

Absorptive Capacity and Regional Patterns of Innovation

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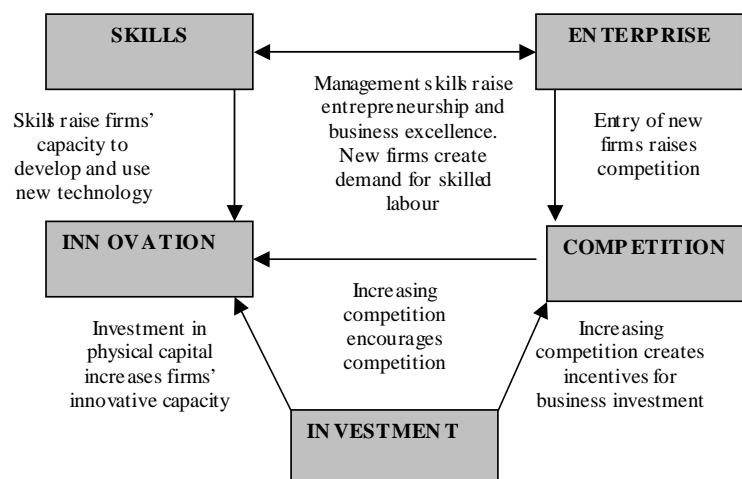
Presentation Structure

- Context: Regional Growth in the UK
- The Absorptive Capacity Concept
- Methodology and Data
- Innovation and Absorptive Capacity: Multivariate Analysis
- The Case Study Evidence
- Implications

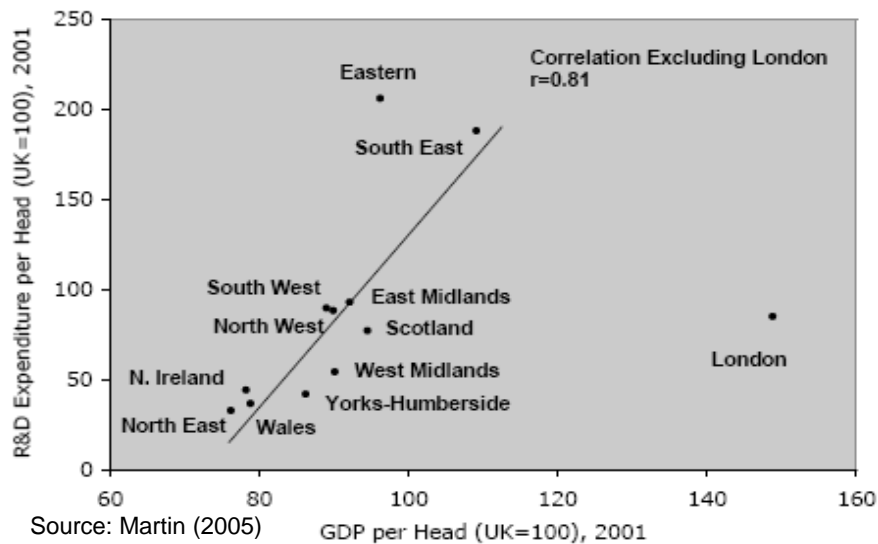
Regional Disparities: The Scale of the Problem

- Since the mid-1980s, major productivity gap has opened up between London and South East on one hand, and rest of UK on the other
- Only three regions have productivity above UK average (London, South East and Eastern)
- Productivity growth in the Northern regions has been especially slower
- The productivity gap is such that output per employee in South East now more than 28 percent above that in Northern Ireland, and 20 percent above that in North East

Drivers of Regional Competitiveness/Productivity According to HM Treasury/DTI



Are innovative regions, prosperous regions?



Research Questions

Absorptive Capacity: "...the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities." (Cohen and Levinthal, 1990)

- What are the main determinants of absorptive capacity?
- Can regional variations in absorptive capacity explain regional differences in innovation?
- Can we draw implications for regional and national innovation policies?

Absorptive Capacity

- Originally developed in the cognitive sciences (Bower and Hilgard, 1981; Lindsay and Norman, 1977)
- Extended by Cohen and Levinthal (1989, 1990) to the firm level:
 - Firm-level absorptive capacity is more than the sum of the absorptive capacities of individual workers.
 - Better internal communication processes improve the firm's ability to absorb external knowledge.
 - Networks are necessary to identify sources of relevant external knowledge.

Absorptive Capacity

- Used at the national level to denote the conditions necessary for a technological catch-up to begin (Nelson and Phelps, 1966; Verspagen, 1991; Keller, 1996; Criscuolo and Narula, 2002)
- Extension to the regional level:
 - Regional absorptive capacity is more than the sum of the absorptive capacities of individual firms.
 - Role of local labour markets (Roper and Love, 2006)
 - Regional networks allow firms to identify potential sources of knowledge.
 - Regional development policies promote firms' investment in absorptive capacity.

CBR Dataset

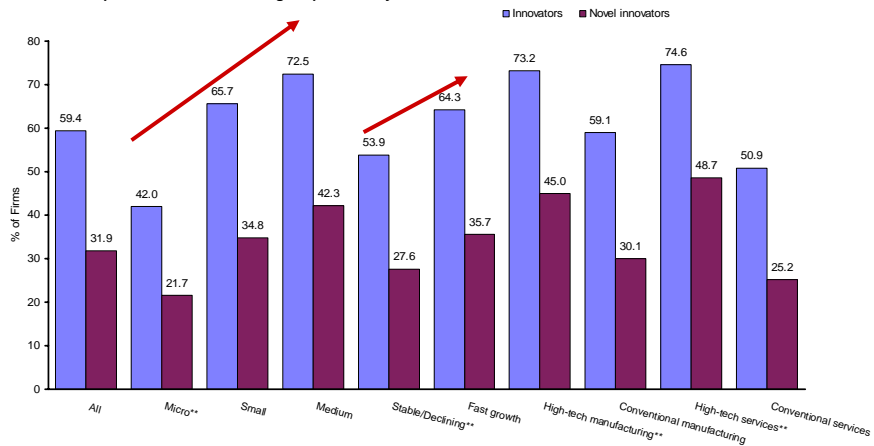
- Centre for Business Research (CBR) Survey 2004
 - 1-499 employees
 - Manufacturing and business services
 - 2137 respondents
 - Provides detailed information on innovation, employment, training, competition and collaboration
 - More detailed information than the Community Innovation Survey (CIS) although the CIS survey is larger
 - CBR Survey also allows the opportunity to review and research respondents in greater depth

Innovation Performance

- Product and Process innovation
 - Positively associated with firm size
 - Positively associated with firm growth
 - Higher in high-technology sectors

Product innovation

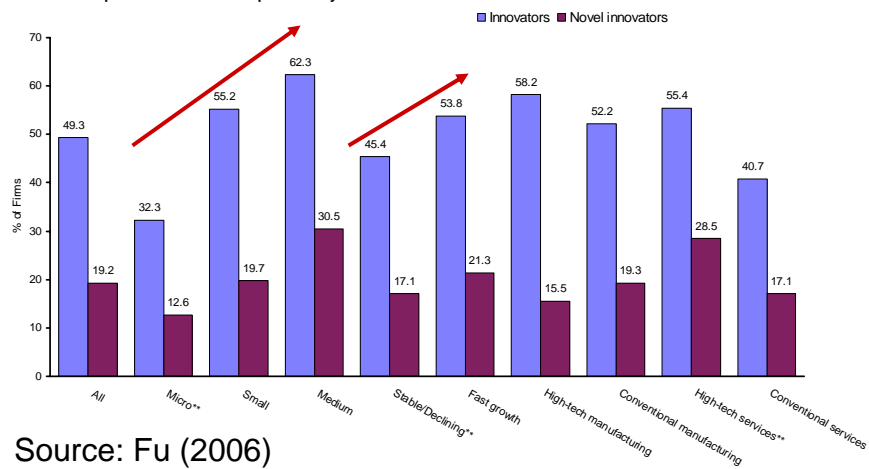
Introduction of product innovations during the previous 3 years



Source: Fu (2006)

Process innovation

Introduction of process innovations in previous 3 years



Source: Fu (2006)

Innovation Statistics by Region, CBR SME Survey 2004

Region	Total Firms	% Innovative Firms	% Goods Innovation	% Service Innovation	% Process Innovation
London	290	52.22	24.11	30.11	33.95
Eastern	257	52.87	27.87	32.52	43.32
South East	344	44.44	26.49	22.59	28.50
South West	181	56.88	31.08	30.35	42.40
West Midlands	185	50.72	28.92	19.86	35.40
East Midlands	139	53.09	26.40	18.82	41.45
Yorkshire	177	57.16	29.09	31.77	47.82
North West	203	46.17	25.94	23.90	26.56
North East	51	56.43	36.18	26.27	21.28
Wales	68	46.27	30.67	26.81	27.01
Scotland	111	56.92	35.11	38.87	34.01
Total	2006	52.11	29.31	27.44	34.67

Methodology

- Empirical analysis of the effect of absorptive capacity on:
 - The probability of introducing a product, service and process innovation.
- Multivariate Probit model to improve efficiency and exploit all available information (Greene, 2003, pp. 174-175).
- Causality
 - Causal mechanisms based on economic theory and evidence
 - Verification through case study analysis

Data Issues

- Absorptive capacity variables:
 - Percentage of R&D employees
 - New management techniques
 - Employee training
- Connectivity variables
 - Collaborations with different spatial dimensions

Data Issues

- Control variables:
 - Age, size and size
 - Ownership structure
 - Market
 - Number of competitors
 - Perceived obstacles to innovation
 - R&D tax credit
 - Policy impacts
 - Sectoral and regional dummies

MV Probit Estimates, CBR SME Survey 2004

Variable	Manufactured Product	Service Product	Manufacturing Process	Service Process
R&D Employees	0.449**	0.529*	0.009	0.687**
Managerial Training	-0.010	0.520***	0.091	0.322**
Scientist Training	-0.056	-0.222	0.013	-0.289**
Other Employee Training	0.341**	-0.078	0.000	-0.027
Total Quality Management	0.154	0.268**	0.322***	0.145
Quality Circles	0.289*	0.102	0.316**	0.161
Job Rotation	0.282**	0.020	0.400***	0.123
Performance-Related Pay	-0.033	0.080	-0.061	0.027
Collaborations: Local	0.044	0.123	0.341**	0.213
Collaborations: National	0.209*	0.340***	-0.052	0.287**
Collaborations: Overseas	0.482***	-0.033	0.269**	0.016

MV Probit Estimates, CBR SME Survey 2004, cont.

Variable	Manufactured Product	Service Product	Manufacturing Process	Service Process
Obstacles: Finance	0.171	-0.022	0.123	0.053
Obstacles: Skills	-0.031	0.160	-0.058	0.337**
Obstacles: Technology	0.269**	0.020	0.066	0.195*
Obstacles: Market	0.086	0.089	0.029	-0.195*
Obstacles: Other	-0.283**	-0.058	-0.252*	0.039
R&D Expenditure / Turn.	0.049	0.003	0.060	0.014
Claimed Tax Credit	0.571***	-0.028	0.199	-0.231*
Business Advice: Bus. Link	0.069	0.081	0.287**	0.141
Business Advice: RDA	-0.088	-0.332**	-0.072	-0.265*

MV Provit Estimates, CBR SME Survey 2004, cont.

Variable	Manufactured Product	Service Product	Manufacturing Process	Service Process
Market: Local	reference	reference	reference	reference
Market: Regional	0.230	0.147	-0.141	0.082
Market: National	0.268	0.152	0.105	0.172
Market: International	0.497**	0.100	-0.003	-0.030
Age (Years)	-0.004**	-0.001	-0.001	0.001
Size: Employees (Ln)	0.032	0.117**	0.110**	0.075
Ownership: Proprietorship	reference	reference	reference	reference
Ownership: Partnership	-0.646**	-0.604**	-1.028***	-0.074
Ownership: Company	-0.537*	-0.165	-0.595**	-0.091
Ownership: Other	-4.368	-0.373	-5.166	-4.602
Observations: 805				
Log Likelihood -1598.04				

Absorptive Capacity: R&D

Innovation Type

	Manufactured Product	Service Product	Manufacturing Process	Service Process
R&D Expenditure	0	0	0	0
R&D Employees	+	+	0	+

Absorptive Capacity: Training

	Manufactured Product	Service Product	Manufacturing Process	Service Process
Managerial Training	0	+	0	+
Scientist Training	0	0	0	-

Absorptive Capacity: Management Practices

	Manufactured Product	Service Product	Manufacturing Process	Service Process
Total Quality Management	0	+	+	0
Quality Circles	+	0	+	0
Job Rotation	+	0	+	0

Connectivity: the Role of Collaboration

	Manufactured Product	Service Product	Manufacturing Process	Service Process
Local	0	0	+	0
National	+	+	0	+
Overseas	+	0	+	0

The Role of Markets

	Manufactured Product	Service Product	Manufacturing Process	Service Process
Regional	0	0	0	0
National	0	0	0	0
Overseas	+	0	0	0

The Impact of Policy

	Manufactured Product	Service Product	Manufacturing Process	Service Process
R&D Tax Credits	+	0	+	-
Business Advice: Business Link	0	0	+	0
Business Advice: RDA	0	-	0	-

Summary of the CBR results

- Absorptive capacity variables have a positive effect on innovation
- Management practices are particularly important for manufacturing product and process innovation.
- Local collaborations are only important for manufacturing process innovation
- National and overseas collaborations are generally more important than local collaborations
- Sectoral specificities are strong and significant.
- Regional dummies are not significant.

Regional Effects

- Regional impacts captured through variations in:
 - Industrial composition
 - Local labour market
 - Extent and reach of networks
 - Spatial variations in constraints

MV Probit Estimates, Fourth Community Innovation Survey, 2004

Variable	Innovation (Product, Goods)	Innovation (Product, Services)	Innovation (Process, Goods and Services)
S&E employees/Total	0.256***	0.244***	0.054
Other high skills empl/Total	0.077	0.253***	-0.006
Training	0.370***	0.522***	0.626***
New Management Technique	-0.097***	0.093***	0.191***
New Organisational Structure	0.124***	0.200***	0.146***
New Marketing Strategies	0.436***	0.373***	0.334***
Collaboration: Local	0.033	0.259***	0.173***
Collaboration: National	0.396***	0.271***	0.393***
Collaboration: Overseas	0.356***	0.004	0.109*
Obstacles: Finance	0.222***	0.260***	0.205***
Obstacles: Knowledge	0.076**	0.098***	0.071**
Obstacles: Market	0.147***	0.067***	0.004
Obstacles: Other	-0.085***	-0.008	-0.043

MV Probit Estimates, Fourth Community Innovation Survey, 2004, cont.

Variable	Innovation (Product, Goods)	Innovation (Product, Services)	Innovation (Process, Goods and Services)
R&D expenditure/Turnover	0.004	-0.030	0.012
Regional Public Support	0.083	0.140**	0.079
Government Public Support	0.313***	0.140*	0.396***
EU Public Support	-0.235***	0.130	-0.099
Claimed R&D Tax Credit	0.497***	-0.117	-0.035
Market: Local	reference	reference	reference
Market: National	0.241***	0.145***	0.116***
Market: International	0.588***	0.141***	0.256***
Age	0.001	-0.111***	-0.008
Size: Employees (LN values)	0.025***	-0.017*	0.068***
Ownership Structure	0.065**	0.049	0.042
Constant	-2.445***	-1.359***	-1.774***
Observations: 13,237			
Log Likelihood: -15753.06			

CIS and CBR

- Analysis of CIS confirms:
 - Importance of science and engineering employees
 - No effect of level of R&D expenditure
 - Importance of training (but CIS does not disaggregate by type)
 - Importance of new management techniques
 - Importance of national and international collaborations
 - Role of tax credits for manufacturing

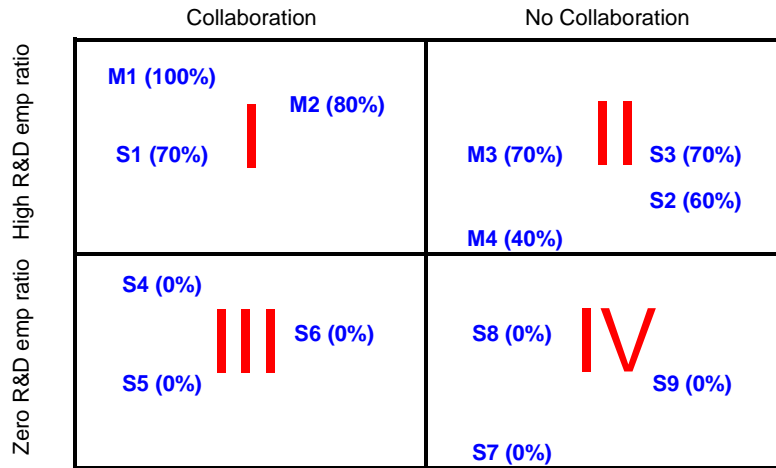
CIS and CBR

- Additionally analysis of CIS suggests:
 - A stronger impact of supplying national and international markets
 - Regional policy support positive for service product innovation
 - Government support positive for manufactured product innovation and process innovation
 - EU support negative for manufactured product innovation

Case Study: Rationale

- To understand the dynamics and interrelationships of absorptive capacity variables
- To provide greater understanding of causal processes
- To explore the role of place, institutions and policies

Case Studies: Innovation Matrix



M and S denote manufacturing and services companies respectively
 % in brackets is R&D employees fraction = (R&D employees/Total Employees)*100

Case Studies: Characteristics

	I	II	III	IV
Turnover (£mln)	2.1; 3.0 & 3.8	4.5; 9.0; 9.7 & 14	3.2; 7.9 & 16.6	2.2; 3.5 & 14.5
Number of employees	40; 43 & 68	60; 120; 124 & 99	20; 100 & 175	23; 130 & 260
Age (years)	6-17	14-23	21-30	16-22
Location	EM & SW	SE & SW	EM, NW & SE	EM, NW & SE
Sectors	Semiconductors, Organic Chemicals & Software Supply	Semiconductors, Medical Instruments, Engineering and Architectural Activities	Management, Technical and Software Consultancy and Engineering Activities	Business Services, Software Supply and Computer Related activities

Case Studies: Innovation Behaviour

Innovation reported		I	II	III	IV
new to the firm and industry	manufactured product	3	2	1	
	service product		3	2	
	manufacturing process	1			
	service process			1	1
new to the firm only	manufactured product		1		
	service product	1	1	1	3
	manufacturing process		2	1	
	service process	1	1	2	2

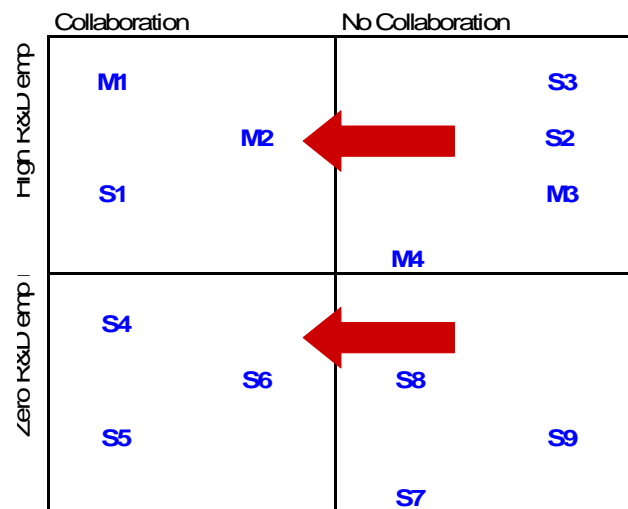
Case Studies: Quadrant I and Quadrant II

- Q1
 - Important role of external sources for innovation such as market, customers and suppliers
 - Company ability to understand and exploit such sources
 - Innovation is iterative and interactive
- Q2
 - Emphasise internal sources for innovation
 - Innovation seen as linear – interactions with customers only at the final stages of delivery

Case Studies: Quadrant III and Quadrant IV

- Q3
 - Important role for external sources and internal capability
 - High innovation expenditure on non R&D activities eg, training and innovation related ICT
- Q4
 - Passive reactive innovators – respond to external demands (customers, consultants and technical standards)

Case Studies: Quadrant dynamics



Case Studies Across-Quadrant Results: Absorptive Capacity Indicators

- Related prior knowledge and staff skills
 - Founders knowledgeable about the core technology
 - Employees have a high general level of education
 - Use of external and internal training but training budgets tend to be small
 - Use of variety of recruitment channels tailored to the company needs

Case Study Across-Quadrant Results: Absorptive Capacity Indicators

- Organisational structure and management practices
 - Job and functional rotation
 - Quality management practices
 - Internal knowledge exchange mechanisms
 - Emphasis on corporate culture
 - Importance of workplace layout to maximise learning and knowledge exchange

Case Studies Across-Quadrants Results: Barriers to Innovation

- Finance
- Shortage of skilled labour
- Location specific factors
 - Local labour market
 - Attractiveness to labour
 - Infrastructure
- Choice of Location
 - Importance of residential preference and path dependence

Case Studies Across-Quadrants Results: Role of Networks

- Local networks
 - Low rates of participation
 - Few real benefits other than general awareness raising
- National and international networks
 - Provide innovation-related benefits mainly in the form of technical and professional inputs

Policy Implications

- Different forms of absorptive capacity have different effects on goods, service and process innovation.
- Management practices are important for innovation
- Training is important – but the evidence suggest that it is the training of managers not scientists that is important
- R&D tax credit has a positive and significant association with manufacturing product innovation.
 - But case studies suggests that the transmission mechanism is through the impact on cashflow
- Networks are important, but their geographical impact varies across types of innovation.
- Policy focus in UK to develop local and regional networks might be detrimental in some sectoral and regional contexts.

Collaboration and Clusters

- According to Porter (1998) clusters are '**geographic concentrations** of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also co-operate'

Collaboration and Clusters

- The stress on 'geographic concentrations' is misleading
- The Porter analysis is based on where firms are, not what firms do
 - Local collaborative behaviour is not an important driver of innovation
 - National collaborations are consistently more important than local collaborations
 - Important to distinguish between 'bridging and bonding' networks – bridging networks that are outward looking may be more important for knowledge based activity

Future Research

- Testing for complementarities between internal and external sources of knowledge
- Disentangling collaboration patterns also in terms of type of partners (i.e. businesses versus university and public research institutes)
- Controlling for endogeneity between innovation and collaboration patterns
- Testing whether there are regional patterns in the error correlation structure

Further Information

- Centre for Business Research
www.cbr.cam.ac.uk
- Programme on Regional Innovation
www.regionalinnovation.org.uk