reduce employment, while emphasizing the phenomenon of unemployment, especially since the second half of 2008. Analysis phenomenon of unemployment is necessary, because it has implications not only economic but also social. Many studies aimed at measuring the impact of unemployment on quality of life. As shown in recent studies EUROSTAT, 46.9% percent of unemployed in the European Union is below the poverty line. "Over this relatively place are the unemployed in Malta, Bulgaria, Hungary, Luxembourg, Romania, UK Latvia, Lithuania, Estonia, Germany. The lowest rates of poverty for the unemployed are registered in Denmark, Cyprus, the Netherlands, Belgium, Ireland, France and Porugalia"[2]). But it is not enough just analysis at national level. An analysis should be made at territorial level in order to find territorial disparities between the different administrative units. So, "the regional statistics plays an important role in formulating, implementing and evaluating the regional policies" as is shown in "Regional national accounts 2008-2012".

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Quantitative methods applied in the analysis of teenagers problems

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Abstract

The theme of the article is the study of teenagers problems based on quantitative methods, the scientific approach is divided into two parts: the part of knowledge and the practical approach. During the first part we describe the problems of adolescents based on national and international literature, and during the second part we use some quantitative methods (diagnosis, regression and investigation) we aim to achieve an in-depth analysis of the addressed topic. Through the diagnosis we highlight changes in numerical terms of the number of adolescents, and also their problems: poverty and delinquency.

Regression functions are used to show the nature, direction and intensity of the relationship between a number of causal variables and the outcome variable. The investigation aims to identify the extent to which cultural values of the country leave their mark on the perception of the importance of family and friends for teens. The main conclusions of the research points out the fact that the decrease in the number of Romanian teenagers their problems still persist.

Keywords: *adolescent, problems, obesity, aggression*

JEL Classification: *C 01, C12*

1. The knowledge part

Supporting young people and creating favorable conditions (European Commission, 2007) in order to develop their skills, to participate actively in society is essential for economic and social development of the European Union, particularly in the context of globalization, knowledge-based economics and aging societies, it is crucial that every young person is fulfilling their potential (Walthe A,Stauber B, 2009).The adolescence is a stage of emotional and intellectual personality restructuring, a process of individualization and physiological change. It is difficult to say at present time what is the end of teenage years judging by the extent of their personalization process. It constitutes a privileged field for studying psychological change. (http://www.medtorrents.com/download/Dictionar_de_psihologie-Roland_Doron-Humanitas.pdf). Tomorrow's Society relies on young people. Teenagers represent the foundation and for this they must be prepared to assume their quality towards the family, community and society which will enhance their development. Experts have played a vital role in the consolidation by generating basic knowledge also having an applicability character, the likelihood that adolescents become citizens able to make commitments is increasingly higher.

Stages of adolescence (Albu E, 2007):

1. Pre-teens. This is a step of biological maturity stabilization.
2. Adolescence itself or the great adolescence (from 16/18 to 20 years). It is characterized by an intensive intellectualization (development of abstract thinking)
3. Prolonged adolescence (from 18/20 to 25 years) includes youth already integrated into the labor market and students.

From the psychological perspective of adolescence, it is marked by the enablement and flourishing of the sexual instinct, shaping the socio-professional interests, the desire for freedom and autonomy, amplification of affective life. The intelligence diversifies, increase of the power of abstract thinking, specifying particular skills.

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The function of adolescence is to recognize the entire range of existing virtues, every possibility that will allow individuals to choose a path and engage in adult life. On the other hand is to discover more closely each human being he's surrounded by, himself and others and to establish new relations with the entourage: distancing from parents, and getting closer to their peers (friendship, love). Adolescents have rich social and dynamic virtues (Sillamy N, 1998). Recent studies using MRI analysis indicates that a wave of overproduction of gray matter on the thinking part of the brain occurs just before puberty. This thickening of gray matter appears around the age of 11 in girls and 12 in boys, after which the gray matter thins (Giedd J, Blumenthal J, 1999).There were identified some significant differences in the cognitive development of adolescents that concluded that their confidence in certain cognitive skills and abilities differ. Teen girls are more inclined to reading and social skills, while boys tend to feel more confident on the athletic side and math skills (Gentra J, 2002). An important issue for teens is obesity. Their predisposition to obesity can be inherited. Changes in society have led teenagers to consume fatty foods regularly, only when the sporting activity is reduced. Starting from DEX, obesity comes from the French word 'obese', is overgrowth of the body weight through an abnormal fattening due to accumulation of fat in various organs and tissues (http://www.bjmures.ro/bd/P/001/09 /P00109.pdf)

There is a number of environmental factors that contribute to obesity in adolescents (Rosenbaum, James. 2001):

1. The school stores sell products that are rich in fat,
2. Low income communities offer limited access to healthy food,
3. Adolescents live sedentary lives. Teens spend most of the school day in front of a TV or computer screen,
4. Physical education programs were reduced.

Optimum nutrition is the intake of nutrients that (Pasca M, 2009):

a. helps us achieve emotional balance and mental performance;
b. helps us achieve optimal mental performance;
c. Is associated with low incidence of health disease - ratio;
d. is associated with a long healthy lifestyle.

Aggression, another problem that teenagers face generate internal conflicts, conflicts regarding power or obligations, conflicts in families and couples, social conflicts. Without exception, people want more than anything to be loved and accepted. They want to feel that they have control over their own lives, but also know that they have a reliable support when life situations far outweigh their power to overcome the obstacles (Ispas C, 2011). In recent years different patterns of delinquency and antisocial behavior were observed (such as shoplifting, drug abuse, school dropout, robbery or breaking the rules of society) For most teenagers this behavior has an unidentified cause (Moffitt T, 1993). Psychology specialists draw attention to the resistance to change of young people. This should be seen as a function used in development. If a community is able to provide the relationships, resources, and commitment at the same time it can provide supports to adapt to change(Perry C, 2000).

The figure below shows the support and opportunities for teens.

Figure 1. Support oportunites for teans
Source: McNeely C, Blanchard J, The Teen Years Explained: A Guide to Healthy Adolescent DevelopmenCenter for Adolescent Health Johns Hopkins Bloomberg School of Public Health 615 N. Wolfe St., 2009.

Social support is seen as a protection for the adolescent from the impact of stress. There are a variety of ideas regarding sources of stress of teenagers. Even if their call for support has been demonstrated as functional strategy to cope with stress it was not applied by them. This, in turn, didn't help prevent the development of social-effective interventions (Camara M, Bacigalupe G, Padillahe P). The effects of a major disaster as seen by teens may vary depending on the extent to which it disrupts family and community functioning. The impact of the disaster may stimulate fears of loss of family relationships, peers and school life. Teens struggle to find their own identity. Signs announcing that young people face problem (Speier H, 2004):

- withdrawal and isolation;
- physical complaints (eg, headaches or stomach aches);
- depression and sadness;
- antisocial behavior (eg theft, aggressive behavior or acting out);
- school problems (eg disruptive behavior or avoidance);
- decline in academic performance;
- sleep disorders (eg withdrawal in heavy sleep, sleep terrors, or insomnia);
- confusion;
- risk-taking behavior;
- alcohol and other drugs;
- avoidance.

2. Study on the problems teenagers

2.1. Research methodology

The purpose of research - to identify the problems adolescents face.

Objectives:

1. The extent to which changes are manifested in terms of numbers of adolescents according to statistics last year;
2. Observing the problems facing the Romanian teenagers;
3. Knowing the nature and direction of the link between education and delinquency, poverty and delinquency,
4. The degree of importance of friends and family for teens.

Assumptions:

H1 - dynamic analysis of the number of teenagers in recent years reflects an involution trend;

H2 - Between education reflected by the rate of early school leaving and delinquency indicator reflected by the people sentenced to life imprisonment or rehabilitation centers there is a correlation;

H3 - poverty rate has no influence on the crime phenomenon among teenagers Romanian;

H4 - For most adolescents in Romania, Germany, Australia, Japan and the United States family and friends are important.

Organizing the research

Research focused on the analysis of secondary sources. As quantitative methods the simple linear regression and the questionnaire were used. The first method Romanian teenagers were used with the data from the National Statistics Institute. The second method - which is basically a comparative analysis of the perception of individuals on the importance of family and friends (Romania, Germany, Australia, Japan and the USA). This questionnaire was developed and applied by the representatives of the World Values Survey, and the data was retrieved and processed.

2.2. The results obtained

2.2.1. Statistics of adolescents in the country

The number of adolescents are shown in Tables 1 and 2.

Table 1. POPULATION BY RESIDENCE at 1st of July by age groups							
Ages and age groups	Years						
	1992	2010	2011	2012	2013	2014	2015
	UM: Number of people						
10-14 years	1887927	1158990	1156951	1151916	1139003	1128849	1124802
15-19 years	1909028	1255343	1220401	1178188	1165882	1150170	1152902

Source:http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=66

The data found in the table reflects the fact that the number of adolescents in the two age ranges from 1992 to 2015 reflect a stage of involution.

Table 2. Average number of members of a household by age and age groups and main social categories, by sex and area	
AIG - Age and age groups of the members of the household included in the selective research	**Years**
	Year 2000
	Number of people
Total	2,672
Under 14 years	0,384
14 years	0,041
15 years	0,04

Source: http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=66

According to statistics – the number of teenagers per household is 2.67.

Statistics of the adolescent problems can be seen in Tables 3 and 4.

Table 3. Persons definitively convicted in penitentiaries and rehabilitation centers by the length of sentences					
Punishment duration	**Years**				
	Year 2010	**Year 2011**	**Year 2012**	**Year 2013**	**Year 2014**
	UM: Number of people				
Life sentence	145	149	150	148	161

Source:http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=66

From 2010 until 2014 the number of crimes punishable with the life sentence in reeducation centers and prisons has increased by 16.

Table 4. The relative poverty rate by age groups

Age groups	Years			
	2010	2011	2012	2013
	UM: Percents			
0-17 years	31,3	32,9	34,6	32,1

Source: http://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=66

Adolescent poverty rate for the same reference period shows an average of 30%.

2.3. Quantitative methods of analysis of the teenager problems

2.3.1. Regression

In all cases it is applied the first-degree linear function using the correlation coefficient r.

The relationship between the rate of people dropping out school and juvenile delinquency

Table 5. Data Calculation

Years		x	y	xy	xx	xxy
2010	18.4	145	2668	338.56	49091.2	21025
2011	17.5	149	2607.5	306.25	45631.25	22201
2012	17.4	150	2610	302.76	45414	22500
2013	17.3	148	2560.4	299.29	44294.92	21904
Sum	70.6	**592**	10445.9	1246.86	184431.37	87630

r = -0.8832601 strong inverse link

x-rate of people who drop out of school early

y- Persons definitively convicted in penitentiaries and rehabilitation centers punished by life sentence

The link between education and poverty

Table 6. Calculating data

years	x	y	xy	xx	xxy	yy
2010	18.4	36.7	675.28	338.56	12425.15	1346.89
2011	17.5	35.8	626.5	306.25	10963.75	1281.64
2012	17.4	37.9	659.46	302.76	11474.6	1436.41
2013	17.3	34.1	589.93	299.29	10205.79	1162.81
Sum	70.6	**144.5**	2551.17	1246.86	45069.3	5227.75

r = 0.306209- weak link

x- rate of people who drop out of school early

y- rate of severe material deprivation, by age groups

The link between poverty and delinquency

Table 7. Data Calculation

years	x	y	xy	xx	xxy	yy
2010	31.3	145	4538.5	979.69	142055.1	21025
2011	32.9	149	4902.1	1082.41	161279.1	22201
2012	34.6	150	5190	1197.16	179574	22500
2013	32.1	148	4750.8	1030.41	152500.7	21904
Sum	**130.9**	**592**	19381.4	4289.67	635408.82	87630

r = 0.89712637 strong direct link

x- relative poverty rate for people in the age range of 0-18 years

y- Persons definitively convicted in penitentiaries and rehabilitation centers punished with the life sentence

2.3.2. Survey based on questionnaires

1. How important is family to teenagers

Table 8. The importance of family

	TOTAL					
		Australia	Germany	Japan	Romania	United States
Very important	88.7%	92.5%	77.6%	90.8%	93.1%	90.9%
Rather important	9.0%	6.1%	17.9%	6.8%	5.5%	7.3%
Not very important	1.4%	0.6%	3.6%	0.6%	1.1%	0.8%
Not at all important	0.4%	0.2%	0.6%	0.2%	0.2%	0.6%
BH: Missing; AR,DE,SE: Inapplicable;RU: Inappropriate response	0.1%	-	0.2%	-	-	-
No answer	0.2%	0.5%	-	-	0.1%	0.4%
Don´t know	0.4%	-	0.1%	1.6%	0.1%	-
(N)	(9,701)	(1,477)	(2,046)	(2,443)	(1,503)	(2,232)

Source: http://www.worldvaluessurvey.org/WVSOnline.jsp

At a rate of over 90% of the analyzed respondents consider that family is important for teens.

3. How important are friends for teenagers

Table 9. Importance of friends

TOTAL					
	Australia	Germany	Japan	Romania	United States
Very important	46.3%	55.6%	50.9%	45.0%	22.4%
Rather important	43.8%	37.5%	42.6%	47.0%	52.2%
Not very important	7.8%	3.5%	6.1%	5.4%	22.1%
Not at all important	0.9%	0.4%	0.3%	0.4%	3.1%

No answer	0.7%	3.0%	-	-	0.1%
Don't know	0.6%	-	-	2.2%	-
(N)	(9,701)	(1,477)	(2,046)	(2,443)	(1,503)

Source: http://www.worldvaluessurvey.org/WVSOnline.jsp

Most respondents think that friends are important to teenagers.

Conclusion

Adolescence is the transition from childhood to adult life and reflects the dynamic stages of evolution. It is characterized by a variety of changes in physical, cognitive, socio-emotional fields, basically presenting both opportunities and dangers for teens. The most important signs that indicate that a child becomes a teenager are reflected by the transformations the go through. The diagnosis in terms of the number of teenagers in our country for the reviewed period shows that there is a downward trend, and adolescent delinquency diagnosis reflects stages of evolution and regression. The poverty rate for the age range of 0-17 exceeds 30% throughout the analyzed period.

Among the analyzed statistical indicators: the rate of people dropping out of school and persons sentenced to life imprisonment in penitentiaries and rehabilitation centers shows a strong and inverse link. Thus, they influence each other, but the strong link is not a strong causal variable influence on the resulting variable, but is as causal variable influencing the outcome variable.

The relationship between education and poverty seen in terms of indicators: the ratio of persons dropping out of school and the severe material deprivation, by age groups shows that there is no connection, and this explains – the rate of severe material deprivation represents the share in total of population with severe material deprivation, ie persons aged 18 and over who, due to financial problems, cannot afford the basic things they need. The link between poverty and delinquency is strong and direct.

For the Romanian, Australian, German, Japanese and American teenage respondents the family and friends are important. Assumptions 1, 2 and 4 verify and assumption number 3 is not verified because the correlation of the coefficient between poverty and delinquency are direct and strong. In conclusion, the problems with an impact on teenagers are criminality and poverty.

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The long-term causality. A comparative study for some EU countries.

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Abstract

Confronted with the inadequacies of the macro econometric models of Keynesian inspiration, Sims (1980) formulates the famous criticism of Sims and proposes a multivariate modelling, where the only limitations are the choice of the selected variables and the number of integrated delays. An alternative to this formulation is the starting point of this article namely, only statistical data can confirm a theory. As it is well-known, the endogenous growth models usually examine all kinds of dependencies between macroeconomic variables. In this paper, we propose an analytical approach of some of these dependencies via the VAR approach, in order to put in evidence the causal effect and to do a comparative study of three EU countries Germany, France and Romania. The obtained results widely confirm the theoretical hypotheses of the endogenous growth models.

Keywords: *Vector Autoregressive model, economic growth, Causality Test.*

JEL classification: *C01, C32, C51.*

1. Introduction

The question I will try to give an answer in this paper is: Does investment in education necessarily enhance economic growth? There are compelling reasons that it should, but the empirical evidence does not always support this conclusion, as it follows from the paper of

Benhabib and Spiegel (1994). Other studies especially those realized by Psacharopoulos (1993) and Carnoy (1995), essentially show that there exists a positive relation between an individual's level of education, his or her productivity, and his or her earnings.

The macroeconomic analyses of growth appeared at the end of the 1990s, with the paper of Barro and Salla-i-Martin (1991), within a convergence framework. They were was the first to show that, for a given level of wealth, the economic growth rate was positively related to the initial level of human capital of a country, whereas for a given level of human capital, the growth rate was negatively related to the initial level of GDP per capita. Convergence, therefore, appears to be strongly conditioned by the initial level of education. One year later, Mankiw, Romer, and Weil (1992) assume that the level of saving, demographic growth and investment in human capital determine a country's stationary state. They also find that these different stationary states seem to explain the persistence of development disparities. Consequently, these different studies show that the variations of growth rates among countries can be explained partly by the initial level of human capital.

However, can we claim that a higher level of investment in education affects the growth path? That is, in terms of the economic convergence analyzed by Barro and Salla-i-Martin (1991), could investments in education modify the transitional path to equilibrium? It is difficult to formulate an answer to this question using only econometric techniques. As I mentioned above, it is this attempt to estimate the macroeconomic relation between investment in education and output that produces major contradictions. For this reason, my analysis requires two different approaches: the VAR model introduced by Christopher Sims in the early 1980s and the concept of causality.

The concept of causality was initially introduced by Wiener (1956) and later by Granger (1969) and constitutes a basic notion for studying dynamic relationships between time series. This concept is defined in terms of predictability at horizon one of a (vector) variable X from its own past and the past of another (vector) variable Y. Granger gave a very simple definition of the causality, which can be easily tested by econometric techniques.

Definition 1. *We say that the variable y_t causes the variable x_t, if the predicted error variance of the variable x_t obtained using both its past and the past of the variable y_t is lower than the forecast error variance of variable x_t obtained by knowing only its past:*

$$\sigma_{\epsilon}^{2}(x_t|x_{t-1}, x_{t-2}, \dots, y_{t-1}, y_{t-2}, \dots) \leq \sigma_{\epsilon}^{2}(x_t|x_{t-1}, x_{t-2}, \dots).$$

This theory, known our days as the theory of Wiener-Granger causality has generated a considerable literature. We mention here only reference work in the field of Geweke (1982).

For the case of a bivariate VAR model, the analysis of Wiener-Granger distinguishes among three types of causality: two unidirectional causalities (called feedbacks) from X to Y and from Y to X and an instantaneous causality associated with contemporaneous correlations. In practice, it is possible that these three types of causality coexist, hence the importance of finding means to measure their degree and determine the most important ones. Unfortunately, existing causality tests fail to accomplish this task, because they only inform us about the presence or the absence of causality. Geweke extended the causality concept by defining measures of feedback and instantaneous effects, which can be decomposed in time and frequency domains. This measure has been determined for a time horizon equal to unity and can not capture indirect causal effect, i.e. when an auxiliary variable Z does not influence directly the variable X, but indirectly through the variable Y.

Another issue that requires to be studied is the persistence of causality, or simply the manner in which it is transmitted. To understand this one we examine the following example. Let us consider the following stationary bivariate VAR(1) model:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} 0.50 & 0.70 \\ 0.40 & 0.35 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix} \qquad (1)$$

so that x_t is given by the equation:

$$x_t = 0.50x_{t-1} + 0.70y_{t-1} + u_t. \qquad (2)$$

Since the coefficient of $y_{(t-1)}$ in equation (2) is equal to 0.7, we can conclude that Y causes X in the sense of Granger. However, this does not give any information on causality at horizons larger than one nor on its strength. To study causality at horizon two, consider the system (1) at time t + 1 and obtain:

$$\begin{bmatrix} x_{t+1} \\ y_{t+1} \end{bmatrix} = \begin{bmatrix} 0.530 & 0.595 \\ 0.340 & 0.402 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} 0.50 & 0.70 \\ 0.40 & 0.35 \end{bmatrix} \begin{bmatrix} u_t \\ v_t \end{bmatrix} + \begin{bmatrix} u_{t+1} \\ v_{t+1} \end{bmatrix}. \qquad (3)$$

In particular, $x_{(t+1)}$ is given by

$$x_{t+1} = 0.530x_{t-1} + 0.595y_{t-1} + 0.50u_t + 0.70v_t + u_{t+1.} \qquad (4)$$

The coefficient of $y_{(t-1)}$ in equation (4) is equal to 0.595, so Y causes X at horizon two. But, how can one measure the importance of this long-run causality? Existing measures do not answer this question. Nevertheless, recent approaches have succeeded to clarify this issue, in a very simple manner. I mention in particular here the contributions of Dufour and Renault (1998), Dufour and Taamoutic (2010) who managed to define a causality measure at a time horizon h> 0, and those of Stern and Enflo (2013) who applied these techniques to study the effect of energy consumption on economic growth.

This paper has four sections. The first one is this introduction. The second section is dedicated to developing a VAR model which aims to highlight causality. Section three studies the causality between GDP per capita and investments allocated to education, and the last section presents some conclusions.

2. A measure of causality - a VAR approach

Education plays a crucial role in creating human capital, which contributes to production and economic growth just as physical capital and labor do. One of the arguments in support of the conclusion that investment in education does contribute to growth is that almost all countries with high level of economic growth have labor forces with high level of education. This standard of education was obviously obtained as a result of resources

allocated to education. On the other hand, it can also apparently be said that investment in education were in turn substantially determined by the level of development of each country.

Can we argue all these conclusions resulting from statistical observations by using mathematical models? If the answer is positive, for example, by using various statistical tests, then we can claim that the theoretical aspects correspond widely with the reality, as expected Sims. By doing in this way, we can obviously justify some of the theoretical aspects concerning the development of the endogenous growth models.

The starting point of the analysis I intend to develop in this paper is the model introduced by Dufour and Taamouti. I consider the case of a stationary bivariate VAR(1) model, where the two variables are: GDP per capita and investment in education, denoted here by X and by Y.

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \varphi_{xx} & \varphi_{xy} \\ \varphi_{yx} & \varphi_{yy} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix} \qquad (5)$$

where u_t and v_t are uncorrelated white noise stochastic processes with zero means and constant variances, sometimes called innovations. The assertion that the model is stationary, is actually equivalent to the claim that the absolute value of the roots of the lag polynomial

$$det[\Phi(L)] = det[I_2 - \phi L]$$

are all superior to one. ϕL simply signify the multiplication of matrix ϕ with variable L. Let denote by Φ*(L) the adjoint matrix of the matrix Φ(L), given by:

$$\Phi^*(L) = \begin{bmatrix} 1 - \varphi_{yy}L & \varphi_{xy}L \\ \varphi_{yx}L & 1 - \varphi_{xx}L \end{bmatrix} \qquad (6)$$

then we obviously have

$$\Phi^*(L)\Phi(L) = det[\Phi(L)]I_2 \qquad (7)$$

and finally obtain:

$$\mathrm{Det}[\Phi(\mathrm{L})] = 1 - (\varphi_{xx} + \varphi_{yy})\mathrm{L} - (\varphi_{xy}\varphi_{yx} - \varphi_{xx}\varphi_{xx})\mathrm{L}^2. \qquad (8)$$

In matrix form, the model (5) can also be written:

$$X_t = \phi X_{t-1} + U_t, \qquad \phi = \begin{bmatrix} \varphi_{xx} & \varphi_{xy} \\ \varphi_{yx} & \varphi_{yy} \end{bmatrix}, \; X_t = \begin{bmatrix} x_t \\ y_t \end{bmatrix}, \; U_t = \begin{bmatrix} u_t \\ v_t \end{bmatrix} \qquad (9).$$

Under stationarity, X_t is characterized by the following autoregressive moving average representation VMA(∞).:

$$X_t = \sum_{j=0}^{\infty} \psi_j U_{t-j}, \qquad \text{where } \psi_j = \phi^j \text{ si } \psi_0 = \phi^0 = I_2. \qquad (10)$$

The results obtained in this paper, use the lemma 5.1 of the paper of Dufour and Taamouti and for that reason I shall give here a short presentation.

Let u_t be a bidimensional white noise process with nonsingular variance-covariance matrix Σ_u and let

$$W_t = \mu + \sum_{j=1}^{q} \psi_j u_{t-j} + u_t \qquad (11)$$

be a bidimensional invertible VMA(q) process. Furthermore, let F= [1 0]. Then the one dimensional process V_t=FW_t, has an invertible VMA($\bar{q}$) representation:

$$V_t = F\mu + \sum_{j=1}^{\bar{q}} \bar{\theta}_j \varepsilon_{t-j} + \varepsilon_t, \quad \bar{q} < q \qquad (12)$$

where ε_t is one dimensional white noise with nonsingular variance σ_ε^2, and $\theta_j, j = 0, 1, \ldots, \bar{q}$ are constant coefficients that can be determined by solving the system:

$$\gamma_\varepsilon(i) = \gamma_u(i), \; i = 0, 1, \ldots \qquad (13)$$

$\gamma_\varepsilon(i)$ and $\gamma_u(i)$ represent the auto-covariance functions $\theta(L)\varepsilon_t$ and $F\Phi^*(L)\Theta(L)u_t$. Dufour and Taamouti proved that the marginal representation of x_t can be written:

$$\det[\Phi(L)]x_t = F\Phi^*(L)U_t. \qquad (14)$$

Combining now the equations (8) and (14) obtain

$$x_t - \varphi_1 x_{t-1} - \varphi_2 x_{t-2} = \varphi_{xy} v_{t-1} - \varphi_{yy} u_{t-1} + u_t, \qquad (15)$$

$$\varphi_1 = \varphi_{xx} + \varphi_{yy} \text{ and } \varphi_2 = \varphi_{xy}\varphi_{yx} - \varphi_{xx}\varphi_{yy}.$$

Observe now that the right-side of equation (15), denoted by $\omega_{(t,)}$ is the sum of an MA(1) process and a white noise process. By Lemma 5.1, $\omega_{(t,)}$ has an MA(1) representation

$$\omega_t = \bar{\theta}\varepsilon_{t-1} + \varepsilon_t. \qquad (16)$$

To determine parameters $\bar{\theta}$ and σ_ε^2 in terms of the parameters of the unconstrained model, we can solve system (13) for v = 0 and v = 1,

$$\mathrm{Var}(\omega_t) = \mathrm{Var}\left(\varphi_{xy} v_{t-1} - \varphi_{yy} u_{t-1} + u_t\right) \qquad (17)$$

$$\mathrm{Cov}[\omega_t, \omega_{t-1}] = \mathrm{E}\left[\left(\varphi_{xy} v_{t-1} - \varphi_{yy} u_{t-1} + u_t\right)\left(\varphi_{xy} v_{t-2} - \varphi_{yy} u_{t-2} + u_{t-1}\right)\right] \qquad (18)$$

and finally obtain:

$$(1 + \bar{\theta}^2)\sigma_\varepsilon^2 = \left(1 + \varphi_{yy}^2\right)\sigma_u^2 + \varphi_{xy}^2\sigma_v^2, \quad \bar{\theta}\sigma_\varepsilon^2 = -\varphi_{yy}\sigma_u^2 \qquad (19)$$

because Cov(u,v)=0.

Here we have two equations and two unknown parameters $\bar{\theta}$ and σ_ε^2. These parameters must satisfy the constraints $\sigma_\varepsilon^2 > 0$ and $|\bar{\theta}| < 1$. To quantify the degree of causality from Y to X at horizon h, we first consider the unconstrained and constrained models of process X. The unconstrained model is

$$x_t = \varphi_{xx} x_{t-1} + \varphi_{xy} y_{t-1} + u_t \qquad (20)$$

whereas the constrained model is

$$x_t = \varphi_1 x_{t-1} + \varphi_2 x_{t-2} + \bar{\theta}\varepsilon_{t-1} + \varepsilon_t \qquad (21)$$

Second, we need to calculate the variance-covariance matrices of the unconstrained and constrained forecast errors of X(t + h). According to Dufour and Taamouti, we can immediately deduce the causality measure from Y to X denoted by $\mathrm{CL}_{yx}(h)$ at any horizon h using only the unconstrained parameters. This is given by:

$$\mathrm{CL}_{yx}(h) = \ln\left[\frac{\mathrm{Var}[x_{t+h}|x_t]}{\mathrm{Var}[x_{t+h}|x_t, y_t]}\right] \qquad (22)$$

where $\mathrm{Var}[x_{t+h}|x_t]$ represents the variance of the forecast errors of the constrained model given by (21), and $\mathrm{Var}[x_{t+h}|x_t, y_t]$ represents the variance of the forecast errors of the unconstrained model given by (20). In terms of predictability, this can be viewed as the amount of information brought by the past of Y that can improve the

forecast of X(t+h). Following Geweke, this measure can be also interpreted as the proportional reduction in the variance of the forecast error of X(t + h) obtained by taking into account the past of Y.

The two variances can be determined as follows (see Dufour and Taamouti):

$$V_1(h) = \mathrm{Var}[x_{t+h}|x_t, y_t] = \sum_{i=0}^{h-1} F\psi_i \Sigma_u \psi_i^T F^t \qquad (23)$$

$$V_2(h) = \mathrm{Var}[x_{t+h}|x_t] = \sum_{i=0}^{h-1} F\bar{\psi}_i \Sigma_\varepsilon \bar{\psi}_i^T F^t \qquad (24)$$

where $\bar{\psi}_i$can be determined in the same way as $\psi_i$from equation (10). Obviously this measure causality is non-negative and is zero, only is there is no causal relationship between the two variables. The causality is higher, the higher is the measure. In terms of predictability, this could be interpreted by the amount of information brought by the variable y in predicting variable x.

For the case of a VAR model (1) we can analytically determine causality measure at a horizon equal to h, using only unrestricted model parameters. For example, the measure causality from Y to X, from a horizon equal to one and two, are given by very simple relations (see Dufour and Taamouti, working paper version).

3. Causality GDP - Investment in education

The data necessary to this study refers to gross domestic product and investment for education, both in terms of per-capita quantities, in 2005 constant prices and were obtained for the three countries, namely France, Germany and Romania, from database of the World Bank. As expected, these series are not stationary, an assertion confirmed with Dickey-Fuller test. Consequently, we used the transformed time series, i.e. in differences of logarithm to eliminate in this way potential serial correlation. According to the same test, the transformed time series are all stationary. Then, using a conventional model to estimate the parameters of the model VAR (1) we obtained the following results for the three countries:

Romania:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} 0.0147 \\ -0.0019 \end{bmatrix} + \begin{bmatrix} 0.445348 & 0.118334 \\ 0.990355 & 0.122812 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix}$$

Germany:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} 0.0100 \\ 0.0144 \end{bmatrix} + \begin{bmatrix} -0.100967 & 0.177284 \\ 0.050164 & 0.487530 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix}$$

France:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} 0.0026 \\ 0.0181 \end{bmatrix} + \begin{bmatrix} 0..356579 & 0.198782 \\ -0.143363 & 0.122613 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix}$$

The roots of the lag polynomials are: (-10.60; 1.51), (-8.64; 1.99) and respectively (3.32 + 1.69i; 3.32-1.69i). As we can see, all these roots are superior to one, in absolute value, and consequently I can claim that the three VAR (1) models are stationary. Using now the relations (23), (24) and the residual variances of the three models estimated above, we can determine a measure of causality for a horizon equal to one and two.

I. We will analyze in a first stage the causality relation between investment in education and gross domestic product. Below is presented in a detailed manner the computational procedure, only for the Romanian economy.

1. We first determine the prediction of error variance of variable x, at a horizon equal to one and then equal to two, using both its own past and that of the variable y. Using equation (23) for h = 1 and he = 2 we have:

$$V_1(1) = [1 \quad 0]\begin{bmatrix}\varphi_{xx} & \varphi_{xy}\\ \varphi_{yx} & \varphi_{yy}\end{bmatrix}^0\begin{bmatrix}\sigma_u^2 & \sigma_{uv}\\ \sigma_{vu} & \sigma_v^2\end{bmatrix}\begin{bmatrix}\varphi_{xx} & \varphi_{yx}\\ \varphi_{xy} & \varphi_{yy}\end{bmatrix}^0\begin{bmatrix}1\\0\end{bmatrix} = 0.00070049$$

$$V_1(2) = V_1(1) + [1 \quad 0]\begin{bmatrix}\varphi_{xx} & \varphi_{xy}\\ \varphi_{yx} & \varphi_{yy}\end{bmatrix}\begin{bmatrix}\sigma_u^2 & \sigma_{uv}\\ \sigma_{vu} & \sigma_v^2\end{bmatrix}\begin{bmatrix}\varphi_{xx} & \varphi_{yx}\\ \varphi_{xy} & \varphi_{yy}\end{bmatrix}\begin{bmatrix}1\\0\end{bmatrix} = 0.00087966.$$

2. We will now determine the prediction error variance of the variable x using only its past. . $\bar{\theta}$ and σ_ε^2 are given by the relations (19). $\bar{\theta} = -0.11605$ and $\sigma_\varepsilon^2 = 0.00074131$. We now need to determine the structure of the model restricted to a horizon of t + 1 and t + 2 then. Applying equation (21) we obtain

$$x_{t+1} = \varphi_1 x_t + \varphi_2 x_{t12} + \bar{\theta}\varepsilon_t + \varepsilon_{t+1},$$

$$x_{t+2} = (\varphi_1^2 + \varphi_2)x_t + \varphi_1\varphi_2 x_{t-1} + \varphi_1\bar{\theta}\varepsilon_t + (\varphi_1 + \bar{\theta})\varepsilon_{t+1} + \varepsilon_{t+2}$$

from where we it follows:

$$V_2(1) = \sigma_\varepsilon^2 = 0.00074131 \text{ and } V_2(2) = [(\varphi_1 + \bar{\theta})^2 + 1]\sigma_\varepsilon^2 = 0.00089284.$$

Substituting these results into the relation (22), we get:

$$CL_{xy}(1) = 0.0566 \text{ and } CL_{xy}(2) = 0.0148.$$

The complete results concerning the causality between investment in education and gross domestic product are presented in the table below.

Country	**$V_1(1)$ (10^{-3})**	**$V_1(2)$ (10^{-3})**	**$V_2(1)$ (10^{-3})**	**$V_2(2)$ (10^{-3})**	**CL(1)**	**CL(2)**
Romania	0.7005	0.8790	0.7410	0.8930	0.0566	0.0148
Germany	0.5006	0.5371	0.5409	0.5431	0.0773	0.0111
France	0.1976	0.2707	0.2461	0.2818	0.2196	0.0403

II. Proceeding in the same way as above, we can now examine the causal relationship between GDP and investment in education. In this case, the vector F of the equation (14) is of the form $F = [0 \quad 1]$ and the equation (15) is written as follows:

$$y_t - \varphi_1 y_{t-1} - \varphi_2 y_{t-2} = \varphi_{yx} u_{t-1} - \varphi_{xx} v_{t-1} + v_t, \qquad (15')$$

that finaly gives:

$$(1 + \bar{\theta}^2)\sigma_\varepsilon^2 = (1 + \varphi_{xx}^2)\sigma_v^2 + \varphi_{yx}^2\sigma_u^2, \quad \bar{\theta}\sigma_\varepsilon^2 = -\varphi_{xx}\sigma_v^2 \qquad (19')$$

1. We first determine the prediction of error variance of variable y, at a horizon equal to one and then equal to two, using both its own past and that of the variable x. Using the same equation (23), but this time with $F = [0 \quad 1]$, for h = 1 and he = 2 we have:

$$V_1(1) = [0 \quad 1]\begin{bmatrix}\varphi_{xx} & \varphi_{xy}\\ \varphi_{yx} & \varphi_{yy}\end{bmatrix}^0\begin{bmatrix}\sigma_u^2 & \sigma_{uv}\\ \sigma_{vu} & \sigma_v^2\end{bmatrix}\begin{bmatrix}\varphi_{xx} & \varphi_{yx}\\ \varphi_{xy} & \varphi_{yy}\end{bmatrix}^0\begin{bmatrix}0\\1\end{bmatrix} = 0.00287299$$

$$V_1(2) = V_1(1) + [0 \quad 1]\begin{bmatrix}\varphi_{xx} & \varphi_{xy}\\ \varphi_{yx} & \varphi_{yy}\end{bmatrix}\begin{bmatrix}\sigma_u^2 & \sigma_{uv}\\ \sigma_{vu} & \sigma_v^2\end{bmatrix}\begin{bmatrix}\varphi_{xx} & \varphi_{yx}\\ \varphi_{xy} & \varphi_{yy}\end{bmatrix}\begin{bmatrix}0\\1\end{bmatrix} = 0.00360337.$$

2. We will now determine the prediction error variance of the variable y using only its past. $\bar{\theta}$ and σ_ε^2 are given by the relations (19'). $\bar{\theta} = -0.34715$ and $\sigma_\varepsilon^2 = 0.00368568$. We now need to determine the structure of the model restricted to a horizon of t + 1 and t + 2 then. Applying equation (21), written this time for y, we obtain:

$$y_{t+1} = \varphi_1 y_t + \varphi_2 x_{t-2} + \bar{\theta}\varepsilon_t + \varepsilon_{t+1},$$

$$y_{t+2} = (\varphi_1^2 + \varphi_2)y_t + \varphi_1\varphi_2 y_{t-1} + \varphi_1\bar{\theta}\varepsilon_t + (\varphi_1 + \bar{\theta})\varepsilon_{t+1} + \varepsilon_{t+2}$$

from where it follows that:

$$V_2(1) = \sigma_\varepsilon^2 = 0.00368568 \text{ and } V_2(2) = [(\varphi_1 + \bar{\theta})^2 + 1]\sigma_\varepsilon^2 = 0.00386571.$$

Substituting these results into the relation (22), modified for the causality x→y, we get:

$$CL_{yx}(1) = 0.2491 \text{ and } CL_{yx}(2) = 0.0703.$$

The complete results concerning the causality between gross domestic product and investment in education are presented in the table below.

Country	$V_1(1)$ (10^{-3})	$V_1(2)$ (10^{-3})	$V_2(1)$ (10^{-3})	$V_2(2)$ (10^{-3})	CL(1)	CL(2)
Romania	2.873	3.603	3.686	3.866	0.2491	0.0703
Germany	0.998	1.237	0.999	1.237	0.00127	0.00015
France	1.213	1.235	1.218	1.236	0.00383	0.00086

4. Conclusions and consequences

Analyzing the above results we can conclude that in all three cases the causality measure is positive and persistent, both in terms of the effect of investment in education on gross domestic product and in terms of the reverse effect. In terms of numerical dimensions, they confirm the importance given to education in the three countries. Although for the French economy, the level of causality seems to be a little bit excessive compared with that of Germany, although it reflects undoubtedly a trend - France is among the European countries which allocates considerable resources in the education. Furthermore, it is the country where the private education system is almost non-existent.

Romanian economy presents the lowest degree of causality, which can only confirm the extremely low resources allocated to education. However, what can be seen from the results is that with increasing gross domestic product, investment in education began to increase substantially, claim justified by the coefficient CL (1) of the final table.

What can be seen from the above results is that in Germany and France, the causal effect of GDP on investment in education is significantly lower than that of the causal effect of investment in education on gross domestic product, while in Romania, it is exactly the opposite. This can be explained by the fact that the two countries have reached a level of relative stability in the resources allocated to education. In Romania, however, these results confirm that further efforts are still required to finance education system.

Obviously, the analysis can be questioned here by the limited number of statistical data taken into account - the period 1991-2013, but this was the only available period, particularly for the Rumanian economy.

Acknowledgement

This work was financially supported through the project "Routes of academic excellence in doctoral and post-doctoral research-READ" co-financed through the European Social Fund, by Sectoral Operational Programme Human Resources Development 2007-2013, contract no POSDRU /159/1.5/S/137926.

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