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Abstract

This paper analyzes the importance of taxes on corporate income and production-related tangible infrastructure as determinants of Foreign Direct Investment (FDI) in Central- and Eastern European Countries (CEECs). We operationalize taxes using effective average tax rates on the bilateral level and employ indices derived from principal component analysis as a proxy for the infrastructure endowment. In the empirical analysis we control for a possible interrelation between taxes and infrastructure as determinants of FDI – an issue usually neglected in the literature. Thus, we posit that there are likely to be interaction effects between taxes and infrastructure as determinants of FDI. Specifically, a favorable infrastructure endowment may compensate for relatively high taxes. Hence, higher taxes may not deter FDI. The results from our panel econometric analysis of bilateral outward FDI flows of 7 home in 8 CEE host countries for the 1995-2004 period in an augmented gravity model setting show that (i) both taxes and infrastructure play a role in the location decisions made by Multinational Enterprises; (ii) telecommunication and transport infrastructure are of special significance to FDI; and (iii) the tax-rate sensitivity of FDI indeed decreases with the level of infrastructure endowment.

Key words: Foreign direct investment, transition economies, infrastructure, taxation

JEL code: F15, F21, F23

1. Introduction

Multinational Enterprises (MNEs) continually make investment decisions, which include seeking new locations, acquiring other firms, merging with other firms, expanding or reducing their existing activities. From a policy perspective, the Foreign Direct Investment (FDI) location decisions of MNEs are important, as FDI may have a substantial economic impact on both the host and home country of FDI. From a host country perspective, certain empirical evidence points to a positive impact of FDI on economic growth and the possibility of spill-over effects to local firms (e.g. Castellani and Zanfei 2006). Both arguments have been used to justify government policies designed to attract FDI.

Among other factors, the FDI location decisions of MNEs may be determined by taxes and production-related tangible (public and private) infrastructure, since both can have an impact on the producer rent of an investment (Richter et al. 1996). On the one hand an increase in taxes, *ceteris paribus*, leads to a lower post-tax net present value of an investment and thus to a lower producer rent. On the other hand, if public capital stock is complementary to private capital stock, an increase in production-related tangible infrastructure might increase the producer rent via its contribution to output and labor productivity and hence lower production costs (e.g. Fontagné and Mayer 2005). Thus, a decrease in taxes or an increase in the infrastructure endowment[1] is capable of increasing FDI. Furthermore, as high taxes and a favorable infrastructure endowment have opposing effects on the profitability of an investment, these two public policy measures should not be analyzed in isolation. Specifically, a country may not lose FDI in the case of a tax increase relative to competitor countries if the country compensates for it with an above average infrastructure endowment. Put differently, MNEs may value higher taxes as a price for better infrastructure (e.g. Haufler 1998).

The empirical literature on infrastructure and taxes as determinants of FDI is characterized by three main aspects: (1) While many studies deal with taxes comparatively few empirical studies consider the endowment with infrastructure as a determinant of FDI; (2) even fewer studies model the possible interaction effects between taxes and infrastructure, and. (3) while these two aspects are valid for the general literature on the determinants of FDI, their significance may become even more pronounced when one examines FDI in Central and Eastern European Countries (CEECs).

The aim of this paper is to shed some light on the role of infrastructure and taxes as determinants of FDI in CEECs and on the possible interaction effects between these location factors. Specifically, we test the conditional hypothesis that the tax-rate sensitivity of FDI decreases with an increase in a country's infrastructure endowment.

We first expect infrastructure and taxes to be relevant location factors for FDI *per se*. Second, we expect that the tax-rate sensitivity of FDI, measured as semi-elasticity, indeed decreases with an increase in a country's infrastructure endowment. If empirically confirmed, such results may contribute significantly to the recent literature on determinants of FDI, as they may indicate that tax-rate elasticities of FDI derived without controlling for infrastructure may be biased. More importantly however, our results may confirm that high tax countries can also successfully attract FDI, as governments may compensate for higher corporate taxes by offering foreign investors a more favorable infrastructure endowment.

[1] Hereafter infrastructure means production-related tangible infrastructure if not stated otherwise.

The paper is structured as follows: section two reviews the related literature and section three discusses the variables and data used in our empirical analysis. Section four introduces the empirical model and methodology applied. Section five presents and discusses the results, while section six summarizes and concludes.

2. Taxes and infrastructure as determinants of FDI

So far, much effort has been put into the analysis of taxation as a determinant of location decisions (e.g. DeMooij and Ederveen 2006 and Bellak et al. 2007). DeMooij and Ederveen (2006) carry out a meta-analysis of 35 empirical studies and find a median FDI tax-rate elasticity (semi-elasticity) of about -3 for FDI mainly between homogenous countries (i.e. for FDI from the US to Europe or vice versa, or within the US and the EU). This result implies that a reduction of one percentage point in the corporate tax rate will increase FDI by about 3 percent. DeMooij and Ederveen also show that the tax-rate elasticity *inter alia* crucially depends on the measure of corporate tax burden used. It is well established in the literature that among the various measures proposed (see e.g. OECD 2000 for an overview), forward-looking effective average tax rates (EATR) in the spirit of Devereux and Griffith (1999) are the best measures for examining the investment decisions of firms. DeMooij and Ederveen (2006) find a tax-rate elasticity of about -5.8 when the conceptually superior EATRs are used. For CEECs Bellak et al. (2007) find a relatively low tax rate elasticity of about -1.45. A common feature of the studies surveyed is that they use the statutory corporate tax rate (STR) as a measure of corporate tax burden, which is relevant to analyzing incentives to shift profits but not to selecting a particular FDI location. Bellak and Leibrecht (2007) use EATRs at the bilateral level and find higher and statistically significant tax-rates (about -4.5). From these studies one can conclude that low (effective average) corporate tax rates indeed attract FDI in general and FDI in the CEECs in particular.

With respect to infrastructure, Gramlich (1994) and Regan (2004) argue that the relevant infrastructure includes transport, communication and electricity production facilities, as well as transmission facilities for electricity, gas and water.[2]

One of the seminal works examining infrastructure as a determinant in firms' international location decisions is Wheeler and Mody (1992). Using a comprehensive indicator for "infrastructure quality", this study finds a significant positive effect of high infrastructure quality on FDI. Specifically, the authors state that "agglomeration economies [including infrastructure, authors] are indeed the dominant influence on investor calculations". (p. 57) Goodspeed et al. (2006) explain FDI between a broad range of countries and include the consumption of electric power, the number of mainline telephone connections and a composite infrastructure index (from the World Competitiveness Yearbook) in their regressions. These authors also find a significant positive impact of infrastructure on FDI. Bénassy-Quéré et al. (2007a) use data on the net stock of public capital provided by Kamps (2006), which they extend for several countries and to the year 2002, as a proxy for the quantity and quality of infrastructure. They analyze FDI from the US to 18 EU countries and

[2] Of course, these types of infrastructure may be used by both households and firms. However, it is impossible to draw a clear demarcation between production- and consumption-related infrastructure. This is also true when one distinguishes between privately and publicly provided infrastructure. Usually, a substantial part of the listed types of infrastructure is owned and maintained by the public sector. Yet, infrastructure is also to an increasing extent provided by the private sector under public regulation, particularly in the field of telecommunications and electricity. In more recent years, this has also been the case for CEECs (see European Bank for Reconstruction and Development 2004, p. 77).

find a significant positive impact of infrastructure on FDI. Mollick et al. (2006) analyze the role of telecommunications (telephone lines) and transport infrastructure (roads) for FDI to Mexico and find a positive impact of both types of infrastructure.

For FDI in CEECs, two recent studies have included proxies for infrastructure. Demekas et al. (2007) include an indicator of infrastructure reform from the EBRD. This index reflects the state of regulation of infrastructure services (European Bank for Reconstruction and Development 2004). They find that for the less developed economies in their sample infrastructure is important as a determinant of FDI, while it becomes insignificant for the more developed countries. Kinoshita and Campos (2006) use the number of mainline telephone connections as an infrastructure proxy. A positive impact on FDI is found only for the former Soviet Union countries.

Notable examples for relating taxes and infrastructure as determinants of FDI are Mutti (2004) and Bénassy-Quéré et al. (2007a). Yet, none of these studies focuses on CEECs. Mutti (2004) establishes a link between the corporate tax burden of an FDI host country and its income level and indeed finds that the tax sensitivity of MNEs decreases as the income level increases. Mutti concludes that “a possible reason for this result is that in high-income countries the benefits of public infrastructure partially offset the tax burden” (Mutti 2004, p. 62). Bénassy-Quéré et al. (2007a) separate their sample into high and low public capital countries. Their findings indicate that “the tax elasticity for ‘high public capital’ countries is not significant, as opposed to that of ‘low public capital’ countries” (Bénassy-Quéré et al. 2007a, p. 413), and conclude that “we can assert that tax decisions are of relatively less importance in high public capital countries than in low public capital countries”. (Bénassy-Quéré et al. 2007a, p. 414)

3. Empirical model, data and methodological aspects

3.1. Empirical model

Our analysis is based on an augmented gravity model, which is the workhorse model for the analysis of international trade flows. More recently it has also been successfully applied to explain bilateral FDI flows (e.g. Bevan and Estrin 2004; Petroulas 2007). The “core” panel-gravity model is represented by equ. (1):

$$\ln FDI_{ijt} = b_0 + b_1 \ln gdphome_{it} + b_2 \ln gdphost_{jt} + b_3 \ln gdpcaphome_{it} + b_4 \ln gdpcaphost_{it} + b_5 \ln dist_{ij} + h_{ijt} \quad (1)$$

with: $h_{ijt} = \gamma_t + \alpha_{ij} + e_{ijt}$

The core model will be augmented by several location factors discussed below. Furthermore, *gdpcaphost* will be substituted by various factors as outlined in the next subsections leading to an “augmented” panel-gravity model (equ. (2)):

$$\ln FDI_{ijt} = c_0 + c_1 \ln gdphome_{it} + c_2 \ln gdphost_{jt} + c_3 \ln gdpcaphome_{it} + c_4 \ln dist_{ij} + c_5 X_{ijt} + c_6 W_{jt} + m_{ijt} \quad (2)$$

with: $m_{ijt} = \gamma_t + \alpha_{ij} + e_{ijt}$,

whereby $\ln FDI_{ijt}$ is the log of FDI outflows from home country *i* to host country *j* at time *t*. $\ln gdphome_{it}$ is the log of GDP in home country *i* at time *t,* and $\ln gdphost_{jt}$ is the log of the GDP in host country j at time t. $\ln gdpcaphome_{it}$ is the log of the GDP per capita of home country *i* at time *t* and analogously $\ln gdpcaphost_{jt}$ for host country *j*. $\ln dist_{ij}$ is the log of the bilateral distance between capital cities of countries *i* and *j*. X_{ijt} are location factors which vary between country pairs over time and W_{jt} are location factors which vary over time and over host countries. γ_t are time dummies (TD), α_{ij} are country-pair-specific effects and e_{ijt} is the remainder error term.

3.2. Variables and data

3.2.1. The dependent variable

We operationalize FDI flows by bilateral FDI outflows of seven major home countries (AUT, DEU, FRA, GBR, USA, NLD and ITA) to eight CEE (CEEC-8) host countries (CZE, HUN, POL, SVK, SVN, BRG, HVN and ROM) during the period from 1995 to 2004. The CEEC-8 have been chosen as host countries as they are the main CEE target countries of FDI within all CEECs (the share of the CEEC-8 in 17 CEECs' inward FDI stock was 65 percent in 2004), while the seven chosen FDI home countries are the main investor countries (the share of the seven home countries in the CEEC-8's inward FDI stock was 75 percent in 2004). FDI data are denominated in millions of current Euros and have mainly been obtained from Eurostat's 'New Cronos' database, the 'OECD International Direct Investment Statistics Yearbook' and the 'OECD Foreign Direct Investment' database. Missing values have been substituted using information from National Banks and National Statistical Offices.[3]

3.2.2. Variables of main interest

<u>Taxes</u>

Concerning the first variable of main interest, taxes, we use effective average tax rates on a bilateral basis (*beatr*) in the spirit of Devereux and Griffith (1999). As mentioned above, EATRs are the conceptually proper measure of the corporate income tax burden when dealing with the incentive effects of taxes on investment location decisions. Moreover, using tax rates on a bilateral level is especially relevant for the CEECs as these countries adopted new double-taxation agreements during the transition process and joined the European Union (EU) in 2004. Both developments have had a substantial impact on the effective average tax burden levied on FDI in CEECs. Clearly, as higher taxes *ceteris paribus* have a negative impact on the profitability of an FDI we expect the tax variable to carry a negative sign. Figure 1 shows the development of the *beatr* used in our regression analysis averaged over home countries. It reveals first, that the bulk of the CEECs had relatively high rates in 1995. Second, there is a remarkable fall in the tax rates between 1995 and 2004. Third, tax rates show a marked convergence over time. Fourth, the adoption of the EU parent subsidiary directive by five of the CEECs included in the sample in 2004 is reflected by a marked drop and further convergence in the averaged rates in 2004.

Figure 1 here

<u>Infrastructure</u>

Examining the measurement of infrastructure we have to focus on telecommunication, electricity and transport production facilities due to data restrictions. These are multi-facetted

[3] The De Nederlandsche Bank, the Austrian National Bank, the Croatian National Bank, the Office of National Statistics in the U.K. and the Bureau of Economic Analysis in the U.S.

concepts and include many different categories. For example, telecommunications can be described by factors such as the number of fixed lines, the number of mobile phone connections, the number of internet users etc. In order to reduce this complexity we derive infrastructure indices using principal component analysis (PCA; see, e.g. Bortz 2005, chapter 15). This strategy has been widely used in empirical studies (e.g. Wheeler and Mody 1992, Kumar 2001, Calderón and Servén 2005). PCA allows reducing the number of variables used in the estimation while still retaining a substantial part of the information contained in the various variables. In particular, four proxies for the infrastructure endowment are derived: (i) a measure of overall infrastructure (*infra*), (ii) a measure of the telecommunications infrastructure (*telecom*); (iii) a measure of the transport infrastructure (*transport*) and (iv) a measure of electricity supply capacity (*electricity*).

Data are derived from various sources. In order to proxy telecommunication production facilities we use per capita data on penetration with telephone mainlines, mobile phones, personal computers, broadband connections to the internet and the number of internet users. To capture the electricity production facilities we use the annual electricity generation capacity per capita in GWh. Transport production facilities are proxied by the density of railways, motorways, non-motorway-roads and waterways, as well as by the number of major air- and seaports. To this aim, we use information from Eurostat's New Cronos database, the World Bank's "World Development Indicators" database and, most importantly, information from national sources (e.g. statistical yearbooks). All variables are used in logs in order to account for possible non-linearity between them (e.g. Bortz 2005, p. 523) and to control for accelerating growth rates in the telecommunications infrastructure endowment. We use the first principal component obtained by performing the PCA on the pooled observations.[4]

Note that only one variable is available for the electricity supply capacity. Thus, a PCA can not be performed and *electricity* is generated via standardization of the underlying variable (i.e. electricity generation capacity per capita in GWh). Standardization is carried out to make this variable comparable to the other three indices, which also follow a standard normal distribution. Thus, a value of zero indicates an average endowment given the construction of the infrastructure index. Note also that capturing quality aspects is not possible given the existing data (also see Yeaple and Golub 2007).[5]

Figure 2 shows the development of the index for the overall infrastructure endowment (*infra*). The figure reveals that each of the host countries considered has substantially improved its infrastructure endowment. However, those countries found at the lower end at the beginning of the period did not change their position by the end of the period. At the same time, Figure 2 signals that some convergence is given.[6]

Figure 2 here

We expect the sign of the various infrastructure variables to be positive as a higher quantity of infrastructure provided reduces production costs and thus leads *ceteris paribus* to a higher

[4] Details on the results of the PCA will be provided upon request.

[5] The only quality measure available in panel format for the CEECs included here are "losses" in energy distribution. Yet, according to information given by national statistical offices this variable is calculated as a residual between energy demand and energy supply and thus captures more than pure distribution losses.

[6] The appendix includes graphs for the three sub-categories of infrastructure.

profitability of the investment. Table 1 summarizes the discussion of the variables of main interest.

Table 1 here

3.2.3 Control variables

The selection of host countries by MNEs has been well researched by economists and international business scholars alike. For example, studies by international economics scholars that focus on traditional trade theory include the relative availability of factor endowments such as labor and capital (Markusen 2002). International business studies usually refer to the eclectic paradigm by Dunning (1988). Together, both fields of research point toward a rich set of factors determining FDI location decisions.

Indeed, empirical applications based on either field have used a wide variety of location factors, measured in different ways. In addition to taxes on corporate income and infrastructure as variables of main interest, we use control variables based on well established findings in the empirical literature.[7] The control variables used, the abbreviation in (*brackets*) and the expected sign of their impact on FDI in [brackets] are as follows: wages (*wages*) [-] and labor productivity (*labprod*) [+] to capture labor market conditions; annual privatization revenues (*priv*) [+] to capture the privatization process; producer price inflation to proxy macroeconomic risk (*infl*) [-]; an indicator of forex and trade liberalization (*forex*) [+], indicating the liberalization of trade and foreign exchange transactions; tariff revenues in percent of imports (*tar*) [-] to capture trade costs; the bilateral distance between home and host countries' capital cities (*dist*) [-] to proxy transport costs and cultural ties; the home country size (*gdphome*) [+]; the host market size (*gdphost*) [+], the per capita GDP of the home countries of FDI (*gdpcaphome*) [+] as an indicator of the capital abundance of the home country of FDI - more capital abundant countries should conduct higher outward FDI (Egger and Pfaffermayr 2004); and, in equ. (1), the per capita GDP of the host countries of FDI (*gdpcaphost*) [?].

Most of the expected signs of the variables are standard in the literature. However, *dist, tar* and *gdpcaphost* require brief discussion as their signs are not straightforward. While a larger distance (*dist*) as a proxy of trade costs may encourage FDI due to high export costs, it may also discourage FDI due to differences in culture and institutions that may increase monitoring and investment costs. Thus*, a priori* the sign on the distance coefficient is ambiguous (Carr et al. 2001, p. 699). At the same time, we expect a negative sign for several reasons. First, intra-firm trade flows between parent and affiliate tend to be high in the case of efficiency-seeking FDI, while the costs of re-exporting add to overall costs. Second, a large distance will even have a negative impact on market-seeking FDI if the affiliates are relatively new, since then they typically depend on headquarter services and other intermediate inputs supplied by the parent. Third, the majority of empirical studies revealed a negative impact of distance on FDI. Turning to tariffs, the impact of high tariffs on the volume of FDI received by a country also depends on the underlying motive for FDI, whether it is efficiency or market seeking FDI. In the former case, FDI may be deterred by high tariffs,

[7] Some recent studies are Bevan and Estrin (2004), Carstensen and Toubal (2004) and Demekas et al. (2007).

while in the latter case high tariffs may spur FDI ("tariff-jumping FDI"). Thus, the sign of this variable is again ambiguous *a priori*, but for similar reasons to those mentioned above we expect a negative sign for *tar*.

As more capital abundant countries should receive less FDI (Egger and Pfaffermayr 2004) the expected sign of the coefficient of *gdpcaphost* should be negative, thus mirroring our expectation for the *gdpcaphome* variable. Yet, as stressed by Bénassy-Quéré et al. (2007b), this variable might actually catch the impact of different host country location factors on FDI. On the one hand it might capture the negative effects of high wage costs on FDI (e.g. Mutti and Grubert 2004). On the other hand *gdpcaphost* might also capture positive effects of a favorable infrastructure endowment (e.g. Mutti 2004) and of high labor productivity (e.g. Mutti and Grubert 2004) on FDI. Thus, the expected sign is considered as ambiguous *a priori* (Bénassy-Quéré et al. 2007b). Furthermore, this "catch-all" characteristic of *gdpcaphost* implies that it could be substituted by these underlying variables, i.e. *infra, wages and labprod,* in an empirical model aiming to explain FDI. Hence, we substitute these variables for *gdpcaphost* in the majority of the estimated empirical models (see Javorcik and Spatareanu 2005 for a similar treatment). Table 2 displays details of the control variables used.

Table 2 here

Table 3 shows the correlation matrix of the various location factors used in the empirical study. As expected, the table reveals pronounced pairwise correlations of *gdpcaphost* with the infrastructure variables, as well as *wages*, *labprod and risk*. Moreover, we find a relatively high correlation between the various infrastructure measures and between *labprod* and *wages*.

Table 3 here

Finally, Table 4 shows the descriptive statistics for the variables used. It signals that the variability is higher between country-pairs than within country-pairs. Thus, an estimator which does not drop all of the former variability (e.g. the random effects estimator) may be suitable here.

Table 4 here

3.3. Methodological aspects

Country-pair specific effects can be considered fixed (correlated with explanatory variables) or random (not correlated with explanatory variables). We apply standard Hausman-tests to determine whether the random effects assumption can be maintained. Looking at time effects, we consider these to be fixed as they are likely to be correlated with *gdphome*, *gdphost* and *gdpcaphome* in particular, as time dummies account *inter alia* for the business cycle and common shocks (Egger and Pfaffermayr 2004). Following Bevan and Estrin (2004) and Egger and Winner (2005) we take the log of all variables denominated in Euros (i.e. *priv, wages, labprod*) in addition to the core gravity variables (*gdphome, gdphost, gdpcaphost, gdpcaphome and dist)*. Lagged values of all variables are used to guard against the possibility of reverse causality (e.g. Egger and Winner 2005) and to take into account that FDI flows to the CEECs may rely on lagged rather than contemporaneous information, as argued by Bevan and Estrin (2004). Furthermore, we conduct a jack-knife analysis with respect to host countries and years included in the sample in order to shed light on the robustness of our results.

The novelty of our approach is that we explicitly take into account the interrelation between taxes and infrastructure as determinants of FDI. To capture these interaction effects between *beatr* and *infra* we use the product (*tax_infra)* of these two variables jointly with each single variable in the augmented panel gravity model (equ (2)). The use of interaction terms is justified whenever conditional hypotheses are tested (e.g. Brambor et al. 2006) as here. We expect that controlling for the interaction between taxes and infrastructure will reduce the sensitivity of FDI to changes in tax rates, i.e. we expect a positive sign on the coefficient of the *tax_infra* variable.

4. Empirical Results

4.1 Models without interaction effects

Table 5 shows the results for six different specifications.[8] M1 gives the estimates for the "core" gravity model. It is important to note that the coefficient on *gdpcaphost* is statistically insignificant, a result not unusual in the literature (see Bénassy-Quéré et al. 2007b). This insignificance may be driven by the fact that *gdpcaphost* simultaneously captures the positive and negative impact of different location factors on FDI as outlined above. Substituting *gdpcaphost* with underlying variables is therefore a viable alternative.

M2 gives the results when *gdpcaphost* is substituted with *infra*, *wages* and *labprod*. Moreover the model is augmented by *beatr*, a variable of main interest, and *priv*, a variable shown to be an important determinant of FDI in CEECs (e.g. Carstensen and Toubal 2004; Bellak and Leibrecht 2007). With the exception of *labprod*, all of the included variables carry the expected sign and are statistically significant. The insignificance of *labprod* is due to the inclusion of *infra*. This is plausible, as labor productivity is crucially determined by infrastructure. Thus infrastructure can be considered as an underlying variable for labor productivity. Indeed, if *infra* is dropped from this specification, the coefficient of *labprod* turns positive and almost statistically significant (see m3). Due to its insignificance, *labprod* is dropped in models m4 to m7. The results derived from these models imply semi-elasticities of about -5 (*beatr*), +47 (*infra*), +84 (*telecom*), +32 (*transport*) and +10 (*electricity*). With the exception of *electricity* all variables are statistically significant.

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[8] Note that the Hausman-test does not reject the null hypothesis of uncorrelated effects for all estimated specifications (cf. Tables 5 and 6). Thus, results are derived based on the random effects estimator. Also, the null hypothesis of no serial correlation is not rejected throughout. Thus, it is not necessary to model an autoregressive model to avoid dynamic misspecification. As we use FDI out*flows* rather than FDI *stocks* this is a plausible result. Moreover, using heteroscedasticity robust standard errors has virtually no impact on the estimated variances. Nevertheless, as stressed by Wooldridge (2002, p. 263), nothing is lost if robust standard errors are used for the random effects estimator even in the case of spherical residuals. Thus, with the exception of the Hausman-test, robust standard errors are used throughout.

The estimated tax-rate elasticity is in line with the study by Bellak and Leibrecht (2007) as well as the meta-analysis by DeMooij and Ederveen (2006) outlined above. A one percentage point change, which is about a one standard deviation change, in the index of infrastructure *infra* would lead to an increase in FDI of 47 percent. A semi-elasticity of +47 appears rather high at first glance. However, considering that our infrastructure index ranges only between -2.5 and 2 for the CEECs included (cf. Figure 2), a one-point change in this variable captures a substantial increase in *infra*. Indeed, the average yearly change in *infra* is about 0.21, which *ceteris paribus* implies a change of FDI outflows by approximately 9.87 percent. In comparison, the average yearly growth rate of bilateral FDI outflows was about 22 percent between 1995 and 2004. Moreover, models m4 to m6 signal that telecommunications is more important than transport infrastructure and that electricity generation capacity does not have a statistically significant impact on FDI flows. This result supports the study by Mollick et al. (2006) in which telecommunications infrastructure (telephone lines) appears to be more relevant to FDI flowing to Mexico than transport infrastructure (roads).
With respect to the control variables included, the coefficients of the core gravity variables (*gdphome, gdphost, gdpcaphome and dist*) carry the expected signs. The magnitudes of the coefficients are also in line with prior studies (e.g. Bevan and Estrin 2004; Bellak and Leibrecht 2007). As expected, high wages have a significant negative impact on FDI. The estimated coefficients suggest an elasticity of about -1, which stands in line with Bellak et al. (2008). The privatization process has a positive impact on FDI – a result shared with various other studies (e.g. Carstensen and Toubal 2004 or Bellak and Leibrecht 2007).

Table 5 here

Our results clearly show that infrastructure has a direct effect on FDI. While these results are encouraging, the neglect of the interaction between taxation and infrastructure is questionable, particularly from a policy perspective. As outlined above, investors may consider infrastructure endowment as a form of compensation for higher taxes.

4.2 Models with interaction effects

Before discussing the results, some points concerning the interpretation of results of models with interaction effects should be considered. First, the coefficients in interaction models no longer show the average effect of the variables entering the interaction effects (Brambor et al. 2006, p. 8) – here *beatr* and *infra.* Instead, they show the impact of a marginal change of *beatr* (*infra*) when *infra* (*beatr*) is evaluated at zero. Zero is usually not an economically meaningful value (see Brambor et al. 2006, p. 13f. for a discussion). Rather, one needs to further evaluate the marginal effect of *beatr* (*infra*) on FDI at different, economically meaningful values of *infra* (*beatr*). Second, if an insignificant impact of *beatr* or *infra* is shown in standard result tables (cf. Table 6), one must bear in mind that this represents an insignificant impact of *beatr* (*infra*) if *infra* (*beatr*) is evaluated at zero. Thus, it does *not* imply that *beatr* (*infra*) does not have a statistically significant impact on FDI at other values of *infra* (*beatr*). It is possible for *beatr* (*infra*) to have a statistically significant impact on FDI for substantively relevant values of *infra* (*beatr*) even when both variables enter insignificantly[9] (Brambor et al. 2006, p. 9). Third, this latter point also holds for the interaction effect, here *tax_infra*. Even if its coefficient is not statistically significant, it is possible for the marginal effects of *beatr* (*infra)* to be significant for relevant values of *infra* (*beatr*) (Brambor et al. 2006, p. 14). Fourth, in interaction models it is not unusual that one of the interacting variables carries the "wrong" sign with the model nevertheless showing the expected marginal effects (Kennedy 2005, example 8). The results are shown in Table 6.[10]

Table 6 here

Model m8 gives the result for model m4 augmented by *tax_infra*. We see that the coefficient of *beatr* does not change much and remains highly statistically significant and the coefficient of *tax_infra* carries the expected sign. The question we want to answer is "How does the marginal effect of *beatr* change with the level of *infra?"* This is shown by Figure 3. The full black line in Figure 3 depicts the marginal effect of *beatr* at different levels of infrastructure endowment for m8, while the 90 percent confidence band in Figure 3 allows us to determine the range of values of *infra* for which the marginal effect of *beatr* on FDI is statistically significant.[11] The effect of *beatr* on FDI is negative throughout the whole range of sample values of *infra* (cf. Table 4). This negative impact is also statistically significant up to a level of *infra* of about 1.2. This value implies that over 90 percent of all sample values fall into the significant range. The negative effect of taxes on FDI only vanishes for countries with relatively high infrastructure endowment. This result is in line with Bénassy-Quéré et al. (2007a).

Figure 3 here

Turning to infrastructure, Figure 4 shows the marginal effect of *infra* on FDI at various levels of *beatr* again based on m8. The impact of *infra* on FDI is positive if *beatr* = 0 and it increases with an increase in the tax burden. This, of course, mirrors the results shown by Figure 3. Furthermore, the impact of *infra* on FDI is positive throughout the sample range and statistically significantly different from zero for about 98 percent of the sample values of our tax variable.

Figure 4 here

Finally, models m9 to m12 show the results when different control variables are added to m8. With the exception of *risk,* these variables enter with the expected signs, yet are statistically insignificant. More importantly, the estimates for *beatr*, *infra* and *tax_infra* do not change

[9] See equation 1 in Brambor et al. (2006).

[10] We present results for *infra* only. Using sub-categories might lead to biased estimates as different types of infrastructure are relevant for FDI. Yet, as expected given m5 to m7 in Table 5, the results for sub-categories (*telecom, transport, electricity*) show that *telecom* has the largest impact on the marginal effect of taxes (highest coefficient on *tax_infra*). Moreover, each of the coefficients on *tax_infra* is positively signed.

[11] The Stata program which is used to generate Figures 3 and 4 is based on the code made available by Thomas Brambor on his homepage.

much with the inclusion of additional control variables. Thus, model m8 and the results displayed in Figures 3 and 4 are robust with respect to the control variables added.

4.3 Jackknife analysis

To evaluate the robustness of the results against the impact of possible host country and period outliers, a jackknife analysis excluding host countries and years is conducted. The results are reported in Tables 7 and 8, whereby the focus lies on the variables of main interest (i.e. *beatr*, *tax_infra*, *infra*, *telecom*, *transport* and *electricity*). The Tables report the resulting minimum and maximum values of the coefficient estimates, the country or the year excluded and the model on which the analysis is based. Moreover, the corresponding results form Tables 5 and 6 are displayed in the columns titled “estimates”. We find that the results are robust when countries and years are dropped. Only one coefficient changes signs, yet this is for *electricity* which does not have a statistically significant impact on FDI. Moreover, excluding host countries or years only has a minor impact on the statistical significance of the estimates. Thus, in addition to the results derived from including various control variables (cf. models m9 to m12), the jackknife analysis confirms the robustness of the results.

Table 7 here

Table 8 here

5. Summary and Conclusions

This study focuses on two interrelated policy factors, namely taxes and infrastructure, as determinants of FDI. The results show, first, that infrastructure is a relevant location factor for FDI in CEECs. Second, the results imply that, among the various types of infrastructure information and communication infrastructure is more important than transport infrastructure and electricity generation capacity. Third, and most importantly, the analysis shows that the tax-rate elasticity of FDI is indeed a decreasing function of infrastructure endowment. The latter generates location-specific and immobile “infrastructure rents”, which can be taxed without a loss of FDI. Thus, from a public finance perspective, the income side (taxes) and the expenditure side (infrastructure) of public budgets are clearly interlinked with regard to FDI attraction policies. Countries with an above average infrastructure endowment can – at least in part – afford to finance their infrastructure by taxing corporations. However, countries with an inferior infrastructure endowment most likely have to cut corporate income taxes to receive FDI in the short run. In the medium to the long run these countries should improve their infrastructure position in order to make FDI sustainable. However, this increase in infrastructure endowment needs to be funded mainly by non-corporate income taxes in the short run.

Our analysis can be extended in several ways. First of all, the inclusion of infrastructure quality indicators should provide further insights into the role of infrastructure as a determinant of FDI and its impact on the tax-rate elasticity of real multinational activity. Furthermore, the inclusion of further interaction effects of infrastructure and other policy variables (e.g., the institutional environment, employment protection, legislation, education system) would allow for more informed policy advice to governments in CEECs beyond the public finance aspects raised here.

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8. Tables and Figures

Table 1: Definition and Sources of control variables

Abbreviation	Data Source	Variable	Expected Sign
gdphome	New Cronos database	Home country size measured as GDP home country in mn. Euro.	+
gdphost	New Cronos database	Host market size measured as GDP host country in mn. Euro	+
gdpcaphome	New Cronos database (GDP and Euro-PPP) Ameco database (population)	GDP of home country in Euro-PPP per capita	+
gdpcaphost	New Cronos database (GDP and Euro-PPP) Ameco database (population)	GDP of host country in Euro-PPP per capita	?
dist	CEPII	Distance in kilometers	–
wages	Ameco and WIIW (labor compensation for HRV) online databases	Calculations based on the definition of unit labor costs given in Bellak et al. (2008); *wages* is the numerator of this unit labor cost variable; Labor costs per employee measured as labor compensation per employee in Euro	–
labprod	New Cronos (GDP) and WIIW (Euro-PPP) databases	Calculations based on the definition of unit labor costs given in Bellak et al. (2008); *labprod is* the denominator of this unit labor cost variable; Labor productivity measured as GDP in Euro-PPP over employment	+
priv	Own calculations; EBRD: Transition Reports	Annual privatization revenues in mn. Euro	+
risk	Euromoney	Political Risk; index ranging from 0 (highest risk level) to 25	+
infl	EBRD: Transition Reports	Inflation measured as the percentage increase in producer prices	–
tar	EBRD: Transition Reports	Ratio of taxes and duties on imports excluding VAT over imports of goods and services; in percent	–
forex	EBRD: Transition Reports	Indicator of the liberalization of trade and international monetary transactions and payments	+

Table 2: Definition and measurement of variables of main interest

Variable name	*Source*	*Indicator*	*Expected Sign*
beatr	Own calculations based on Devereux and Griffith 1999; assumptions follow Devereux and Griffith except that we give investment in inventory less (10%) and investment in buildings more weight, as data for the CEECs show that investment in inventories is of minor importance; pre-tax financial flow of 20% is assumed; only corporate income taxes are considered; raw tax data are taken from the European Tax Handbook and KPMG's Corporate Tax Rate Surveys	Bilateral effective average tax rate; measured in per cent	–
Telecom Index (*telecom*)	Principal Component Analysis based on the following variables:		+
broadband	World Development Indicators, OECD and country-specific sources	Broadband connections	
mainmob	World Development Indicators	Fixed line and mobile phone subscribers	
internet	World Development Indicators	Internet users	
computers	World Development Indicators	Personal computers	
Electricity Variable	Standardized electricity variable		+
electricity	New Cronos	Electricity generation (GWh per capita)	
Transport Index *(transport)*	Principal Component Analysis based on the following variables:		+
rail	World Development Indicators	Rail line density (total route-km divided by surface)	
waterways	Statistical yearbook on candidate countries 1997 – 2001; Development of Transport Infrastructure in the republic of Croatia; Ministry of Sea, Tourism, Transport and Development, Thessaloniki, 19-20th December 2005; Panorama of transport, part 1 1970 – 2001, Eurostat 2003; http://commercecan.ic.gc.ca/scdt/bizmap/interface2.nsf/vDownload/ISA_5656/$file/X_4911598.DOC	Inland Waterways density (total route-km divided by surface)	
motorways	Statistical yearbook on candidate countries 1997-2001; New Cronos; and various national sources	Motorway density (total route-km divided by surface)	
otherroads	Statistical yearbook on candidate countries 1997-2001; New Cronos; and various national sources	Non-motorways density (total route-km divided by surface)	
airports	Statistical yearbook on candidate countries 1997 – 2001; Eurostat (2003); Panaorama of transport 1970 – 2001 of Eurostat (2003); except for Croatia: http://commercecan.ic.gc.ca/scdt/bizmap/interface2.nsf/vDownload/ISA_5010/$file/X_970344.DOC	Airports (number)	
seaports	Statistical yearbook on candidate countries 1997 – 2001; Eurostat (2003); Panaorama of transport 1970 – 2001 of Eurostat (2003); except for Croatia: http://commercecan.ic.gc.ca/scdt/bizmap/interface2.nsf/vDownload/ISA_5010/$file/X_970344.DOC	Seaports (number)	
Overall infrastructure Index (*infra)*	Principal Component Analysis based on all the above mentioned variables		+

Table 3: Correlation Matrix

	gdphome	*gdphost*	*gdpcaphome*	*gdpcaphost*	*Dist*	*beatr*	*priv*	*tar*	*infl*	*risk*	*infra*	*transport*	*telecom*	*electricity*	*wages*	*labprod*	*forex*
gdphome	1.00																
gdphost	0.06	1.00															
gdpcaphome	0.32	0.19	1.00														
gdpcaphost	0.06	0.31	0.27	1.00													
dist	0.74	0.02	0.32	-0.23	1.00												
beatr	-0.04	0.09	-0.18	-0.17	0.06	1.00											
priv	0.04	0.66	0.21	0.11	0.03	0.05	1.00										
tar	-0.07	-0.59	-0.32	-0.65	0.12	-0.06	-0.39	1.00									
infl	-0.04	-0.22	-0.13	-0.32	0.06	0.11	-0.05	0.29	1.00								
risk	0.06	0.53	0.21	0.88	-0.16	-0.08	0.34	-0.66	-0.25	1.00							
infra	0.08	0.15	0.41	0.93	-0.18	-0.30	0.04	-0.52	-0.23	0.78	1.00						
transport	0.01	-0.08	0.02	0.82	-0.21	-0.17	-0.13	-0.33	-0.17	0.70	0.79	1.00					
telecom	0.12	0.22	0.60	0.76	-0.10	-0.36	0.10	-0.53	-0.22	0.61	0.90	0.47	1.00				
electricity	0.02	-0.09	0.09	0.59	-0.13	0.05	-0.17	-0.19	0.00	0.52	0.64	0.68	0.38	1.00			
wages	0.04	0.27	0.23	0.86	-0.20	-0.35	-0.01	-0.51	-0.37	0.70	0.81	0.70	0.72	0.29	1.00		
labprod	0.05	0.28	0.30	0.94	-0.24	-0.30	0.13	-0.57	-0.35	0.79	0.88	0.70	0.79	0.36	0.91	1.00	
forex	0.08	0.27	0.36	0.43	-0.05	-0.21	0.28	-0.32	-0.20	0.39	0.52	0.31	0.53	0.25	0.44	0.43	1.00

Notes: majority of coefficients statistically different from zero at 10 percent

Table 4: Descriptive Statistics

Variable		Mean	St. Dev.	Min	Max	Variable		Mean	St. Dev.	Min	Max
lnfdi	overall	4.24	1.73	-1.20	8.44	*infl*	overall	27.24	112.41	-1.80	971.08
	between		1.42	1.64	7.22		between		44.18	1.36	170.81
	within		1.05	0.49	7.75		within		103.66	-142.4	864.61
lngdphome	overall	27.72	1.12	25.93	30.06	*risk*	overall	13.86	3.37	5.32	19.82
	between		1.13	26.01	29.88		between		2.95	9.34	17.33
	within		0.15	27.29	28.04		within		1.66	7.98	17.65
lngdphost	overall	24.25	0.81	22.80	26.08	*infra*	overall	-0.14	0.96	-2.27	1.90
	between		0.77	23.18	25.80		between		0.76	-1.44	1.18
	within		0.22	23.76	24.79		within		0.58	-1.19	1.05
lngdpcaphome	overall	10.06	0.15	9.75	10.41	*transport*	overall	-0.03	0.99	-1.37	1.86
	between		0.11	9.93	10.33		between		1.01	-1.29	1.79
	within		0.11	9.81	10.30		within		0.06	-0.21	0.14
lngdpcaphost	overall	9.03	0.36	8.38	9.71	*telecom*	overall	-0.18	0.92	-2.21	1.72
	between		0.33	8.52	9.52		between		0.46	-1.00	0.67
	within		0.15	8.71	9.39		within		0.81	-1.51	1.47
lndist	overall	7.00	0.99	4.04	9.15	*electricity*	overall	-0.04	0.99	-2.06	1.67
	between		1.00	4.04	9.15		between		0.98	-1.45	1.26
	within		0.00	7.00	7.00		within		0.20	-0.70	0.48
beatr	overall	33.51	8.15	5.19	56.20	*lnwages*	overall	8.58	0.60	7.18	9.76
	between		6.71	12.16	48.60		between		0.56	7.63	9.57
	within		4.86	17.78	47.32		within		0.25	7.98	9.09
lnpriv	overall	20.32	1.26	17.87	22.85	*lnlabprod*	overall	9.97	0.33	9.31	10.50
	between		1.02	18.34	21.75		between		0.29	9.48	10.32
	within		0.77	16.86	22.27		within		0.16	9.66	10.34
tar	overall	4.37	3.85	0.50	18.45	*forex*	overall	4.21	0.20	3.00	4.30
	between		3.16	1.06	12.13		between		0.08	4.03	4.30
	within		2.27	-0.10	13.45		within		0.18	3.11	4.48

Note: negative signs for infrastructure variables are possible as these variable follow N ~ (0,1) in full sample.

Table 5: Results for models without interaction effect

	m1	m2	m3	m4	m5	m6	m7
lngdphome	0.332*	0.277**	0.294**	0.273**	0.278**	0.292**	0.310***
	(1.90)	(2.41)	(2.52)	(2.33)	(2.36)	(2.55)	(2.62)
lngdphost	1.200***	1.173***	1.067***	1.168***	1.165***	1.186***	1.096***
	(8.14)	(6.76)	(6.51)	(6.83)	(7.01)	(6.52)	(6.52)
lngdpcaphome	3.133**	2.877***	2.913***	2.877***	2.864***	2.947***	2.982***
	(2.49)	(2.88)	(2.82)	(2.91)	(2.88)	(2.97)	(2.97)
lngdpcaphost	-0.404						
	(-1.23)						
infra		**0.502***		**0.477*****			
		(1.92)		**(2.65)**			
telecom					**0.844*****		
					(2.91)		
transport						**0.323****	
						(1.97)	
electricity							**0.103**
							(1.01)
lndist	-0.922***	-0.825***	-0.851***	-0.819***	-0.826***	-0.853***	-0.880***
	(-3.91)	(-5.69)	(-5.52)	(-5.61)	(-5.75)	(-5.73)	(-5.86)
beatr		**-0.052*****	**-0.049*****	**-0.053*****	**-0.055*****	**-0.050*****	**-0.049*****
		(-5.06)	**(-4.58)**	**(-5.10)**	**(-5.50)**	**(-4.85)**	**(-4.72)**
lnpriv		0.270***	0.270***	0.269***	0.301***	0.260***	0.275***
		(3.02)	*(3.01)*	(3.02)	(3.36)	(2.90)	(3.09)
lnwages		-0.989***	-0.828***	-1.018***	-1.112***	-0.939***	-0.573***
		(-3.70)	(-3.04)	(-4.09)	(-4.39)	(-3.48)	(-3.46)
lnlabprod		-0.128	0.731				
		(-0.16)	(1.35)				
cons	-55.893***	-49.809***	-57.873***	-50.663***	-50.887***	-52.306***	-54.363***
	(-4.30)	(-4.75)	(-5.50)	(-5.44)	(-5.28)	(-5.59)	(-5.57)
obs	452	452	452	452	452	452	452
HT Chi2():	(12): 17.45	(15): 12.60	(15): 14.25	(14): 11.48	(14): 9.10	(14): 10.72	(14): 12.02
AR(1): Chi2(1)	0.47	0.50	0.44	0.40	0.40	0.34	0.36
TD: Chi2(8)	24.45***	36.35***	32.35***	36.93***	30.98***	29.38***	32.66***
R2_overall	0.45	0.56	0.55	0.56	0.56	0.56	0.55
R2_within	0.18	0.24	0.23	0.24	0.24	0.24	0.23
R2_between	0.60	0.76	0.75	0.76	0.76	0.77	0.76

Notes: t-statistics in parentheses. * / ** / *** indicates significance at 10 / 5 / 1 percent level, respectively; TD = test for joint significance of time dummies; HT = Hausman-test; AR(1) = test for serial correlation according to Wooldridge 2002, pp. 282.

Table 6: Results for models with interaction effect

	m8	m9	m10	m11	m12
lngdphome	0.260**	0.260**	0.258**	0.261**	0.258**
	(2.18)	(2.20)	(2.15)	(2.20)	(2.17)
lngdphost	1.160***	1.166***	1.152***	1.162***	1.156***
	(6.74)	(5.68)	(5.99)	(6.71)	(6.64)
lngdpcaphome	2.745***	2.733***	2.744***	2.739***	2.721***
	(2.70)	(2.67)	(2.69)	(2.67)	(2.64)
infra	**0.160**	**0.172**	**0.148**	**0.171**	**0.168**
	(0.51)	**(0.36)**	**(0.42)**	**(0.55)**	**(0.53)**
tax_infra	**0.010**	**0.010**	**0.010**	**0.010**	**0.011**
	(1.11)	**(0.98)**	**(1.04)**	**(1.09)**	**(1.12)**
lndist	-0.804***	-0.804***	-0.801***	-0.805***	-0.801***
	(-5.40)	(-5.42)	(-5.36)	(-5.40)	(-5.33)
beatr	**-0.047*** **	**-0.047*** **	**-0.048*** **	**-0.047*** **	**-0.047*** **
	(-3.77)	**(-3.68)**	**(-3.78)**	**(-3.74)**	**(-3.69)**
lnpriv	0.271***	0.272***	0.271***	0.268***	0.274***
	(3.06)	(3.00)	(3.06)	(2.95)	(3.06)
lnwages	-1.051***	-1.053***	-1.045***	-1.066***	-1.073***
	(-4.09)	(-3.91)	(-4.13)	(-3.98)	(-4.22)
risk		-0.003			
		(-0.06)			
tar			-0.004		
			(-0.12)		
forex				0.103	
				(0.44)	
infl					0.000
					(-0.23)
cons	-48.779***	-48.747***	-48.536***	-49.000***	-48.247***
	(-5.02)	(-4.82)	(-4.74)	(-4.94)	(-4.79)
obs	452	452	452	452	452
HT Chi2():	(16): 22.80	(17): 22.70	(17): 24.11	(17): 22.99	(17): 24.40
AR(1): Chi2(1)	0.55	0.56	0.63	0.54	0.65
TD: Chi2(8)	34.44***	33.19***	34.30***	34.16***	31.19***
R2_overall	0.55	0.55	0.55	0.55	0.55
R2_within	0.24	0.24	0.24	0.24	0.24
R2_between	0.75	0.75	0.75	0.75	0.75

Notes: t-statistics in parentheses. * / ** / *** indicates significance at 10 / 5 / 1 percent level, respectively; TD = test for joint significance of time dummies; HT = Hausman-test; AR(1) = test for serial correlation according to Wooldridge 2002, pp. 282.

Table 7: Host country jackknife analysis

Variable	Minimum	Country excluded	Model	Estimate	Model	Country excluded	Model	Maximum
beatr	-0.041***	CZE	m4	-0.053***	m4	ROM	m4	-0.053***
tax_infra	0.005	ROM	m8	0.010	m8	BGR	m8	0.015
infra	0.384**	HRV	m4	0.477***	m4	ROM	m4	0.650***
telecom	0.714**	SVN	m5	0.844***	m5	ROM	m5	1.056***
transport	0.287'	SVN	m6	0.323**	m6	ROM	m6	0.381**
electricity	-0.036	HRV	m7	0.103	m7	HUN	m7	0.153'

Notes: ‘ / * / ** / *** sign at 15 / 10 / 5 / 1 percent level

Table 8: Period jackknife analysis

Variable	Minimum	Year excluded	Model	Estimate	Model	Year excluded	Model	Maximum
beatr	-0.049***	1998	m4	-0.053***	m4	2000	m4	-0.059***
tax_infra	0.006	2000	m8	0.010	m8	2003	m8	0.013
infra	0.429**	1997	m4	0.477***	m4	1999	m4	0.561***
telecom	0.737**	2000	m5	0.844***	m5	2002	m5	0.964***
transport	0.255'	2002	m6	0.323**	m6	1999	m6	0.402**
electricity	0.083	1996	m7	0.103	m7	2004	m7	0.173*

Notes: ‘ / * / ** / *** sign at 15 / 10 / 5 / 1 percent level

Figure 1: Bilateral effective average tax rates averaged over home countries of FDI (beatr)

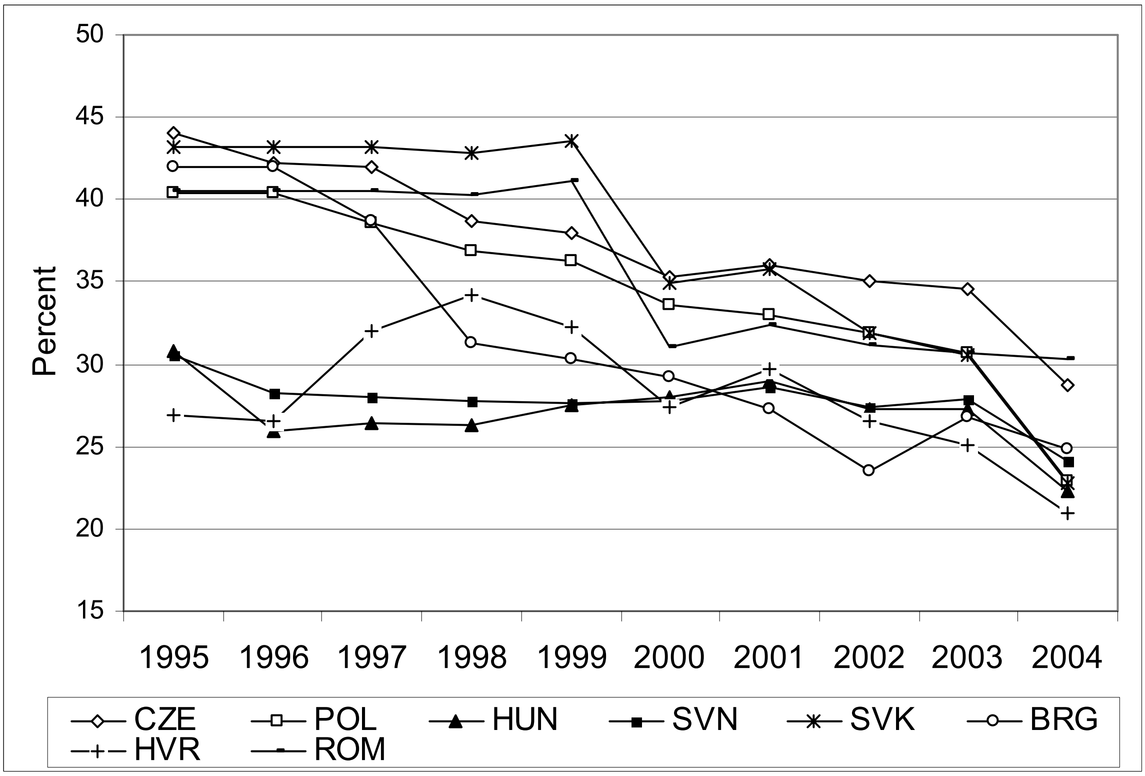


Figure 2: Infrastructure endowments of host countries of FDI (infra)

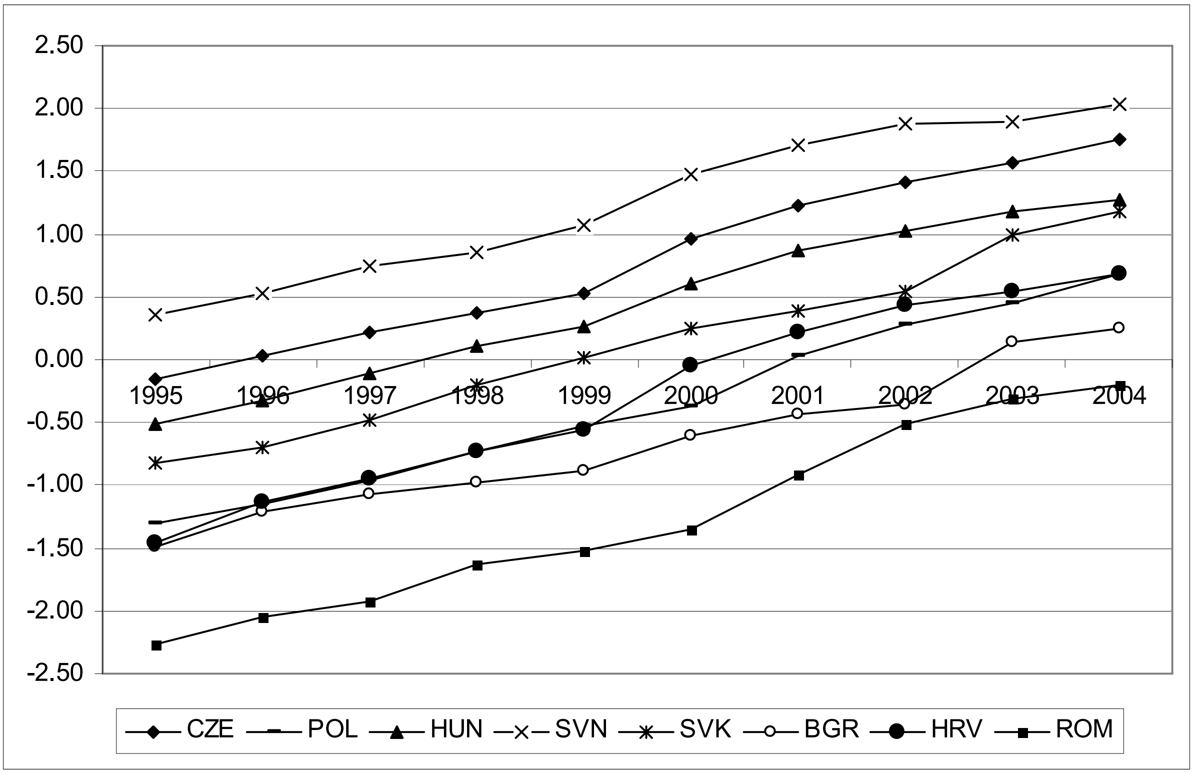
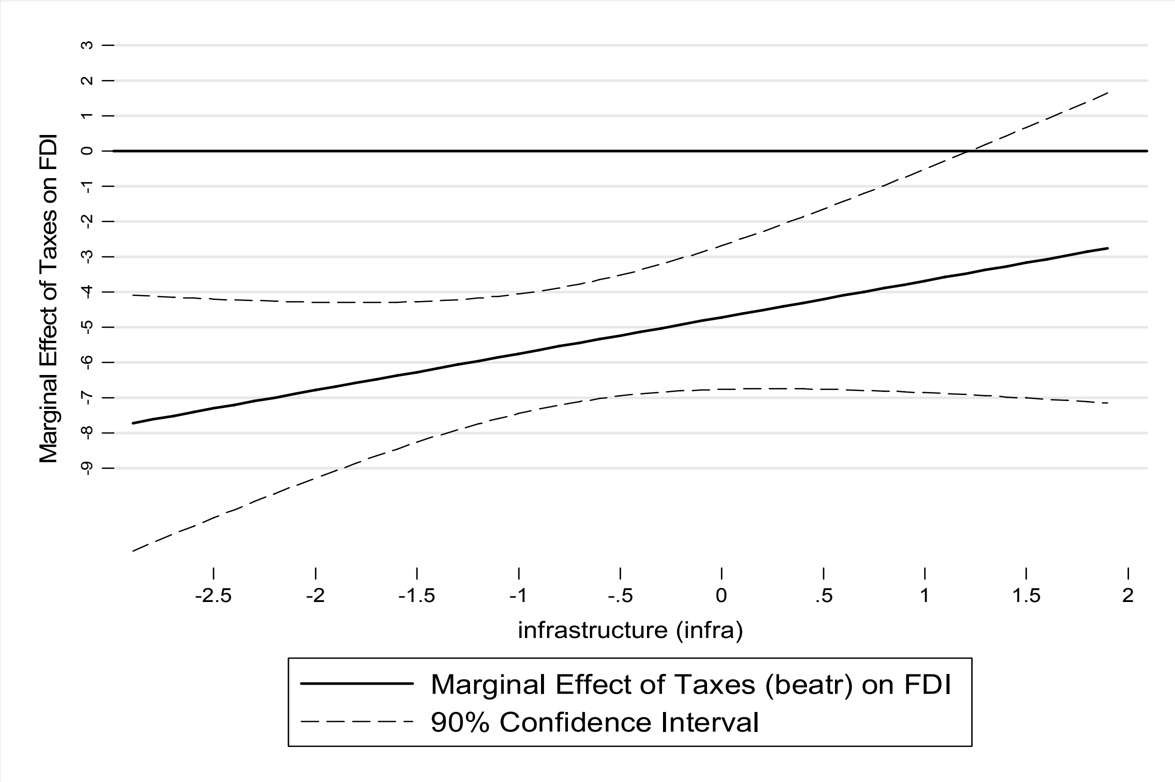
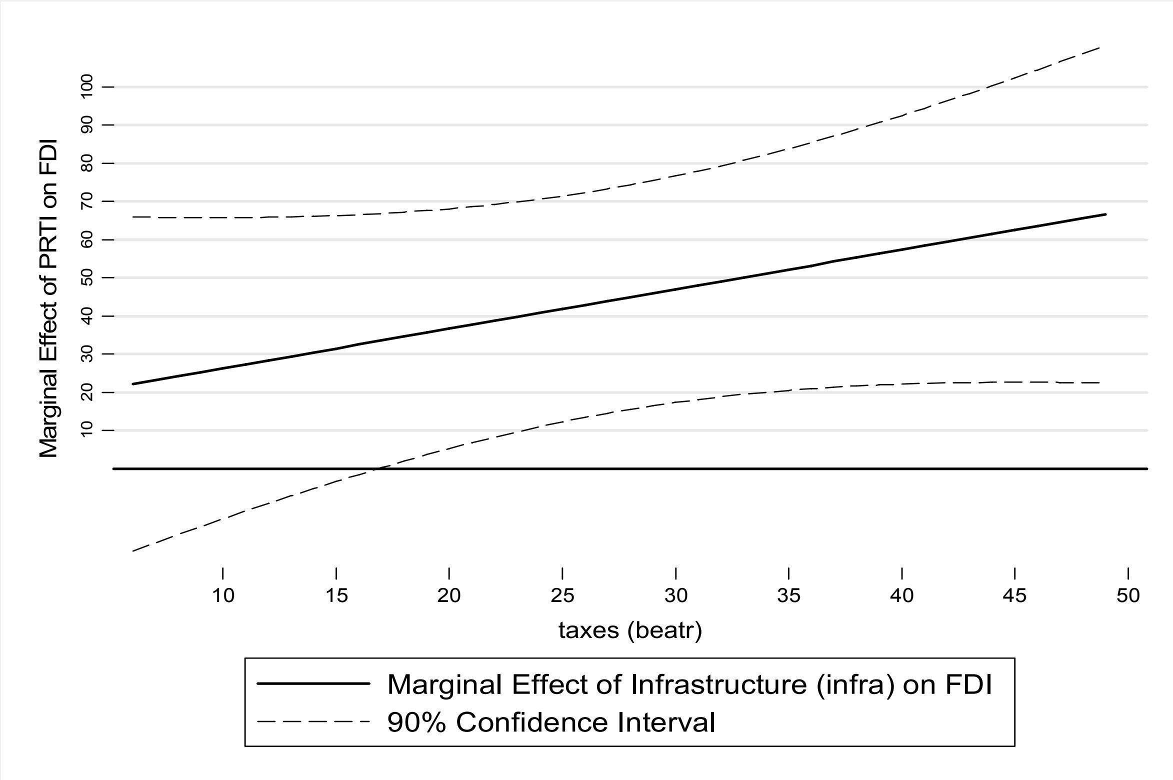


Figure 3: Marginal effect of taxes on FDI-flows as infrastructure endowment changes



Notes: Figure drawn using the code provided by Brambor et al. (2006)

Figure 4: Marginal effect of infrastructure on FDI-flows as tax-level changes



Notes: Figure drawn using the code provided by Brambor et al. (2006)

Appendix: Graphs for the *telecom*, *transport* and *electricity* indices

Figure A1: Telecom Index (telecom) of host countries

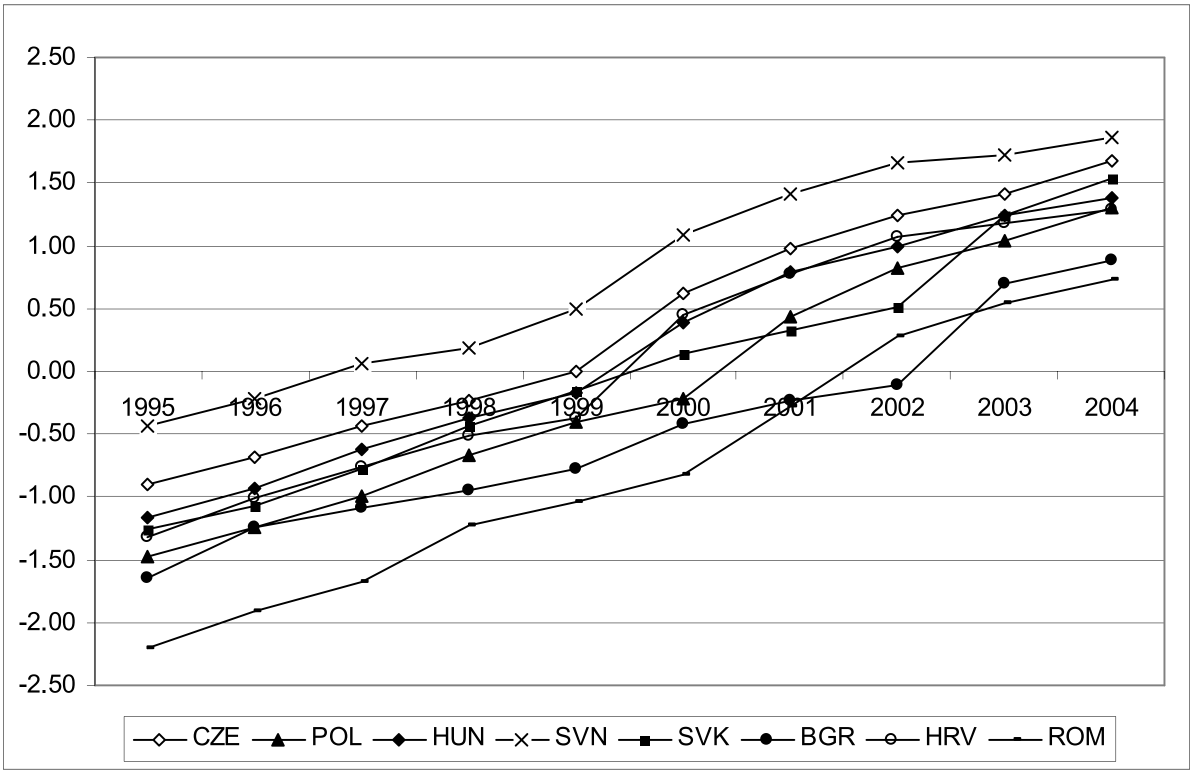


Figure A2: Transport Index (transport) of host countries

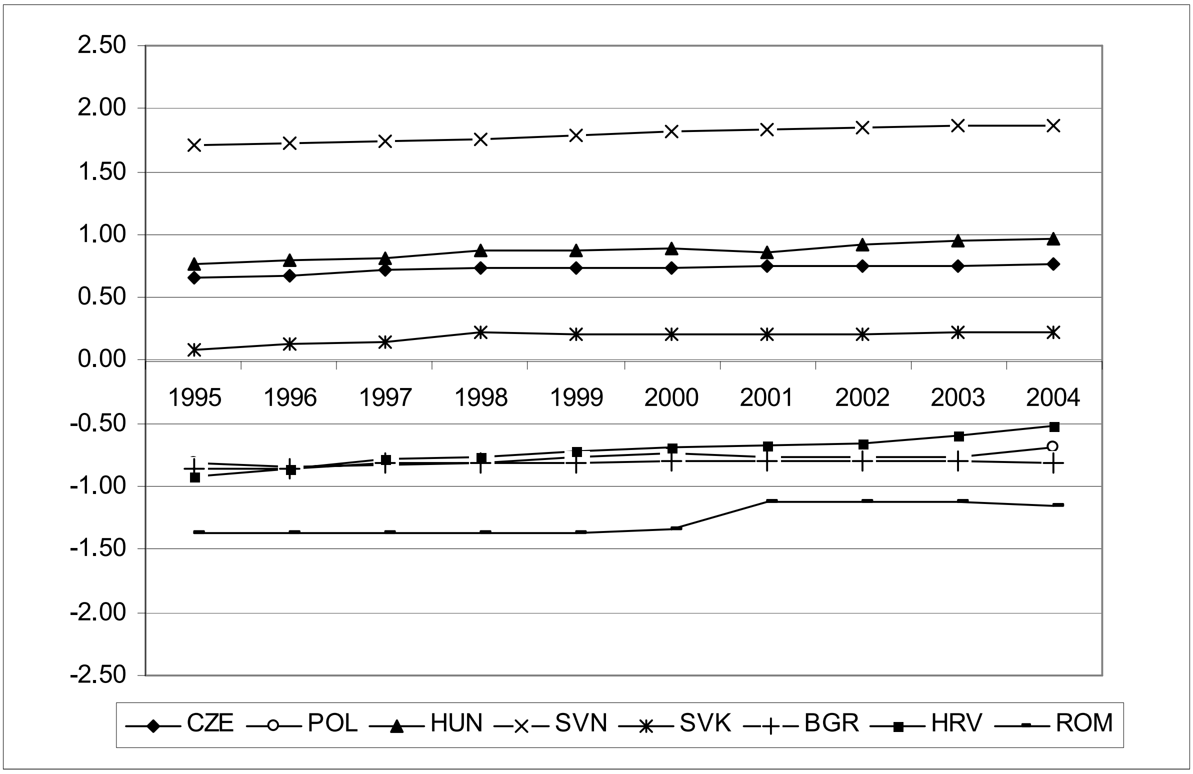


Figure A3: Electricity Index (electricity) of host countries