International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:9, No:11, 2015

Foreign Direct Investment on Economic Growth by Industries in Central and Eastern European Countries

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***Abstract*—**Present empirical paper investigates the relationship between FDI and economic growth by 10 selected industries in 10 Central and Eastern European countries from the period 1995 to 2012. Different estimation approaches were used to explore the connection between FDI and economic growth, for example OLS, RE, FE with and without time dummies. Obtained empirical results leads to some main consequences: First, the Central and East European countries (CEEC) attracted foreign direct investment, which raised the productivity of industries they entered in. It should be concluded that the linkage between FDI and output growth by industries is positive and significant enough to suggest that foreign firm's participation enhanced the productivity of the industries they occupied. There had been an endogeneity problem in the regression and fixed effects estimation approach was used which partially corrected the regression analysis in order to make the results less biased. Second, it should be stressed that the results show that time has an important role in making FDI operational for enhancing output growth by industries via total factor productivity. Third, R&D positively affected economic growth and at the same time, it should take some time for research and development to influence economic growth. Fourth, the general trends masked crucial differences at the country level: over the last 20 years, the analysis of the tables and figures at the country level show that the main recipients of FDI of the 11 Central and Eastern European countries were Hungary, Poland and the Czech Republic. The main reason was that these countries had more open door policies for attracting the FDI. Fifth, according to the graphical analysis, while Hungary had the highest FDI inflow in this region, it was not reflected in the GDP growth as much as in other Central and Eastern European countries.

***Keywords*—**Central and East European countries (CEEC), economic growth, FDI, panel data.

I. Introduction

THE current rapid international flows of FDI and globalization of the world economy are an incentive to understand the relationship between FDI and growth by industry. From the different evidence, the connection between FDI and economic growth is mixed. Some empirical investigations confirm the positive productivity effect [10], [11]. However, others find negative or no productivity effect [1], [9]. It should be mentioned that for the developed countries there are positive and significant spillover effects [14], [15]. For the developing countries, results are more mixed. For example, Borensztein, De Gregorio, and Lee find a negative linkage between FDI and economic growth for a sample of 69 developing countries [5]. However, Johnson finds that the relationship between FDI and economic growth for developing countries is positive and significant [12]. There have been several attempts by different researchers to find the connection between FDI and economic growth but few studies use an industry level approach because of lack of proper data. For instance, Bijsterbosch and Kolasa investigate the relationship between FDI and economic growth from the different manufacturing industries in the Central and Eastern European countries and find a positive connection between them [3]. The lack of relevant research of FDI on growth by industries in the Central and Eastern European countries proves the potential importance of the present study. The objective of this research is to investigate how FDI affects growth according to industries in 10 Central and Eastern European countries (CEEC) (except Croatia). Ten industries and the time period from 1995 to 2012, for which the proper data is available, is to be selected. In addition, from a micro (industry) level analysis we go to a macro (country) level analysis for 11 Central and Eastern European countries (CEEC) (including Croatia). Based on some general FDI and GDP trends at the country level, the relationship between them will be analyzed from the period 1994 to 2012.

The last 25 years can be considered as the period when developing and formerly communist countries have been dramatically reforming and striving to become part of the multilateral trading systems. It also coincides with the period when FDI has become less limited to flows between industrial countries. These reforming countries apparently see FDI as crucial to their successful reform and development. Thus, they are in competition with each other to attract FDI. This competition takes various forms, such as tax incentives and regional trading arrangements which have also dramatically increased in the last 25 years. Most countries have reduced barriers to FDI while many aggressively offered tax incentives and subsidies, believing that the relationship between FDI and economic growth is positive. Therefore, it should be emphasized that the increase of the productivity levels remains one of the major priorities for economic policy in the CEE countries.

Regional trading arrangements between partner countries strengthen investment environment for investors from abroad. The 11 Central and Eastern European countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) featured in this paper are prominent participants in this competition. These 11 countries are European Union countries and regional trading arrangements and trade liberalization gave this region a chance to be more competitive in attracting FDI. Central and Eastern European countries enhanced their involvement in the world market after the collapse of the communist system.

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They opened the economy in order to attract foreign direct investment. Since 1990, these economies have grown faster because of going global in the world economy [7]. Thus, this is all based squarely on the presumption that attracting FDI is important for these countries.

II. Methodology

In order to test the relationship between FDI inflow and growth by industries, the panel data approach and the software STATA were used. A Cobb-Douglas production function was applied with stable long run elasticity.

The Cobb-Douglas production function model investigates the relationship between labour (L), capital (K) and economic growth, with the Y shown as a function L and K, and that is an endogenous growth model:

$$Y_{cit} = A_{cit} K^{\alpha}_{cit} L^{1-\alpha}_{cit} \quad (1)$$

where Y_{cit} is gross output in the i -th industry at time t in the specific country c, and A_{cit}, K_{cit} and L_{cit} respectively refer to technological progress, fixed capital accumulation stock and labour.

Taking logs of the Cobb-Douglas production function, the equation can be written as:

$$\log Y_{cit} = \log A_{cit} + a \log K_{cit} + (1 - a) \log L_{cit} \quad (2)$$

FDI was used from [13], which is the function of total factor productivity:

$$tfp\ it = f(FDI_{it}, X_{it}, IM_{it}, e_{it}) \quad (3)$$

Research and development (R&D) was used from [4], where it is the function of the total factor productivity. In this model, technological progress is determined as:

$$A_{cit} = f(FDI_{cit}, R\ \&\ D_{cit}, e_{it}, d_t) \quad (4)$$

where FDI_{cit} and $R\ \&\ D_{cit}$ reflect foreign direct investment and research and development, respectively, in the specific industry in the definite country at the concrete time. FDI and R&D are the main variables for the total factor productivity. FDI and R&D should have a positive effect on total factor productivity, which will enhance output growth. FDI increases the capital stock and positively affects economic growth via technological progress. e_{it} is the industry specific variable. Also d_t is the time dummy that reflects macroeconomic shocks that affect all industries at point in t time.

Assuming a log-linear technology function, the model can be written in the following way:

$$y_{cit} = \phi + \beta k_{cit} + cl_{cit} + gfdi_{cit} + dR\&D_{cit} + \eta d_t + e_{it} \quad (5)$$

with

$$e_{it} = a_i + \varepsilon_{it} \quad (6)$$

where, a_i captures industry heterogeneity, for example, autonomous productivity, concentration level, foreign trade barriers facing the sector in which the FDI takes place, and etc.; as for, it reflects ε_{it} is the independent and identical distributed (IID) error term in this regression model.

As widely used in panel data approaches, ordinary least squares (OLS), Random Effects (RE), Fixed Effects (FE) and First Differences (FD) estimation approaches were used, with and without time dummies. As is known, FE estimation, like FD, uses a transformation to remove the unobserved effect prior to estimation. As mentioned, both FE and RE estimation methods will be used. To choose which one to be use, the Hausman test will be performed.

The crucial issue of endogeneity to be stressed depends on the existence of the industry specific effects. If they exist this means that OLS will be biased due to omitted variables and the Random Effects (RE) that treats ai $\approx (0,\sigma^2_a)$ will be estimated by the feasible generalized least squares (GLS). But, if the ai is endogenous then Fixed Effect (FE) will be more appropriate in this case. In addition, to remove industry specific effects first difference (FD) estimation approach can be used that yields the equation:

$$\Delta y_{i,t} = \sum_j \emptyset_{1j} \Delta fdi_{i,t-j} + \emptyset_2 \Delta l_{i,t-j} + \emptyset_3 \Delta k_{i,t-j} + \emptyset_4 \Delta r\&d_{i,t-j} + \Delta \emptyset_5 y_{i,t-j} \quad (7)$$

The dependent variable sometimes depends not only on the exogenous variables, but also on its own lag values. Such kind of modelling gives an opportunity to use dynamic panel data, because of its nature. This kind of modelling of the regression is highlighted by [2]. Choosing the dynamic panel data should give us lower standard error in our estimated regression; also, it should increase our R-squared and give our model the right specification. Therefore, lags of output growth are going to be added as independent variables, because current performance might be a function of past performance as well. The regression in output growth will be persistent. In addition, 5 lags of output growth (Y) were added, but the last one was insignificant. After these, the last one was taken out until it became significant. Hence, third lag was significant. For the FDI and R&D the same was done. The 5 lags from the FDI and R&D were taken, but the last one of the both variables was insignificant. The last one was being taken out until it became significant. Therefore, in the used model the third lags of the FDI and R&D were significant.

The time frame plays a vital role applied to make FDI and R&D operational. It means that it might take some years for FDI and R&D to have a positive effect on economic growth via the total factor productivity. So, the lags of FDI and R&D are added to the regression model. To correct the serial correlation and heteroskedastisity, estimation robust is used to heteroskedastisity and autocorrelation. To remedy heteroskedastisity, robust matrix is used to make the variances constant. To correct serial correlation lags of output growth were added. In addition, what are the net FDI inflows in the specific country in overall is highlighted by using the tables. To analyze the latter issue, figures should be used where the

relationship between net FDI and GDP growth is emphasized in each of the 11 Central and Eastern European countries.

III. Data Description

The main data source of which this paper makes is the Eurostat database. The panel dataset contains 10 Central and Eastern European Countries (except Croatia), 10 industries, and the period from 1995 to 2012 (Table I). Because of missing values in the dependent and independent variables, a limited amount of observations are used in the different estimation approaches (Tables III–VII).

TABLE I
ISO Code, List of Countries and Industries

ISO code	10 Countries	10 Industries
Bg	Bulgaria	Agriculture, forestry and fishing
Cz	Czech Republic	Manufacture of food products, beverages and tobacco
Ee	Estonia	Manufacture of coke, refined petroleum products and nuclear fuel
Hu	Hungary	Manufacture of chemicals, chemical products and man-made fibres
Lv	Latvia	Manufacture of rubber and plastic products
Lt	Lithuania	Manufacture of basic metals and fabricated metal products
Pl	Poland	Manufacture of machinery and equipment n.e.c.
Ro	Romania	Manufacture of transport equipment
Sk	Slovak Republic	Electricity, gas and water supply
Si	Slovenia	Construction

In the regression model, the dependent variable is GVA (Y) by industries. The independent variables are Gross capital accumulation (K), labor (L), foreign direct investment (FDI), research, and development (R&D). FDI, K and R&D are represented in millions of Euros. Labor is represented in total percentage (based on hours worked). Capital (K) shows us fixed capital accumulation in the specific industry. FDI reflects millions of Euros of inflows in the specific industry in a concrete year. R&D reflects how many millions of Euros are spent in specific industries in research and development. Time specific variables are added as well. After CEE countries have entered EU (in May 2004), this could be interpreted as a productivity shock. Time dummies are used for these 10 countries. Therefore, after 2004, time dummies will be denoted 1 and 0 otherwise; exceptions here are Bulgaria and Romania which entered EU in 2007, so these dummies are denoted 1 in 2007 and 0 otherwise.

From Fig. 1 we can see the dynamics of GVA and FDI and how they are simultaneously changing over time in 10 CEE countries by 10 selected industries from 1995 to 2012. Another important data by years which is used in the paper was collected from the World Development Indicators, where the time is defined from 1994 to 2012 for the 11 CEE countries, which is shown in Table II. It should be mentioned that all variables are reflected in billion US$.

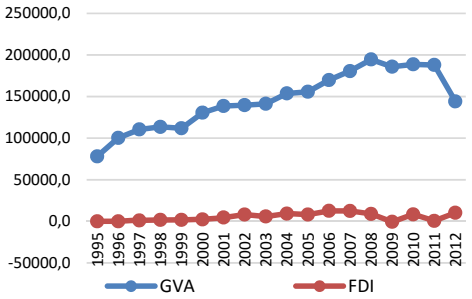

Fig. 1 GVA and net FDI inflow in the 10 CEE countries in the 10 selected industries (Million Euro)

IV. Empirical Results

A. Analysis of FDI and Economic Growth at the Country Level

Since the Soviet Union collapsed, FDI has become one of the key indicators for the Central and Eastern European countries. From Table II we can see that from 1994 to 2012, countries which mostly benefited from FDI inflows were Hungary, Poland and the Czech Republic, with approximately US$ 204.68, US$ 188.15 and US$ 100.83 billion, respectively. It should be mentioned that high growth of FDI in Central and Eastern European countries was caused by the increasing purchase of privatized state-owned firms by the foreign investors. Comparing the period 1994 to 2007, it can be said that there is the increasing tendency of FDI inflows in the most of 11 CEE countries. If compare the period of 2007 to 2008 there is decreasing tendency of FDI inflow in the CEE countries but the exceptions here are Croatia, Hungary, Romania and Slovak Republic, where can be seen slightly increasing tendency of FDI inflows. The decreasing tendency in 2008-2009 can be explained by the starting of the Global Financial Crises. From 2009 to 2011 in most of 11 CEE countries there is an increasing tendency, but from 2011 to 2012 there is decreasing tendency. From Table II it can be seen that from 1994 to 2012, the whole summation of net FDI inflows to 11 CEE countries, based on the World Development Indicators, is 752.34 billion US dollar.

Figs. 2-12, noticed the relationship between FDI and economic growth in each Central and Eastern European country separately. Among the figures, it can be seen how the values of FDI and GDP are scattered. FDI and economic growth reflects the growth rates of each of the countries. The period is defined from 1994 to 2012. Because of negative slope of the main trends which is represented from the different figures can be noticed that there are negative relationships between FDI and economic growth in three Central and Eastern European countries: Croatia, Estonia, Hungary which are reflected on Figs. 3, 5 and 6, respectively. The rest of the figures show positive slopes of the main trend. Therefore, there seems to be a positive relationship between FDI and economic growth in the remaining countries.

TABLE II
NET FDI INFLOW IN CEEC, 1994-2012 (BILLION US$)

	Bulgaria	Croatia	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovak Republic	Slovenia
1994	0,11	0,11	0,88	0,21	1,14	0,21	0,03	1,88	0,34	0,27	0,12
1995	0,09	0,11	2,57	0,20	4,80	0,18	0,07	3,66	0,42	0,24	0,15
1996	0,11	0,49	1,44	0,15	3,29	0,38	0,15	4,50	0,26	0,35	0,17
1997	0,51	0,54	1,29	0,27	4,15	0,52	0,35	4,91	1,22	0,17	0,33
1998	0,54	0,94	3,70	0,58	3,34	0,36	0,93	6,37	2,03	0,56	0,22
1999	0,82	1,45	6,31	0,31	3,31	0,35	0,49	7,27	1,04	0,35	0,11
2000	1,00	1,11	4,99	0,39	2,77	0,41	0,38	9,34	1,04	2,05	0,14
2001	0,81	1,58	5,64	0,54	3,94	0,13	0,45	5,71	1,16	0,00	0,50
2002	0,91	1,10	8,50	0,28	3,01	0,25	0,71	4,13	1,14	4,10	1,66
2003	2,10	2,05	2,02	0,92	2,18	0,30	0,18	4,59	1,84	0,56	0,30
2004	2,66	1,08	4,98	0,97	4,28	0,64	0,77	12,72	6,44	3,04	0,83
2005	4,10	1,78	11,60	3,13	8,51	0,81	1,19	11,05	6,87	3,00	0,97
2006	7,87	3,22	5,52	2,21	18,68	1,70	2,05	21,52	11,45	4,07	0,69
2007	13,88	4,95	10,61	3,43	70,63	2,71	2,33	25,57	10,29	3,89	1,88
2008	10,30	5,81	6,57	1,87	74,99	1,43	1,91	15,03	13,85	4,08	1,82
2009	3,90	3,40	2,87	1,87	-2,97	-0,04	0,02	14,39	4,93	1,61	-0,35
2010	1,87	0,85	6,12	2,05	-20,93	0,43	0,86	17,07	3,20	2,12	0,63
2011	2,12	1,24	2,25	0,52	10,50	1,50	1,44	17,36	2,56	3,66	0,82
2012	1,58	1,34	7,98	1,65	9,78	1,08	0,57	6,70	2,63	1,53	-0,23

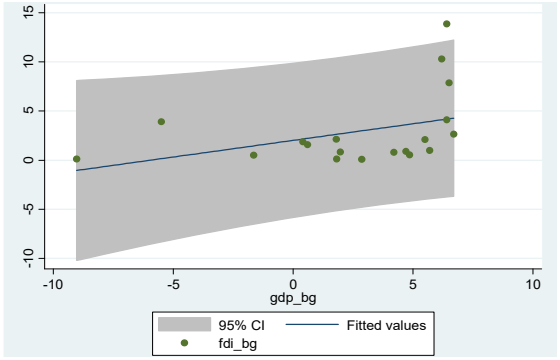

Fig. 2 Relationship between the FDI and GDP growths in Bulgaria

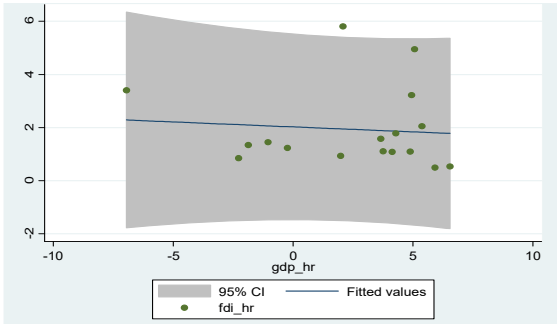

Fig. 3 Relationship between the FDI and GDP growths in Croatia

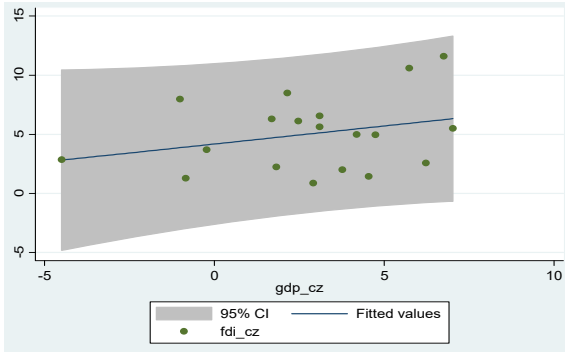

Fig. 4 Relationship between the FDI and GDP growths in the Czech Republic

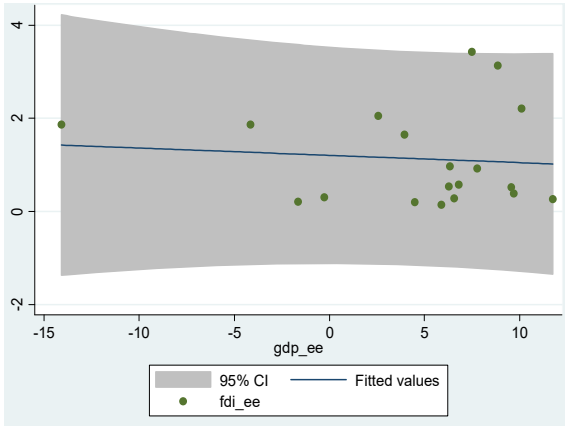

Fig. 5 Relationship between the FDI and GDP growths in Estonia

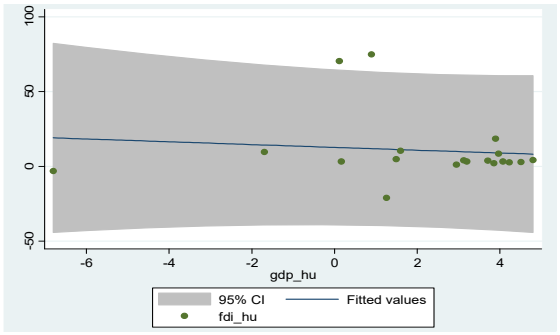

Fig. 6 Relationship between the FDI and GDP growths in Hungary

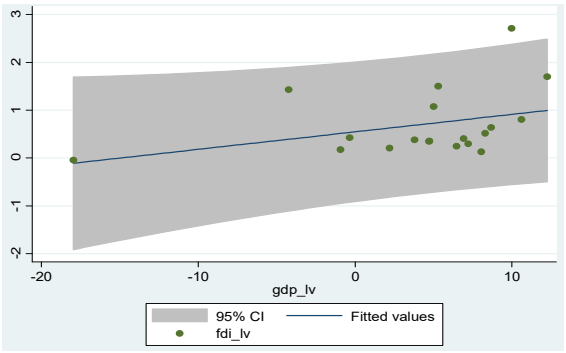

Fig. 7 Relationship between the FDI and GDP growths in Latvia

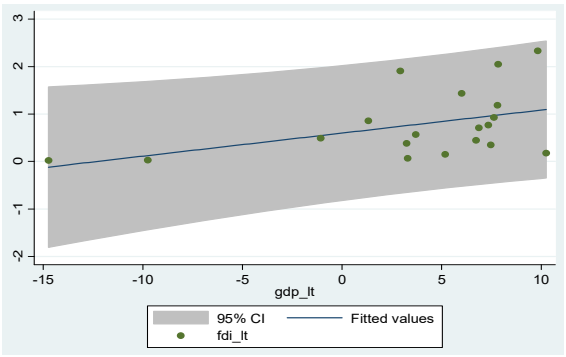

Fig. 8 Relationship between the FDI and GDP growths in Lithuania

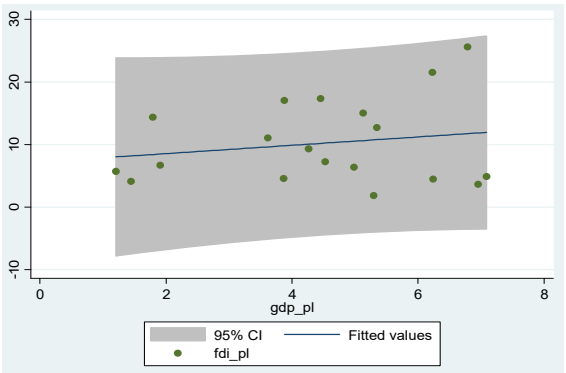

Fig. 9 Relationship between the FDI and GDP growths in Poland

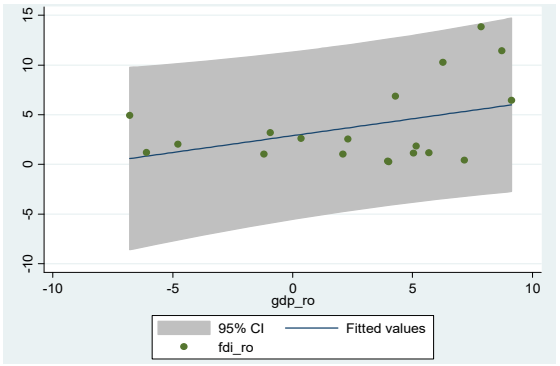

Fig. 10 Relationship between the FDI and GDP growths in Romania

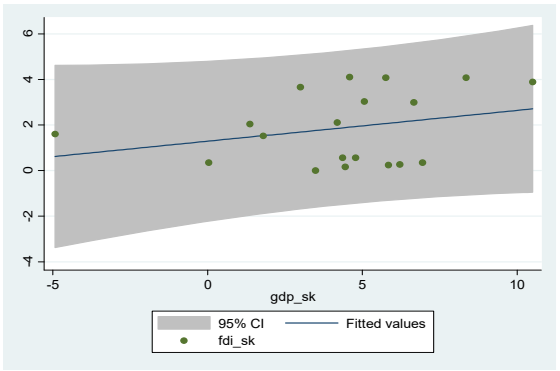

Fig. 11 Relationship between the FDI and GDP growths in the Slovak Republic

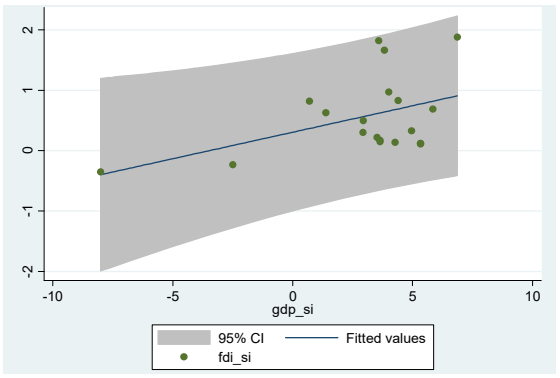

Fig. 12 Relationship between the FDI and GDP growths in Slovenia

From Fig. 13, it can be observed that from the period 1994 to 2012 the connection between average FDI and GDP is strong, except for Hungary.

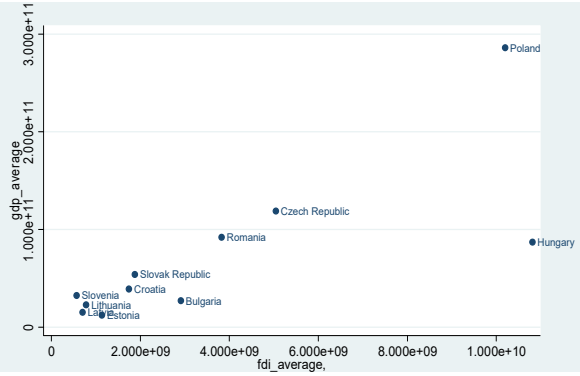

Fig. 13 Average net FDI and GDP in 11 CEE countries

B. Empirical Results at the Industry Level

The empirical results at the industry level can be sorted in the following observations:

It should be started from the baseline model and then refine it. Table III shows five variables: one dependent and four independent. In column (1) OLS estimation approach is used. There can be seen that FDI and R&D have positively and significantly correlated with output growth. FDI is significant at the 5% level and R&D is significant at the 10% level. If you increase FDI by 100% your output growth will enhance approximately by 1.76% in CEE countries. At the same time if you increase the research and development by 100% the output growth will increase approximately by 1.23%. Labor and capital are insignificant. R-square is low enough. In column (2) the Random Effects (RE) estimation approach is used, where FDI and R&D have positively and significantly correlated with output growth. FDI is significant at the 5% level and R&D - at the 10% level. If you increase FDI by 100% the output growth will boost approximately by 1.82%. At the same time if you increase the research and development by 100% the output growth will increase approximately by 1.16%. Capital and labour are insignificant. In the model, the R-squared is extremely low. In column (3) the Fixed Effects (FE) estimation approach is used, where FDI is significant with 5% level and positively correlated with the output growth. If you increase FDI by 100% the output growth will boost approximately by the 3.12% in ceteris paribus. At the same time, research and development, Capital and Labour are insignificant. In the model within R-square is quite low.

Table IV shows that FDI is positively and significantly correlated with output growth. In this table, the output growth lags were added and different estimation tools were presented. In column (1) OLS estimation approach is used, there can be seen that elasticity of output growth with respect to FDI is 1.84%, it is significant at the 5% level and positively correlated with output growth. Labour is insignificant, the capital is significant at the 10% level and research and development is significant at the 5% level. It should be mentioned that only the first lag of output growth is significant. In this model R-square is low enough. In column (2), Random Effects (RE) estimates suggest that a 2.24% increase in output growth occurs when FDI increases by 100%. FDI coefficient is significant at the 1% level. Labour is insignificant as it was in OLS case; however, capital and the R&D are significant at the 10% level. In the model only the first lag of output growth is significant. From the result of F-test we can say that the lags of GVA are jointly significant. In column (3) the Fixed Effects (FE) regressions are presented, and estimated results show that, ceteris paribus, if FDI increases by 100% it will enhance output growth in 10 CEE countries on average by 3.66% and by 3.88% in the model that accounts for macroeconomic shocks which is captured by the time dummies in column (4). Also, FDI in columns (3) and (4) are significant at the 1% level. Also, R&D and labour are insignificant with and without time dummies. Capital is significant in both cases with 5% level. According to F test the time dummies are insignificant. Furthermore, F test suggests that output growth lags are significant. However, the fixed effect a_i might be endogenously correlated with the other determinants of growth and using OLS or RE we will end up with biased results. So, the Hausman specification test can be used that gives us opportunity to determine which estimation approach is more appropriate: RE or FE. As the Hausman test prompts from the regression analysis, it is more appropriate to use Fixed Effects (FE) because there is a correlation between industry specific heterogeneity and independent variables. There might be a problem also of serial correlation and heteroskedastisity.

TABLE III
OLS, RE AND FE IN BASELINE MODEL

VARIABLES	(1) OLS	(2) RE	(3) FE
FDI	0.0176**	0.0182**	0.0312**
	(2.153)	(2.177)	(2.421)
K	0.0102	0.0108	0.0280
	(1.268)	(1.257)	(1.351)
R&D	0.0123*	0.0116*	0.00612
	(1.941)	(1.806)	(0.624)
L	-0.00558	-0.00604	-0.0976
	(-0.470)	(-0.469)	(-1.053)
Constant	-0.0823	-0.0872	-0.143
	(-1.617)	(-1.614)	(-0.877)
Observations	123	123	123
R-squared	0.115	0.0509	0.082
Number of count_ind		26	26

t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1. All variables in natural logs.

As robustness check, in Table V lags of FDI and R&D has been added, to check for past effects, how FDI and R&D in previous year affect economic growth. In columns (1), (2) and (3) can be seen that FDI is positively and significantly correlated with output growth. It should be mentioned that FDI with its first lag is negatively and significantly correlated with output growth. In column (4) the Fixed Effect estimation results with time dummies indicates that the time frame has not a crucial role for the effect of FDI on GVA growth. FDI has a positive and significant at the 10% level effect on current output growth of 2.92%, *ceteris paribus.* From columns (1) and (2) can be seen that labour is in both cases insignificant,

however, capital is significant at the 10% level and has the same coefficient in both estimation approach (OLS, RE). As for the research and development, it is insignificant in both OLS and RE estimation approaches. In columns (3) and (4) research and development, capital and labour are insignificant. It should be pointed out that in columns (3) and (4) the first lags of output growth are significant and negatively correlated with output growth.

TABLE IV
OLS, RE, FE WITH AND WITHOUT TIME DUMMIES IN THE BASELINE MODEL WITH THREE LAGS OF OUTPUT

VARIABLES	(1) OLS	(2) RE	(3) FE	(4) FE with time dummies
GVA_{t-1}	-0.159**	-0.246***	-0.345***	-0.346***
	(-2.021)	(-3.389)	(-4.830)	(-4.850)
GVA_{t-2}	-0.0207	-0.0819	-0.148*	-0.146*
	(-0.246)	(-1.048)	(-1.911)	(-1.891)
GVA_{t-3}	-0.0183	-0.107	-0.232***	-0.218**
	(-0.197)	(-1.243)	(-2.712)	(-2.531)
FDI	0.0184**	0.0224***	0.0366***	0.0388***
	(2.232)	(2.585)	(3.173)	(3.320)
K	0.0141*	0.0187*	0.0457**	0.0478**
	(1.704)	(1.928)	(2.442)	(2.547)
R&D	0.0134**	0.0111*	0.00608	0.00319
	(2.121)	(1.710)	(0.701)	(0.353)
L	-0.00421	-0.00382	-0.0547	-0.0688
	(-0.356)	(-0.255)	(-0.664)	(-0.828)
Constant	-0.101*	-0.127**	-0.268*	-0.249*
	(-1.940)	(-2.093)	(-1.834)	(-1.695)
F-test (GVA_{t-1}, GVA_{t-2}, GVA_{t-3})	1.40	13.25	9.75	9.56
Prob > F	0.2465	0.0041	0.0000	0.0000
Observations	123	123	123	123
R-squared	0.146	0.2755	0.307	0.317
Number of count_ind		26	26	26
Hausman test=52.30; Prob>chi2= 0.0000				
F-test(time dummies)= 1.30; Prob > F = 0.2571				

t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All variables in natural logs.

After using first difference (FD) estimation approach regression model can be corrected for the heteroskedastisity and serial correlation. In Table VI, dynamic panel results show that Δ FDI has positive effect with 2.19% on output growth. It is significant at the level of 10%. However, the first lag of FDI is insignificant. As F-test shows, they are jointly insignificant. It can be interpreted that today and previous years FDI have positive effects on output growth, but is not significant. ΔY_{t-1}, ΔR&D and $\Delta R\&D_{t-1}$ are insignificant. It should be mentioned that labour and capital are both insignificant too.

$$F(\Delta FDI, \Delta FDI_{t-1}) = 1.75$$
$$Prob > F = 0.1866$$

$$F(\Delta R\&D, \Delta R\&D_{t-1}) = 0.16$$
$$Prob > F = 0.8535$$

To correct for the serial correlation and heteroskedastisity, estimation robust is used to heteroskedastisity and autocorrelation. In Table VII, R-square (within) is 0.278, which gives reasonable motive for the conclusion to be based on the results produced by this regression. Hence, it can be strongly believe these results which will be important for the conclusion. The coefficients which are in log forms can be interpreted as direct elasticity's for the dependent variable.

TABLE V
OLS, RE, FE WITH AND WITHOUT TIME DUMMIES IN THE BASELINE MODEL WITH GVA, FDI AND R&D LAGS

VARIABLES	(1) OLS	(2) RE	(3) FE	(4) FE with time dummies
GVA_{t-1}	0.0788	0.0788	-0.255*	-0.243*
	(0.839)	(0.839)	(-1.974)	(-1.862)
FDI	0.0269**	0.0269**	0.0269*	0.0292*
	(2.199)	(2.199)	(1.800)	(1.907)
FDI_{t-1}	-0.0217*	-0.0217*	-0.0272*	-0.0241
	(-1.829)	(-1.829)	(-1.737)	(-1.483)
R&D	-0.00349	-0.00349	-0.00129	-0.00260
	(-0.231)	(-0.231)	(-0.0828)	(-0.166)
$R\&D_{t-1}$	0.0162	0.0162	0.0153	0.0143
	(1.105)	(1.105)	(0.929)	(0.860)
K	0.0167*	0.0167*	0.0320	0.0344
	(1.854)	(1.854)	(1.253)	(1.331)
L	-0.0154	-0.0154	-0.125	-0.135
	(-1.193)	(-1.193)	(-0.910)	(-0.977)
Dyear				-0.0272
				(-0.756)
Constant	-0.0779	-0.0779	-0.0144	-0.0137
	(-1.358)	(-1.358)	(-0.0637)	(-0.0604)
Observations	79	79	79	79
R-squared	0.215	0.256	0.207	0.215
Number of count_ind		20	20	20

t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All variables in natural logs.

TABLE VI
FIRST DIFFERENCE (FD) WITH ROBUST T-RATIOS, OLS, FIRST DIFFERENCE (FD), RESULTS WITH ROBUST T-RATIOS

VARIABLES	(1) gva_gr
ΔGVA_{t-1}	0.150
	(1.113)
ΔFDI	0.0219*
	(1.744)
ΔFDI_{t-1}	0.00230
	(0.156)
ΔK	0.0338
	(1.395)
ΔR&D	-0.00665
	(-0.542)
$\Delta R\&D_{t-1}$	0.00128
	(0.120)
ΔL	0.120
	(1.008)
Constant	0.0475**
	(2.404)
Observations	50
R-squared	0.202

Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All variables in natural logs.

From Table VII, it can be observed that current FDI is significant at the 10% level and if you increase current FDI by 100% current, output growth should boost approximately 3.07% on average in ceteris paribus. The first lag of FDI is insignificant and negatively correlated with output growth. In this case, the first lag of FDI is very important because FDI needs some time to effect on productivity and increase output growth. At the same time, the F test shows that FDI and FDI $_{t-1}$ are jointly insignificant. From Table VII, can be seen that the first lag of R&D has positive and insignificant effect on output growth. Current R&D has negative and insignificant effect on output growth and from the F test can be seen that R&D and R&D $_{t-1}$ are jointly insignificant. Also, from Table VII it can be seen that the first and second lags of output growth are significant, but the third lag is insignificant. However, all three lags of the output growth are jointly insignificant and negatively effect on output growth. In the regression, capital (K) and labour (L) are insignificant on output growth.

While fixed effect robust was used to heteroskedastisity and autocorrelation with time and industry dummies there could be also the problem of endogeneity. Using fixed effect with industry dummies should correct the endogeneity problem partially, but not totally. To correct for endogeneity problem a twostage least square regression (2SLS) method is used, which means that the proper variable which will be highly correlated with FDI should be found and at the same time should be independent with output growth. However, 2SLS regression method is beyond of the presented paper's scope.

$$F\ (GVA_{t-1,}\ GVA_{t-2,}\ GVA_{t-3}) = 2.04$$
$$Prob > F = 0.1426$$
$$F\ (FDI,\ FDI_{t-1}) = 2.43$$
$$Prob > F = 0.1151$$
$$F\ (R\&D,\ R\&D_{t-1}) = 1.15$$
$$Prob > F = 0.3374$$

V. Concluding Remarks

The objective of this research is to investigate how FDI affects growth by industries for 10 Central and Eastern European countries (except Croatia). Ten industries and the time period from 1995 to 2012 were selected, for which the proper data was available. To explore the connection between the FDI and economic growth, was used different estimation approaches, for example OLS, RE, FE with and without time dummies. In addition, based on a micro (industry) level analysis a macro (country) level analysis was made for 11 Central and Eastern European countries (CEEC) (including Croatia). Based on some general FDI and GDP trends at the country level, the relationship between them was analyzed from the period 1994 to 2012.

TABLE VII
FE Robust to Heteroskedastisity and Autocorrelation

VARIABLES	(1) gva_gr
GVA_{t-1}	-0.324**
	(-2.334)
GVA_{t-2}	-0.165*
	(-1.958)
GVA_{t-3}	-0.186
	(-1.184)
FDI	0.0307*
	(1.870)
FDI_{t-1}	-0.0232
	(-1.638)
K	0.0266
	(0.668)
R&D	-0.00532
	(-0.325)
$R\&D_{t-1}$	0.0190
	(1.256)
L	-0.141
	(-0.960)
Constant	0.0333
	(0.114)
Observations	79
Number of count_ind	20
R-squared	0.278

Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All variables in natural logs.

TABLE VIII
Simple Correlation Matrix

	FDI	K	R&D	L	GVA	GVA1	GVA2	GVA3	FDI1	FDI2	FDI3	R&D1	R&D2	R&D3
FDI	1													
K	0,43	1												
R&D	0,37	0,17	1											
L	0,13	-0,39	0,06	1										
GVA	0,34	0,26	0,10	-0,01	1									
GVA1	0,34	0,53	0,08	-0,01	0,06	1								
GVA2	0,14	0,36	-0,05	-0,07	0,07	0,40	1							
GVA3	-0,04	0,17	-0,05	-0,18	0,11	0,31	0,13	1						
FDI1	0,62	0,39	0,22	0,13	-0,02	0,36	0,38	-0,07	1					
FDI2	0,54	0,19	0,29	0,04	0,09	0,23	0,28	-0,06	0,75	1				
FDI3	0,55	0,22	0,25	-0,15	0,15	0,19	0,13	0,02	0,68	0,81	1			
R&D1	0,44	0,04	0,77	0,26	0,07	0,08	-0,04	-0,04	0,30	0,30	0,31	1		
R&D2	0,46	-0,02	0,64	0,21	0,07	0,06	0,15	0,02	0,28	0,29	0,24	0,82	1	
R&D3	0,33	-0,10	0,51	0,19	0,10	0,09	0,17	0,17	0,39	0,43	0,37	0,72	0,83	1

List of abbreviations; FDI – foreign direct investment, K – gross capital, GVA – gross value added, L – Labor, R&D – research and development.

Results of this research are supported by Castejón and Wörz who concluded that FDI positively affects growth, particularly in the catching-up economies [6]. In addition, Darrat, Kherfi and Soliman concluded that FDI positively affected economic growth in CEE countries [8].

This study could be extended by using export and import penetration, which are the main competing sources of international knowledge transmission, but, because of the given limited data which is still not available for the industry level analyses had not had opportunity to include exports and imports here. It can also be extended by adding the country specific dummies, and total labour productivity variables. Finally, for future research a variable could be added which is defined by the way: the number of high school and college graduates divided by the total population in the proper country. Thus, further research should make clear in more detail the FDI and GDP relationship in CEE countries.

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