

Transfer of Technology through FDI to New Member States:

How Important are Direct Effects, Horizontal and Vertical Spillovers?

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Motivation (1)

Huge inflows of FDI into CEECs in 1990s

	1998	1999	2000	2001	FDI/GDP
Czech Rep.	3700	6313	4583	4916	52,8 %
Estonia	581	305	387	538	47,1 %
Hungary	2037	1977	1692	2414	49,6 %
Latvia	357	348	407	170	34,5 %
Lithuania	926	487	379	405	23,5 %
Poland	6365	7270	9342	8830	24,5 %
Slovakia	562	354	2053	1475	30,5 %
Slovenia	248	181	176	724	18,2 %

Motivation (2)

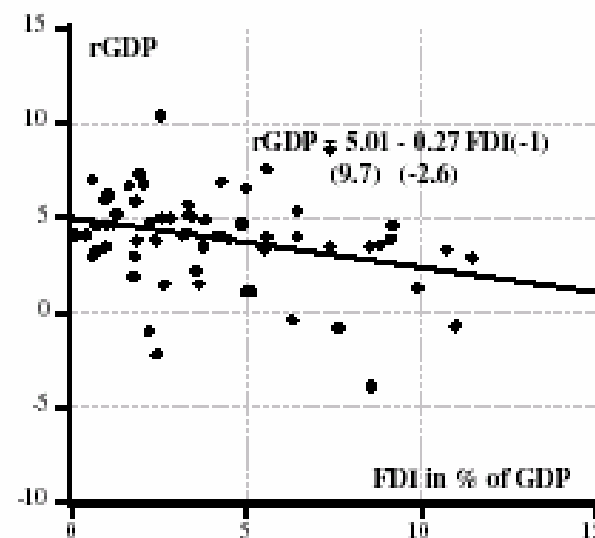
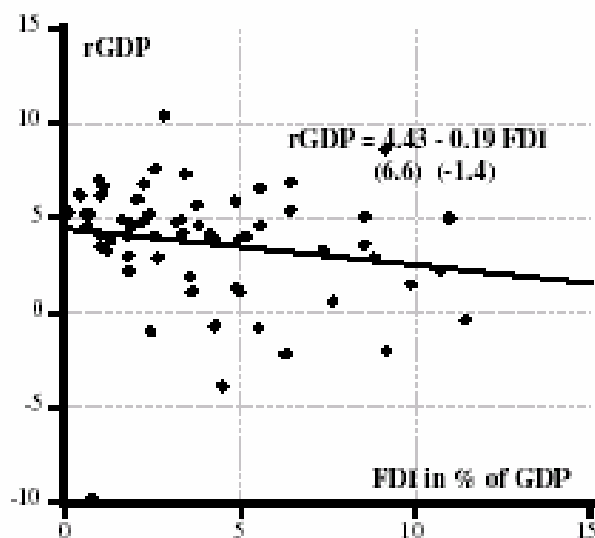
- Existing empirical evidence focussing on spillovers from FDI is inconclusive (see Hanson 2001; GG 2001)
- The evidence, however, relies on horizontal spillovers only
- One should differentiate between macro, sectoral and firm level effects of FDI
- Three effects at the firm level: direct effects, horizontal and vertical spillovers

Evidence (1)

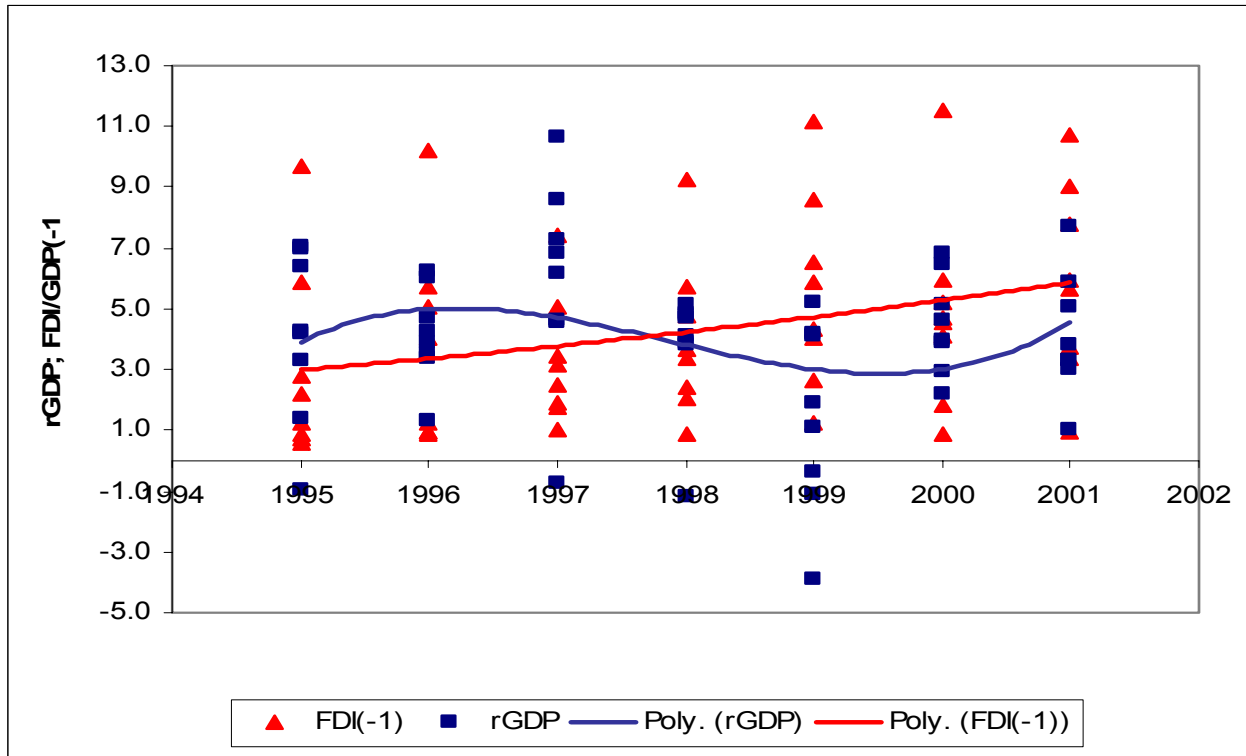
Macro effects (Mencinger, Kyklos, 2003)

Figure 1

Growth and Foreign Direct Investment in Eight Candidate Countries, 1994–2001



Problems with this specification



- Aggregate data, small dataset
- Unobserved external shocks (Czech rep., Russian crisis), which affected growth but not FDI inflows

Evidence (2)

Searching for horizontal spillovers in CEECs

Study	Country	Period	Result
Djankov & Hoekman (2000)	Czech Republic	1993-96	-
Kinoshita (2001)	Czech Republic	1995-98	? or + in R&D int. firms
Bosco (2001)	Hungary	1993-97	?
Konings (2001)	Bulgaria	1993-97	-
	Poland	1994-97	?
	Romania	1993-97	-
Damijan et al (2003)	BG, CZ, E, H, PL, RO, SK, SI	1994-98	? or -, + only for RO

However ...

- Macro and sectoral studies are questionable
- Most firm-level studies on spillovers are conducted
 - in search for horizontal spillovers
 - as single country cases
- A plausible study should focus on firm-level effects:
- distinguish between direct effects of FDI as well as horizontal and vertical spillovers
- conduct a comparative analysis on importance of different FDI effects on a set of comparable countries
- by using a common methodology and up-to-date dynamic panel data techniques

Benefits of FDI for CEEC's (1)

1. Direct effects on recipient firms

- Transfer of technology
- Transfer of »management skills«
- Helping the strategic restructuring of firms
- Use of »intangible assets« of parent firms
- Efficient corporate governance

Benefits of FDI for CEECs (2)

2. Spillover effects on other firms (1)

- **Horizontal (intra-industry) spillovers**

- **Positive effects:** intra-sector diffusion of technology, mainly through
 - (i) labor turnover (job reallocation),
 - (ii) imitation processes and
 - (iii) entry of international supporting professional service firms (accounting firms, etc.)
- **Negative effects:** business stealing effects

Benefits of FDI for CEEC's (3)

2. Spillover effects on other firms (2)

- **Vertical (inter-industry) spillovers** (organisation of vertical supply-chains)
 - **backward linkages:** local firms serve as suppliers of inputs to FIE's (downstream FDI)
 - **forward linkages:** FIE's serve as suppliers of inputs to local firms

Measuring horizontal spillovers

Common measure:

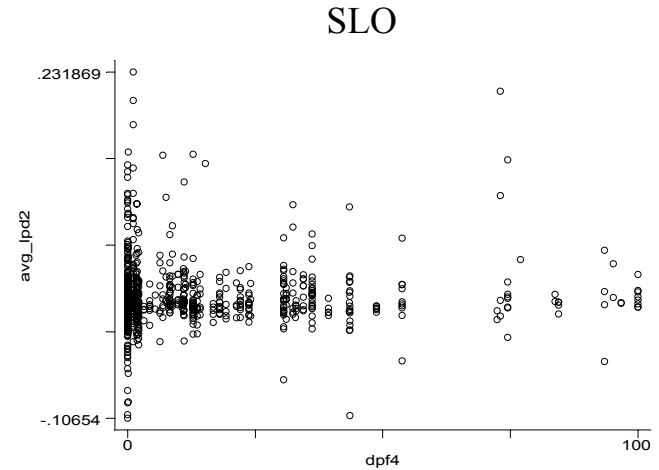
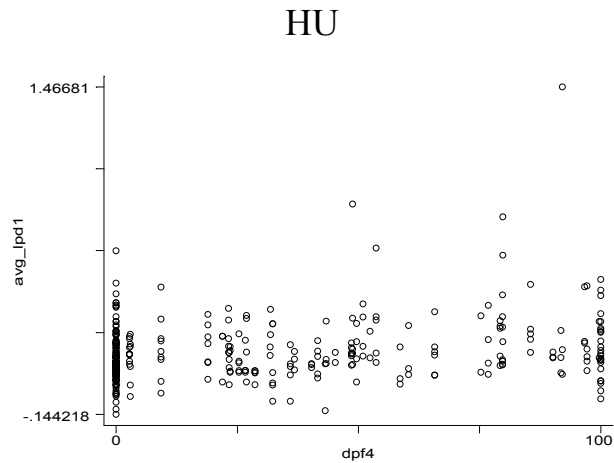
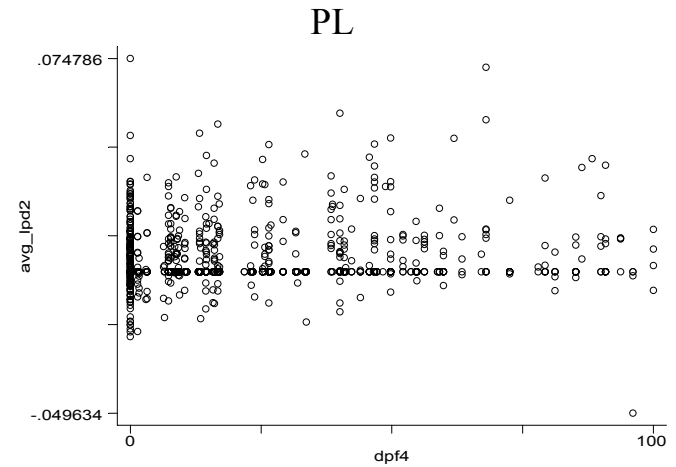
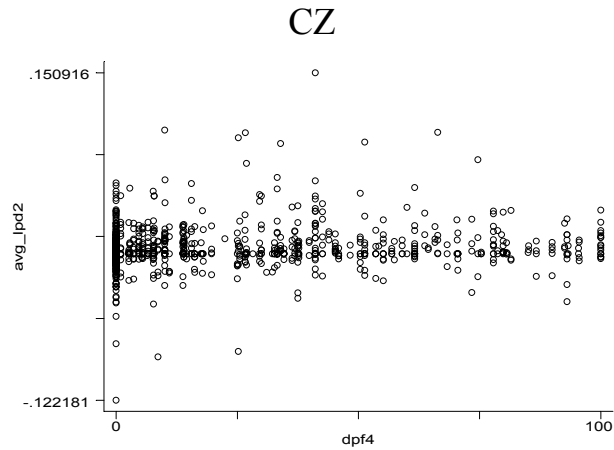
$$(4) \quad HS_{kt} = \frac{\sum_{i=1}^n FA_{ikt}}{\sum_{i,j=1}^{n,m} (FA_{ikt} + DF_{jkt})},$$

Corrected HS measure:

$$(5) \quad \overline{HS}_{kt} = \frac{\sum_{i=1}^n FA_{ikt}}{\sum_{i,j=1}^{n,m} (FA_{ikt} + DF_{jkt})} * (1 - \sum_{i=1}^n \frac{EX_{ikt}}{Y_{ikt}}).$$

Scope for horizontal spillovers

FIEs' penetration of industries and firms' average growth)



Measuring vertical spillovers

Common measure:

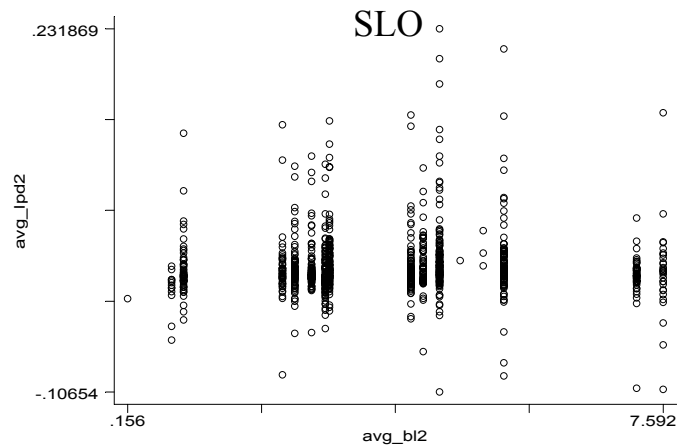
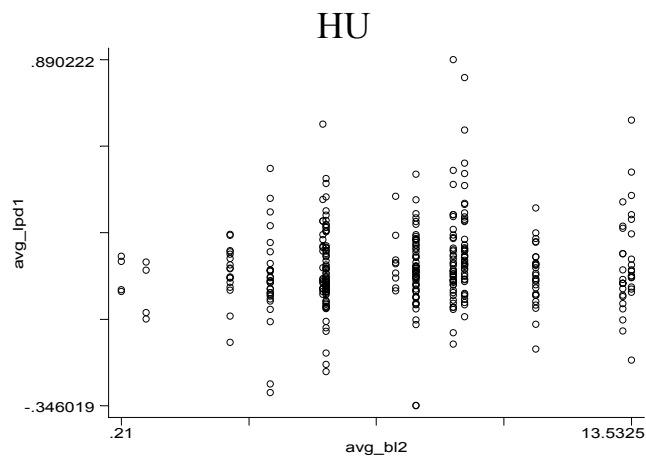
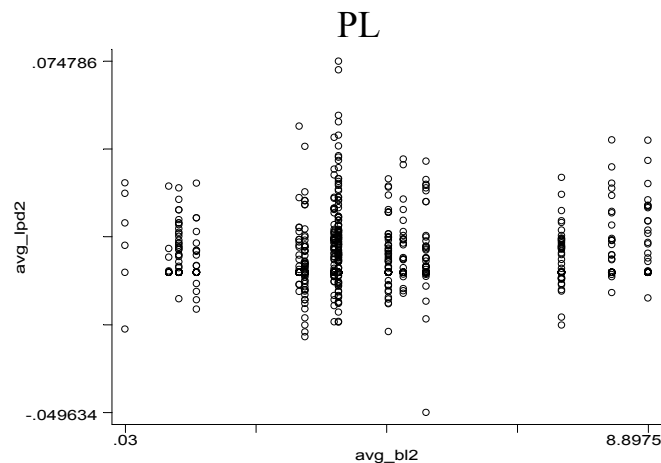
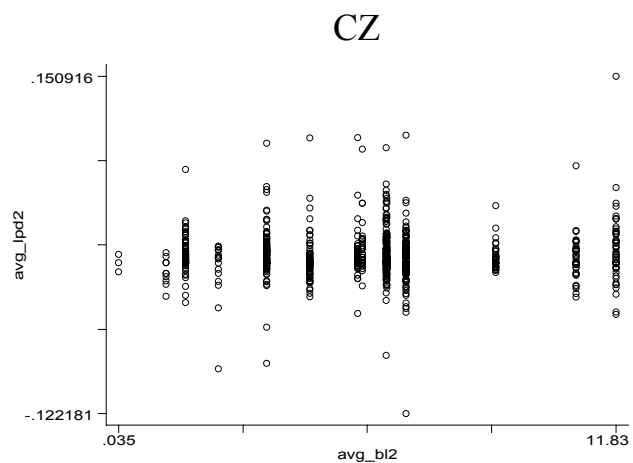
$$(6) \quad VS_{kt}^B = \sum_{r,k=1}^p (\alpha_{krt} * HS_{kt})$$

Corrected VS^B measure:

$$(7) \quad \overline{VS}_{kt}^B = \sum_{r,k=1}^p \left(\alpha_{krt} * HS_{kt} * \left(1 - \sum_{i=1}^n \frac{IM_{ikt}}{MC_{ikt}} \right) \right).$$

Scope for vertical spillovers

Backward linkages by FIEs and firms' average growth)



Empirical model (1)

$$(1) \quad y_{it} = \alpha k_{it} + \beta l_{it} + \delta_t + \eta_i + \gamma \mathbf{a}_{it} + e_{it}, \quad r = \alpha + \beta \neq 1$$

where:

y_{it} log value added, k_{it} and l_{it} are log capital stock and log labor inputs,

δ_t is a year specific intercept.

η_i time-invariant un observed firm -specific effect and e_{it} is the usual error term.

\mathbf{a}_{it} an identified productivity (TFP) shock (due to foreign ownership, spillovers).

Potential simultaneity between firm's performance and ownership:

Exogeneity assumption between inputs and the error term $E(\mathbf{z}_{it}' e_{it}) = 0$

But: \mathbf{a}_{it} possibly correlated with the error term, i.e. $E(\mathbf{a}_{it} e_{it}) \neq 0$,

which means that the ownership structure is endogenous.

Table 1: Descriptive statistics for foreign vs. domestic manufacturing firms in 1999

	BG	CZ	EST*	HU	LT	LV	PL	RO	SK	SLO	Avg.
No. of all firms	1334	1168	373	360	171	194	1540	1711	151	1093	810
No. of FIEs	95	191	108	84	6	36	198	289	9	118	113
% of FIEs in no. firms	7.1	16.4	29.0	23.3	3.5	18.6	12.9	16.9	6.0	10.8	14.4
% of FIEs in sales	26.6	62.3	92.1	96.4	9.1	51.7	53.3	30.9	8.5	38.0	46.9
% of FIEs in emp.	15.2	30.0	56.0	48.9	3.4	31.6	18.8	19.4	6.2	17.3	24.7
% of FIEs in R&D	33.7	34.8	90.1	36.9	18.0	19.0	56.5	32.1	32.7	14.5	36.8
wage FIE / wage DE	1.73	1.34	1.41	1.31			0.74	1.21	1.25	1.16	1.22

* 1998 for Estonia

Possible ways to deal with the simultaneity:

- 2SLS IV approach (taking initial values of variables)
- Fixed effects approach (which is not efficient)
- Heckman (1979) two step method:

Probability $[0, 1]$ of firms to be selected by MNC:

- (2) $\Pr(p_{it} = 1 | \mathbf{M}_{it}) = G(\omega \mathbf{M}_{it})$
- where \mathbf{M}_{it} is a matrix of operational characteristics of firms.

Table 2: Probability of foreign investment decisions in 1995
(Results of probit model)

	BG	CZ	EST#	HU	LT	LV	PL	RO	SK	SLO
Size	-1.8E-07	1.2E-06	-3.4E-05	8.7E-07	-7.0E-05	8.1E-06	-1.8E-10	8.3E-07	-2.3E-06	3.7E-0
z-stat.	(-0.080)	(1.255)	(-1.627)	(0.440)	(-0.460)	(0.350)	(0.000)	(0.490)	(-0.540)	(1.294
Capital intensity	*0.019	*0.003	***0.024	*-0.004	0.018	**0.072	***0.009	**0.008	0.004	-0.00
z-stat.	(1.854)	(2.180)	(3.457)	(-1.856)	(0.509)	(2.503)	(5.201)	(2.231)	(0.222)	(-0.70
Skill intensity	**0.216	-0.015	0.080	*0.038				-0.017	-0.056	**0.02
z-stat.	(2.252)	(-1.237)	(1.002)	(1.769)				(-0.457)	(-1.135)	(2.436
Labor productivity	-0.001	-0.001	***0.015	0.001	-0.004	0.006	0.000	*0.002	-0.009	7.2E-0
z-stat.	(-0.218)	(-0.784)	(2.648)	(1.531)	(-0.079)	(0.759)	(-0.363)	(1.667)	(-0.253)	(0.154
Sector size	**0.036	0.015	0.002	0.018	0.005	0.007	0.011	-0.004	***0.037	-0.00
z-stat.	(2.210)	(1.589)	(0.250)	(1.581)	(0.119)	(0.262)	(0.973)	(-0.206)	(4.447)	(-0.584
Foreign penetration	***0.024	***0.023	***0.012	***0.026	**0.050	***0.031	***0.021	***0.025	***-0.026	***0.02
z-stat.	(10.835)	(13.518)	(3.347)	(8.538)	(2.539)	(5.783)	(11.736)	(13.521)	(-4.056)	(8.488
Number of obs.	1334	1168	373	360	171	194	1540	1711	151	109
Pseudo R2	0.281	0.232	0.146	0.358	0.336	0.453	0.230	0.162	0.623	0.14

1994 for Estonia and Slovenia

Empirical model (2)

Potential correlation between input levels and the unobserved firm-specific shocks:

$$(3) \quad y_{it} = \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \delta_t + (\eta_i + v_{it} + m_{it}), \quad r = \alpha + \beta + \gamma \neq 1$$

$$v_{it} = \rho v_{i,t-1} + \mathbf{a}_{it} + e_{it} \quad |\rho| < 1$$

$$e_{it}, m_{it} \approx MA(0)$$

where:

v_{it} is an autoregressive part of productivity shock,

\mathbf{a}_{it} is identified productivity shock and m_{it} represent serially uncorrelated measurement errors.

Inputs are potentially correlated with firm-specific effects, and with both productivity shocks (\mathbf{a}_{it}, e_{it}) and measurement errors (m_{it}).

Given the AR(1) process in v_{it} , a firm's respond to positive productivity shock in the past ($v_{it} > 0$) by using more inputs in the period t clearly violates the OLS assumption on strict exogeneity between inputs and the error term ($E(\mathbf{z}_{it}' u_{it}) \neq 0$).

Ways to deal with the endogeneity problem

- **Olley and Pakes (1996):**
 - investment expenditure as a proxy for unobservable technological shocks
- **Levinsohn and Petrin (2000):**
 - materials as a proxy for unobservable technological shocks
- **Blundell and Bond (1998, 1999):**
 - system-GMM approach, which in addition to lagged levels uses also lagged first differences as instruments for equations in levels.
 - as model is estimated in first differences, corresponding instruments for X_{it-1} are $(X_{it-2}, X_{it-3}, \dots)$ and $(\Delta X_{it-2}, \Delta X_{it-3}, \dots)$

Empirical model (3)

Dynamic version of the model (1):

$$(4) \quad y_{it} = \rho y_{i,t-1} + \alpha k_{it} - \rho \alpha k_{i,t-1} + \beta l_{it} - \rho \beta l_{i,t-1} + (\delta_t - \rho \delta_{t-1}) \\ + \gamma \mathbf{a}_{it} + \eta_i (1 - \rho) + e_{it} + m_{it} - \rho m_{i,t-1}$$

Where firm's productivity shocks t_{it} are determined as:

$$\mathbf{a}_{it} = f^i(\mathbf{G}_{it}, \mathbf{Z}_{it}) \\ (5) \quad (F_i, M_i, R \& D_{it}) \in \mathbf{G}_{it} \\ (ES_{jt}, HS_{jt}, VS_{jt}^B) \in \mathbf{Z}_{it}$$

where \mathbf{G}_{it} accounts for technology determinants internal to the firm, and \mathbf{Z}_{it} accounts for factors external to the firm, i.e. spillovers.

Estimated models

Search for direct effects and spillovers (test 1):

$$(6) \quad y_{it} = \rho y_{it-1} + \alpha k_{it} - \rho \alpha k_{it-1} + \beta l_{it} - \rho \beta l_{it-1} + \gamma n_{it} - \rho \gamma n_{it-1} \\ + \pi F_i k_{it} - \rho \pi F_i k_{it-1} + \psi F_i l_{it} - \rho \psi F_i l_{it-1} + \omega F_i n_{it} - \rho \omega F_i n_{it-1} \\ + \kappa F_i + \mu M_i + \varepsilon ES_{it} + \chi HS_{it} + \varphi F_i HS_{it} + \upsilon VS_{it}^B + \varpi F_i VS_{it}^B \\ + \lambda \Lambda_{it} + \delta_t + u_{it}$$

Importance of absorptive capacity (test 2)

$$(7) \quad y_{it} = \rho y_{it-1} + \alpha k_{it} - \rho \alpha k_{it-1} + \beta l_{it} - \rho \beta l_{it-1} + \gamma n_{it} - \rho \gamma n_{it-1} \\ + \phi RD_{it} - \rho \phi RD_{it-1} + \chi HS_{it} + \theta HS_{it} RD_{it} + \upsilon VS_{it}^B + \tau VS_{it}^B RD_{it} \\ + \varepsilon ES_{it} + \delta_t + u_{it}$$

Estimation process

- Estimation of a dynamic model (included lagged variables for sales and inputs)
- Estimation of data in log first differences
- Endogeneity problem
- No valid instruments for dependent as well as independent variables can be found
- System GMM estimator is used which combines both lagged levels as well as lagged first differences in order to instrument for the first-differences equation
- Explicit control for selection bias due to non-random foreign investment decisions using Heckman two-step procedure

Data

- **Firm level panel data for ten transition countries**
- **Manufacturing firms only, with more than 100 employees**
- **Period 1994 (5)-1999**
- **Source: local Statistical offices; Amadeus**

Table 3: Impact of FDI: Direct effects and spillovers (Test 1)
(Sample of domestic and foreign owned firms)

Test1	BG	CZ	EST	HU	LT	LV	PL	RO	SK	SLO
FDI dummy	-0.027 (-0.99)	***-0.126 (-3.82)	**0.162 (2.50)	*0.070 (1.73)	***-0.544 (-2.69)	-0.001 (-0.01)	***-0.091 (-2.92)	*-0.050 (-1.70)	0.047 (0.81)	**0.052 (2.12)
Majority FDI	0.013 (1.07)	0.002 (0.20)	**0.041 (2.16)	0.002 (0.14)	***0.492 (4.82)	0.015 (0.76)	-0.001 (-0.25)	**0.015 (2.48)	0.004 (0.26)	-0.002 (-0.37)
Hor_Spill	0.0001 (0.69)	***0.0003 (2.67)	-0.0004 (-1.35)	0.0002 (1.60)	-0.0010 (-1.24)	-0.0001 (-0.41)	**0.0002 (2.09)	***0.0003 (3.02)	*0.0006 (1.87)	0.00004 (0.98)
Hor_Spill_FDI	*0.0007 (1.79)	0.0002 (1.40)	0.0001 (0.25)	0.0003 (0.89)	-0.0076 (-0.86)	0.0002 (0.37)	0.000002 (0.02)	0.0002 (1.55)	0.0003 (0.63)	-0.00001 (-0.08)
Backward_Spill	-0.001 (-0.94)	***0.003 (2.65)	-0.001 (-0.59)	-0.003 (-1.31)	0.032 (1.40)	0.002 (1.25)	**0.002 (2.29)	0.001 (0.83)	0.010 (0.29)	**0.001 (2.21)
Backward_Spill_FDI	***0.009 (2.59)	0.002 (0.60)	0.002 (0.90)	0.000 (0.01)	*-0.984 (-1.83)	***-0.013 (-2.74)	0.002 (0.63)	0.000 (0.11)	-0.053 (-1.28)	-0.002 (-0.94)
No. of obs.	4123	3985	1047	760	422	555	4271	6018	426	5170
AR(1)	***-10.62	***-5.68	***-6.28	** -2.31	** -2.71	** -2.63	***-7.37	***-10.82	** -2.05	***-10.20
AR(2)	0.08	-0.40	-	-	1.30	0.17	0.26	-1.68	-0.80	0.55

Table 4: Impact of R&D - Importance of innovative and absorptive capacity (Test 2)
(Sample of domestic firms only)

Test2	BG	CZ	EST	HU	LT	LV	PL	RO	SK	SLO
R&D	0.021 (0.98)	0.001 (1.60)	-0.006 (-0.40)	-0.005 (-1.48)	*0.115 (1.88)	***0.015 (2.98)	0.000 (0.21)	*0.009 (1.70)	** -0.011 (-2.09)	-0.002 (-0.92)
R&D(-1)	-0.024 (-1.05)	-0.001 (-1.60)	0.017 (0.67)	*0.016 (1.68)	-0.069 (-0.82)	*-0.011 (-1.82)	0.000 (-0.10)	-0.009 (-1.57)	0.009 (1.49)	0.005 (1.46)
Hor_Spill	-0.0001 (-0.79)	-0.0001 (-0.81)	0.0001 (0.21)	0.0001 (0.32)	-0.0011 (-1.45)	-0.00004 (-0.21)	0.0001 (1.57)	**0.0001 (2.45)	-0.0004 (-1.05)	0.0001 (1.41)
Hor_Spill_R&D	4.6E-05 (1.24)	-2.8E-07 (-0.55)	** -0.0001 (-2.24)	**5.4E-05 (2.18)	3.3E-04 (0.75)	*-5E-06 (-1.80)	4.9E-06 (0.59)	4.3E-07 (0.56)	**0.0004 (2.31)	-3.8E-06 (-0.51)
Backward_Spill	-0.001 (-1.18)	***0.004 (2.74)	-0.001 (-0.58)	-0.0002 (-0.06)	0.014 (0.54)	0.002 (0.84)	**0.002 (2.28)	0.0004 (0.59)	-0.009 (-0.34)	***0.002 (2.95)
Backward_Spill_R&D	-0.0004 (-0.86)	0.00001 (0.50)	0.0002 (0.46)	-0.0004 (-0.76)	0.010 (0.47)	0.0001 (0.71)	0.00002 (0.16)	*-0.0001 (-1.83)	-0.002 (-0.86)	** -0.0002 (-2.06)
No. of obs.	3820	3308	759	583	411	438	3712	5075	398	4633
AR(1)	-9.99	-4.49	-4.91	-2.72	-2.73	-3.36	-7.71	-8.94	-1.79	-9.69
AR(2)	0.44	-0.17	-	-	1.30	0.61	-1.00	-1.82	-1.27	0.54

Conclusions

- Existing empirical evidence focussing on spillovers from FDI is inconclusive
- However, the latest evidence show:
 - Direct FDI effects provide by far the most important productivity spillover for local firms
 - Impact of backward vertical spillovers is higher by factor 10 relative to horizontal spillovers
- In general, the characteristics of the home economic environment are the most important factors attracting domestic as well as foreign investments
- If any FDI promotion, then careful linkages promotion program is desired

Is there a need for a policy?

- FDI promotion should focus not only on the quantity of FDI but also on its quality, including linkages
- A clear vision of how FDI fits into the overall development strategy
- Setting up a linkage program that should, in particular, address the competitive needs of domestic enterprises
- The capabilities of local firms are the single most important determinant of success.