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FOREIGN DIRECT INVESTMENTS - A FORCE DRIVING TO ECONOMIC GROWTH. EVIDENCE FROM EASTERN EUROPEAN COUNTRIES

Abstract. *The objective of this study is to put into question the impact of foreign direct investments on economic growth, based on an analysis made on seven East-European countries, for the period 1993 - 2008. For this purpose we have resorted to panel OLS and GMM fixed and random effects estimations for first difference series, the results obtained being in compliance with the economic theory. Also panel cointegration and causality techniques have been used, considering the presence of heterogeneity in the estimated parameters and dynamics across countries. The overall results show that foreign direct investments exert a direct and positive influence on the target countries, both in the short-run and in the long-run, thus improving their economic growth and reducing the technological gap with the leading country. The Granger causality revealed a bidirectional relationship: the causality goes not only from FDI to economic growth but also in the reverse direction, suggesting that an increase in FDI will cause an increasing FDI-GDP chain reaction effect. Therefore, we insist on the importance of taking any necessary measures fit for stimulating foreign direct investments in the analyzed countries so as to ground their overall well-being.*

Keywords: *economic growth, foreign direct investments, spillover effects, panel analysis, cointegration*

JEL Classification: F21, F43

1. Introduction

Recently, an increasing attention has been paid to the study of the impact of foreign direct investments (FDI) on economic growth. Considering the population increase rate, economic growth appears as an essential mechanism for raising if not at least maintaining the standard of living of societies. This is the reason why it is highly important to analyze the key factors supposed to lead to economic development, in order to be able to take any appropriate measures to stimulate the positive influencing and to annihilate the negative influencing factors.

Consecrate theoretical models use FDI as one of the variables exerting certain influence on economic growth. Within the neoclassical growth model (Solow, 1957), FDI is deemed to contribute to economic growth as the latter may be supported by the augmentation of the volume of investments and/or by the increase of their efficiency. Instead, the endogenous growth theory (Romer, 1986, 1987; Lucas, 1988) underlines the role of science and technology, human capital and externalities in economic development. FDI influences economic growth by acting as an engine of technological diffusion coming from the developed world and being directed towards the target country (Borensztein, Gregorio, & Lee, 1998). FDI is seen as a mix of capital stock, technology and know-how, being an instrument fit for the increase of the existing stock of knowledge of the target economy by labour training, skill acquisition and diffusion, and by using alternative and adaptive management practices, thus providing substantial spillover effects (Balasubramanyam, Salisu, and Sapsford, 1996 and De Mello, 1999). This new growth theory has developed under the circumstances of an increasingly globalisation and world economy integration trend, FDI playing an important role in this process (Kreuger, 1975; Greenaway and Nam, 1988).

However, as revealed in “Literature Review”, unlike the existing theoretical studies, the empirical ones deal with various controversies on this topic, the impact of FDI on growth being contested by various authors. While some studies evidence a positive influence of FDI on economic growth, others indicate a negative impact, a reverse or a bi-directional relationship between these two variables or even no causality relationship at all.

In this paper we intend to call into question the existing of a direct and positive impact of FDI on economic growth. Starting from the premises that many controversial results have been caused by data insufficiency or by the use of cross-country or time-series investigations that do not evidence all facets of this complex issue, we further undertake to make use of panel data in order to capture the continuously evolving country-specific differences, thus eliminating many of the difficulties encountered in other types of estimations.

We will focus on the economy of seven Eastern European countries, namely: Romania, Bulgaria, Hungary, Poland, Moldova, Czech Republic and Slovak Republic, for the period 1993-2008, considering, by applying the methodology of panel cointegration and causality, the presence of heterogeneity in the estimated parameters and dynamics across countries.

The structure of our paper is as follows: section 2 renders a brief literature review, being followed by section 3 with the presentation of the approached model and data and section 4 depicting the methodology and empirical results obtained. The paper ends with conclusions in section 5 and suggestions for further research in section 6.

2. Literature Review

The impact of FDI on economic growth seems to have various facets, as rendered by the series of empirical studies considered, grouped according to the specific empirical results obtained.

Positive effects of FDI on growth or productivity are identified by Li and Liu (2005), who resorted to panel data for 84 countries between 1970 and 1999 and approached random/fixed effects estimations, finding a significant endogenous relationship FDI-economic growth from the mid-1980s onwards. FDI influences economic growth not only directly but also indirectly by means of its interaction terms. Also positive results, but conditional on certain levels of human capital, infrastructure, financial market development and trade policy of the target country were obtained by Lai et al.(2006) who aimed to investigate the relationship between international technology spillovers, the host country's absorptive capability and endogenous economic growth and revealed that long-run growth arose from improvements in absorptive capability and higher human capital stocks, while the relationships between openness, the technology gap and the steady-state growth rate were uncertain. Econometric estimates of China's economic growth, obtained using data covering the period 1996–2002, indicated that technology spillovers depended on the target country's investment in human capital and on the degree of openness, and that FDI was a more significant spillover channel than imports. Kinoshita et al. (2006) highlighted the role of infrastructure as one of the most important determinants for enhancing the efficiency of FDI. In overlapping generational model, the degree of technology spillover is determined by FDI inflows and technology gap conditional on the country's infrastructure level. A panel data of 42-non OECD developing countries for the period 1970-2000 is selected, the empirical analysis being based on a reduced form approach. The main finding was that FDI by itself does not represent a panacea for economic development, the target country having to undertake infrastructure investment prior to attracting FDI so as to maximize the incidence of technology spillover from FDI.

Yet, several authors did not find a clear or significant relationship between foreign direct investments and economic development. Carkovic and Levine (2005) have criticized the existing empirical studies as not fully controlling for simultaneity bias, country-specific effects and the use of lagged dependent variables in their growth regressions. They used ordinary least squares (OLS) and generalized method of moments (GMM) techniques on cross-section and panel data and assessed the FDI-growth relationship for 72 countries covering the period 1960-1995, their findings suggesting that FDI does not exert a robust, independent influence on economic growth. Herzer et al. (2008) challenged the belief that FDI usually has a positive impact on economic growth in developing countries, reexamining the FDI-led growth hypothesis for 28 developing countries by using cointegration techniques on a country-by-country basis. The paper revealed that in the vast majority of countries, there exists neither a long-term nor a short-term effect of FDI on growth. Furthermore, their results indicated that there was no clear association between the growth impact of FDI and the level of per capita income, the level of education, the degree of openness and the level of financial market development in developing countries. By applying techniques of panel cointegration and panel error correction models for a set of 37 countries using annual data for the period 1970-2002, Lee and Chang (2009) have explored the directions of causality among FDI, financial development, and economic growth and obtained solid evidence of a strong long-run relationship. Besides, the financial development indicators proved to have a larger effect on economic growth than FDI. Overall, the findings underscored the potential gains associated with FDI when coupled with financial development in an increasingly global economy.

Contrasting results have been obtained by Bende-Nabende et al. (2003) who, by using the Johansen cointegration methodology and resultant Vector Error Correction Models within a panel framework, found that the direct long-term impact of FDI on output is significant and positive for comparatively economically less advanced Philippines and Thailand, but negative in the more economically advanced Japan and Taiwan. The absorptive abilities of Philippines and Thailand are clearly lower than those of Japan and Taiwan. Their finding seemed to be consistent with that of Sjoholm (1999) at the micro-level; the larger the technology gap between domestic and foreign establishments, the greater the productivity spillovers. Onaran and Stockhammer (2008) have estimated the effect of FDI and trade openness on average wages by sectors in the manufacturing industry of 5 countries Central and East European countries in the post-transition era, by using cross-country sector-specific econometric analysis based on panel data for 2000-2004. The results suggested that in the short-run, productivity had a weak effect on wages, unemployment a strong one, FDI a positive one mainly driven by the capital intensive and skilled sectors, and international trade, none. Yet, in the medium-run, the effects of productivity remained modest, that of unemployment became stronger, while the effect of FDI turned negative.

The above literature review suggests that the impact of FDI on economic growth remains extremely controversial, partly due to the use of different samples and partly due to various methodological problems. Therefore, the relationship between FDI and economic development remains far from conclusive. The role of FDI seems to be country or period-based, and it can be positive, negative or insignificant, depending on the economic, institutional and technological conditions of the target economy.

3. Model and Data

After having considered the main influencing factors impacting on GDP, we resorted to 4 explanatory variables of economic growth, therefore grounding our study based on the following linear model.

$$GDP_{it} = \alpha + \beta_1 FDI_{it} + \beta_2 DI_{it} + \beta_3 TG_{it} + \beta_4 INF_{it} + \varepsilon_{it} \quad (1)$$

where ε_{it} is the stochastic error term, and β_1, β_2, β_3 and β_4 are the parameters to be estimated.

We have used in our model annual data on 5 variables:

- gross domestic product per capita (GDP);
- net overall inflows of foreign direct investments (FDI);
- domestic investments (DI) ;
- technological gap (TG), rendered by the economic gap, computed as the difference between the output level per capita of a leading country and that of country *i*, divided by the GDP per capita of country *i* (Li and Liu, 2004), where USA is selected as leading country:

$$TG_{it} = \frac{GDP_{USAt} - GDP_{it}}{GDP_{it}} \quad (2)$$

all the above-mentioned variables being expressed in U.S. dollars, at constant 2000 prices;

- infrastructure (INF), obtained by resorting to Principal Component Analysis, based on road density, energy consumption and telephone lines.

In order to standardize our data we have used some variables in natural logarithm (l_GDP, l_FDI and l_DI).

All data used in this paper were obtained from the World Development Indicators 2009 of the World Bank. All estimates were performed by using Eviews 7.0 software.

4. Methodology and empirical results

4.1. Panel unit root tests

Testing the stationarity of variables has become one of the main issues to be approached when performing an econometric analysis, since Granger and Newbold (1974), Dickey-Fuller (1979) and Philips-Perron (1988). When dealing with panel data, the range of available root tests extends. Here we have: Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Fisher-type tests using ADF and PP tests (Maddala and Wu, 1999 and Choe, 2001), and Hadri (2000). Such tests are in fact multiple-series unit root tests applied to panel data structures (the existing cross-sections generating multiple series out of one series).

We begin by classifying the unit root tests on the basis of whether there are or not restrictions on the autoregressive process across cross-sections or across series.

Let's take the following AR(1) process for panel data:

$$y_{it} = \theta_i y_{it-1} + X_{it}\omega_i + \varepsilon_{it} \quad (3)$$

where: i - cross-section; $i = 1, 2, ... N$
t - time period; $t = 1, 2, ... T$

X_{it} - represents the model exogenous variables, θ_i are the autoregressive coefficients, and the errors ε_{it} is the error term. If $|\theta_i| < 1$ then y_i is deemed to be weakly stationary. On the other hand, if $|\theta_i| = 1$ then y_i contains unit root.

In order to test if data are stationary, we can make two assumptions relating to θ_i. We can assume either that the persistence parameters are common across our cross-sections, meaning that $\theta_i = \theta$ for any i (assumption considered by Levin, Lin, and Chu (LLC), Breitung, and Hadri tests), or that θ_i varies across cross-sections (Im, Pesaran, and Shin (IPS), and Fisher-ADF and Fisher-PP tests). Therefore, IPS and Fisher relax the identical assumption and estimate an ADF test equation for each and every individual.

Maddala and Wu (1999) resorted to a comparison between these tests and found that, on one hand, when there is no cross-sectional correlation in the errors, the IPS test is more powerful than the Fisher one and, on the other hand, when dealing with the issue of heteroscedasticity and serial correlation of errors, the Fisher test is better than the LL or IPS test. Besides, for medium values of T and large N, the scale of distortion of the Fisher test is of the same level as that of the IPS test. In cases of a mixture of stationary and non-stationary series in the group, the Fisher test is the best. One of the Fisher test disadvantages is that the critical values are to be derived by Monte Carlo simulation. The IPS test is easy to be used as tables of the critical values are made available in the same framework. Therefore, we have decided to use in our paper the IPS test in order to see if the selected series are stationary.

Im, Pesaran, and Shin begin by specifying a separate ADF regression for each cross section:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{\theta_i} \beta_{ij} \Delta y_{it-j} + X'_{it}\,\omega + \varepsilon_{it} \tag{4}$$

where the null hypothesis (the series contains a unit root I(1)) might be rendered as follows:

$$H_0: \ \alpha_i = 0 \quad for \quad i = 1,2,...N$$

while the alternative hypothesis (some cross-sections do not have unit root) shall be:

$$H_1: \begin{cases} \alpha_i = 0 & for \quad i = 1,2,...N_1 \\ \alpha_i < 0 & for \quad i = N_{1+1}, N_{1+2},...N \end{cases}$$

IPS calculates ADF t-stat separately for each individual group and then it averages across these groups.

This test, based on the Augmented Dickey-Fuller (ADF) statistic (Dickey and Fuller, 1981), allows each member of the cross section to have a different autoregressive root and different autocorrelation structures under the alternative hypothesis.

The results of the unit root in panel data are presented in Table 1:

Table 1. IPS Panel Unit Root Test

Variables	IPS panel unit root test	
	Level	**1st difference**
l_GDP	3.91016 (1.0000)	-1.55736 (0.0597)*
l_FDI	0.30892 (0.6213)	-4.29183 (0.0000)***
l_DI	0.95980 (0.8314)	-3.34402 (0.0004)***
TG	2.67458 (0.9963)	-1.41654 (0.0783)*
INF	0.79350 (0.7863)	-3.14637 (0.0008)***

*P-values are in parenthesis. *, ** and *** show significance at 10%, 5% respectively 1% level.*
The Null hypothesis is that series are non stationary.

The null hypothesis, stating that the variables of our modelled equation: l_GDP, l_FDI, l_DI, TG and INF contain a unit root, cannot be rejected, as indicated by the p-values contained in the left side column of the table above.

On the contrary, when first difference is used, unit root non-stationarity is rejected at 1% significance level, for foreign direct investment in natural logarithm (0.0000), infrastructure (0.0008) and domestic investment in natural logarithm (0.0004), respectively at 10% significance level, for gross domestic product in natural logarithm (0.0597) and technological gap (0.0783). These results reveal that all analysed series could be individually considered as being integrated of first order.

When such cases occur, one should think about testing to see whether there is a cointegrating relationship among variables, this meaning the existence of some vector of coefficients able to form a linear combination of the said items.

The ordinary procedure used for testing hypotheses relating to the relationship set between non-stationary variables is OLS or GMM regressions on data which had initially been differenced. Even if this method is recommended for large samples, cointegration provides more powerful tools when talking about data sets limited in terms of length, as it is the case of most economic time-series.

However, we decided to take into account both alternatives and therefore to make proof of the facts stated by the specialized literature in the matter.

4.2. OLS and GMM estimations with none, fixed and random effects

If data are stationary or are rendered stationary by resorting to differences of various orders, the model may be estimated by using several econometric methods, among which the panel ordinary least squares (OLS) or the generalized method of moments (GMM), with none, fixed or random effects.

We begin with the well known OLS, which is a method used to estimate the unknown parameters in a linear regression model, by minimizing the sum of squared distances between the observed responses in the dataset, and the responses predicted by the linear approximation. Yet, given the endogeneity issue reflected by the literature in the matter as regards the variables concerned, that is the correlation of the regressors X with the error terms ε, we make use of instrumental variables Z, correlated with the regressors but uncorrelated with the error terms, therefore estimating by means of the generalized method of moments (GMM) formalized by Hansen (1982).

Considering the specific features characterizing each country, it is not quite suitable to use panel estimation methods with none effects. For this reason, we also resort to fixed effects (FE) and random effects (RE) estimates for both OLS and GMM methods, followed by a Hausman test which may help us in selecting the most appropriate model.

Suppose we have the following model:

$$y_{it} = \alpha + \beta x_{it} + u_{it} \quad (5)$$

In order to see how the fixed effects model works, we can decompose the disturbance term, u_{it}, into an individual specific effect, λ_i (encapsulating all of the variables that affect y_{it} cross-sectionally but without varying over time) and the *remainder disturbance*, v_{it}, which varies over time and entities (capturing everything that is left unexplained about y_{it}).

$$u_{it} = \lambda_i + v_{it} \quad (6)$$

Therefore, we can rewrite the initial model and obtain:

$$y_{it} = \alpha + \beta x_{it} + \lambda_i + v_{it} \quad (7)$$

This is the equivalent of generating dummy variables for each cross-section and including them in a standard linear regression to control for these fixed "cross-section effects". It usually works best when there are relatively fewer cross-sections and more time periods, as each dummy variable removes one degree of freedom from the model.

$$y_{it} = \alpha + \beta x_{it} + \lambda_1 D1_i + \lambda_2 D2_i + \lambda_3 D3_i + ... + \lambda_N DN_i + v_{it} \quad (8)$$

An alternative to the fixed effects model is to use the random effects model. As with fixed effects, the random effects approach proposes different intercept terms for each entity, these intercepts being constant over time. Yet, the difference is that under the random effects model, the intercepts for each cross-sectional unit are assumed to arise from a common intercept *α* (the same for all cross-sectional units and over time), plus a random variable η_i that varies cross-sectionally but is constant over time, where η_i measures the random deviation of each cross-section's intercept term from the intercept term *α*.

The random effects panel model as may be written as follows:

$$y_{it} = \alpha + \beta x_{it} + \omega_{it} \quad (9)$$

where:

$$\omega_{it} = \eta_i + v_{it} \quad (10)$$

Unlike the fixed effects model, the random effects one does not capture the heterogeneity in the cross-sectional dimension by means of dummy variables but via the η_i terms (where η_i has zero mean, is independent of the individual observation error term v_{it}, has constant variance σ^2 and is also independent of the explanatory variables x_{it})

The fixed effect assumption is that the individual specific effects are correlated with the independent variables. On the contrary, the random effects hypothesis regards the uncorrelation between the above-mentioned. Therefore, if the random effects assumption holds, the random effects model is more efficient than the fixed effects one.

The generally accepted way of choosing between fixed and random effects is running a Hausman test. The Hausman test checks a more efficient model against a less efficient but consistent model to make sure that the more efficient model also gives consistent results. If we accept the null hypothesis, the random effects model prevails.

H_0: both estimators are consistent, but the random effect estimator is more efficient (has smaller asymptotic variance) than the fixed effect one.

H_1: one or both of these estimators is/are inconsistent.

As we shall see hereinafter in Tables 2, 3 and 4 (none, fixed and random effects OLS and GMM estimations), foreign direct investments, domestic investments and infrastructure exert a positive influence on the gross domestic product, while higher the technological gap between a leading country and country *i* determines, as expected, lower gross domestic product per capita.

Therefore, for estimations with no effects, we have used the regression:

$$d\_l\_GDP_{it} = \alpha + \beta_1 d\_l\_FDI_{it} + \beta_2 d\_l\_DI_{it} + \beta_3 d\_TG_{it} + \beta_4 d\_INF_{it} + \varepsilon_{it} \quad (11)$$

Table 2. OLS and GMM Estimation with no effects

Dependent variable: d_l_GDP		
Variables	**OLS estimation**	**GMM estimation**
d_l_FDI	0.002612 (0.0027)***	0.006296 (0.0001)***
d_l_DI	0.013771 (0.0007)***	0.018168 (0.0097)***
d_TG	-0.886651 (0.0000)***	-0.814641 (0.0000)***
d_INF	0.000793 (0.0409)**	0.002267 (0.0020)***
c	0.031741 (0.0000)***	0.027988 (0.0000)***
*P-values are in parenthesis. ** and *** show significance at 5%, respectively 1% level.*		

Taking a look at the p-values relating to our results rendered in Table 2, we see that they are significant at 1%, respectively 5% level, both for ordinary least square and generalized method of moments, the impact of the explanatory variables on the endogenous one being in compliance with the studied literature.

Thus, in case of OLS estimation with no effects, the direct influence on gross domestic product is revealed as for foreign direct investments, with an impacting value amounting to 0.0026, at a significance level of 1% (0.0027), for domestic investment, with 0.0137, also at a threshold of 1% (0.0007) and for infrastructure, rendered by principal component analysis, with 0.0007, the significance being this time of 5% (0.0409). The technological gap, a key element of our analysis, seriously adversely impacts on gross domestic product, with -0.8866, at 1% (0.0000) significance level.

When analysing the output of GMM estimation with no effects, quite close values are revealed for all variables considered. Therefore, foreign direct investments positively impact on gross domestic product with 0.0062, at a significance level of 1% (0.0001), domestic investment, with 0.0181, at 1% (0.0097) and infrastructure with 0.0022, again at 1% (0.0020), while the technological gap causes a contrary movement of GDP, with -0.8866, at 1% (0.0000) significance level.

As mentioned before, taking into account that specialists in the matter do not recommend the use panel estimation methods with none effects, given the fact that, for a pertinent approach, either all or some of the explanatory variables should be treated as arising from random causes, we have subsequently performed fixed effects and random effects estimates for both OLS and GMM methods.

For estimations with fixed effects, we have resorted to:

$$d\_l\_GDP_{it} = \alpha + \lambda_i + \beta_1 d\_l\_FDI_{it} + \beta_2 d\_l\_DI_{it} + \beta_3 d\_TG_{it} + \beta_4 d\_INF_{it} + v_{it} \quad (12)$$

where: $$\varepsilon_{it} = \lambda_i + v_{it} \quad (13)$$

Table 3. OLS and GMM Estimation with fixed effects

Dependent variable: d_l_GDP		
Variables	**OLS estimation**	**GMM estimation**
d_l_FDI	0.002660 (0.0004)***	0.004884 (0.0002)***
d_l_DI	0.014097 (0.0000)***	0.008697 (0.0859)*
d_TG	-0.893748 (0.0000)***	-0.815785 (0.0000)***
d_INF	0.000984 (0.0068)***	0.001465 (0.0213)**
c	0.030455 (0.0000)***	0.029294 (0.0000)***
*P-values are in parenthesis. *, ** and *** show significance at 10%, 5% and 1% level.*		

For OLS estimation with random effects, irrelevant differences are observed in terms of registered values. Therefore, FDI affects gross domestic product with 0.0026, which coincides with the result obtained by means of OLS estimation with fixed effects, the significance level being again of 1% (0.0004). Domestic investment, with a influence of 0.0140, comes very close to the previous outcome of 0.0137, at a threshold of 1% (0.0000), while infrastructure impacts on GDP with 0.0009 as compared to 0.0007, with a significance level of 1% (0.0068). As anticipated, technological gap appears this time too as negatively influencing the gross domestic product, with -0.8937, at 1% (0.0000) significance level, obviously similar to -0.8866 rendered in Table 2.

As regards the GMM estimation with random effects, insignificant discrepancies appear in relation to the same analysis performed for the variant with fixed effects, as follows: foreign direct investments positively impact on gross domestic product with 0.0048 as to 0.0062, at a significance level of 1% (0.0002), domestic investment, with 0.0086 as to 0.0181, at 10% (0.0859) and infrastructure with 0.0014 as to 0.0022, this time at 5% (0.0213), while the technological gap causes an adverse movement of GDP, with -0.8157 as to -0.8866, at 1% (0.0000) significance level.

The alternative to the no effect and fixed effects models is the random effects model which considers the explanatory variables as being generated by random causes. The random effects model uses different intercepts for each country, these ones being constant in time.

For estimations with random effects, we have resorted to:

$$d\_l\_GDP_{it} = \alpha + \beta_1 d\_l\_FDI_{it} + \beta_2 d\_l\_DI_{it} + \beta_3 d\_TG_{it} + \beta_4 d\_INF_{it} + \omega_{it} \quad (14)$$

where:
$$\omega_{it} = \eta_i + v_{it} \quad (15)$$

Table 4. OLS and GMM Estimation with random effects

Dependent variable: d_l_GDP		
Variables	**OLS estimation**	**GMM estimation**
d_l_FDI	0.005167 (0.0892)*	0.005134 (0.0000)***
d_l_DI	0.020164 (0.0037)***	0.012825 (0.0000)***
d_TG	-0.846806 (0.0000)***	-0.832185 (0.0000)***
d_INF	0.001368 (0.0849)*	0.001103 (0.0000)***
c	0.029734 (0.0000)***	0.027972 (0.0000)***
*P-values are in parenthesis. * and *** show significance at 10%, respectively 1% level.*		

The results of the ordinary least squares estimation with random effects is also reflected in comparison with the outcomes obtained by means of no effects and fixed effects models. Thus, the direct impact of foreign direct investments on gross domestic product amounts this time to 0.0051, as compared to 0.0026 (for no effects and fixed effects), at a significance level of 10% (0.0892), the domestic investment, with 0.0201, as compared to 0.0137 (for no effects) and 0.0140 (for fixed effects), at a threshold of 1% (0.0037) and the infrastructure, with 0.0013, as compared to 0.0007 (for no effects) and 0.0009 (for fixed effects), the significance being this time of 10% (0.0849). The technological gap, adversely impacts on gross domestic product, with -0.8468, as compared to -0.8866 (for no effects) and -0.8937 (for fixed effects), at 1% (0.0000) significance level.

As for the generalized method of moments estimation with random effects, the said results are as follows: foreign direct investments with a direct impact on GDP of 0.0051, as compared to 0.0062 (for no effects) and 0.0048 (for fixed effects), at a significance level of 1% (0.0000), domestic investment, with 0.012, as compared to 0.0181 (for no effects) and 0.0086 (for fixed effects), at 1% (0.0000) and infrastructure with 0.0011, as compared to 0.0022 (for no effects) and 0.0014 (for fixed effects), again at 1% (0.0000), while the technological gap causes a contrary movement of GDP, with -0.8321, as compared to -0.8866 (for no effects) and -0.8157 (for fixed effects), also at 1% (0.0000) significance level.

As we can see, the tables above clearly reveal that the results are highly similar and significant for both OLS and GMM estimation, no matter if none, fixed or random effects are used, therefore indicating the robustness of our findings.

From the economic perspective, the obtained data indicate the chain effect generated by investments, be they foreign or domestic, on the well being of the target country. Investments are indissolubly related to a subsequent increase in the production and/or services provided, this generating, on one hand, an augmented supply on the market of goods and services and, on the other hand, more jobs and consequently a decrease of unemployment. More satisfied labour force mean more aggregate income, therefore more consumption, this implying a higher demand manifested on the market of goods and services. In such a case a new equilibrium on this market, at a superior level, is revealed.

The contribution of FDI to economic growth also occurs through technology transfer. Technology spillover supposes the acquirement of knowledge from more developed countries, but these benefits are directly linked to the capacity of the target country to assimilate such technology and the related know-how. Given this fact, the technological gap, representing the convergence of countries to the most developed ones, is highly correlated to the absorption capacity. From this perspective, higher the distance between the host country and a reference developed one, lower the capacity of the host country to benefit from the advantaged of FDI and, therefore, lower gross domestic product.

As concerns the infrastructure variable, the positive effect on GDP can be partially explained by the elements specified above for investments, as a better infrastructure creates the premises for more investments, with the related consequences. Beside this issue, not only a quantitative evolution, in absolute values, of production and/or services is achieved by an adequate infrastructure, but the said country also benefit from an increased rate of such evolution, generated by the accelerated movement of the economic life.

Resuming our econometric analysis, the following results are revealed:

Table 5. Hausman test for OLS and GMM estimation

Hausman test	OLS estimation	GMM estimation
Cross-section random	1.713709 (0.7882)	2.092040 (0.7188)

Given our intention to discover the most appropriate estimation means for our variables, we considered the possibility to resort to other instruments able to help us in correctly appreciating the previously considered methods. From this perspective, we tried to see whether the fixed effects models or the random effects models are more appropriate for our analysis, appealing, for this purpose, to the Hausman test (1978).

The Hausman test (Table 5 above) checks a more efficient model against a less efficient but consistent one to make sure that the more efficient model also gives consistent results. In other words, it such an instrument assesses the significance of an estimator versus an alternative one, revealing whether the statistical model corresponds or not to the data used in the related research.

As the results, obtained after having performed the above-mentioned test, show a p-value, amounting to (0.7882), for the ordinary least squares estimation, and to (0.7188), for the generalized method of moments estimation, this indicating, in both cases, that the null hypothesis is to be accepted, we assume the idea according to which the random effects model is consistent and more efficient and, therefore, it is the most appropriate to be further used in similar studies.

4. 3. Panel Cointegration Tests

The increasing interest manifested relating to panel data analysis has led to focusing on the extension of the existing range of statistical tests to panel data. During the last two decades, various cointegration techniques have been used in many empirical researches. Recent literature has centered its attention on tests of cointegration in a panel setting, among which the following could be mentioned: Pedroni (1999), Pedroni (2004), Kao and Chiang (1999) and a Fisher-type test using an underlying Johansen methodology (Maddala and Wu, 1999).

If there are two or more non-stationary variables and if there is a linear combination between them which is stationary, these variables are deemed to be cointegrated. This concept of cointegration is of much interest for the economic theory, as the idea behind it corresponds to a stable long run equilibrium.

Once the order of integration established, we can move to a panel cointegration approach. Our analysis will be based on Pedroni cointegration test which has extended the framework of Engel-Granger in order to test cointegration in panel data into two steps. Pedroni residual based cointegration starts with computing the residual from the regression model:

$$y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + ...\beta_n X_{nit} + \varepsilon_{it} \quad (16)$$

where: i - cross-section; $i = 1, 2, ... N$

t - time period; $t = 1, 2, ... T$

n - number of variables;

ε_{it} - deviation from the modeled long-run relationship.

If the series are cointegrated, this term should be a stationary variable. Thus, stationarity is achieved by testing whether ρ_i is unity in:

$$\varepsilon_{it} = \rho_i \varepsilon_{it-1} + v_{it} \quad (17)$$

Pedroni has developed seven tests for cointegration in panel data, where there is more than one independent variable in the regression model. Four such tests are based on within dimension statistics (panel v-stat, panel rho-stat, panel pp-stat and panel adf-stat) and the other three on between dimension statistics (group rho-stat, group pp-stat and group adf-stat).

The null hypothesis, associated with Pedroni's test procedure is:

$$H_0: \quad \rho_i = 1 \quad for \quad i = 1,2,...N$$

This implies that the null hypothesis associated with Pedroni's test procedure is equivalent to testing the null of no cointegration for all i.

The alternative hypothesis for between dimension would be:

$$H_1: \quad \rho_i < 1 \quad for \quad i = 1,2,...N$$

while the within dimension statistics would be rendered by:

$$H_1: \quad \rho_i = \rho < 1 \quad for \quad i = 1,2,...N$$

The variance (panel v-stat) and rho (panel rho-stat, group rho-stat) statistics are more reliable when the time dimension is at least equal to 100 (Salotti, 2008). The panel pp-stat and group pp-stat as well as the panel adf-stat and group adf-stat tests are certainly more powerful for smaller time dimensions (Bonham and Gangnes, 2007). Given that our time series observations are restricted to 16 years (1993-2008), we shall relate hereinafter to the above mentioned parametric and non-parametric results.

At this point of the present paper, we have resorted to the following regression model, our purpose being to compute the residual and to find out if the deviation of the modelled long-run relationship is indeed a stationary variable:

$$l\_GDP_{it} = \alpha + \beta_1 l\_FDI_{it} + \beta_2 l\_DI_{it} + \beta_3 TG_{it} + \beta_4 INF_{it} + \varepsilon_{it} \quad (18)$$

Table 6. Pedroni Residual Cointegration Test (within-dimension)

	Statistic Probability	**Weighted statistic Probability**
Panel v-stat	-1.990607 (0.9767)	-2.174568 (0.9852)
Panel rho-stat	0.706167 (0.7600)	0.819825 (0.7938)
Panel PP-stat	-1.686893 (0.0458)**	-1.437406 (0.0753)*
Panel ADF-stat	-2.685765 (0.0036)***	-2.669599 (0.0038)***

Regressors: l_GDP, l_FDI, l_DI, TG, INF
*P-values are in parenthesis. * , ** and *** show significance at 10%, 5% and 1% level.*

For the within dimension Pedroni residual cointegration test, we obtained both insignificant and significant results, the latter at a threshold of 1%, 5% and 10% .

Thus, for the statistic probability, panel panel v-stat and panel rho-stat rendered a p-value of (0.9767), respectively (0.7600), clearly showing insignificance, while panel pp-stat and panel adf-stat registered significant levels of 5% (0.0458), respectively 1% (0.0036), as it can be seen in the lower part of the previous table.

Similar outcomes have been for revealed for the weighted statistic probability, where panel panel v-stat and panel rho-stat registered a p-value of (0.9852), respectively (0.7938), evidencing insignificant levels, but panel pp-stat and panel adf-stat reflected significance of 10% (0.0753), respectively 1% (0.0038).

Table ***7. Pedroni Residual Cointegration Test (between-dimension)***

	Statistic Probability
Group rho-stat	1.653956 (0.9509)
Group PP-stat	-2.829460 (0.0023)***
Group ADF-stat	-5.161905 (0.0000)***

Regressors: l_GDP, l_FDI, l_DI, TG, INF
*P-values are in parenthesis. *** shows significance at 1% level.*

For the between-dimension cointegration test, we also obtained both irrelevant and pertinent outcomes, the latter being reached at a significance level of 1%.

The statistic probability indicated for group rho-stat a p-value of (0.9509), meaning insignificance, while group pp-stat and group adf-stat showed significant levels of 1% (0.0023), respectively (0.0000).

As panel pp-stat and group pp-stat, respectively panel adf-stat and group adf-stat are deemed to be, according to the literature in the matter, more significant for reduced time dimensions (less than 100 periods), and considering the length of our sample, we have taken such values into account, drawing the conclusion that, for a significance level of 1%, 5%, respectively 10%, the null hypothesis of no cointegration is to be rejected, resulting in a cointegration relationship of the variables concerned.

Therefore, in economic terms, among the variables approached in our analyses, there is not only a short run relationship, as revealed by the OLS and GMM estimations above, but also, as Pedroni test reflects, a long-term one.

4. 4. Panel causality

The interest in discovering the exact nature of the relationship between variables makes us examining the direction of the causal links among them. We may test for reverse or bi-directional causality by conducting a Granger causality test.

The approach of Granger (1969) relating to whether *x* causes *y* is to see how much of the current *y* may be explained by the past values of *y* and subsequently to see whether, by adding lagged values to *x*, we succeed in improving the explanation of *y*. We state that *x* Granger causes *y* if *x* helps us in correctly predicting *y*, respectively if the coefficients of the lagged *x* are jointly statistically significant.

Granger causality runs, for all possible pairs of (x,y) series in the group, bi-variate regressions of the form:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + ... + \alpha_j y_{t-j} + \beta_1 x_{t-1} + ... + \beta_j x_{t-j} + \varepsilon_t \quad (19)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + ... + \alpha_j x_{t-j} + \beta_1 y_{t-1} + ... + \beta_j y_{t-j} + v_t \quad (20)$$

The reported F-satistics are the Wald statistics for each model, for the joint hypothesis:

$$\beta_1 = \beta_2 = ... = \beta_j = 0$$

Therefore, the null hypothesis is, for the first regression, that *x* does not Granger – cause *y* and, for the second regression, that *y* does not Granger – cause *x*.

Once the variables considered in our analysis proved being cointegrated, the next step is to implement causality tests. As our interest was to discover the direction of the long-run relationship between GDP and FDI, we have tested the Granger causality for the said variables, taking one lag length:

$$l\_GDP_{it} = \alpha_0 + \alpha_1 l\_GDP_{i(t-1)} + \beta_1 l\_FDI_{it} + \beta_2 l\_FDI_{i(t-1)} + \varepsilon_{it} \quad (21)$$

$$l\_FDI_{it} = \alpha_0 + \alpha_1 l\_FDI_{i(t-1)} + \beta_1 l\_FDI_{it} + \beta_2 l\_FDI_{i(t-1)} + v_{it} \qquad (22)$$

Table 8. Granger Causality

Null hypothesis:	F-statistic Probability
l_FDI does not Granger cause l_GDP	7.97217 (0.0057)***
l_GDP does not Granger cause l_FDI	5.25510 (0.0239)**

*P-values are in parenthesis. ** and *** show significance at 5%, respectively 1% level.*

Analysing the Granger causality, we detected a positive causal relationship running from foreign direct investments to gross domestic product, both used in natural logarithm, the significance level in this case being of 1% (0.0057), while, by resorting to the same procedure, the relationship running from gross domestic product to foreign direct investments, also causal, proved to have a significance level of 5% (0.0239).

As revealed by Table 8, there is a bi-directional causality between GDP and FDI, this being in compliance with the economic theory grounds: more foreign direct investments cause economic growth, as, on one hand, there is an increase of capital stock accumulation and, on the other hand, there is a diffusion of technology and know-how from the more developed countries to the targeted ones, but, at the same time, as countries develop economically there will be a higher temptation for the foreign investors to direct their financial resources to those countries.

5. Conclusions

In this paper we have examined the relationship existing between foreign direct investments and economic growth for seven Eastern European countries. The empirical analysis revealed that FDI influences economic growth for the countries and periods included in the sample. First of all, we have performed the Im, Pesaran, Shin unit root test in order to see if the series are stationary and thus if there is any possibility of cointegration between variables. We found out that all of the series are stationary while first difference is used. Fixed and random effects OLS and GMM estimations for first difference series have been performed, the results obtained being in compliance with the economic theory, revealing FDI impact in the short-run on GDP. Once we have obtained all series I(1), we have also resorted to Pedroni cointegration test so as to test the long-run relationship between the variables of interest. For Pedroni panel pp-stat and group pp-stat, respectively adf-stat and group adf-stat, the most significant analyses for panel data not exceeding 100 time periods, a cointegration relationship was revealed, therefore indicating a long-run relationship between FDI, DI, TG, INF and GDP. Finally the Granger causality test evidenced a bi-directional causal relationship between the gross domestic product and the foreign direct investments, strengthening the importance of FDI in sustaining economic growth which, at its turn attracts, by the increase of the infrastructure level, more foreign investments, a permanent source of technology diffusion, and diminishes the technological gap, converging to the status of more developed countries.

6. Suggestions for Further Research

As revealed by the analyzed empirical studies, FDI does not have just a direct impact on GDP, but also an indirect one, by means of its interaction terms. Therefore, our analysis could be improved under various aspects. First of all, our regression could be extended by introducing also the schooling variable (SCH), reflecting the level of education of the target country, and thus its absorption capacity. Besides, interaction terms such as $FDI \times TG \times INF$, $FDI \times TG \times SCH$ and $FDI \times TG \times INF \times SCH$, meaning the technological spillover of FDI conditional on infrastructure, the technological spillover of FDI conditional on educational level, respectively the technological spillover of FDI conditional on infrastructure and educational level at the same time, could be used in order to render the indirect impact of FDI on GDP, depending on determined minimum threshold levels.

As for the econometric techniques, we could resort to WinRats econometric software in order to make estimates allowing us to deal with the endogeneity bias in regressors. Once there is a cointegration relationship between variables, we might consider the Dynamic Ordinary Least Squares (DOLS) estimation method that introduces a parametric bias correction, or the Fully Modified Ordinary Least Squares (FMOLS) that uses non-parametric correction terms in the estimation to eliminate endogeneity bias.

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