

# **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

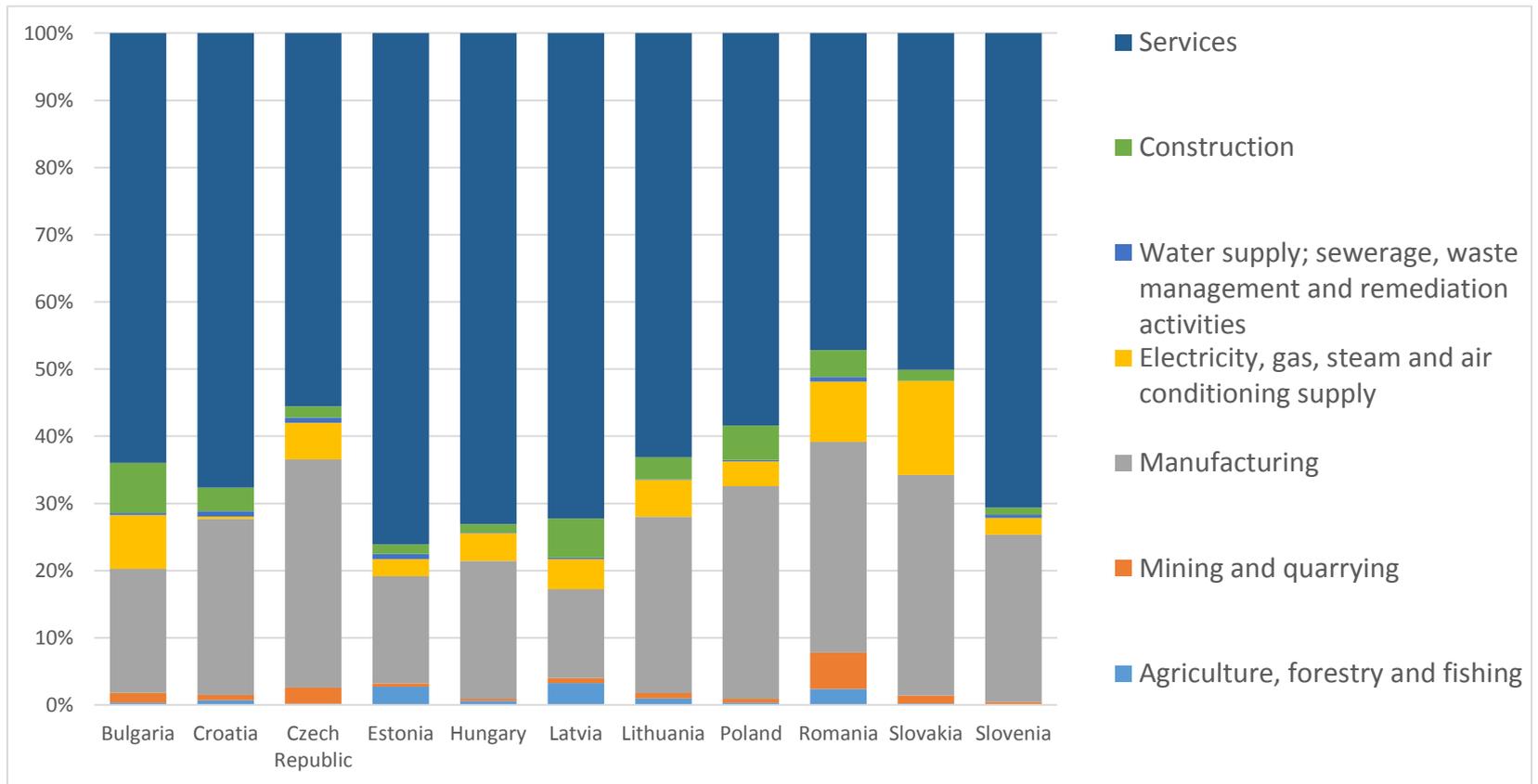


# SHARE OF FDI STOCK IN GDP (%)

|                | 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 Wolinsky, 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  $g(\dots)$ :

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

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

- 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:

$$E[\omega_{it} | \omega_{it-1}] = f[g(\mathbf{k}_{i,t-1}, \mathbf{m}_{i,t-1})] + \xi_{it} \quad (5)$$

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

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

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

$$\ln(Y_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + g(\mathbf{k}_{i,t}, \mathbf{m}_{i,t}) + \varepsilon_{it} \quad (6)$$

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

- 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:

$$\text{Horizontal}_{jt} = \frac{\sum_{i \in j} \text{Foreign}_{it} * Y_{it}}{\sum_{i \in j} Y_{it}}$$

- 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:

$$\text{Manufacturing Backward}_{jt} = \sum_{k=1}^K \alpha_{jkt} \text{Horz}_{mant}$$

$$\text{Services Backward}_{jt} = \sum_{k=1}^K \alpha_{jkt} \text{Horz}_{servt}$$

- 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):

$$\text{Manufacturing Forward}_{jt} = \sum_{l=1}^L \gamma_{jlt} \text{Horz}_{mant}$$

$$\text{Services Forward}_{jt} = \sum_{l=1}^L \gamma_{jlt} \text{Horz}_{servt}$$

- 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



Data

# 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     |

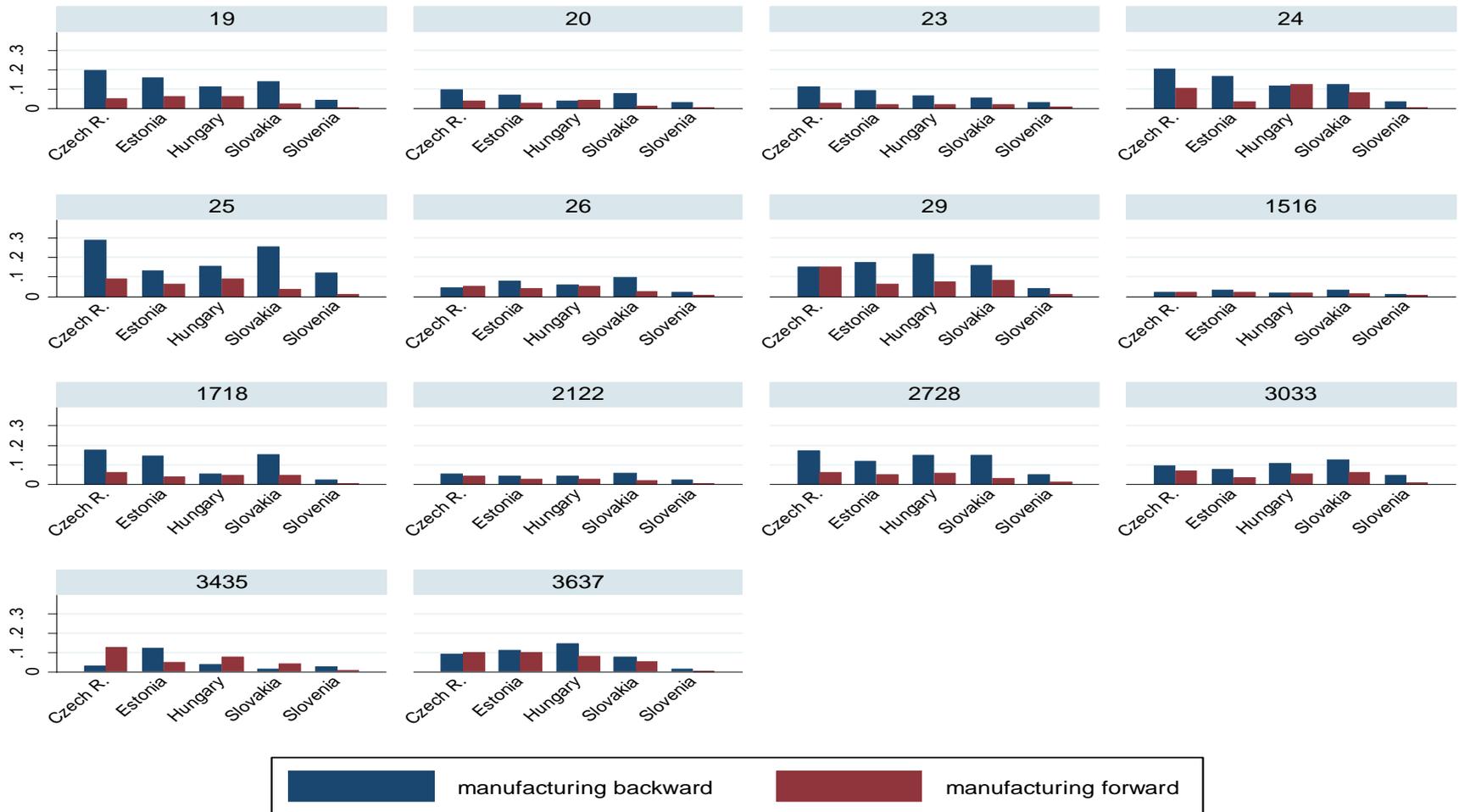


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# SHARE OF FOREIGN FIRMS' OUTPUT

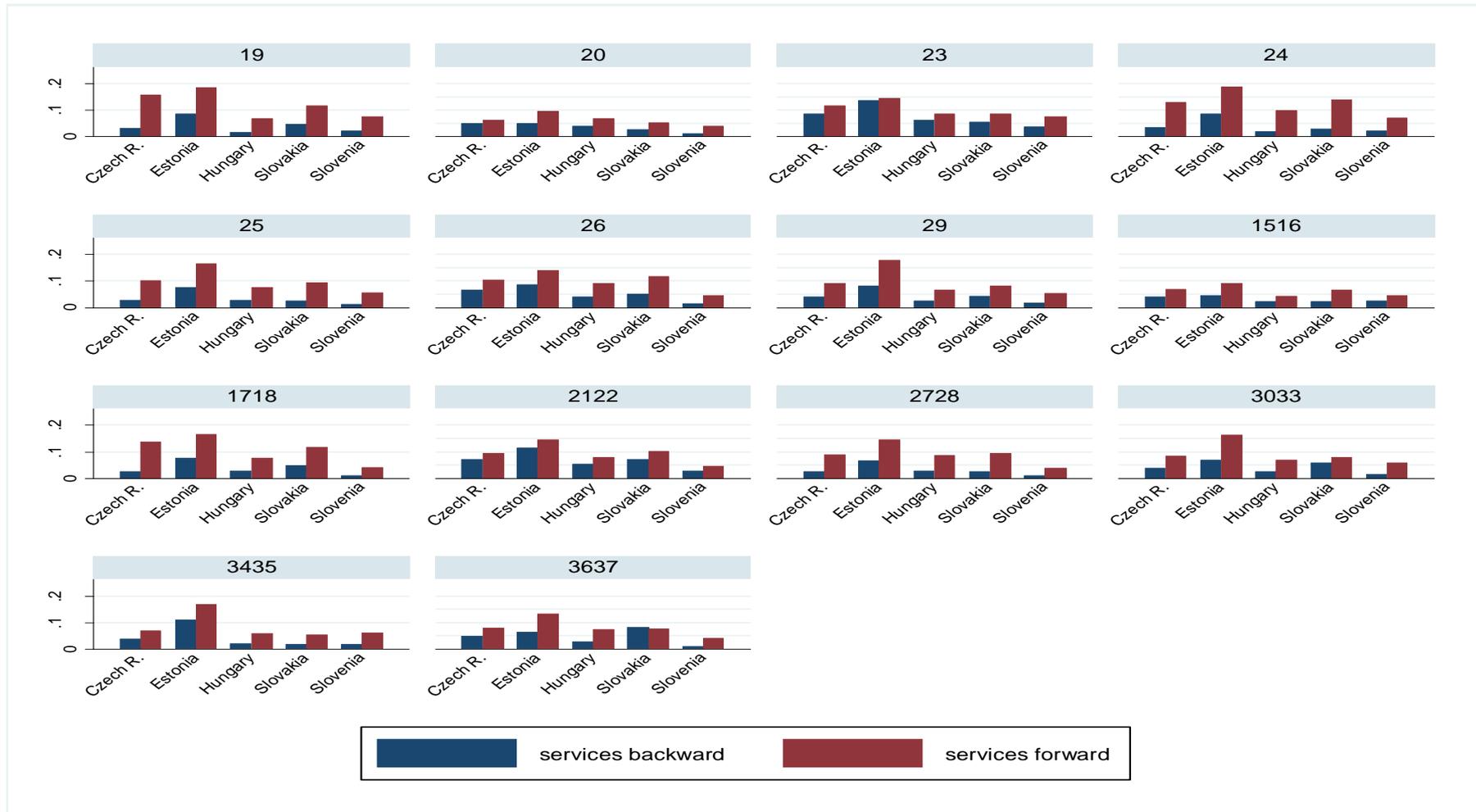


# MANUFACTURING LINKAGES ACROSS INDUSTRIES AND COUNTRIES



Data

# SERVICES LINKAGES ACROSS INDUSTRIES AND COUNTRIES

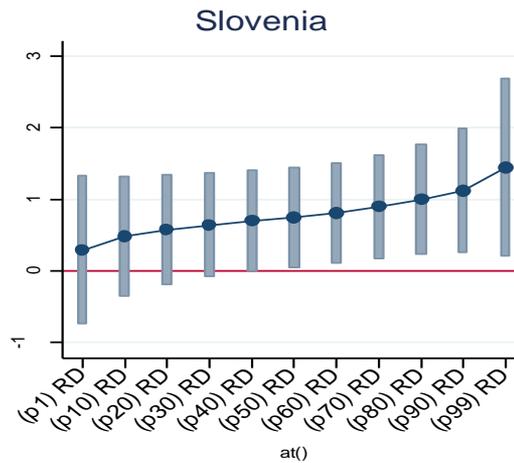
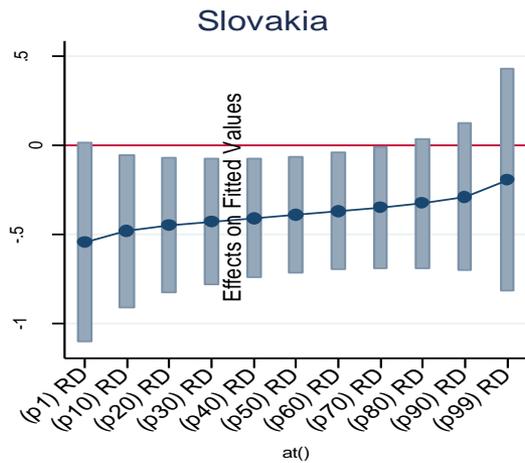
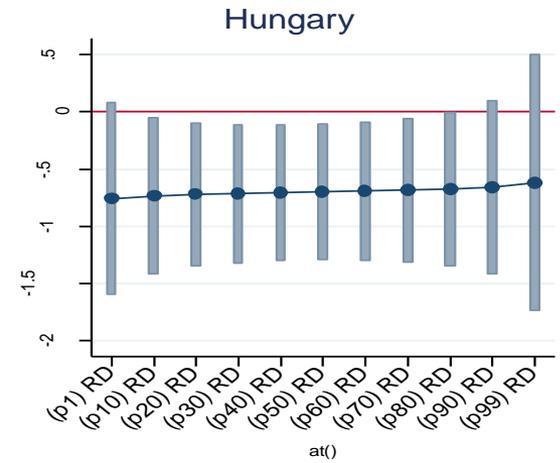
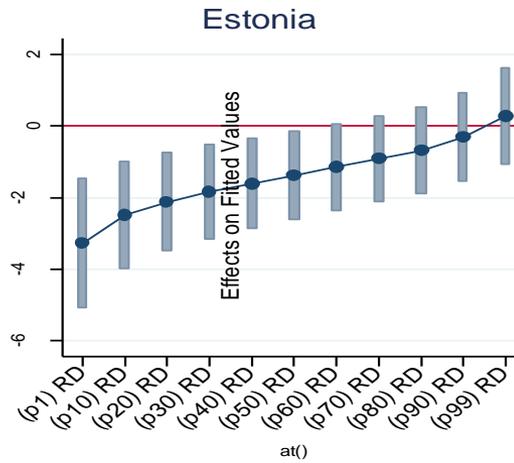
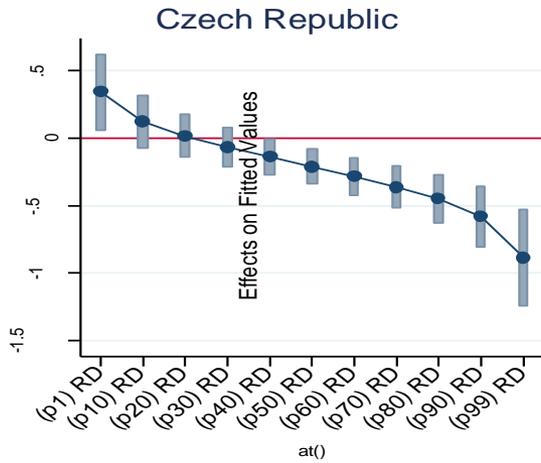


# RESULTS FOR THE BASELINE MODEL

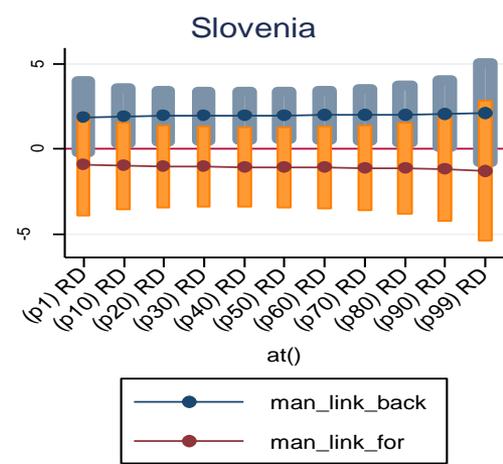
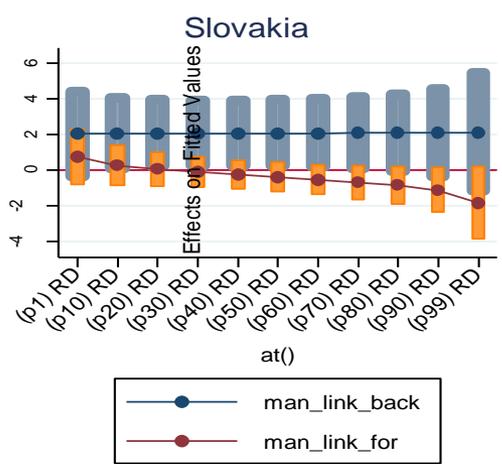
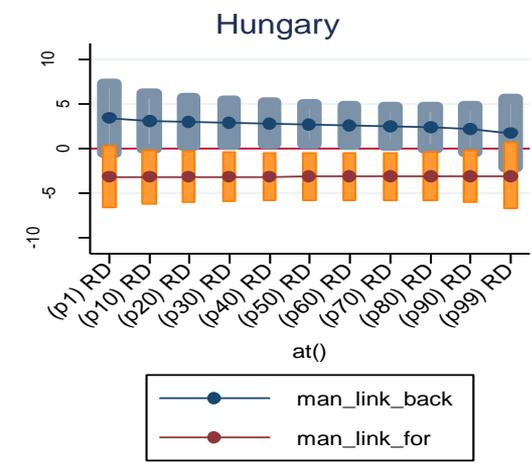
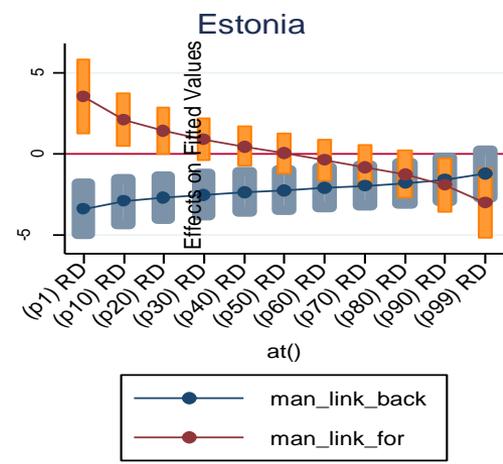
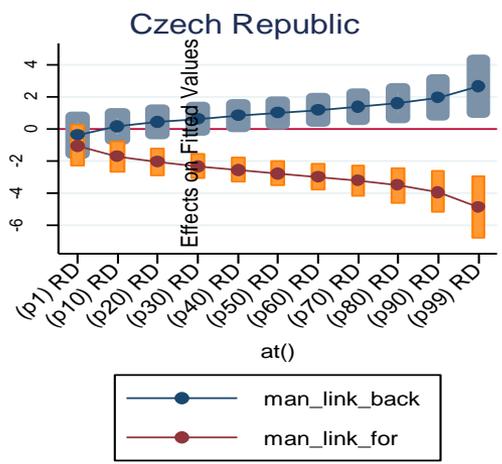
| VARIABLES            | Czech Republic     | Estonia            | Hungary          | Slovakia           | Slovenia          |
|----------------------|--------------------|--------------------|------------------|--------------------|-------------------|
| l.ln TFP             | <b>0.385***</b>    | <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>     |



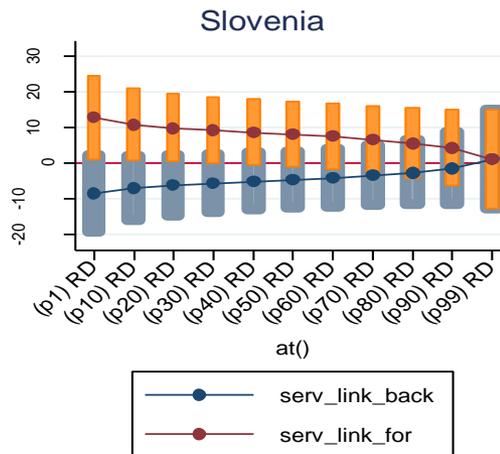
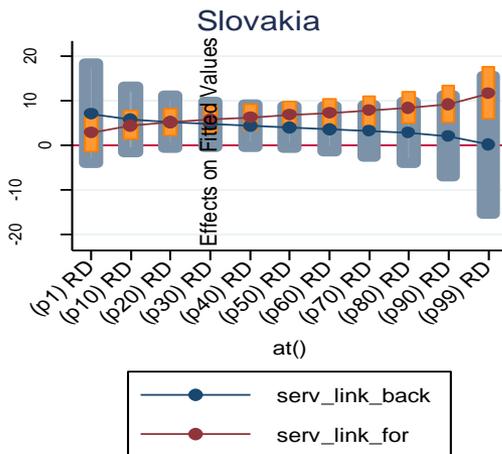
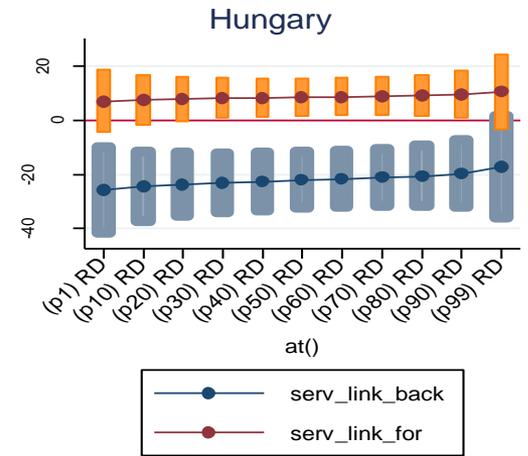
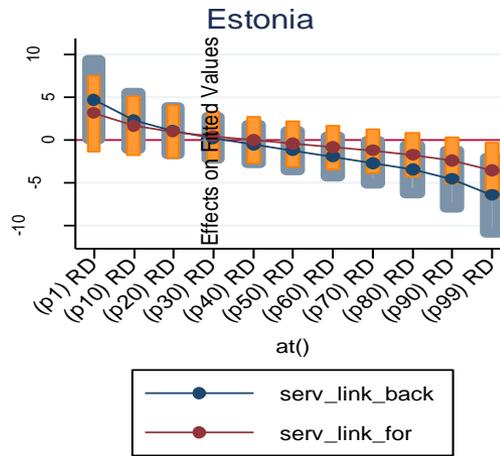
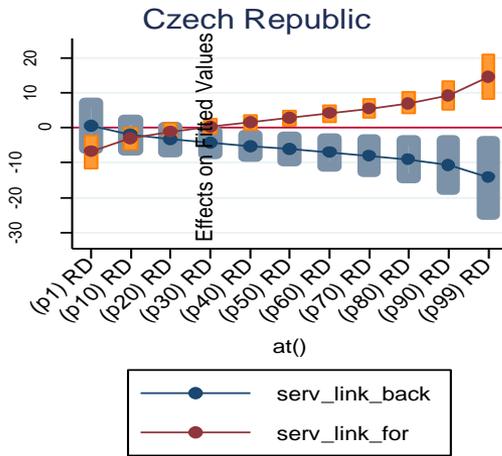
# MODERATING EFFECTS OF ABSORPTIVE CAPACITY – HORIZONTAL EFFECTS



# 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

