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In Search of Growth Effects by inward FDI in Central East Europe

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In Search of Growth Effects by inward FDI into Central East Europe

by

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very early draft, please do not quote

Abstract

With systemic change in Central East European countries (CEECs), foreign direct investment (FDI) became an important factor for the transition economies. FDI not only played a leading role in privatisation in most transition countries. FDI is also widely assumed to spur restructuring in terms of capital and technology transfer, spillovers, breaking up of national monopolies and alignment of sectoral specialisation to comparative advantages. This way, FDI is often entrusted with a leading role in the growth and development processes in CEECs. Alas, empirical proof of FDI's positive contributions to macroeconomic growth remains not robust in an already large body of literature: amongst the contributions where significant positive growth effects are found, the analyses sometimes use surprising, sometimes complex modelling techniques and determinants that are not always suggested by theory – this makes it very difficult to assess the robustness of the results. For CEECs, the literature is generally optimistic which is not least used by policy makers (and lobbyists) to argue for active FDI-attracting policies.

This contribution revisits the FDI-growth-contribution hypothesis for the case of CEECs. The analysis uses the clearest and simplest econometric set-up in the form of a Cobb-Douglas production function that distinguishes between FDI flows and stocks and controls for physical and human capital endowments, technological level of firms, and for heterogeneity between countries. Applying a large number of alternative models and specifications and post-estimation tests, the analysis concludes for CEECs that there is in fact a robust and convincing independent effect of total inward FDI (in stocks or inflows) on economic growth, if assumed to work via accelerating technical efficiency (the A in AK-models) in a neoclassical world; this also applies to R&D as another important driver of technology. But, the analysis also suggests that FDI that flows into CEE still appears to be less advanced, as it does not require any complementary R&D within the host economies of CEE with a view on improving absorptive capacities.

For future empirical analysis, this suggests that the search for the true extent of growth effects by inward FDI in CEECs has to consider indirect effects beyond the strict conceptualisation of neoclassical or new growth theory. Although these theoretical frameworks allow robust interpretation of econometric results due to their clarity and simplicity, the true underlying mechanisms and channels of technology transfer and spillovers have to be analysed at the firm level in complementary studies.

JEL-codes: F23 - Multinational Firms; International Business; F43 - Economic Growth of Open Economies

Keywords: Central East Europe, economic growth, foreign direct investment

Introduction

During socialist times, the economies in Central East Europe (CEE) lost ground in comparison to West European countries in terms of economic growth and development. Their economies were governed by central planning and economic integration (almost entirely directed towards the other socialist countries of the eastern bloc) was equally governed by political considerations rather than economic competitiveness. Upon the demise of the integration area of the “Council for Mutual Economic Assistance” in 1989/1990, the economies in CEE had to re-orient towards the West.

Alas, these countries had much lower levels of labour productivity: their physical capital stock was largely outdated; the stock of human capital appeared to be high due to high rates of formal qualification and yet proved to be obsolete in many cases. The technological standard was much lower; the countries were delinked from western technology for too long to be able to swiftly close the technology and productivity gaps. The kind of investment that would have been necessary to catch up, however, was heavily constrained by underdeveloped financial and capital markets. The banking systems, reminiscent of the previous system of monobanks (in which commercial banks were integrated under the roof of the central bank), were unable to effectively provide credit for investment. Further aggravating matters, direct capital markets still did not exist and had to be established from scratch, barring investors in CEE from supply of (venture) capital. At the same time, however, the transition process evolved around vast privatisation programmes for state-owned enterprises. Privatisation during such volatile times carried significant risks involved with the uncertainties of an unprecedented political and economic transformation process, and the demand side of the privatisation process was unable to draw on significant private wealth and lacked deep financial and capital markets to be able to buy assets to be privatised and to finance the subsequent restructuring of privatised firms.

It is these legacies and particularities of the transition process that made foreign direct investment (FDI) such an important factor for the economies in CEE: FDI not only played a leading role for privatisation in most transition countries, FDI was also assumed to be potentially able to close the capital and technology gaps. FDI potentially carries relevant technology that is so far unavailable in the region and yet can be expected to fall on fruitful ground in terms of absorptive capabilities, due to the uninterrupted industrial history. Furthermore, FDI was entrusted with the role of breaking up of national (formerly) state-owned monopolies, and with the alignment of sectoral specialisation with the patterns of national comparative advantages. This way, FDI assumed a leading role in the growth and development processes in most economies in CEE. It is now time to empirically test the effective contribution of FDI to these processes in CEE.

Empirical proof of FDI’s positive contributions to macroeconomic growth remains rather weak in an already large body of literature: significant positive growth effects are mostly to be found in studies that use very complex modelling techniques and at times potentially results-sensitive model specifications with rather unconvincing theoretical motivations. This casts doubt on the robustness of the alleged contribution of FDI. For the economies in CEE, the literature is generally quite optimistic, which not least is used by policy makers (and lobbyists) to argue for active FDI-attracting policies. Using the experience made with the analysis of FDI-led growth in other regions and sufficiently trustworthy data from the past decade in CEE, we are able to test vigorously for the validity of the FDI-led growth hypothesis in a region in which the conditions for an important role for FDI are particularly good. The aim of this analysis is to test whether we find robust support for a

positive and significant role of FDI as productivity enhancing factor in a multitude of different econometric specifications of a very pure growth model, i.e. without using any additional variables or restrictions in time, country-selection or industry-selection: as interesting as these may be, they do blur the results, making it difficult to interpret the core question of FDI-led technical advance and growth. As a further addition to the literature, this analysis includes another source of technological development, namely research and development (R&D). R&D can be conceptualised as independent driver of economic growth and development or as complement for FDI to generate technology transfer and spillovers by way of improving absorptive capacities, in addition to the pure investment-effect of FDI. In the analysis, R&D is tested alone (to compare the R&D-effect with the FDI-effect) and in conjunction with FDI (to test for the relationship between the two alternative or complementary representations of technical advance and drivers of economic growth).

The tests are conducted in the framework of a simple version of endogenous growth model (AK model augmented with human capital, FDI and R&D entering the model as representations of A) and using the clearest and simplest econometric set-ups. Significant effort is invested into testing a variety of different model specifications and applying a number of post-estimation tests to find models that are econometrically justifiable. This is necessary, because the low number of years and countries confront us with the problem of a very small sample. All models are vigorously tested for autocorrelation (or serial correlation, i.e. trends in time), multicollinearity (or non-independence of independent variables), and heteroscedasticity (e.g. variability changing over time, hence error terms are not uncorrelated and normally distributed), the applicability of fixed vs random effects-models, and the applicability of OLS, GLS, and SUR models. This vigour is applied to allow strong interpretation of results, straight forward and devoid of effects related to the theoretical base or the technical method.

Literature review and development of own hypotheses

The large body of literature on FDI and growth describes various ways for foreign investment to affect the growth path of the economy and leads to disagreements on the effective role that FDI plays in host economies. Carkovic/Levine (2002, p. 219) conclude that whilst studies based on microeconomic analyses are generally rather pessimistic with regard to evidence on the growth effect of foreign capital, macroeconomics studies more often do find a positive link between FDI and growth. The outcome of macro-level studies however often depends on the countries' intrinsic characteristics: Ozturk (2007) argues that the heterogeneity of studied samples and research goals leads to a variety of results and interpretations. Studies considering in their analysis e.g. labour costs, trade openness, investment climate, the developmental state of the host country, fiscal incentives produce mixed evidence of a growth contribution of FDI. Other, however, find that free trade zones, trade regime, the human capital base in the host country, financial market regulations, banking system, infrastructure quality, tax incentives, market size, regional integration arrangements, and economic/political stability are very important determinants for FDI and are found to have effected a positive impact on economic growth. This plurality leads to two major stands of empirical literature.

On the one hand, there is a number of studies that find positive effects of FDI on growth. Li/Liu (2005) studied a panel of 84 developed and developing countries over the period 1970-99 and report that FDI is a positive growth contributor in both types of economies, especially when a high absorptive capacity is coupled with a high technology gap. This result confirms the previous findings from Borensztein/De Gregorio/Lee (1998) who studied 69 developing countries between 1970 and

1989. They report that FDI is a growth contributor in their study and that its effect is probably due to efficiency gains rather than capital accumulation. They add that “higher productivity of FDI holds only when the host country has a minimum threshold stock of human capital” (p. 115). The view that the technology gap increases the effects of FDI in host countries also finds support in De Mello (1999), who reports that “the impact of FDI on growth seems to depend inversely on the technology gap between leaders and followers” (p. 148).

On the other hand, negative, ambiguous or insignificant effects of FDI on growth are found by others. Studying the role of the financial market with cross-country data in 20 OECD and 51 non-OECD countries between 1975 and 1995, Alfaro et al. (2004) find an ambiguous effect of FDI on growth. Foreign investment plays an overall positive role but once controlling for different financial market variables “an unusually large number of countries seem to experience negative effects” (p. 101). This view supports the results from Carkovic/Levine (2002) that analysed 72 countries between 1960 and 1995 and found that FDI does not exert a positive impact on growth after controlling for endogeneity, hidden heterogeneity across panels, and serial correlation.

Campos/Kinoshita (2002) argue that the heterogeneity of countries and transfer mechanisms from FDI to growth might lead to contradictory results of empirical studies. They choose to focus on transition economies because here, the technology content of FDI is more likely to impact growth due to a “unique combination of a complete industrial structure and a sizeable technological gap” (p. 21). Studying 25 countries between 1990 and 1998, they find that the effect of FDI on growth is significant and positive; irrespective from the interaction of FDI and human capital. Sohinger (2005) refines this result by finding support for two distinct impacts of FDI on growth in CEE: first, he observes a direct stimulation through capital accumulation and increased competitiveness. Second, he finds an indirect impact through spillovers, as “FDI is setting the stage for the second phase in which, not only imitation, but also innovation become the engines of growth” (p. 91).

Restricting studies to CEE and former Soviet states however also raises ambiguous evidence of the impact of FDI on growth. Applying a Bayesian analysis on 17 eastern countries on the period 1996-98, Lyrouti et al. (2004) find no significant link between foreign investment and growth. Using a panel of 13 eastern countries over 1989 to 2003, Nath (2005) finds no positive effect of FDI on growth except when foreign trade is accounted for or interacted with FDI. In 25 transition economies over 1990 to 2005, Sapienza (2009) finds a positive and significant impact of lagged FDI on growth, but not of current FDI. The author explains that “spillover effects from FDI in terms of know-how and technology require time to arise”. She however mentions that this results “could also be determined by the great heterogeneity that affect the data set” (p. 14).

In a study on Middle East and North Africa (MENA) and the CEE between 1970 and 2002, Kherfi/Soliman (2005) separate their sample in three groups: the MENA, CEE accession, and CEE non-accession countries. They find that FDI only shows a positive and significant sign in the new EU countries and conclude that “the degree of commitment to, and depth of, reforms is an important determinant of the effects of FDI on growth” (p. 116). This echoes the need for homogenised pre-conditions in host countries to assess the impact of foreign investment on growth in empirical studies. Concentrating on FDI flowing into the financial market of the new EU members, Eller et al. (2005) found that FDI enhances economic growth through increased efficiency, as foreign owned banks might use better risk-management techniques for example. Over the period 1990 to 2005 and restricting the analysis on the 10 new EU members, Sapienza (2009) however finds that “the FDI variable becomes not significant” (p. 12).

The still different paradigms constituting the former Soviet states' political and social environment imply a variety of impacts from FDI to growth. As stated by Weber (2011) in a study of seven new EU countries plus Russia from 1993-2009, the use of "[i]mpulse responses and variance decompositions reveal quite different growth effects in various Eastern European countries". His results however generally show that "FDI bears substantial potential for fostering economic growth" (p. 512).

No consensus on the impact of FDI on growth in the CEE is found in the literature, which leads to our own motivation for this analysis: if the FDI-led hypothesis is to be supported, then this should be in a set-up like the one in CEE countries due to their socialist legacies and the structures resulting from their particular transition phases. FDI can serve as a channel of technology transfer and spillovers from a foreign economy to the host economy, giving rise to the growth-effect via an acceleration of technical change. This FDI-effect may solidify or even accelerate, if the alien technology is absorbed by the firms in the host economy: the most important condition for the development of absorptive capabilities is R&D (for this hypothesis from "two faces of R&D", see Cohen/Levinthal, 1989, 1990). In fact, we find in the relevant literature that absorptive capacities are held to be a particular bottleneck in CEE (see e.g. Dyker et al., 2006, pp. 79-82; see also Dyker, 2006; Varblane et al., 2007).

The tremendous social, economic and political evolution experienced in these countries since 1989 led the states to react in heterogeneous ways. We choose to restrict the timeframe of the study to a coherent period where the countries were not subject to structural changes and therefore authorise a rigorous econometrical study of the impact of FDI on growth.¹

Two testable hypotheses are hence proposed:

- (1) growth of aggregate value added in CEE countries accelerates with increasing FDI inflows between 1998 and 2008 (or growing FDI stocks)
- (2) the FDI-led growth hypothesis becomes stronger if FDI is complemented by R&D

Each hypothesis is tested using varying model specifications and estimation techniques.

Description: FDI, R&D, and growth in Central East Europe

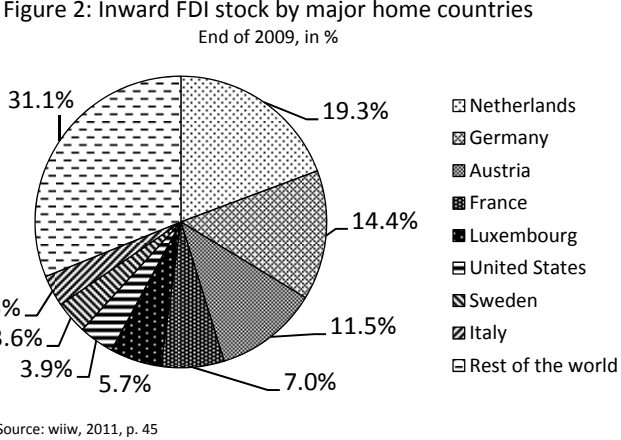
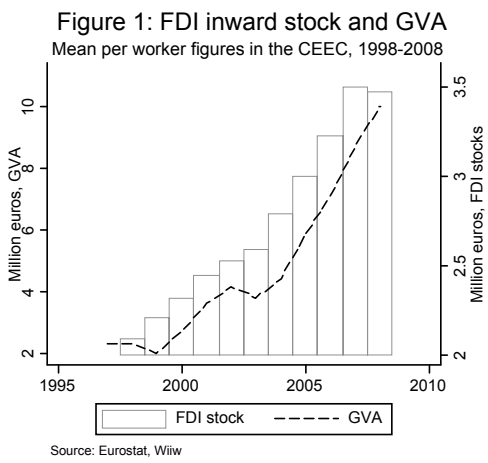
On a global scale, CEE is only a small recipient of FDI. Yet the role of FDI in their host economies (measured at the most general level in FDI per capita) has become more important than in any other emerging market. And this despite the fact that the economies in CEE had practically no inward FDI before 1990. With the transition process having overcome the most limiting structural distortions and institutional weaknesses, inward FDI has not only increased in size but also in terms of prospects for FDI-led intensive economic growth via improvements of technology.² Today, FDI has helped the economies in CEE to integrate more deeply with the West and to play a role in the global (innovation) networks of their western foreign investors.

Up until the mid-1990, it had been the Czech Republic, Hungary, and Poland (i.e. Visegrád without Slovak Republic), who were main recipients of inward FDI in CEE. Today, Bulgaria, Romania, Slovakia,

¹ Fidrmuc/Tichit (2009) study 25 eastern European countries over 18 years and identified structural breaks at a-priori unknown point in time or space. They find robust evidence that the pattern of growth did not change countries studied in this paper between 1998 and 2007.

² In the early period of transition, the countries in CEE often attracted so-called outward processing trade (Andreff/Andreff, 2001) which carries little new technology.

and Slovenia have caught up considerably whilst Poland has even outpaced all other economies in the region. Inward FDI stocks in the three Baltics remain comparatively low in absolute terms. FDI outflows are still of less importance in the region.



Another important commonality of inward FDI in CEE is that the majority of foreign investors originate from West European countries: the further East, the more FDI comes from the former Soviet region, the further West, the larger the share of neighbouring countries in West Europe. For the Baltics (and especially Estonia), FDI often originates from the Scandinavian region. In any case, home countries of FDI into CEE have typically much higher levels of economic development and hence aggregate productivity levels.

As of more lately, inward FDI has experienced a stark decline, probably effected by the current financial crisis. In 2010, we already see some signs of recovery, but amounts are still lower today than previously: the world financial crisis lingers on and depresses investment on a global scale.

Theoretical models

The relevant literature discusses a large variety of model specifications to test the role of FDI and/or R&D for technical advance, and hence economic growth. Basically, three main groups emerge: one assesses economic growth determinants in Mankiw-Romer-Weill (MRW)-type models (see Mankiw et al., 1992), often using the main variable of interest (here: FDI and R&D) plus initial income, an investment ratio, a measure of human capital, and the other variables accounting for political conditions or inflation as determinants. This approach has a potential weakness that has to be duly dealt with: FDI may be correlated with physical capital- even if only through greenfield investment - and to human capital through knowledge spillovers³ (see Durlauf et al., 2004). A second group follows the strict structure of a growth theory represented e.g. by the AK model: here, either technical advance is directly represented by a multitude of different proxies all together representing A in a single step equation, or it is represented by a single variable A (typically coined TFP: total factor productivity) that is then subsequently decomposed in a second step (the usual growth accounting method) (see e.g. Bodman/Le, 2011, using FDI and R&D). A third group relaxes the growth theory

³ Whilst the first does not seem to be a problem in CEE (see Figure 3 below), the relationship between FDI and human capital will be assessed here explicitly, following the absorptive capacity-case in the relevant international business literature (see below).

assumptions and estimates models that include all that may be determinants of economic growth, either in the more structured form of a *translog* function, or completely free of any structure using initial growth rates, lagged growth rates, a distinction between domestic and foreign drivers of growth including foreign trade, etc.

The second group-approach is followed in this analysis, augmenting the strict AK model with human capital from new growth theory. No additional adjustments are made to retain the clean and clear structure of the growth theory. This reflects the objective of the analysis to be vigorous in the test of the FDI-led growth assumption: adherence to a strict empirical application of growth theory allows us to interpret results with some confidence of robustness; the results remain straight forward and devoid of effects from any kind of particular design of the analysis. The representation of A used in this analysis is focussed on the most important drivers of technology in emerging markets, and those include most prominently FDI and R&D.

The model is based on a standard perfect competition neoclassical production function with constant return to scale (Cobb-Douglas) and augmented with human capital:

$$Y = AK^\alpha H^\beta L^{1-\alpha-\beta} \quad (1)$$

where Y is aggregate gross value added, A the overall efficiency factor, K is physical capital stock, H is human capital stock, and L the labour force. α, β are the elasticities of substitution.

The intensive form of the growth model highlights the technology-driven character of economic growth tested here (whereas growth driven by pure increases in the labour force and/or capital stocks would represent extensive growth). The intensive form reads:

$$y = Ak^\alpha h^\beta \quad (2)$$

where the small letters are the original variables divided by the labour force (proxied by workers, accounted for as individuals within the labour force – between 15 and 64 years old).

Taking the rate of change of the variables gives the final form:

$$\Delta \ln y = \Delta \ln A + \alpha \Delta \ln k + \beta \Delta \ln h \quad (3)$$

where \ln stands for the natural logarithm of the factor and Δ is the derivative over time, representing the growth rate in continuous time.

In our analysis, FDI is assumed to act through the efficiency factor A (the pure investment. i.e. physical capital augmenting character of FDI is already covered by k). Likewise is R&D assumed to affect A . FDI and R&D therefore are treated as representations of A , or at least parts of it (which corresponds to TFP as in growth accounting frameworks). The tested models vary according to the composition of $A_{i,t}$, where its representation may include FDI and/or R&D and/or interaction terms between FDI, R&D, physical and human capital, as well as an exogenously given factor γ :

$$\Delta \ln A = \gamma + \delta_1 \Delta \ln FDI + \delta_2 \Delta \ln R\&D + \dots \quad (4)$$

Using the equation (3) representing growth theory and equation (4) specifying technical advance, several models based on panel data with random or country and/or time fixed effects are estimated.⁴ The number of determinants goes up to K .

The empirical form of the basic equation augmented by indices for time and countries to account for the panel characteristics, reads:

⁴ The best panel structure is found by using the Hausmann test for fixed or random effect, see the discussion of analytical techniques below.

$$y'_{i,t} = \delta A'_{i,t} + \alpha k'_{i,t} + \beta h'_{i,t} + \vartheta_t^* + \gamma_i^* + u_{i,t}, \text{ with} \quad (5)$$

$$i = 1, \dots, N \quad t = 1, \dots, T$$

where y'_{it} is growth of aggregate gross value added, δ a $1 \times K$ vector of slope coefficients for technical advance, $A'_{i,t}$ is the $K \times 1$ vector of explanatory variables used to represent technical advance, $i=1 \dots N$, $t=1 \dots T$ are country and time indexes, α and β the slope coefficients of physical and human capital, and ϑ_t^* and γ_i^* are time and country dummies (the $*$ indicates that the variable is optional, depending on the best panel structure of each equation) and $u_{i,t}$ is the error term. It is assumed to be an independently identically distributed random variable with zero mean and variance σ_i^2 ($u_{it} \sim \text{IID}(0, \sigma_i^2)$).

Data

The period of analysis ranges from 1998 to 2008: the start marks a time where the transition recessions and profound structural changes had been overcome in those countries, by 1998, privatisation had proceeded significantly and competitive markets can be assumed to have prevailed by then. This is an important assumption for the kind of growth analysis ventured here. The year of 2008 is the year where the financial crisis started to take hold in the region. The years following may be considered to have been effected by a structural break, weakening the growth trajectories, and hence equally potentially weakening the growth analysis without adding information on the role of FDI or R&D for technical advance. The countries considered in the analysis include the 9 countries of Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.⁵

The database consists of 99 observations from nine countries and eleven years. Growth rates are calculated as the derivative over time of the natural logarithm of a variable.⁶

The data source for FDI figures are taken from the wiiw database 2011 from the Vienna Institute for International Economic Studies, prepared by Gabor Hunya. This dataset is probably the most developed and comprehensive one on CEE, in which the data is comparable across the host countries and time. Data on economic growth, physical and human capital stocks as well R&D are taken from the Eurostat database in million Euros⁷. For economic growth, aggregate gross value added is used to exclude possible effects of indirect taxes and subsidies from the analysis: the AK theory equates economic growth with changes in per capita capital stocks and the technical advance. The physical capital stock is estimated using the perpetual inventory method with the 11 years of the period of analysis (lacking reliable earlier data) and a constant depreciation rate of 0.07 (as in as in Easterly/Levine, 2001). The human capital stock is a constructed index derived from the labour force survey of Eurostat (ISCED): the shares of three distinct education-level groups are weighted as suggested by Eller et al. (2005).

Econometric tests and results

A set of seven sets of models (plus a base-line model) are tested, all with their own representation of technical advance:

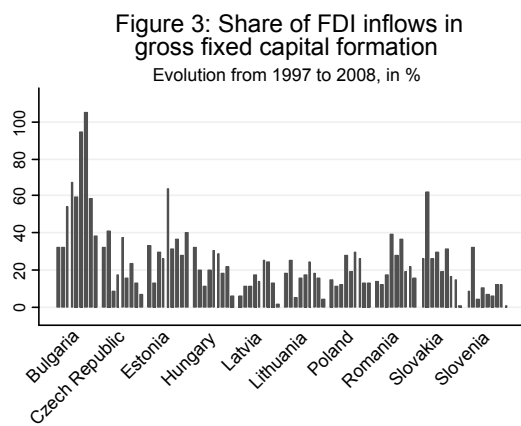
⁵ Romania is excluded from the sample because of its lack of data on FDI.

⁶ Missing values are predicted using simple least square regressions of the growth rate of a variable over time (with a constant) to predict missing value.

⁷ Real values are obtained by deflation with the harmonised indices of consumer price from Eurostat.

- 0 pure growth model, not specifying the size and shape of A
- 1 A represented by FDI alone
- 2 A represented by FDI and interactions between FDI and k and h
- 3 A represented by R&D alone
- 4 A represented by R&D and interactions between R&D and k and h
- 5 A represented by FDI and R&D (without interactions)
- 6 A represented by FDI and R&D and an interaction between FDI and R&D
- 7 A represented by FDI and R&D and all interaction terms above

All models contribute to answering the two central hypotheses of this paper: the first hypothesis on the traditional FDI-led growth case is tested by models 1 and 2 with a view on the changes effected to the base-line model by adding FDI alone and with interactions. Here, it is the interaction with human capital that is of particular interest: according to the absorptive capacity-case, technology transfer and spillovers via FDI accelerate with increasing absorptive capacities (see e.g. Cohen/Levinthal, 1989), and the change in stocks of human capital, proxied by education levels, tests for this. It is important to note that the change in national physical capital stocks (i.e. investment) may be quite distinct from inward FDI: figure 3 shows that the share of FDI inflows in gross fixed



Source: Wiiv, 2011, p. 35

capital formation usually stays below 40 per cent in most CEE countries, and even below 30 per cent in at least six of the nine countries of this analysis. Only in Czech Republic, Estonia and Slovakia did foreign investments assume higher shares in total investment; Bulgaria is an entirely different case with rates ranging from shares above 80 per cent in 2006 and 2007 and around 20 per cent in 2009 and 2010. This warrants the test of the interaction between the changes in FDI and physical capital stocks.

The second hypothesis on the additional consideration of R&D and the relationship between FDI and R&D that emerges from this is tested by the models 3 to 7, again with a view on the changes effected to the base-line model by adding the additional determinants. Model 3 tests for the role of R&D alone in representing technical change, i.e. replacing FDI as the regressor for A . Model 4 tests for the interaction between R&D and the physical capital stock, thereby reflecting the assumed complementary nature of technical advance and investment in new machinery. The intuition behind the interaction of investments in R&D and human capital is straight forward.

To test for the role of R&D when FDI is also considered in the analysis, model 5 includes both regressors for technical advance simultaneously. This test is subsequently extended by adding the interaction between R&D and FDI, providing indication on the shape of the relationship between FDI and R&D (model 6). Finally, the model 7 includes all regressors and interaction terms as a test for robustness of the previous results.

The FDI-led growth hypothesis may in fact be interpreted in two distinct ways: first, the inflow of foreign investment may affect aggregate productivity (and hence represent technical efficiency) because an FDI inflow increases the amount of technology in the FDI-hosting country. This would correspond to a temporary effect, because the technology inflow affects technical efficiency in the

year where it happens only. Second, FDI may be held to have a more long-term, permanent build-up effect: using FDI stocks as a regressor allows the stocks accumulated during past years to have an effect on technical advance (e.g. via learning). This distinction is borrowed from Eller et al. (2005). Both interpretations are tested (see the group of rows under “net FDI inflows” for the temporary effect, and “change in FDI stocks” for the permanent effect in the following Table).

The choice of econometrical approach and model specification followed a rigorous process. The Hausman's specification test is first performed to determine the best panel structure to apply to the data and control for unobserved heterogeneity across countries. A pooled OLS equation $y_{it} = \beta_0 + \beta_1 X_{it} + u_{it}$, $i = 1, \dots, N$ and $t = 1, \dots$ (1) suffers from unmodelled heterogeneity because time invariant country characteristics cannot be accounted for. To correct this situation, the theory assumes that $u_{it} = v_i + \varepsilon_{it}$, (2) where v_i is a country specific error and ε_{it} a stochastic error term. Combining (1) and (2), the equation becomes an error-component model which can be written $y_{it} = \beta_0 + \beta_1 X_{it} + v_i + \varepsilon_{it}$ (3). Subtracting the average of equation (3) for each t from equation (3) itself results in the final form $y_{it} - \bar{y}_i = \beta_1 (X_{it} - \bar{X}_i) + \varepsilon_{it} - \bar{\varepsilon}_i$ (4) where unobserved heterogeneity has been removed (the constant terms has disappeared). This “within transformation” assumes that each country has its own specific intercept. The same estimations can therefore be made by inclusion of dummy variables for every country in the panel, f_i , that leads to N separate parallel regression lines (Least-squared dummy variable LSDV). The fixed effects model can therefore be written $y_{it} = \beta_1 X_{it} + f_i + \varepsilon_{it}$ (5). The alternative is random effects, where v_i in equation (2) is assumed to be randomly distributed with $cov(x_{it}, v_i) = 0$ rather than constant. It reads $y_{it} = \beta_0 + \beta_1 X_{it} + \{v_i + \varepsilon_{it}\}$ (6). The seven equations plus the base-line model mainly call for random effect after performing the Hausman test. When fixed effect is preferred, an F-test is performed to determine if two-way fixed effect on countries and years should be used.

Once the best panel structure is defines, statistical tests are performed and only reveal statistical weaknesses in few cases. These are either treated through the use of proper econometrical tools or let aside for theoretical motives. The assumption of homoskedasticity cannot be rejected in a vast majority of the models using the Breusch-Pagan (1979) and Cook-Weisberg (1983) test. The hypothesis used for this test is based on independently and normally distributed residuals with constant variance. This assumption can only be rejected in model 7 and for the permanent effect-specification using FDI stocks according to the Shapiro-Wilk and Shapiro-Francia tests for normality. The Ramsey (1969) regression specification-error test (RESET) suggests misspecification in the base-line model and the R&D only in the models 3 and 4 (both temporary and permanent effects). Although these equations might suffer from an incorrect functional form, the power of the test decreases in a small finite sample. As the variables are integrated of degree 1, their derivation through time (thus their growth rates) is stationary⁸. Level variable however do contain a unit root and are used in some models with respect to the theory.

The major problem of the data is pointed out by the Wooldridge (2002) test for serial correlation. Autocorrelation appears in most models in pre- and post-OLS estimations. In a setup without lagged dependent variable used as explanatory variable, the point estimates are unbiased and consistent but inefficient, leading to invalid variance. A general least square approach (GLS) with independent

⁸ Tested with robust Hadri LM stationary test for panels. The strict hypothesis H0 that all panels are stationary around a trend cannot be rejected for growth rate of all variables except for physical capital. The Levin-Lin-Chu unitroot test however rejects the less strict hypothesis H0 that all panels contain a unitroot.

and identically distributed errors and panel specific AR1 autocorrelation structure is used. Even if first order serial correlation can be treated in some cases, post-estimation tests often reveal the presence of a higher order autocorrelation.

The cause might be due to endogeneity between FDI and GDP. It is however difficult to statistically confirm that the two variables show reverse causality with the available data. The Granger and Toda-Yamamoto tests for causality imply an autoregressive approach that cannot be performed due to the sample size. Introducing instrumental variables such as past values of GVA also reduces the number of degrees of freedom to a point that hampers the quality of the results.

The seemingly unrelated equation approach (SUR) is used to overcome these issues. On a theoretical point of view, this method allows an exogenous shock to hit all countries at the same time, letting each country react in an individual way as is a realistic assumption in the CEE (Brezinski/Stephan, 2011). In addition, this method cures some technical problems. In the actual setup, the number of countries (N) is smaller than the number of years (T), which violates the asymptotic propriety of OLS. According to Baum (2006), the SUR approach can be used in such a setup. Constraining the coefficients to be equal in each individual regression allows reproducing the OLS estimates. It also permits the use of small sample adjustment that increases the efficiency of the estimates and gets rid of post-estimation autocorrelation in most specifications, using estimated cross-section residual variance-covariance weight (Sapienza, 2009). This method however also suffers from the sample size, as T should tend to infinity in order for the estimates to be perfectly efficient. In addition, it does not allow for random effect in the country specific term.

The results of our analysis are presented in the following table: the base-line model behaves as the growth theory suggests: physical and human capital are both highly significant. As a seemingly unrelated regression, this model assumes country-specific fixed effects.

Adding FDI as a single proxy for technical advance produces the expected effect whilst not changing much of the results in the base-line model: significances and signs remain unchanged, and even magnitudes of coefficients largely stay the same. The coefficient for FDI (interpretable as elasticity due to the double- \ln -definition of the models) remains, however, much lower than the ones for the capital stocks. This applies to both versions of the model using FDI net inflows (temporary effects) and changes to FDI stocks (permanent effects). The only marked difference between those two model specifications is that the elasticity for changes in the human capital stock falls in model 1 as compared to the base-line model in the permanent effect specification. These results lend support to the FDI-led growth hypothesis, where inward FDI generates intensive economic growth via technical advance (hypothesis 1). This holds true even if controlling for interactions between physical and human capital stocks and FDI. With respect to the latter, it is noteworthy that the growth-effect of FDI is further supported by a complementary relationship with human capital, not however, with physical capital, and only in the case of a test for temporary effects. Technology transfer and spillover effects from new foreign investment flowing in are accelerated by increasing absorptive capacities of workers in the host economy.

Table: Impact of inward FDI on GDP (real GVA per worker = dependent variable)

	M0	M1	M2	M3	M4	M5	M6	M7	M1	M2	M3	M4	M5	M6	M7
	net FDI inflows (temporary effects)								change in FDI stocks (permanent effects)						
K	0.377*** (0.006)	0.369*** (0.006)	0.362*** (0.012)	0.379*** (0.007)	0.344*** (0.025)	0.358*** (0.012)	0.355*** (0.014)	0.333*** (0.073)	0.354*** (0.009)	0.340*** (0.029)	0.379*** (0.007)	0.344*** (0.025)	0.354*** (0.010)	0.352*** (0.012)	0.342*** (0.046)
H	0.999*** (0.095)	0.986*** (0.067)	1.104*** (0.158)	0.791*** (0.123)	0.984*** (0.219)	0.823*** (0.110)	0.801*** (0.130)	0.770 (0.596)	0.774*** (0.139)	0.983*** (0.263)	0.791*** (0.123)	0.984*** (0.219)	0.771*** (0.152)	0.786*** (0.171)	1.175** (0.419)
FDI		0.058*** (0.004)	0.053*** (0.009)			0.089*** (0.010)	0.087*** (0.012)	0.098* (0.047)	0.026*** (0.001)	0.026*** (0.004)			0.026*** (0.003)	0.026*** (0.003)	0.026*** (0.006)
FDI*K			-0.001 (0.001)					-0.001 (0.007)		0.004 (0.003)					-0.007 (0.007)
FDI*H			0.009*** (0.002)					0.006 (0.009)		0.003 (0.004)					0.012 (0.007)
R&D				0.031*** (0.002)	0.036*** (0.007)	0.042*** (0.004)	0.043*** (0.005)	0.053 (0.027)			0.031*** (0.002)	0.036*** (0.007)	-0.000 (0.006)	-0.004 (0.010)	0.005 (0.022)
R&D*K					0.016*** (0.002)			0.013* (0.006)				0.016*** (0.002)			0.021*** (0.006)
R&D*H					-0.005* (0.002)			-0.007 (0.006)				-0.005* (0.002)			-0.012 (0.007)
R&D*FDI							0.001 (0.002)	-0.000 (0.007)						0.002 (0.003)	0.001 (0.007)
Obs.	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99
Serial_Coor.	Yes	Yes	No	No	No	No	No	No	Yes	No	No	No	Yes	Yes	Yes
Homosced.	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Effect	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C	fe, C
True effect	re	re	re	re	re	re	re	re	re	re	re	re	re	re	re

Note: Coefficients represent elasticities due to double \ln in the regressions. Data in parenthesis are standard errors. "fe" and "re" stand for fixed and random effect, "C" stands for one-way fixed effect on countries (in contrast to "Y" and "Y+C" as one-way fixed effect on years, and two-way fixed effect on countries and years). "Yes" on line SerialCorr. stands for non-defined serial correlation.
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Data sources: for FDI: wiiw, for the other data: Eurostat.

Adding R&D as an alternative single proxy for technical advance results in qualitatively the same results: the base-line model results remain intact with respect to significances and signs, the elasticities for changes in the human capital stocks fall now for both model specifications, be they temporary or permanent: it appears that some of the growth driving effect is now more correctly allocated to R&D (the pairwise correlation between changes of R&D and of h is XXX^9). The interaction terms for R&D with physical and human capital stocks are in fact significant, even if negative significant in the case of human capital – a result already suggested by the fall of the coefficient for h in model 3 (and not an empirical problem of multicollinearity). Alas, all other results remain intact. These results support the R&D-related hypothesis (hypothesis 2), in particular its first aspect that R&D can effect intensive growth by itself. The second aspect of this hypothesis is concerned with the relationship between R&D and FDI: does R&D support the technology transfer and spillover-effects of inward FDI by supporting absorptive capacities, as we would expect from theory, and hence hypothesised? Is R&D even driven to a large extent by FDI, with foreign invested firms engaging more in R&D than domestic firms, or foreign affiliates triggering R&D amongst domestic suppliers or customers? Or will R&D assume some of the explanatory power that was erroneously held by the determinant of FDI in the previous regression results, hence a spurious result?

The test for the temporary effect shows that both FDI and R&D remain significant and the coefficient for FDI even turns out to be higher when including R&D. In the test for the permanent effect, FDI likewise stays significant with an unchanged magnitude of the coefficient, but R&D becomes insignificant. This suggests that a change in FDI-stocks (i.e. permanent effect) already suffices to explain economic growth via technical advance and R&D does not add more to this. Model 6 tests directly for the relationship between FDI and R&D in a common interaction term, but this does not turn out to be significant in either model specification: both FDI and R&D appear to contribute to technical efficiency, but their simultaneous occurrence does not seem to accelerate technology. This remains the case even when testing with all interaction terms between FDI, R&D, human and physical capital stocks. The results for the other determinants (levels of significance, signs, and magnitudes of coefficients) remain largely unchanged. Whilst these results do add credibility to the robustness of the original FDI-led growth hypothesis for CEE countries, the inability to find significant results for the interaction between R&D and FDI remains puzzling: it is in particular in CEE countries that we would expect the absorption-supporting “face” of R&D to be particularly important (and intensive growth effects should be particularly large for FDI inflows that are complemented by simultaneous R&D expenditure). After all, those countries do have research institutions and domestic firms do have financial and capital markets able to finance research and development, which can be expected to be particularly productive where targeted at customising foreign technology to suit the local environment. And still, the results very clearly negate this. We will discuss this result in more depth in the conclusions and find some convincing answers.

Conclusions

This rigorous econometrical analysis is able to robustly establish the validity of the FDI-led intensive growth hypothesis for the economies in CEE during the period of 1998 to 2008. The

⁹ Whilst a close relationship between R&D and human capital is very probable, the definition of human capital here in formal education levels makes it highly improbable that R&D will have an effect on education levels in such a short period of time

specification of the analysis is derived from a strong theoretical basis, even if the neo-classical growth theory is considerably strong in assumptions that may not necessarily be met in CEE. Many different specifications of econometric models were tested to establish the robustness of results.

In CEE during this period of time, intensive economic growth was partly driven by FDI, R&D also played a role, and yet not a complementary one with respect to FDI inflows. The absorptive capacities-issue via R&D is not supported by our analysis, despite its intuitive charm and the results to be drawn from related body of literature. This may be due to domestic firms in CEE on average are still at a stage unable to follow long-term strategies beyond fighting for their operational sustainability (Dyker, 2006). It also suggests that national research institutions (remnants of the former academies of science) as other important players in national innovation systems (à la Lundvall, 1988; or with explicit reference to FDI: Cantwell/Iammarino, 2003) are still insufficiently restructured to support industry in their task to technologically upgrade (see for support for this: McGowan et al., 2004; Meske, 2004; von Tunzelmann, 2004; von Tunzelmann et al., 2010). Finally, the result that a complementation of foreign investment with its assumed technology transfer and spillovers by research efforts made by institutions on the receiving end may also signify that the kind of technology that flows into CEE is not in need of much adaptation to particularities in the local environment. Maybe the technological trajectories are not all that different between host and home industries, even if at lower levels in host industries (see the obvious productivity gap observed at the national levels between the typical FDI home and the host countries in CEE). If so, then FDI would in fact drive intensive economic growth (as does national R&D), but only with rather low intensity. Potential for much more could then be assumed to be in place as soon as foreign investors transmit even more advanced technology that would necessitate complementary R&D, either because this technology has now become more specific to different applications, or because industries in CEE more often form part of the innovation systems and networks of home industries. The latter would then mark the highest intensity of integration between East and West Europe, and intensive growth would then be less of an issue of catching up but rather more in line with technical advance in the West. Despite using a neoclassical framework for our analysis, we still abstain from calling this steady-state growth with West and East forming a common sigma-convergence club (and without much more potential for beta-convergence), because of the perceived dynamic nature of technical change and productivity growth in today's world.

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