



EUROPEAN CENTRAL BANK

EUROSYSTEM

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The post-crisis TFP growth slowdown in CEE countries:

Exploring the role of Global Value Chains

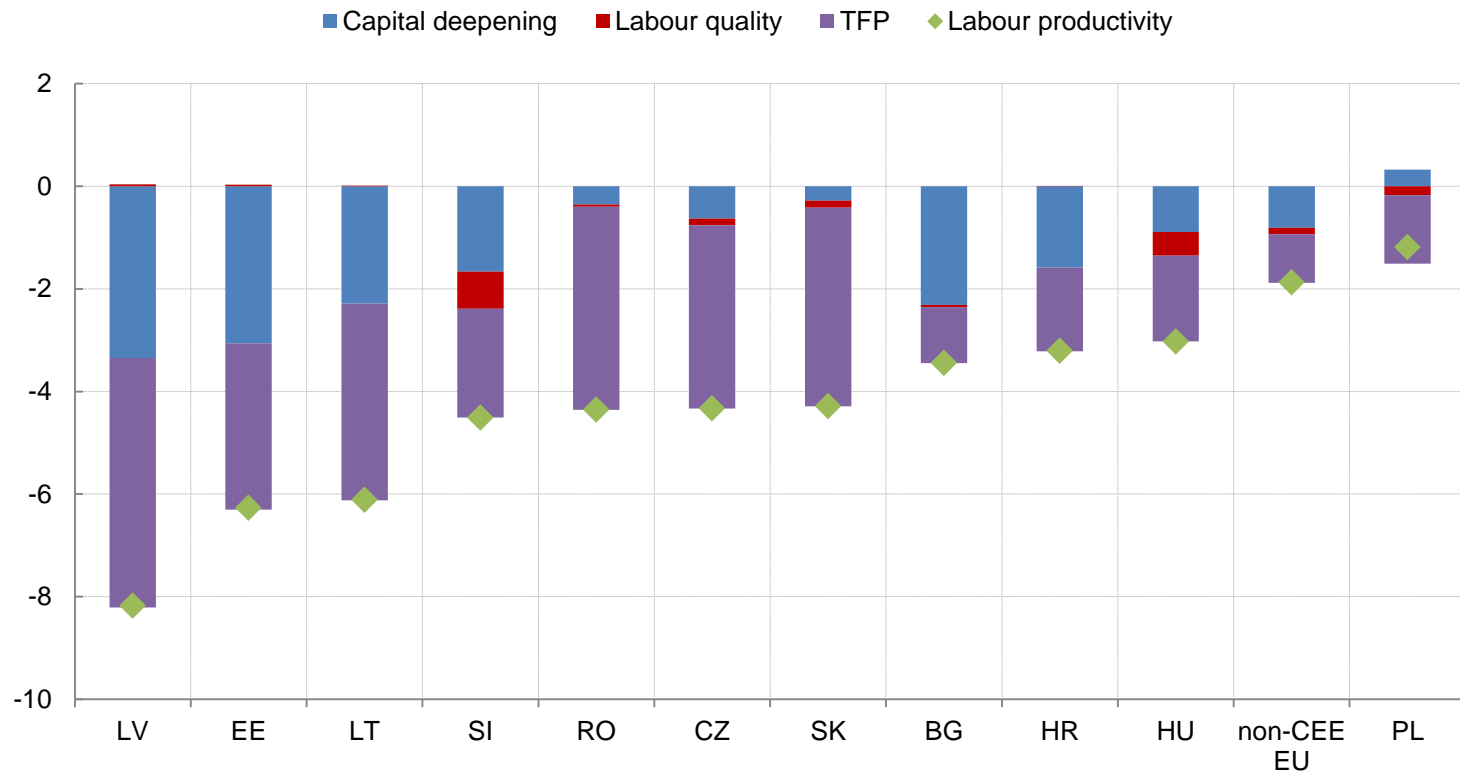
CompNet 13th Annual Conference, Brussels 29-30 June

An earlier version of this paper greatly benefitted from the inputs of Elisa Gamberoni. Usual disclaimer applies

- 1 Motivation**
- 2 Framework for the analysis
- 2 Empirical specification, data and variable definition
- 3 Econometric results
- 4 Preliminary conclusions

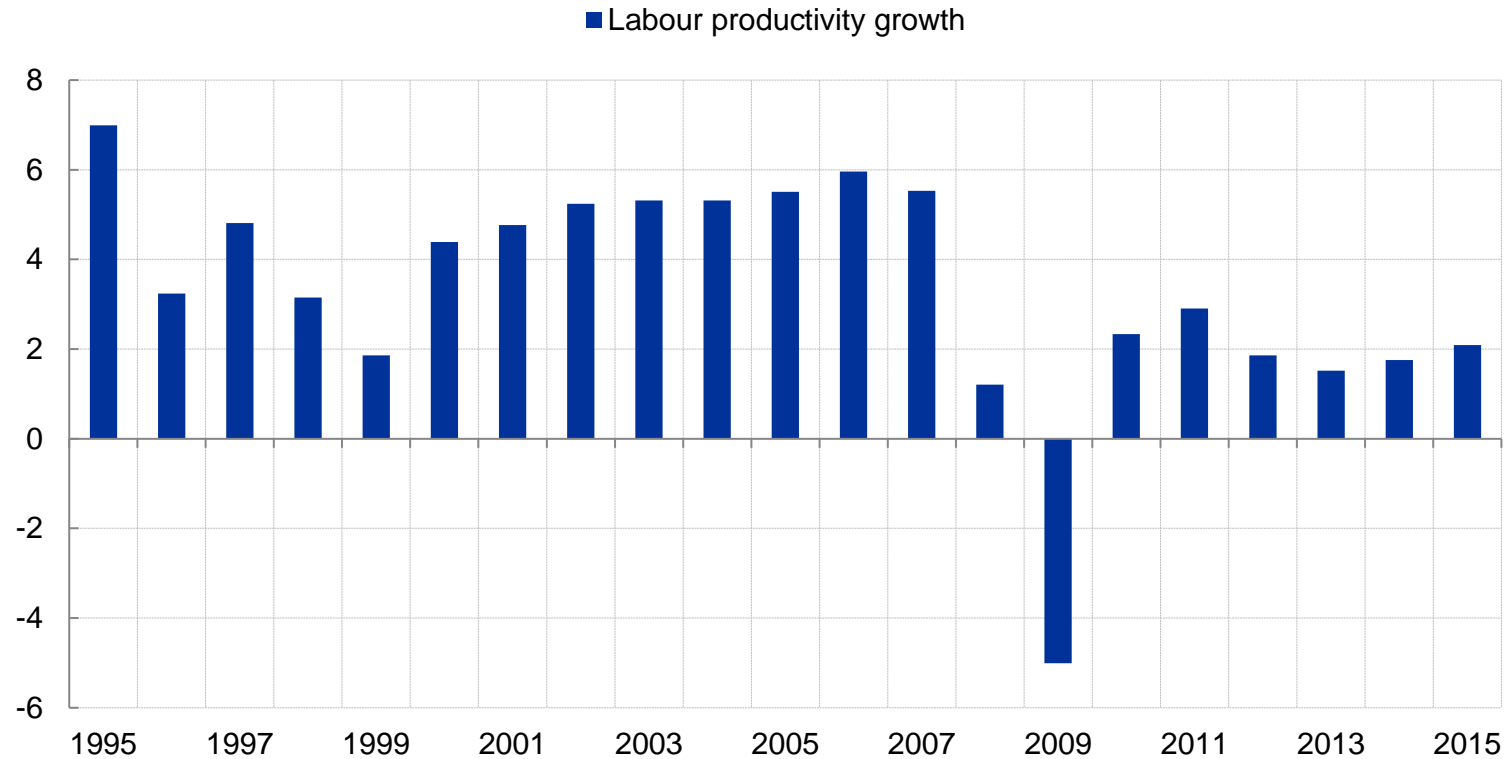
Labour productivity growth slowed down to a larger extent in CEE countries relative to other countries in the EU; driven by TFP

Difference in average labour productivity growth (in %) between the crisis/post-crisis (2008-2015) and pre-crisis period (2000-2007) and decomposition into its main contributors.



Source: Authors' calculations based on Conference Board.

Labour productivity (y-o-y change)

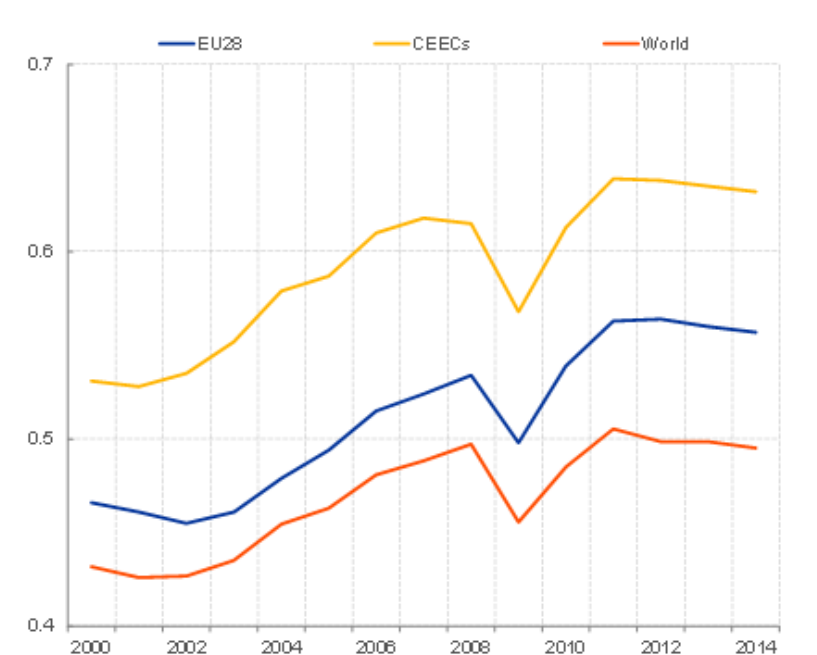


Source: Authors' calculations based on Conference Board.
Note: Y-o-Y labour productivity, average over CEE-countries.

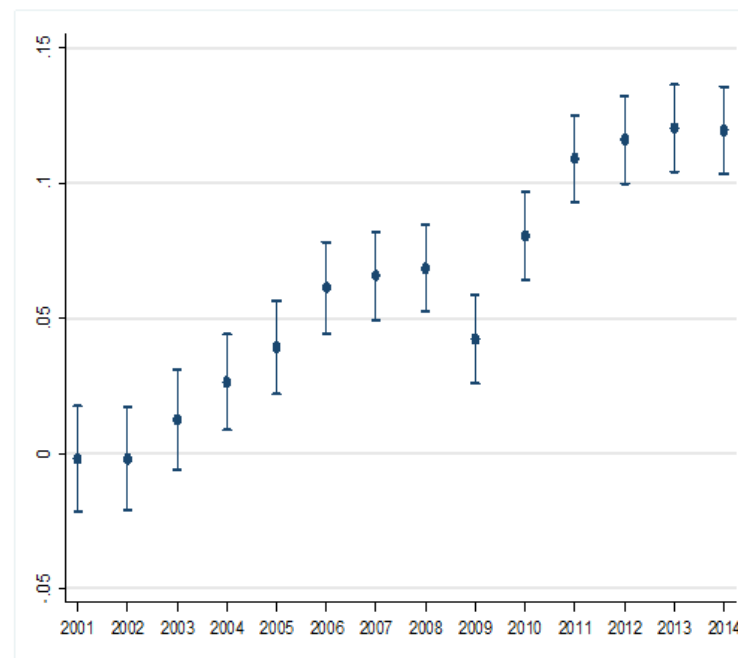
What has happened in the post-crisis period with larger impact in CEEc?

1. GVCs have shortened in the post-crisis period. Not clear why: uncertainty and relocation to final goods markets?

GVC participation



Import intensity of production over time, CEE countries



Sources: Authors' calculations based on WIOD (2016).

Note: GVC participation: share in gross exports of the sum of: (i) domestic value added in third country exports (forward GVC participation); and (ii) the foreign value added in own exports (backward GVC participation).

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Sources: Authors' calculations based on WIOD (2016) following Timmer et al. (2016).

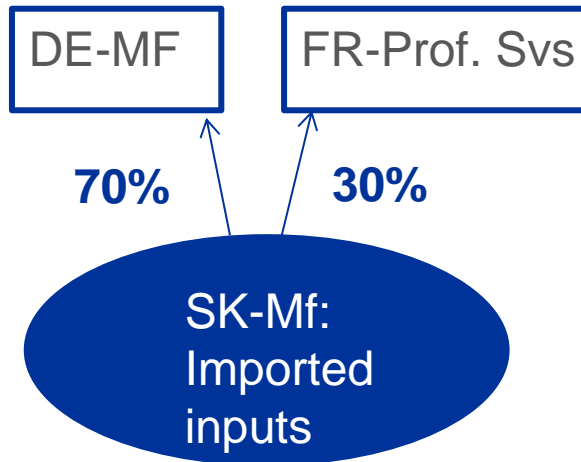
Note: Estimated coefficients and 95%-confidence intervals on year dummies after regressing CEE countries' import intensity on country-sector and year fixed effects. Coefficients are relative to 2000. www.ecb.europa.eu ©

2. TFP growth of parent companies in GVCs has slowed down

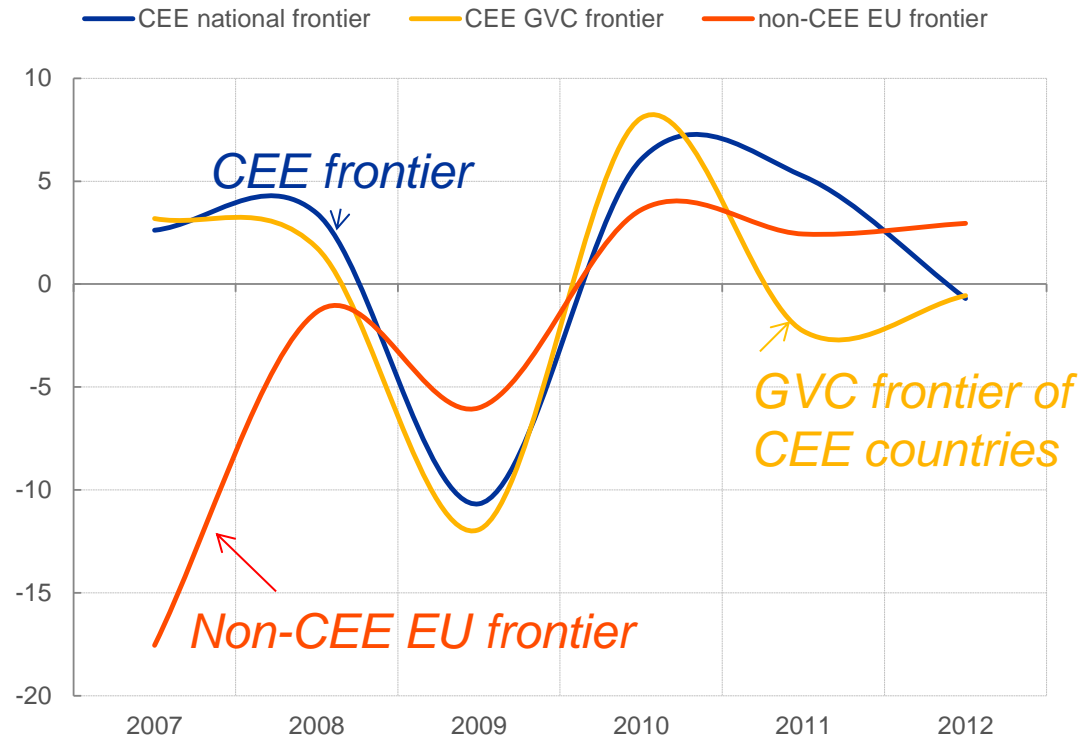
Frontier firms:

20% most productive firms in each country-sector;

GVC weights:



Annual TFP growth of frontier firms in CEE, EU, and GVC partners
(annual growth rates)



Source: Authors' calculations based on CompNet.

The paper in a nutshell

- In the big picture, we contribute to the literature exploring the role of GVCs (trade) as channel of technology transfer (and TFP growth)
- We use as a case study the observed TFP growth slowdown in CEECs. Interesting because:
 - They are deeply integrated in GVCs
 - They are catching-up economies in Europe
- Our framework of analysis:
 - Departs from a neo-Schumpeterian growth model (Acemoglu et al. 2006)
 - Adding insights from a 2-stage technology diffusion process (Bartelsman et al. 2013)
 - Including elements unique to the GVCs (Mariscal and Taglioni 2017)
- We use data for 9 CEE EU countries, 9 non-CEE EU countries, 9 macro-sectors and 12 years (2002-2013) from **CompNet and WIOD**

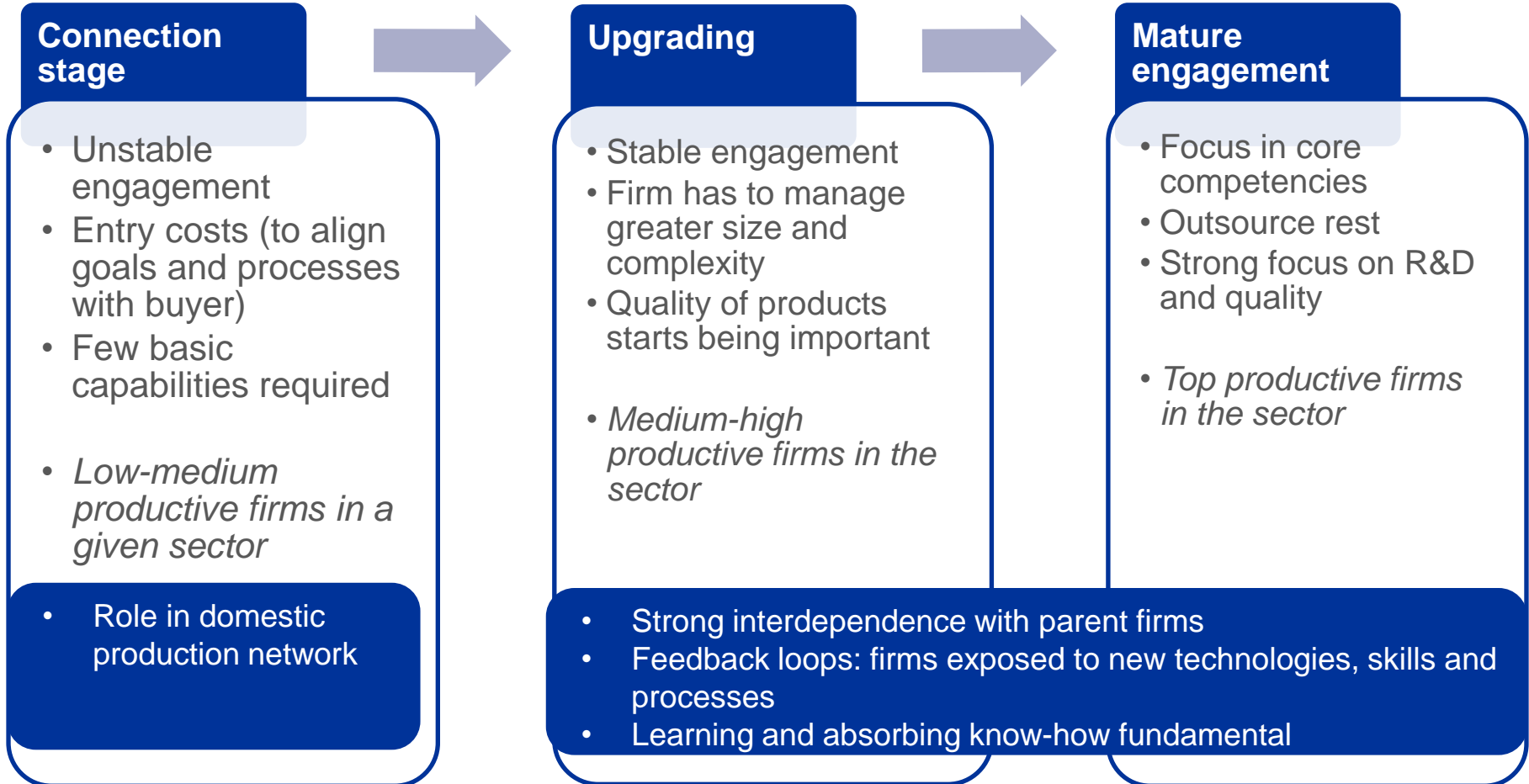
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- **Neo-schumpeterian growth model** based on Acemoglu et al. (2006), Aghion and Howitt (1998), Griffith et al. (2006)...
- TFP growth in a given country-sector-year in a catch-up economy depends on:
 - **Technology created at the frontier**: proxied by TFP growth of global frontier firms
 - **Cath-up or distance to the global frontier**: proxied by lagged gap in productivity level to the global frontier
- **2-stage diffusion process** (Bartelsman et al. 2013):
 - New technology is transferred and adapted first by frontier firms, and then diffused to the rest of the (non-frontier) firms

GVCs are generally considered key channels for technological diffusion from global frontier firms

- Firms' engagements in GVCs combines “arm's strength length transactions” with features typical of intragroup investment
 - Large opportunities for transferring capabilities and absorbing foreign technology and processes
 - Baldwin and Yan (2014), Bas and Strauss-Kahn (2014), Goldberg et al (2010), IMF (2015), Guadalupe (2015), Mariscal and Taglioni (2017)
 - New technology embedded in inputs; new varieties; R&D collaboration; investment to meet quality standards...

GVC participation is a dynamic process, with different capabilities required in each stage (Mariscal and Taglioni 2017)



Putting everything together

When a neo-Schumpeterian model meets a 2-stage technology diffusion process and GVCs...

Parent firms in non-CEE countries:

GVC frontier is the relevant global technology frontier

Fragmented production process

Stage 1

National frontier:

Top productive firms participate directly in GVCs

exposed to new technology & process; catch-up

Outsource non-core capabilities

Stage 2

Rest of firms:

Exposed to technology from national frontier

Some direct access to parent companies

Irregular engagement in GVCs, basic capabilities

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1. TFP growth of frontier firms in host economy: directly involved in GVCs

$$\begin{aligned} TFP\ growth_{z,j,i=p80-90,t} \\ &= \alpha_{zj} + \beta tfp\ growth\ GVC_{z,j,t} + \gamma Distance\ to\ the\ GVC\ frontier_{t-1} + crisis \\ &+ postcrisis + c * s + u_{z,j,t} \end{aligned}$$

Crisis defined as 1 for years between 2008 and 2010; post crisis equal 1 for years 2011-2012
FE (country*sector), robust and clustered standard errors (at the country-sector level).

2. TFP growth of rest of firms in host economy: suppliers of top productive firms in the sector (directly involved in GVCs); with unstable engagement in GVCs

$$\begin{aligned} TFP\ growth_{z,j,i=p10-20,t} \\ &= \alpha_{zj} + \beta_1 tfp\ growth\ national\ frontier_{z,j,t} \\ &+ \gamma_1 Distance\ to\ national\ frontier_{t-1} + \beta_2 GVC\ frontier\ growth_{z,j,t} \\ &+ \gamma_2 Distance\ to\ GVC\ frontier_{t-1} + \beta_3 GVC\ growth_{z,j,t} + crisis \\ &+ postcrisis + c * s + u_{z,j,t} \end{aligned}$$

Crisis defined as 1 for years between 2008 and 2010; post crisis equal 1 for years 2011-2012
FE (country*sector), robust and clustered standard errors (at the country-sector level)

- Firm-level TFP: $TFP_{it} = rva_{it} - (\hat{\beta}_0 + \hat{\beta}_1 k_{it} + \hat{\gamma} Year_t + \hat{\omega} L_{i(t-1)})$

Technology coefficients are estimated at the 2-digit industry level using a semi-parametric approach (Levinson-Pakes-Wooldridge) to correct simultaneity bias

- GVC participation:

$$GVC\ participation_{z,j,t} = \frac{Use\ of\ imported\ intermediates_{z,j,t}}{Use\ of\ domestic\ intermediates_{z,j,t}}$$

$$GVC\ participation_{z,j,t} = \frac{Exports\ of\ intermediates_{z,j,t}}{Domestic\ supply\ of\ intermediates_{z,j,t}}$$

- R&D/VA: Country-sector-year R&D fixed capital formation (in current prices) / country-sector-year value added (in current prices)

Data sources: **CompNet**, **WIOD** and **Eurostat**

- 9 CEE countries (all CEE countries but CZ and BG), 9 macro-sectors, period 2003-2012
- The ECB Competitiveness Research Network ([CompNet](#)) provides the productivity of frontier, middle and laggard firms in each country, macro-sector and year (full sample)
- **WIOD** provide the participation in GVCs of each CEE country-sector, and the link between each non-CEE country-sector and CEE country-sector
- Sector R&D comes from **Eurostat** (National Accounts)

Sample coverage: non-financial corporations with at least 1 employee operating in the business economy

| Country | Sample period | Missing sectors | Exclusion rule | Coverage vis-a-vis National Accounts ^{1/} | |
|-----------|---------------|---|----------------|--|-----|
| | | | | Employment | VA |
| Croatia | 2003-2012 | none | none | 56% | 75% |
| Estonia | 2003-2012 | none | none | 58% | 34% |
| Hungary | 2004-2012 | none | none | 56% | 49% |
| Latvia | 2006-2012 | none | none | 59% | 43% |
| Lithuania | 2003-2011 | none | none | 59% | 36% |
| Poland | 2005-2012 | Accommodation and food service activities | >19 employees | 38% | 29% |
| Romania | 2004-2012 | none | >19 employees | 41% | 47% |
| Slovakia | 2003-2012 | none | >19 employees | 38% | 67% |
| Slovenia | 2003-2012 | none | none | 55% | 44% |

1/ Source of reference: Eurostat – National Accounts Series.

Note: CompNet data for Poland, Romania and Slovakia refer to firms with 20 employees or more. Average coverage over the respective sample period.

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The baseline: TFP growth at the sector level (CEEC)

| | | GVC participation based on imports | GVC participation based on exports |
|---------------------------------------|---------------------|------------------------------------|------------------------------------|
| | (1) | (2) | (3) |
| 2008-2010 dummy | -0.082*** (0.01) | -0.051*** (0.01) | -0.048*** (0.02) |
| Post-2010 dummy | -0.023** (0.01) | -0.001 (0.01) | -0.003 (0.01) |
| TFP growth GVC frontier | | 0.483*** (0.06) | 0.167*** (0.05) |
| Lagged gap TFP GVC frontier to sector | | 0.521*** (0.14) | 0.426*** (0.10) |
| GVC participation growth | | 0.182* (0.11) | 0.057 (0.06) |
| Constant | 0.049*** (0.01) | -1.662*** (0.44) | -1.252*** (0.32) |
| Observations | 613 | 613 | 613 |
| Adjusted R-squared | 0.062 | 0.345 | 0.267 |

Robust standard errors in parentheses, clustered at the country-sector level. Co

*** p<0.01, ** p<0.05, * p<0.10

Robust standard errors in parentheses, clustered at the country-sector level. Country-sector FE included.

*** p<0.01, ** p<0.05, * p<0.10

- Sector TFP growth was lower relative to pre-crisis period both during the crisis and in the post-crisis
- Once we control for GVC-related variables, post-crisis TFP growth was not significantly different
- Both technology creation at the GVC frontier and catch-up matter for TFP growth
- Sectors where GVC participation grows relatively faster display larger TFP growth
- Stronger correlation through import of inputs

National frontier firms (most productive in the sector), CEEc

| | (1) | (2) | (3) |
|--|----------------------|----------------------|----------------------|
| 2008-2010 dummy | -0.069*** (0.010) | -0.046*** (0.010) | 0.033 (0.032) |
| Post-2010 dummy | -0.012 (0.009) | 0.004 (0.011) | 0.073* (0.039) |
| TFP growth GVC frontier | | 0.430*** (0.058) | 0.445*** (0.118) |
| TFP growth GVC frontier*2008-2010 dummy | | | 0.045 (0.145) |
| TFP growth GVC frontier*post-2010 dummy | | | -0.245* (0.143) |
| Lagged gap TFP GVC frontier to national frontier | | 0.364*** (0.054) | 0.386*** (0.052) |
| Lagged gap*2008-2010 dummy | | | -0.030*** (0.010) |
| Lagged gap*post-2010 dummy | | | -0.028** (0.012) |
| GVC participation growth | | 0.199** (0.079) | -0.080 (0.107) |
| GVC participation growth*2008-2010 dummy | | | 0.358*** (0.134) |
| GVC participation growth*post-2010 dummy | | | 0.317* (0.181) |
| Constant | 0.040*** (0.005) | -0.991*** (0.148) | -1.048*** (0.145) |
| Observations | 642 | 642 | 642 |
| Adjusted R-squared | 0.087 | 0.334 | 0.355 |

- Same results as in sector baseline
- Capacity to learn from parent firms decreased in the crisis and post-crisis period
- Sectors with higher GVC growth were **more resilient** to the crisis (and post-crisis) slowdown

Robust standard errors in parentheses, clustered at the country-sector level. Country-sector FE included.

*** p<0.01, ** p<0.05, * p<0.10

Laggard firms

| | (1) | (2) |
|--|----------------------|----------------------|
| 2008-2010 dummy | -0.090*** (0.011) | -0.025*** (0.008) |
| Post-2010 dummy | -0.009 (0.012) | -0.022** (0.008) |
| TFP growth national frontier | | 0.920*** (0.049) |
| Lagged gap TFP national frontier to laggards | | 0.569*** (0.080) |
| TFP growth GVC frontier | | 0.151*** (0.041) |
| Lagged gap TFP GVC frontier to laggards | | 0.010 (0.024) |
| GVC participation growth | | 0.203** (0.079) |
| Constant | 0.040*** (0.005) | -1.054*** (0.113) |
| Observations | 642 | 642 |
| Adjusted R-squared | 0.092 | 0.736 |

- Exposure to national frontier firms is more important for laggards than direct exposure to GVC
 - 2-stage diffusion process
- Operating in a sector with expanding GVC participation growth is important
- Interaction with crisis and post-crisis period does not change anything
 - Crisis only affected absorptive capacity of frontier firms

Robustness: year dummies

Robustness: other FE

Robustness: GVC level

Robustness: Other GVC indicator

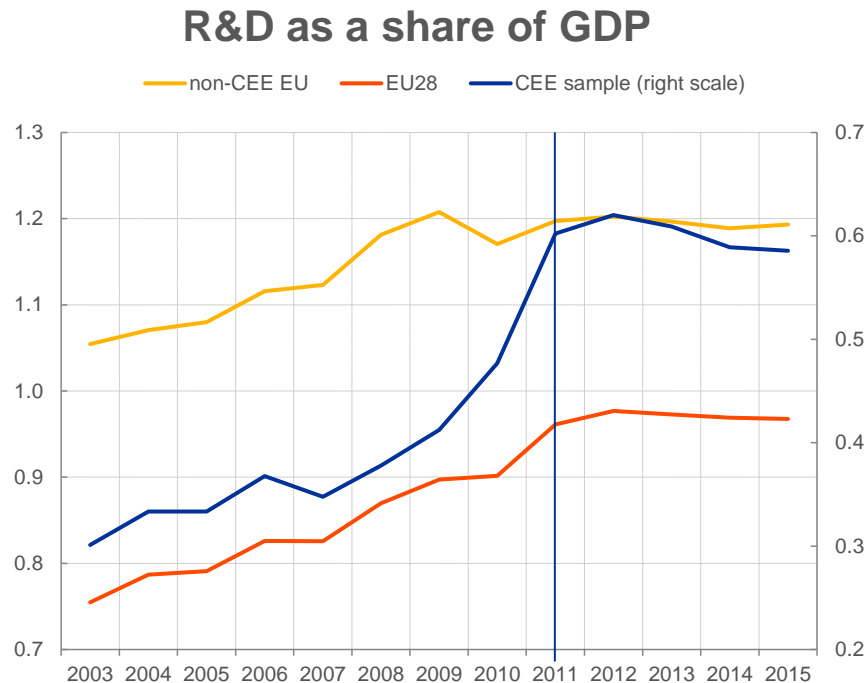
Robust standard errors in parentheses, clustered at the country-sector level. Country-sector FE included.

*** p<0.01, ** p<0.05, * p<0.10

Middle firms

National frontier firms: why has absorptive capacity decreased?

- The absorptive capacity of firms depends on their own investment in R&D and human capital
 - Cohen and Levinthal (1989, 1990 and 1994); Griffith, R., S. Redding and J. Van Reenen (2004); Lopez-Garcia and Montero (2011)
- Our hypothesis is that during the post-crisis period, the investment in intangibles of CEE frontier firms decreased



Source: Eurostat.

Note: R&D expenditure of the business enterprise sector. Non-CEE EU refers to the unweighted average of AT, BE, CY, DK, FI, FR, DE, IT, IE, UK, PT, MA, NE, PT, SW and UK. CEE sample: HR, EE, HU, LV, LT, PO, RO, SK, SV.

No data on R&D of frontier firms; split sectors in more and less dependent on R&D

| VARIABLES | 1 | 2 | 3 |
|--|----------------------|-------------------------------|-------------------------------|
| | Pooled | Sectors more intensive in R&D | Sectors less intensive in R&D |
| 2008-2010 dummy | -0.046*** (0.010) | 0.027 (0.038) | 0.013 (0.084) |
| Post-2010 dummy | 0.004 (0.011) | 0.088* (0.043) | 0.084 (0.087) |
| TFP growth GVC frontier | 0.430*** (0.058) | 0.677** (0.255) | 0.416+ (0.265) |
| TFP growth GVC frontier*2008-2010 dummy | | -0.320 (0.250) | 0.005 (0.347) |
| TFP growth GVC frontier*post-2010 dummy | | -0.494** (0.212) | 0.028 (0.274) |
| Lagged gap TFP GVC frontier to national frontier | 0.364*** (0.054) | 0.530*** (0.090) | 0.511*** (0.108) |
| Lagged gap*2008-2010 dummy | | -0.024* (0.014) | -0.027 (0.023) |
| Lagged gap*post-2010 dummy | | -0.023* (0.012) | -0.036 (0.029) |
| GVC participation growth | 0.199** (0.079) | -0.183 (0.148) | -0.538 (0.444) |
| GVC participation growth*2008-2010 dummy | | 0.618** (0.250) | 1.217* (0.631) |
| GVC participation growth*post-2010 dummy | | 0.344* (0.191) | 1.069+ (0.713) |
| Constant | -0.991*** (0.148) | -1.447*** (0.258) | -1.480*** (0.327) |
| Observations | 642 | 184 | 185 |
| Adjusted R-squared | 0.334 | 0.461 | 0.408 |

- Identification à la Rajan and Zingales:
 - Significant impact only in sectors highly dependent on R&D
- Split sectors in a given country-year according to R&D intensity
- We find that drop in absorptive capacity only in R&D intensive sectors; all the rest equal

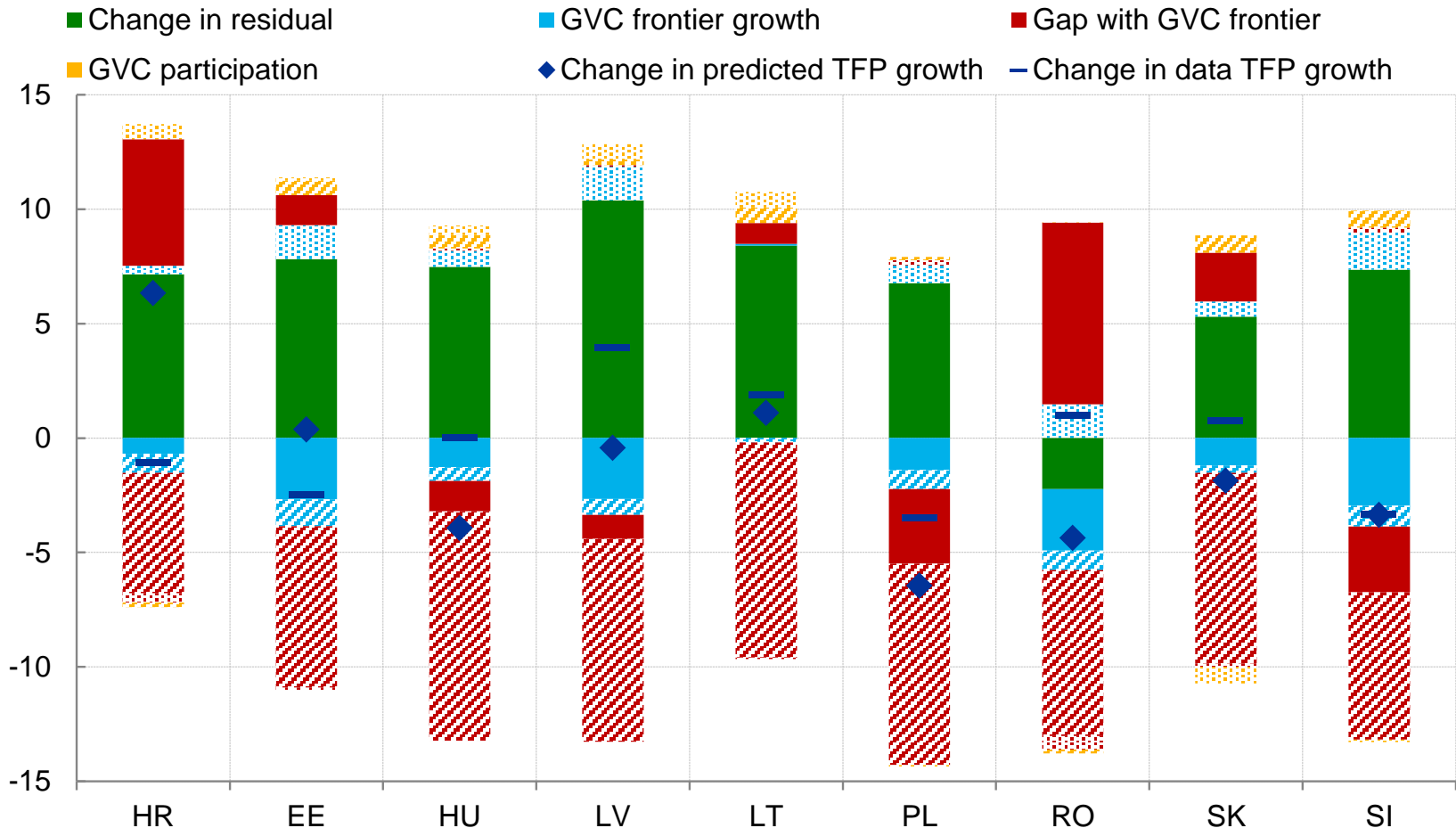
Robust standard errors in parentheses, clustered at the country-sector level. Country-sector FE included.

*** p<0.01, ** p<0.05, * p<0.10, + p<0.15

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Why has TFP growth slowed down?

Shift-share analysis (*p.p.*, *frontier*, 2012-2011 vs. 2003-2007)



| Legend | GVC frontier | | | Gap with GVC frontier | | | GVC participation | | |
|----------|--------------|------------|------------|-----------------------|------------|------------|-------------------|------------|------------|
| | Data ch. | Coeff. ch. | Covariance | Data ch. | Coeff. ch. | Covariance | Data ch. | Coeff. ch. | Covariance |
| Residual | | | | | | | No effect | | |

- Frontier and laggard firms in host countries benefit from GVC participation in different ways:
 - Frontier firms are directly involved in GVCs and benefit from technology transfers from parent companies
 - Laggards benefit from contact with national frontier firms and also, to a lesser extent, from direct contact with parent companies
- In post-crisis period, frontier firms have decreased their absorptive capacity
 - Therefore benefit less from technology creation
- One possible reason is their reduction in investment in intangibles: **scarring effect of the crisis?**

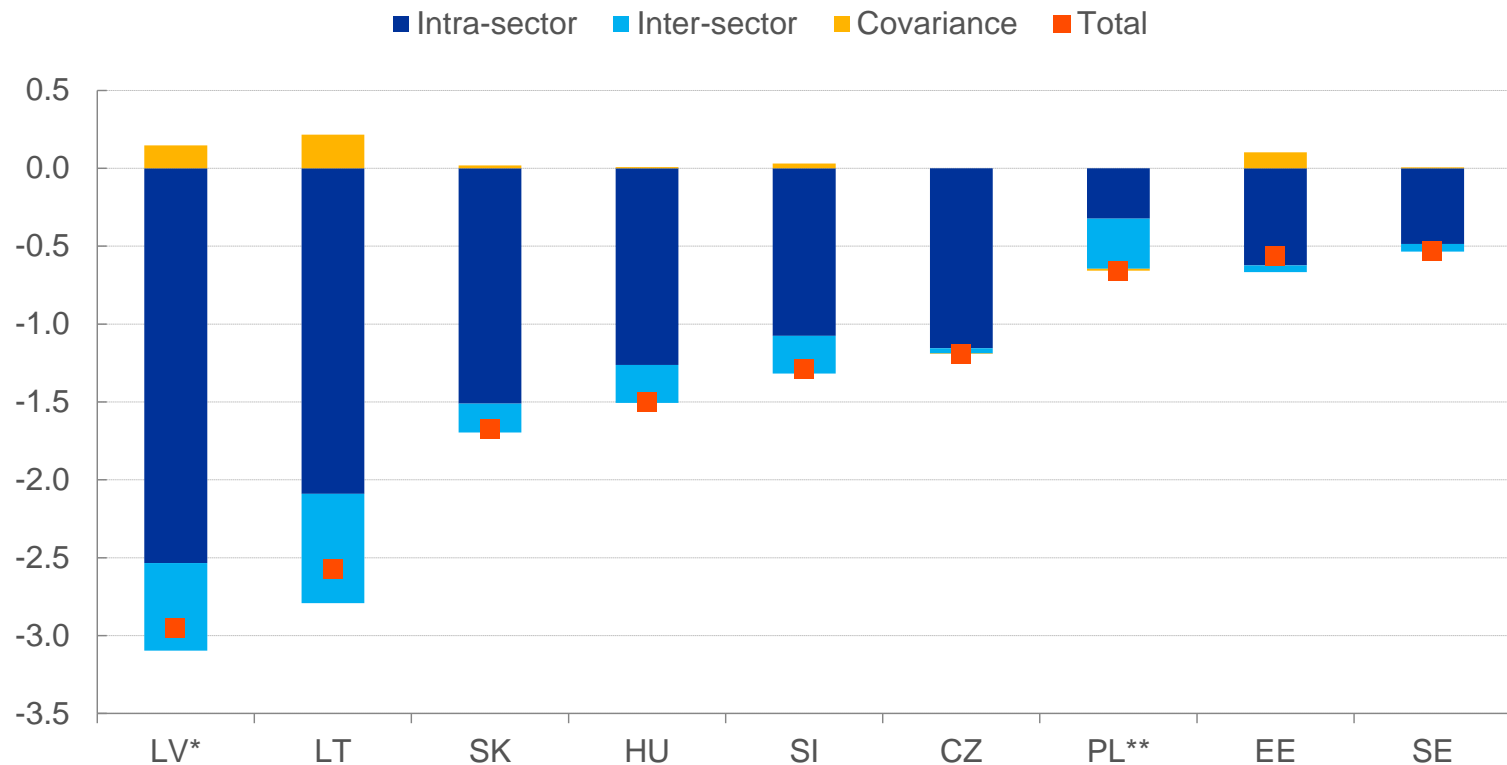
Thanks for your attention!

Reserve slides

The slowdown in TFP was driven by within-sector developments

The slowdown is driven by within-sector developments, rather than by inter-sector resource reallocation

Shift-share analysis, pre-crisis (2008-2014) vs. pre-crisis period (2000-2007)



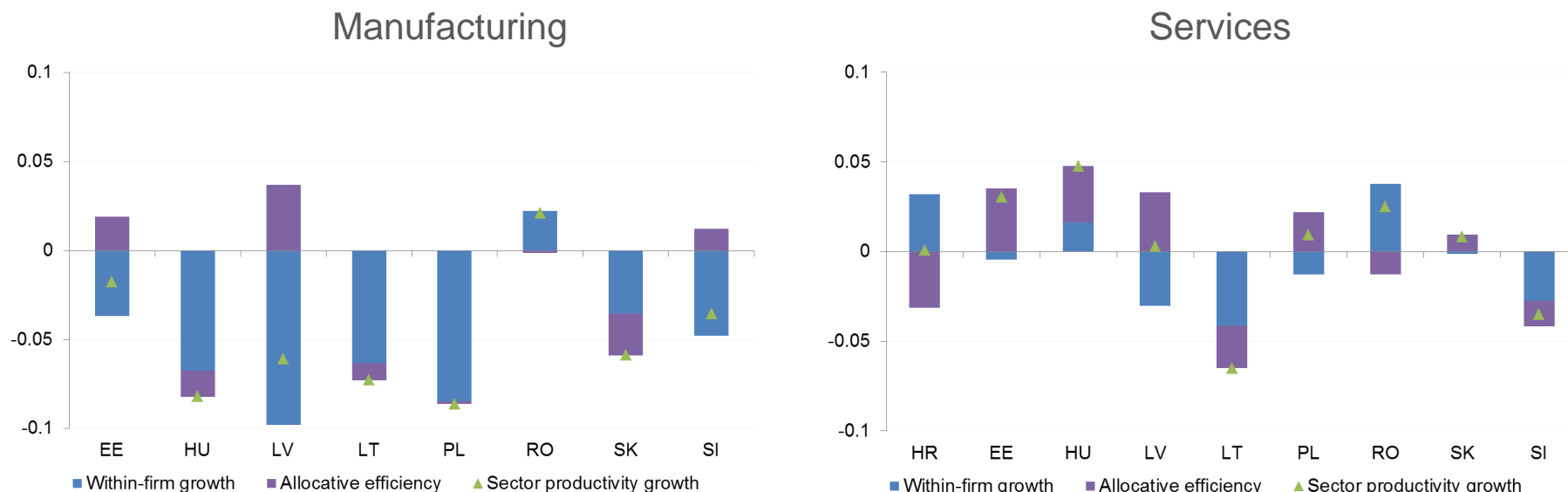
Source: Authors' calculations based on Eurostat.

Notes: TFP computed as sector RVA over a weighted average of labour and capital services;

*Missing 2014 manufacturing **Missing 2000-2003

Within-firm labour productivity growth, rather than allocative efficiency, is poor, particularly in manufacturing

Contribution of within-firm productivity growth and change in allocative efficiency to sector productivity growth between the pre-crisis (2002-2007) and crisis period (2008-2012)



Source: Authors' calculations based on CompNet, 20E sample.

Notes: Allocative efficiency computed as the difference between sector weighted and unweighted productivity.

Data Sources, some more details

| Country | Name of the source of the microdata used to produce the CompNet indicators (both in English and in original language): |
|----------|--|
| Belgium | Annual account : Centrale des bilans / Balanscentral / Central Balance Sheet Office database (Version commercial : Belfirst, Bureau Van Dijk) International trade date : Intra-Stat and Extra-Stat database |
| Croatia | Annual Financial Statements Registry (in Croatian: Registar godišnjih financijskih izvještaja, RGFI). All modules are based on this source. |
| Estonia | Source 1: Foreign trade statistics data (Väliskaubanduse andmed) |
| Finland | Structural Business Statistics (Yritysten rakenne- ja tilinpäätöstilastoaineistot) |
| France | Fiscal Form – liasse fiscale |
| Germany | Financial Statements Data Pool (Jahresabschlussdatenpool) based on different sources which partly cannot be revealed in detail. The sources are: - Financial statements collected within the framework of the Bundesbank's refinancing operations - Customers' formally anonymized financial statements from seven voluntarily participating financial institutions (so-called partners of the Data Pool) - Financial statements from commercial data providers Bisnode and Bureau van Dijk (DAFNE database) |
| Italy | Financial statements from Chamber of Commerce (Bilanci delle società presentati alle CCIA) |
| Latvia | Source 1: Complex report on activities "1-annual" (Kompleksais pars kats par darbibu "1-gada") Source 2: Foreign trade /Areja tirdznieciba/ Source 3: Annual reports of companies (balance sheet and profit or loss account). Gada pars kats (balance, pelnas vai zaudejumu aprekins) |
| Poland | F-01 and F-02 forms (dane z formularzy F-01 i F-02) |
| Portugal | The source is called Informação Empresarial Simplificada (Simplified Corporate Information, Portuguese acronym: IES). The IES is an integrated system that meets different reporting needs, namely trade registers and provision of notarial services, accounting statements and tax returns, production of statistics and economic analysis of corporations and activity sectors. Under the IES, data submitted by non-financial corporations are integrated in the Balance Sheet Database of Banco de Portugal, which discloses aggregate statistics based on such data. Simplified Corporate Information / Informação Empresarial Simplificada (IES). |
| Slovakia | Report on production industries (Výkaz produkčných odvetví) |
| Slovenia | Letna porocila slovenskih podjetij (Slovenian companies' annual reports). [For detailed information please refer to: http://www.ajpes.si/Registers/Annual_Reports/Information |
| Spain | Source 1: Annual Central Balance Sheet Data Office (CBA), Central de Balances Anual (CBA) Source 2: Annual Accounts Deposited in Mercantile Registries Data Base (CBB-RM), Base de Datos de Cuentas Anuales Depositadas en los Registros Mercantiles (CBB-RM) |
| Sweden | SBS (Företagens ekonomi), VAT register (Momsregister), Trade statistics (Utrikeshandelsstatistik) |



A solution to the non-comparability of cross-country firm data and confidentiality problem is to use a micro-distributed approach

- Write a code (in STATA) to compute different indicators of interest at the firm-level
 - In our case: competitiveness –related indicators; computed from items of the balance sheets, matched, if possible, with customs or exports info
- Harmonise definitions, target samples and cleaning and treatment of the raw data
- Distribute code to our national counterparts; they run the code in their computers (we do not see the data)
- Collect results, aggregated at a country/sector/size/year level to preserve confidentiality, but keeping much of the richness of the firm-level data

Keeping the richness of the firm-level data

- For each indicator, in addition to mean, median, sd and skewness, CompNet compiles:
 - **Full distribution (10 deciles)** considering all firms operating in a given **level of aggregation** (country, macro-sector, 2-digit industry, country/size class and macro-sector/size class)
 - **Full set of firms' characteristics** within a given level of aggregation for different splits of firms (e.g. exporting vs. non-exporting firms)
 - **Joint distributions:** median characteristics of firms in a given decile of the productivity, size etc. distribution in each level of aggregation

What is available?

Productivity and allocative efficiency

Labor productivity

TFP

ULC

LC per employee

Firm size

Capital intensity

Static Allocative Efficiency

Dynamic Allocative Efficiency

Financial

Investment Ratio

RoA

Cash holdings

Leverage

Financing gap

Collateral

Equity to Debt

Cash flow

Implicit interest rate

Trade Credit/Debt

Debt burden

Credit constraint index

Trade

% permanent exp.

% sporadic exp.

Export value

Export value added

Productivity premium of exporters

Competition

Weighted PCM

Sector-specific mark-ups

Sector-specific collective bargaining power

Concentration measures

Labour

% firms that increase/decrease employment productivity or ULC between t and t+3

Characteristics of growing and shrinking firms

Share of High-growth firms

More info on CompNet at:
www.comp-net.org



Lower TFP growth in the post-crisis compared to the pre-crisis period

| | 2003-2007 | 2008-2010 | 2011-2012 | 2003-2012 |
|------------------------------|-----------|-----------|------------|-----------|
| TFP growth GVC frontier | 3.0 | -0.4 | -1.5 | 0.9 |
| TFP growth sector | 4.7 | -3.2 | 2.8 | 1.3 |
| TFP growth national frontier | 3.9 | -2.9 | 2.8 | 1.1 |
| TFP growth middle | 3.8 | -3.1 | 2.5 | 0.9 |
| TFP growth laggards | 4.0 | -5.0 | 3.1 | 0.4 |
| GVC participation growth | 1.4 | -0.0 | 1.0 | 1.1 |

Source: Authors' calculations based on CompNet and WIOD (2016).



Middle firms

| | (1) | (2) |
|--|----------------------|----------------------|
| 2008-2010 dummy | -0.069*** (0.009) | -0.004 (0.005) |
| Post-2010 dummy | -0.014 (0.009) | -0.004 (0.005) |
| TFP growth national frontier | | 0.862*** (0.028) |
| Lagged gap TFP national frontier to middle | | 0.593*** (0.072) |
| TFP growth GVC frontier | | 0.095*** (0.019) |
| Lagged gap TFP GVC frontier to middle | | 0.032* (0.018) |
| GVC participation growth | | 0.065* (0.037) |
| Constant | 0.038*** (0.004) | -0.608*** (0.064) |
| Observations | 642 | 642 |
| Adjusted R-squared | 0.093 | 0.861 |

Robust standard errors in parentheses, clustered at the country-sector level. Country-sector FE included.

*** p<0.01, ** p<0.05, * p<0.10

Baseline with year dummies

| | Sector | Frontier | Middle | Laggards |
|--|----------------------|----------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) |
| TFP growth national frontier | | | 0.852*** (0.029) | 0.896*** (0.049) |
| Lagged gap TFP national frontier to middle | | | 0.584*** (0.070) | |
| Lagged gap TFP national frontier to laggards | | | | 0.565*** (0.076) |
| TFP growth GVC frontier | 0.395*** (0.088) | 0.269*** (0.072) | 0.080*** (0.022) | 0.099** (0.045) |
| Lagged gap TFP GVC frontier to sector | 0.520*** (0.142) | | | |
| Lagged gap TFP GVC frontier to national frontier | | 0.347*** (0.057) | | |
| Lagged gap TFP GVC frontier to middle | | | 0.036* (0.019) | |
| Lagged gap TFP GVC frontier to laggards | | | | 0.024 (0.023) |
| GVC participation growth | 0.171* (0.093) | 0.103 (0.070) | 0.068 (0.043) | 0.207** (0.087) |
| Constant | -1.661*** (0.464) | -0.960*** (0.164) | -0.624*** (0.067) | -1.130*** (0.124) |
| Observations | 613 | 642 | 642 | 642 |
| Adjusted R-squared | 0.352 | 0.366 | 0.862 | 0.744 |



Robust standard errors in parentheses, clustered at the country-sector level.³⁶
Country-sector and year FE included. *** p<0.01, ** p<0.05, * p<0.10

Baseline with country, year and sector dummies

| | Sector | Frontier | Middle | Laggards |
|--|---------------------|--------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) |
| TFP growth national frontier | | | 0.816*** (0.033) | 0.878*** (0.052) |
| Lagged gap TFP national frontier to middle | | | 0.054*** (0.017) | |
| Lagged gap TFP national frontier to laggards | | | | 0.015* (0.008) |
| TFP growth GVC frontier | 0.161* (0.090) | 0.095 (0.083) | 0.043 (0.027) | 0.050 (0.053) |
| Lagged gap TFP GVC frontier to sector | 0.018 (0.016) | | | |
| Lagged gap TFP GVC frontier to national frontier | | 0.002 (0.008) | | |
| Lagged gap TFP GVC frontier to middle | | | 0.009*** (0.003) | |
| Lagged gap TFP GVC frontier to laggards | | | | 0.024*** (0.006) |
| GVC participation growth | 0.287*** (0.086) | 0.155** (0.063) | 0.084** (0.042) | 0.247** (0.094) |
| Constant | -0.055 (0.042) | -0.001 (0.023) | -0.082*** (0.020) | -0.147*** (0.030) |
| Observations | 613 | 642 | 642 | 642 |
| Adjusted R-squared | 0.101 | 0.199 | 0.812 | 0.636 |

Robust standard errors in parentheses, clustered at the country-sector level.³⁷

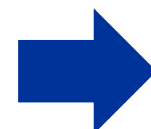
Country, sector, and year FE included. *** p<0.01, ** p<0.05, * p<0.10



Alternative GVC measure: level of GVC participation

| | Sector | Frontier | Middle | Laggards |
|--|----------------------|----------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) |
| 2008-2010 dummy | -0.054*** (0.014) | -0.049*** (0.011) | -0.005 (0.005) | -0.028*** (0.009) |
| 2011-2012 dummy | -0.014 (0.017) | -0.002 (0.012) | -0.007 (0.006) | -0.026** (0.010) |
| TFP growth national frontier | | | 0.859*** (0.029) | 0.921*** (0.050) |
| Lagged gap TFP national frontier to middle | | | 0.597*** (0.070) | |
| Lagged gap TFP national frontier to laggards | | | | 0.572*** (0.080) |
| TFP growth GVC frontier | 0.493*** (0.057) | 0.452*** (0.056) | 0.101*** (0.018) | 0.176*** (0.039) |
| Lagged gap TFP GVC frontier to sector | 0.542*** (0.137) | | | |
| Lagged gap TFP GVC frontier to national frontier | | 0.380*** (0.056) | | |
| Lagged gap TFP GVC frontier to middle | | | 0.040** (0.019) | |
| Lagged gap TFP GVC frontier to laggards | | | | 0.023 (0.026) |
| GVC participation | 0.270*** (0.089) | 0.169*** (0.060) | 0.086** (0.039) | 0.122** (0.054) |
| Constant | -1.815*** (0.461) | -1.089*** (0.164) | -0.671*** (0.065) | -1.157*** (0.114) |
| Observations | 613 | 642 | 642 | 642 |
| Adjusted R-squared | 0.354 | 0.336 | 0.863 | 0.735 |

Robust standard errors in parentheses, clustered at the country-sector level.³⁸
Country-sector FE included. *** p<0.01, ** p<0.05, * p<0.10



Alternative GVC measure: Imported intermediates / total intermediates

| | Sector | Frontier | Middle | Laggards |
|--|----------------------|----------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) |
| 2008-2010 dummy | -0.050*** (0.013) | -0.046*** (0.011) | -0.003 (0.005) | -0.024*** (0.009) |
| Post-2010 dummy | -0.001 (0.014) | 0.004 (0.011) | -0.004 (0.005) | -0.022*** (0.008) |
| TFP growth national frontier | | | 0.861*** (0.028) | 0.921*** (0.049) |
| Lagged gap TFP national frontier to middle | | | 0.591*** (0.072) | |
| Lagged gap TFP national frontier to laggards | | | | 0.567*** (0.081) |
| TFP growth GVC frontier | 0.486*** (0.068) | 0.426*** (0.059) | 0.088*** (0.020) | 0.140*** (0.044) |
| Lagged gap TFP GVC frontier to sector | 0.522*** (0.137) | | | |
| Lagged gap TFP GVC frontier to national frontier | | 0.364*** (0.054) | | |
| Lagged gap TFP GVC frontier to middle | | | 0.030* (0.018) | |
| Lagged gap TFP GVC frontier to laggards | | | | 0.007 (0.024) |
| GVC participation growth | 0.360 (0.354) | 0.456* (0.260) | 0.218** (0.106) | 0.549** (0.219) |
| Constant | -1.663*** (0.445) | -0.990*** (0.151) | -0.602*** (0.064) | -1.040*** (0.116) |
| Observations | 613 | 642 | 642 | 642 |
| Adjusted R-squared | 0.343 | 0.333 | 0.862 | 0.736 |



Robust standard errors in parentheses, clustered at the country-sector level.³⁹

Country-sector FE included. *** p<0.01, ** p<0.05, * p<0.10

No data on R&D of frontier firms; split sectors in more and less dependent on R&D

- Same results using other indicators to split sample
 - Here Intellectual Property

| VARIABLES | 1 | 2 | 3 |
|--|----------------------|-------------------------------|-------------------------------|
| | Pooled | Sectors more intensive in IPP | Sectors less intensive in IPP |
| 2008-2010 dummy | -0.046*** (0.010) | 0.046 (0.041) | -0.086 (0.097) |
| Post-2010 dummy | 0.004 (0.011) | 0.074* (0.044) | 0.006 (0.091) |
| TFP growth GVC frontier | 0.430*** (0.058) | 0.931** (0.358) | 0.303 (0.255) |
| TFP growth GVC frontier*2008-2010 dummy | | -0.476+ (0.320) | 0.025 (0.330) |
| TFP growth GVC frontier*post-2010 dummy | | -0.731** (0.320) | 0.282 (0.292) |
| Lagged gap TFP GVC frontier to national frontier | 0.364*** (0.054) | 0.535*** (0.092) | 0.447*** (0.103) |
| Lagged gap*2008-2010 dummy | | -0.024* (0.014) | 0.007 (0.028) |
| Lagged gap*post-2010 dummy | | -0.018+ (0.011) | -0.010 (0.028) |
| GVC participation growth | 0.199** (0.079) | -0.142 (0.116) | -0.485 (0.434) |
| GVC participation growth*2008-2010 dummy | | 0.504*** (0.180) | 1.370** (0.565) |
| GVC participation growth*post-2010 dummy | | 0.359** (0.142) | 1.216+ (0.759) |
| Constant | -0.991*** (0.148) | -1.455*** (0.263) | -1.373*** (0.330) |
| Observations | 642 | 188 | 182 |
| Adjusted R-squared | 0.334 | 0.447 | 0.408 |

Robust standard errors in parentheses, clustered at the country-sector level.
Country-sector FE included.
*** p<0.01, ** p<0.05, * p<0.10

Robust to different indicators of R&D
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