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ABSTRACT

The tradition of gravity models is in the analysis of trade flows with market size and geographic or economic distance as core variables. Both these variables can be important determinants of FDI, too. However, when such models are used to explain FDI, there can be differences in the mode of operation of these variables so that the interpretation can become uncertain. Market size can reach beyond the host country and distance can be an incentive as well as an impediment to FDI.

In the present paper, we use gravity-type models in order to assess the level of German FDI in CEE countries, distinguishing between the four nearby core countries and the other six EU accession countries. Estimates are done both on the basis of an in-sample as well as an out-of-sample approach on the basis of FDI in 81 important host countries. From the various specifications it becomes obvious that (1) beside the size of the host country, the market potential of neighboring countries is an important determinant of the regional structure of German FDI, and (2) the costs of operating at a distance seem to be weighted higher than the advantage of being close to distant markets. Geographic distance seems to be more important than various measures of economic distance. On the whole, gravity-type models seem to be appropriate to explain the regional structure of FDI. However, the results should be interpreted with caution given the extremely wide confidence intervals of the estimates which is a feature of former studies, too.

JEL classification: F200, F230
Keywords: Foreign Direct Investment, Gravity Model, Transformation Countries

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1 THE ISSUE

With the opening up of the Central and Eastern European countries (CEEC) and the perspective of accession to the EU, inward FDI has increased sharply in the region. German firms were among the forerunners. From 1995 to 2002, production of German affiliates in the region have more than tripled: With roughly 7% of total German production abroad, CEE locations have developed into a more than marginal production site. This notably refers to the largest and nearby economies Hungary, Poland, Czech Republic and Slovakia. Foreign investors have put a particular focus on that region especially in certain industries, such as traditional consumer goods, cars, trade and public utilities (Borrmann/Jungnickel/Keller 2005).

The exceptional constellation of FDI conditions and the rapid development of German FDI, as well as FDI from other countries, raises the question, how the current level and future prospects are to be assessed:

- Has there been reached some sort of „normal“ level of FDI in the East, or
- will the extraordinary growth rates of FDI continue in future, not least as a result of deeper EU integration, or
- has there already been an overshooting of FDI which will finally result in lower growth rates?

To answer these questions, the assumption has to be made that there actually exists something like a „normal“ position of FDI. This could be defined on the basis of the average of FDI in other countries with country-specific factors controlled for. Gravity models are often used to this end. In this paper, we address the question to what extent such models, both in traditional structure and in more sophisticated and modified versions - “gravity model-like regressions” - can contribute to assess the position of CEE countries in foreign production of German firms and discuss what such models can suggest about the future development of FDI in this region.

2 GRAVITY MODELS

Originally, gravity models were used to explain bilateral trade flows between countries in analogy of Newton’s law of gravitation (Breuss/Egger 1997, pp. 3). Basically, gravitation comes about by the attraction of two masses with distance reducing this effect. Applied to bi-

lateral trade flows, the pull forces are represented by the size of the economies concerned, measured by GDP or population, while distance is proxied either by kilometers, transportation costs or, more generally, transaction costs.

The basic gravity equation as formulated by Breuss/Egger (1997), based upon Linnemann (1966, pp. 34) is:

$$X_{ij} = e^{\beta_0} Y_i^{\beta_1} N_i^{-\beta_2} Y_j^{\beta_3} N_j^{-\beta_4} D_{ij}^{-\beta_5} e^{\sum_k \gamma^k P_{kij}}$$

with the following notations:

X_{ij} = trade flow from country i (country of origin) to country j (destination)
Y = gross national product of the two countries involved
N = population[1]
D = geographical distance
P = preferential-trade factor.[2]

The Linnemann equation was adjusted by various authors to theoretical advances[3] and the core gravity variables size and distance were complemented by more specific elements. Consequently, researchers have used various specifications of factor endowment of the countries concerned as well as transaction-cost-related variables, such as common language, common border, general openness of destination country to foreign competition, etc.[4] What is called "gravity model", therefore, often goes beyond the core idea of such models, namely to take into account the size of the economies concerned and their distance.

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1 Linnemann used population as an indicator of self-sufficiency increasing with population. Hence the negative sign of this variable in the original equation.

2 By including trade preferences, this equation goes beyond the simple measurement of geographic distance. P_{kij} is the dummy variable representing the k^{th} preference relationship between countries i and j.

3 The New Trade Theory (Helpman 1987; Bergstrand 1990) as well as various other models, including Ricardian, Heckscher-Ohlin, and models of monopolistic competition with increasing returns to scale and product differentiation (Evenett/Keller 2002, p. 282) provided theoretical foundations for taking into account further determinants.

4 It is sometimes criticized, on theoretical reasons, that the variables included in tested equations would seldom be derived from one specific trade model, but are rather based upon ad hoc specifications „Although considerable attempts have been undertaken to underpin the gravity approach with standard and modern international trade theory ,...., when it comes down to econometric estimations, the theoretically postulated variables (e.g. capital-labour ratio or trade costs, tariffs) are approximated with the same simple aggregate variables (income, per capita income, distance, preference dummies) as at the beginning of the research in that field." (Breuss/Egger 1997, p. 6). Such criticism is, however, not important in the context of this paper.

Such gravity-type-models, i.e. traditional gravity models modified by other theoretically relevant factors, turned out to be quite successful[5] in explaining bilateral trade flows (Görg/Greenaway 2002). Recently, they have also been used to analyze FDI. Central issues discussed in this context are

- the relation between trade and FDI (Africano/Magalhães 2004; Egger 2000a; Pfaffermayer 1996; Brenton/DiMauro/Lücke 2002), and, especially most recently,

- the potential of FDI flowing into specific countries or groups of countries in the course of integration (Brenton/Di Mauro 1999; Buch/ Kokta/Piazolo 2001; Görg/Greenaway 2002; Piazolo 2001).

Using gravity models in the analysis of regional FDI distribution presumes that country size (markets) and distance can be considered important FDI determinants. Prevailing theoretical approaches to explain FDI support this view in principle. However, there seem to be significant differences in the mode of operation of these specific gravity-related factors:

- There are two qualifications to be made regarding the market factor. On the one hand, in the case of FDI, the market concept should be wider than in the case of exports. The markets of foreign affiliates may often reach beyond the host country and extend at least to neighboring countries. This could hold particularly in integration areas, such as Europe and NAFTA and, although to a lesser extent, in South East Asia and Latin America. On the other hand, FDI is not necessarily oriented towards the market of the host country region concerned. It has become common in the literature to distinguish *horizontal* FDI (Horstmann/Markusen, 1992 and Brainard, 1993) which is indeed market-oriented from *vertical* FDI (Helpman, 1984 and Helpman/Krugman, 1985) which is endowment-oriented. Vertical FDI thus aims at exploiting comparative advantage of the host country irrespective of the size of the market.[6]

- Qualifications have to be made especially with regard to the theoretical basis of the distance factor when using gravity models for FDI analyses. While trade is clearly impeded by the distance of partner countries, for FDI distance can be an impediment as well as an incentive. It is an impediment since coordination and other transaction costs should nor-

5 The term "successful" in this context means that the specific gravity and distance-related variables are found to be statistically significant and important.

6 These two approaches were integrated by Markusen et al. (1996) and Markusen (1997).

mally increase with distance. On the other hand, distance can be an incentive for FDI which would aim at avoiding transportation costs or overcoming other trade barriers by local production. Such investments would take place as long as the advantages of proximity to the respective market (and, by the same token, to suppliers, the scientific community, etc.) exceed the costs of operating at a distance and as long as alternative exporting from concentrated production in the home country is less profitable.

Given the ambiguous character of distance as an FDI determinant, it is obvious that empirical testing is confronted with severe problems. If distance comes out to be insignificant, this does not necessarily mean that distance is unimportant. Insignificance may simply result from a positive effect on some investors and a negative one on others. These problems are aggravated by unsatisfactory specification of the variables, i.e. by similar problems faced when testing trade theories.[7] Moreover, the detailed specification of various other variables is impeded by multicollinearity. This holds, for example, for GDP per capita which often goes along with differentiated demand, (wage) costs, skills, openness and several ways to measure country-specific investment risk - theoretically an element of a factor measuring economic distance.

According to various theoretical approaches to explain FDI and, more specifically, the regional distribution of FDI, empirical studies based upon a gravity-type approach should include three sets of variables:

1) Market-related variables

- GDP of host country as an indicator of market volume,
- development level, representing the degree of demand differentiation,
- population of host country as indicator of country size,
- GDP of neighboring countries as an indicator of the market potential beyond the host country, especially in integration areas.

2) Distance-related variables

- geographical distance between capitals or economic centers in kilometers,
- factors affecting the economic distance between the countries concerned, such as trade preferences, openness for imports, common language, economic and political risk in host country, common border, etc.

7 Breuss' and Egger's criticism concerning the empirical tests of gravity-type trade models (see fn 4) thus holds for FDI tests, too.

3) Endowment-related variables

- skill variables of employees in host country
- wages in host country
- GDP per head as an indicator of technological and general development level
- agglomeration forces.

The two first-mentioned groups can be regarded as elements of a modified traditional gravity approach, while the third group is derived from "new" theories of FDI.

3 METHODOLOGICAL ASPECTS

In order to interpret the level of German FDI in CEE, the actual value has to be compared to a „normal" one. Deviations from a „normal" position will occur if the adjustment process has not led to what could be called equilibrium. If adjustment is slow or the adjustment period too short, the actual FDI value is below the „normal" level and there can be expected above average growth in the future. On the other hand, FDI adjustment could have been overshooting so that the actual FDI value would exceed the expected normal position. This possibly leads to a relative decline of FDI in the future.

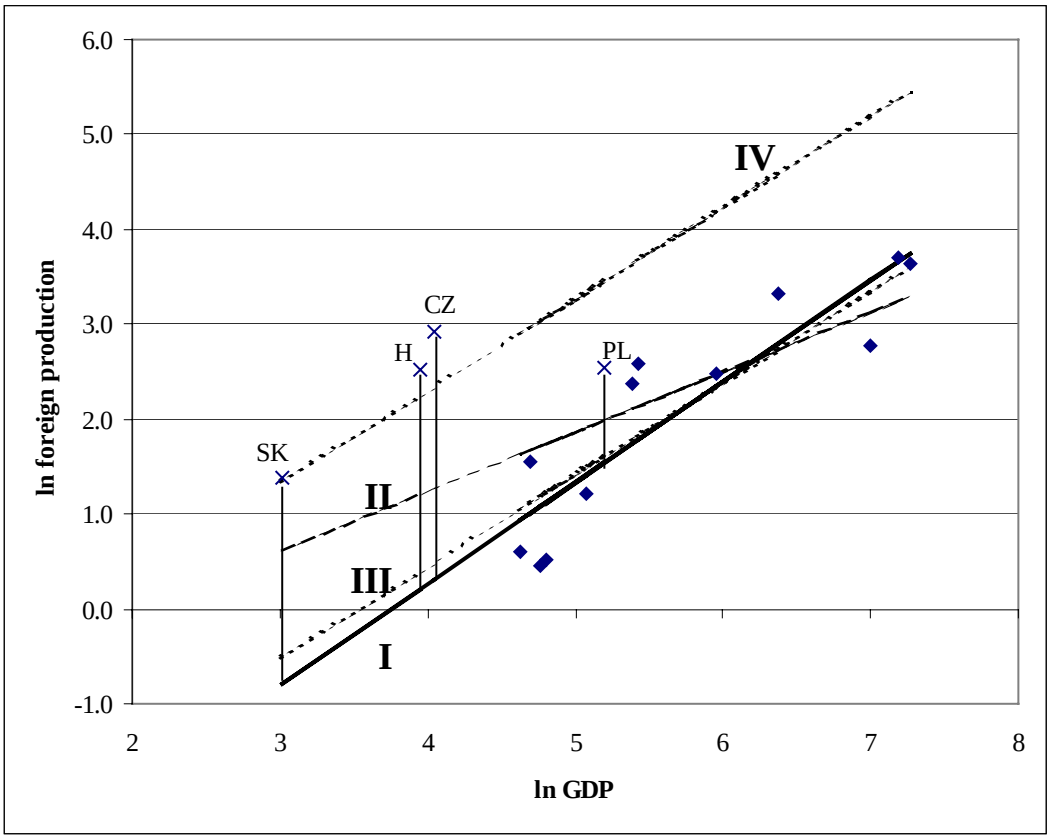
„Normal" FDI positions are estimated on the basis of the actual level of German FDI[8] in the 81 most important host countries when relevant country-specific variables are controlled for. Two different approaches are followed up:

- *„Out-of-sample approach"*: Only Non-CEECs enter the regression, while CEECs are excluded. This approach would be justified, if regression parameters were different for Non-CEECs and CEECs. Parameters may diverge due to the short FDI-tradition in CEECs. Out-of-sample projection may become increasingly inappropriate as transformation proceeds and CEECs have found their position in the European economy.

8 In our estimates, we do not take FDI capital as dependent variable but foreign affiliates' production values instead. We do this for two reasons. First, FDI data, especially the annual flows, are characterized by strong volatility. Second, FDI capital cannot really be considered an indicator of economic activity since there is no corresponding domestic variable: FDI does not necessarily go along with real investment, and real investment at a foreign affiliate can well take place without any FDI transfer (Jungnickel 2000, Borrmann 2002). Foreign production of German firms is defined as sales of affiliates excluding the trade sector. Data on foreign affiliates' production were kindly supplied by the Deutsche Bundesbank. The terms "foreign production" and FDI are used interchangeably.

- *„In-sample approach“*: CEE countries are included in the regression. This is appropriate when regression parameters are supposed not to differ fundamentally between CEECs and Non-CEECs.

Figure 1 In-sample and out of sample projection



Source: Deutsche Bundesbank; Statistisches Bundesamt; own calculations

Figure 1 gives an example for in-sample and out-of-sample estimation for cross-section analysis: The relation between country size (measured as GDP - other variables are not considered here) and local production of German affiliates is displayed for several EU(15) countries and four Core-CEE countries.

In an *out-of-sample* projection for the Core-CEEC, only EU(15) countries enter the regression equation (represented by regression line I). The estimation of the “normal” level of “German” production in each CEE-country is then represented by the intersection of each vertical line (originating from each Core-CEE-country) with regression line I. The difference between the actual and estimated “normal” level is thus represented by the length of each vertical line.

In an *in-sample* regression, not only the EU(15) countries, but also the CEE-countries enter the regression; the resulting regression line II is much flatter than line I as the core-CEECs are positioned above regression line I in the left part of the figure. As they are also placed clearly above regression line II, it follows that every single Core-CEE-country has attracted more German production than could be explained by its country size (GDP). Obviously, there are unobserved characteristics of CEECs which attract FDI, but do not enter the regression equation. This systematic bias in case of CEECs indicates misspecification of model II. To control for this, a dummy variable for CEECs has to be added. The insertion of a dummy results in regression lines III and IV parallel to each other. The vertical distance between the two lines represents the size of the CEECs' dummy coefficient. Both lines are hardly flatter than line I. Line III represents the EU(15) countries, whereas line IV can be used for estimates of German FDI in the CEECs.

Now the normal position of each CEE-country is represented by the intersection of each vertical line with regression line III. Line IV should not be used for the estimation of a normal position as it includes the effects of all unobserved characteristics of CEECs. Alternatively, the coefficient of the dummy variable can deliver information concerning a normal FDI-position: It tells us, to what extent estimated German production might increase, on average, due to the fact that a host country belongs to the group of CEECs.[9] Brenton/Di Mauro/Lücke (1998) as well as Africano/Magalhães (2004)[10] interpret such a dummy variable as an indicator of divergence from „normal" FDI stocks. If it were significantly negative, CEECs would have attracted below-normal FDI and might expect above-average inflows in the future, whereas non-significant coefficients may indicate that a „normal" FDI position was achieved. On the other hand, significantly positive coefficients could indicate an „overshooting" of FDI.[11]
As our data are available not only for one single year, but for five years from 1996 to 2001, pooled or panel regressions can be possible. Panel regressions (for example fixed or random effects models) have the advantage of taking into account host-country-specific heterogeneity. But there are important arguments against it:

9 Since all variables have been turned into natural logarithms, the interpretation of the dummy variable coefficient is not straight forward. The exponential function of the dummy coefficient shows the degree of deviation from the normal level as a percentage. A value of 1.2 for instance means that a CEE-country exceeds the "normal" FDI-position by 20%.

10 Africano/Magalhães focus on FDI (and exports) between Portugal and various destinations, esp. the EU and CEECs.

11 In our example, the positive deviation of actual FDI in CEE countries from the estimated normal level should not be over-interpreted since we included GDP as the only independent variable.

- Usually, panel analysis is preferably used for short-term analysis with fluctuating data (Kennedy, 2004, 307 pp.), while we are primarily interested in mid- to long-term developments of the regional structure of FDI. Then, cross section or between-groups estimation seems to be more appropriate. Compared with FDI-flow data, our data on foreign production display a rather stable development. In our view, it does not make sense to relate annual changes in FDI to annual changes in dependent variables. The relationship concerned should rather be compared over a longer period of time.

- Out-of-sample projection is not possible with panel regressions, because host-country-specific effects of the excluded countries are not known.

- In fixed-effects panel regressions, time-invariant variables are not considered. This means that distance as a core variable of gravity models can be missing.

The last-mentioned point also is an argument against pooling the available data: In that case, annual changes receive more weight than appropriate according to our perception of FDI behavior.

We, therefore, primarily run between-groups[12] and cross-section regressions. In order not to forego information on the development of regional structure over time, we do estimations for 1996 and 2001 which are then compared.[13]

4 DATABASE

Data for the dependant variable FDI (German production abroad) were kindly supplied by the Bundesbank. Relevant exogenous variables explaining German production abroad were selected according to theoretical reasoning along the modified gravity approach as outlined above. Those host-country-specific characteristics are compiled in Box 1, including their sources, The World Bank's World Development Indicators (WDI) and the World Bank Institute.[14] Population which is often taken as proxy for country size or degree of self-sufficiency

12 Between-groups regression means that the average of all variables (dependent and independent) has been taken over all years. The regression is run with the averaged variables.

13 For the sake of methodological rounding off, we additionally run pooled, fixed effects, and random effects regressions.

14 URL: http://www.worldbank.org/wbi/governance/wp-governance.html

was not included here because it is perfectly collinear with GDP and GDP per head.[15] Also, GDP per head strongly correlates with soft indicators of country risk. Among these soft indicators, only VOICE was less closely correlated and therefore included in the regression. Regarding the CEE countries, we distinguished the four core countries - CEE(4) , Poland, Czech Republic, Slovakia and Hungary - from the other six - CEE(5-10) Baltic States, Slovenia, Romania, Bulgaria. This differentiation was made because the focus of German investors clearly is on the first-mentioned group. even when country size is taken into account.

Our basic regression equation, therefore, reads as follows:

$$\begin{aligned} FPROD_j = {} & \beta_0 + \beta_1 GDP_j + \beta_2 MPOT + \beta_3 GDPPC_j + \beta_4 IMPQU_j + \beta_5 FDIQU_j \\ & + \beta_6 SCIENCEQU_j + \beta_7 NEIGHBOUR_j + \beta_8 GERMAN_j + \beta_9 ENGLISH_j \\ & + \beta_{10} DIST_j + \beta_{11} CEE(4)_j + \beta_{12} CEE(5-10)_j + \beta_{13} VOICE_j + \varepsilon_j \end{aligned}$$

As can be seen from the expected sign, GDP per capita leaves room for ambiguous interpretation. It could not only reflect the development level and qualification of labour, but also labour cost. If labour cost were the main component, a negative influence on outward employment can be assumed. If, however, both aspects are important, although for different investors, this can result in insignificance. The distance factor at the heart of gravity models is captured by various variables. Beside the geographical distance (DIST) which is the distance between Germany and host countries (capital or economic center) in km, some variables are included in order to take into account specific factors that make economic distance different from geographic distance. NEIGHBOUR refers to neighboring countries. GERMAN and ENGLISH indicate cultural proximity. Also VOICE can be considered as reflecting aspects of economic distance, a high value indicates transparency and, to some extent, efficiency of the host country's political and administrative system.

Logarithms were taken from all variables (except soft indicators and dummy variables).

15 The removal of population seems to be justified even for theoretical reasons. It is inferior to GDP in reflecting the market volume of a country, except for basic needs consumption which is determined by the number of consumers.

BOX 1: The variables

Variable	Indicating (expected sign)	Definition	Source
1) Market-related			
GDP	market potential (+)	GDP of host country	WDI
MPOT	Market potential in neighboring countries (+)	GDP of neighboring countries up to 500 km from host country. GDP weights: - Europe (ex. Balkan and CIS), NAFTA, Australia/New Z., Hong Kong: 100% - ASEAN, MERCOSUR, CIS, Balkan: 60% Other: 40%	WDI/ HWWA
GDPpc	Differentiated demand (+)	GDP per head	WDI
2) Endowment-related			
GDPpc	qualification, labor cost (?)	GDP per head	WDI
SCIENCEQU	scientific competitiveness (+)	scientists and engineers in R&D per million inhabitants	WDI
FDIQU	agglomeration of MNE (+)	inward FDI / GDP	WDI
3) Distance-related			
DIST	distance (?)	distance in km (capital or economic center)	HWWA
NEIGHBOUR	proximity (+)	dummy for adjacent countries	HWWA
IMPQU	openness (+)	import quota of host country	WDI
GERMAN	cultural proximity (+)	dummy language host country	HWWA
ENGLISH	cultural proximity (+)	dummy language host country	HWWA
VOICE	political risk (+)	composite indicator of political stability	World Bank Institute
4) Other indicators			
CORE_CEECs	unobserved CEEC characteristics	dummy variable	
OTHER_CEECs	unobserved CEEC characteristics	dummy variable	

5 EMPIRICAL RESULTS

Table 1 presents in-sample estimates, i.e. CEE countries included (specification I-V). Specification I is our starting regression containing all variables considered to be important. The high and significantly positive regression and beta coefficients for GDP and, although on a lower level, MPOT come as no surprise since these variables are the only size-dependent variables

on the right hand side. According to the beta coefficients the lion's share of the dependent variables' variation is explained by host-country size. It does not only reflect market size, but also to some extent the potential to absorb FDI. The positive coefficients of MPOT indicate that German firms have developed border-crossing production and sales networks, especially where regional integration takes place. However, border-crossing orientation of foreign affiliates seems to be clearly less important than sales in the host country.

The DIST variable turns out to be significantly negative and displays a high Beta coefficient. This indicates that, with increasing distance, the additional costs of operating abroad become more important compared with the advantages of being closer to the market.[16] Contrary to geographic distance, other distance variables (NEIGHBOUR, GERMAN, ENGLISH) are hardly significant except for VOICE. Surprisingly, even the openness variable IMPQU is insignificant. This could be the result of two countervailing effects: In an open host economy FDI can, on the one hand, be substituted by exports. On the other hand, it may be induced by openness when it is part of international production networks. As expected, the dummy for CEE(4) is significantly positive, while the one for CEE(5-10) is not. The model fit is reasonably high with 0.87. The coefficient for the FDI quota is significantly positive indicating a positive impact of agglomeration effects.[17]

16 One could think that the negative coefficient of DIST could as well result from the fact that FDI is concentrated in highly developed countries primarily located in Europe and in the USA and that the host countries are not weighted by their market size. The USA count as one case, the same as e.g. Denmark , although the German manufacturing affiliates there realize a production value more than 50 times the one in Denmark. However, weighting the estimates with GDP (not reported here) does not change regression parameters significantly.

17 This is the interpretation given in a number of studies. In a less ambitious way, one might interpret the positive sign as an indication that investors from all countries are attracted by the same country-specific factors, be it advantages of agglomeration or other location advantages.

Table 1: Determinants of the regional structure of German outward production

	I In-sample between	II In-sample between	III In-sample between	IV In-sample cross sect 1996	V In-sample cross sect 2001	VI Out-of-sample cross sect 2001
GDP	1.18***(0.85)	1.13***(0.81)	1.13***(0.82)	0.98***(0.68)	1.04***(0.80)	1.12***(0.84)
MPOT	0.22**(0.17)	0.25**(0.19)	0.25**(0.19)	0.30**(0.22)	0.34***(0.26)	0.27**(0.21)
GDPPC	-0.12 (-0.07)	-0.09 (-0.06)	2.03**(1.19)	2.18*(1.21)	2.34**(1.45)	2.41**(1.53)
GDPPCSQ			-0.14**(-1.35)	-0.13*(-1.17)	-0.15***(-1.60)	-0.17***(-1.81)
IMPQU	0.17 (0.04)	0.17 (0.04)	0.17 (0.04)	-0.28 (-0.06)	0.20 (0.05)	0.28 (0.07)
FDIQU	0.32**(0.12)	0.29**(0.11)	0.29**(0.11)	0.46***(0.18)	0.27**(0.11)	0.25**(0.11)
SCIENCEQU	-0.25**(-0.14)	-0.22*(-0.12)				
NEIGHBOUR	-0.71 (-0.10)					
GERMAN	0.98 (0.08)					
ENGLISH	-0.03 (0.00)					
DIST	-0.42***(-0.22)	-0.35***(-0.18)	-0.36***(-0.19)	-0.32**(-0.16)	-0.39***(-0.22)	-0.41***(-0.22)
VOICE	0.41**(0.15)	0.35*(0.13)	0.33*(0.12)			0.37**(0.16)
Core-CEEC	1.71***(0.16)	1.49***(0.14)	1.00**(0.09)	1.04 (0.09)	0.99**(0.10)	-
other CEEC	0.48 (0.05)	0.51 (0.05)	0.00 (0.00)	-0.10 (-0.01)	0.10 (0.01)	-
constant	-2.54	-3.36**	-12.57***	-13.56***	-13.60***	-13.06***
observations	556	556	556	80	81	71
groups	82	82	82			
R2:						
within	0.23	0.22	0.23			
between	0.90	0.90	0.90			
overall	0.87	0.87	0.87			
R2 adj.				0.84	0.88	0.88

Beta-coefficients in brackets; ***: significant at the 1% level, **: 5% level, * 10% level
Source: Own calculations.

Specification I is used as our basic model being further refined in the following specifications.[18] Refinements concern distance- as well as endowment-related variables:
In a first step, we drop the insignificant distance-related variables NEIGHBOUR, GERMAN and ENGLISH (specification II). This leaves the plain DIST variable significant, although with slightly lower coefficients (in absolute terms).

In a second step, we drop the share of scientists that correlates positively with income per head and add a quadratic term of GDPPC since regression-diagnostics indicate a nonlinear relationship between GDP per head and foreign production (specification III). It turns out that

18 As mentioned above, we also ran pooled and panel regressions the results of which are displayed in annex table A 2. Results rendered by a random effects model seemed to be plausible. However, the Hausman specification test suggests that the preconditions of such estimation are not met. Alternative methods such as the Hausman-Taylor model or dynamic panel models, such as Arellano/Bond (1991) were tried, but turned out to produce implausible results. They are not reported here.

the quadratic term is highly significant.[19] This indicates a positive, but decreasing relationship between host country income per head and "German" production. The FDI-quota remains significantly positive indicating an important role of agglomeration for production decisions, while the import quota remains insignificant.

Also, the CEE dummies remain rather unchanged in specification 3. According to these results, "German" production in CEE(4) is 2.7 times the "normal" levels. This might, at first sight, be interpreted as a fundamental overshooting. For two reasons, this conclusion seems to be a bit overstated: First, the 90% confidence interval covers a broad range from 1.2 to 6.2. In view of this high uncertainty, the coefficients should rather be interpreted as "above normal" than as precise values. Second, German (as well as other home countries') investors do not only react to past economic performance of potential host countries. Especially in Central and Eastern Europe, expectations of a lasting catching up and above-average growth performance could be reasons for investing more than"normal", given the development until 2001.[20] The insignificance of the CEE(5-10) dummy renders no indication of expectations-driven FDI in these countries, at least until 2001.

Brenton/Di Mauro/Lücke also ran a gravity regression on German FDI-stocks. Contrary to our results they found a positive but insignificant dummy coefficient for two groups of CEECs (CEEC1: Czech Republic, Estonia, Hungary, Poland, Slovenia; CEEC2: Bulgaria, Latvia, Lithuania, Romania, Slovakia). The insignificance in case of Core-CEECs may be due to the fact that they used earlier data. Furthermore, their gravity equation distinctly differs from ours as they include population and do not take account of market potential.

By comparing cross-section regressions for the years 1996 and 2001 we can take into account the time dimension (specifications V and VI).[21] While the results for most independent variables remain unchanged, it turns out that the CEE(4) dummy becomes significant only in 2001. This is not unexpected as it took some time after opening-up to foreign investors since the desired stock of FDI had ben built up.

While specifications I to V are used for in-sample estimates, specification VI forms a basis for out-of-sample estimates. As the 10 CEE countries are dropped from the estimation, it is based

19 The functional form is of an inverted U-shape.
20 This aspect and the extremely wide confidence intervals are rarely discussed in former studies.
21 The VOICE variable was dropped because the development of the CEEC-dummy becomes clearer.

on the data of 71 important industrial and developing countries in 2001.[22] The results are displayed in table 2. They largely confirm the in-sample estimates: Actual production of German affiliates exceeds projected, i.e. "normal" production, especially in Hungary, Czech Republic, and Slovakia. Contrary to this, projected production is far behind the actual level in Romania, Estonia and Lithuania. Thus, out-of-sample estimates confirm on the whole results of in-sample estimates. This also holds for the extremely large confidence intervals limiting the degree of detail of all conclusions.

Table 2: Out-of-sample estimates[a] for German outward production in CEECs (basis: 71 industrial and developing countries), in bn Euro, 2001

	confidence interval (90%)				actual /
	lower bound	upper bound	estimated	actual	estimated
Estonia	0.064	1.050	0.260	0.177	68.1
Latvia	0.077	1.241	0.309	0.451	145.8
Lithuania	0.124	1.979	0.495	0.353	71.2
Poland	3.474	56.668	14.031	12.718	90.6
Czech Rep.	1.672	28.147	6.860	18.539	270.2
Slovakia	0.360	6.134	1.486	3.951	265.8
Hungary	0.970	15.597	3.889	12.449	320.1
Slovenia	0.115	1.757	0.449	0.854	190.4
Romania	0.334	5.029	1.296	0.641	49.4
Bulgaria	0.103	1.591	0.404	0.415	102.7

a For the computation of confidence intervals s. Annex 2
Source: Deutsche Bundesbank; own calculations

FDI theory suggests that the significance of the variables tested in the estimates is different in the various industries, depending on differing factor input requirements and differing competitive positions:

- Manufacturers of *traditional consumer goods* (TCG, comprising mainly textiles, clothing, leather goods, ceramics, jewelry/toys/sporting goods) are often assumed to be especially sensitive to (wage) cost differentials and less market-oriented.

- In *core manufacturing*, made up of mechanical and electrical engineering, as well as the chemical industry, internationalization can be assumed to be based particularly upon market access, high income demand, realization of agglomeration advantages and availability of qualified labor.

22 Additional regressions were run on the basis of merely 23 industrial countries. As the results are very similar, they are not reported here.

- *Business services*, made up of business services in a narrow sense as well as R&D facilities and data processing, probably are also largely market-oriented.

- Internationalization of *wholesale and retail trade* are probably based on demand in host country, but also in neighboring markets.

Table 3: Determinants of German outward production differentiated by industries

	TCG between	Core Manufact. between	Business services between	Trade Between
GDP	0.72***(4.0)	0.97***(7.2)	1.01***(6.1)	0.88***(5.8)
MPOT	0.27 (1.3)	0.27**(2.0)	0.11 (0.7)	0.29*(1.9)
GDPPC	0.42 (0.2)	2.96**(2.4)	0.75 (0.5)	0.60 (0.4)
GDPPCSQ	-0.04 (-0.3)	-0.17**(-2.3)	-0.04 (-0.5)	-0.01 (-0.1)
IMPQU	-0.01 (0.0)	-0.55*(-1.8)	0.06 (0.2)	0.12 (0.4)
FDIQU	0.14 (0.6)	0.50***(3.2)	0.58***(3.2)	0.25 (1.5)
DIST	-0.22 (-1.3)	-0.23*(-1.7)	-0.29*(-2.0)	-0.22 (-1.4)
Core-CEEC	1.36*(1.7)	0.68 (1.1)	0.98 (1.4)	1.62**(2.2)
other CEEC	0.00 (0.0)	-0.39 (-0.7)	-1.23*(-2.0)	0.38 (0.6)
constant	-7.95 (-1.1)	-17.44***(-3.4)	-11.62*(-2.0)	-10.77*(-1.9)
observations	400	510	387	536
groups	65	77	65	80
R2:				
within	0.03	0.11	0.14	0.24
between	0.61	0.84	0.78	0.82
overall	0.54	0.79	0.70	0.80

T-values in brackets; ***: significant at the 1% level, **: 5% level, * 10% level
Source: Deutsche Bundesbank; own calculations

Table 3 shows the gravity-type regressions for these industries. On the whole, the results are according to our expectations. Most remarkable exceptions are *TCG industries*. These investors seem to concentrate on big markets rather than on low (wage)cost locations with a certain focus on Core CEE. However, it has to be taken into account that, according to established FDI theories, foreign investors need firm-specific advantages in order to successfully operate in a foreign country. It seems likely that such advantages on the side of German firms rather exist in the development and production of high-end products than in the exploitation of lowest wage costs (which is often achieved by other means than FDI, such as subcontracting). Moreover, higher wages in CEE(4), as compared with CEE(5-10) and further-away developing countries could be over-compensated by higher productivity and lower transaction costs in nearby CEE(4). Seen from this perspective, the significance of the CEE(4) dummy could well indicate relocation of production due to low labor costs. This could, along with

relocations to low-wage developing countries in Asia, also explain the insignificance of the DIST variable.

Core manufacturing foreign affiliates are mainly located largely market-oriented, often beyond the host country, and are focussed on highly developed countries. The regional structure thus resembles the one of international FDI. CEE countries, however, seem to be average host countries only. This is because the dominating car industry is not included in this group. *Business services* affiliates closely follow core manufacturing to the bigger host country markets, whereas *trading* affiliates to some extent are also oriented beyond the host country. They have also established a strong position in CEE(4) countries.

6 CONCLUSIONS

The tradition of gravity models is in the analysis of trade flows with country (market) size and distance as core variables. Both these variables can be important determinants of FDI, too. However, when such models are used to explain FDI, there are differences in the mode of operation of the core variables so that the interpretation can become uncertain. Market size can reach beyond the host country and distance can be an incentive as well as an impediment to FDI. This would be diametrically opposed to the idea of gravity models assuming distance generally as an impediment.

In the present paper, we use gravity-type models in order to assess the level of German FDI (operationalized as production value of foreign affiliates) in CEE countries: Has the rapid growth in recent years already led to a "normal" level, is there a backlog, or has an overshooting taken place? In the respective regressions we estimate what could be called a "normal" level of FDI which can be used as yardstick for assessing actual values. Beside size and geographic distance of host countries, we include some variables reflecting economic distance, market potential of neighboring countries and endowment-related variables. Estimates are done both on the basis of an in-sample as well as an out-of-sample approach on the basis of FDI in 81 important host countries. We differentiate by the four core CEE countries - CEE(4) - and the other CEE countries - CEE(5-10) - because there is an obvious focus of German FDI on the big and nearby CEE(4).

From the various specifications it becomes obvious that beside the size of the host country, the market potential of neighboring countries and distance are important determinants of the regional structure of German FDI. Distance carries a negative sign. This indicates that, on balance, the costs of operating at a distance seem to be weighted clearly higher than the advantage of being close to distant markets. Insofar, the gravity-type model seems to be appropriate to explain the regional structure of FDI.

Actual FDI values for CEE(4) clearly exceed the estimated "normal" ones. However, for two reasons it would be premature to interpret this as overshooting:

- The confidence intervals of the estimates are extremely wide with the upper bands a multiple of actual values and the lower band clearly below.

- Especially with regard to CEE countries, it can be assumed that FDI decisions are not only based on past host country performance, but also on future growth prospects which are brighter compared with Western European countries.

Against this background, the high estimates of German FDI especially in CEE(4) should not be interpreted as overshooting, but rather as "already above average". Conclusions regarding the future development of FDI can hardly be drawn from this. Ascribing the most recent slowdown of German FDI flows to CEE as a a reaction to prior overshooting is not convincing.

ANNEX 1

Table A1: Correlation-coefficients of regressors, 2001

	foreign. prod	GDP	market.pot	population	GDP pc	distance	imp.qu.	FDI qu.
foreign. prod	1	0.81	0.79	0.40	0.52	-0.37	-0.10	0.04
GDP	0.81	1	0.60	0.64	0.46	-0.01	-0.45	-0.18
market.pot	0.79	0.60	1	0.04	0.68	-0.52	0.11	0.10
population	0.40	0.64	0.04	1	-0.39	0.33	-0.60	-0.39
GDP pc	0.52	0.46	0.68	-0.39	1	-0.39	0.16	0.23
distance	-0.37	-0.01	-0.52	0.33	-0.39	1	-0.40	-0.13
imp.qu.	-0.10	-0.45	0.11	-0.60	0.16	-0.40	1	0.59
FDI qu.	0.04	-0.18	0.10	-0.39	0.23	-0.13	0.59	1
science qu.	0.57	0.40	0.68	-0.21	0.72	-0.55	0.21	0.19
lab. cost	0.51	0.60	0.57	-0.07	0.79	-0.37	-0.06	-0.02
neighbor	0.38	0.19	0.45	-0.13	0.38	-0.64	0.22	0.21
voice	0.48	0.26	0.65	-0.38	0.75	-0.42	0.17	0.25
reg.qual.	0.44	0.31	0.62	-0.41	0.84	-0.32	0.34	0.43
corruption	0.48	0.41	0.61	-0.34	0.89	-0.37	0.22	0.30
pol.stab.	0.39	0.24	0.64	-0.42	0.77	-0.40	0.36	0.32
gov.eff.	0.55	0.43	0.67	-0.30	0.87	-0.40	0.29	0.36
rule of law	0.52	0.43	0.65	-0.33	0.90	-0.40	0.25	0.28

Table A1: continued

	science qu.	lab. cost	neighbor	voice	reg.qual.	corruption	pol.stab.	gov.eff.	rule of law
foreign. prod	0.57	0.51	0.38	0.48	0.44	0.48	0.39	0.55	0.52
GDP	0.40	0.60	0.19	0.26	0.31	0.41	0.24	0.43	0.43
market.pot	0.68	0.57	0.45	0.65	0.62	0.61	0.64	0.67	0.65
population	-0.21	-0.07	-0.13	-0.38	-0.41	-0.34	-0.42	-0.30	-0.33
GDP pc	0.72	0.79	0.38	0.75	0.84	0.89	0.77	0.87	0.90
distance	-0.55	-0.37	-0.64	-0.42	-0.32	-0.37	-0.40	-0.40	-0.40
imp.qu.	0.21	-0.06	0.22	0.17	0.34	0.22	0.36	0.29	0.25
FDI qu.	0.19	-0.02	0.21	0.25	0.43	0.30	0.32	0.36	0.28
science qu.	1	0.62	0.36	0.69	0.63	0.72	0.66	0.72	0.72
lab. cost	0.62	1	0.43	0.54	0.60	0.77	0.56	0.74	0.76
neighbor	0.36	0.43	1	0.37	0.34	0.39	0.35	0.42	0.40
voice	0.69	0.54	0.37	1	0.83	0.78	0.74	0.78	0.79
reg.qual.	0.63	0.60	0.34	0.83	1	0.91	0.81	0.92	0.91
corruption	0.72	0.77	0.39	0.78	0.91	1	0.82	0.97	0.98
pol.stab.	0.66	0.56	0.35	0.74	0.81	0.82	1	0.84	0.85
gov.eff.	0.72	0.74	0.42	0.78	0.92	0.97	0.84	1	0.97
rule of law	0.72	0.76	0.40	0.79	0.91	0.98	0.85	0.97	1

Source: Authors´ calculations

Table A2: Determinants of German outward production - pooled and panel regressions

	I pooled	II fixed effects	III random effects	IV between
GDP	1.35***(38.3)	-1.08 (-1.5)	1.28***(17.4)	1.34***(15.9)
GDPPC	-0.13**(-2.2)	2.21***(3.0)	-0.07 (-0.6)	-0.12 (-0.8)
IMPQU	0.29***(2.8)	-0.08 (-0.4)	-0.04 (-0.2)	0.30 (1.2)
FDIQU	0.39***(8.1)	0.79***(12.2)	0.64***(11.6)	0.32**(2.6)
SCIENCEQU	-0.23***(-4.6)	-	-0.15 (-1.4)	-0.26**(-2.1)
NEIGHBOR	-0.81***(-4.2)	-	-0.86*(-1.8)	-0.80*(-1.7)
GERMAN	1.22***(4.8)	-	1.22**(2.0)	1.15*(1.9)
ENGLISH	-0.10 (-1.0)	-	-0.08 (-0.3)	-0.09 (-0.4)
DIST	-0.48***(-9.4)	-	-0.54***(-4.5)	-0.51***(-4.2)
VOICE	0.51***(7.0)	0.06 (0.5)	0.24**(2.3)	0.52***(2.8)
CORE_CEECs	1.94***(9.7)	-	2.01***(4.2)	1.90***(3.9)
OTHER_CEECs	0.71***(4.0)	-	0.70*(1.7)	0.67 (1.6)
constant	-2.07***(-2.9)	-16.33***(-4.6)	-1.79 (-1.2)	-1.55 (-0.9)
R2 adj.	0.86			
R2 within		0.32	0.30	0.23
R2 between		0.00	0.88	0.90
R2 total		0.00	0.86	0.87
groups		82	82	82
N	556	556	556	556

T-values in brackets; ***: significant at the 1% level, **: 5% level, * 10% level
Source: Deutsche Bundesbank; own calculations

ANNEX 2

Computation of confidence intervals

For the out-of-sample projection of German outward production in each CEE-country i we computed confidence intervals according to the following formula (s. Gruber 1995, p 100):

$$lower\ bound = \hat{P}_i - t(\alpha; DF) * \hat{\sigma}$$
$$upper\ bound = \hat{P}_i + t(\alpha; DF) * \hat{\sigma}$$

$$\hat{\sigma} = \sqrt{\hat{\sigma}_u^{\,2} + \hat{\sigma}_u^{\,2} x'_i (X'X)^{-1} x_i}$$

$\hat{P}$	Foreign production in country i
t	t-distribution
α	level of significance
DF	degrees of freedom
$\hat{\sigma}_u^{\,2}$	estimated variance of OLS estimation
x_i	vector of regressors for observation i
X	regressor matrix

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