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by

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Modelling FDI based on a spatially augmented gravity model: Evidence for Central and Eastern European Countries

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Abstract

Based on a spatially augmented gravity model the current paper isolates spatial interrelationships in Foreign Direct Investment (FDI) to Central and Eastern European Countries (CEECs) not only across the destination but also across the origin country dimension of FDI. Results show that: (i) spatial interrelationships across destination countries are present and are consistent with the predominance of vertical-complex FDI in total FDI; (ii) spatial correlation across origin countries is given in earlier years of transition, while demonstration and competition effects cancel over the whole sample period; and (iii) agglomeration forces gain in importance for FDI to CEECs.

Keywords: Foreign Direct Investment, Spatial Econometrics, Central and Eastern Europe, Third country effects

JEL classification: C33, F21

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1 Introduction

There is a huge literature exploring the factors that lead Multinational Enterprises (MNEs) to conduct Foreign Direct Investment (FDI) (see e.g., Blonigen, 2005; Bevan and Estrin, 2004). To a large extent the papers in question are based on the well-known gravity model, which accounts for the possibility that FDI depends on uni- as well as bilateral factors. However, utilizing purely uni- and bilateral information abstracts from spatial interrelationships ("third-country effects") in FDI. If spatial interrelationships are present, then FDI between origin country i and destination country j *inter alia* depends on the amount of FDI that neighboring origin countries invest in the same destination country or neighboring destination countries receive from the same origin country of FDI.

Recent FDI-theory implies that the analysis of spatial interdependencies in FDI may uncover important insights with respect to the motives that lead MNEs to finance an investment abroad. Moreover, from an economic policy viewpoint, the information covered by spatial interrelationships is relevant as spillover effects from FDI to the destination economy depend on the heterogeneity of MNEs in terms of their motives to finance FDI as well as on the country of origin (see e.g., Smeets and Wei, 2010; Ford et al., 2008).

More recent empirical work therefore utilizes spatial regression techniques that account for third-country effects when modelling FDI (e.g., Baltagi et al., 2007; Blonigen et al., 2007; Garretsen and Peeters, 2009). Their results reveal the importance of spatial patterns in FDI. Yet, these studies focus on investment activity emerging from one particular origin country (the US of America and the Netherlands), and thus exploit spatial interrelationships solely across the destination country dimension of FDI.[1]

However, the analysis of spatial patterns in FDI across origin countries might as well contain valuable information on the factors and motives that determine FDI. In particular, modelling spatial correlation across origin countries allows discriminating between so called spatial demonstration (herding) effects and competition effects in FDI.

The present paper explores the existence of spatial interrelationships in FDI while controlling for uni- and bilateral location factors usually employed in traditional gravity models. Although our paper is closely related to the papers by Blonigen et al. (2007) and Garretsen and Peeters (2009), it deviates from the literature on third-country effects in three important aspects:

First, in addition to considering spatial effects across destination countries, we are the first to explore the presence of spatial interdependencies in FDI between countries of origin. Hence, our analysis provides a more complete picture on the significance of third-country effects for FDI. In order to tackle this issue empirically, we base our analysis on the recently proposed model of LeSage and Pace (2008), which is suitable for analysing various spatial patterns inherent in interregional flow data.

Second, and in contrast to previous studies which analyse third-country effects in FDI across advanced

[1]For instance, Blonigen et al. (2007) find that spatial interrelationships are present but are stable over time. Garretsen and Peeters (2009) predominantly find a statistically significant positive spatial effect. Their results also indicate the importance of agglomeration forces for Dutch outward FDI.

OECD destination countries, we focus on bilateral FDI flows from advanced OECD countries to Central and Eastern European Countries (CEECs) and, thus, to newly industrializing economies. CEECs have received huge inflows of FDI since the fall of the iron curtain, which reflects the importance of these markets as investment opportunities for MNEs from industrialized economies. Yet, the factors and motives which lead MNEs to invest in advanced countries may be different from those to invest in emerging economies like the CEECs (see e.g., Blonigen and Davies, 2004). For instance, it is frequently shown that privatization of former state utilities is important for FDI in CEECs (e.g. Carstensen and Toubal, 2004). As further discussed in section 6.2, the privatization process also impacts on the sign and significance of the spatial correlation of FDI across origin countries.

Third, due to the incorporation of two spatial lags into the empirical model and the unbalanced panel nature of our data set, our econometric setting not only deviates from the ones applied so far in the context of third-country effects but also from LeSage and Pace (2008). This requires a non-standard estimation procedure to derive consistent parameter estimates. In particular, it involves deriving the log-likelihood function for an unbalanced spatial panel data set and applying a suitable bootstrapping technique to calculate valid standard errors.[2] The whole estimation routine, which is available from the authors upon request, might serve as a guide for future applications of spatial flow data in an unbalanced random-effects panel data setting. Furthermore, as detailed in section 6, in a setting with interdependent observations of the exploratory variable vector, regression parameters on uni- and bilateral variables do not show their actual impact on the dependent variable. In particular, spatial spillover effects have to be considered in order to isolate the actual impact of variables. We therefore follow LeSage and Pace's (2009) approach and derive "average direct effects".

Our sample comprises bilateral FDI flows from seven major OECD origin countries (AUT, GER, FRA, GBR, USA, NLD and ITA) to eight major CEE destination countries (CZE, HUN, POL, SVK, SVN, BGR, HVN and ROM) over the period from 1995 to 2004. These countries are by far the most important recipients and the most important origin countries of FDI in CEECs. Specifically, in 2006, the most recent year data for all CEECs are available, the share of the CEEC-8 in 17 CEECs' inward FDI stock was 85.4 per cent. Moreover, the share of the seven origin countries considered in the CEEC-8s' inward FDI stock was 69.2 per cent in 2006 (data derived based on the wiiw database on FDI (http://www.wiiw.ac.at)). The years 1995 and 2004 are chosen as starting and ending years due to data limitations. Specifically, bilateral FDI flow data are lacking for many countries prior to 1995 and comparable data for some relevant control variables are only available until 2004. Moreover, present-day Czech Republic and Slovakia, two important destination countries in our sample, were founded not before 1993.

The remainder of the paper is structured as follows: Section 2 discusses the relevance of spatial effects for understanding the factors and motives that lead MNEs to finance an FDI. Section 3 elaborates on the

[2] In a robustness analysis results derived from an Instrumental Variable (IV) estimator are additionally provided.

spatially augmented gravity model of FDI. Section 4 contains a description and discussion of variables and data issues. Section 5 outlines the empirical methodology applied. Section 6 contains the most important results of our analysis while section 7 summarizes the paper.

2 Third-country effects and firms' investment motives

Taking into account third-country effects may lead to important insights with respect to the factors and motives that lead MNEs to finance an FDI. This section summarizes theoretical insights about the information covered by third-country effects.

Spatial interdependencies across origin countries of FDI may arise due to the presence of two effects: a "spatial demonstration or herding effect" (related to Barry et al., 2003) and a "competition effect" (related to e.g., Brakman et al., 2009; also see Blonigen et al. 2004, p. 14). In the first case, a positive correlation in FDI across origin countries is expected: FDI from one country is seen as a device to reduce uncertainty about the locational quality among investors from other countries leading them to also invest in the CEECs (see Barba Navaretti and Venables, 2004, p. 148). In the second case, a negative correlation arises: An increase in an origin country's FDI leads to a crowding out of competitors from other countries as these face lower opportunities to invest, a lower market share and a higher competition in the goods, input or housing markets of the destination economy. Thus, this effect resembles the impact of deglomerative forces found in models of the New Economic Geography (see e.g., Brakman et al., 2009, pp. 124).

Likewise, modelling spatial correlations across destination countries informs whether "export-platform" motives are important, whether "complex-vertical" FDI considerations are given or whether FDI is purely horizontally (market-seeking) or purely vertically motivated (Blonigen et al., 2007; Garretsen and Peeters, 2009).[3]

Market-seeking FDI implies that an MNE sets up a plant in destination country j to serve this market. Thus, FDI from the origin country i to destination country j substitutes for exports from i to j. Exports from destination country j to other foreign countries are no concern in this case. Spatial correlation in FDI across destination countries should be absent for purely horizontally motivated FDI (see e.g., Garretsen and Peeters, 2009). In contrast, export-platform FDI is characterized by the fact that an MNE invests only in one destination country from where it supplies other foreign destinations via exports. A negative spatial correlation across destination countries is expected in this case.

Vertical FDI means that an MNE exploits factor price differences between the origin and the destination countries. If vertical FDI from origin country i to destination country j is at the expense of vertical FDI from i to destination country k then FDI is of pure vertical nature. Again a negative spatial correlation across destination countries is expected. If an MNE sets up its vertical chain of production across multiple

[3]Note that models based on uni- and bilateral factors are in principle capable to show whether FDI in a particular destination country is purely horizontally or purely vertically motivated. Yet, they fail to uncover complex-vertical or export-platform motives, which necessitate a multilateral perspective (see e.g., Blonigen et al. 2004, p. 2).

destination countries to exploit factor price differences, one refers to complex-vertical FDI which leads to a fragmentation of the value chain. Complex-vertical FDI results in a spatial clustering of FDI for supply reasons and, hence, a positive spatial correlation in FDI across destination countries (see e.g., Blonigen et al., 2007; Garretsen and Peeters, 2009).

One way to differentiate between the pure vertical and the export-platform FDI case, which both lead to a negative spatial correlation, is to consider a variable capturing the market size of countries surrounding a particular destination country (see Garretsen and Peeters, 2009). The surrounding market potential intends to capture demand- and supply-related location advantages provided by a large market. That is, it accounts for the fact that FDI may flow to regions with good access to (nearby) markets with high demands for goods and services or to regions with good access to (nearby) markets with major suppliers of intermediate inputs (see e.g., Baldwin and Wyplosz, 2009, pp. 395; Head and Mayr, 2004). In case of export-platform FDI the coefficient of the surrounding market potential should carry a positive sign, because large nearby markets make a particular destination country more attractive as export-platform (Garretsen and Peeters, 2009, p. 323). In contrast, the presence of a pure vertical FDI motive is indicated by a negative spatial correlation paired with an insignificant surrounding market potential. Location advantages provided by large nearby markets play no role for pure vertical FDI.

While the surrounding market potential should not matter for pure horizontal FDI, complex-vertical FDI is compatible with an insignificant or a positive coefficient on the surrounding market potential. If the surrounding market potential predominantly captures good access to markets with high demands for goods and services it should not matter for complex-vertical FDI. A positive coefficient is an indication that a higher surrounding market potential provides access to suppliers of intermediate inputs that is not fully captured by the spatial correlation in FDI. Put differently, a positive coefficient is expected if a larger surrounding market potential accounts for an increasing availability of vertical suppliers which are either local firms or firms from other origin countries (see Blonigen et al. 2004, p. 7f). Following Garretsen and Peeters (2009) we take a positive coefficient in the complex-vertical FDI case as indication for the presence of agglomeration forces.

This brief overview implies that our empirical model should contain three sources of third-country effects, namely destination and origin spatial lags, and a variable capturing the market size of countries surrounding a particular destination country of FDI. In the following section we present the econometric model which extends the traditional gravity model by these third-country effects. Table 1 summarizes the interrelationships between the two spatial lags and the surrounding market potential on the one hand and the motives to finance or not to finance an FDI on the other hand.

[Table 1 here]

3 A spatially augmented Gravity Model

The departure of our analysis is the well known gravity model. The basic gravity approach is frequently applied to study the determinants of bilateral FDI flows. It rests on the assumption that FDI flows are larger between large economies and the more so if the countries are close neighbors. Hence, FDI flows are modeled as a function of the economic masses (usually measured by the countries' GDPs) of the origin ($i = 1, \ldots, n^i$) and destination ($j = 1, \ldots, n^j$) country as well as the geographical distance between them. In its log-linear form the gravity model is represented by equation (1):

$$lnFDI_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDist_{ij} + \eta_{ijt} \quad (1)$$

where the subscript $t = 1, \ldots, T$ denotes the time period. In order to account for unobservable country-pair and time specific effects we include two-way error components disturbances, i.e.,

$$\eta_{ijt} = \mu_{ij} + \nu_t + u_{ijt}. \quad (2)$$

Time effects (ν_t) are usually modeled as fixed parameters as they are correlated with $lnGDP_{it}$ and $lnGDP_{jt}$. Including time fixed effects in the empirical model is one way to consider spatial autocorrelation in disturbances (see Elhorst, 2010, pp. 385). In order to explore the cross-sectional dimension of the panel we assume that the country-pair effects μ_{ij} are random and *i.i.d.* with $(0, \sigma_\mu^2)$. While this assumption allows to capture unobserved time-invariant country-pair specific effects it requires μ_{ij} to be uncorrelated with the observed regressors. We will verify the latter condition by means of a Hausman test. Finally, u_{ijt} denotes the stochastic remainder disturbance term which we allow to suffer from heteroskedasticity and serial correlation of unknown forms.

The basic gravity model abstracts from interdependencies across origin and destination countries. It thus ignores that "bilateral prediction do not readily extend to a multilateral world because of complex interactions [...]." (Behrens et al., 2010, p. 1) To incorporate spatial interrelationships we augment the basic gravity model given in equations (1) and (2) by adding two spatial lag variables, one for the origin and one for the destination country dimension of FDI, and a variable capturing the surrounding market potential of a particular destination country, $lnMpot_{jt}$. This variable is defined as the distance weighted market size of neighboring countries.

We consider two weight matrices W^i and W^j reflecting relations among origin and destination countries, respectively. Multiplying these matrices by our dependent variable results in the regressor vectors W^iFDI and W^jFDI. Note that W^iFDI contains $lnFDI_{-it}$ and W^jFDI includes $lnFDI_{-jt}$. Thereby -i stands for neighboring origin countries and -j for neighboring destination countries. From a substantive viewpoint

W^iFDI captures the possibility that FDI from one origin country i to a particular destination country j depends on the volume of FDI flowing from an origin country's neighbors -i to the same destination country j. Analogously, the vector W^jFDI represents the possibility that FDI flowing from a particular origin country i to a particular destination country j depends on the volume of FDI flowing from the same origin country i to a destination country's neighbors -j (LeSage and Pace, 2008).

We also consider a broad set of location factors which may have an impact on the volume of FDI an origin country finances and a destination country receives. These factors may vary over time and over the bilateral dimension (i.e., X_{ijt}), over time and destination countries (M_{jt}) or over time and origin countries (P_{it}).

Concerning the definition of the weight matrices used, we follow the literature (see e.g., Anselin, 1988) and use weights based on spatial criteria. One important advantage of these weights is that they can be regarded as exogenous with respect to the endogenous variable. Denoting the identity matrix by I, the weight matrices can be defined as follows:

$$W^i = (\mathrm{w}^i \otimes I_{n^j}) \otimes I_T \quad (3)$$

$$W^j = (I_{n^i} \otimes \mathrm{w}^j) \otimes I_T \quad (4)$$

where w^i and w^j are row-standardized matrices with dimension $n^i \times n^i$ and $n^j \times n^j$, respectively.

In our baseline specifications (cf. Table 5), the entries of w^i and w^j are constructed according to the k *nearest neighbors* concept with k equal to three (for this weight concept see, e.g., LeSage and Pace, 2009; Pinske and Slade, 1998). We rely on the k-nearest neighbors concept as it is quite similar to the widely applied contiguity concept but rules out that islands, like the UK, are not considered in the construction of W^iFDI. A contiguity weighting concept assigns an entry of one to each country pair that shares a common border. Moreover, we decide to choose only a small number of neighbors ($k = 3$) because W^iFDI and W^jFDI then exhibit a higher variability due to the sparseness of the row-standardized weight matrix. In particular, we assign a weight of 1 for countries that are among the three nearest neighbors of origin (destination) country i (j) in terms of linear distances between the countries' capital cities. Formally, the entries of the matrix w^i are defined as follows:

$$\omega_{i,-i} = \begin{cases} 1, & \text{if } -i \text{ is among the 3 nearest neighbors of origin country } i, \\ 0, & \text{otherwise.} \end{cases} \quad (5)$$

The entries of w^j are constructed analogously. As the choice of the weighting concept must be determined in advance and might have an effect on coefficient estimates, we will present results for several alterations to our weighting scheme in the robustness analysis. First, we vary k in the interval [2,4]. Second, we will apply the well-known *distance decay* concept. In this case the entry of the matrix w^i is defined as shown in equation (6):

$$\omega_{i,-i} = \begin{cases} \frac{1}{Dist^a_{i,-i}}, & \text{for } i \neq -i \\ 0, & \text{otherwise.} \end{cases} \quad (6)$$

Thereby $Dist_{i,-i}$ stands for the linear distance (in kilometers) between the capital cities of the origin countries i and $-i$. Again, the weight matrix w^j is constructed analogously. In contrast to the k nearest neighbors concept the distance decay approach incorporates the amount of all neighboring countries' FDI in the weighting matrix. Yet, higher values are assigned to countries that are close neighbors. The extent nearby countries are weighted more heavily depends on the parameter a, which we will vary in the interval [1,2].

Finally, subsuming X_{ijt}, M_{jt}, P_{it} and the constant term ι_{NT} (vector of ones) in the matrix $\overline{Z}$ and extending the core model in equations (1) and (2) by the regressors introduced so far, the spatially augmented gravity model in its matrix form is displayed in equation (7):

$$FDI = \rho^i W^i FDI + \rho^j W^j FDI + \beta_1 GDP^i + \beta_2 GDP^j + \beta_3 Dist + \overline{Z}\beta_4 + Z_\nu \nu + \tilde{\epsilon}. \quad (7)$$

FDI, GDP^j, GDP^i and $Dist$ denote vectors containing log-values of the core gravity variables included in equation (1). Time dummies are included in $Z_\nu = \iota_N \otimes I_T$ with $N = n^i * n^j$. Country-pair effects and the remainder error term are subsumed in $\tilde{\epsilon}$, where the observations are stacked such that the slower index is over country-pairs and the faster index is over time, i.e., $\tilde{\epsilon}' = (\tilde{\epsilon}_{11,t}, \ldots, \tilde{\epsilon}_{11,T}, \ldots, \tilde{\epsilon}_{n^i n^j,t}, \ldots, \tilde{\epsilon}_{n^i n^j,T})$.

4 Variables and Data Issues

4.1 Endogenous variable

FDI flows are taken from balance of payment statistics. Specifically, FDI flow data are denominated in millions of current Euro 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 which results in a balanced panel of 560 observations (56 cross-sections and ten years). However, 52 FDI flows ($\approx 9\%$) are negative (divestment) which we loose due to taking the logarithm of the dependent variable. Moreover, most right-hand side regressors enter the empirical model with one year lagged values. These latter two aspects leave us with 452 observations for estimation. Note, that our database does not contain zero bilateral FDI flows.

4.2 Core gravity variables and third-country effects

The GDP-related core gravity variables $lnGDP_{it}$ and $lnGDP_{jt}$ capture size effects: the larger the origin country of FDI the more FDI should emerge from this country; the larger the market size of a destination country the more FDI it should receive. Thus, for both variables we expect a positively signed coefficient. The third core gravity variable is the bilateral distance between capital cities of origin and destination countries ($lnDist_{ij}$). It aims to proxy transport costs as well as the institutional and cultural distance between two countries. Conceptually the expected sign of its coefficient crucially hinges on the motive for FDI, efficiency- or market-seeking FDI. In the latter case FDI substitutes for exports. A larger bilateral distance is then expected to lead to an increase in FDI. In case of efficiency-seeking FDI, which is exports generating in nature (exports from the destination to the origin country), a negative relationship is likely to arise. Yet, the latter is also the case - independently of the motive of FDI - if geographically separated countries are culturally and institutionally distant as this may result in increased monitoring and investment costs. Furthermore, market-seeking motivated foreign affiliates are frequently dependent on imports of intermediary goods from the parent company (e.g., Kleinert and Toubal, 2010). Thus, not only is the sign on the distance coefficient ambiguous *a priori* (see e.g., Carr et al., 2001). It is also not possible to conclude from a specific sign on the underlying motive for FDI.

$lnMpot_{jt}$ is calculated for each destination country as the sum of the distance weighted GDPs of Greece and Turkey as well as all Eastern European countries that share a common border with at least one of the CEEC-8. Specifically, the following countries are included in the surrounding market potential: the CEEC-8, Serbia, Bosnia-Herzegovina, Macedonia, Moldavia, Lithuania, Ukraine, Belarus, Greece and Turkey. The latter two countries are included as they also share a common border with at least one of the CEEC-8. As noted in section 2, depending on the motive for FDI, $lnMpot_{jt}$ could capture demand effects as well as agglomeration forces (also see Garretsen and Peeters, 2009). As our destination countries of FDI essentially comprise the European periphery, agglomeration effects may be of minor importance. The analysis of Disdier and Mayer (2004) indicates weaker agglomeration effects in CEECs than in EU countries over the period 1991 to 1999. Yet, they also show that differences in the determinants of FDI between "old and new EU" are vanishing over time. Put differently, as our sample period ranges until 2004 non-negligible agglomeration effects may be present even in the case of the CEECs.

Spatial correlation across origin and destination countries of FDI are captured by W^iFDI and W^jFDI. As outlined in the section 2, the coefficients of these variables convey relevant information on the motives for MNEs to finance an investment in CEECs. Their sign, significance and magnitude are of central interest here (cf. Table 1).

4.3 Control variables

Besides the core gravity variables a wide variety of location factors is considered in empirical studies elaborating on the determinants of FDI. The control variables considered here are those used in other empirical studies exploring FDI in CEECs. The expected FDI impact of the various location factors considered is isolated based on the assumption that an MNE invests were (after-tax) profits are highest (see e.g., Devereux and Griffith, 1998). Thus, the impact on marginal costs and marginal revenues is considered. However, profits also depend on any fixed costs incurred by investing in a foreign location. For example, a country's political and macroeconomic risk level may generate transaction costs that have to be covered independently of any effective production activity. Moreover, the possibilities for FDI also depend on legal stipulations towards FDI in a prospective destination country.

Specifically, the variables used and the expected sign of their impact on FDI in [] are as follows (also see Bellak et al., 2009):

(a) wage-related labor costs, $lnWages_{jt}$ [-], and (b) labor productivity, $lnLabprod_{jt}$ [+], intend to capture labor market conditions. A rise in $lnWages_{jt}$ increases, *ceteris paribus*, production costs and lowers an investment's profitability. We therefore expect a negatively signed coefficient. In contrast, via its favorable impact on production costs and thus on an investment's profitability an increase in $lnLabprod_{jt}$ should impact positively on FDI. Note that some empirical studies use a unit labor cost variable instead of $lnLabprod_{jt}$ and $lnWages_{jt}$ separately. Yet, this implies that the coefficients on the latter two variables are restricted to be equal in magnitude with opposite sign, a restriction which might not be valid empirically;

(c) annual privatization revenues, $lnPriv_{jt}$ [+], capture the privatization process in CEECs. We expect a positive sign on the estimated coefficient as a higher degree of privatization implies more investment opportunities for foreign investors; (d) consumer price inflation, $Infl_{jt}$ [?], is used as a proxy for macroeconomic risk as a high inflation rate indicates macroeconomic uncertainty which may generate transaction costs that lead to a lower level of an investment's profitability. Yet, as our dependent variable is measured in nominal terms, higher inflation may also imply larger FDI flows (see Buch and Lipponer, 2007). Thus, the sign of this variable's coefficient is ambiguous *a priori*;

(e) an indicator of forex and trade liberalization, $Forex_{jt}$ [+], is used to capture the *de jure* liberalization of trade and foreign exchange transactions. The less restrictions countries impose the higher will be the $Forex_{jt}$ score. Thus, a positively signed coefficient is expected; (f) the political risk level, $Risk_{jt}$ [+], which *inter alia* captures the likelihood of expropriation of assets and other forms of a weak institutional environment. Less political risk should lead to more FDI not least due to lower transaction costs. Yet, due to the particular definition of the measure of $Risk_{jt}$ used we expect a positively signed coefficient;

(g) in addition to $lnDist_{ij}$ and $Forex_{jt}$ tariff revenues in percent of imports, Tar_{jt} [?], are considered to proxy certain aspects of a country's *de facto* openness for trade and FDI. Conceptually the impact of high tariffs on the volume of FDI received by a country depends on the underlying motive for FDI.

Efficiency-seeking FDI may be deterred by high tariffs, while high tariffs may spur market-seeking FDI ("tariff-jumping FDI"). Yet, similar considerations as outlined in case of $lnDist_{ij}$ (e.g., also market-seeking motivated foreign affiliates may be dependent on imports of intermediary goods from the parent company) apply here. Thus, not only is the sign of this variable ambiguous *a priori*. It is also not possible to infer from a negative coefficient to the importance of vertically motivated FDI; (h) a proxy for the effective bilateral corporate income tax burden, $Beatr_{ijt}$. This variable is measured following Devereux and Griffith (2003). We expect a negatively signed coefficient on $Beatr_{ijt}$ as a higher average tax rate leads to a lower after-tax profitability of an investment. The latter should deter (infra-marginal) investments. Moreover, as the $Beatr_{ijt}$ is a weighted average of the (adjusted) statutory tax rate on corporate income and the effective marginal tax rate, a higher $Beatr_{ijt}$ might be due to an increase in the effective marginal tax rate. This implies, *ceteris paribus*, a lower scale of investments;

(i) a proxy for a destination country's endowment with production-related material infrastructure. Here we use the index established by Bellak et al. (2009) via principal component analysis ($Infra_{jt}$). This indicator comprises telecommunication, electricity and transport production facilities, which are the most important components of a country's production-related material infrastructure (see Gramlich, 1994). We expect a positive relationship between FDI and $Infra_{jt}$: Increases in the infrastructure endowment lower production costs and lead *ceteris paribus* to a higher profitability of the investment; (j) finally, the per capita GDP of the origin countries of FDI, $lnGDPcap_{it}$ [+], is used as an indicator of the capital abundance of the country (see e.g., Egger and Pfaffermayer, 2004). Under standard assumptions FDI outflows should be higher the higher the capital abundance of a country (see e.g., Razin et al., 2008). Thus we expect a positively signed coefficient.

All variables that are measured in units of Euro are log-transformed to cope with outliers. To summarize the discussion of variable and data issues, Table 2 displays details of the variables used, Table 3 shows the correlation matrix of the various location factors and Table 4 provides the descriptive statistics for the variables included in the empirical study.

[Table 2 here]

[Table 3 here]

[Table 4 here]

5 Empirical Methodology

As the embedded spatial lags (W^iFDI and W^jFDI) of our baseline model outlined in equation (7) are endogenous with respect to the error term, we follow Anselin (1988) and LeSage and Pace (2008) and obtain parameter estimates via Maximum Likelihood techniques. Due to the unbalancedness of the panel data set (cf. section 4.1) we follow Baltagi (2005, p. 167) and denote the variance-covariance matrix $E(\tilde{\epsilon}\tilde{\epsilon}') = \sigma_\nu^2 \Sigma$ as follows:

$$\Sigma = I_{\tilde{N}} + \theta Z_\mu Z_\mu' \tag{8}$$

$$Z_\mu = diag\left\{\iota_{T_{ij}}\right\} \tag{9}$$

where $\tilde{N} = \sum_{ij=1}^{N} T_{ij}$ and $\theta = \sigma_\mu^2/\sigma_u^2$. This allows to account for missing data points as the matrix Z_μ contains the N country-pairs with varying time-period lengths T_{ij}.

Denoting the vector FDI by y and defining $Z \equiv [GDP^i, GDP^j, Dist, \overline{Z}, Z_\nu]$, $\delta \equiv (\beta_1, \beta_2, \beta_3, \beta_4', \nu')'$ and $A \equiv I - \rho^i W^i - \rho^j W^j$, the log-likelihood function can be written as

$$\mathcal{L} = -\frac{\tilde{N}}{2} log(2\pi) - \frac{\tilde{N}}{2} log\sigma_u^2 - \frac{1}{2} log\,|\Sigma| - (Ay - Z\delta)'\Sigma^{-1}(Ay - Z\delta)/2\sigma_u^2 + log\,|A| \tag{10}$$

where log $|A|$ represents the Jacobian obtained when deriving the joint distribution of y. Closed form solutions for $\hat{\delta}$ and $\hat{\sigma}_u^2$ can be obtained from first-order conditions and are given by

$$\hat{\delta} = (Z'\hat{\Sigma}^{-1}Z)^{-1}Z'\hat{\Sigma}^{-1}Ay \tag{11}$$

$$\hat{\sigma}_u^2 = (Ay - Z\delta)'\hat{\Sigma}^{-1}(Ay - Z\delta)/\tilde{N}. \tag{12}$$

Yet, the relevant first-order conditions for ρ^i, ρ^j and θ are nonlinear in ρ^i, ρ^j and θ, respectively. Therefore, they have to be obtained numerically. This is accomplished by applying a gradient-based method implemented in the Optimization Toolbox of Matlab that attempts to find a minimum of the negative multivariate log-likelihood function ("fmincon"). By optimizing the function, we impose a set of equality constraints. First, we set $\theta > 0$ as in the random effects case $0 < \sigma_\mu^2 < \infty$ and $0 < \sigma_u^2 < \infty$. Second, in order to assure that the asymptotic properties for the Maximum likelihood estimates hold (i.e., to ensure that A is non-explosive), we constrain ρ^i and ρ^j to be smaller than one in absolute values and set $-1 < \rho^i + \rho^j < 1$ (see e.g., LeSage and Pace, 2009, p. 221).

To derive standard errors for the Maximum Likelihood estimates we rely on bootstrapping techniques. In the present model setting, two issues need special consideration when re-sampling techniques are implemented. First, in a Maximum Likelihood setting the *paired* bootstrap is inconvenient as it destroys the spatial structure of the data (Anselin, 1988, pp. 94). Unlike in an IV environment, spatial lags (e.g., $W^i y$) in the Maximum Likelihood case are not supplied as right-hand-side regressors with final entries but change when re-sampling from the vector y. Thus, the inherent characteristics of the data set are destroyed when drawing from $(y, W^i y, W^j y)$ equation-wise. Second, the alternative *residual* bootstrap in its usual form requires *i.i.d.* errors which is quite restrictive. Therefore, we employ the *wild* bootstrap, which provides asymptotic refinement even in the case of heteroskedastic and serially correlated residuals (see e.g., Cameron and Trivedi, 2005, p. 378).[4]

When estimating the empirical model, we apply a general to specific approach starting with the most general model containing all variables introduced above. We proceed by dropping the variables with the smallest t-value (in absolute values) one at a time until only variables that are significant in a statistical sense remain. We apply two-sided tests with a 10% significance level for all variables with an *a priori* ambigious sign (cf. Table 2). For variables which should enter the empirical model with a certain, theoretically motivated sign, we apply one-sided tests at the 5% significance level. The direction of the alternative hypothesis follows the expected sign as shown in Table 2.

The random effects assumption is tested by a bootstrapped Hausman test as developed in Cameron and Trivedi (2010). To consider that FDI flows may react to variations in location factors with a time lag (see e.g., Bevan and Estrin, 2004) we use all non-spatially lagged variables with a one year lag in the econometric analysis. Using lagged values is also capable to mitigate problems arising from reverse causality (see e.g., Wooldridge, 2001). Finally, we conduct several robustness checks with respect to the estimation technique and the definition of the weight matrices applied.

6 Results

6.1 Baseline results

This section displays our baseline results which rely on equation (7) employing the weight matrix defined in (5). First we discuss the results concerning the third-country effects. Then we touch the findings for the core gravity variables and the control variables considered. Note that time dummies are included in each specification. Also note that the bootstrapped version of the Hausman test (see Cameron and Trivedi, 2010, p. 443) indicates that the random effects assumption cannot be rejected (see $HAUS$ in Tables 5 and 6). Moreover, excluding insignificant determinants of FDI stepwise starting with the variable with the lowest t-value (i.e., $lnLabprod_{jt-1}$ in column (1) of Table 5) leads us to the model shown in column (2).[5]

Column (1) in Table 5 displays the estimation results for our full model, containing all variables. With regard to W^iFDI (and thus $lnFDI_{-it}$), columns (1) and (2) of Table 5 show that the average FDI flow of neighboring origin countries to a particular destination country has a small negative but statistically insignificant impact on the amount of FDI flows from a certain origin country to the same CEEC. Thus, the results signal the absence of herding and competition effects in FDI flows. Yet, the insignificant coefficient may also arise when the two effects cancel each other.

In contrast, we are able to establish evidence for the dependence of the volume of FDI a destination

[4]A detailed description of the wild bootstrap is outlined in appendix 8.1. The Matlab code for the whole routine is available from the authors upon request.

[5]Details on the testing down procedure are available upon request.

country receives from a particular origin country on the FDI flows from the same origin country to neighboring destination countries. The positive sign of ρ^j implies that a CEEC receives more FDI the more FDI a neighboring CEEC is able to attract. As is evident from columns (1) and (2), $lnMpot_{jt-1}$ enters the empirical model significantly with a positive coefficient. Thus, our results point to the relevance of complex-vertical FDI in total FDI flows to CEECs and the importance of agglomeration forces (see Table 1). This finding is in line with Garretsen and Peeters (2009) based on Dutch outbound FDI to a broad range of advanced OECD destination countries.

Note that the results established so far do not change when the insignificant $lnFDI_{-it}$ variable is excluded from the empirical model. Column (3) of Table 5 displays the specification where only statistically significant variables are included.

The core gravity variables $lnGDP_{it-1}$, $lnGDP_{jt-1}$ and $lnDist_{ij}$ are statistically significant with expected signs. The negatively signed coefficient on $lnDist_{ij}$ is in line with the vast majority of empirical studies based on the gravity model. Out of the control variables considered, $lnGDPcap_{it-1}$, $lnWages_{jt-1}$, $lnPriv_{jt-1}$, Tar_{jt-1}, $Beatr_{ijt-1}$ and $Infra_{jt-1}$ enter the empirical model significantly. The coefficients also carry the expected signs. Specifically, the positive coefficient on $lnGDPcap_{it-1}$ implies that more capital abundant countries undertake disproportionate more FDI. Moreover, in line with many other studies, high wage costs deter FDI while countries with a progressing privatization process receive more FDI (see e.g., Carstensen and Toubal, 2004; Bevan and Estrin, 2004). The positive and significant coefficient on Tar_{jt-1} points to the presence of "tariff-jumping" FDI. Yet, in contrast to other findings, the robustness checks contained in Tables 6 and 7 will show that this result crucially depends on model specifications.

Based on the specification displayed in column (3) of Table 5, the coefficient on $Beatr_{ijt-1}$ implies that a one percentage-point drop in $Beatr_{ijt-1}$, *ceteris paribus*, leads to an immediate increase in FDI by about 5.0%. This result is in line with the meta-analysis of DeMooji and Everdeen (2008). Furthermore, the coefficient on $Infra_{jt-1}$ implies that a one-point change in the infrastructure index results in an increase in FDI flows by about 55% which is in line with Bellak et al. (2009).

The coefficients of the remaining variables $Risk_{jt-1}$, $Forex_{jt-1}$, $lnLabprod_{jt-1}$ and $Infl_{jt-1}$ are not statistically different from zero. The results for $Infl_{jt-1}$, $Risk_{jt-1}$ and $Forex_{jt-1}$ imply that our destination countries are countries with already low levels of macroeconomic and political risks as well as low legal obstacles for trade and capital flows. These findings are not unexpected, as the destination countries in our sample are the most economically and politically developed CEECs. Moreover, our estimations also suggest that FDI is not driven by differences and changes in labor productivity. Although this result is in line with Holland and Pain (1998) it is somewhat unexpected. However, it is consistent with the view that MNEs are able to transfer their origin market productivity levels into the CEE destination markets, which, in turn, is consistent with the evidence that "labour productivity in foreign subsidiaries of MNEs is higher than in domestic firms". (Barba Navaretti and Venables, 2004, p. 158).

Yet, when interpreting regression results based on models containing spatial interaction variables one has to keep in mind that the immediate effects of variables shown by the "normal" regressions coefficients neglect "feedback loops" arising from the presence of $lnFDI_{-it}$ and $lnFDI_{-jt}$ (see LeSage and Pace, 2009, p. 35). Average direct effects capture these feedback loops. Column (4) of Table 5 displays the average direct effects derived from the specification given in column (3).[6] For instance, for $Beatr_{ijt-1}$ and $Infra_{jt-1}$ these average direct effects are -0.051 and 0.56. Thus, they differ only slightly from the regression coefficients. This is not unexpected given the rather low coefficient of 0.203 on $lnFDI_{-jt}$.

Finally, column (5) of Table 5 shows the result when the two statistically significant third-country variables, $lnMpot_{jt-1}$ and $lnFDI_{-jt}$, are dropped. Comparing the coefficients displayed in column (3) and column (5) reveals that our conclusions with respect to the control variables are rather robust to the inclusion of third-country effects.

[Table 5 here]

6.2 Robustness analysis

Although our results are robust with respect to the exclusion of variables they may nevertheless crucially hinge upon the estimator employed (i.e. Maximum likelihood principle paired with a normality assumption) and on the definition of the weight matrix. Moreover, one can argue that the demonstration (herding) and competition effects are independent of the geographical closeness of countries. For example, German FDI in the CEEC-8 could be equally affected - through either demonstration or competition effects - by FDI emerging from the United Kingdom as it is affected from FDI emerging from neighboring Austria. In this case, using contiguity or distance weights may be misleading. To cope with this issue we explore how results change if we define W^i as uniform weight matrix which gives each origin country equal weight. Furthermore, as shown by Bellak and Leibrecht (2009) privatization, which involves the transfer of the assets of state-owned companies to domestic or foreign investors, is a particularly important driver of FDI until the year 2000 (also see Roberts et al. (2008)). Hence, privatisation often leads to cross-border Mergers and Acquisitions (Roberts et al., 2008). Yet, if FDI that finances M&A due to privatizations is important in total FDI, huge FDI outflows from one particular origin country may be paired with low outflows from the other origin countries at the same time, pointing to a competition effect. Put differently, due to the importance of the privatization process in the early years of our sample, we might observe a negative coefficient of $lnFDI_{-it}$ in the respective period. To test this presumption we re-estimate the specification given in column (2) of Table 5 for the years 1995-2000.

Table 6 and Table 7 summarize these robustness checks. Note that we include $lnFDI_{-it}$ in most robustness checks as one may argue that the importance of this variable changes with the definition of

[6] Appendix 8.2 explicates how these average direct effects are derived based on equation (2.43) given in LeSage and Pace (2009). Note, that standard errors for average direct effects are derived via a bootstrap approach.

the weight matrix and / or the econometric estimator applied. The first two columns of Table 6 show the results when the models contained in columns (1) - (3) of Table 5 are estimated via IV techniques with bootstrapped standard errors.[7] Thereby $lnFDI_{-jt}$ and $lnFDI_{-it}$ are instrumented by employing the variables suggested by Kelejian and Prucha (1998). That is, we use spatial lags of all exogenous regressors contained in the various models as excluded instruments.

With respect to size and sign of the estimated coefficients the IV results are qualitatively similar to the Maximum likelihood estimates. However, the statistical significance of $lnGDP_{it-1}$, $lnMpot_{jt-1}$ and Tar_{jt-1} is reduced in the IV case. This may indicate the inefficiency of the IV estimator compared to the Maximum Likelihood approach.

Note that the serial correlation and heteroskedasticity robust F tests for weak instruments (one for each endogenous variable) reject the null hypothesis of weak instruments. This result is reinforced by the Kleibergen and Paap weak identification test statistic. Moreover, the Hansen J statistic for over-identification does not reject the null hypothesis of joint validity of the employed exogenous instruments. Finally, a Wald-test shows that time dummies are jointly highly statistically significant.

The remaining columns of Table 6 and the first two columns of Table 7 display results when we alter the definition of the weight matrix W. Estimates are based on the Maximum Likelihood estimator. In particular, columns (4) and (5) rely on the same weighting scheme (k *nearest neighbors*) but consider the 2 and 4 nearest countries to be neighbors. Results displayed in columns (1) and (2) of Table 7 are based on the distance decay weighting concept which leads to a full weight matrix. Column (1) sets a of equation (6) equal to 1 and column (2) sets $a = 2$. Again, most results are robust to the definition of the weight matrices. Specifically, $lnFDI_{-it}$ remains statistically insignificant throughout. Moreover, Tar_{jt-1} is statistically insignificant in case of $k = 2$, $a = 1$ and $a = 2$.

Column (3) of Table 7 shows that results remain unaltered when a uniform weight matrix is used to define W^i. This confirms the impression that spatial autocorrelation across origin countries is absent over the whole sample period. However, column (4) includes the estimates for the reduced sample period (1995-2000). The negatively signed coefficient of $lnFDI_{-it}$ now achieves statistical significance. This result is consistent with the presence of competition effects due to the importance of the privatization process for FDI during the early years of our sample period.

Note that the coefficient on $lnMpot_{jt}$ keeps its positive sign but falls short of statistical significance. Thus, only weak evidence in favour of agglomeration effects in the early transition period is given. The result of an increased importance of agglomeration forces over time is consistent with Disdier and Mayer (2004).

Finally note that the robustness checks also suggest that the empirical evidence in favor of tariff-jumping as motive for FDI in CEECs is rather weak as the statistically significance of Tar_{jt-1} crucially

[7] Estimations are carried out using the xtivreg command (with the vce(boot) option) of Stata 11.1.

depends on the definition of the two weight matrices W^i and W^j.

[Table 6 here]

[Table 7 here]

7 Summary and Conclusions

This paper models bilateral FDI flows from industrialized to emerging countries based on a spatially augmented gravity model. We add to the literature by isolating substantive information about the motives of MNEs to invest abroad, which can be derived from spatial interrelationships in FDI. Unlike former studies dealing with third-country effects, we model spatial autocorrelation not only across the destination country dimension but also across the origin country dimension of FDI. Drawing on recently developed spatial econometric techniques, we obtain the following results:

1. Spatial interactions across the destination country dimension matter for FDI;
2. Vertical-complex FDI is important in total FDI to the CEEC-8 as the coefficient of the destination based spatial lag variable is positively signed;
3. Evidence in favor of spatial autocorrelation across origin countries is rather weak. We find spatial autocorrelation in the early years of our sample period (1995 to 2000). In this subsample the corresponding spatial lag coefficient turns statistically significant with a negative sign. This result is interpreted as indicating competition effects across origin countries due to the importance of cross-border M&A induced by the privatization process in the earlier years of transformation. For the whole sample period the negative coefficient falls short of statistical significance. This is consistent with the view that demonstration (herding) effects cancel competition effects over the years 1995 to 2004;
4. Agglomeration forces are becoming increasingly important for FDI in the CEEC-8.

Thus, although - in our application - coefficients of "standard" location factors change only slightly when spatial interdependencies are not considered, the exclusion of third-country effects, that is, the exclusion of spatial lags in FDI and the surrounding market potential, would lead to a loss of valuable information concerning the factors and motives that lead MNEs to finance an investment abroad.

Finally, we want to emphasize that our analysis is based on a rather narrow set of origin and destination countries of FDI. A promising avenue for further research therefore would be to extend the analysis to capture a broader range of countries and years. Moreover, recent empirical analyzes show that the determinants of FDI may crucially depend on the industrial sector (see e.g., Riedl, 2010). Thus, applying the spatially augmented gravity model considered here at a more disaggregated level seems to be another avenue for further research. However, at least for the CEECs, bilateral FDI data at the industry level are still lacking.

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8 Appendix

8.1 The wild bootstrap

After maximizing the log-likelihood function outlined in equation (10) we obtain the estimated parameter vector $\hat{\phi} = (\hat{\rho}^i, \hat{\rho}^j, \hat{\theta}, \hat{\delta}')'$ and calculate the residuals $\hat{\tilde{\epsilon}} = \hat{A}y - X\hat{\delta}$ where $\hat{A} = I - \hat{\rho}^i W^i - \hat{\rho}^j W^j$. Note that, the residual vector $\hat{\tilde{\epsilon}}$ consists of the individual ($\hat{\mu}$) and the remainder error component ($\hat{u}$). Hence, in order to bootstrap the remainder error $\hat{u}$, we have to purge the error term $\hat{\tilde{\epsilon}}$ from the individual effects component $\hat{\mu}$. We do this by following Baltagi (2005, p. 20) and arrive with the expression for the remainder error $\hat{u} = (I_{\tilde{N}} - \hat{\theta} Z_\mu Z'_\mu \hat{\Sigma}^{-1})\hat{\tilde{\epsilon}}$ which accounts for the unbalancedness of our data set. The wild bootstrap replaces $\hat{u}_{ijt}$ by the following residual (see Cameron and Trivedi, 2005, p. 377):

$$\hat{u}^*_{ijt} = \begin{cases} \frac{1-\sqrt{5}}{2}\hat{u}_{ijt}, & \text{with probability: } \frac{1+\sqrt{5}}{2\sqrt{5}} \\ (1 - \frac{1-\sqrt{5}}{2})\hat{u}_{ijt}, & \text{with probability: } 1 - \frac{1+\sqrt{5}}{2\sqrt{5}} \end{cases} \quad (13)$$

which has zero conditional mean. From B bootstrap realizations of $\hat{u}^*_{ijt}$, one obtains B different realizations of $y^*_{ijt} = \hat{A}^{-1}(Z\hat{\delta} + \hat{\mu}_{ij} + \hat{u}^*_{ijt})$. Based on the new bootstrap sample, we proceed by estimating B different $\hat{\phi}^*$ from which we can calculate the standard errors as $\widehat{se} = \left\{\frac{1}{B-1}\sum(\hat{\phi}^*_b - \overline{\phi})^2\right\}^{1/2}$, where $\hat{\phi}^*_b$ is the calculated parameter vector of the bth bootstrap sample, B equals the number of replications and $\overline{\phi} = \frac{1}{B}\sum\hat{\phi}^*_b$.

8.2 Average direct effects

Due to the cross-section dependence implied by the model $y = \rho^i W^i y + \rho^j W^j y + Z\delta + \tilde{\epsilon}$, the impact of a change in Z on y is not δ as in standard OLS regressions but can be derived from the transformed model $y = A^{-1}(Z\delta + \tilde{\epsilon})$ with $A = I_{\tilde{N}} - \rho^i W^i - \rho^j W^j$. Specifically, the impact of a change in the rth variable of Z equals $A^{-1}(I_{\tilde{N}}\delta_r)$. Hence, the derivative of y with respect to Z_r results in a matrix with dimension $\tilde{N} \times \tilde{N}$. From this expression, one can calculate a summary measure proposed by LeSage and Pace (2009) to obtain the direct effect, i.e., the impact of changes in the ijt observation of Z_r (Z_{ijtr}) on y_{ijt}. This measure is given by $\delta^*_r = \tilde{N}^{-1}\text{trace}[A^{-1}(I_{\tilde{N}}\delta_r)]$ which is simply the average of the diagonal entries contained in $A^{-1}(I_{\tilde{N}}\delta_r)$. This value can then be interpreted like a usual regression coefficient in least-squares, namely, as the "average response of the dependent to independent variables over the sample of observations" (LeSage and Pace, 2009, p. 37).

Table 1: Expected sign for spatial lags and market potential

	ρ^j	β	ρ^i
Pure market-seeking (horizontal) FDI	0	0	
Pure vertical FDI	-	0	
Export-platform FDI	-	+	
Complex-vertical FDI	+	0/+	
Demonstration (herding) effect			+
Competition effect			-

Notes: Based on Garretsen and Peeters (2009); ρ^j = coefficient on destination country spatial lag; ρ^i = coefficient on origin country spatial lag; β = coefficient on surrounding market potential; 0 = regression coefficient not statistically significant; +/- = positively / negatively signed regression coefficient.

Table 2: Definition of variables and expected signs

Abbreviation	Data Source	Variable	Expected Sign
$lnGDP_{it-1}$	New Cronos database	origin country size measured as GDP origin country in mn. Euro	+
$lnGDP_{jt-1}$	New Cronos database	destination market size measured as GDP destination country in mn. Euro	+
$lnGDPcap_{it-1}$	New Cronos database (GDP and Euro-PPP); Ameco database (population)	GDP of origin country in Euro-PPP per capita	+
$lnDist_{ij}$	CEPII	Distance in kilometers	?
$lnWages_{jt-1}$	Ameco and WIIW databases	Labor costs per employee measured as labor compensation per employee in Euro	−
$lnProd_{jt-1}$	New Cronos (GDP) and WIIW (Euro-PPP) databases	Labor productivity measured as GDP in Euro-PPP over employment	+
$lnPriv_{jt-1}$	Own calculations; EBRD: Transition Reports	Annual privatization revenues in mn. Euro	+
$Risk_{it-1}$	Euromoney	Political risk index ranging from 0 (highest risk level) to 25	+
$Infl_{jt-1}$	EBRD: Transition Reports	Inflation measured as the percentage increase in consumer prices	?
Tar_{jt-1}	EBRD: Transition Reports	Ratio of taxes and duties on imports excluding VAT over imports of goods and services; in percent	?
$Forex_{jt-1}$	EBRD: Transition Reports	Indicator of the liberalization of trade and international monetary transactions and payments	+
$lnFDI_{-jt}$	Own calculations	Spatial lag in the destination country dimension	?
$lnFDI_{-it}$	Own calculations	Spatial lag in the origin country dimension	?
$Infra_{jt-1}$	Bellak et al. (2009)	Index for the endowment with production-related material infrastructure (transport, ICT- and electricity generation infrastructure)	+
$Beatr_{ijt-1}$	Bellak et al. (2009)	bilateral effective average tax rate on corporate income	−
$lnMpot_{jt-1}$	Own calculations	Surrounding market potential of destination countries	+ / 0

Table 3: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
$lnGDPcap_{it-1}$ (1)	1.00															
$lnGDP_{jt-1}$ (2)	0.19	1.00														
$lnDist_{ij}$ (3)	0.32	0.02	1.00													
$lnWages_{jt-1}$ (4)	0.23	0.27	-0.20	1.00												
$Beatr_{ijt-1}$ (5)	-0.18	0.09	0.06	-0.35	1.00											
$lnPriv_{jt-1}$ (6)	0.21	0.66	0.03	-0.01	0.05	1.00										
$Infra_{jt-1}$ (7)	0.41	0.15	-0.18	0.81	-0.30	0.04	1.00									
$lnGDP_{it-1}$ (8)	0.32	0.06	0.74	0.04	-0.04	0.04	0.08	1.00								
$lnMpot_{jt-1}$ (9)	0.67	0.32	-0.05	0.52	-0.24	0.28	0.70	0.14	1.00							
$Risk_{it-1}$ (10)	0.21	0.53	-0.16	0.70	-0.08	0.34	0.78	0.06	0.49	1.00						
$lnProd_{jt-1}$ (11)	0.32	0.26	-0.22	0.90	-0.31	0.09	0.88	0.06	0.61	0.79	1.00					
Tar_{jt-1} (12)	-0.32	-0.59	0.12	-0.51	-0.06	-0.39	-0.52	-0.07	-0.62	-0.66	-0.57	1.00				
$Infl_{jt-1}$ (13)	-0.13	-0.22	0.06	-0.37	0.11	-0.05	-0.23	-0.04	-0.32	-0.25	-0.30	0.29	1.00			
$Forex_{jt-1}$ (14)	0.36	0.27	-0.05	0.44	-0.21	0.28	0.52	0.08	0.53	0.39	0.36	-0.32	-0.20	1.00		
$lnFDI_{-jt}$ (15)	0.17	0.03	-0.34	-0.04	-0.21	-0.02	-0.04	-0.22	0.13	-0.06	-0.03	-0.08	0.00	0.01	1.00	
$lnFDI_{-it}$ (16)	-0.02	0.61	0.06	0.04	0.26	0.56	-0.03	0.07	0.06	0.28	0.03	-0.31	-0.10	0.18	-0.16	1.00

Table 4: Descriptive statistics

		Mean	Std.Dev	Min	Max
$lnFDI_{ijt}$	overall	4.24	1.73	-1.20	8.44
	between	1.42	1.64	7.22	
	within	1.05	0.49	7.75	
$lnGDPcap_{it-1}$	overall	10.06	0.15	9.75	10.41
	between	0.11	9.93	10.33	
	within	0.11	9.81	10.30	
$lnGDP_{jt-1}$	overall	24.25	0.81	22.80	26.08
	between	0.77	23.18	25.80	
	within	0.22	23.76	24.79	
$lnDist_{ij}$	overall	7.00	0.99	4.04	9.15
	between	1.00	4.04	9.15	
	within	0.00	7.00	7.00	
$lnWages_{jt-1}$	overall	8.58	0.60	7.18	9.76
	between	0.56	7.63	9.57	
	within	0.25	7.98	9.09	
$Beatr_{ijt-1}$	overall	33.51	8.15	5.19	56.20
	between	6.71	12.16	48.60	
	within	4.86	17.78	47.32	
$lnPriv_{jt-1}$	overall	20.32	1.26	17.87	22.85
	between	1.02	18.34	21.75	
	within	0.77	16.86	22.27	
$Infra_{jt-1}$	overall	-0.14	0.96	-2.27	1.90
	between	0.76	-1.44	1.18	
	within	0.58	-1.19	1.05	
$lnGDP_{it-1}$	overall	27.72	1.12	25.93	30.06
	between	1.13	26.01	29.88	
	within	0.15	27.29	28.04	
$lnMpot_{jt-1}$	overall	21.21	1.60	17.94	23.43
	between	0.57	20.02	22.27	
	within	1.50	18.35	23.99	
$Risk_{it-1}$	overall	13.86	3.37	5.32	19.82
	between	2.95	9.34	17.33	
	within	1.66	7.98	17.65	
$lnProd_{jt-1}$	overall	22.57	6.53	11.36	36.22
	between	5.56	13.29	30.62	
	within	3.49	15.07	30.44	
Tar_{jt-1}	overall	4.37	3.85	0.5	18.45
	between	3.16	1.06	12.13	
	within	2.27	-0.09	13.45	
$Infl_{jt-1}$	overall	27.24	112.41	-1.80	971.08
	between	44.18	1.36	170.81	
	within	103.66	-142.40	864.61	
$Forex_{jt-1}$	overall	4.21	0.20	3	4.3
	between	0.08	4.029	4.3	
	within	0.18	3.11	4.48	
$lnFDI_{-jt}$	overall	3.78	1.47	0	7.04
	between	1.06	1.70	5.89	
	within	1.03	-1.54	5.99	
$lnFDI_{-it}$	overall	4.08	1.37	0.54	7.37
	between	1.01	2.17	6.22	
	within	0.92	0.31	6.45	
Obs = 452	n = 56	T=8.07			

Table 5: Baseline results

	FULL MLE	DT-EX MLE	PREF MLE	ADE	PLAIN MLE
$lnFDI_{-jt}$	0.203***	0.199***	0.203***		
	(0.035)	(0.035)	(0.036)		
$lnFDI_{-it}$	-0.0478	-0.042			
	(0.035)	(0.034)			
$lnGDPcap_{it-1}$	2.021***	2.085***	2.124***	2.141***	2.949***
	(0.516)	(0.497)	(0.499)	(0.501)	(0.895)
$lnGDP_{jt-1}$	1.331***	1.236***	1.199***	1.209***	1.170***
	(0.127)	(0.111)	(0.103)	(0.104)	(0.159)
$lnDist_{ij}$	-0.574***	-0.585***	-0.589***	-0.594***	-0.821***
	(0.074)	(0.069)	(0.070)	(0.069)	(0.157)
$lnWages_{jt-1}$	-1.146***	-1.033***	-1.019***	-1.028***	-1.018***
	(0.201)	(0.149)	(0.146)	(0.147)	(0.264)
$Beatr_{ijt-1}$	-0.049***	-0.050***	-0.050***	-0.050***	-0.054***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.010)
$lnPriv_{jt-1}$	0.295***	0.282***	0.270***	0.272***	0.269***
	(0.061)	(0.060)	(0.058)	(0.058)	(0.062)
$Infra_{jt-1}$	0.751***	0.555***	0.551***	0.555***	0.468**
	(0.146)	(0.098)	(0.096)	(0.097)	(0.195)
$lnGDP_{it-1}$	0.198***	0.202***	0.201***	0.203***	0.271**
	(0.053)	(0.053)	(0.053)	(0.053)	(0.128)
$lnMpot_{jt-1}$	0.317**	0.292**	0.269**	0.272**	
	(0.150)	(0.147)	(0.142)	(0.143)	
$Risk_{it-1}$	-0.052				
	(0.036)				
Tar_{jt-1}	0.038*	0.039*	0.036*	0.036*	-0.001
	(0.022)	(0.021)	(0.021)	(0.021)	(0.028)
$Infl_{jt-1}$	-0.000				
	(0.001)				
$Forex_{jt-1}$	0.076				
	(0.208)				
$lnProd_{jt-1}$	0.066				
	(0.418)				
$cons$	-52.983	-51.572***	-44.994***		-49.944***
	(6.215)	(6.251)	(5.167)		(9.629)
σ_u^2	0.88	0.89	0.89		0.98
TD (χ^2 (8))	28.55***	29.49***	29.01***		33.36***
$LogL$	-654.78	-655.57	-655.96		-669.43
$HAUS$ (χ^2 in ())	(23): 17.16	(19): 17.76	(18): 15.44		

Notes: estimation period 1995-2004; MLE = Maximum likelihood estimator; FULL = model including all discussed variables; PREF= preferred model; DT-EX = Full model less insignificant determinants of FDI; ADE = Average direct effects for PREF, calculated based on the information given in appendix 8.2; PLAIN = traditional gravity model without third-country effects; fully robust (bootstrapped with 1000 replications) standard errors in parenthesis (except for column (5) where analytic standard errors are given); σ_u^2 = variance of remainder error term; TD = test on joint significance of time dummies; LogL = Log Likelihood value; HAUS = bootstrapped version of Hausman test based on the IV-estimator and 1000 replications; *** / ** / * = statistical significance at 1 / 5 / 10% significance level; the 10% significance level is relevant only for two-sided tests which are conducted for variables with *a priori* ambigous sign (cf. Table 2); one-sided tests are conducted on 1% and 5% significance levels.

Table 6: Robustness checks

	FULL IV	DT-EX IV	PREF IV	K2 MLE	K4 MLE
$lnFDI_{-jt}$	0.250***	0.247***	0.250***	0.167***	0.224***
	(0.065)	(0.062)	(0.062)	(0.030)	(0.040)
$lnFDI_{-it}$	-0.0489	-0.055		-0.023	-0.047
	(0.071)	(0.066)		(0.028)	(0.042)
$lnGDPcap_{it-1}$	1.772**	1.815**	1.893**	2.123***	2.080***
	(1.065)	(1.038)	(1.025)	(0.492)	(0.502)
$lnGDP_{jt-1}$	1.360***	1.252***	1.202***	1.208***	1.254***
	(0.120)	(0.186)	(0.181)	(0.108)	(0.112)
$lnDist_{ij}$	-0.516***	-0.529***	-0.534***	-0.634***	-0.575***
	(0.166)	(0.165)	(0.163)	(0.068)	(0.069)
$lnWages_{jt-1}$	-1.208***	-1.023***	-1.002***	-0.938***	-1.103***
	(0.310)	(0.259)	(0.254)	(0.149)	(0.151)
$Beatr_{ijt-1}$	-0.045***	-0.046***	-0.046***	-0.052***	-0.047***
	(0.012)	(0.011)	(0.011)	(0.007)	(0.007)
$lnPriv_{jt-1}$	0.300***	0.285***	0.270***	0.269***	0.274***
	(0.093)	(0.088)	(0.088)	(0.060)	(0.064)
$Infra_{jt-1}$	0.806***	0.597***	0.585***	0.464**	0.545***
	(0.287)	(0.199)	(0.195)	(0.095)	(0.099)
$lnGDP_{it-1}$	0.180	0.187	0.188	0.218***	0.194***
	(0.115)	(0.118)	(0.117)	(0.030)	(0.052)
$lnMpot_{jt-1}$	0.357	0.322	0.288	0.263**	0.323**
	(0.279)	(0.278)	(0.278)	(0.146)	(0.148)
$Risk_{it-1}$	-0.066				
	(0.049)				
Tar_{jt-1}	0.046	0.046	0.042	0.030	0.038*
	(0.034)	(0.033)	(0.034)	(0.021)	(0.022)
$Infl_{jt-1}$	-0.000				
	(0.001)				
$Forex_{jt-1}$	0.118				
	(0.288)				
$lnProd_{jt-1}$	0.014				
	(0.037)				
cons	-49.316***	-48.047***	-47.000***	-51.091***	-45.390***
	(10.286)	(10.130)	(10.457)	(6.349)	(5.332)
σ_u^2	0.92	0.96	0.96	0.89	0.89
TD (χ^2 (8))	37.5***	42.29***	44.57***	28.77***	28.19***
$LogL$				-657.40	-655.48
$HAUS$ (χ^2 in ())	(23): 17.16	(19): 17.76	(18): 15.44		
$HANS$ (χ^2 in ())	(25): 18.69	(18): 12.33	(9): 9.214		
$KLEP$	45.36	47.05	142.30		
CD	20.79	20.48	20.74		
$F1$ ($lnFDI_{-jt}$)	105.99***	97.95***	142.32***		
$F2$ ($lnFDI_{-it}$)	50.93***	49.95***			

Notes: estimation period 1995-2004; fully robust (bootstrapped with 1000 replications) standard errors in parenthesis; IV = Instrumental variable estimator; MLE = Maximum likelihood estimator; FULL = model including all discussed variables; DT-EX = Full model less insignificant determinants of FDI; PREF= preferred model; $K = 2$ (4) = weight matrix based on 2 (4) nearest neighbors; σ_u^2 = variance of remainder error term; TD = test on joint significance of time dummies; LogL = Log Likelihood value; HAUS = bootstrapped version of Hausman test based on the IV-estimator and 1000 replications (same values as in Table 5); HANS = Hansen-J-test for over-identification; KLEP = Kleibergen-Paap test statistic for weak identification; CD = Cragg-Donald 5% critical value; F1 (F2): test on joint significance of Kelejian and Prucha type instruments in first stage regression; IV-estimates are based on Stata's xtivreg command (with the vce(boot) option); *** / ** / * = statistical significance at 1 / 5 / 10% significance level; the 10% significance level is relevant only for two-sided tests which are conducted for variables with *a priori* ambigous sign (cf. Table 2); one-sided tests are conducted on 1% and 5% significance levels.

Table 7: Further robustness checks

	$dist^{-1}$ MLE	$dist^{-2}$ MLE	K6 MLE	2000 MLE
$lnFDI_{-jt}$	0.253***	0.218***	0.200***	0.183***
	(0.046)	(0.040)	(0.035)	(0.045)
$lnFDI_{-it}$	-0.052	-0.026	-0.047	-0.125**
	(0.047)	(0.037)	(0.049)	(0.060)
$lnGDPcap_{it-1}$	2.148***	2.128***	2.130***	2.273***
	(0.497)	(0.498)	(0.489)	(0.458)
$lnGDP_{jt-1}$	1.250***	1.198***	1.245***	1.764***
	(0.120)	(0.114)	(0.118)	(0.163)
$lnDist_{ij}$	-0.566***	-0.577***	-0.581***	-0.713***
	(0.071)	(0.071)	(0.069)	(0.074)
$lnWages_{jt-1}$	-0.993***	-0.942***	-1.043***	-1.321***
	(0.153)	(0.151)	(0.152)	(0.158)
$Beatr_{ijt-1}$	-0.047***	-0.048***	-0.050***	-0.058***
	(0.007)	(0.007)	(0.007)	(0.007)
$lnPriv_{jt-1}$	0.278***	0.267***	0.283***	0.212***
	(0.063)	(0.059)	(0.062)	(0.077)
$Infra_{jt-1}$	0.481***	0.459***	0.562***	0.753***
	(0.096)	(0.096)	(0.100)	(0.122)
$lnGDP_{it-1}$	0.196***	0.197***	0.197***	0.303***
	(0.053)	(0.053)	(0.052)	(0.054)
$lnMpot_{jt-1}$	0.276**	0.243**	0.295**	0.195
	(0.149)	(0.148)	(0.149)	(0.161)
Tar_{jt-1}	0.033	0.029	0.039*	0.092***
	(0.022)	(0.021)	(0.022)	(0.022)
$cons$	-46.862***	-50.423***	-52.148***	-59.905***
	(5.288)	(6.543)	(6.331)	(5.542)
σ_u^2	0.88	0.88	0.89	0.69
TD (χ^2 (8))	25.05***	24.82***	28.49***	4.28
$LogL$	-655.13	-654.75	-655.68	-351.896

Notes: estimation period 1995-2004; fully robust (bootstrapped with 1000 replications) standard errors in parenthesis; MLE = Maximum likelihood estimator; $dist^{-1}$ and $dist^{-2}$ = weight matrix based on distance decay concept; $K = 6$ = weight matrix based on 6 nearest neighbors which implies uniform weight matrix; 2000 = sample ranging from 1995 to 2000 to exploit impact of privatization process on spatial autocorrelation across the origin country dimension; σ_u^2 = variance of remainder error term; TD = test on joint significance of time dummies; LogL = Log Likelihood value; *** / ** / * = statistical significance at 1 / 5 / 10% significance level; the 10% significance level is relevant only for two-sided tests which are conducted for variables with *a priori* ambigous sign (cf. Table 2); one-sided tests are conducted on 1% and 5% significance levels.

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