Productivity growth in the Old and New Europe: the role of agglomeration externalities

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ESPON project KIT: Knowledge, Innovation, Territory

The stylised facts: a dualistic scenario

- In the last decade GDP in Europe has been growing at a dual speed:
  - in the 12 New accession countries at 5% per year
  - whilst in the EU15+ Old countries at around 2.5%
- EU enlargement and the consequent economic integration has induced the Western economies to delocalize eastwards part of their traditional industries, generating a specialization in:
  - knowledge intensive services (KIS) in the Old Europe [21.8% vs 15.8%]
  - low tech manufacturing (LTM) in the New Europe [16.5% vs 9.8%]

The European economy is characterized by a dualistic scenario shaped by geographical and industrial interconnected factors.

Research questions and agenda

1. What are the forces behind this huge asymmetry in the development path among the two “Europes”?
2. At which territorial level do they operate and are they locally bounded?
3. Is there any role for agglomeration externalities which are industry-specific?

Research agenda

analyze the intertwined economic performances of regions and industries in Western/Old and Eastern/New economies by assessing the role played by different types of agglomeration economies (mainly specialisation and diversity externalities)

Background /1

EU enlargement provides an exceptional “natural experiment” to test for the presence of agglomeration forces, induced by market integration, which has favoured a large process of production delocalization from mature European economies towards new accession countries changing their specialization pattern.

New Economic Geography models, where localization decisions depend on the combination of centripetal and centrifugal agglomeration externalities, predict increased specialization, economies of scale opportunities, workers migration and firms delocalization (Krugman, 1991).

Such agglomeration externalities enhance local productivity and are associated with a restructuring of local economies with main consequences on sectoral and geographical distributions (Baldwin and Martin, 2004 Bruhlart and Koenig, 2006).

Background /2

Agglomeration externalities act differently in line with the industry life cycle (Duranton and Puga, 2001; Neffke et al, 2011):

- new industries benefit more from a diversified environment essential to promote search and experimentation of new prototypes
- mature industries are standardized and, to avoid urban areas congestion, can be relocated to specialized areas, where Marshall's externalities prevail

At the end of the life cycle, specialisation might prove even harmful to economic growth since lock-in effects prevent firms from exploiting new promising technological trajectories (Boschma, 2005)

Specialisation externalities (Marshall) are stronger in low-tech industries while diversity externalities (Jacobs) are usually more important among high-tech sectors and services (Henderson et al 1995)

Background /3

A large amount of literature has inquired about the influence of agglomeration externalities on local economic performance, with a large range of methodologies, data and results (survey by Beaudry and Schiffaurova, 2009 and meta-analysis by De Groot, Poot and Smit, 2009)

Only two previous works focus on sectors and regions in the enlarged Europe:

Brülhart – Mathys (2008) analyse sectors where firms tend to move to exploit agglomeration-induced productivity effects; they found that:

- manufacturing: evidence of cross-sector urbanization economies
- financial services: positive effects of own-sector density on productivity

Foster - Steher (2009) consider differences in the extent of agglomeration effects between New and Old Europe, and conclude that such effects tend to be stronger for New member states

Purpose and Novelties

Investigate the effects of agglomeration externalities on Total Factor Productivity growth for 13 sectors, 29 European countries (EU27 + CH, NO), 276 regions, years 1999-2007.

Novelties

- The local industry performance is measured by estimated TFP growth rates to account for the high heterogeneity across sectors.
- The use of spatial econometric techniques to take into account the possibility of cross-border externalities.
- The broad geographical coverage of Europe allows discriminating the growth process in old mature countries *vs* new developing economies and in urban *vs* rural territorial settlement.
- The sectoral coverage allows distinguishing between the potential role of specialisation and diversity agglomeration economies (LTM *vs* KIS).
- The assessment of the role of regional environment in terms of intangible assets, such as human capital and technological assets.

Research strategy and presentation layout

1. Estimation of C-D production function with traditional inputs for a long time period 1990-2007 and computation of TFP at local-industry level
2. Estimation of TFP growth as a function of local-industry agglomeration externalities
3. Analysis of the differentiated impact of agglomeration externalities on TFP growth changes according to:
   - development stage: New *vs* Old Europe
   - macro-sectors: low tech manufactures *vs* knowledge intensive service
   - territorial characteristics: urban *vs* rural areas
4. Extending the analysis to assess the role of regional intangibles assets

Total Factor Productivity estimation

Rather than imposing factor elasticities, TFP levels have been estimated.

First, we derive factor elasticities for each of the 13 sectors by estimating a traditional C-D production function within a panel model:

$$\ln(VA_{it}) = a + \alpha \ln(K_{it}) + \beta \ln(L_{it}) + \delta_t + u_{it}$$

i=1,… 276 regions; *t*=1990,… 2007

Data Cambridge Econometrics

Second, by applying the growth accounting approach we use the estimated sectoral elasticities to compute TFP levels for each couple of industry and region.

Finally, we calculate the annual average percentage change for the period 1999-2007 for each region and sector to obtain our 3588 dependent variable observations (276x13).

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Production functions estimated elasticities

Dependent variable: value added		Capital stock	Labour units
S1	Mining, energy	0.466	0.269
S2	Food, etc	0.455	0.375
S3	Textiles, etc	0.444	0.391
S4	Chemicals etc.	0.607	0.365
S5	Electrical, optical eq.	0.488	0.488
S6	Transport equipment	0.451	0.400
S7	Other manufacturing	0.501	0.431
S8	Construction	0.164	0.802
S9	Distribution	0.191	0.862
S10	Hotels, restaurants	0.125	1.029
S11	Transport, communications	0.249	0.689
S12	Financial intermediation	0.059	1.035
S13	Real estate, business ect.	0.160	0.792
All sectors		0.336	0.587

For each sector estimates are obtained from a balanced regional panel (N=276), observed over the period 1990-2007 (T=18), NxT=4968

Estimation method: 2SLS with one year lagged regressors as instruments

Constant and time period fixed effects included, all coefficients are significant at 1% level

The estimation of varying elasticities at sectoral levels across regions capture the well documented heterogeneity in traditional inputs production effectiveness

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Total Factor Productivity in Europe

	1999		2007		Annual average growth rate % 1999-2007
	index Europe=100	variation coefficient	index Europe=100	variation coefficient	
Old Europe: EU15, Norway, Switzerland	115	0.86	113	0.59	0.48
New Europe: 12 new accession countries	41	0.33	50	0.28	2.80
Whole Europe	100	0.93	100	0.65	0.95

Significant economic divide between Old Europe and New accession countries.

The divide shows a decreasing trend.

The annual average TFP growth rate of New EU is almost six times as high as the one exhibited by the Old regions.

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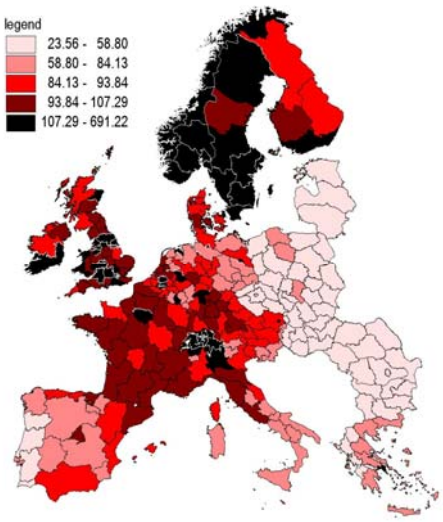
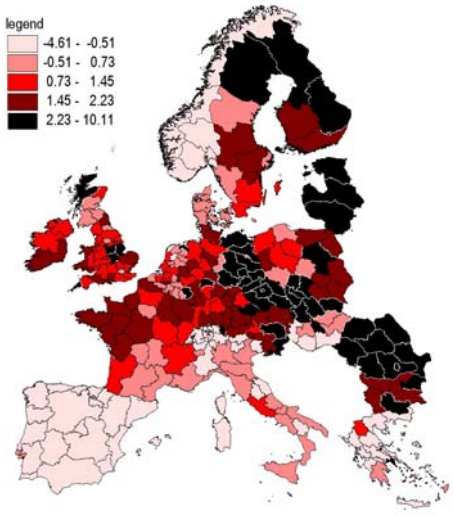
TFP levels, 1999 (EU average=100)



TFP growth rates, 1999-2007



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Determinants of productivity growth /1

We expect that the different development and specialisation paths followed by the Western Old Europe and the Eastern New Europe depend on the distinctive role played by three types of externalities computed for each couple of industry and region.

Specialisation externalities (Marshall, 1890)

- firms in the same industry tend to work side by side since proximity can facilitate knowledge transmission, reduce production and transport costs, favour efficiency in the labour market (labour market pooling, input sharing, better markets access)...pecuniary and technological externalities
- expected sign: positive up to the point when congestion and competitive effects start to prevail

SPE: index of relative production specialisation (location quotient); quota of industry employment in a region relative to the national share

Determinants of productivity growth /2

Diversity externalities (Jacobs, 1969)

- industrial variety is a major engine of creativity and innovation thanks to fruitful imitation, fertilization and recombination of ideas across sectors. It is usually attributed to dense urban regions and can be offset by the typical congestion effects of metropolitan areas.
- expected sign: depends on the development stage and life cycle.

DIV: inverse of the Herfindahl index applied to employment in all sectors except the one considered.

Firms size (Porter, 1990)

- presence of economies of scale which can enhance the efficiency of the local sector.

FS: employment over local units.

Initial TFP level (conditional convergence or catching up models)

- the initial TFP level influences the subsequent growth path for each couple of region and sector.

Basic model and methodological issues

$$TFP\_growth_{ij,99-07} = \beta_0 + \beta_1 SPE_{ij} + \beta_2 DIV_{ij} + \beta_3 FS_{ij} + \beta_4 \ln(TFP_{ij,99}) + \sum_{j=1}^{12} \gamma_j SD_j + \varepsilon_{ij}$$

Sectoral dummy variables (SD) are included to control for heterogeneity across industries (technological opportunities, national and international market structure and openness).

Explanatory variables are measured at their initial period level (1999) in order to deal with potential endogeneity problems.

To take into account the possibility of some cross-regional externalities, we initially consider both the spatial lag model (for the case of spatial spillovers) and the spatial error model (omitted explanatory variables with spatial features related to the spatial features of the data). On the basis of the LM tests for spatial dependence we selected the spatial error model.

To guard against possible heteroskedasticity and remaining spatial correlation we also apply the spatial heteroskedasticy and correlation consistent (SHAC) estimator for the variance-covariance matrix: results confirm the empirical significance levels reported in the tables.

Basic model: spatial dependence

Dependent Variable: TFP, % annual average growth rate 1999-2007

	4.1 OLS	**4.2** ML, error model	**4.3** ML, lag model
Specialisation externalities	0.41 **	0.27	0.40 **
	(2.13)	(1.35)	(2.11)
Diversity externalities	-0.32 ***	-0.29 ***	-0.28 ***
	(-5.84)	(-5.09)	(-5.16)
Firms size	0.002 ***	0.001 ***	0.001 ***
	(3.18)	(2.70)	(2.73)
Initial TFP level (1999)	-0.95 ***	-0.97 ***	-0.93 ***
	(-11.81)	(-11.81)	(-11.87)
Spatial error autocorr. coefficient (ρ)		0.84 ***	
		(27.42)	
Spatial lag coefficient (λ)			0.80 ***
			(27.37)
Square correlation (actual, fitted values)	0.55	0.51	0.47
Robust LM test - spatial error	80.68		
p-value	0.00		
Robust LM test - spatial lag	1.65		
p-value	0.20		

Observations: 276 regions, 13 sectors, total 3588
All regressions include a constant and 12 sectoral dummies
The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized
Asymptotic t-statistics in parenthesis; significance: *** 1%; ** 5%; * 10%

Differences

Analysis of the differentiated impact of agglomeration externalities on TFP growth changes according to:

- development stage: New *vs* Old Europe
- macro-sectors: low tech manufactures *vs* knowledge intensive service
- territorial characteristics: urban *vs* rural areas

Introduce the dummy variable: New countries (drop initial TFP level)

Variable SST: Settlement Structure Typology

1=less densely populated without centres, 2=less densely populated with centres, 3=densely populated without large centers, 4=less densely populated with large centres, 5= densely populated with large centres, 6=very densely populated with large centres

Differences between Old and New Europe

Dependent Variable: TFP, % annual average growth rate 1999-2007

	5.3 ML	5.4 ML	5.5 ML	
Specialisation externalities	-0.23	-0.49 **	-0.48 *	Old EU
	(-0.95)	(-1.93)	(-1.90)	
Diversity externalities	-0.18 ***	-0.16 **	-0.17 ***	
	(-2.80)	(-2.38)	(-2.53)	
Firms size	0.002 ***	0.002 ***	0.002 ***	
	(3.13)	(3.23)	(3.23)	
Specialisation externalities in New countries[1]	1.69 ***	1.28 **	1.21 **	New EU
	(3.33)	(2.21)	(2.09)	
Diversity externalities in New countries	-0.46 ***	-0.51 ***	-0.49 ***	
	(-2.65)	(-2.90)	(-2.82)	
Firms size in New countries	-0.01 ***	-0.005 ***	-0.005 ***	
	(-2.90)	(-2.48)	(-2.48)	
Specialisation externalities for LTM[2] sectors in New countries		3.22 ***	3.29 ***	
		(2.81)	(2.87)	
Specialisation externalities for KIS[2] sectors in Old countries[1]		1.98 ***	1.50 **	
		(2.61)	(1.93)	
Diversity externalities for KIS sectors and Urban settlement pattern			0.03 ***	
			(2.77)	
New countries	4.34 ***	4.46 ***	4.37 ***	
	(3.30)	(3.39)	(3.32)	
Spatial error autocorr. coefficient (ρ)	0.84 ***	0.84 ***	0.84 ***	
	(27.82)	(27.03)	(26.66)	
Square correlation (actual, fitted values)	0.50	0.50	0.50	

Computed effects of agglomeration externalities

	Old Europe	New Europe
	LTM	LTM
Specialisation externalities	-0.480	4.020
Diversity externalities	-0.170	-0.660
Firms size	0.002	-0.003
	KIS	KIS
Specialisation externalities	1.020	0.730
Diversity externalities, SST=1	-0.140	-0.630
Diversity externalities, SST=6	0.010	-0.480
Firms size	0.002	-0.003

From the most general model 5.5.

Agglomeration externalities: main results

Old mature countries:

- specialization externalities in LTM are negatively related to growth suggesting the prevalence of congestion effects, while Marshall's predictions have still a role to play in KIS
- diversity externalities show a positive influence on productivity growth only for KIS sectors in very densely populated area with large urban centers

New developing countries:

- specialization externalities exert a positive growth effect in the whole economy although their effect is five time higher in LTM
- diversity externalities have a negative impact without significant differences among sectors and territorial settlement

The role of regional intangibles assets

TFP growth in a local industry may also be affected by the regional environment, which influences all sectors in a common way. Thus, we extend the model by considering the availability of two regional intangible assets

Human capital

- well-educated labour forces represents an advantage for the localization of innovative firms, promoting local productivity (Benhabib-Spiegel 1994; Moretti 2004; Faggian-McCann 2006)
- **HHK** "high" human capital: share of population who has attained at least a tertiary (university) level of education (ISCED 5-6) [or life-long learning]

Technological capital

- firms benefit from the local availability of a high degree of technological capital (Griliches 1979, Audretsch-Feldman 2004).
- **TK:** stock of patents required at European Patent Office in the ten years to 1999 by inventors resident in the region [or R&D expenditure]

TFP growth and intangible assets

Dependent Variable: TFP, % annual average growth rate 1999-2007
ML spatial error models

	7.1
Regional intangible assets	
High human capital	3.48 ***
	(3.37)
Technological capital	0.23 ***
	(2.78)
Alternative proxies for regional intangible assets	
Life-long learning	
Research and development	
New countries	4.13 ***
	(3.15)
Spatial error autocorr. coefficient (ρ)	0.83 ***
	(26.47)
Square correlation (actual, fitted values)	0.51

Observations: 276 regions, 13 sectors, total 3588
All regressions include a constant and 12 sectoral dummies
All regressions include the local industry variables as in model 5.5
The spatial weight matrix is the square of the inverse distance matrix, max-eigenvalue normalized
Asymptotic t-statistics in parenthesis. Significance: *** 1%; ** 5%; * 10%

All regressions include all local industry variables as in model 5.5

Conclusions

We investigate the effects of agglomeration externalities on TFP growth over 1999-2007 for 13 sectors in 276 regions within a spatial error model.

As predicted by the NEG models, we find interesting evidence that the impact of agglomeration externalities on TFP growth changes according to:

- development stage: New vs Old Europe
- macro sectors: low tech manufactures vs knowledge intensive service
- territorial characteristics: urban vs rural areas

Old Europe is in an advanced phase of industrial restructuring with the traditional manufacturing districts partially delocalized to the New Europe and with more focus on high value added KIS, which are exploiting both specialization and diversity externalities especially in the urban environment through cross fertilization and exchange of knowledge among sectors.

New accession countries are still in an initial development stage and are exploiting a full range of the typical Marshallian externalities which affect production in the LTM through a self-reinforcing agglomeration process.

Policy implications

Our results suggest the importance of more specific targets of policy interventions aiming at:

- defining more effective policies which differentiate economies according to their current development stage and their key growth sources in terms of specialisation and diversification
- implementing a dual policy strategy oriented to specialised industrial clusters in manufactures in New Europe and to diversified urban economies in Old Europe
- Promoting faster human and technological capital accumulation in the whole Europe, but with a different objective in the two macro-areas according to their differentiated production structures and economic performances
- In a nutshell: we need place and sector based policies

Sectoral employment shares (% over total empl.)

	Low tech manufacturing		Knowledge intensive services	
	1999	2007	1999	2007
Old Europe: EU15, Norway, Switzerland	11.7	9.8	19.5	21.8
New Europe: 12 new accession countries	17.7	16.5	13.3	15.8
Whole Europe	12.9	11.1	18.3	20.6

Data sources and definition

Variable	Primary Source	Definition
Value added	Cambridge Econometrics	Millions euros, 2000
Capital stock	Own calculation	Millions euros, 2000
Units of labour	Cambridge Econometrics	Thousands
Total Factor Productivity	Own estimation	
Specialisation externalities	Cambridge Econometrics	Normalised index of relative sectoral specialisation of employment, 13 sectors
Diversity externalities	Cambridge Econometrics	Inverse of Herfindhal index computed on sectoral employment, 13 sectors
Firms size	Eurostat - SBS	Employment over local units (thousands), 13 sectors
High Human Capital	Eurostat	Population aged 15 and over by highest level of education attained. Tertiary education - levels 5-6 (ISCED 1997), over population 15 and over
Life-long learning	Eurostat	Participation of adults aged 25-64 in education and training, over population 25 and over
Technological capital	OECD, REGPAT	Patent applications at EPO, stock for the years 1990- 1999, over thousands population
Research and Development	Eurostat	Total intramural R&D expenditure (GERD), over GDP
Population density	Eurostat	Population per km^2, thousands
Settlement Structure Typology	ESPON project 3.1 BBR	1=less densely populated without centres, 2=less densely populated with centres, 3=densely populated without large centers, 4=less densely populated with large centres, 5= densely populated with large centres, 6=very densely populated with large centres

Sectors

	Sector Name	NACE Sector Code	Typology
S1	Mining, quarrying and energy supply	C+E	
S2	Food, beverages and tobacco	DA	LTM
S3	Textiles and leather etc.	DB+DC	LTM
S4	Coke, refined petroleum, chemicals etc.	DF+DG+DH	
S5	Electrical and optical equipment	DL	
S6	Transport equipment	DM	
S7	Other manufacturing	DD+DE+DN+DI+DJ+DK	LTM
S8	Construction	F	
S9	Distribution	G	
S10	Hotels and restaurants	H	
S11	Transport, storage and communications	I	KIS
S12	Financial intermediation	J	KIS
S13	Real estate, renting and business activities	K	KIS

LTM: Low Tech Manufacturing
KIS: Knowledge Intensive Services

Countries, Regions and NUTS level

Code	Country	NUTS	Regions	New
AT	Austria	2	9	
BE	Belgium	2	11	
BG	Bulgaria	2	6	x
CH	Switzerland	2	7	
CY	Cyprus	1	1	x
CZ	Czech Republic	2	8	x
DE	Germany	2	39	
DK	Denmark	2	5	
EE	Estonia	1	1	x
ES	Spain (a)	2	16	
FI	Finland	2	5	
FR	France (a)	2	22	
GR	Greece	2	13	
HU	Hungary	2	7	x
IE	Ireland	2	2	
IT	Italy	2	21	
LT	Lithuania	1	1	x
LU	Luxembourg	1	1	
LV	Latvia	1	1	x
MT	Malta	1	1	x
NL	Netherlands	2	12	
NO	Norway	2	7	
PL	Poland	2	16	x
PT	Portugal (a)	2	5	
RO	Romania	2	8	x
SE	Sweden	2	8	
SI	Slovenia	2	2	x
SK	Slovakia	2	4	x
UK	United Kingdom	2	37	

(a) Territories outside Europe are not considered