Building World-class Research Infrastructures as a Source of Growth

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The Lisbon Agenda and regional development

- **Contradiction at the heart of the Lisbon Agenda**
  1. Making Europe the most competitive knowledge-based economy in the world
  2. Promoting territorial cohesion
- **This means**
  1. European growth needs to be knowledge-fuelled
  2. Its growth must outstrip that of its main competitors (US)
  3. The periphery of the EU must growth faster than the core
     - And technology and knowledge should play a leading role in this process
- **But this is virtually impossible to achieve**
  1. Unless you are a neoclassical economist believing in technology as an exogenous factor in the growth equation
  2. Otherwise numerous factors are likely to favour the concentration of knowledge
- **Generating knowledge-based growth and cohesion may be mutually exclusive**

Knowledge-based growth and agglomeration

- **Why is knowledge likely to be spatially concentrated?**
- **3 approaches:**
  1. **Endogenous growth**
     - Accumulation of R&D and technology leads to increasing returns to scale
     - Neo-Schumpeterian variant: Existence of clear thresholds to innovation
  2. **The ‘systems of innovation’ approach**
     - ‘Territorially-embedded’ institutional networks favour the genesis of innovation
     - The capacity to set these networks depends on:
       - ‘The social filter’: Education, skills, demographic structure, employment
       - The economic structure: Size of the economy, specializaton vs. diversity, presence of externalities (MAR, Jacobs, Urbanization), face-to-face
       - Local institutions
  3. **Knowledge spillovers**
     - Strong distance decay effects

Aim of the presentation

- To analyse to what extent the goal of cohesion of the Lisbon Agenda is compatible with knowledge-driven economic growth
- Especially in the light of Europe's lag vis-à-vis the US

Structure of the presentation

- **Europe vs. the US**
- **Model**
- **Dataset**
- **Empirical results**
  1. Growth in Europe
  2. Innovation capacity: Europe vs. the US
- **Conclusions**

Europe vs. the US

- **The EU lags behind as a knowledge-based economy**
  1. **The US devotes more resources to innovative activities**
     - 2.6 percent of GDP vs. 1.9 percent in the EU
     - Gap created by private-sector expenditure in the EU (roughly double that of the EU: 1.9 vs. 1 percent of GDP)
  2. **The US has more researchers**
     - 5.4 researchers per 1,000 workers in the EU vs. 9.0 in the US (2003)
     - Greater capacity to attract the top researchers
     - Much higher investment in education (€8,000 vs. €20,500)
  3. **The US patents more**
     - 36.4 percent of the share of triadic patent families in 2003 vs. 30.3% of the EU.
     - Weighted by population, US patent intensity is 47% higher than for the EU-15
  4. **The US does more research, which has greater impact**
     - Citations per head almost double that of the EU-15
     - More than double the share of the top 1% most cited publications

Europe vs. the US: the dilemma

- **Need to catch up in order to:**
  1. Remain competitive
  2. Maintain standard of living
- **But need to raise competitiveness in all territories**
  1. Obligation to spread and diffuse the innovative effort
  2. And even to put greater emphasis in the periphery
  3. So as to reduce the distance between the core and the periphery
- **But, does this work?**

The model

	Endogenous factors	External factors (spillovers)
Initial conditions	Regional GDP per capita	GDP per capita in neighbouring regions
R&D	Investment in R&D in the region	Investment in R&D in neighbouring regions
Infrastructure	Infrastructure and investment in infrastructure in the region	Infrastructure and investment in infrastructure in neighbouring regions
Agglomeration economies	Total regional of state GDP/ Population density	
Specialisation of the local economy	Krugman index	
Human capital mobility	Migration	
Social filter	Structural characteristics that would make a region more 'innovation prone' (conducive to the establishment of a regional system of innovation) including: 1.Education 2.Life-long learning 3.Sectoral composition 4.Use of resources (unemployment) 5.Demographics	Conditions conducive to the establishment of a regional system of innovation in neighbouring regions
National effects	National dummies (in the case of Europe) and Geographical dummies (for the US)	

The empirical model

- **Modified Cobb-Douglass knowledge production function:**

$$I_i = AK_i^{\beta} RD_i^{\gamma} SpillRD_i^{\delta} C_i^{\zeta} SpillC_i^{\eta}$$

Where :

I is level of innovative output of region *i*,

A is constant,

K is the initial stock of knowledge available in the region *i*,

RD is the knowledge created in the region or 'regional technological activity',

SpillRD is a vector of neighbouring regions' innovative efforts which may spill over into and contribute to the local production of innovative output,

C is a vector of local economic and socio-institutional characteristics,

SpillC is a vector of external economic and socio-institutional characteristics.

Dataset

- **EU data**
  1. **EUROSTAT New Cronos-Regio data**
  2. **Regional division**
     - NUTS1 regions for Germany, Belgium and the UK
     - NUTS2 for all other countries (Spain, France, Italy, the Netherlands, Greece, Austria, Portugal, Finland, Czech Republic, Hungary, Poland, Slovakia).
     - Uniregional countries (Denmark, Ireland, Luxemburg, Estonia, Latvia, Lithuania, Slovenia, Malta and Cyprus) excluded
     - Total of 166 regions
  3. **Time span: 1990-2005 or 1995-2005**
- **US data**
  1. **Regional divisions**
     - 266 MSA/CMSAs covering all continental US States (and the District of Columbia)
     - Standard & Poor's Compustat North American firm-level data for private R&D expenditure in 145 MSAs out of the total of 266.
     - US-Census data included in the USA COUNTIES 1998 CD-ROM.
  2. **Time span: 1990-1999**

Growth, EU: R&D, social filter, and spillovers

Investment in R&D positive and statistically significant

Relying on your own investment, better than hoping for a free-ride

H-C OLS estimation o[illegible]he empirical model. R&D, social filter and k[illegible]w

	2	[illegible]
Constant	0.09406***	0[illegible]182***
	(0.02572)	*(0.02796)*
Log GDP 95	-0.0030[illegible]	-0.00663*
	(0.003255)	*(0.003543)*
R&D expenditure	0.2682**	0.1791
	(0.1174)	*(0.1218)*
Social Filter Index		0.010787**
		(0.004598)
Accessibility to ExtraRegional Innovation	0.013236	0.01387*
	(0.008148)	*(0.008031)*

*, ** and *** denote significance at a 10%,5% and 1% level respectively. SE in parantheses

But its impact is conditioned by the 'social filter'

The 'social filter' enhances the capacity to assimilate knowledge spillovers

Full table

Growth, EU: The role of "Social Filter"

H-C OLS estimation of the empirical model. R&D, social filter and knowledge spillovers

	3	4	5	11
Constant	0.12182***	0.1126***	0.10707***	0.12187***
	(0.02796)	*(0.02563)*	*(0.02561)*	*(0.0280[illegible])*
Log GDP 95	-0.00663*	-0.00574*	-0.005112	[illegible]349*
	(0.003543)	*(0.003267)*	*(0.00[illegible])*	*(0.003668)*
R&D expenditure	0.1791	0.136[illegible]	[illegible].166	0.177
	(0.1218)	*(0[illegible])*	*(0.1208)*	*(0.1223)*
Social Filter Index	0.010787**			0.010538**
	(0.004598)			*(0.004682)*
Accessibility to ExtraRegional Innovation	0.01387*	0.013157*	0.013733*	0.013936*
	(0.008031)	*(0.007908)*	*(0.007975)*	*(0.008059)*
Social Filter Individual Components:				
Education Population		0.017003***		
		(0.005341)		
Education Labour Force			0.019224***	
			(0.006986)	
Extra-Regional Social Filter				
Accessibility to Innovation Prone Extra-Regional areas				-0.00808
				(0.0261)

The social filter index is always significant

But the significance comes down to education

The socio-economic conditions of neighbouring regions do NOT influence local performance

Infrastructure endowment vs. investment

A good infrastructure endowment is a precondition for economic development

But additional investment in infrastructure seems to be completely disconnected from growth

EU-15: Regional growth and transport infrastructure, 1990-2004

	Simple model: Infrastructure endowment	Simple model: Infrastructure endowment and investment	*plus*: Infrastructure network effects	
Dependent variable: Regional GDP per capita (annual growth rate)	(1)	(2)	(3)	(4)
Kms of motorways per 1000 inhabitants	0.093***	0.117***	0.049***	0.046**
	(0.015)	*(0.017)*	*(0.018)*	*(0.018)*
Log of GDPpc	-0.047***	-0.049***	-0.076***	-0.079***
	(0.008)	*(0.008)*	*(0.009)*	*(0.009)*
Annual national growth rate	0.005***	0.004***	0.004***	0.004***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*
Change in Kms of motorways/1000 inhab.		-0.075	-0.054	-0.048
		(0.052)	*(0.048)*	*(0.046)*
Spatial weighted average of Kms of motorways/1000 inhab.			0.169***	0.186***
			(0.023)	*(0.024)*
Spatial weighted average of Change in Kms of motorways/1000 inhab.				-0.180***
				(0.067)

Infrastructure vs. other factors

Infrastructure endowment and investment appear also to be less relevant for growth in the medium-term than other factors

Investment in R&D in neighbouring regions matters more

But the overall endowment of education is the best predictor for high economic performance

	Dependent variable: Regional GDP per capita (annual growth rate)		
Nu[illegible]r of annual lags	2	4	6
Kms of motorways per thousand inhabitants	0.046**	0.028	0.0[illegible]
	(0.023)	*(0.023)*	*(0.0[illegible]*
Change in Kms of motorways/1000 inhab.	0.014	-0.048*	0.[illegible]
	(0.031)	*(0.028)*	*(0.0[illegible]*
Total intra-regional R&D expenditure (all sectors) in percent of GDP	0.000**	-0.000	0.00[illegible]
	(0.000)	*(0.000)*	*(0.000)*
Spatial weighted average of Total R&D expenditure	-0.001	-0.001**	0.001**
	(0.000)	*(0.001)*	*(0.000)*
Ratio of employed people with Higher education in percent	0.002***	0.001***	0.001**
	(0.000)	*(0.000)*	*(0.000)*

Growth, EU: Knowledge spillovers

$$\frac{1}{J}\ln\left(\frac{Y_{i,t}}{Y_{i,t-J}}\right) = \alpha + \beta_1 \ln(y_{i,t-J}) + \beta_2 RD_{i,t-j} + \beta_3 SocFilter_{i,t-J} + \beta_4 Spillov_{i,t-j} + \beta_5 ExtSocFilter_{i,t-J} + \beta_6 ExtGDPcap_{i,t-J} + \beta_7 D + \varepsilon$$

Accessibility to ExtraRegional Innovation				
Continous Space	0.01387* *(0.008031)*			
180 minutes cutoff		0.00983** *(0.00481)*		
300 minutes cutoff			0,002556 *(0.004712)*	
600 minutes cutoff				-0,005154 *(0.007263)*

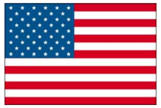
Knowledge spillovers are significant in explaining regional growth performance

But strong distance decay effects

Full table

Comparison: Innovative activities

Table 1	(1)	(2)
	Patent growth rate 1990-99, USA	Patent growth rate 1990-99, USA
Constant	0.205***	0.220***
	(0.042)	*(0.045)*
Natural Log of patents per million inhal	-0.019**	-0.028***
	(0.008)	*(0.008)*
Private R&D expense as a percentage	0.009*	0.011**
	(0.005)	*(0.005)*
Spat. Weigh. average of neighbouring	-0.029	-0.010
	(0.035)	*(0.036)*
Social Filter		0.016***
		(0.003)
Spat. Weigh. Average of neighbouring MSAs' Soc		-0.005
		(0.022)



In the U.S. positive and statistically significant impact of local innovative activities on innovative output:

The transmission of economically productive knowledge is limited within the functional borders of the MSA: no evidence of inter-MSA spillovers

Table 3	(1)	(2)
	Patents growth rate 1990-2002, EU	Patents growth rate 1990-2002, EU
Constant	0.060**	0.094***
	(0.026)	*(0.032)*
Natural Log of Patents per million inhab	-0.021***	-0.025***
	(0.006)	*(0.007)*
R&D Expenditure (% Regional GDP)	0.960	0.712
	(0.691)	*(0.773)*
Spatially weighted average of neighbou	8.311**	7.066*
	(3.884)	*(3.575)*
Social Filter		0.011*
		(0.006)
Spatially weighted average of neighbouring regions		0.014
		(0.037)

In the EU local innovative productivity not related to the level of R&D expenditure

Exposure to interregional knowledge spillovers matters more

Factors behind these differences

- **Three potential factors:**
  1. **Distance between innovative centres**
     - Large innovative areas tend to be physically closer in Europe than in the US.
     - Stronger distance decay effects in the US.
     - Greater proximity and lower distance decay: Stronger capacity to rely on innovative inputs in neighbouring areas in the EU
     - Greater distance and stronger distance decay effects: Creation of self-contained innovative areas in the US
  2. **Specialization in R&D investment**
     - R&D inputs in the US tend also to be more specialised and better targeted than in Europe
  3. **Labour mobility**
     - In the US, high levels of mobility allow a between matching of innovative actors in space

Comparison: Socio-economic conditions

Table 1	(1)	(2)
	Patent growth rate 1990-99, USA	Patent growth rate 1990-99, USA
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		(0.037)

Local socio-economic conditions seem to play an important role in explaining differential innovative performance in the EU and the US

Conclusions

- **The potential of knowledge-based growth in the periphery are relatively limited:**
  1. **Greater returns in areas with a good 'social filter', good infrastructure and surrounded by areas with good accessibility and a high investment in R&D**
  2. **But, by definition, the periphery is:**
     - Remote
     - And has weaker human capital
  3. **Spillovers are geographically bounded and decay with distance**

Policy implications

- **If the aim is to achieve greater efficiency and close the gap with the US…**
  1. **R&D should be invested in areas with:**
     - A critical research capacity
     - Surrounded by other areas with high investment in R&D
     - With a strong ‘social filter’ (human capital)
  2. **That is, in the core**
- **If the aim is also to achieve cohesion…**
  1. The best bet for the periphery is to promote a rapid assimilation of innovation
  2. This is best achieved by investment in human capital
  3. Infrastructure investment is a double-edged sword
- **But the trade off between efficiency and cohesion remains**
  1. And it will be difficult for the periphery to catch up, at least in the short and medium term