ESPON Scientific Conference
12-13 September 2013
Walferdange, Luxembourg.

What can we learn from the comparative analysis of the territorial innovation dynamics in China, India and the U.S.?

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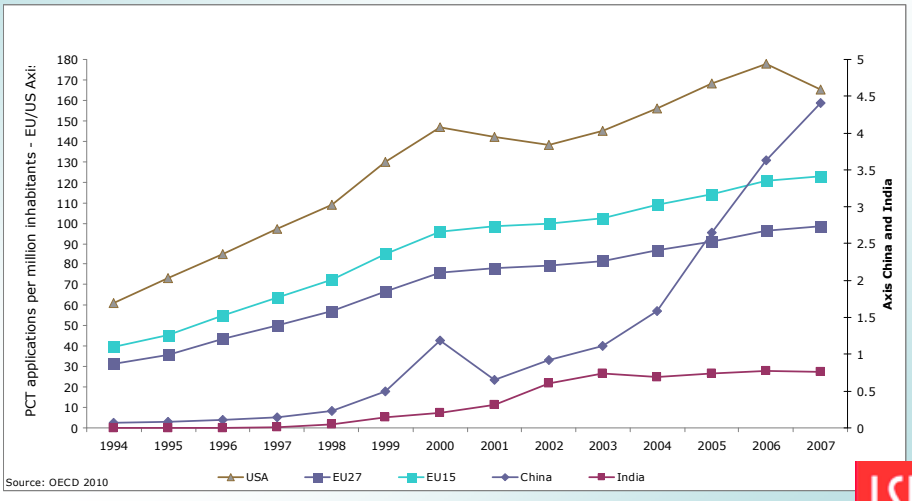
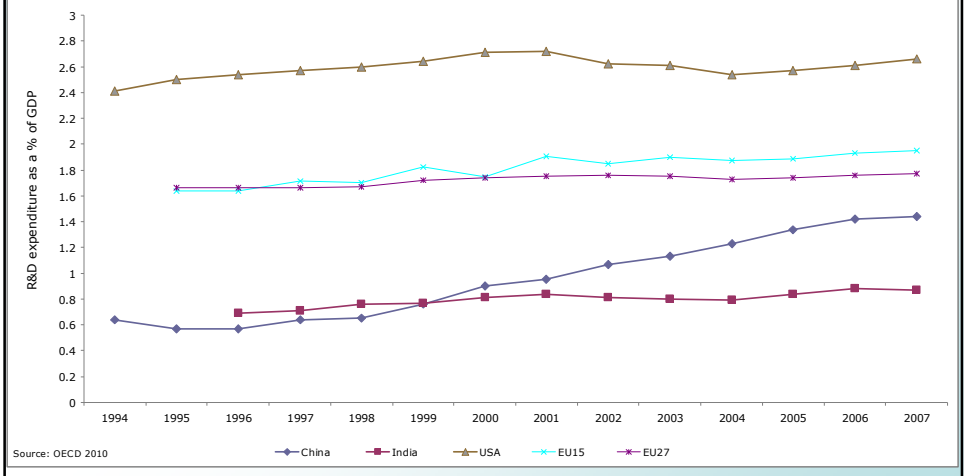
Stylised facts (1) …Innovation Gap(s) - Patenting

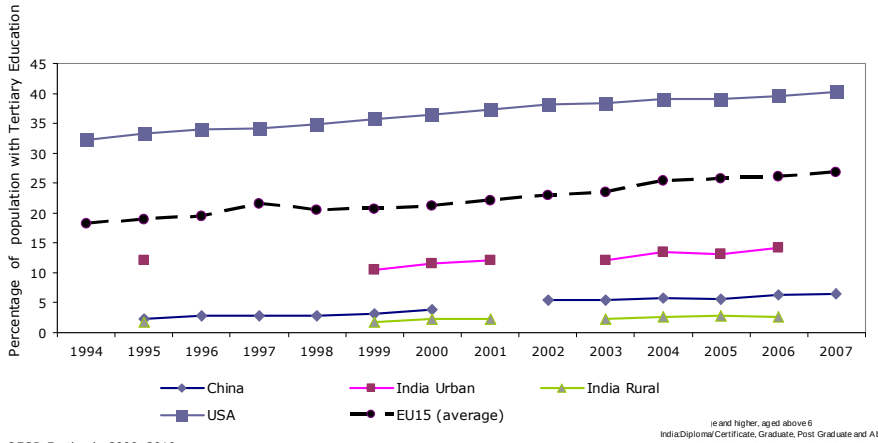


Stylised facts (2)…Innovation Gap(s) – R&D Activities



Source: OECD 2010

Stylised facts (3)…Innovation Gap(s) – Human Capital



Source: OECD Factbook, 2009, 2010
China Statistic book, 1996-2008
India National Sample Survey

ie and higher, aged above 6
India:Diploma/Certificate, Graduate, Post Graduate and Above;
1995 (aged above 15), other years (aged above 7)
USA and EU15:Tertiary attainment for age group 25-64

Outline

- International technological dynamism offers significant learning opportunities for innovation policies;
- This presentation will discuss:
  - Why look at the **territorial level** in order to support innovation policy learning;
  - Why adopt a **comparative perspective**;
  - How an '**integrated framework**' makes comparative analysis of territorial dynamics possible;
  - Evidence from **USA, China and India**;
  - Insights for **innovation policy.**

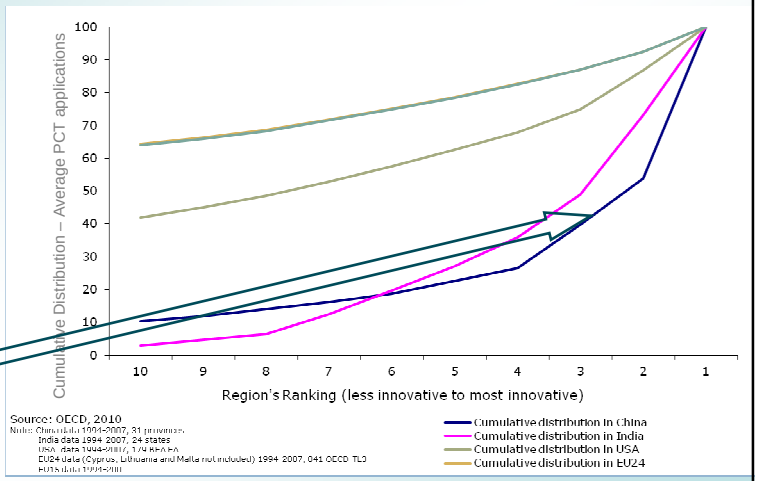
Why look at territorial-level dynamics of innovation?

- **The position of Europe and the USA as the most innovative poles in the world is being challenged by emerging countries**
  - And specifically by the BRIICS, in general, and China and India, in particular
- **But very little is know about the territorial dynamics of innovation in emerging countries**
  - There has been a tendency to assume that these countries are in an earlier stage of the innovative process than the EU or the US
  - And that they will tend to follow a similar path in the future
  - But, the territorial dynamics of innovation are rather different in the EU with respect to the US
  - So will they follow the EU path? Or that of the US?
  - Are they building their own territorial dynamics of innovation?

The territorial dimension of innovation

Clear difference between 'mature' and 'emerging' systems

In India and, especially, in China, patent applications are much more concentrated than in the EU and US

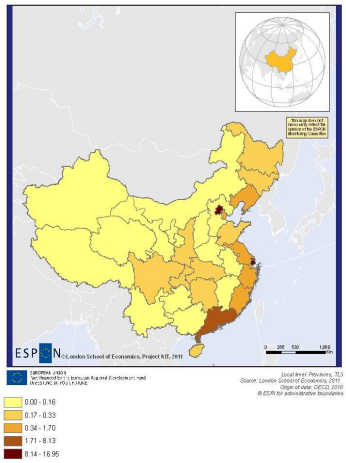


innovation (IV)

China

Huge concentration of innovation in main cities and coastal provinces

CHINA: Average PCT applications per million inhabitants, 94-07

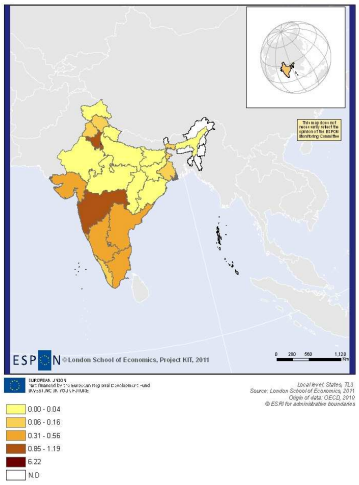


innovation (V)

India

Concentration around Delhi and Mumbai, with a significant presence of innovation in southern states (Karnataka, Tamil Nadu)

INDIA: Average PCT applications per million inhabitants, 94-07

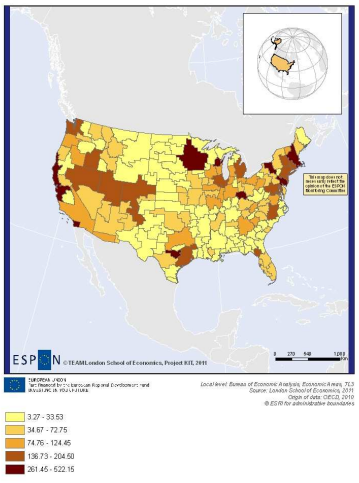


innovation (VI)

US

Concentration along the northeast and the west coast, but strong poles throughout the country (Minneapolis, Milwakee-Madison, Cincinnati, Austin)

USA: Average PCT applications per million inhabitants, 94-07



Why comparative analysis? (1)

Relevant to supra-national, national and sub-national policy-making in both developed and emerging countries:

- Captures factors that shape the genesis of innovation at different stages of the process of technological development.
  - This is an important 'laboratory' for EU/US leading and lagging regions;
  - Relevant benchmark for Emerging Countries to assess the 'sustainability' of their internal geography of innovation;

Why comparative analysis? (2)

- Detects the emergence of new actors in the international technological competition and situate existing leading/lagging regions.
  - Developed countries' regions can identify their 'competitors';
  - Firms and institutions (e.g. universities) can identify new opportunities in 'distant' markets
- Supports 'policy transfer' where developed countries aim to provide emerging countries with technical support on territorial policies.
  - [E.g. China-EU cooperation on regional policy].

What do we need for comparative analysis?

- Different approaches:
  - Innovation Scoreboard approach
    - Exclusively quantitative;
    - Important processes overlooked;
    - Limited applicability to emerging countries.
  - Case studies
    - Limited comparability across different contexts/ development stages;
    - Often lacking in homogenous conceptual framework.
- In this presentation I will argue in favour of an 'integrated framework' based on:
  - Cross-fertilisation of different strands of literature;
  - Integration of quantitative and qualitative information

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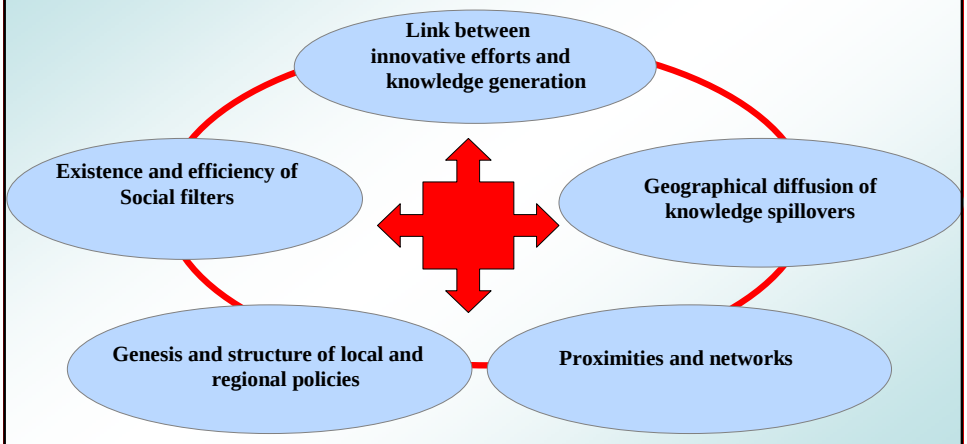
Integrated Framework



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Increase in innovative efforts (where achieved) may boost innovative performance even at the regional level.

A variety of local factors have an influence on this process;

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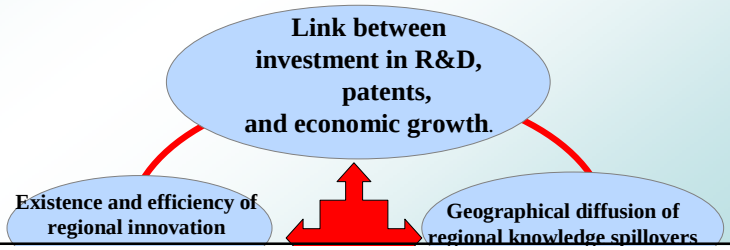
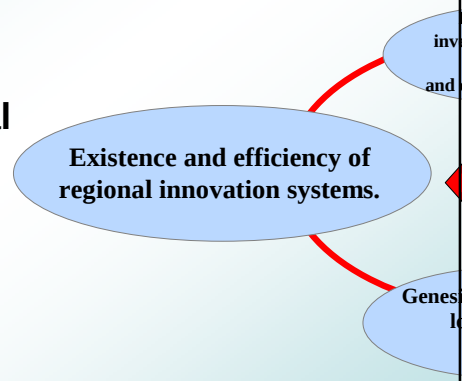
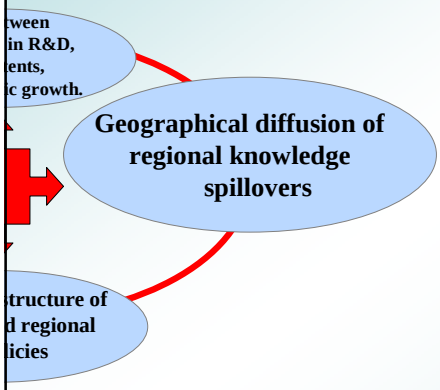


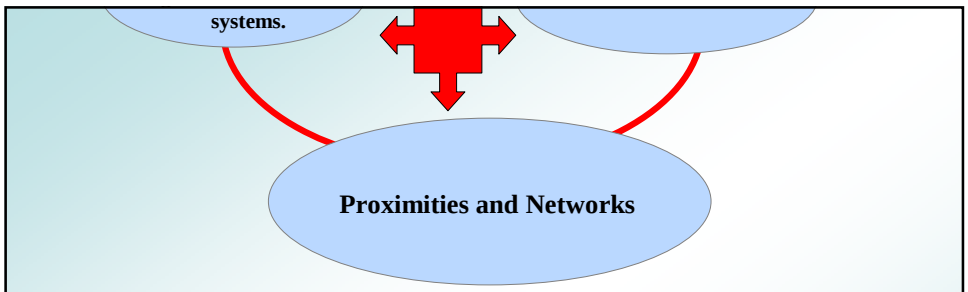
Socio-economic contextual factors (as proxies for regional systems of innovation) are fundamental for the process of innovation





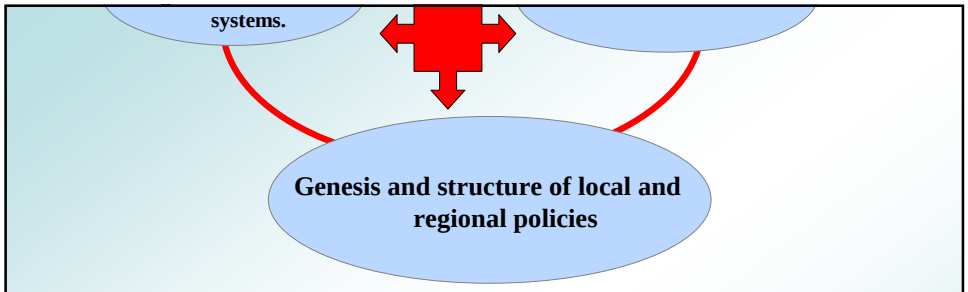
Knowledge spillovers are spatially bounded. Proximity is important for the transmission of economically productive knowledge, as spillovers show a strong distance-decay effect.

- Since knowledge spillovers are spatially bounded they tend to create localised pools of knowledge in core areas.
- Limited exposure to knowledge flows can be compensated for by a more efficient exploitation of existing knowledge where the correct system of innovation is in place locally.



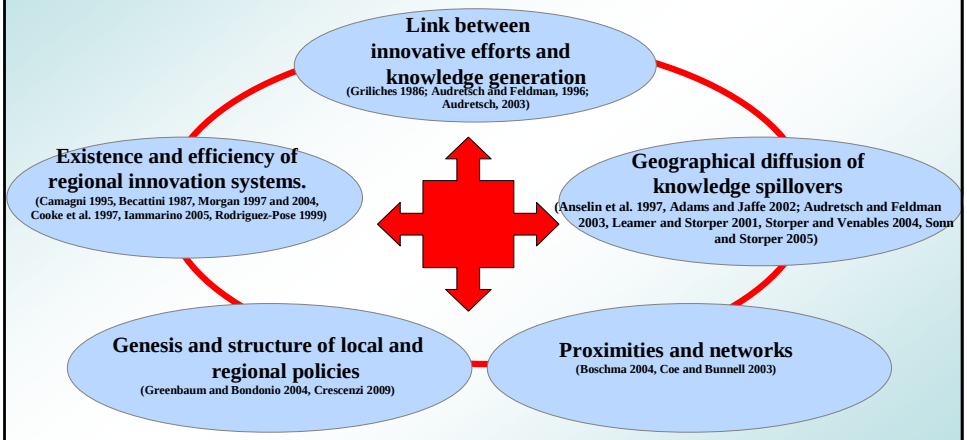
Innovation systems are a combination of intra-local, extra local and transnational network connections

The position in these networks is a important feature of each territory



Public policies may or may not be supportive of long-term innovative performance;
"Power" factors might generate a mismatch between policy targets and local needs.

Integrated Framework (Baseline)



An empirical model based on the 'Integrated Framework'

Variable	Internal Factors	External Factors
R&D	Local Investment in S&T/R&D	Investment in S&T/R&D in neighbouring areas
Social filter	Structural characteristics that would make a region more 'innovation prone', including: •Human Capital •Sectoral composition •Use of resources (unemployment) •Demographics	Same characteristics in neighbouring areas
Specialisation	Krugman Index	
Relative wealth	GDP per capita	
Agglomeration economies	Population Density	
Infrastructure endowment	Kilometres (Kms) of motorways/railways	
Mobility of people	Migration rate	
Fixed effects	Region/Province-specific fixed effect + Time Trends	

The empirical model

- **Regional Knowledge production function (KPF) estimated by two-way fixed effect panel data:**

$$y_{i,t} = \alpha_i + \tau_t + \beta R\&D_{i,t} + \gamma WR\&D_{i,t} + \delta SF_{i,t} + \zeta WSF_{i,t} + \upsilon x_{i,t} + \varepsilon_{i,t}$$

- **where:**

Y **represents Regional Patent intensity;**

R&D **is the share of R&D/S&T Expenditure in regional GDP;**

SF **is the Social Filter Index;**

WR&D **and** ***WSF*** **are spatial lags of R&D/S&T and SF respectively with appropriate Spatial Weights;**

x **is a set of structural features/determinants of innovation of region *i*;**

ε **is an idiosyncratic error;**

and where *i* represents the region and *t* time.

Datasets

- **China**
  - 22 Provinces, 4 Autonomous Regions, 4 Municipalities
  - 2 Special Administrative Regions (Hong Kong and Macau) and 1 Autonomous Region (Tibet) excluded
- **India**
  - 18 States and 3 Union Territories that will be covered by the analysis
  - **1994-2007 for both countries**
- **USA**
  - 266 MSA/CMSAs covering all continental US States (and the District of Columbia), while MSAs in Alaska, Hawaii or in other non mainland territory of the US are excluded from the analysis. More recent work focused on BEA/Economic Areas
  - Model estimated for 1990-1999 but more recent work covers 1990-2007

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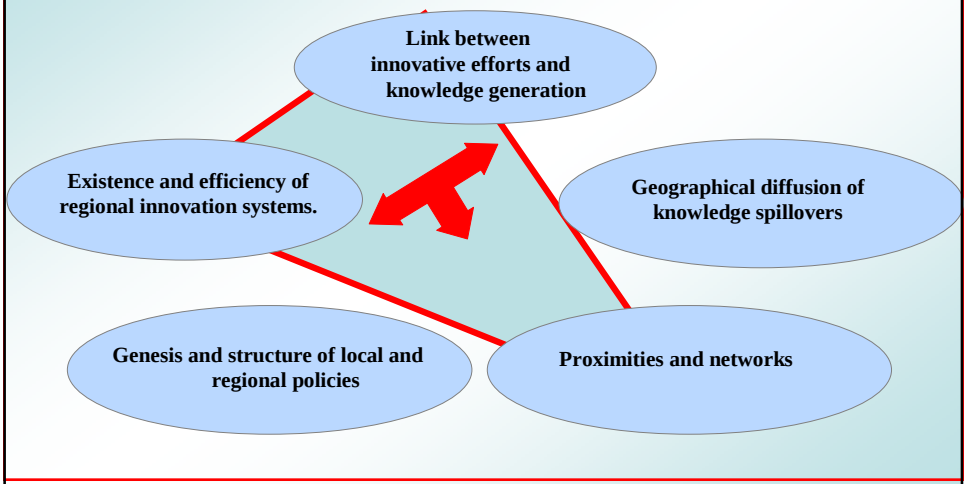
Territorial Dynamics of Innovation: USA



Empirical Results: Local impact of innovative activities

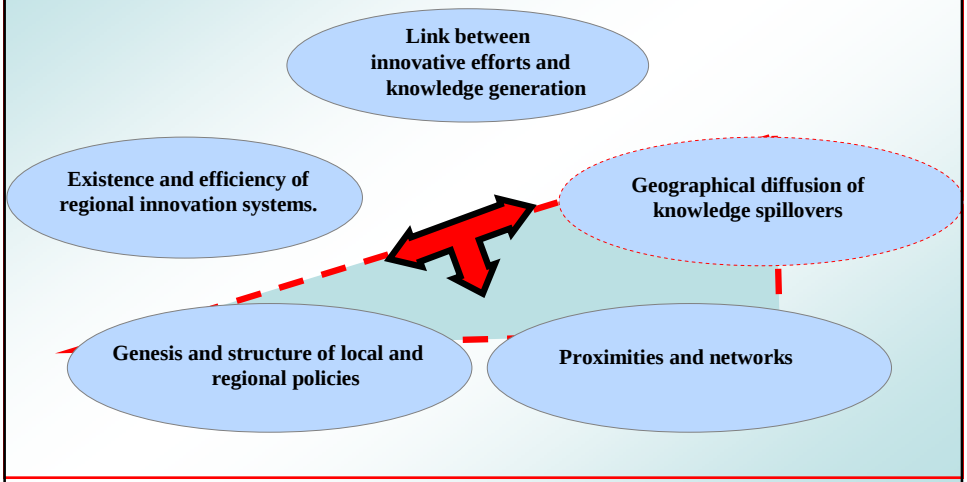
Table 1	(1) Patent growth rate 1990-99, USA	(2) Patent growth rate 1990-99, USA
Constant	0.205***	0.220***
	(0.042)	*(0.045)*
Natural Log of patents per million inhat	-0.019**	-0.028***
	(0.008)	*(0.008)*
Private R&D expense as a percentage	0.009*	0.011**
	(0.005)	*(0.005)*
Spat. Weigh. average of neighbouring	-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

The existence of a set of local socio-economic conditions which may be considered pre-conditions for the establishment of a successful regional system of innovation seems to play an important role in explaining differential innovative performance in the EU and US regions.

Territorial Dynamics of Innovation: CHINA



Results: China

Pure agglomeration, NEG-type of story

VARIABLES	(9) PCT_app_pc	(10) PCT_app_pc	(11) PCT_app_pc	(12) PCT_app_pc
Regional R&D/S&T Expenditure	-0.0533	-0.0963	0.492*	-0.0961
	(0.0601)	(0.0701)	(0.267)	(0.0707)
Spatially Weighted S&T (Inverse Dist)	-1.63e-08***	-7.98e-09***	-7.45e-09***	-7.84e-09***
	(3.85e-09)	(2.56e-09)	(2.28e-09)	(2.59e-09)
Spatially Weighted S&T (First Order Contiguity)				
Social Filter	2.76e-06	-0.000552	-0.000377	-0.000537
	(0.000520)	(0.000564)	(0.000506)	(0.000548)
Spatially Weighted Social Filter (Inverse Dist)				
Spatially Weighted Social Filter (First Order Contiguity)	-0.00141*	-0.00210***	-0.00110	-0.00217***
	(0.000761)	(0.000742)	(0.00100)	(0.000766)
Krugman Index		-0.0204***	0.0213***	0.0205***
		(0.00408)	(0.00427)	(0.00418)
Railway Density		0.134**	0.141***	0.134**
		(0.0604)	(0.0496)	(0.0615)
Population Density	0.000148***	0.000176***	0.000294***	0.000175***
	(5.52e-05)	(4.91e-05)	(5.86e-05)	(5.19e-05)
Net Migration	-1.81e-05	-2.83e-05***	-4.57e-05***	-2.79e-05***
	(2.24e-05)	(1.04e-05)	(1.06e-05)	(1.07e-05)
GDP Per Capita	8.27e-07***			
	(2.63e-07)			

Richer , agglomerated more-specialised regions with a good endowment of infrastructure more innovative

Results: China (II)

VARIABLES	(9) PCT_app_pc	(10) PCT_app_pc	(11) PCT_app_pc	(12) PCT_app_pc
Regional R&D/S&T Expenditure	-0.0533	-0.0963	0.492*	-0.0961
	(0.0601)	(0.0701)	(0.267)	(0.0707)
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Krugman Index		0.0204***	0.0213***	0.0205***
		(0.00408)	(0.00427)	(0.00419)
Railway Density		0.134**	0.141***	0.134**
		(0.0604)	(0.0496)	(0.0615)
Population Density	0.000148***	0.000176***	0.000294***	0.000175***
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Net Migration	-1.81e-05	2.83e-05***	4.57e-05***	2.79e-05***
	(2.24e-05)	(1.04e-05)	(1.06e-05)	(1.07e-05)
GDP Per Capita	8.27e-07***			
	(2.63e-07)			

But the key varaibles of interest (R&D and social filter) are insignificant

Once these factors are controlled for, migration is also a force for innovation

Results: China (III)

VARIABLES	(9) PCT_app_pc	(10) PCT_app_pc	(11) PCT_app_pc	(12) PCT_app_pc
Regional R&D/S&T Expenditure	-0.0533	-0.0963	0.492*	-0.0961
	(0.0601)	(0.0701)	(0.267)	(0.0707)
Spatially Weighted S&T (Inverse Dist)	-1.63e-08***	-7.98e-09***	-7.45e-09***	-7.84e-09***
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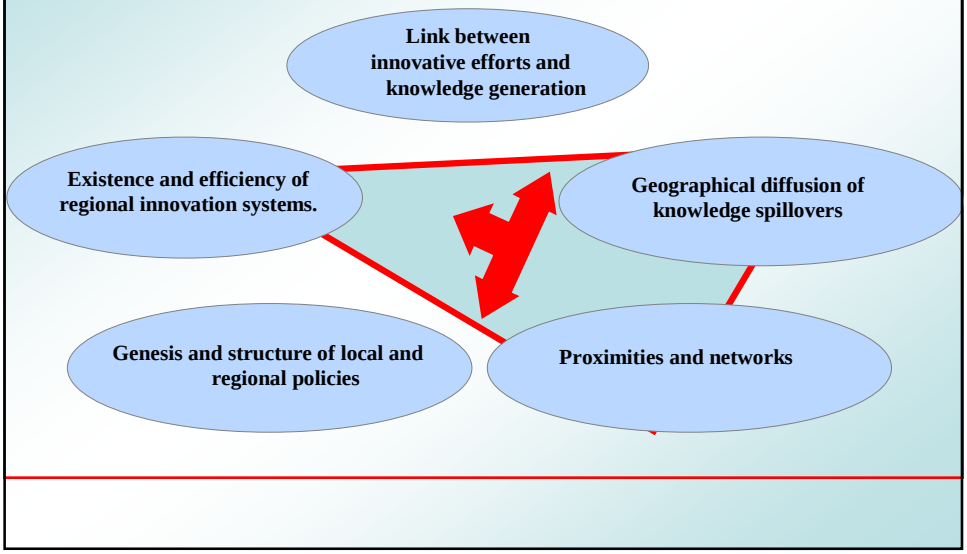
GDP Per Capita	8.27e-07***			
	(2.63e-07)			

There are no spillovers. Core innovative regions are sucking resources from neighbouring ones

Territorial Dynamics of Innovation: INDIA



Results: India

A more traditional story

VARIABLES	(9) PCT_app_pc	(10) PCT_app_pc	(11) PCT_app_pc
Regional R&D Expenditure	1.314*	1.545*	0.194
	(0.774)	*(0.810)*	*(0.321)*
Spatially Weighted R&D (Inverse Dist)			
Spatially Weighted R&D (First Order Contiguity)	1.04e-09	1.24e-09	1.06e-09
	(8.96e-10)	*(9.54e-10)*	*(8.19e-10)*
Social Filter	0.000253**	0.000210*	0.000194**
	(0.000108)	*(0.000110)*	*(9.07e-05)*
Spatially Weighted Social Filter (Inverse Dist)			
Spatially Weighted Social Filter (First Order Contiguity)	0.000848	0.000694	0.000357
	(0.000517)	*(0.000472)*	*(0.000304)*
Krugman Index		-8.15e-05	-0.000985
		(0.00133)	*(0.000951)*
Road Density		-4.53e-05**	-3.69e-05**
		(2.12e-05)	*(1.75e-05)*
Population Density	-3.56e-06	1.41e-06	-7.68e-08
	(2.87e-06)	*(1.26e-06)*	*(1.07e-06)*
GDP Per Capita	-6.04e-08		
	(3.80e-08)		
Gross Migration (Inter-State)	1.75e-05***	1.74e-05**	1.30e-05**
	(6.53e-06)	*(7.55e-06)*	*(6.07e-06)*
Int.Term Exp.S&T*Pop.Density			0.000999***
			(0.000276)

Innovation is driven by investment in R&D

In states with adequate social filters

Results: India (II)

VARIABLES	(9) PCT_app_pc	(10) PCT_app_pc	(11) PCT_app_pc
Regional R&D Expenditure	1.314*	1.545*	0.194
	(0.774)	*(0.810)*	*(0.321)*
Spatially Weighted R&D (Inverse Dist)			
Spatially Weighted R&D (First Order Contiguity)	1.04e-09	1.24e-09	1.06e-09
	(8.96e-10)	*(9.54e-10)*	*(8.19e-10)*
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	(0.000108)	*(0.000110)*	*(9.07e-05)*
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Road Density		-4.53e-05**	-3.69e-05**
		(2.12e-05)	*(1.75e-05)*
Population Density	-3.56e-06	1.41e-06	-7.68e-08
	(2.87e-06)	*(1.26e-06)*	*(1.07e-06)*
GDP Per Capita	-6.04e-08		
	(3.80e-06)		
Gross Migration (Inter-State)	1.75e-05***	1.74e-05**	1.30e-05**
	(6.53e-06)	*(7.55e-06)*	*(6.07e-06)*
Int.Term Exp.S&T*Pop.Density			0.000999***
			(0.000276)

Social filter is a 'real' social filter

R&D spillovers are positive and significant, when the social filter is decomposed into its key elements

With migration reinforcing R&D and the social filter

Interaction between R&D and density highly significant

'General lessons' from the 'integrated framework'

What 'general lessons' can be learnt from the literature cross-fertilised in the 'integrated framework'?

- No 'best practice' approach: territorial specificities are crucial. Cases of success cannot be easily replicated in different contexts;
- No 'optimal' model to be replicate (e.g. 'Americanisation' of the EU geography of innovation);
- Policies should be tailored to local conditions.

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Lessons for EU policies (I)

- New territories in international competition (increased competition for both EU leading and lagging regions).
- The EU clearly faces competition from 'below' (China and India) and from 'above' (USA). But the picture is more complex when analysed at the sub-national level
- There are new opportunities for EU firms/actors, which are highly localised but the situation is constantly changing/evolving. Comparative analysis clearly shows where this is happening and what forces are driving the process of change
- The growing development of 'global networks' involving new emerging actors might reinforce ability of EU firms, institutions and regions to benefit from the new global scenario. Further research is needed on this

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