

# **DISENTAGLING VERTICAL LINKAGES FROM FOREIGN MNCS AND THEIR IMPACT ON MANUFACTURING PRODUCTIVITY**

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# OUTLINE

- Motivation
- Aim and research questions
- Review of the literature
- Empirical strategy
- Data and descriptive statistics
- Results
- Conclusions

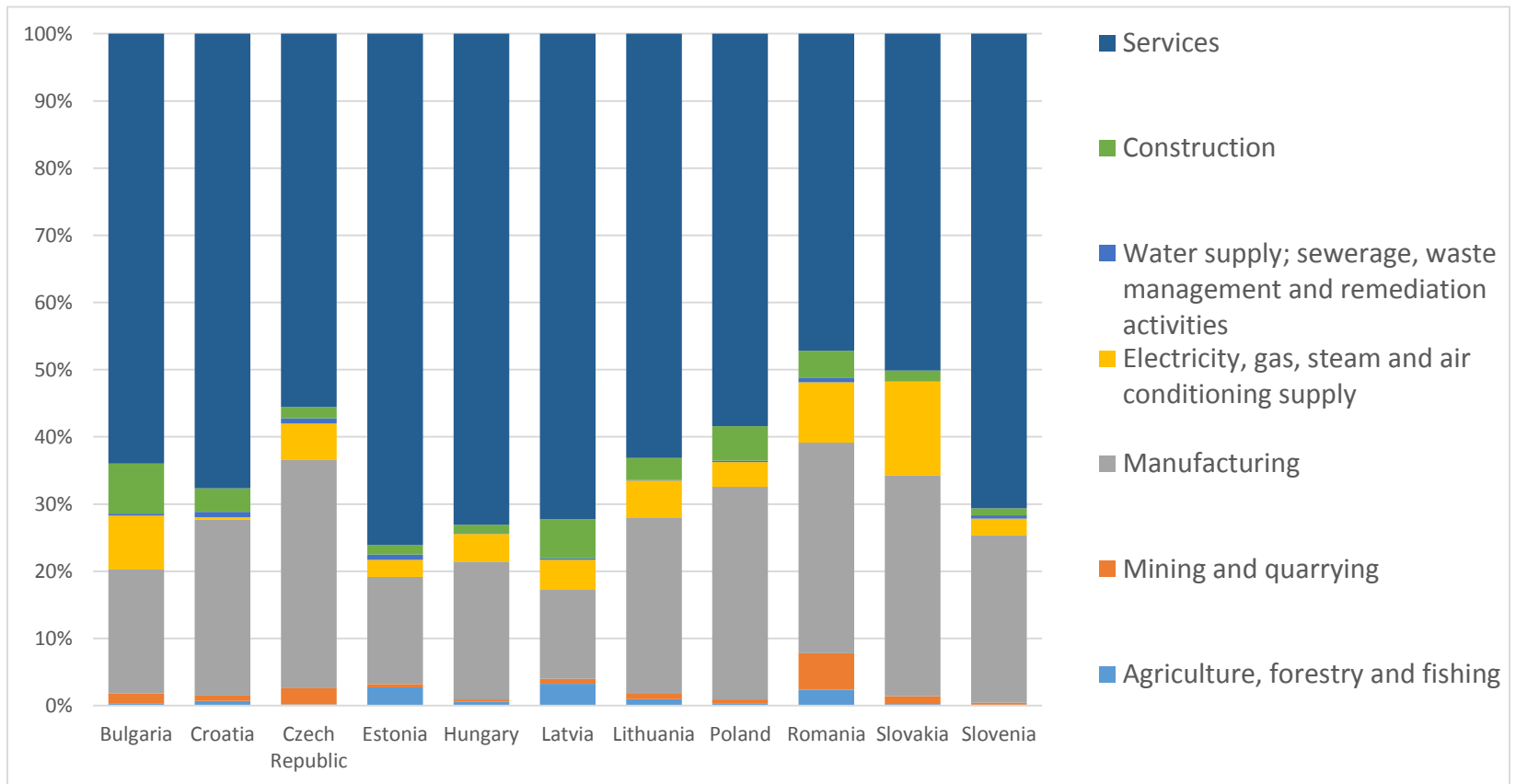


# SHARE OF FDI STOCK IN GDP (%)

	1995	2000	2007	2014
Bulgaria	3.2	20.2	86.8	83.3
Croatia	2.2	12.2	72.5	52.1
Czech Republic	12.3	35.2	59.5	59.1
Estonia	17.8	46.4	70.4	74.4
Hungary	24.5	48.5	68.9	71.7
Latvia	11.4	21.5	35.6	45.6
Lithuania	5.2	20.3	37.8	30.5
Poland	5.6	19.5	40.1	44.8
Romania	2.3	18.6	35.9	37.4
Slovakia	6.5	33.6	62.1	53.2
Slovenia	8.5	14.2	22.7	25.7
Average	9.1	26.4	53.8	52.5



# FDI STOCK BY COUNTRY AND MAIN ECONOMIC ACTIVITIES, 2012



# AIM AND RESEARCH QUESTIONS

- Analysis of indirect effects of FDI on productivity of local manufacturing firms
  - How heterogeneity of vertical linkages resulting from MNCs operating in manufacturing and service sector affect local firms' productivity in manufacturing sector?
  - What are the moderating effects of absorptive capacity and how strong are they?
  - Do all foreign services inputs matter for manufacturing productivity?



# THE IMPORTANCE OF SERVICES

- Services play an important role in economic output of advanced economies (on average over 70% in GDP)
  - In NMS services value added contributes on average 65% of GDP
- Increasing reliance of manufacturing industries on services inputs
  - In the EU, on average 25% of direct cost shares are services inputs
  - When taking direct and indirect linkages the share comes close to 40%
- Manufacturing industries increasingly engaged in provision of services – “servitisation of manufacturing”
- Increasing importance of upstream and downstream functions in value chains



# MANUFACTURING SERVICES INTER-LINKAGES

- Direct impact on growth as additional input in production function (Antonelli, 1998; Tomlinson, 2000)
- Indirect impact as providers of inputs to downstream clients resulting in increased productivity (Arnold et al., 2011; Fernandes and Paunov, 2012), value added (Kox and Rubalcaba, 2007) and innovation (Evangelista et al., 2013)
- Liberalisation of services leads to:
  - Increased specialisation (Francois, 1990)
  - Increased variety, availability and better quality of inputs (Horn and Wolinksy, 1998; Barone and Cingano, 2011)
  - Knowledge spillovers (Mirodout, 2006; Kox and Rubalcaba, 2007)



# BENEFITS OF FDI FOR NMS

- Direct effects:
  - Provision of tangible and intangible capital
  - Restructuring of firms
  - Improved export performance and shift to higher value added segments
  - Improved corporate governance
  - Transfer of technology, management skills and know how





# BENEFITS OF FDI FOR NMS

- FDI spillovers:
  - Intra-industry unintentional knowledge diffusion of technology through:
    - Demonstration or imitation (Koizumi and Kopecky, 1977; Das, 1987)
    - Worker mobility (Fosfuri et al., 2001; Markusen and Trefler, 2009)
    - Competition – in short run may cause crowding out effects (Wang and Blomstrom, 1992; Aitken and Harrison, 1997)
  - Inter-industry through direct knowledge transfer potentially resulting in technology spillovers to other firms (Rodriguez-Clare, 1996; Markusen and Venables, 1999; Lin and Saggi, 2007; Carluccio and Fally, 2013):
    - Backward linkages: demand effects, assistance effects, diffusion effects
    - Forward linkages: availability of high quality inputs



# SUMMARY OF EMPIRICAL EVIDENCE

- Micro evidence on intra-industry mostly inconclusive (Gorg and Greenaway, 2004) or negligible (Havranek and Irsova, 2013)
  - However, when taking firm heterogeneity into account some positive effects emerge mainly from:
    - Joint ventures, small technological gaps, human capital, medium to high productivity firms (Damijan et al., 2013)
- Backward linkages mostly positive and significant (Havranek and Irsova, 2011)
- Forward linkages mostly insignificant (Havranek and Irsova, 2011)
  - The role of services inputs?



# EMPIRICAL STRATEGY

- First stage:
  - Cobb Douglas production function
    - $Y_{it} = A_{it} K_{it}^{\beta_k} L_{it}^{\beta_l}$
    - Taking logs and differentiating with respect to time:
    - $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + \varepsilon_{it}$
- Empirical issues:
  - Potential correlation between input levels and the unobserved firm-specific shocks
    - firms that experience a large positive productivity shock may respond by using more inputs, violating the OLS assumption of strict exogeneity between inputs and the error term
- Potential solutions:
  - Semi-parametric estimators (OP, 1996; LP, 2003; ACF, 2006; Wooldridge, 2009)
  - System GMM (Blundell and Bond, 1998, 1999)



# WOOLDRIDGE ESTIMATOR (2009)

- For firm  $i$  in time period  $t$  production function is:

- $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + \omega_{it} + \varepsilon_{it}$  (1)

- A key assumption in OP (1996) and LP (2003) is that for some function  $g(.,.)$ :

- $\omega_{it} = h_t(M_{it}, K_{it})$  (2)

- Substituting eq. (2) into eq. (1) we get:

- $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + g_t(K_{it}, M_{it}) + \varepsilon_{it}$  (3)

$$= \beta_l \ln(L_{it}) + h(K_{it}, M_{it}) + \varepsilon_{it}$$

where  $h(K_{it}, M_{it}) = \beta_0 + \beta_k \ln(K_{it}) + g_t(K_{it}, M_{it})$



# WOOLDRIDGE ESTIMATOR (2009)

- Productivity evolves as a first order Markov process:

- $\omega_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it}$  (4)

- Productivity innovation  $\xi_{it} = \omega_{it} - E[\omega_{it} | \omega_{it-1}]$  is assumed to be uncorrelated with current values of capital as well as past values of labour, capital and materials:

- $E[\omega_{it} | \omega_{it-1}] = f[g(k_{i,t-1}, m_{i,t-1})] + \xi_{it}$  (5)

- Plugging the eq. (5) into eq. (1) gives:

- $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + f[g(k_{i,t-1}, m_{i,t-1})] + \xi_{it} + \varepsilon_{it}$

- Now it is possible to estimate two equations to identify labour and capital:

- $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + g(k_{i,t}, m_{i,t}) + \varepsilon_{it}$  (6)

- $\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + f[g(k_{i,t-1}, m_{i,t-1})] + \xi_{it} + \varepsilon_{it}$  (7)

- Orthogonality conditions necessary for GMM estimations differ for two eq.:

- For eq. (6):  $E(\varepsilon_{it} | l_{it}, k_{it}, m_{it}, l_{i,t-1}, k_{i,t-1}, m_{i,t-1}, \dots, l_{i1}, k_{i1}, m_{i1}) = 0$

- For eq. (7):  $E(u_{it} | k_{it}, l_{i,t-1}, k_{i,t-1}, m_{i,t-1}, \dots, l_{i1}, k_{i1}, m_{i1}) = 0$

where  $u_{it} = \xi_{it} + \varepsilon_{it}$



# TFP MEASURE AND FINAL EMPIRICAL MODEL

- We obtain TFP as:
  - $\omega_{it} = \ln(Y_{it}) - \beta_k \ln(K_{it}) - \beta_l \ln(L_{it})$
- The second stage:
  - Empirical model of FDI spillovers:
    - $\ln TFP_{it} = \beta_0 + \rho \ln(TFP_{it-1}) + \delta_1 MNC_{j,t-k} + \theta_2 DF_{it} + \lambda_3 IND_{jt} + \gamma_j + \gamma_r + \gamma_t + \varepsilon_{ijt}$

TFP: Total factor productivity of domestic firms  $i$  in time  $t$

MNC: Vector of FDI spillover channels

DF: Vector of firm specific variables (age, size, intangible asset and average wage)

IND: Vector of industry controls (demand in downstream sectors and sector competition)

$\gamma_j, \gamma_r, \gamma_t$ : industry, region and time dummies



# MEASURING FDI SPILLOVERS

- Horizontal spillovers:

- $$Horizontal_{jt} = \frac{\sum_{i \in j} Foreign_{it} * Y_{it}}{\sum_{i \in j} Y_{it}}$$

- Vertical linkages (backward):

- Specifically, if sector  $k$  is the sector in which MNCs are present and sector  $j$  is manufacturing sector backward linkages from manufacturing and services sector are calculated as follows:

$$Manufacturing\ Backward_{jt} = \sum_{k=1}^K \alpha_{jkt} Horz_{mant}$$

$$Services\ Backward_{jt} = \sum_{k=1}^K \alpha_{jkt} Horz_{servt}$$

- Where the coefficient  $\alpha_{jkt}$  measures the share of output of sector  $j$  (manufacturing) sold to downstream industry  $k$  (manufacturing or services)

- Vertical linkages (forward):

$$Manufacturing\ Forward_{jt} = \sum_{l=1}^L \gamma_{jlt} Horz_{mant}$$

$$Services\ Forward_{jt} = \sum_{l=1}^L \gamma_{jlt} Horz_{servt}$$

- Where  $\gamma_{jlt}$  is the amount of inputs sourced from sector  $l$  (manufacturing or services), expressed as a fraction of the total inputs used by manufacturing sector  $j$



# DATA

- Amadeus database on five NMS
- Period: 2002-2010
- Up to 102,988 firm year observations in 23 manufacturing sectors
- WIOD as a source of time varying I-O tables used to construct vertical linkages





# TFP SAMPLE — NUMBER OF LOCAL FIRMS

	Czech R.	Estonia	Hungary	Slovakia	Slovenia
High tech manufacturing	3439	424	338	493	192
Medium high tech manufacturing	16027	1596	966	2983	869
Medium low tech manufacturing	20029	3784	1448	4036	2247
Low tech manufacturing	19762	9228	1539	4478	1997

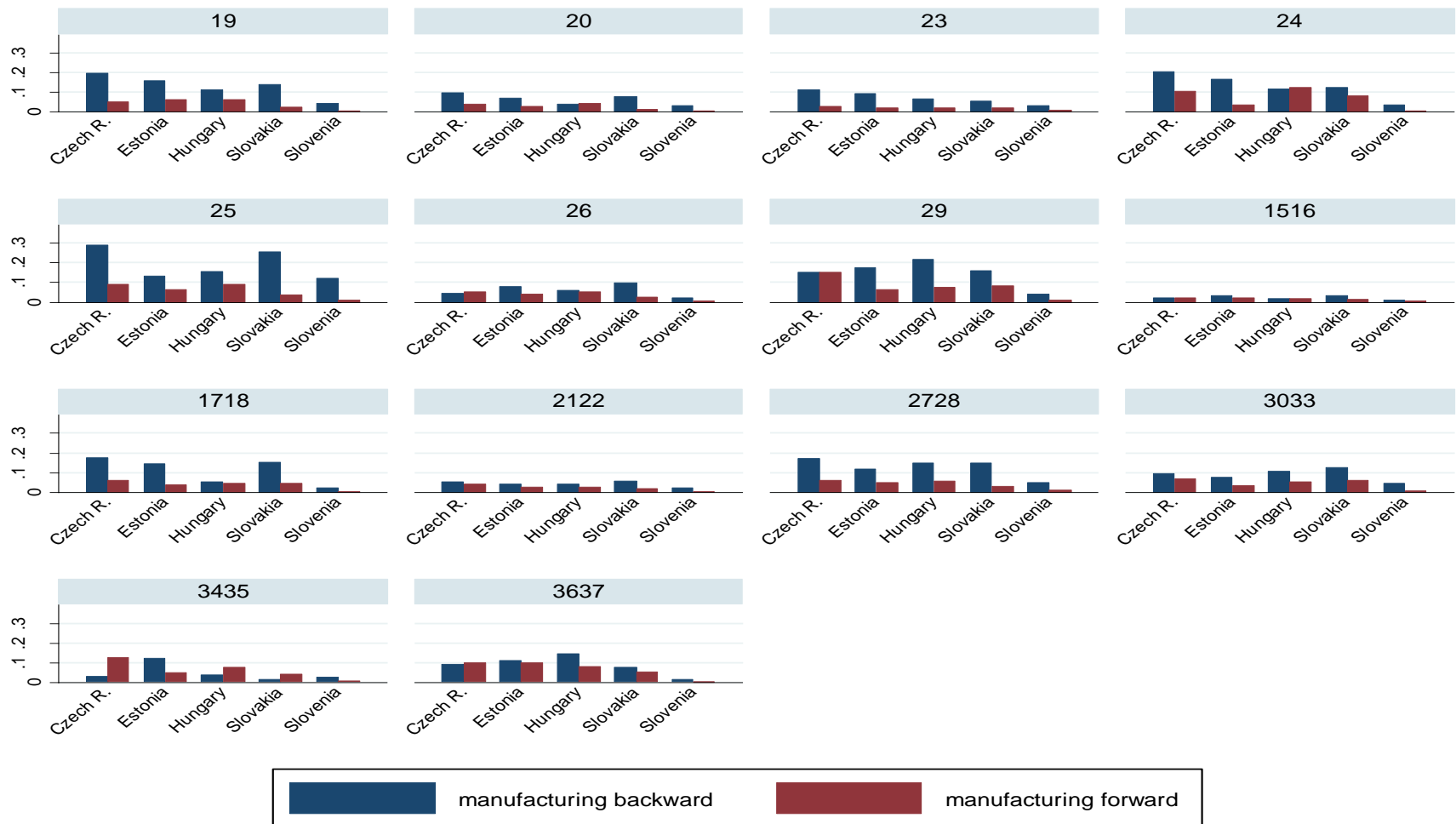


Data

# SHARE OF FOREIGN FIRMS' OUTPUT

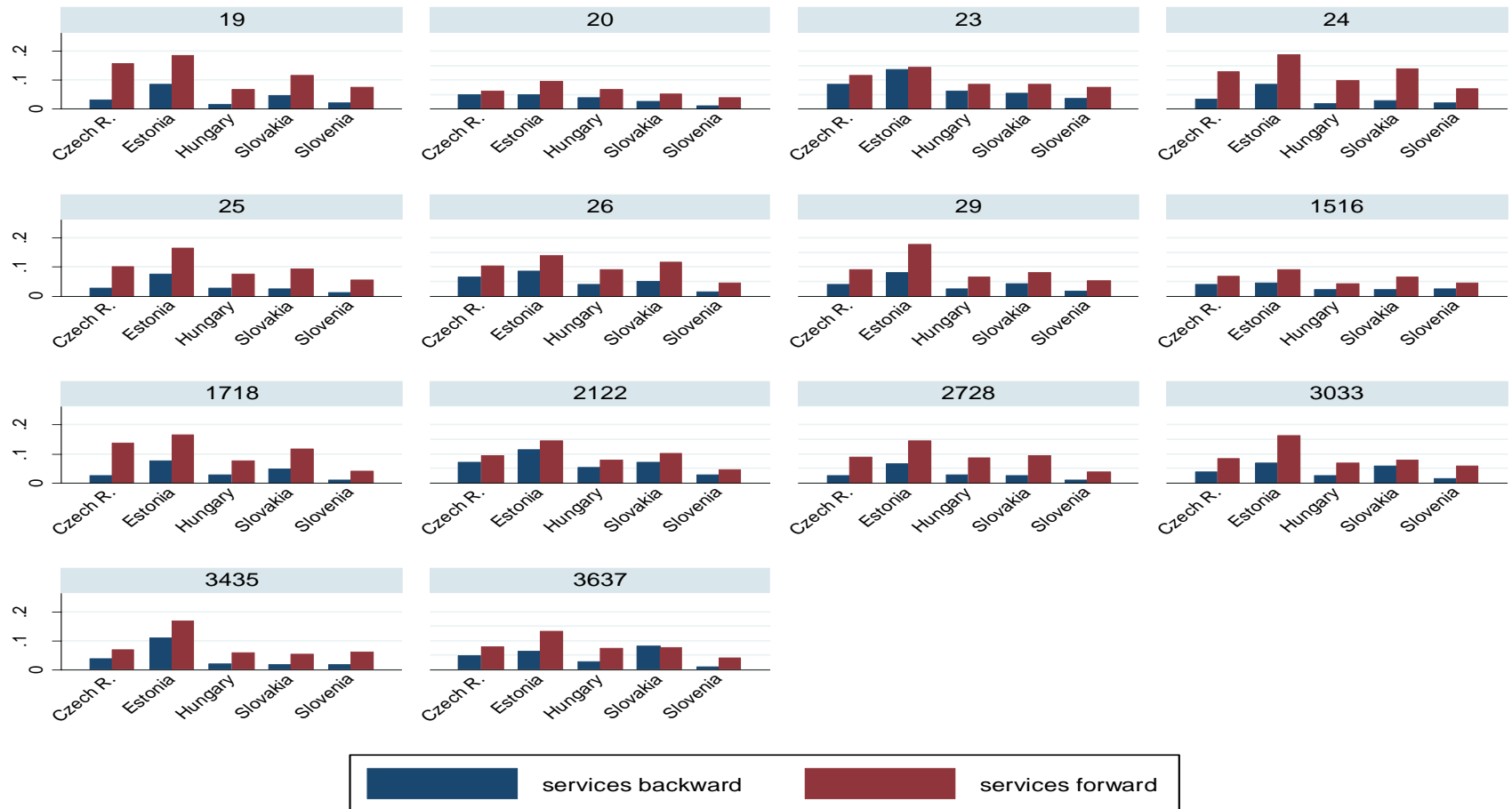


# MANUFACTURING LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Data

# SERVICES LINKAGES ACROSS INDUSTRIES AND COUNTRIES

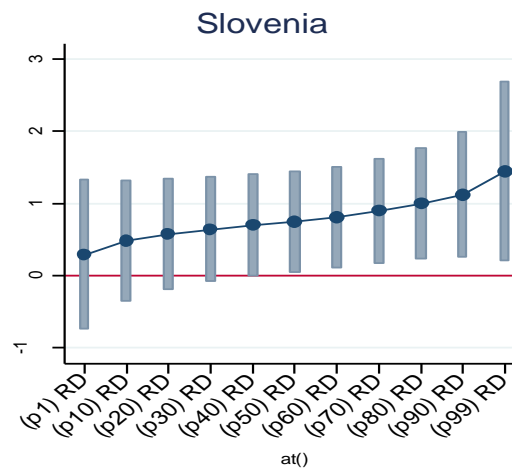
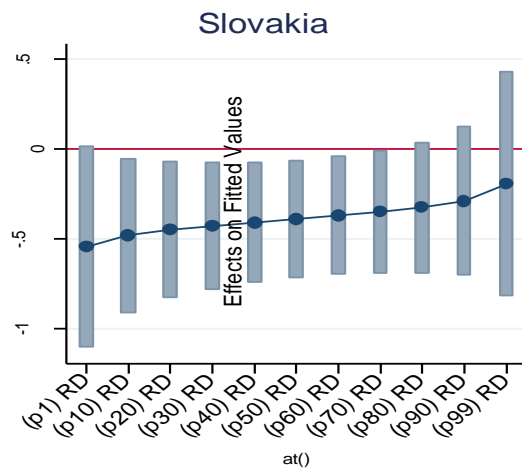
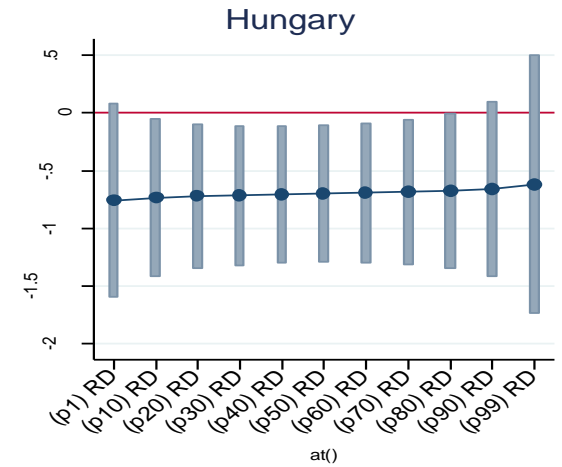
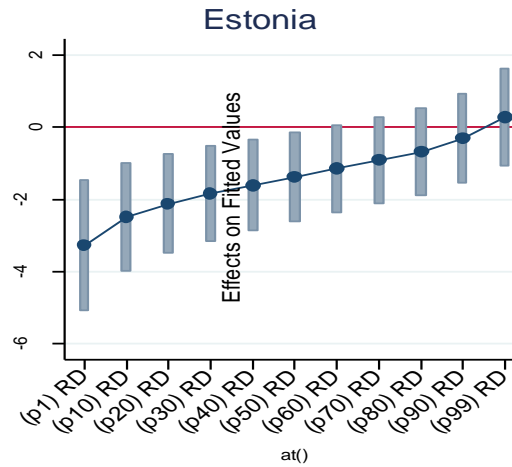
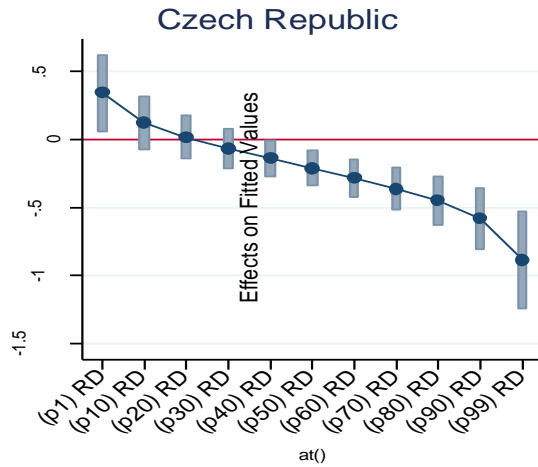


# RESULTS FOR THE BASELINE MODEL

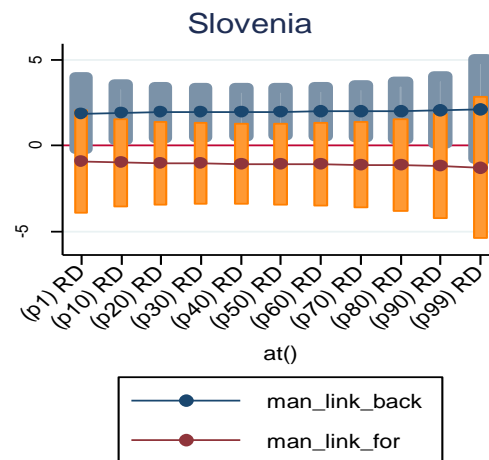
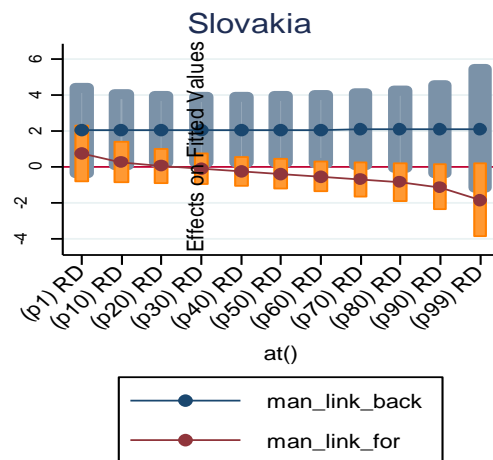
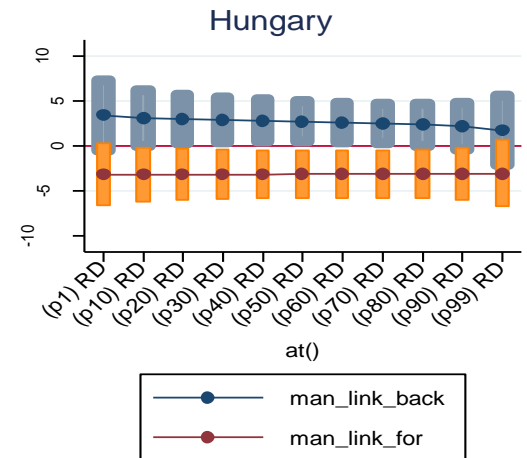
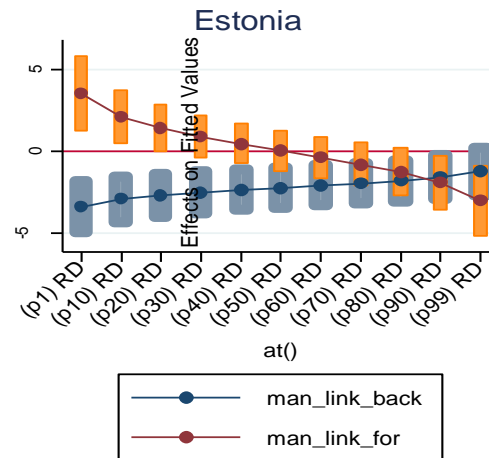
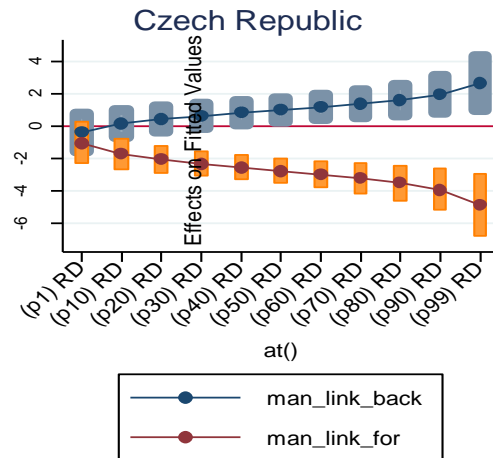
VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
l.ln TFP	<b>0.385***</b>	<b>0.267***</b>	<b>0.600***</b>	<b>0.385***</b>	<b>0.431***</b>
Horizontal	<b>-0.167**</b>	<b>-0.635***</b>	<b>-0.701**</b>	<b>-0.383**</b>	<b>0.206</b>
<b>Backward_man</b>	<b>1.740***</b>	<b>-0.597*</b>	<b>2.765**</b>	<b>1.815*</b>	<b>1.841**</b>
<b>Forward_man</b>	<b>-2.573***</b>	<b>-1.331***</b>	<b>-3.082**</b>	<b>-0.257</b>	<b>-0.333</b>
<b>Backward_serv</b>	<b>-7.576***</b>	<b>1.286*</b>	<b>-20.66***</b>	<b>5.331*</b>	<b>-9.719**</b>
<b>Forward_serv</b>	<b>4.417***</b>	<b>3.110***</b>	<b>6.913*</b>	<b>6.150***</b>	<b>13.60***</b>
Human capital	<b>0.482***</b>	<b>0.488***</b>	<b>0.295***</b>	<b>0.332***</b>	<b>0.526***</b>
Intangibles	<b>0.0453***</b>	<b>0.0766***</b>	<b>0.00774*</b>	<b>0.0597***</b>	<b>0.0289***</b>
Age	<b>-0.00877***</b>	<b>-0.0150***</b>	<b>-0.00491</b>	<b>-0.00930***</b>	<b>-0.0103***</b>
Age^2	<b>7.68e-05*</b>	<b>0.000172***</b>	<b>-8.37e-05</b>	<b>9.16e-05*</b>	<b>6.29e-05</b>
Size	<b>0.213***</b>	<b>0.270***</b>	<b>0.0800*</b>	<b>0.146***</b>	<b>-0.0265</b>
Size^2	<b>-0.00427***</b>	<b>-0.00725***</b>	<b>0.000436</b>	<b>-0.00269</b>	<b>0.0105**</b>
HHI	<b>-0.232***</b>	<b>0.241*</b>	<b>-0.142</b>	<b>-0.159</b>	<b>-0.189</b>
Demand	<b>-0.0332</b>	<b>-0.0456</b>	<b>0.0655</b>	<b>-0.0204</b>	<b>0.0293</b>



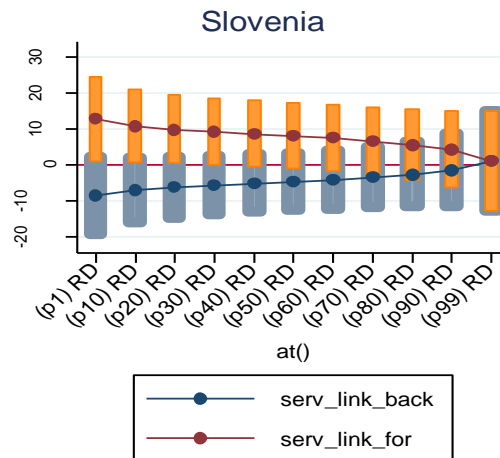
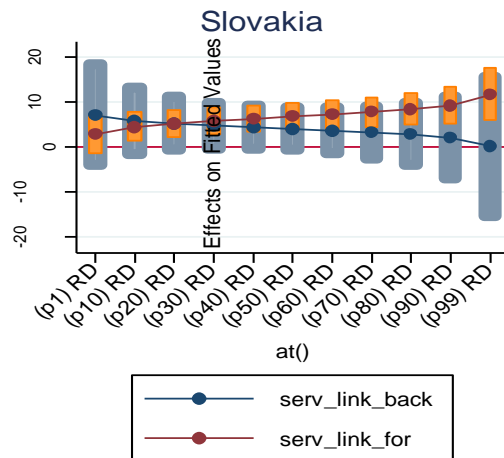
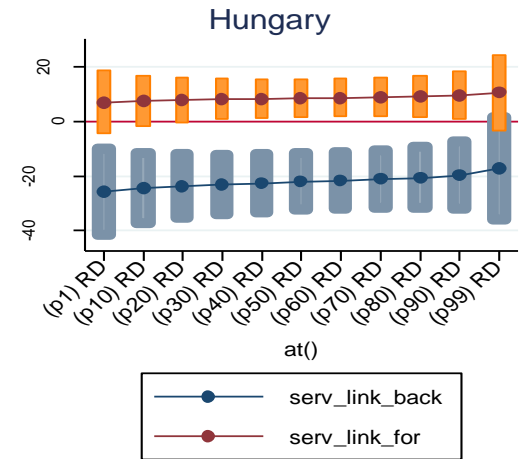
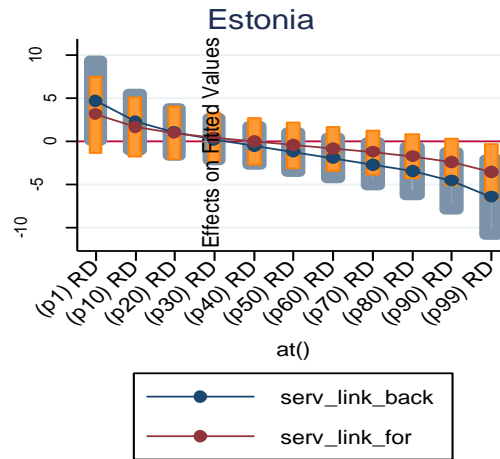
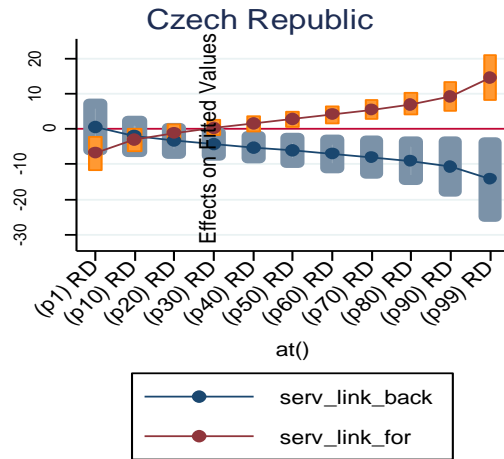
# MODERATING EFFECTS OF ABSORPTIVE CAPACITY – HORIZONTAL EFFECTS



# MODERATING EFFECTS OF ABSORPTIVE CAPACITY — MANUFACTURING LINKAGES



# MODERATING EFFECTS OF ABSORPTIVE CAPACITY – SERVICES LINKAGES





# KIS VS LKIS

VARIABLES	Czech Republic	Estonia	Hungary	Slovakia	Slovenia
L.TFP	<b>0.473***</b>	<b>0.285***</b>	<b>0.621***</b>	<b>0.374***</b>	<b>0.436***</b>
Horizontal	<b>-0.233***</b>	<b>-0.417**</b>	<b>-0.603*</b>	<b>-0.533**</b>	<b>0.136</b>
Backward_man	<b>0.944***</b>	<b>-0.926**</b>	<b>1.178</b>	<b>2.469*</b>	<b>1.458*</b>
Forward_man	<b>-0.719</b>	<b>-0.739</b>	<b>-2.808*</b>	<b>-4.376**</b>	<b>0.152</b>
Backward_serv	<b>-8.240***</b>	<b>1.230*</b>	<b>-16.01***</b>	<b>1.945</b>	<b>-8.713*</b>
<b>ForwardKBIS</b>	<b>8.932***</b>	<b>2.229*</b>	<b>19.75**</b>	<b>3.432*</b>	<b>13.21*</b>
<b>ForwardLBIS</b>	<b>-1.102</b>	<b>0.200</b>	<b>2.615</b>	<b>0.465</b>	<b>12.65***</b>
Human capital	<b>0.435***</b>	<b>0.481***</b>	<b>0.278***</b>	<b>0.335***</b>	<b>0.509***</b>
Intangibles	<b>0.0380***</b>	<b>0.0732***</b>	<b>0.00688*</b>	<b>0.0604***</b>	<b>0.0279***</b>
Age	<b>-0.00734***</b>	<b>-0.0155***</b>	<b>-0.00457</b>	<b>-0.00914***</b>	<b>-0.0112***</b>
Age^2	<b>8.90e-05**</b>	<b>0.000178***</b>	<b>-8.82e-05</b>	<b>8.44e-05*</b>	<b>8.92e-05</b>
Size	<b>0.161***</b>	<b>0.251***</b>	<b>0.0643</b>	<b>0.151***</b>	<b>-0.000814</b>
Size^2	<b>-0.00332***</b>	<b>-0.00592**</b>	<b>0.00124</b>	<b>-0.00295</b>	<b>0.00831*</b>
HHI	<b>-0.295***</b>	<b>0.306</b>	<b>-0.208**</b>	<b>-0.114</b>	<b>-0.215*</b>
Demand	<b>-7.86e-05</b>	<b>-0.0218</b>	<b>0.103*</b>	<b>-0.00898</b>	<b>-0.00328</b>



# CONCLUSIONS

- Heterogeneity of vertical linkages is important
  - Dual effects of manufacturing and services linkages
- Horizontal effects are negative indicating possible negative competition effects
  - However, absorptive capacity matters
- Backward manufacturing linkages important and increasing with investment in new technology
- Forward services linkages consistent with the idea that services liberalisation followed by increased entry of foreign firms in services has beneficial effects on downstream firms' productivity
  - The positive results are almost entirely driven by KIS

