Central European Journal of Economic Modelling and Econometrics

Is Foreign Direct Investment a Real Driving Force of Economic Growth? A Panel Data Analysis

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Submitted: 14.07.2019, Accepted: 19.06.2020

Abstract

The purpose of this empirical study is to find the relationship between economic growth and foreign direct investment (FDI) in the Commonwealth of Independent States (CIS) and Central and Eastern European Countries (CEECs) using endogenous technological change model. First, we combine the CIS and CEECs into one group to test our hypothesis, and then we test each group separately to account for heterogeneity and draw a conclusion whether FDI is indeed a driving force of the economy. Panel data have been used from 2003 to 2014 and different panel estimation methods have been applied. Additionally, we use the Generalized Method of Moments (GMM) panel estimator to control for endogeneity problem. The present study finds that FDI is an important factor explaining economic growth in the pooled group and CEECs, although it is not significant in the case of CIS.

Keywords: economic growth, FDI, human capital, research and development, panel analysis

JEL Classification: C23, C26, F21, O10, O33

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1 Introduction

Technology is a driver of economic growth. Economic growth driven by the diffusion of technology is the focus of many economists and policy makers. The study of technological diffusion dates back to the second half of the twentieth century (Findlay, 1978; Wang, 1990; Grossman and Helpman, 1989; Romer, 1990). Since then many studies have been devoted to studying the role of technological diffusion in economic growth (Helpman, 1997; Barro and Sala-i-Martin, 2004; Borensztein et al., 1998; Xu, 2000; Comin et al., 2006). Two prominent growth theories, one of which is the traditional Solow-Swan, and the other endogenous, emphasize the role of technology diffusion in achieving long-term economic growth. Although the former assumes that the rate of technological change is exogenous, and long-term economic growth cannot be explained within the model, the latter suggests that technological change is endogenous, and long-term economic growth can be explained within the model.

When countries trade internationally or open up their economies to foreign investment, ideas and new technologies are transferred between partner countries. The diffusion of technology can happen in two ways: one through trading in goods (Grossmann and Helpman, 1989) and the other through international capital movements (Findlay, 1978; Wang, 1990). As Wang and Blomstorm (1992) note, most of the previous studies on technology diffusion through international capital movements *"mostly confined to an ad hoc modeling of externalities"*. The diffusion of technology in the form of foreign investment is the result of the joint activities of multinational corporations (MNCs) and domestic firms. Rent-seeking innovator firms of leading countries discover and design new products or technologies by virtue of their superior ability, and imitator firms of follower countries imitate or adopt it at lower prices (Krugman, 1979; Barro and Sala-i-Martin 2004). Further, Krugman (1979) explains the patterns of trade between developed and developing countries in terms of innovation and technology transfer by suggesting the North-South trade model. According to him, the difference in the level of technology between North and South gives impetus to the trade-in old and new products and ultimately causes the movement of capital between the two.

In this study, we examine empirically the role of foreign direct investment (FDI) in the economic growth of Commonwealth of Independent States (CIS) and Central and Eastern European Countries (CEECs) using panel data. For an econometric model building, we apply a model of technological change proposed by Romer (1990) and Barro and Sala-i-Martin (2004) to study the effect of FDI on economic growth and development. In this endogenous technology change model, research and development (R&D) plays a significant role. Investment in R&D leads to the creation of a new variety of producers and consumption goods. Technology diffusion that fuels growth in the endogenous technological change model is driven by the intentional investment of firms to invent new products (Romer, 1990). However, the presence and proportion of well-educated human capital are important prerequisites to achieve R&D efficiency.

This empirical paper has several features to characterize. First, we study comparatively the effect of FDI on economic growth in the pooled group of CIS and CEECs, and separately in each group of countries using the endogenous technology-change model. Second, up until now, this group of countries, especially the CIS, has not been sufficiently covered in research papers. Therefore, this research study approaches the problem empirically using panel data and attempts to discover whether FDI is a key growth tool in the selected groups of countries. Third, we apply several econometric tools to obtain robust estimation results. Finally, in addition to other estimation methods, we also use instrumental variable estimation to account for endogeneity problems, which are one of the main issues in many empirical studies. Our findings suggest that FDI has a positive effect on the economic growth of CIS and CEECs pooled group and individual CEECs, but not on the growth of CIS.

The remainder of the present paper is organized as follows: the Literature review discusses previous studies related to this topic; we then outline the data and model we employed in this study and subsequently describe the estimation results; finally, we make concluding remarks about the main results.

2 Literature review

In growth literature, the role of technology diffusion has gained an enormous amount of attention from researchers. A distinctive character of technology is that it is a nonrival good. Romer (1990) notes that because of the nonrival nature of newly invented technology, its use by one firm does not limit its use by other firms. Diffusion, imitation, and adaptation of technological changes explain the spread of modern economic growth from the *dynamic* places to relatively *stagnant* places (Findlay, 1978). Although the diffusion of technology is important in the process of economic growth, it takes some time for any new technology to become economically important (Mukoyama, 2004).

The role of FDI in the process of technology transfer is huge and is considered one of the important mechanisms of this process. However, many early studies neglect the role of FDI in technology transfer (Wang, 1990). Several empirical studies have examined the role of FDI in technology diffusion and economic growth, with particular emphasis on different economies. Borensztein et al. (1998), for example, study the effect of FDI on economic growth using an endogenous growth model with an increasing variety of capital goods in developing countries.

An increasing number of theoretical studies assert that FDI is beneficial for the economic growth of recipient countries. However, empirical country-specific studies show mixed results. Most studies have argued that the level of FDI impact on economic growth is largely due to the absorptive capacity and host country conditions. Tarzi (2005) studies the location and public policies of recipients as key factors determining the attraction of large volumes of FDI. Furthermore, the rate of technology transfer via FDI is highly dependent on the level of interaction of host-country firms with MNCs (Wang and Blomstrom, 1992). Borensztein et al. (1998)

find that foreign direct investment is an important factor in the process of technology transfer and economic growth, but the higher importance of FDI in this process is largely dependent on the stock of human capital. However, Blomstrom et al. (1992) show that it is the level of development that determines the productivity of FDI, not the stock of human capital, and they believe that the richer the country, the higher the growth-effect of FDI.

Recently, a growing number of studies emphasize that institutions are fundamental causes of economic growth and development (Acemoglu et al., 2005). In this regard, it is also worth to say that institutions also matter for FDI inflow, and generally, for the growth-effects of FDI. Hermes and Lensink (2003) confirm the argument that education relates to the inflow of FDI, and add that FDI contributes to the process of technological diffusion and economic growth in countries with developed financial systems. Similarly, Alfaro et al. (2004) also suggest that well-developed financial markets are important prerequisites for a positive relationship between FDI and economic growth.

Moreover, voluminous studies emphasize the role of trade policy as the main factor determining the inflow of FDI. Bhagwati (1978), for example, proposes an interesting hypothesis that the trade policy of the recipient economy determines the magnitude and effectiveness of FDI inflow. Some empirical research papers on the growth-effect of FDI in countries with different trade policies support these hypotheses (Nair-Reichert and Weinhold, 2001).

Besides, there are some conflicting views about the role of FDI in economic growth and development. Several cross-country studies show that FDI does not enhance economic growth and these two have either a negative relationship or no correlation at all. Some findings argue that FDI may crowd out domestic investment, and then its effect on the economy diminishes (Agosin and Machado, 2005). Therefore, FDI and domestic investment should have some level of complementarity, at least in the short term, to affect growth positively (De Mello 1997). De Mello (1999) comparatively studies the impact of FDI on output, total factor productivity, and capital accumulation and finds that FDI and output have a positive association in OECD countries, while having a negative association in non-OECD countries. In turn, Carkovic and Levine (2002) provide cross-section evidence that FDI does not lead to economic success. Likewise, Mencinger (2003) and Herzer (2012) stress that FDI and growth are negatively correlated in transition and developing economies. Furthermore, some country-level studies also support the idea that FDI is not the factor causing economic growth. For instance, Carbonell and Werner (2018) find that FDI has no positive effect on Spanish economic growth, which is another contradictory result for our expectations.

Coming to the relationship between FDI and economic growth in the CIS and CEECs, the results are also mixed. Some recent studies suggest that FDI causes a positive impact on the economic growth of CEECs (Weber, 2010; Kornecki and Raghavan, 2011; Prochniak, 2011; Jimborean and Kelber, 2014; Hlavacek and Bal-Domanska, 2016). Other studies present either a negative relationship (Curwin and Mahutga, 2014), or no relationship at all (Hamm et al., 2012) between FDI and economic prosperity in post-communist transition countries. Sapienza (2010), for example, believes that the lagging value of FDI is significant and positive, while the current value is also significant, but negative, to explain GDP growth in countries with economies in transition in the CEECs and CIS. Eller et al. (2006) study the impact of financial sector FDI on the economic growth of CEECs and find that the impact of FDI on growth depends on a certain threshold, that is, the lower the degree of FDI, the higher the impact. Okafor and Webster (2015) suggest that economic growth and FDI are closely related in transition economies of Europe and the Former Soviet Union, although the association is more complex than we might expect. According to Curwin and Mahutga (2014), the ambiguous relationship between FDI and economic growth in the transition economies of the CIS and CEECs is partly explained by data limitations and the age of transition.

To sum up, we can say that the role which FDI plays in economic growth is somehow ambiguous. There is no single empirical conclusion that FDI stimulates economic growth. The lack or poor quality of data can also be one of the decisive reasons for these ambiguous results. Besides, cross-country differences in levels of development, institutional quality, and trade regimes also provide some explanation for the various findings of these discussions.

3 Model specifications and data

3.1 Model specifications

Our model is based on the models of technological change where the expansion of input varieties causes the invention of new products. In this sense, we apply the model used by Romer (1990) and Barro and Sala-i-Martin (2004). Hereafter, we follow a leader-follower model and the notations from Barro and Sala-i-Martin (2004) and provide a quick summary of this leader-follower model to explain the role of foreign investment in the process of technological diffusion.

In this model country 1 is an innovator or leading country and country 2 is an imitator or follower country. Firms in country 1 discover new jth intermediate goods at δ costs and firms in country 2 imitate or adapt these new goods at γ costs. Since we focus on the effect of FDI on the recipient country, we present model derivations for the follower country. The model of imitation in country 2 is like the model of innovation in country 1, except that the cost of imitation in country 2, which we denote by γ, replaces the cost of innovation δ, in country 1.

A general production function with a fixed number of products for firms in country 2 can be given as:

$$Y_2 = A_2 H_2^{\beta_1} K_2^{\beta_2} \tag{1}$$

where Y_2 is the output, A_2 is the level of technology, H_2 is the stock of human capital, and K_2 is the stock of physical capital.
The stock of physical capital is given by:

$$K_2 = \left(\int_0^{N_2} X_{2j}^{\beta_2} dj \right)^{1/\beta_2} \tag{2}$$

where X_{2j} is the jth type of intermediate goods and N_2 is the number of intermediate products available for use in country 2. In this case, $N_2 \leq N_1$, where N_1 is the number of intermediate goods discovered in country 1. Thus, the total physical capital consists of different types of X_{2j} intermediate goods.
Hence, we may rewrite the production function in Eq. (1) as:

$$Y_2 = A_2 H_2^{\beta_1} \left(\int_0^{N_2} X_{2j}^{\beta_2} dj \right). \tag{3}$$

The imitators of jth variety of X_{2j} intermediate goods choose the price P_{2j} to maximize the flow of profits.
Equalizing the marginal product of the intermediate goods to P_{2j} gives:

$$P_{2j} = A_2 \beta_2 H_2^{\beta_1} X_{2j}^{\beta_2 - 1}. \tag{4}$$

If we solve it with respect to X_{2j}, then we obtain:

$$X_{2j} = \left(A_2 \beta_2 / P_{2j} \right)^{1/(1-\beta_2)} H_2^{\beta_1/(1-\beta_2)}. \tag{5}$$

The flow of profits of imitator firms from the sales of the jth intermediate goods in country 2 is then:

$$\pi_{2j} = \int_t^{\infty} \left(P_{2j} - 1 \right) X_{2j} e^{-r(t-n)} dt. \tag{6}$$

If we maximize the profit given in Eq. (6) subject to the Eq. (4), then we will have the demand for intermediate goods from the final producers. Thus, the first-order conditions for profit maximization gives:

$$X_{2j} = \left(A_2 \beta_2^2 H_2^{\beta_1} \right)^{1/(1-\beta_2)}. \tag{7}$$

We substitute X_{2j} from Eq. (7) into Eq. (4) and have monopoly mark up:

$$P_{2j} = \frac{1}{\beta_2} > 1. \tag{8}$$

Substitution of X_{2j} from Eq. (7) and P_{2j} from Eq. (8) into Eq. (6) gives:

$$\pi_{2j} = \left(\frac{1-\beta_2}{\beta_2} \right) A_2^{1/(1-\beta_2)} \beta_2^{2/(1-\beta_2)} H_2^{\beta_1/(1-\beta_2)}. \tag{9}$$

When there is free entry condition for imitation we may have:

$$r_2 = \frac{\pi_{2j}}{\gamma} = \frac{1}{\gamma}\left(\frac{1-\beta_2}{\beta_2}\right) A_2^{1/(1-\beta_2)} \beta_2^{2/(1-\beta_2)} H_2^{\beta_1/(1-\beta_2)} \tag{10}$$

where r_2 is the rate of return in country 2.
Next, we consider an economy where the representative of households maximizes the following utility function:

$$\int_t^{\infty} \frac{\left(c_2^{1-\theta}-1\right)}{(1-\theta)} e^{-(\rho-n)t} dt \tag{11}$$

where c_2 is the unit of household consumption of the final good Y_2.
The Euler equation for consumption implies that the growth rate of consumption in a steady-state is:

$$\frac{\dot{C}_2}{C_2} = g_2 = \left(\frac{1}{\theta}\right)(r_2 - \rho). \tag{12}$$

Moreover, in a steady state condition, consumption and output grow at the same rate that we denote by g_2.
So, if we substitute r_2 in Eq. (10) into Eq. (12), then we obtain the rate of growth of the economy in country 2:

$$g_2 = \left(\frac{1}{\theta}\right)\left[\frac{1}{\gamma}\left(\frac{1-\beta_2}{\beta_2}\right) A_2^{1/(1-\beta_2)} \beta_2^{2/(1-\beta_2)} H_2^{\beta_1/(1-\beta_2)} - \rho\right]. \tag{13}$$

According to Barro and Sala-i-Martin (2004), the role of FDI in this technological diffusion is explained by the intellectual property rights of inventor firms in country 1. The above settings are the case when innovator firms in country 1 do not hold perpetual property rights over the use of their discoveries in country 2. However, when innovator firms in country 1 hold property rights over the use of goods they discover, imitator firms in country 2 cannot simply imitate or adapt these discoveries. In the context of strong and enforced intellectual property rights, both innovation and adaptation of new goods are driven by the efforts of firms in country 1. In this case, the number of intermediate goods, N_1, discovered in country 1 exceeds the number of intermediate products, N_2, available in country 2. Thus, now firms in country 1 incur the additional cost γ, in addition to their fixed R&D expenditure δ, to transfer and adapt their goods to country 2. This transfer cost is considered as foreign investment in country 2.
As indicated in Eq. (13), foreign investment in country 2 by firms from country 1, which is presented by the transfer and adaptation cost of $N_1(\gamma)$, reduces the cost of imitation due to $\gamma = \gamma\,(N_2/N_1)$. A decrease in the cost of imitation raises the rate of return, r_2, in Eq. (10) and, therefore increases the growth rate, g_2, in Eq. (13). Furthermore, a reduction in the cost of introducing new varieties of capital goods due to foreign investment in an imitating country increases the rate of introduction

of new capital goods (Borensztein et al., 1998). As mentioned in the same literature, an imitator country tends to have lower costs of introducing new capital goods, that is, it produces fewer varieties of capital goods than an innovator country, and enjoys lower costs of imitation and therefore grows faster. Besides, the growth rate of the economy of the imitating country has a positive association with the level of human capital, that is, the higher the level of human capital in the country, the greater the ability of the economy to catch up with the leader. Barro and Sala-i-Martin (2004) note that the larger the economy, which is represented by the stock of human capital, the lower the cost of transfer per unit of human capital or production. Consequently, a decrease in the transfer cost due to foreign investment, and an increase in the stock of human capital increase the growth rate, g_2.

To test the effect of FDI on growth empirically, we estimate the following approximated equation:

$$GDP_{it} = \alpha_1 + \alpha_2 HC_{it} + \alpha_3 FDI_{it} + \alpha_4 S_{it} + e_{it} \tag{14}$$

where *GDP* is the GDP per capita, *HC* is the stock of human capital, *FDI* is foreign direct investment, and S is a set of other variables that determine growth, such as research and development (RD), population (POP), government consumption (GOV), and business freedom (*BusFred*).

Firstly, we assume that the error term is $\epsilon_{it} \sim iid(0, \sigma_\epsilon^2)$; that is, it is independently and identically distributed (*iid*) with zero mean and constant variance. Secondly, we will relax that the error term is *iid*, that is, the error term is not necessarily *iid*, because it may have heteroscedasticity and/or serial relations. Thirdly, we assume that the error term is normally distributed.

3.2 Data

Originally, we planned to have 24 countries and a longer period but because of the shortage of data, we have to shorten the number of countries and years. Consequently, we collect the 2003-2014 annual data of 18 countries for this empirical study. The list of countries includes seven states of the CIS (Armenia, Belarus, Kyrgyzstan, Moldova, Tajikistan, Ukraine, and Uzbekistan) and eleven CEECs (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia). The data have been taken from the World Bank Open Data source, UNCTAD data center, UNESCO Institute for Statistics and the Heritage Foundation. We use GDP per capita, tertiary enrolment, population and government consumption series from the World Bank data, FDI stock from UNCTAD, and R&D expenses from the UNESCO Institute for Statistics. Data on institutional quality have been taken from the Heritage Foundation data source. Our dependent variable, GDP, is defined as the GDP per capita in Purchasing Power Parity (PPP). FDI measured as the ratio of FDI stock to GDP. For the human capital stock, we use the gross enrollment ratio in tertiary education. As a measure of R&D, we take the ratio of R&D expenditure to GDP. Total population and the ratio of general government final consumption expenditure to GDP are used as the proxies of population and government consumption, respectively. Finally, the index of business freedom has been used as the proxy of institutional quality. All variables are used in the natural logarithm. For the estimation of our growth model, we apply several panel data estimation methods to generate robust results.

4 Results and discussions

As mentioned earlier, the regression is applied to seven countries in the CIS region and eleven CEECs for the period 2003-2014. Because the error term is not certainly *iid*, we use the Pooled Ordinary Least Squares (POLS), the Fixed Effect Model (FEM), the Random Effect Model (REM), and the Feasible Panel Generalized Least Squares (FGLS) methods to test our hypothesis and choose the most appropriate one that fits the data well. To handle the issue of endogeneity, we apply the Generalized Method of Moments (GMM) estimator. Moreover, to address the absorptive capacity issues, we include the interaction of FDI and human capital in our regressions. First, we pool CIS and CEECs to test the effect of FDI and other given explanatory variables on economic growth using the above-mentioned methods of panel estimation. In the end, we test CIS and CEECs as single groups for comparison.
Since panel data consist of time-series and cross-sectional data, first of all, we need to confirm whether our series are stationary or not. Otherwise, there is always the risk of having spurious regression problems when nonstationary series are used in regression analysis. For this reason, we test our data for the panel unit root. In this regard, we apply four types of unit root tests, Levin, Lin, and Chu (2002), Breitung (2000), Im, Pesaran, and Shin (2003), and Fisher-ADF and PP (Maddala and Wu (1999), and Choi (2001)), for the series of all groups. Most of these tests show that our series have a unit root. However, we can expect non-spurious regression with non-stationary series in levels when they have a cointegration. Given panel cointegration tests, Engle-Granger based Pedroni (1999, 2004) and Kao (1999), confirm that our series have a stable, long-run relationship (see Table 8 - Table 16 in Appendix A).

4.1 Estimation of CIS and CEECs pooled group

Following the pre-tests for panel unit root and cointegration, the selected estimation methods have been applied sequentially to test the impact of FDI on economic growth. As shown in Table 1, regressions 4.1.1 to 4.1.4 report that FDI has a positive impact on economic growth after controlling for human capital, research and development, population, government consumption and business freedom. The coefficients of FDI range from 0.149 to 0.208. However, in the POLS, we do not distinguish the countries by ignoring heterogeneity among them.

Table 1: Estimation results: Pooled group

	OLS	FEM-1	REM-1	FGLS-1	REM-2	FGLS-2	PCSE
	(4.1.1)	(4.1.2)	(4.1.3)	(4.1.4)	(4.1.5)	(4.1.6)	(4.1.7)
HC (ln)	0.2306*** (0.0730)	0.4456*** (0.0900)	0.4614*** (0.0845)	0.2306*** (0.0718)	0.4614** (0.2119)	0.5063*** (0.0387)	0.4719*** (0.0854)
FDI (ln)	0.1487*** (0.0506)	0.2077*** (0.0360)	0.2068*** (0.0352)	0.1487*** (0.0498)	0.2068** (0.0870)	0.0671*** (0.0095)	0.0796** (0.0332)
RD (ln)	0.7807*** (0.0574)	0.3601*** (0.0544)	0.4042*** (0.0519)	0.7807*** (0.0565)	0.4042*** (0.0864)	0.4675*** (0.0251)	0.5615*** (0.0725)
POP (ln)	0.1146*** (0.0311)	−0.1636 (0.3253)	0.0515 (0.0984)	0.1146*** (0.0306)	0.0515 (0.1365)	0.0401** (0.0164)	0.0395 (0.0261)
GOV (ln)	−0.4275** (0.1925)	−0.4023*** (0.1183)	−0.4011*** (0.1137)	−0.4275** (0.1893)	−0.4011** (0.1935)	−0.1721*** (0.0491)	−0.2681* (0.1451)
BusFred (ln)	1.1273*** (0.1761)	0.7187*** (0.0848)	0.7190*** (0.0840)	1.1273*** (0.1732)	0.7190*** (0.1787)	0.4040*** (0.0498)	0.5143*** (0.1363)
R-squared	0.80	0.97	0.65	–	0.65	–	0.98
Joint LM test			773.43				
B-P LM test				404.69			
Wald test				1406.78			
No. of obs.	216	216	216	216	216	216	216
No. of countries	18	18	18	18	18	18	18

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; standard errors in parentheses; results of FGLS-2 are based on a generalized inverse of a singular matrix due to $T < N$; REM-2 and FGSL-2 with robust std. errors; PCSE results with panel corrected standard errors.

To address this issue, we use the FEM and REM methods. To decide the most appropriate method between the FEM-1 and REM-1, we apply the Hausman test. The Hausman test χ^2 statistic with a 7.53 value fails to rejects the null hypothesis of REM is consistent.

Because panel data consist of time series and cross-sections, it may suffer from autocorrelation and heteroscedasticity problems. A joint Lagrange Multiplier (LM) test for homoscedasticity and no first-order serial correlation in a random effects panel data model strongly rejects the null hypothesis of homoscedasticity and no serial correlation in the REM-1. Furthermore, the BP LM residual cross-section correlation test and the Modified Wald test for groupwise heteroscedasticity suggest that the FGLS-1 also suffers from heteroscedasticity and serial correlation problems. To obtain robust standard errors, we correct the REM-1 and the FGLS-1 for the presenting problems.

In the case of the FGLS-1, we use the Parks-Kmenta FGLS (FGLS-Park) method, because it can handle group-wise heteroscedasticity, autocorrelation, and cross-sectional dependence at the same time. The FGLS-Park method is usually infeasible in the case of the number of time periods T being smaller than the cross-sections N in the panel data (Beck and Katz 1995). Accordingly, Beck and Katz (1995) proposed OLS based panel corrected standard errors (PCSE) to alleviate this problem of the FGLS-Park method. However, it is now possible to estimate the FGLS-Park method in *Stata* using a generalized inverse of a singular matrix when $T < N$ or $T = N$, although estimated parameters may not work properly (Moundigbaye, Rea, and Reed 2018). Table 1 reports the results of the REM-2, FGLS-2 (Park), and PCSE estimators with robust standard errors.

In accordance with the robust results reported in Table 1, we can see that the parameters of regressions 4.1.5 to 4.1.7 are significant for explaining economic growth in the pooled group of CIS and CEECs, except for population in the regression 4.1.5 and 4.1.7. It is worth noting that regression 4.1.6 produces significant and well-performed parameters under the $T < N$ case. However, regression 4.1.5 gives a higher estimate of FDI compared with the regressions 4.1.6 and 4.1.7 with an overall R-squared of 65%. Thus, according to estimated results, FDI turns out to have a positive and significant impact on growth, with the corresponding elasticity ranging from 0.067 to 0.207 in the reporting estimations.

These findings support previous studies (Kottaridi, 2005; Weber, 2010; Kornecki and Raghavan, 2011; Jimborean and Kelber, 2014; Okafor and Webster, 2015) that FDI is positively associated with the economic growth. In addition, enrollment in higher education institutions, R&D and business freedom also show a positive and statistically significant effect on economic growth.

4.2 Estimation of CIS

For the sake of comparison, we also assess the effect of FDI on the economic growth of CIS using similar estimation methods. The results, shown in Table 2, indicate that the role of FDI as a determinant of growth is ambiguous. Regressions 4.2.1 and 4.2.3 report that FDI negatively affects economic prosperity, while regression 4.2.2 confirms our expectations with a coefficient of 0.054, although it is not significant. Further, to obtain robust estimators, we follow the same procedures as in the previous section.

Due to known issues in the POLS, we again use the FEM and REM estimators. The obtained value of the Hausman test χ^2 statistic is 5.10, and it also fails to reject the null hypothesis that is the REM-1 is consistent. However, a joint Lagrange Multiplier (LM) test for homoscedasticity and no first order serial correlation in a random effects panel data model strongly rejects the null hypothesis of homoscedasticity and no serial correlation in the REM-1. Furthermore, the BP LM residual cross-section correlation test and a modified Wald test for group-wise heteroscedasticity indicate that FGLS-1 estimator suffer from autocorrelation and heteroscedasticity problems by highly rejecting the null hypothesis.

Table 2: Estimation results: CIS

	OLS (4.2.1)	FEM-1 (4.2.2)	REM-1 (4.2.3)	FGLS-1 (4.2.4)	REM-2 (4.2.5)	FGLS-2 (4.2.6)
HC (ln)	0.3452*** (0.0798)	0.7779*** (0.1523)	0.3452*** (0.0798)	0.3452*** (0.0764)	0.3452** (0.1587)	0.4349*** (0.0412)
FDI (ln)	−0.1788** (0.0614)	0.0538 (0.0406)	−0.1788*** (0.0614)	−0.1788*** (0.0587)	−0.1788 (0.1902)	−0.0182 (0.0214)
RD (ln)	0.6342*** (0.0794)	−0.1505 (0.0925)	0.6342*** (0.0794)	0.6342*** (0.0760)	0.6342*** (0.1219)	0.3339*** (0.0452)
POP (ln)	0.1594*** (0.0491)	2.1784*** (0.4284)	0.1594*** (0.0491)	0.1594*** (0.0470)	0.1594 (0.0995)	0.1480*** (0.0197)
GOV (ln)	−0.9595*** (0.1799)	−0.2320* (0.1237)	−0.9595*** (0.1799)	−0.9595*** (0.1723)	−0.9595*** (0.1578)	−0.4712*** (0.0756)
BusFred (ln)	1.2327*** (0.1809)	0.6705*** (0.0852)	1.2327*** (0.1809)	1.2327*** (0.1732)	1.2327*** (0.2294)	0.3565*** (0.1070)
R-squared	0.81	0.97	0.81	–	0.81	–
Joint LM test			85.04			
B-P LM test				73.74		
Wald test				56.63		
No. of obs.	84	84	84	84	84	84
No. of countries	7	7	7	7	7	7

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; standard errors in parentheses; REM-2 and FGSL-2 with robust standard errors.

We handle both autocorrelation and heteroscedasticity issues in both the FEM-1 and FGLS-1 methods with certain econometric tools and obtain robust estimators. According to robust results of regressions 4.2.5 and 4.2.6 in Table 2, FDI comes out not statistically significant, although negative, for generating growth in the CIS. These presented results are consistent with the findings of Mencinger (2003) and Hamm et al. (2012) in which the FDI does not promote economic growth. Other remaining factors turn out to be significant for explaining economic growth in the CIS.

4.3 Estimation of CEECs

To continue our comparative study, we now turn to the estimated results of our last group of countries, CEECs, to test the role of FDI as an important determinant of growth. As shown in Table 3, regressions from 4.3.1 to 4.3.3 support our expectations that FDI is the driving force behind economic growth, although they are not robust. We again follow the same procedures to obtain robust estimators. The Hausman test χ^2 statistic with an 82.84 value and six degrees of freedom convincingly confirms that FEM-1 is the right estimate to test our hypothesis.

Yet, the BP LM residual cross-section correlation test and a modified Wald test for group-wise heteroscedasticity tests strongly reject the null hypothesis of no serial-correlation and homoscedasticity in the FEM-1 and FGLS-1 estimates, respectively.

Table 3: Estimation results: CEECs

	OLS (4.3.1)	FEM-1 (4.3.2)	REM-1 (4.3.3)	FGLS-1 (4.3.4)	FEM-2 (4.3.5)	FGLS-2 (4.3.6)
HC (ln)	0.2797**	0.6904***	0.4839***	0.2797**	0.6904***	0.4158***
	(0.1095)	(0.0770)	(0.0924)	(0.1066)	(0.1490)	(0.0270)
FDI (ln)	0.1243***	0.1631***	0.3066***	0.1243***	0.1631*	0.0691***
	(0.0456)	(0.0534)	(0.0592)	(0.0444)	(0.0933)	(0.093)
RD (ln)	0.4523***	0.3811***	0.4820***	0.4523***	0.3811***	0.3162***
	(0.0474)	(0.0446)	(0.0531)	(0.0461)	(0.0694)	(0.0192)
POP (ln)	0.0385*	−3.9153***	0.0130	0.0385*	−3.9153***	0.0094
	(0.0217)	(0.4341)	(0.0613)	(0.0211)	(0.5193)	(0.0135)
GOV (ln)	−0.3589*	−0.4660***	−0.8473***	−0.3589*	−0.4660**	−0.6357***
	(0.2059)	(0.1578)	(0.1899)	(0.2003)	(0.2164)	(0.0422)
BusFred (ln)	0.1345	−0.1237	0.1823	0.1345	−0.1237	0.1377***
	(0.1957)	(0.1301)	(0.1606)	(0.1904)	(0.1347)	(0.0246)
R-squared	0.59	0.92	0.72	–	0.92	–
BP LM test		161.32		314.59		
Wald test		184.25		380.05		
No. of obs.	132	132	132	132	132	132
No. of countries	11	11	11	11	11	11

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; standard errors in parentheses; FEM-2 and FGSL-2 with robust standard errors.

Using certain econometric tools to correct the problems of autocorrelation and heteroscedasticity, we obtain new results with robust standard errors.
As illustrated in Table 3, all robust parameters, except for business freedom in regression 4.3.5 and population in regression 4.3.6, are statistically significant for explaining economic growth in the CEECs. The elasticity of FDI parameters ranges from 0.069 to 0.163. It is noticeable that regression 4.3.5 gives a higher robust estimate of FDI with an overall *R*-squared of 92% compared to regression 4.3.6. These findings also support previous studies that FDI is a real driving force of economic prosperity in the CEECs (Prochniak, 2011; Hlavacek and Bal-Domanska, 2016). Furthermore, admission to higher education institutions, R&D expenses, and government expenditure are in line with our expectations, although the impacts of population and the quality of institutions on economic growth are ambiguous.

4.4 Endogeneity issues

Endogeneity is a fundamental problem in many empirical studies. This may happen when one of the explanatory variables that are incorporated in the model under study is correlated with the error term. If it is the case then we may have simultaneity issues. We have reason to believe that FDI is endogenous in growth regressions, i.e., FDI and growth may have simultaneity, although we assume that FDI is exogenous in the previous estimation methods. A high rate of economic growth may determine high levels of FDI inflow due to better profit opportunities (Herzer, 2012). That's why the association between FDI and economic growth may result from the endogenous determination of FDI. In this regard, we apply the GMM (Arellano and Bond, 1991) panel estimation method to deal with the endogeneity problem.

The panel GMM method can help to handle endogeneity problems by producing consistent and efficient estimators. We use lagged values of FDI and other explanatory variables as instruments to control for the endogeneity. Although there is no single rule to choose ideal instruments, the validity of the instruments can be evaluated through the Sargan-Hansen test (Sargan, 1958) for over-identifying restrictions. Moreover, valid instruments under the Sargan-Hansen test generate a consistent GMM estimator.

Table 4: GMM estimation results: all groups

	Pooled group (CIS + CEECs)	CIS	CEECs
	(4.4.1)	(4.4.2)	(4.4.3)
HC (ln)	0.1991***	0.3782***	0.3230**
	(0.0624)	(0.0734)	(0.1610)
FDI (ln)	0.1728***	−0.1952**	0.1285**
	(0.0541)	(0.0771)	(0.0591)
RD (ln)	0.8154***	0.6152***	0.4102***
	(0.0658)	(0.0708)	(0.0516)
POP (ln)	0.1272***	0.2070***	0.0238
	(0.0352)	(0.0547)	(0.0186)
GOV (ln)	−0.6221**	−1.3219***	−0.3827
	(0.2677)	(0.1592)	(0.3025)
BusFred (ln)	1.1511***	1.3848***	−0.0766
	(0.2289)	(0.2262)	(0.2323)
R-squared	0.80	0.88	0.50
Hansen's J-statistic	3.16	3.48	1.42
No. of obs.	180	70	110
No. of countries	18	7	11

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; standard errors in parentheses; instruments are lagged values of FDI and the other explanatory variables in the regression.

The GMM estimation results reported in Table 4 are consistent with the results of previous estimation methods. The Sargan-Hansen test of over-identifying restrictions also confirms that our instruments used are valid and good to control the endogeneity problem by accepting the null hypotheses of instruments that are valid. Thus, regressions 4.4.1 and 4.4.3 exhibit that FDI has a significant and positive effect on economic growth in the combined group of CIS and CEECs and individual CEECs, respectively. However, FDI negatively contributes to growth in the CIS according to the results of regression 4.4.2, which differs from previous results. Most of the control variables, except for population, government consumption and business freedom in the CEECs, are in line with our expectations.

4.5 Absorptive capacity issues

Recently, many studies have shed light on the absorptive capacity of the economy when examining the impact of FDI on economic growth. Upon receiving different results on the role of FDI in growth in the CIS and CEECs, we also perform some analysis of the absorptive capacity. In this regard, we include the interaction between FDI and human capital to take into account absorptive capacity. The impact of FDI on growth is closely related to the level of human capital in recipient countries, that is, the higher the level of human capital, the greater the impact of FDI on their economic growth (Borensztein et al., 1998). To test jointly the impact of FDI and the interaction term, we include the interaction term along with the individual variables FDI and human capital.

Table 5: Estimation results with interaction term: Pooled group

	OLS (4.5.1.1)	REM (4.5.1.2)	FGLS (4.5.1.3)	PCSE (4.5.1.4)	GMM (4.5.1.5)
HC (ln)	0.2015***	0.4443**	0.5460***	0.4423***	0.1468**
	(0.0748)	(0.2017)	(0.0795)	(0.0829)	(0.0615)
FDI (ln)	0.1340***	0.2038**	0.0705***	0.0881***	0.1253**
	(0.0512)	(0.0881)	(0.0263)	(0.0332)	(0.0619)
RD (ln)	0.7795***	0.4120***	0.5342***	0.5927***	0.8103***
	(0.0572)	(0.0839)	(0.0461)	(0.0704)	(0.0626)
POP (ln)	0.1099***	0.0573	0.0731**	0.0453*	0.1158***
	(0.0312)	(0.1274)	(0.0339)	(0.0255)	(0.0351)
GOV (ln)	−0.4241**	−0.3988**	−0.2468**	−0.2669*	−0.5310**
	(0.1917)	(0.1931)	(0.1130)	(0.1467)	(0.2585)
BusFred (ln)	1.1904***	0.7095***	0.3818***	0.5574***	1.2485***
	(0.1796)	(0.1759)	(0.0974)	(0.1408)	(0.2336)
FDI*HC (ln)	0.0261	−0.0112	−0.0015	−0.0009	0.0459**
	(0.0161)	(0.0084)	(0.0050)	(0.0063)	(0.0180)
R-squared	0.81	0.65	–	0.98	0.81
Hansen's J-statistic					3.41
No. of obs.	216	216	216	216	180
No. of countries	18	18	18	18	18

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; std. errors in parentheses; REM and FGLS results with robust std. errors; PCSE results with panel corrected std. errors; GMM instruments are lagged values of FDI and the other explanatory variables in the regression.

According to Table 5, in the pooled group of CIS and CEECs, most methods with robust estimators, except for GMM, show that the interaction term of FDI and human capital does not yield positive and significant coefficient. However, the coefficient of FDI is positive and statistically highly significant to explain economic growth which

in line with previous estimation results without the inclusion of the interaction term. In the GMM estimation method, both FDI and interaction between FDI and human capital are positive and significant to generate growth. But FDI yields a higher estimate of FDI than its interaction with human capital.
In the case of CIS, we find results that are consistent with the previous results, where the interaction term is omitted. The robust regressions 4.5.2.2 and 4.5.2.3 in Table 6 show that the inclusion of the interaction term of FDI and human capital does not improve the regression coefficients. Thus, both individual FDI variable and its interaction term with human capital do not cause growth in the CIS. However, the results of the GMM method given in regression 4.5.2.4 indicate that the coefficient on FDI is negative and statistically significant, while the interaction term is not significant.

Table 6: Estimation results with interaction term: CIS

	OLS	REM	FGLS	GMM
	(4.5.2.1)	(4.5.2.2)	(4.5.2.3)	(4.5.2.4)
HC (ln)	0.3551***	0.3551***	0.4031***	0.3066***
	(0.0883)	(0.1657)	(0.0961)	(0.0951)
FDI (ln)	−0.1811***	−0.1811	−0.0091	−0.2416***
	(0.0623)	(0.1875)	(0.0432)	(0.0671)
RD (ln)	0.6361***	0.6361***	0.3725***	0.6622***
	(0.0802)	(0.1188)	(0.0818)	(0.0805)
POP (ln)	0.1599***	0.1599	0.2079***	0.1824***
	(0.0494)	(0.0993)	(0.0532)	(0.0502)
GOV (ln)	−0.9670***	−0.9670***	−0.5697***	−1.1801***
	(0.1832)	(0.1425)	(0.1377)	(0.1743)
BusFred (ln)	1.2285***	1.2285***	0.7106***	1.4246***
	(0.1827)	(0.2339)	(0.1477)	(0.2191)
FDI*HC (ln)	−0.0059	−0.0059	−0.0146	0.0438
	(0.0218)	(0.0274)	(0.0116)	(0.0420)
R-squared	0.81	0.81	–	0.87
Hansen's J-statistic				0.57
No. of obs.	84	84	84	70
No. of countries	7	7	7	7

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; std. errors in parentheses; FEM and FGSL with robust std. errors; GMM instruments are lagged values of FDI and the other explanatory variables in the regression.

When it comes to CEECs, although FDI has a positive impact on growth, the interaction between FDI and human capital also does not appear to be statistically significant to explain economic prosperity. As presented in Table 7, all three robust regressions confirm that the interaction term does not cause growth. However, two out of three regressions exhibit that FDI itself has a positive impact on economic growth. Control variables also have results are line with the previous findings.

Table 7: Estimation results with interaction term: CEECs

	OLS (4.5.3.1)	FEM (4.5.3.2)	FGLS (4.5.3.3)	GMM (4.5.3.4)
HC (ln)	0.2059* (0.1088)	0.6584*** (0.1440)	0.3848*** (0.0880)	0.3308** (0.1590)
FDI (ln)	0.1360*** (0.0444)	0.1492 (0.0883)	0.0796** (0.0327)	0.1578** (0.0630)
RD (ln)	0.4335*** (0.0463)	0.3864*** (0.0677)	0.4069*** (0.0430)	0.4034*** (0.0502)
POP (ln)	0.0381* (0.0210)	−3.9844*** (0.5380)	0.0305 (0.0268)	0.0244 (0.0192)
GOV (ln)	−0.3022 (0.2003)	−0.4157* (0.2234)	−0.6234*** (0.1396)	−0.4256 (0.3003)
BusFred (ln)	0.0544 (0.1914)	−0.1268 (0.1367)	0.0692 (0.1024)	−0.1445 (0.2365)
FDI*HC (ln)	−0.0362*** (0.0119)	−0.0129* (0.0069)	−0.0033 (0.0038)	−0.0209* (0.0125)
R-squared	0.62	0.92	–	0.50
Hansen's J-statistic				0.90
No. of obs.	132	132	132	110
No. of countries	11	11	11	11

Notes: ***, **, * indicate the significance at the 1%, 5% and 10% levels, respectively; std. errors in parentheses; FEM and FGSL with robust std. errors; GMM instruments are lagged values of FDI and the other explanatory variables in the regression.

In conclusion, empirical results suggest that the importance of FDI in this process of technology transfer and growth does not depend on the amount of human capital in the selected group of countries. In all three groups, the interaction term tends to be insignificant. However, individual FDI produces results that are consistent with regressions without the interaction term, where FDI generates economic growth in the pooled group and individual CEECs, but not in the CIS. We need to look for an answer elsewhere to the question of why CIS and CEECs differ in the importance of FDI in economic growth.

5 Conclusions

As we have already mentioned, the role of FDI in the economy is huge. It is considered the second most important driver of economic growth after export. Nowadays, many countries have adopted open policy measures aimed at attracting more FDI. However, the open policy itself is not enough to attract the biggest share of global FDI. Countries must have an attractive economy to be an FDI recipient. Factors, such as the size of the economy, political and economic stability, stable economic growth, the existence of well-functioning political and economic institutions, and developed infrastructure make the country attractive to foreign investors.

In this study, we have attempted to find the relationship between economic growth and FDI in CIS and CEECs. For this purpose, we apply several methods to obtain robust estimation results. Based on our panel data estimation, we find that FDI is a significant factor explaining economic growth in the CEECs and pooled CIS and CEECs group. In the case of CIS, however, our panel estimation shows that FDI plays an ambiguous role in economic growth. Two of the three robust estimations suggest that FDI is not the driving force behind growth. However, the GMM estimation indicates that FDI negatively affects growth. These findings require more in-depth research to study the determinants of FDI performance in the CIS.

Most of these CIS countries have not been able to create a favorable economy for foreign investors, at least not so far. According to our data, the share of FDI in the economy of these CIS countries is much lower than those of the CEECs. A large proportion of FDI in GDP is a good signal for MNCs to determine future destinations for their overseas investments. The larger the share of FDI in the economy, the more favorable it is for foreign investors. Unfortunately, being former members of the Soviet Union, most of these CIS countries still have some administrative problems associated with the legacy of socialism. Without addressing these drawbacks, they may not be able to attract more foreign investment and achieve economic prosperity soon. Also, the lack and poor quality of FDI data can be another reason for the ambiguous role of FDI in economic growth in the CIS region.

Furthermore, the efficiency of FDI in economic growth in the CIS can be also explained in terms of political and economic institutions. Institutions are important for maintaining the rule of law and creating economic incentives for investors. The lack of well-functioning institutions can be a serious obstacle to the implementation of FDI projects in the economy. This may be the case for most of the countries of the CIS. Thus, the ratio of approved FDI to implemented FDI is the most concerning issue to test the effect of FDI on economic growth.

In contrast to the CIS, we observe a slightly different scenario in the CEECs. After becoming member countries of the European Union, CEECs were able to create a favorable economy for foreign investment. They adapted their political and economic institutions to those of other members. Besides, joining the European Union allowed them to attract foreign investment from member countries. Creating a common market with other member countries, CEECs quickly integrated into the global economy and opened their economies to foreign investors. In short, these countries have become attractive economies for MNCs.

Furthermore, we have also performed an analysis of absorptive capacity by including an interaction term of FDI and human capital in the regression. According to the previous studies, the interaction between FDI and human capital may explain why countries differ in terms of the importance of FDI in growth. However, the inclusion of the interaction term of FDI and human capital has not improved the regression coefficients in our sample. An interaction term of FDI and human capital has yielded results that correspond to regressions without the interaction term, where

FDI generates economic growth in the pooled group and individual CEECs, but not in the CIS. These results suggest that more research is needed to examine why the CIS and CEECs differ in the importance of FDI in economic growth.
Considering the economic implications of this study, we can discover more robust estimators to study the relationship between economic growth and FDI, mainly in the case of the CIS, if we can obtain rich panel data. This means that we need to conduct deeper research on this issue; however, we have left this issue for our future studies.

Acknowledgements

We would like to thank two anonymous referees for their helpful comments and suggestions.

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A Panel unit root and cointegration tests

Table 8: Result of panel unit root tests for CIS

	Levin Lin & Chu		Breitung		Im, Pesaran and Shin		ADF-Fisher		PP-Fisher	
	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*
lnGDP	−4.671	0.000	0.798	0.788	−2.191	0.014	27.187	0.018	51.499	0.000
lnHC	−5.965	0.000	1.553	0.940	−2.695	0.004	30.253	0.007	32.221	0.004
lnFDI	−0.703	0.241	0.661	0.746	1.149	0.875	7.511	0.913	7.114	0.930
lnRD	−3.987	0.000	0.226	0.589	−1.297	0.097	23.570	0.052	26.301	0.023
lnPOP	−1.750	0.040	2.612	0.996	−2.242	0.013	40.497	0.000	62.438	0.000
lnGOV	−2.221	0.013	−1.722	0.043	−1.082	0.140	17.896	0.212	17.826	0.215
lnBusFred	−1.830	0.034	0.079	0.532	0.247	0.598	9.007	0.831	16.225	0.300

Notes: *Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality;
Nulls: LLC - common unit root; IPS, ADF-Fisher and PP-Fisher - individual unit root.

Table 9: Result of panel unit root tests for CEECs

	Levin Lin & Chu		Breitung		Im, Pesaran and Shin		ADF-Fisher		PP-Fisher	
	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*
lnGDP	−6.151	0.000	0.587	0.722	−1.560	0.060	29.233	0.138	74.760	0.000
lnHC	−6.3310	0.000	3.830	1.000	−2.220	0.013	48.902	0.001	40.529	0.009
lnFDI	−6.286	0.000	−0.288	0.387	−3.058	0.001	42.899	0.005	63.490	0.000
lnRD	0.1951	0.577	1.708	0.956	2.331	0.990	21.246	0.506	11.716	0.963
lnPOP	−11.957	0.000	4.058	1.000	−0.005	0.498	32.011	0.077	26.683	0.224
lnGOV	−4.570	0.000	−2.760	0.003	−2.237	0.013	36.786	0.025	47.518	0.001
lnBusFred	−1.515	0.064	0.164	0.565	−0.024	0.491	18.993	0.646	22.468	0.432

Notes: *Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality; Nulls: LLC - common unit root; IPS, ADF-Fisher and PP-Fisher - individual unit root.

Table 10: Result of panel unit root tests for the pooled group

	Levin Lin & Chu		Breitung		Im, Pesaran and Shin		ADF-Fisher		PP-Fisher	
	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*	statistic	p value*
lnGDP	−7.147	0.000	1.005	0.843	−2.583	0.005	56.420	0.016	126.259	0.000
lnHC	−8.156	0.000	4.503	1.000	−3.407	0.000	79.155	0.000	72.750	0.000
lnFDI	−4.878	0.000	0.239	0.594	−1.654	0.049	50.410	0.056	70.604	0.000
lnRD	−1.808	0.035	1.577	0.943	1.028	0.848	44.816	0.149	38.017	0.378
lnPOP	−7.597	0.000	3.466	1.000	−1.426	0.077	72.508	0.000	89.121	0.000
lnGOV	−4.903	0.000	−3.255	0.000	−2.432	0.008	54.682	0.024	65.344	0.002
lnBusFred	−2.351	0.009	0.176	0.570	0.135	0.554	28.000	0.827	36.693	0.349

Notes: *Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality; Nulls: LLC - common unit root; IPS, ADF-Fisher and PP-Fisher - individual unit root.

Table 11: Pedroni residual panel cointegration test for CIS

lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	Panel v-Statistic			
	statistic	p value	weighted statistic	p value
	6.022	0.000	1.707	0.044
	Panel rho-Statistic			
	statistic	p value	weighted statistic	p value
	3.113	0.999	3.407	1.000
	Panel PP-Statistic			
	statistic	p value	weighted statistic	p value
	−11.157	0.000	−10.263	0.000
	Panel ADF-Statistic			
	statistic	p value	weighted statistic	p value
	−6.296	0.001	−4.979	0.000
	Group rho-Statistics			
		statistic	p value	
		4.602	1.000	
	Group PP-Statistics			
		statistic	p value	
		−13.204	0.000	
	Group ADF-Statistics			
		statistic	p value	
		−4.917	0.000	

Notes: Nulls: No cointegration; Alternatives: common AR coefs. (within dimension) for Panel v-Statistic, Panel rho-Statistic, Panel PP-Statistic, Panel ADF-Statistic; individual AR coefs. (between-dimension) for Group rho-Statistics, Group PP-Statistics and Group ADF-Statistics; automatic lag length selection based on SIC, Newey-West automatic bandwidth selection and Bartlett kernel.

Table 12: Kao residual cointegration test for CIS

	ADF		Residual variance	HAC variance
	t-statistic	p value		
lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	−3.505	0.000	0.0051	0.0075

Notes: Null: No cointegration; automatic lag length selection based on SIC Newey-West automatic bandwidth selection and Bartlett kernel.

Table 13: The Pedroni residual panel cointegration test for CEECs

	Panel v-Statistic			
	statistic	p value	weighted statistic	p value
	−3.711	1.000	−4.277	1.000
	Panel rho-Statistic			
	statistic	p value	weighted statistic	p value
	2.452	0.993	2.587	0.995
lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	Panel PP-Statistic			
	statistic	p value	weighted statistic	p value
	−2.812	0.003	−1.809	0.035
	Panel ADF-Statistic			
	statistic	p value	weighted statistic	p value
	−2.728	0.003	−1.896	0.029
	Group rho-Statistics			
	statistic	p value		
	4.555	1.000		
	Group PP-Statistics			
	statistic	p value		
	−6.098	0.000		
	Group ADF-Statistics			
	statistic	p value		
	−1.882	0.030		

Notes: Nulls: No cointegration; Alternatives: common AR coefs. (within dimension) for Panel v-Statistic, Panel rho-Statistic, Panel PP-Statistic, Panel ADF-Statistic; individual AR coefs. (between-dimension) for Group rho-Statistics, Group PP-Statistics and Group ADF-Statistics; automatic lag length selection based on SIC, Newey-West automatic bandwidth selection and Bartlett kernel.

Table 14: Kao residual cointegration test for CEECs

	ADF		Residual variance	HAC variance
	t-statistic	p value		
lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	−2.812	0.003	0.0030	0.0041

Notes: Null: No cointegration; automatic lag length selection based on SIC Newey-West automatic bandwidth selection and Bartlett kernel.

Table 15: Pedroni residual panel cointegration test for pooled group

	Panel v-Statistic			
	statistic	p value	weighted statistic	p value
	4.380	0.000	−1.300	0.903
	Panel rho-Statistic			
	statistic	p value	weighted statistic	p value
	6.391	1.000	6.508	1.000
lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	Panel PP-Statistic			
	statistic	p value	weighted statistic	p value
	−11.233	0.000	−11.988	0.000
	Panel ADF-Statistic			
	statistic	p value	weighted statistic	p value
	−3.563	0.000	−3.278	0.001
	Group rho-Statistics			
		statistic	p value	
		7.965	1.000	
	Group PP-Statistics			
		statistic	p value	
		−14.711	0.000	
	Group ADF-Statistics			
		statistic	p value	
		−4.129	0.000	

Notes: Nulls: No cointegration; Alternatives: common AR coefs. (within dimension) for Panel v-Statistic, Panel rho-Statistic, Panel PP-Statistic, Panel ADF-Statistic; individual AR coefs. (between-dimension) for Group rho-Statistics, Group PP-Statistics and Group ADF-Statistics; automatic lag length selection based on SIC Newey-West automatic bandwidth selection and Bartlett kernel.

Table 16: Kao residual cointegration test for pooled group

	ADF		Residual variance	HAC variance
	t-statistic	p value		
lnGDP lnHC lnFDI lnRD lnPOP lnGOV lnBusFred	−3.842	0.000	0.0053	0.0073

Notes: Null: No cointegration; automatic lag length selection based on SIC Newey-West automatic bandwidth selection and Bartlett kernel.