GROWINPRO

Growth Welfare Innovation Productivity

Determinants of Productivity Gap in the European Union: A Multilevel Perspective

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- The relative importance of each of these factors is still unclear
- $\exists$ role of reallocation of economic activity (market shares and/or factors of productions) towards higher productivity producers -> aggregate productivity growth (Dosi et. al 2015; Dosi & Grazzi 2006)

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- There is increasing evidence that within industry reallocation is shaping changes in industry average aggregates (Dosi in Malerba Brusoni (ed.s) 2007).

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- However, firm level variables are important in explaining intra-national catch up (and not only!)

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3. Research Question: how do the two strategies interact?

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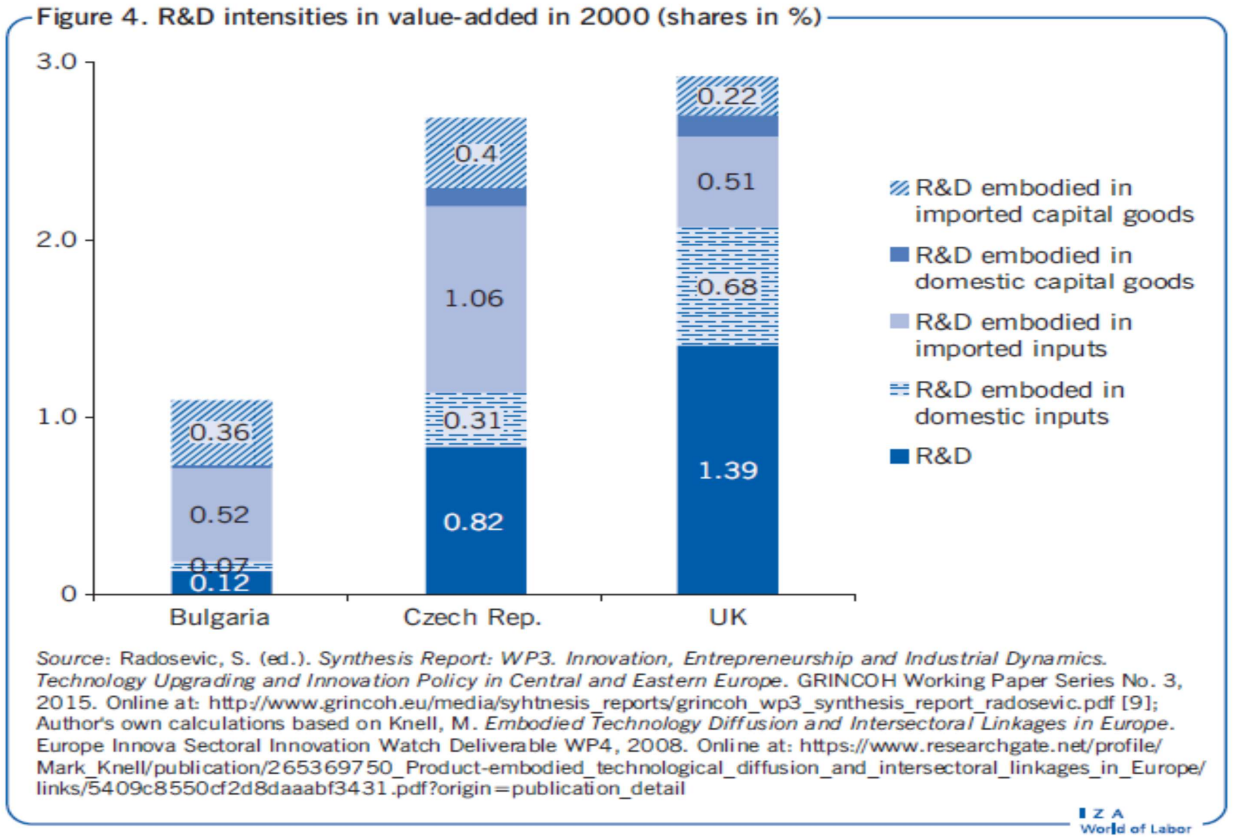
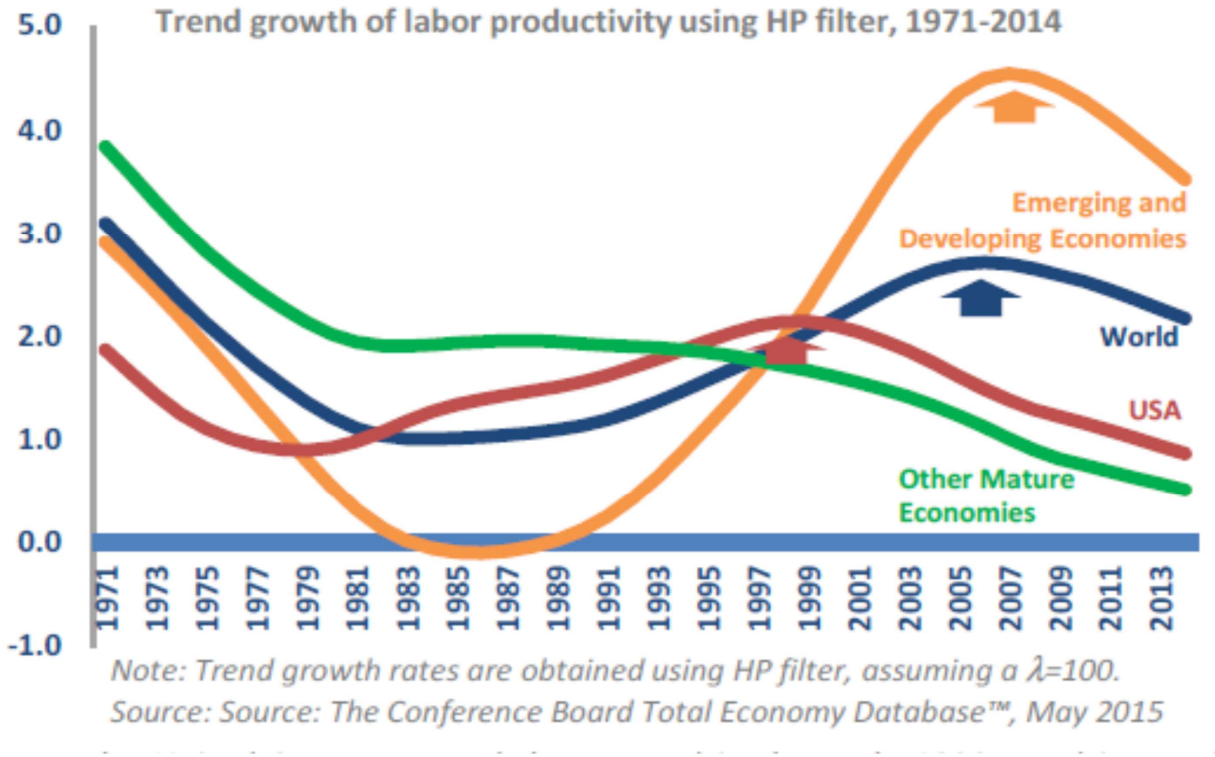
- Breakdown of the EU as "convergence machine" (World Bank 2012). Therefore, we need a new growth and integration model (ISIGrowth.eu Dosi et al., EURO-2-2014 H2020)

Direct and indirect R&D intensity varies across different income levels

A comparison of three countries

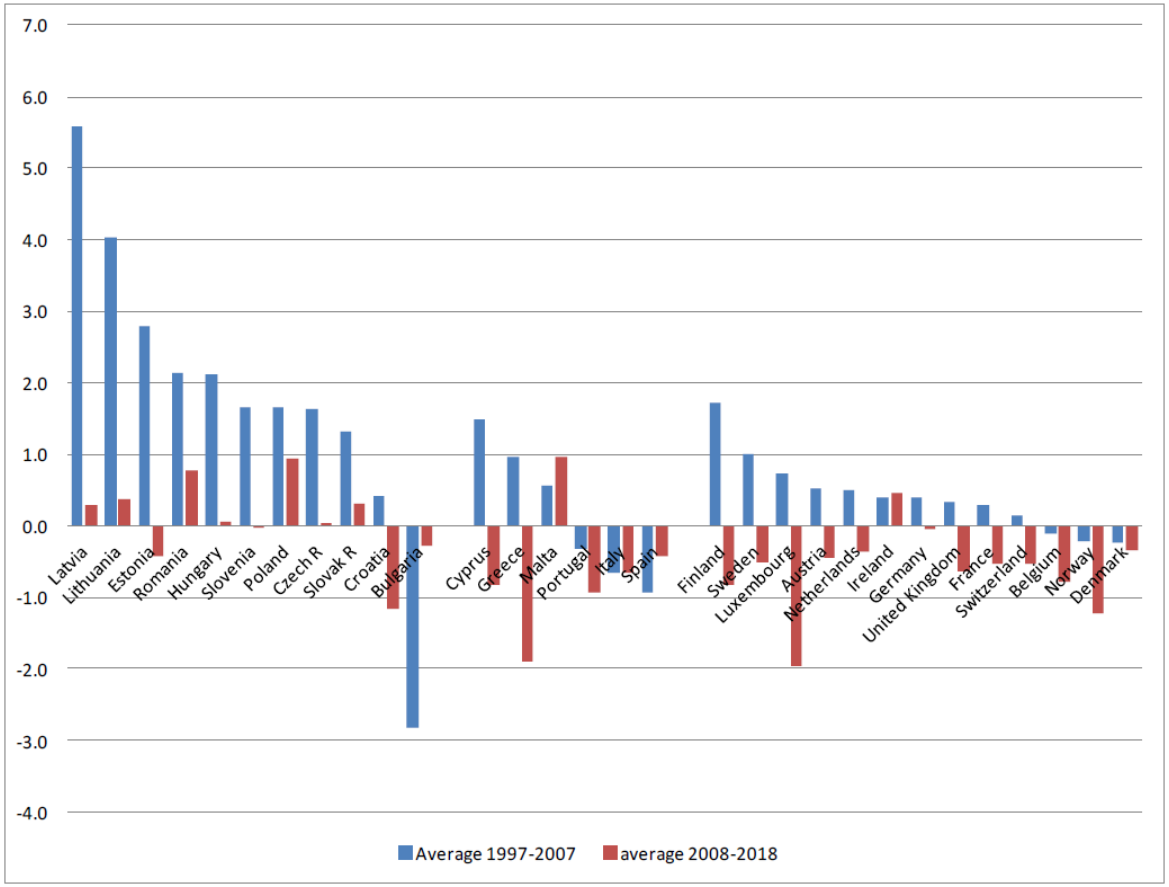


Within our period of exploration (2004-2013): Secular decline in productivity



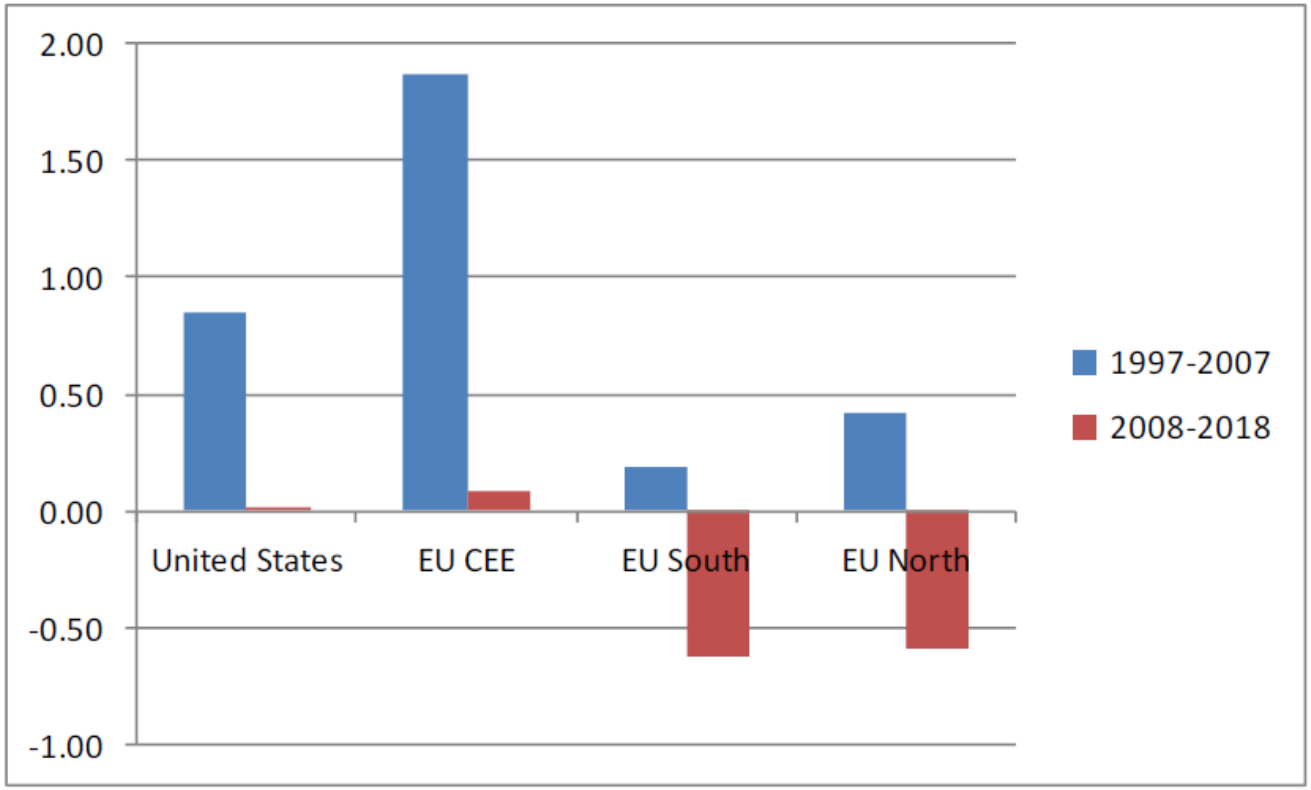
Growth of Total Factor Productivity in EU28 economies - average of two periods: Decline in North and South and divergence in the CEE

Source: The Conference Board Total Economy Database, April 2019



Falling behind technology frontier (cf. US) (average TFP rates)

Source: The Conference Board Total Economy Database, April 2019



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- EU industry level frontier:
  - Jung and Lee (2010), EU industry level frontier in a specific 4-digit sector

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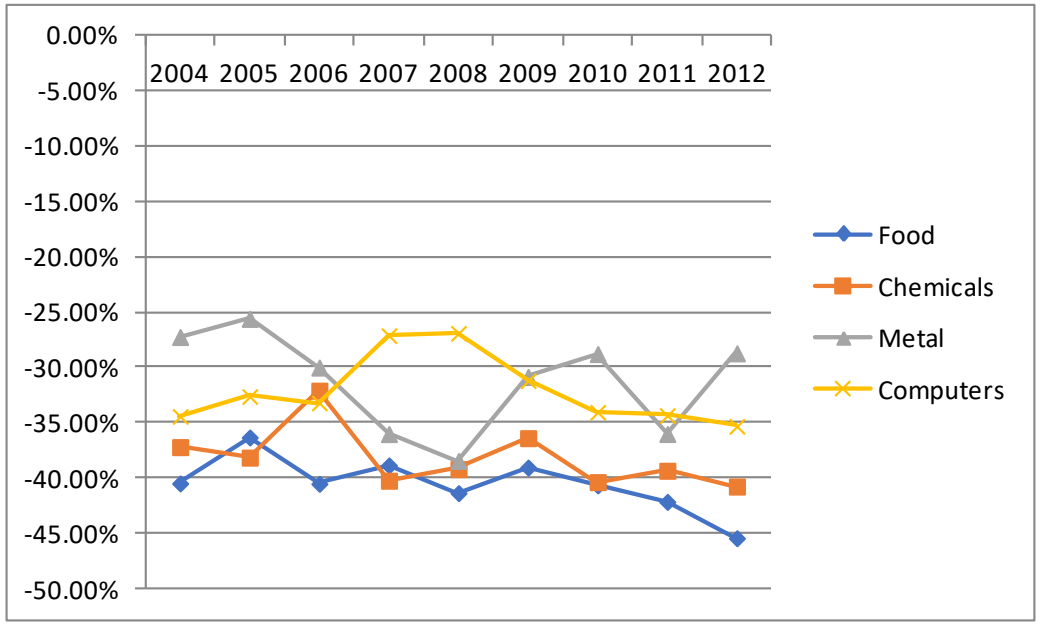
    - own $R\&D_{jct}$ as percentage of GDP at 2 digits/country/year level (ANBERD OECD database)

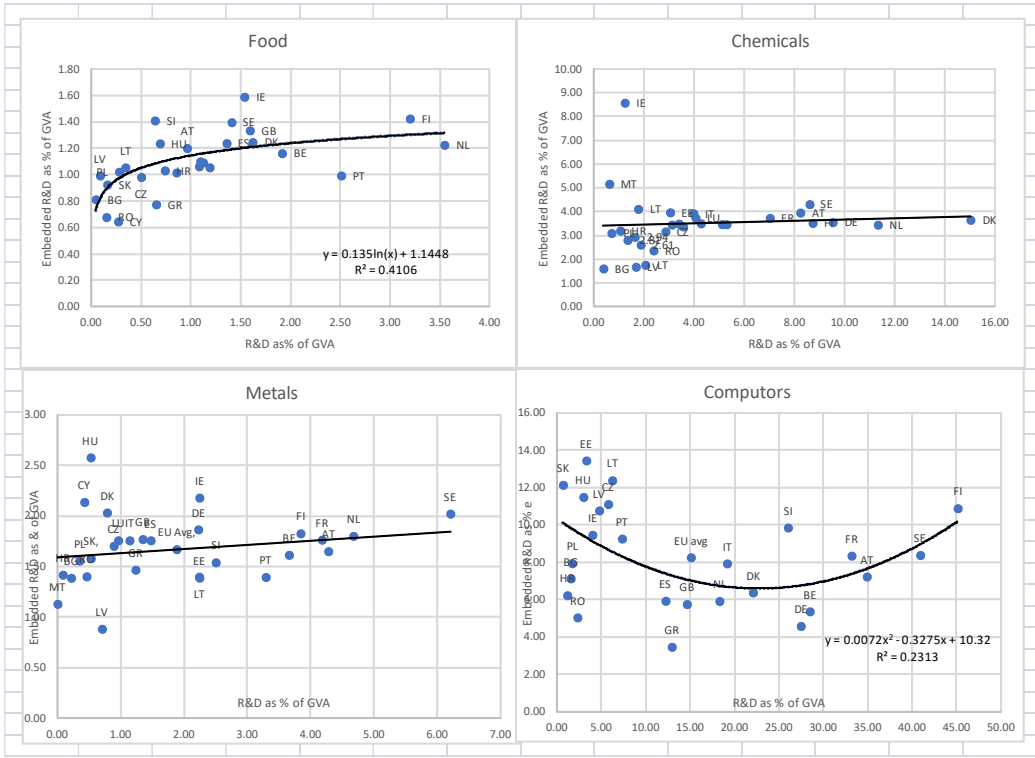
Average Gap Firm-Max TFP weighted by shares of countries in the sample

Source: Amadeus, WIOD, ANBERD



Own R&D and embedded R&D intensity in four sectors, EU28, 2007-2013

Source: Amadeus, WIOD, ANBERD country-sector averages



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3. After that we calculate two GAPS:
   - Firm - sector: LP or TFP for each firm *minus* the 75^{th} percentile from step 1, i.e. in a particular country / sector/ year;
   - Firm - Max: LP or TFP for each firm *minus* the maximum from step 2, i.e. sector/year leader.

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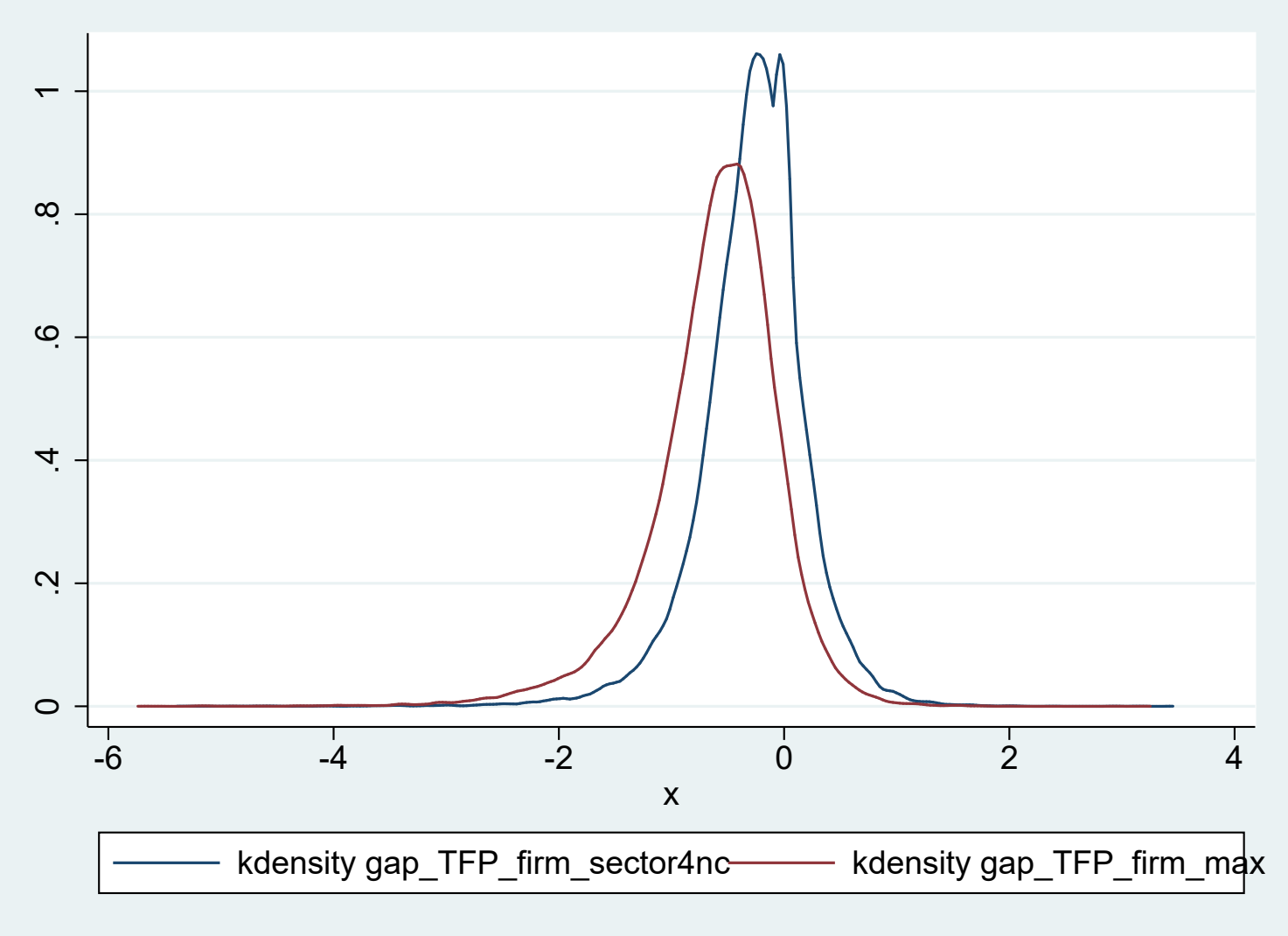
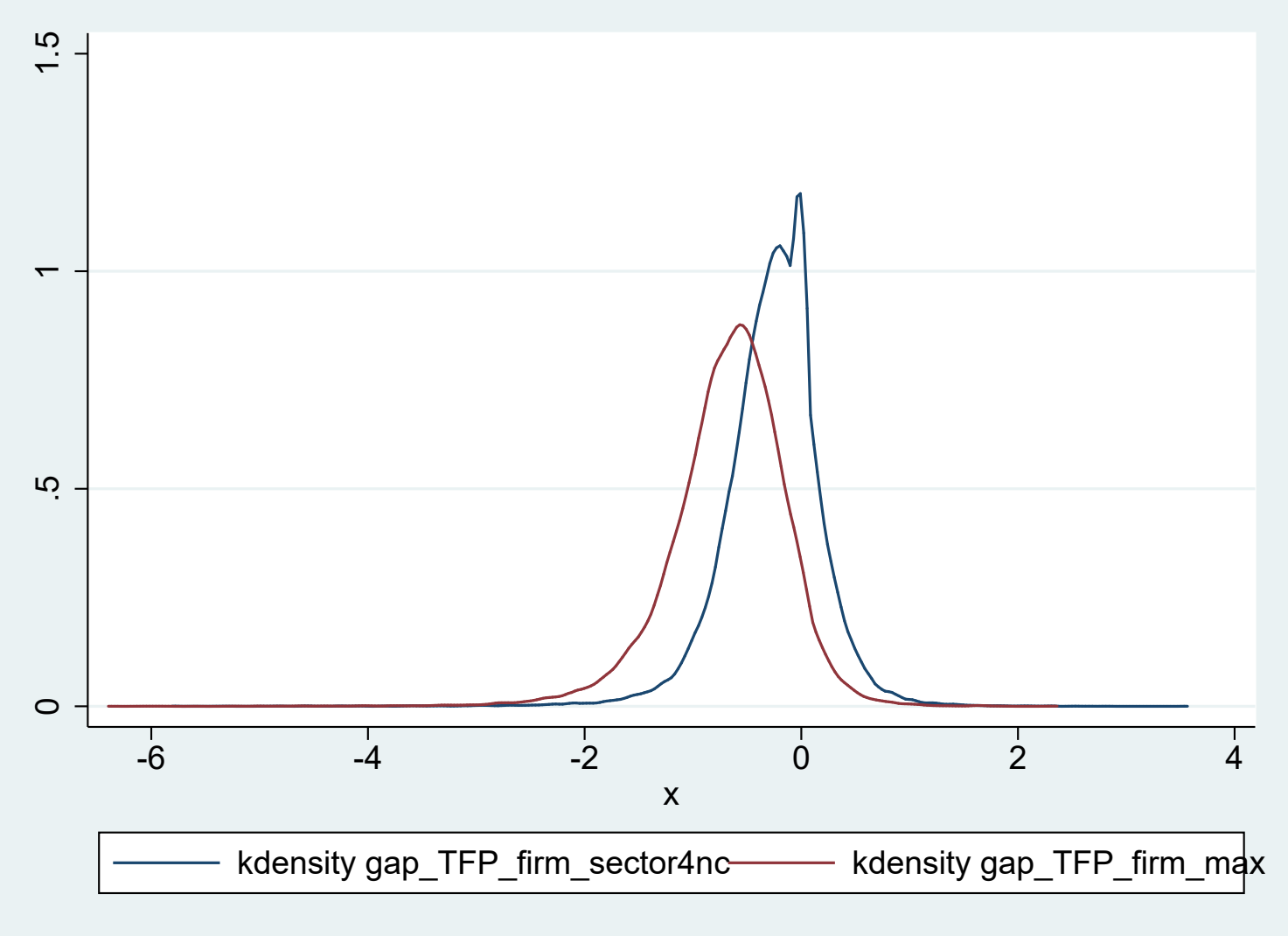
  - $EU^{frontier}_{jt} = max_c \log(TFP_{cjt})^{75^{th}}$

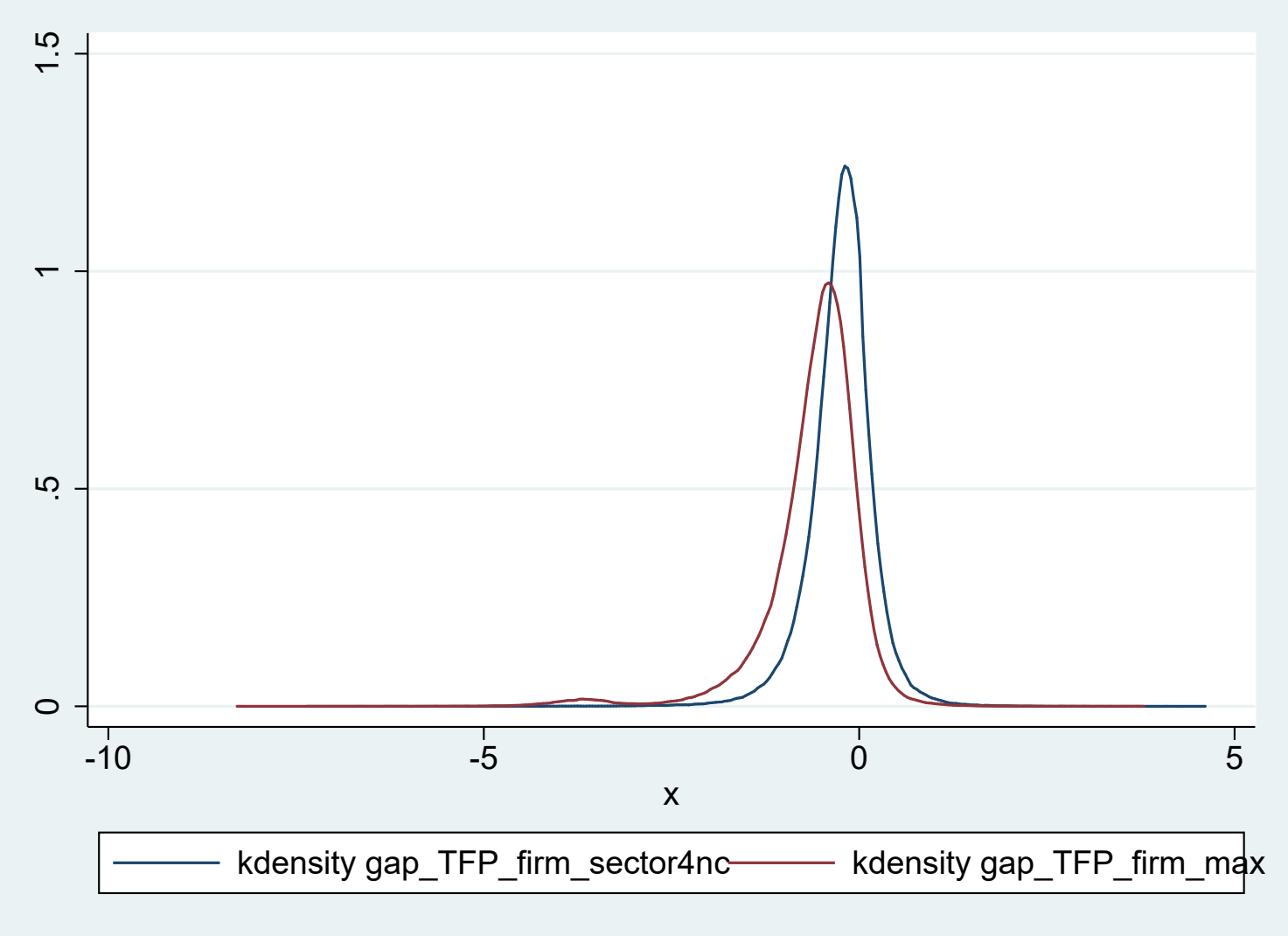
Computing Gaps Distributions



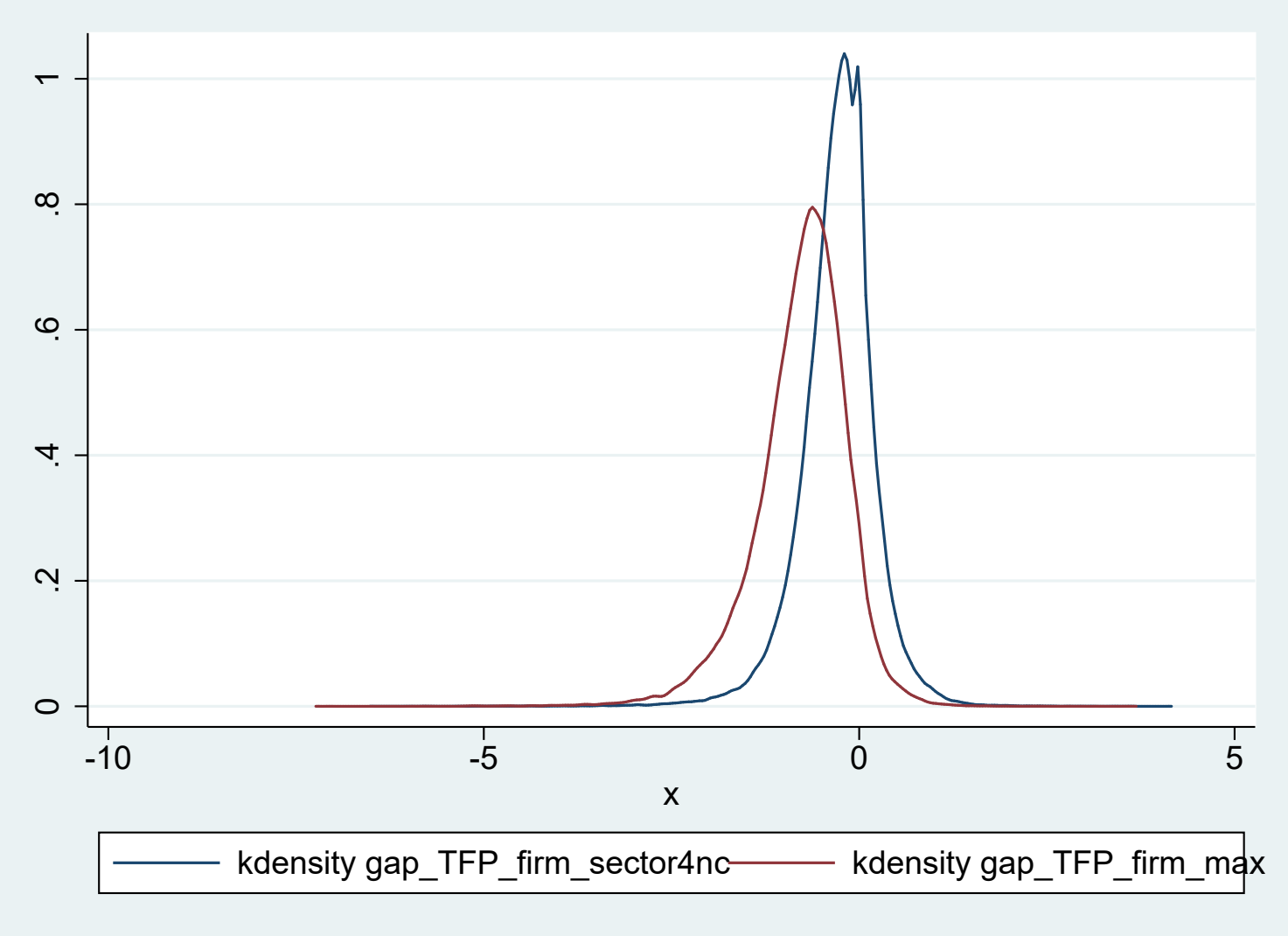
Chemical Gaps Distributions



Metal Gaps Distributions



Food Gaps Distributions



Exploring multilevel determinants of productivity gap

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- Multi-level determinants:
  - Industry determinants:
    - Own disembodied and external embodied technology: Direct and "indirect" R&D investments;
    - Industry concentration (within sector-year-country vs. within sector-year-EU);

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- Multi-level determinants:
  - Industry determinants:
    - Own disembodied and external embodied technology: Direct and "indirect" R&D investments;
    - Industry concentration (within sector-year-country vs. within sector-year-EU);
- Firm-level determinants:
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  - Age;

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- $log(GAP_{ijt}) = \beta_0 + log(\beta_1 \mathbf{X_{it-1}}) + log(\beta_2 \mathbf{Z_{jt-1}}) + \beta_3 log(Embodied_{cjt-1}) + \beta_4 log(RD_{cjt-1}) + \beta_5 log(Embodied_{cjt-1}) * log(RD_{cjt-1}) + D_t + D_i + \varepsilon_{ijt}$

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Fixed Effects Model (non-weighted sample)

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	(1)	(2)	(3)	(4)
Dep: TFP GAP	NACE 26 Computing	NACE 20 Chemicals	NACE 24 Basic Metals	NACE 10 Food
Ln # employees(firm)$_{(t-1)}$	0.0187^{+}	0.0201	-0.0136	0.0417***
	(0.0108)	(0.0146)	(0.0159)	(0.00699)
Age	0.00715*	-0.0413***	-0.0284***	-0.0363***
	(0.00364)	(0.00308)	(0.00420)	(0.00200)
Age^2	-0.0000550^{+}	0.0000633*	0.000116**	0.000137***
	(0.0000281)	(0.0000282)	(0.0000402)	(0.0000221)
Ln Concentration (Country-4digit)$_{(t-1)}$	-0.640***	-0.225*	-0.300**	0.762***
	(0.104)	(0.0903)	(0.114)	(0.0549)
Ln Concentration (EU-4digit)$_{(t-1)}$	1.487***	-0.0459	1.007***	0.832***
	(0.137)	(0.0697)	(0.130)	(0.0602)
Lumpiness dummy(firm)$_{(t-1)}$	-0.00981	0.00117	0.00962	0.00806^{+}
	(0.00663)	(0.00700)	(0.00895)	(0.00460)
Ln Own R&D(Sector)$_{(t-1)}$	0.641***	1.063***	0.971***	10.29***
	(0.113)	(0.172)	(0.280)	(0.411)
Ln Embedded R&D(Sector) $_{(t-1)}$	0.803***	0.812***	-0.0449	2.485***
	(0.138)	(0.136)	(0.103)	(0.129)
Ln Own R&D(Sector) $_{(t-1)}$ *Interacted* Ln Embedded R&D(Sector) $_{(t-1)}$	-0.323***	-0.727***	-0.891**	-11.88***
	(0.0556)	(0.114)	(0.286)	(0.504)
Cons	-2.762***	-0.933***	-0.160	-2.804***
	(0.286)	(0.216)	(0.162)	(0.103)
R^2	0.801	0.777	0.730	0.783
N	20479	25147	16617	81666

Clustered standard errors in parentheses $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Full set of time dummies accounted for. A positive coefficient entails a reduction of the gap.

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Ln # employees(firm)$_{(t-1)}$	0.0168	0.00669	-0.0193	0.0233**
	(0.0104)	(0.0134)	(0.0201)	(0.00745)
Age(firm)	0.00338	-0.0392***	-0.0241***	-0.0361***
	(0.00362)	(0.00310)	(0.00431)	(0.00228)
Age(firm)^2	-0.0000521*	0.0000497	0.000107*	0.000148***
	(0.0000255)	(0.0000303)	(0.0000444)	(0.0000243)
Ln Concentration (Country-4digit)$_{(t-1)}$	-0.552***	-0.485***	-0.870***	0.604***
	(0.0975)	(0.0917)	(0.137)	(0.0592)
Ln Concentration (EU-4digit)$_{(t-1)}$	1.468***	-0.0112	1.181***	0.957***
	(0.136)	(0.0655)	(0.147)	(0.0622)
Lumpiness dummy(firm)$_{(t-1)}$	-0.00380	-0.00719	0.00829	-0.00206
	(0.00654)	(0.00703)	(0.00979)	(0.00453)
Ln Own R&D(Sector)$_{(t-1)}$	0.663***	0.780***	0.256	10.62***
	(0.120)	(0.163)	(0.315)	(0.468)
Ln Embedded R&D(Sector) $_{(t-1)}$	0.792***	0.605***	-0.214+	2.669***
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Ln Own R&D(Sector) $_{(t-1)}$ *Interacted* Ln Embedded R&D(Sector) $_{(t-1)}$	-0.347***	-0.565***	-0.301	-13.40***
	(0.0612)	(0.114)	(0.313)	(0.611)
Cons	-2.588***	-0.443*	0.261	-2.595***
	(0.320)	(0.218)	(0.196)	(0.120)
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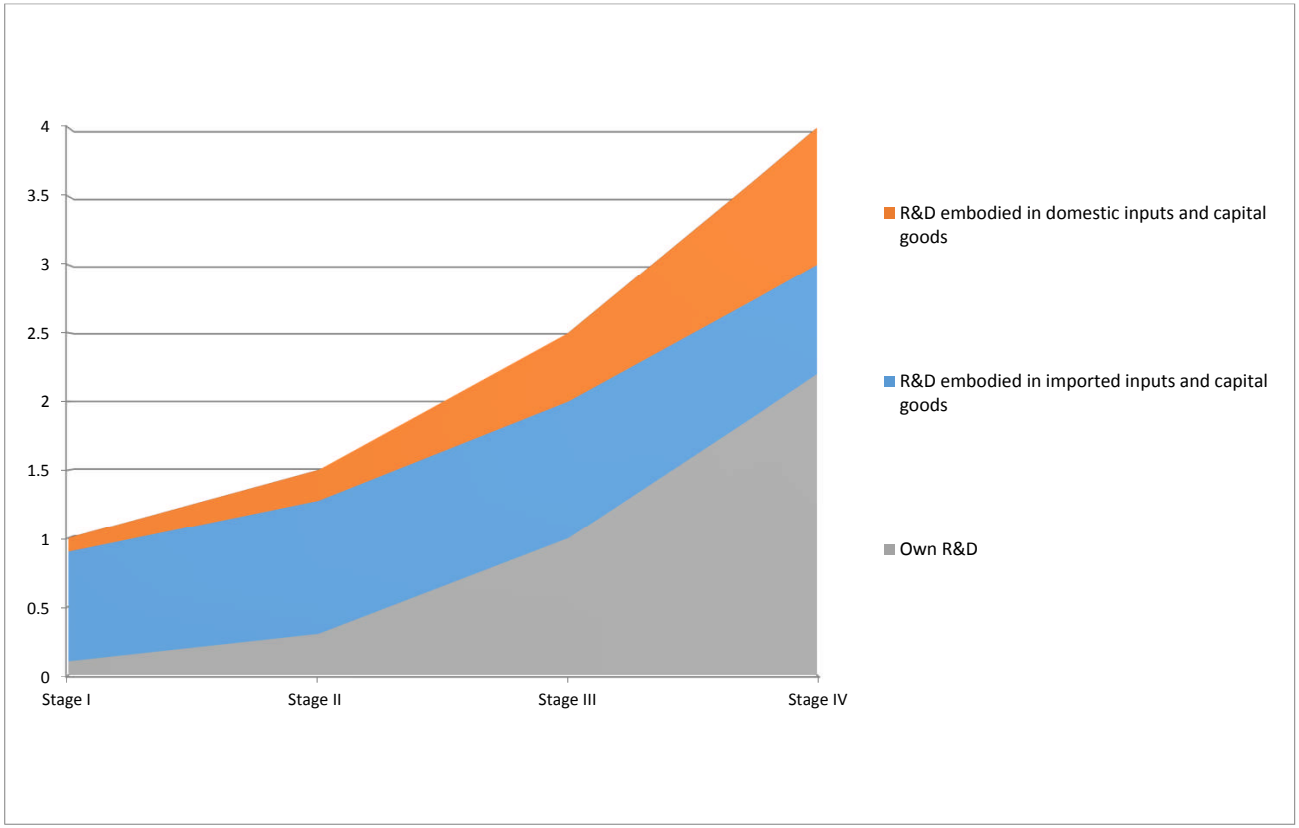
Stylized path of technology upgrading in CEECs: share of R&D components in % of GDP

(Radosevic (2010) and Reinstaller and Unterlass (2010))



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- clear downturn in 2007;

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- Own R&D at the sectoral level is a significant determinant of closing productivity gap: e.g. if R&D increases by 10 percentage points in computing, those firms are moving along the gap an average of 36% !...and this is lower bound of the effect for chemical/metal/food (without accounting for the interaction, though);

Conclusions: The role of technology

Technology: the direct impact

- Own R&D at the sectoral level is a significant determinant of closing productivity gap: e.g. if R&D increases by 10 percentage points in computing, those firms are moving along the gap an average of 36% !...and this is lower bound of the effect for chemical/metal/food (without accounting for the interaction, though);
- Also embodied R&D (domestic and imported from EU) plays a role in closing the gap: e.g. if embodied R&D increases 10% in computing, those firms are moving along the gap an average of 2.3%. The effect if somehow stronger for chemical/metal/food (without accounting for the interaction, though).

Conclusions: The role of technology (c.ed)

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  - Chemical: it is mainly about embodied technology: lock-in at high-high (early switch trap) even if high owned R&D is beneficial
  - Metal: embodied technology
  - Food: there is a clear lock-in at low-low and benefits at high levels of Own R&D

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- Productivity improvements in production via adoption/assimilation of imported technology could spur productivity.

Variables Definitions

Source: Amadeus, WIOD, ANBERD

Variable	*Variable Description(time)*	*Variable Details*	*Source*
Productivity gap of the firm	TFP GAP /Ln(Firm-TFP)-Ln(EU-frontier)-4Digit(t)/	Three Steps procedure: see section 3	Authors computation using Amadeus BvD
Number of employees	Number of Employees (t)	Number of firm's employees	Amadeus BvD
No of recorded subsidiaries	Number of Recorded Subsidiaries (last available year)	Number of the firm's subsidiaries	Amadeus BvD
Age	Age (t)	Number of years the firm has been operating	Authors computation using Date of Incorporation
Concentration Index within a 4-digit domestic sector	Concentration Index (t)	Market Share of the top four firms (turnover) in each sector (based on 4-digit NACE rev.2) in each country	Authors computation using Amadeus BvD
Concentration Index within a 4-digit European Union sector	Concentration Index EU (t)	Market Share of the top four firms (turnover) in each sector (based on 4-digit NACE rev.2) across the whole EU	Authors computation using Amadeus BvD

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Variable	*Variable Description(time)*	*Variable Details*	*Source*
Own R&D as % of Business Production	Own R&D (t)	Percentage of Business production value spend on R&D.	BERD Eurostat (NACE2)
Embedded R&D as % of Gross Value Added	Embedded R&D (t)	R&D imported from other technology-weighted sectors in the EU (including domestic) as a percentage of Gross Value Added	BERD Eurostat combined with WIOD (NACE2)
Dummy Variables			
Lumpiness Dummy	Spike dummy (time-variant)	"1" if the previous year investment capital ratio exceeds 20%, "0" otherwise	Authors computation using Amadeus BvD
EU South East dummy	EU South-East dummy (fixed)	Dummy variable equal to "1" if the country is located in eastern or southern Europe, "0" otherwise	Authors computation using Amadeus BvD
Foreign Ownership	Foreign Owner dummy (last available year)	Dummy variable equal to 1 if the firm has a foreign owner, 0 otherwise	Authors computation using Amadeus BvD

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