Innovation for Development

Teresa de Noronha Vaz (Ed.)

Centro de Investigação sobre o Espaço e as Organizações
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Universidade do Algarve

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Editor
Teresa de Noronha Vaz

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do Centro Regional de Inovação do Algarve e da Universidade do Algarve.

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List of Authors

António Vázquez Barquero
Professor and Ph.D. in Economics from the Autonomous University of Madrid. He was Visiting Fellow at Yale University and Visiting Professor at the Universities of Pavia, Caracas and Montevideo. As a specialist in development, he is a consultant to the World Bank, Economic Commission of Latin America the United Nations and the European Commission.

Bjørn Asheim
Ph.D. in Human Geography from the University of Lund. Since 2001, he is Professor of Economic Geography, Department of Social and Economic Geography at the same University. He is co-founder and vice-director of the Center for Innovation, Research and Competence in the Learning Economy. He has taught at the Center for Technology, Innovation and Culture at the University of Oslo. He is Professor at the Center for Innovation and Work Life Research at the University of Agder. He is currently Visiting Professor in the Department of Geography, National University of Ireland.

Hugo Pinto
Ph.D. fellow of the Foundation for Science and Technology at the Center of Social Studies in the University of Coimbra. Since 2003, is a collaborator of the Regional Center for Innovation in the Algarve.

João Guerreiro
Ph.D. in Economics from the University of Algarve and Professor of Regional Economics in the Faculty of Economics at the same university. He is currently Rector of the University of Algarve.

José Tribolet
Professor at the Department of Computer Engineering, Instituto Superior Técnico. President of the Executive Comission and the Board of Directors of INESC and former President of the College of Computing of the Engineers' Association in Portugal.

José Veiga Simão
Ph.D. in Nuclear Physics from the University of Cambridge. He was Professor at the University of Coimbra and Rector of the University of Lourenço Marques in 1970. He was Minister of Education, Ambassador of Portugal at the United Nations, between 1974 and 1975, and Visiting Fellow at Yale University. He was President of the National Laboratory of Industrial Engineering and Technology (1978-1983). In 1983 he was Minister of Industry and Energy and in 1997, Minister of Defense. He was awarded a degree of *Honoris Causa* by the following universities: University of Witwatersrand (Johannesburg), Eduardo Mondlane University (Maputo), Lesley College (Cambridge/ Massachusetts), University of Aveiro, University of Minho and University of Beira Interior.

Manfred M. Fischer
Ph.D. in Urban Modelling from Friedrich-Alexander-University of Erlangen, and has a habilitation degree in human geography from the University of Vienna. Since 1988 he is Professor of Economic Geography at the Vienna University of Economics and Dean for the Department of Social Sciences.

Marielba Silva Zacarias
Ph.D. in Computer Science and Computer Engineering is currently Assistant Professor at the University of Algarve, Faculty of Science and Technology.

Marisa Cesário
Assistant and Ph.D. student at the Faculty of Economics, University of Algarve.

Pedro Faria
Research Fellow of the Foundation for Science and Technology at the IN + - Center of Studies in Innovation, Technology and Development Policy.

Peter Nijkamp
Professor of Regional Economics and Economic Geography at the Faculty of Economics at the Free University in Amsterdam. Ph.D. in Regional Economics from Erasmus University, Rotterdam. He was president of the Netherlands Research Council (NWO), having won the Spinoza prize in 1996.

Rodrigo Magalhães
Ph.D. in Information Systems from the London School of Economics, United Kingdom. Is academic director at the Kuwait Maastricht Business School. He is Visiting Professor at the Faculty of Social Sciences and the Faculty of Management and Economics, Catholic University, Lisbon.

Rui Baptista
Ph.D. in Business Administration from London Business School and Professor of the Department of Engineering and Management at Instituto Superior Técnico, Technical University of Lisbon. It is also coordinator of the Laboratory of Technology Policy and Technology Management, Center for Innovation, Technology and Policy Research at Instituto Superior Técnico, Technical University of Lisbon.

Rui Guimarães
Professor at the Faculty of Engineering, University of Porto. He was Director of COTEC, Portugal. He was involved in the creation of the Institute of Mechanical Engineering and Industrial Management (INEGI).

Teresa de Noronha Vaz
Ph.D. in Economics from the University of Algarve. She is Professor at the Faculty of Economics of the same university. She has taught courses related to the themes of Regional Economics, Development Economics, Economics of Innovation and Agro-food Economics. Currently she is President of the Research Center on Spatial and Organizational Dynamics and the Centro de Ciência Viva do Algarve.

Preface

Rui Campos Guimarães

On the commemoration of its 30th anniversary, the University of Algarve decided to promote a series of conferences on *Innovation for Development* and then to edit this book on the interventions prepared by the invited speakers.

The overall debate on this topic – broken down into more specific objectives such as competitiveness, entrepreneurship, sustainability, geographic information systems or innovation regional policies – could not be better chosen, in the context of our country which, like many others, is seeking to become more competitive in today's knowledge based global world economy. As a matter of fact it is unanimously accepted that, these days, innovation became a must in the search for development.

The most consensual definition of innovation is probably the one provided by the OECD Oslo Manual, 2005. By entailing four types of innovation – product (be it good or service), process, organizational and marketing – it sensibly extends innovation far beyond a strictly technological perspective.

But, broadly speaking, innovation can be interpreted as the conversion of knowledge into social or economic value. This synthetic definition of the innovation concept has two major implications.

Firstly, it becomes clear that the generation of knowledge – *i.e.* Research and Development (R&D) – and its diffusion – *i.e.* people's qualification – are necessary conditions for innovation to take place.

In this respect, universities are obviously of upmost importance. But they have to recognize that the generation and the diffusion of knowledge although necessary conditions for innovation are not sufficient ones. Recent models on the innovation processes (see Caraça *et al*, 2009) have departed from the traditional linear model which advocated a strict sequence Research ? Development ? Commercialization. Instead what became clear is that although this path is possible it is not the most common one, being generally replaced by an interactive-non-linear-company-centred one involving generating ideas from the market and from clients' needs, developing new products, processes, organizations or markets, getting the necessary knowledge where it exists, generating new knowledge when and if required and incorporating it in the innovation process.

In these innovation processes the universities are no longer necessarily either at their root or at their centre, and they should prepare and organize themselves to better network with companies and other knowledge generating centres, both in their country and abroad. Otherwise they will lose touch with the real economy surrounding them and hence will become less relevant.

This is specially the case in our country, where remarkable changes have been occurring since 2005. As a matter of fact, between 2005 and 2007, Portugal was the European Union (EU-27)

country with the highest rate of growth of the R&D expenditure expressed as a percentage of the GNP. From a value of 0.08% in 2005, it went up to 1.18% in 2007, which meant a growth of 46% (and recently published provisional figures confirm this outstanding upward trend, pointing to an R&D expenditure of 1.51% of the GNP in 2008). But as important as the global growth of the R&D intensity was the fact that in 2007 for the first time in our history the expenditure incurred by the company sector overtook the non company one. Although this fact suggests by itself that more R&D is being directed towards innovation (*i.e.* towards the creation of value in the markets), the 2008 European Innovation Scoreboard confirmed it beyond doubt. In fact, amongst the countries of the EU-27, between 2006 and 2007 Portugal presented the 5th highest recovery rate in terms of the global Summary Innovation Index. It advanced from the 22nd position in 2006 to the 17th one in 2007, progressing from the group of the *Catching-up Countrie*s to that of the *Moderate Innovators*.

In this context, the effort put by the University of Algarve in the organization of the series of conferences on *Innovation for Development* which led to the publication of this book should be emphasized as an important step.

But regarding innovation as the conversion of knowledge into social or economic value underlines another important implication: such a conversion will never take place if not supported by entrepreneurship.

The concept of entrepreneurship was first established in the eighteen century, and its meaning has evolved ever since, unfortunately not always in the clearest way. Many simply equate it with starting one's own business. Others call the attention for its crucial role – in its *intrapreneurship* version – for the ongoing renewal of established organizations.

Today, entrepreneurship is regarded as involving the recognition of opportunities (needs, wants, problems and challenges) and the use of resources to implement innovative ideas for new thoughtfully planned ventures. Successful entrepreneurs share certain personal attributes characterized by Holden, 2007 (creativity, dedication, determination, flexibility, leadership, passion, self-confidence and "smarts") which allow them to develop a set of attitudes and skills regarded as critical for long-term success (e.g. enjoying to make things happen, taking calculated risks, tolerating errors, learning from experience, sharing knowledge, seeking to achieve excellence, and assuming responsibilities).

In what concerns the development of these entrepreneurial skills, most universities all over the world – and the Portuguese ones were no exception – lagged behind what their economies demanded. As shown in the report *Global Entrepreneurship Monitor – Portugal*, 2007, in spite of the recent progress registered in entrepreneurial skills among the Portuguese population as a whole, that progress did not reach a significant proportion of its most qualified segment.

Therefore, it was no surprise that some Portuguese universities have recently started incorporating at the core of their mission the goal of developing entrepreneurial attitudes and skills in their graduates. And, once again, the decision of the University of Algarve of including entrepreneurship among the topics to be discussed in these conferences, is most welcome since it reveals a high concern about this crucial side of today's university life.

In the papers included in this book the reader will find very interesting contributions in different domains connected to innovation, development and policy making, namely the following ones:

- The role of knowledge and collective confidence in the promotion of national development, through competitiveness and innovation.
- The importance of organizational self-awareness as a pre-requisite for effective action, decision-making and learning in organizations.
- A comprehensive analysis of proper ways of building regional competitive advantage through innovation policies adapted to different innovation modes, knowledge bases, varieties of capitalism, and types of work organization and organizational learning.
- A discussion on cities and metropolitan areas as self-organizing innovative complexes that, as crucial engines of growth, should deserve the full attention of different actors and areas of knowledge in an interdisciplinary manner.
- The questioning of the endogenous development concept, regarded as an approach in which different views of development converge and that helps defining strategies and policies that the local actors may implement by taking advantage of the opportunities brought about by globalization.
- An analysis of the geography of knowledge spillovers in Europe based on the usage of patent citations.
- An exploratory approach to the innovative profiles and regional actors of the Algarve and Andalucía neighbour regions.
- An analysis of the relationship among the diffusion of information and communication technologies, foreign direct investment and entrepreneurship in developing countries.
- A discussion on the interactions among regional competitiveness, technological adjustments that companies are forced to introduce and employment.

These interesting contributions vary naturally in both maturity and depth. And as expected many relevant topics were left out of the articles presented in this book.

In these circumstances, I cannot close this preface without expressing my strong wish that the University of Algarve repeats this initiative, contributing to raising the awareness of the importance of research and innovation in the Portuguese society as well as fostering a stronger culture and practice of innovation across its academic staff, its students, and a large number of regional and national players responsible for the development of our country. In spite of the recent progress registered in these areas, they still badly need it.

Competitiveness and innovation for development: Challenging knowledge and trust

Competitividade e inovação para o desenvolvimento: desafio do conhecimento e da confiança

José Veiga Simão

Introdução

No século XX assistimos ao colapso de mitos ideológicos, a confrontos nos domínios da ética e do comportamento humano e a conquistas surpreendentes da ciência e da tecnologia, com directas consequências na economia, na ordem social e na configuração do poder mundial.

No entanto, a lógica do progresso que derivou da Ciência não tem sido facilmente compatibilizada com a "luta pelo reconhecimento de valores e de identidades" que, na visão de Kant e de Hegel, são o "motor da história". Aliás constatamos que perduram raízes do passado. Vale a pena, embora não seja fácil, reflectir sobre o futuro.

Desde logo, algumas perguntas exigem neste início do terceiro milénio respostas que não foram ainda dadas:

- Podem a liberdade e a igualdade, por si, conduzir a sociedades estáveis, capazes de proporcionar a felicidade humana? Ou, pelo contrário, podem proporcionar caminhos regressivos que levam ao caos?
- Qual o papel da ciência e da tecnologia na construção do futuro, que sentimos indefinido? Qual o peso da inovação que, por natureza, é desafiante de uma imaginação sem limites?

Não é fácil fazer previsões. Uma nova ordem mundial, política, económica e social, está longe de ser estabelecida.

A ciência permitiu que a tecnologia venha construindo a "aldeia global", mas não evita que renasçam, virulentas, nas "casas" de vizinhos, rivalidades antigas. E em "casas" mais distantes, o sentimento humano da justiça e da igualdade faz desafios ao pensamento científico e à decisão política.

Felizmente, qualquer que seja o que nos reserva o futuro, a ciência continua indomável, apesar da tecnologia ser domesticável.

É que a ciência conduz-nos ao desejo de perscrutar um horizonte visionário, sempre em expansão, e só aceita a independência de pensamento como a força legítima, capaz de gizar respostas às perguntas imprevisíveis do mundo admirável do mistério da descoberta.

A investigação, na procura do saber novo, floresce no desejo e na curiosidade de penetrar, cada vez mais, na origem da vida, da matéria e do universo. A tecnologia desenvolve processos económicos racionais que, ligados a conquistas da ciência, se tornam cada vez mais visíveis, porventura mais complexos e perigosos para a liberdade individual.

A inovação, associada à medida do conhecimento para o desenvolvimento, mobiliza

múltiplos actores da política, da ciência, da empresa e da civilidade, manifestando-se em aliciantes criações e profundas transformações de bens, de processos, de organização e de mercados, com incidências no indivíduo, nas instituições e na sociedade em geral.

As sociedades capitalistas emergiram como produtos naturais desse desenvolvimento tecnológico. Por isso, apresentam-se, hoje, com um modelo quase único, a ser adoptado por toda a humanidade – designa-se por economia do mercado. Recorre-se à tecnologia para, através dela, se criarem estruturas e aplicar métodos que permitam a adopção desse modelo, mesmo em sociedades culturalmente díspares, algumas delas com preocupações básicas, as mais simples. Mas será que o progresso cria, obrigatoriamente, um mundo mais desigual?

Entretanto, a ciência inquieta-se, não aceita que se tenha atingido o fim da evolução da pessoa humana e procura, obrigatoriamente, caminhos, cada vez mais, à margem do poder. O Estado, preocupado, controla os meios financeiros.

Neste turbilhão de um mundo em mudança questiona-se o futuro da universidade. E pergunta-se: conseguirá ela, sujeita a asfixias financeiras nem sempre racionais, em nome da economia do mercado, impor-se como consciência crítica das nações?

E quais os caminhos previsíveis para a ciência e a tecnologia no terceiro milénio? Onde está o espaço de liberdade da criação?

Conhecimento Científico como Alimento da Inovação

A sociedade da informação, melhor dizendo do conhecimento, assiste à criação e difusão de sucessivas gerações de sistemas, caracterizados pela integração de múltiplos dados tangíveis e intangíveis e pela total conexão entre eles. A banalização dos produtos de informação, a nível individual, das instituições e das empresas, determina novos métodos de trabalho e de gestão empresarial e institucional. Reflecte-se no dia-a-dia do cidadão o peso da informação e dos agentes electrónicos de transformação.

O Estado liberal mostra sinais de perplexidade e pretende o controlo do progresso, em nome do bem comum. Com a liberdade em perigo, a ciência procura formas de defesa do cidadão perante o Estado.

No seu universo de descoberta, a ciência, ao mesmo tempo que não prescinde do saber pelo saber, pretende, também, tornar mais igual a dignidade do trabalho, seja na agricultura, na indústria, nos serviços e nas nossas casas.

Como exemplo, a biotecnologia é, cada vez mais, do que uma ideia. Irá dominar nos campos, nas provetas, na produção vegetal e animal, jogando com a marca da vida, o ADN. A biotecnologia actua na engenharia das drogas, nas fábricas e nos computadores celulares. A medicina tem avanços espectaculares e milhões de bactérias digerem a poluição. Entretanto, o mercado estará cada vez mais ávido de novos produtos. Mas a tentação de dominar o processo da vida e alterar a sua harmonia oferece perigos sem fim. Algumas pessoas julgam que se podem aproximar de Deus ou da origem da vida... É a grande interrogação do terceiro milénio.

Mas os problemas não param. O desafio global do ambiente exige novos modelos de desenvolvimento e, em particular, uma intensa aplicação de tecnologias limpas na produção,

no desenvolvimento de novas formas de energia e na sua utilização racional. A economia sustentável tem de se tornar complementar do ambiente saudável.

Os princípios de Sun-Tzu, na sua sabedoria oriental, são transplantados da guerra para a paz, com o axioma de que "não haverá cegos e ilimitados crescimentos económicos de que qualquer país possa beneficiar".

E, assim, a estabilização do CO2 na atmosfera, a drástica diminuição da poluição, o tratamento e reciclagem de resíduos de toda a espécie, o fabrico de produtos naturais e a valorização da Natureza exigem que um "fundo verde mundial" financie o desenvolvimento harmónico do planeta. Uma iniciativa estratégica, a desenvolver por uma rede mundial de investigação e desenvolvimento, não só deve salvar a Terra, mas dar vida nova aos puros riachos e à floresta repousante, ao animal selvagem e ao homem vivendo com alegria. E, aqui, a ciência e a tecnologia têm desafios sem fim. O espaço será explorado nas suas riquezas e na sua infinita oferta à comunicação entre os homens.

E como a ciência não tem vergonha de sonhar, explorar-se-ão novos conceitos de energia para o século XXI, tão necessários ao natural progresso das nações em vias de desenvolvimento.

Tudo isto não é visão futurista. São projectos que abrangem estações energéticas espaciais, a armazenagem de energia, a supercondutividade, o aproveitamento das potencialidades do mar e dos ventos com aplicações que vão desde os aviões até à florestação do deserto. Mas a ciência no terceiro milénio não deixa dormir os oceanos, vindo em apoio do desenvolvimento piscícola e tentando criar recursos, quase sem limite.

O conhecimento serve de alimento à inovação para a produtividade e para a competitividade. As tarefas subjacentes implicam uma activa internacionalização que acompanhe a globalização económica. A nível mundial, os governos e as sociedades não deixarão de intensificar a abertura previsível de uma cooperação singular entre cientistas de tradições criadoras, dinamizando equipas Oeste-Leste e Norte-Sul. Assim, a ciência e a tecnologia têm de dar resposta inteligente à resolução dos problemas mundiais que vão desde a fome à massificação disforme dos meios urbanos.

Mas será possível, no terceiro milénio, compatibilizar os interesses de Estado-Nação com comunidades de países e com as multinacionais? Não percamos a esperança.

Riqueza e Pobreza das Nações

Perante consequências desastrosas do passado, a ciência não pode viver sem alma. A qualificação humana é a chave-mestra, a saúde, o bem que não pode esconder-se do cidadão.

A inovação implica parceiros múltiplos e diversificados: o sistema científico e tecnológico, os organismos promotores da qualidade, de ensino e de formação científica e profissional, de coesão social e desenvolvimento sustentável, associações empresariais, parceiros e inter-faces público-privadas, empresas inovadoras, consórcios e agrupamentos complementares, organizações da actividade bancária, do capital de risco, *business-angels* e de garantia mútua... A investigação e o desenvolvimento, em particular a que está associada à engenharia, à demonstração e ao projecto é de certo, uma fonte essencial da inovação. Porém, devem-se cultivar, na universidade

e na empresa, outras fontes de inovação, como as que resultam da recolha e tratamento da informação, do *intelligence*, da análise de valor de produtos e serviços em competição; da exploração de ideias contidas em marcas e patentes, do diálogo e intercâmbio, com clientes e fornecedores, em feiras e em congressos.

A inter-relação da ciência com a cultura, a sociologia e porque não a religião, apontam para um espaço de humanização. Nela estão presentes luzes de um progresso que, no respeito pela ética e pela moral, deve estar ao serviço de ideais nobres que, apesar de tudo, vivem mais perto do que julgamos.

Riqueza e Pobreza das Nações

A questão natural que avulta é: e Portugal? Os portugueses têm de fortalecer a ideia de uma Europa, como *oportunidade de criação* e, não a de caírem no pântano de um país reduzido a *fábrica de acessórios e a estação de serviços*, certificados pelos outros. A oportunidade de criação identifica-se com a inteligência nacional, a qual não deve deixar-se abater pelos frios indicadores estatísticos, mas antes procurar nichos de qualidade e de excelência, sabendo correr riscos. O equilíbrio do binómio qualidade-quantidade, sendo a primeira o factor dominante, deve orientar a política e o desenvolvimento.

Faz todo o sentido reflectir aqui sobre o passado no que ele contém de semente da esperança. Para a Europa, os portugueses trouxeram mais cedo do que outros um modo de estar no mundo que a ciência, mais tarde. Geraram um embrião de desenvolvimento tecnológico e cultural, que esbateu antagonismos e criou novas identidades que são orgulho do nosso passado.

A incidência do conhecimento na economia, a sua criação e aplicação, colocadas de forma pragmática na base do desenvolvimento sustentável, confere um valor actual à leitura de David S. Landes em *A Riqueza e a Pobreza das Nações* e de Jean-Louis Levet, em *Inteligência económica, modo de pensamento e modo de acção*.

Todos nós repetimos, sem cessar, que Portugal é um país médio, de moderada fertilidade. Apesar disso, os portugueses doutros tempos não seguiram o caminho que a racionalidade lhes apontava e converteram a sua terra numa plataforma para o império. Portugal não dispunha de gente e de recursos suficientes, mas foi expedito a importar mão-de-obra qualificada. Portugal foi um *peso leve* a investir contra gigantes.

A gesta portuguesa dos descobrimentos, sem os saudosismos históricos das conquistas, que, aliás, não rejeitamos nas virtudes e nos defeitos, é testemunha de um espírito empreendedor, de força, de entusiasmo e, acima de tudo, de capacidade para mobilizar e explorar os conhecimentos e as técnicas que eram, ao tempo, as mais avançadas.

Nenhum chauvinismo; o pragmatismo em primeiro lugar. Os portugueses souberam atrair gente de fora pelo dinheiro e pela aventura; souberam utilizar conhecimentos práticos e rodear-se de mestres de enorme prestígio mundial.

Quando os portugueses conquistaram o Atlântico Sul, área de influência que devemos cultivar de forma solidária e fraterna, estavam na vanguarda da técnica da navegação; tinham empenho em aprender com cientistas estrangeiros e fizeram com que os conhecimentos

adquiridos fossem directamente transferidos para aplicações práticas. Segundo Jean-Louis Levet, os portugueses criaram a primeira empresa de exploração sistemática, que iria derrubar as barreiras do medo e do desconhecido.

Porém, quando os portugueses abandonaram a virtude da tolerância, desprezaram a vida intelectual e científica e congelaram a inteligência em ribeiros do interior, vales das montanhas, e nos subúrbios das cidades desceram a um abismo de fanatismo e de uma irracional pureza de sangue. Assim nos adverte David S. Landes.

A maior perda foi a que o perseguidor infligiu a si próprio, num processo de auto-diminuição que confere à perseguição, uma durabilidade que a torna, não o acontecimento de um dado momento, mas de vidas inteiras, de gerações e de séculos.

A educação formal passou a ser dominada por um currículo medieval, centrado quase exclusivamente na gramática, na retórica e na argumentação escolástica. As características desta educação foram o exibicionismo e o bizantinismo de um saber obsoleto. Deixou de haver jovens portugueses a estudar no estrangeiro. Passou a controlar-se a importação do livro. Os estrangeirados atraiam suspeitas e eram ostracizados. O fracasso dos governos, depois de Pombal, em promover a agricultura e a indústria reduziu Portugal ao papel da *melhor e mais lucrativa colónia de Inglaterra*.

Esta memória está virada para o futuro. Hoje, mais do que nunca, não podemos aceitar que a mesquinhez, a falta de curiosidade e a ausência de empreendedorismo invadam a nação portuguesa. Temos de nos revoltar contra os que pensam ser apenas indispensável saber o estritamente necessário e não correr os riscos da independência do pensamento e da actividade crítica para questionar aquilo que se aprende e o que nos querem incutir. Não podemos aceitar a postura de alguns sociólogos que minimizam a cultura científica e são incapazes de associar a democratização do ensino a dois pilares, ambos essenciais: a igualdade de oportunidades e o acesso pelo mérito.

Temos de dizer não ao facilitismo invasor que elimina a avaliação em todas as suas vertentes e conduz a diplomas e a graus sem conteúdo. Não queremos estar fora de uma autêntica dimensão europeia que, no ensino superior, se deve traduzir por um processo de Bolonha com créditos credíveis de aprendizagem e porta-fólios de competências.

Parafraseando, mais uma vez, David S. Landes, os portugueses, a certa altura, perderam a competência, até mesmo nas áreas que anteriormente tinham dominado. De líderes na vanguarda da teoria e prática de navegação, passaram a andar sem rumo, muito atrás dos outros. É a consequência da atitude perante o dinheiro fácil, da que privilegia a intermediação e da que remete para segundo plano a criação, abrindo caminhos de isolamento e de pobreza. Eis, uma clara advertência para os dias de hoje, designadamente quando nos debruçamos sobre indicadores de qualidade para caracterizar o ensino, a inovação e o desenvolvimento do País. Eles assemelham-se a sinos que tocam a acordar na madrugada para o trabalho. A riqueza de uma Nação e o seu futuro exigem que se aproveitem as oportunidades para realizar novas coisas de novas formas.

Mensuralidade e a Temporalidade na Inovação

Os indicadores de qualidade, que importa seleccionar para avaliar os progressos da inovação para o desenvolvimento, obedecem a conceitos e a critérios de *mensurabilidade* e de *temporalidade* interpretados de acordo com princípios associados à *incerteza* e à *complementaridade*. Perdoem a minha formação em Física: os princípios da incerteza de Heisenberg e da lógica de três valores, extrapolados para a economia, clarificam a racionalidade científica da medida da qualidade e da inovação, e introduzem na economia a variável tempo, à semelhança do espaço de Minkowski da teoria da relatividade. Afinal, estes conceitos ajudam a consolidar a economia como ciência, no que os franceses chamam o *fétiche economique* e permitem-nos enfatizar os cuidados com que devemos interpretar as estatísticas e, em particular, os dados relativos a bens tangíveis, a exportações e a infra-estruturas básicas, a par dos bens intangíveis, das análises de valor e das infra-estruturas do conhecimento.

O "IMD-World Competitiveness Yearbook" ao analisar, na sua publicação anual de 2007, a competitividade entre 55 países mais desenvolvidos do mundo, indica que a "performance global" de Portugal, entre 2003 e 2007, decresceu seis lugares, ocupando em fins de 2006 o 39º lugar. Nos 27 países com menos de 20 milhões de habitantes Portugal ocupa o 24º lugar, quando em 2003 se situava no 20º lugar.

Neste contexto, entre os grandes desafios que Portugal vem enfrentando, com incidência em 2007, citamos:

- A redução do défice público, a que respondeu com sucesso; situa-se em menos de 3%, do PIB, na verdade 2,6%;
- O nível de confiança no futuro (empresários, executivos, professores, magistrados, médicos e população activa em geral) encontra-se longe de ter atingido valores desejáveis;
- A implementação das reformas da justiça e da administração pública estão em curso no meio de intensas polémicas;
- O investimento no capital humano, com incidência na qualidade da educação, da formação e da inovação, permanece com resultados discutíveis e aguarda avaliação;
- O equilíbrio entre a *economia da proximidade* e a *economia baseada no conhecimento*, em nichos de alta e média tecnologia, depara-se sem perspectivas convincentes, apesar de iniciativas louváveis; a globalização é dominada por interesses das multinacionais.

Por outro lado, um olhar sobre o perfil da competitividade dá-nos conta de que em 2007 na *economia da proximidade* nos situamos no último lugar dos 55 países mais desenvolvidos; no investimento estrangeiro em 53º lugar; nas práticas de gestão em 50º lugar; na produtividade em 46º lugar; no mercado do trabalho em 40º lugar; nas atitudes e valores em 40º lugar; na política fiscal em 39º lugar e no desemprego em 35º lugar. Ao mesmo tempo, a estabilidade nos preços confere-nos o 15º lugar; a legislação empresarial o 26º; a educação o 28º lugar. O produto interno bruto *per capita* situa-nos no 30º lugar dos referidos 55 países.

Entretanto, optimistas, refugiam-se em comparações com o passado, à semelhança do que nos ensinavam na escola dos anos 40, esquecendo o progresso das nações que nos ultrapassaram, mercê das oportunidades da aventura europeia, a oeste e a leste da Europa. Não têm ambição.

Carta Magna da Competitividade

A Carta Magna da Competitividade, estabelecida e dinamizada pela Associação Industrial Portuguesa, a partir de 2003, para além de propor políticas públicas e estratégias empresariais, contempla um relatório anual que evidencia a evolução de indicadores de *input* em diversas áreas, tais como: educação e formação; investigação, desenvolvimento e inovação; sociedade de informação; ambiente e energia; investimento; custos laborais; preços e fiscalidade. Também salienta indicadores de *output* tais como: PIB; criação e taxas de emprego e desemprego, produtividade por pessoa e do trabalho, e grau de abertura da economia.

Assim, tem sido possível desenvolver um *benchmaking* da competitividade do País, de modo a melhor compreendermos o nosso posicionamento na Europa e no Mundo.

Registo, nesta ocasião, que ao mesmo tempo que se verifica uma percentagem elevada da população, entre os 25 e os 34 anos, a frequentar o ensino superior, se detecta que o sistema educativo não melhora no sentido de corresponder às necessidades da economia competitiva e do desenvolvimento cultural. Um perigo, já presente, é o aumento progressivo da fuga de talentos para o exterior.

Entretanto, a corrupção tem aumentado, de forma escandalosa, e a responsabilidade social dos líderes políticos e económicos não tem merecido a atenção necessária.

A tudo isto acresce que a administração pública está sob uma grande pressão, sendo prematuro qualquer pronunciamento acerca dos resultados das reformas em curso. A favor delas podemos enumerar o objectivo de diminuir o peso global do Estado, mas não o de se clarificarem os modelos orgânicos das instituições inseridas quer na administração directa, quer na administração indirecta, quer, ainda, administração na autónoma do Estado. A avaliação do desempenho quer institucional quer das pessoas que trabalham na administração pública é condição básica da sua modernização. Porém, a politização, diria melhor, a partidarização da administração pública, simbolizada nos recrutamentos políticos dos altos dirigentes, constitui um sinal negativo para a afirmação da competência e da idoneidade.

Em síntese: as opções prosseguidas lançam dúvidas pela falta de uma visão estratégica do Estado e, consequentemente, da sua missão e funções no mundo moderno, que tentámos descrever em alguns dos seus aspectos.

De qualquer modo, é urgente realizar coisas novas com a inteligência nacional. Tal só é possível se os centros de decisão, estejam onde estiverem – e desejamos que num quadro variável alguns se mantenham junto de nós –, se encontrem associados aos centros do saber e, aos centros de competência. A soberania do conhecimento é, de certo modo, a que nos resta.

A transformação do conhecimento em riqueza exige alianças de actores que se têm ignorado e mede-se pelas suas realizações, pelo sucesso da inovação na administração, nas empresas, nos serviços e noutros domínios da sociedade; pela rentabilidade dos modelos de gestão, pela capacidade competitiva e pelo grau de confiança dos que acreditam na mudança.

A Inovação para o Desenvolvimento e a Civilidade

Em *Making Democracy Work – Civic Traditions in Modern Italy*, Robert Putman, observa que os governos e as instituições são mais eficientes, quando a sociedade civil que os circunda apresenta um nível de elevada participação do cidadão na vida colectiva. Daqui resultam factores decisivos para a cooperação, baseados na tolerância, na confiança e no mérito, congregando interesses orientados para o desenvolvimento social, económico, cultural e científico. Civilidade (*civicness*) é, assim, a chave do futuro da sociedade do conhecimento, que permite aos cidadãos viverem uma vida digna de ser vivida, como já dizia Marcuse. É, porém, difícil criar ou mesmo semear civilidade, designadamente nas comunidades onde ela ainda praticamente não existe. É infelizmente o nosso caso.

Este é, aliás, o grande desafio que se coloca à União Europeia perante os Estados Unidos e os novos países emergentes. Desde logo, a civilidade associada ao empreendedorismo contribui significativamente para um sábio doseamento entre a *globalização* e a *economia da proximidade*, impulsionando formas inteligentes de criação de riqueza e de preservação de valores, alguns dos quais não podem nem devem ser perdidos. O desenvolvimento regional assenta nestes pressupostos. Infelizmente, a desertificação do interior acentua-se sem remédio.

Acontece, também, que um equilíbrio desejável só será atingido pela inovação, com alianças criativas entre a ciência, a tecnologia e a cultura. A *economia cultural* deverá desempenhar um papel determinante, não só em instituições públicas e privadas e em grandes empresas mas, também, nas micro-empresas e empresas familiares, as quais, afinal, constituem mais de 50% da totalidade da estrutura produtiva na União Europeia. Por outras palavras, as empresas culturais devem assumir, no modelo de desenvolvimento europeu, um papel cada vez mais determinante na qualidade de vida dos cidadãos. A cultura é uma vantagem comparativa que tem na Europa uma dimensão singular e que pode contribuir para diminuir o fosso tecnológico que a separa dos Estados Unidos.

Isto não quer dizer que, para que a Europa se afirme como grande pólo de dimensão económica global inter-países, não deva realizar todos os esforços para a criação e distribuição de produtos inovadores nas indústrias das tecnologias de informação e comunicação, de modo a equilibrar as balanças comerciais de computadores e *software*, de equipamentos de comunicação e componentes electrónicos e de instrumentação científica e de medida. Balanças que, hoje, ainda lhe são desfavoráveis quando comparadas com os Estados Unidos, a China, o Japão, e a Índia.

Mas, para atingir o seu objectivo de grande pólo mundial do desenvolvimento, a Europa tem de substituir o actual *modelo analítico* que impera sobre a sua organização, de modo a satisfazer interesses de cada país, por um *modelo orgânico*, fixando objectivos mobilizadores, que permitam decisões oportunas e suscitem a confiança dos cidadãos europeus. A federação e a confederação políticas, podem estar, simultaneamente, em análise, mas os mecanismos democráticos processuais e consensuais, não podem determinar adiamentos sucessivos de decisões. Cada vez mais, *quem na sociedade do conhecimento não resolver as coisas a tempo, está perdido*.

Portugal, em mudança, deve alimentar-se do conhecimento e deve mover-se pela confiança. O maior erro dos políticos, ao não transmitirem uma visão do futuro que incentive e mobilize os cidadãos, é o de correrem o risco de as reformas irem ao encontro dum mundo já desaparecido.

Enhancing organizational self-awareness with enterprise modelling frameworks

José Tribolet, Marielba Zacarias and Rodrigo Magalhães

Introduction

In a time when technology has made the world smaller and important events take place at an incredibly high pace, organizations constantly need to adapt themselves in order to survive. The challenge of today's organizations is to develop capabilities of continuous sensing, learning and adjusting to the dynamics of their environments (Magalhães, 2004). An essential requirement of these capabilities entails developing organization's self-awareness. Human consciousness gives subjects the capacity of self-awareness. Self-aware beings know who they are, how they do things and what they (and others) are doing at any particular moment. Whereas this capacity is innate in individuals, organizational self-awareness must be built and maintained by continuous interactions among their members. From our point of view, the act of modelling enterprises and discussing enterprise models is an effective means of supporting organizational self-awareness.

The evolution of the Information Systems (IS) field has been marked by the emphasis given to models and modelling activities as a means of facilitating the communication among systems stakeholders. The high inter-dependence between IS and organization's structure, culture and processes, as well as the need of aligning IS and organizations, has lead to an expansion of the IS field that include organizational analysis and process (re)design activities as part of systems development efforts. From this expansion, emerged the Enterprise Modelling (EM) activity. EM research and practice has shown that enterprise models are effective communication tools in supporting systems development and process (re)design. A distinctive feature of EM frameworks is the representation of different enterprise concerns in terms of different but inter-related perspectives. The most commonly depicted enterprise perspectives are the process, information, application, and technology perspectives (Schekkerman,2004}. Whereas the former describes enterprise activities *i.e.* what organizations do, the remaining perspectives describe its resources *i.e.* the entities required for their operation. Another important feature of EM framework is the usage of languages with more formal syntax and semantics as well as graphical representations, which have shown to reduce ambiguous and inconsistent interpretations.

However, current EM frameworks are restricted to concerns relevant for participants and stakeholders of systems development. Moreover, most of these representations are based on static, mechanistic and deterministic views of the organization. Modelling the organization for its self-awareness is a more challenging task and entails conceptual and methodological implications. It requires integrating approaches coming from organizational and IS fields, to capture: (1) organization's structural and dynamic aspects, (2) routines and decision-making processes, and (3) its formal and informal sides. Moreover, it entails capturing organization's evolution. All these

aspects must be captured from different viewpoints and levels of details. Means for mapping between different aspects, viewpoints and levels of details must also be provided.

This paper discusses the conceptual and methodological implications of modelling enterprises to enhance organizational self-awareness, and illustrates the benefits of using EM for self-awareness purposes through a set of applications, tested with case studies in real organizational settings. The remainder of this paper is organized as follows; section 2 clarifies our notion of organizational self-awareness and summarizes ideas of the contemporary thinking of organizational science. Section 3 summarizes the state of the art in EM. Section 4 discusses the conceptual and methodological implications. Section 5 summarizes some practical applications.

Organizational Self-Awareness

Organizations as Resultant of the Agency-Structure Duality

The approach proposed in this chapter is based on a view of organization as a socio-technical entity, which self-realizes in the permanent action and interaction of its component parts. This view of organization is the outcome of a number of intellectual influences, namely *organizational constructionism* (Giddens, 1984), *autopoiesis* (Maturana and Varela, 1980), *organizational intelligence* (March, 1999), *organizational complexity* (Tsoukas, 2005) and *organizational evolution* (Aldrich and Ruef, 2006). These theories center on how organizational agents continually (re)create and change the organization. Constructivist theories argue that organizations exist largely in the minds of organization members in the form of cognitive maps, or images. In talking about organizations and designing maps of it, they are *reified*, that is, they are made real. Hence, the existence of shared maps requires social agreement and cooperation.

In the present work, we focus on the organization as the resultant of the actions of individual and social agents. Agency is an essential notion of social theory. Human action is more than a mere combination of acts. Human beings have the capacity to understand what they do (Giddens, 1984). These reflexive capacities are (a) largely carried tacitly and (b) embedded in the flow of day-to-day activities. A social actor is "an organizational entity" whose interactions are simultaneously enabled and constrained by the environments of the firm, its members and its industry (Lamb and Kling, 2003). Structure is another important notion emerged from social theory. According to Giddens (1984), it comprises rules and resources. Rules are generic procedures of action applied in reproduction of social practices. Resources are the media through which power is exercised. Resources may be *allocative* or authoritative. *Allocative* resources include information, objects, goods or material phenomena and capabilities to allocate or transform them. Authoritative resources include soft competencies and social resources such as power relationships.

The notions of agency and structure are the cornerstones of Structuration Theory (Giddens, 1984). This theory suggests a recurrent duality between agency and structure. For Giddens, social action makes up what he calls the system, that is, the observable patterns of events and behaviour. Social systems comprise the situated activities of human agents, reproduced across

time and space. Structure refers to the unobservable rules and resources used to generate the system. Structure is saved as memory traces and is recursively implicated in social systems. Structuration is the process of producing and reproducing social structures through the daily activity of social actors.

Refining Organizational Agency: a Complex, Adaptive Framework

Organizations are also currently regarded as *complex systems* (Magalhães, 2004). (Bohm, 1980) argues that in every complex system there are hidden processes below the surface of reality, which explain the world stage at any time. Complexity introduces notions such as self-organization and emergence (as opposed to deterministic motion), chaos and unpredictability (as opposed to command and control), or sensemaking and understanding (as opposed to rationalizing and predicting).

Another important concern of the constructivist paradigm is *organizational evolution*. Axelrod and Cohen (2000) have taken the principles of complexity and evolution and have put together an innovative framework for analysis and (re)design of social, political and organizational systems, which allows refining the notion of organizational agency. We summarize below the essential concepts of this framework:

- Agents are collections of properties that include location and capabilities. Agents interact with artefacts and other agents. Agents can respond to what happens around them and can do things more or less purposefully. Thus, agents have goals. Agents can be not only persons but also families, businesses, countries or computer programs.
- Artefacts are objects with properties such as location or capabilities. Agents interact with other agents and/or artefacts. An artefact has "affordances" (features evoking certain behaviour from agents). However, they do not have purposes of their own or reproduction capabilities.
- Strategies are ways of an agent of responding to its surroundings and pursuing its goals. A strategy is a conditional action pattern that indicates what to do in which circumstances.
- Success measures are "scores" used by an agent or by a designer to define how well an agent or strategy is doing.
- Populations are collection of agents, or, in some situations, collections of strategies.
- Systems are larger collections, including one or more populations of agents and possibly also artefacts.
- Designers are agents that introduce new agents, artefacts or strategies into the world.
- Adaptation takes place when a selection process leads to improvement according to some measure of success. Adaptations for some agents may not be for others. Moreover, adaptations of agents do not necessarily leads to an adaptation of the system
- Selection involves the change processes triggered by success measures.
- Variety defines the diversity of types within a population or system. Variety is driven by change processes. Variety is a central requirement to adaptation.
- Interactions address the question of who or what should interact with who or what and

when. Interactions make a complex adaptive system come alive. Interactions give rise to events and develop an unfolding history.

- Interaction patterns define the recurring regularities of contact among types within a system. These patterns are neither random nor completely structured. Interaction patterns are determined by two kinds of factors; proximity and activation. *Proximity* determines how agents become likely to interact. Activation determines the sequencing of their activities. *Activation* groups together many different processes that affect the timing of agent activity.

Human Activity and Consciousness

In order to be fully understood, agency must be regarded at collective and individual levels. Whereas Structuration Theory and Axelrod and Cohen's framework explain the formation and evolution of societies, Activity Theory (AT) is a psychological theory which analyzes the formation and evolution of individual and collective activities, and its relationship with human consciousness.

Leont'ev (1974) has described an activity as being composed of *subjects*, *object*, *actions*, and *operations*. Actions are conscious, goal-directed processes that must be undertaken to fulfill the object. Operations are actions, which become unconscious with practice. The subjects involved comprise multiple individuals and/or sub-groups who share the same general object of activity and who construct themselves as distinct from other groups. This model was later extended to include social rules *i.e.* regulations, norms and conventions constraining actions and interactions within the activity system; community *i.e.* activity stakeholders and division of labor *i.e.* horizontal division of tasks and vertical division of power and status (Engeström *et al.*, 2005).

Activity constituents may change in time according to a set of key principles. The first principle assumes that events should not be analyzed in isolation but as result of *developments* over time. Another key principle is *mediation* by tools and signs. Tools and signs are artifacts that shape the way human beings interact with reality. The principle of *object-orientation* (different from object-oriented programming) is one of the most important principles of AT. Every motive is an object, which drives activity execution and coordination. AT also differentiates between internal (mental) and external activities. *Internalization* is the transformation of external activities into internal ones. *Externalization* transforms internal activities into external ones.

According to Leont'ev (1977), consciousness is the basis of all human activity. Activity theorists argue that consciousness is not a mere set of discrete disembodied cognitive acts. For AT, having human consciousness means to be part of a web of social activities and to live and act in a culturally elaborated environment populated by a wealth of tools, including language (Nardi, 1998). In other words, consciousness is an individual and social phenomenon that both influences and is influenced by human activities.

Organizational Consciousness and Self-Awareness

The notion of consciousness of activity and structuration theories can be refined further in search of the intellectual foundations for a new construct that has been labeled as organizational consciousness (Magalhães & Tribolet, in press). Such a refinement can be found in the teaching of Weick (1995; 2001) about sense-making in organizations. Sense-making is defined as structuring unknown contexts and/or actions and assigning them with meaning. Sense-making is distinguished from other explanatory processes such as understanding or interpreting by the following characteristics; the process of sensemaking is (1) social, (2) grounded on identity construction, (3) retrospective, (4) focused on extracted cues, (5) ongoing, (6) driven by plausibility rather than accuracy and (7) enactive. The seven properties of sense-making affect the initial sense that a person develops of a situation and strongly influences how this perception is developed for future action. In other words, sense-making lies at the foundation of the consciousness that organizational agents develop of the organization as a whole and of their place in it. Sensemaking and organizational consciousness are closely related notions. However, these are rather abstract notions comprising several capacities including perception, memory, reasoning, association and awareness among others.

In this work, we narrow our focus and refer to a more specific and operational capacity given by consciousness; self-awareness. Organizational self-awareness has an individual and an organizational dimension. The individual dimension refers to the capacity that individual members of the organization have of answering questions such as; *who am I in this organization?, how are things done here? What is the organization -as a whole- doing now?*. The organizational dimension refers to the combination of human or automated agents, resources and procedures that provides organizations with the necessary intelligence for dealing with questions such as; *who are my members?, how do they do things?, what are they doing now?*. An organization is self-aware when these two dimensions are aligned. In practice, achieving this alignment has proved to be neither straightforward, nor easy. Despite the existence of several IS/IT providing already some degree of self-awareness, it is partial, frequently inconsistent or outdated. It is precisely in supporting a dynamic alignment between organizations and its agents, where we envision the value of enterprise representations and tools.

Enterprise Modelling Today

Structuration theory, AT and the Axelrod and Cohen's Framework provide approaches consistent with the complexity paradigm of organizations. Nonetheless, these approaches are described in natural language and with a high level of abstraction. Hence, they are limited to human use and lead to different interpretations.

Several EM frameworks, including languages, methodologies and supporting tools have been developed and are being increasingly used since their emergence more than 20 years ago in computer-related fields. EM has been addressed by two main areas; IS and Artificial Intelligence (AI). The frameworks developed in these fields are commonly referred as Enterprise Architectures

(EA) or Enterprise Ontologies (EO). In both fields, they have been mainly used to support the development of business applications (Schekkerman, 2004). Several EA frameworks of the IS field including languages, methodologies and supporting tools have been developed. Whereas some focus on specific sectors, others are applied to a wide range of organizations. Some well-known generic frameworks are the Integrated Framework Architecture (IAF) (IAF, 2007), the Open Group Architecture Framework (TOGAF) (TOGAF, 2003), and the Enterprise Unified Process (EUP) (Ambler *et al.*, 2005). Within this field, the Enterprise Ontology developed by J. Dietz (Dietz, 2006) for business process (re)design purposes, and the CEO EA framework (Sousa *et al.*, 2005) are two approaches relevant for our work. Within AI, two well known EO are the Enterprise Ontology proposed by (Uschold, 1998) and the ontologies of the TOVE project (Fox *et al.*, 1998).

Perspective	**EO (Uschold)**	**TOVE**	**EO (Dietz)**	**CEO EA**
Found./time	entity, relationship role, actor, state time point, interval time line	 time point, interval time line	 time unit, range requested time promised time actual time	entity, role
Activity	activity, event doer, owner pre-conditions, effects	activity, constraint state, state tree enabling/caused state	coordination act production act transaction process event, fact, state	goal, activity process
Resource	resource-entity	material labor tool		information-entity application-entity technology-entity
Agent/ Organization	organizational unit purpose corp., legal entity partner, partnership management link manage, delegate manage, delegate person, machine	organizational unit Org.-goal, role-goal agent, group, team speech act, protocol role, skill, policy authority, autho-link information link person, machine, sw.	 actor, role agenda action rule subject	organizational unit

Table 1 - Perspectives and concepts included in several EM frameworks

As mentioned in section 1, the distinguishing feature of EM frameworks is to model an enterprise from different viewpoints or perspectives. Table 1 shows the most relevant perspectives and concepts defined in four frameworks; (1) Uschold's EO, (2) the TOVE ontology, (3) Dietz's EO, and the (4) CEO EA framework. All frameworks -excepting Dietz's ontology- include organizational/ agent, activity, and resource-related perspectives. Organizational behaviour is modelled using activity hierarchies, where atomic activities are represented in terms of initial and final states, resources consumed and produced. Dietz's EO models organizational behaviour in terms of inter-agent transactions, and action rules that define when to activate a given role. Processes are modelled by describing the coordination mechanisms among activities or transactions. Resource-related perspectives describe the resources, and their relationships among them.

Most of the frameworks include a set of foundational concepts such as *entity*, *relationship* (among entities), *event*, *state*, and *time*-related concepts. Event, state and time-related concepts

are used to capture activity dynamics. Events are defined as facts or actions happening at a given point of time. State is typically conceptualized as 'states of affairs', and represented in terms of relationships among entities. In all these frameworks, agent and organizational concepts are put together within a single perspective (named as organizational). Roles represent expected behaviour and/or skills. Activities are associated to roles to indicate the behaviour and skills required to execute them. Agents (actors in some frameworks) are associated to a set of roles indicating the behaviour or skills provided by the agent.

Enhancing Organizational Self-Awareness: Implications for EM

Limitations of Current EM Frameworks

Section 2 states the type of questions that it is necessary to answer in order to achieve organizational self-awareness. The overview summarized in section 2 also shows that none single framework today allows answering all the stated questions. Moreover, maintaining such self-awareness also requires capturing individual and organizational changes, which means the capability of providing not only accurate but up-to-date answers. Due to their underlying assumptions and purpose, EM frameworks cannot model the actual behaviour of organizational agents and less, capture their evolution.

The EM frameworks illustrated in table 1 are created as a means for systems design and implementation. Their purpose is to facilitate the elaboration of systems specifications. Consequently, they mostly focus on organizational processes, and thus, organizational behaviour and dynamics is represented only from an activity perspective. Agent dynamics is not captured. Moreover, since agent behaviour can only be inferred from their assigned roles and associated activities, they model generic, expected behaviour rather than the actual behaviour of specific individuals. Hence, these models do not allow to answer questions such as *how/when a specific individual performs a given task?, or which resources a given individual provide/consume?*.

Including a separate agent-centric perspective is necessary to provide an additional layer to represent behaviour both at role and individual levels. Time-related information is also necessary in order to capture individual and organizational evolution.

Two interdisciplinary EM frameworks overcome some of the previous limitations. The OperA+ framework for the specification of multi-agent systems (MAS) (Dignum, 2004), allows a two-layered approach that separates organizational and social structures, allowing to model both organizational behaviour, as well as the behaviour of given agent populations. The PCANS model of the CASOS group (Carley, 2007) defines four separate perspectives; (1) agent, (2) organization, (3) activities, and (4) resources. The PCANS meta-model models interactions within and between all these perspectives, answering some questions about individuals such as *who interacts with whom?, with which organization/activity/resource a given agent interacts with?*. Time is an explicit variable in all PCANS perspectives, allowing the answer to questions such as *when does an agent perform an activity?*, or *when does an agent use/provide a resource?*. It also allows capturing changes in individual agents and organizations.

Nonetheless, no single framework fully captures the complexity, dynamics and situatedness of human behaviour, leaving several questions to be answered such as *how does a given individual execute a given task?, how does an individual coordinate his own work? Or how does an agent manages his personal resources?*.

Finally, due to their emphasis in modelling expected rather than actual behaviour, these models disregard the problem of associating and aligning the daily actions of individuals with organizational activities and resources.

Conceptual Implications

Overcoming the limitations described in the previous section entails addressing the following issues:

- The addition of an agent-centric perspective: The theoretical background and empirical evidence gathered in this research suggest that adding an agent-centric perspective to EM frameworks enriches currently available representations and enhances the scope of EM. The agent perspective allows capturing behavior of specific agents, whether individual or collective, as well as the interaction patterns among them, regardless of the activity being performed.
- The inclusion of the notion of context: Current EM frameworks do not include the notion of context. However, contemporary paradigms acknowledge that both individual and organization behavior is context-dependent. Hence, this notion is essential in understanding, representing, and analyzing human behavior. The notion of context we propose in our work integrates ideas from cognitive and social sciences. Cognitive and social contexts focus on the interactions among entities rather than the entities themselves. Contexts are thus defined as the network of entities (agents, resources, and rules) that are relevant for an agent in a given situation, created and continually updated by the interactions among them. Drawing on the notion of social contexts, our also acknowledges the existence of hidden rules governing agent interactions that characterize specific interaction settings.
- Separation of design and execution concepts: Constructivism highlights that activity and resource names and models are abstractions, *i.e.* creations of our minds that allow us to understand study, discuss or analyze the operation of enterprises. This assumption suggests the need of having two separate modelling layers, one representing expected behavior (design layer) and the other representing actual or enacted behavior (execution layer). In our work, we accomplish such separation by defining a set of design-related concepts (activities and resources) and execution-related concepts (agents, actions, tools, information-related items, and contexts). Hence, every activity or resource model represents one of several viewpoints that specific agents (individual or collective) may have of a particular context of execution. Since activities are merely abstractions, single actions or single interactions with activities is not straightforward because it depends on how activities have been defined by particular agents. The inclusion of the concept of context aims at facilitating this association. Arguably, actions and activities are analogous

concepts and as such, both are abstractions. This issue is solved by associating actions with smaller semantic units more easily associated with daily work operations (activity "buy book" *vs* "print book information").

- Time as an explicit variable: several EM frameworks include time as an explicit variable to represent activity dynamics. In order to capture and represent agent dynamics, it is essential to include time-related concepts within the agent perspective.

Addressing Conceptual Implications

Figure 1 illustrates how we propose to address conceptual limitations 1, 2 and 3 (for details see (Zacarias *et al.*, 2009)). The agent perspective added acknowledges different organizational levels, distinguishing between individual and collective agents. Individual agents are member of collective agents that in turn are agents within broader organizational units. Secondly, it decouples the concepts of actions and interactions from activities. Since activities are merely abstractions, single actions or single interactions with activities is not straightforward because it depends on the activity definition. According to the proposed model, actions and interaction sequences create and update respectively, action and interaction contexts. Relating actions to activities entails analyzing the whole action sequence, and other characteristics of the corresponding contexts.

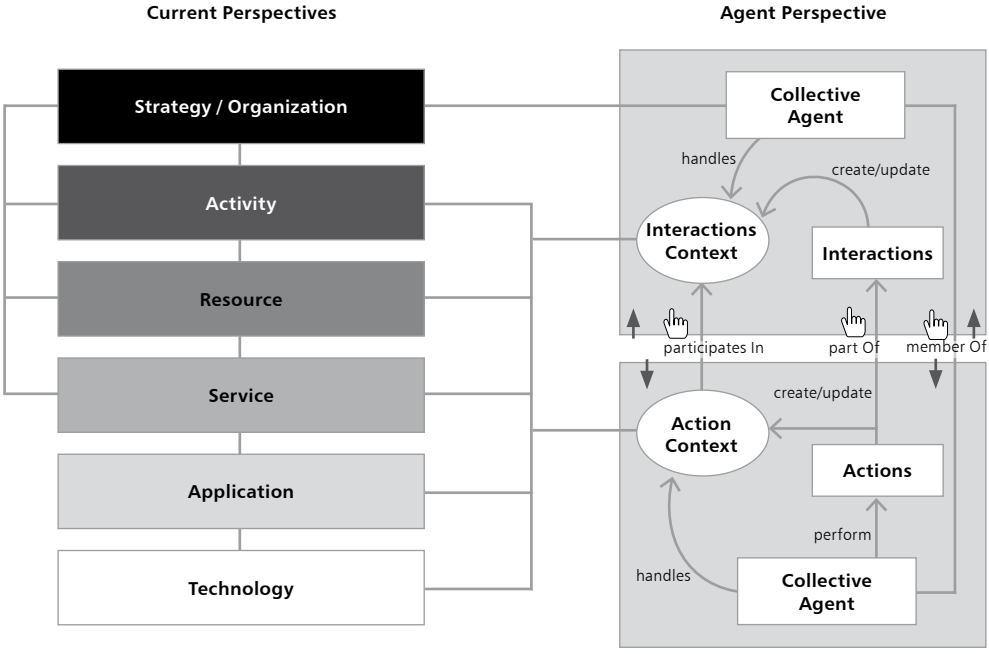

Figure 1 - Adding an agent perspective to current EM frameworks

Methodological Implications

Overcoming current EM limitations also entails addressing the following methodological issues:

- Capturing behavior from actual actions and interactions: In EM models are built using mostly techniques such as interviews, workshops, or questionnaires. However, complexity and constructivist ideas suggest that such approaches are limited since they only capture what subjects say and/or believe they do, rather what they actually do. These points to the need of building representations of human behavior from action repositories.
- Using Context as unit of analysis: The difficulty of universally associating actions with activities due to the context-dependent nature of human behavior suggests the usage context as unit of analysis rather than formally defined activities.
- Periodic Approach: Capturing agent and organizational evolution necessarily entails devising mechanisms to facilitate periodic data collection and analysis processes.

Addressing Methodological Implications

Figure 2 illustrates how we propose to address the previous methodological implications (see details in (Zacarias *et al.*, 2008)). A methodological approach to capture and depict model representations of agent behaviour at personal and inter-personal levels was developed as part of the framework. The method offers a bottom-up approach that captures individual and inter-personal behaviour of action and deliberation layers from action repositories, and makes an instrumental use of the notion of context. It encompasses six activities; (1) bootstrapping, (2) action capture, (3) context discovery, (4) context-based analysis and (5) context integration.

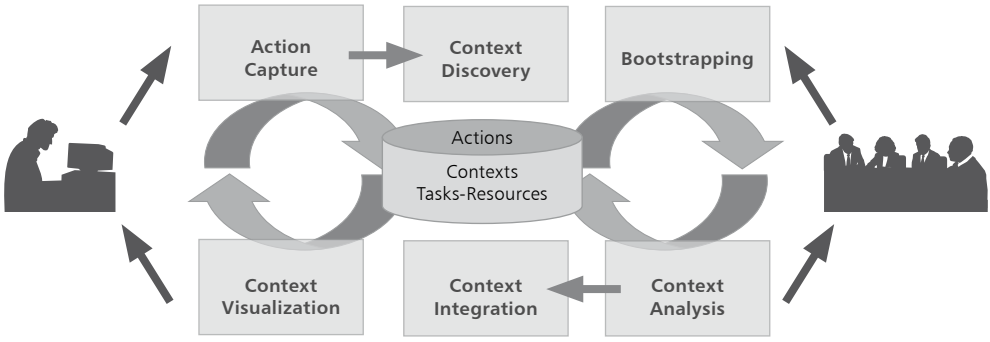

Figure 2 - Defining a bottom-up, context-based approach

In bootstrapping, the basic action types and resources to be registered are defined, and their meanings discussed. Ideally, action and resource definitions are registered. Action capture creates the action repositories. Actions are captured in natural language, using a structure <subject, verb, object>, where the subject represents the agent performing the action, the

verb represents the type of action performed, and the object the resources involved. Context discovery entails identifying, characterizing, and labelling contexts. Contexts are discovered by grouping action sequences involving the same agents, similar sets of tools, and information items, during specific time intervals. Once identified, contexts are characterized with the names of recurrent actions, tools, information items, participating agents, as well as time-related data.

Context visualization displays context main characteristics to their owners, for validation purposes. Action and patterns can then be found within particular contexts. In context-based analysis, contexts are used as units of analysis in representing individual and inter-personal patterns. Hence, such patterns are always associated to a given context. Context-based representations offer situated 'pictures' of the observed subjects and the interactions between them, and allow discussing which behaviour should be standardized or (re)designed. Context integration takes places when patterns are considered good practices, and they are standardized as formal organizational behaviour and consequently, update specific activity/ resource models.

Executing these activities creates three cycles. First, action capture, context discovery and visualization activities are performed by the observed subjects, and are repeated until they are satisfied with the contexts identified. The second cycle reflects the iterations involving observed agents and external observers. The bootstrapping activity produces an initial set of action and resource types, which can be extended throughout the process, according to the results of context analysis and integration activities. The third cycle is due to the evolution of agent behaviours, requiring new iterations of the whole process from time to time.

Using EM for Organizational-Self Awareness: Applications

Organizational self-awareness is exhibited through several capabilities. This section describes three different capabilities that that are provided by our approach and can be related to the notion organizational self-awareness (1) capturing and describing work practice, (2) capturing and measuring human multitasking at work and (2) assessing the alignment between organizational designs and actual work practices. Each capability (which have been validated in real organizational settings), illustrates a different usage scenario of our proposal.

Capturing and Modelling Work Practices

The importance of modelling work practice in developing information systems is acknowledged by (Sierhuis, 2002). Moreover, self-aware organizations know the actual work practices of its members. Current EM frameworks capture generic task, activity, and process model that define behaviour at a role level *i.e.* they only describe generic behaviour. Modelling work practices require the capability of answering the question; "How does Individual i perform Activity A? Which resource(s) use?". This compound question has been addressed by independent research in systems development and simulation, but not by EM frameworks.

Capturing and modelling work practices means building diagrams situated in particular contexts, reflecting the particular action types, action flows and resources employed by given individuals in performing given tasks. Since these resources can be human, diagrams reflecting inter-personal patterns must be built. This means the ability to answer questions such as (1) "Who (Individual i1) interact with who (Individual i2)?", and (2) "How does Individual i1 interact with Individual i2?" These questions must be addressed using a representation language and model acquisition approach better fitted for purposes of organization analysis.

Capturing and Modelling Multi-Tasking Behaviour at Work

Self-aware organizations should also be capable of measuring human multitasking at work. Several researchers have acknowledged the impact of human multitasking in individual productivity (Czerwinski, 2004; Wild, 2004). Multitasking behaviour does not reflect how work is accomplished. Rather, it reflects how agents manage themselves. It requires the capability to answer question such as "How does Individual I manage Resource R?", where Resource R is the individual him/herself. This behavioural concern has been addressed in research works of human-machine interaction, human resource management, cognitive sciences, but no EM framework has addressed it.

Our approach captures and models human multitasking using the notion of context to define work fragmentation, rather than tasks. Multitasking behaviour is modelled in terms of context interleaving, and context activation rules. Different tasks may require similar resources. Likewise, the same task may require different resources, at different stages. Since switching costs are caused by the need to 'pull' different set of physical and cognitive resources, and contexts reflect resource groupings, this criteria is more appropriate to measure work fragmentation than tasks.

Aligning Design with Execution

Self-awareness in organizations does not only entail answering questions about when and how its members execute or organize their work. It also entails assessing if actual behaviour responds to behaviour predefined in procedures or workflow models. The problem of aligning organization's design with actual execution using action logs has been acknowledged and addressed by the process mining research (van der Aalst, 2005). However, the focus of this field is restricted to the alignment of pre-defined application workflows, with workflows acquired from execution data collected from logs produced by workflow and enterprise applications. This work does not collect data from non-structured actions stored in message-based, groupware applications, where messages are not associated with tasks. It also disregards non-computer mediated actions and interactions, which require to be registered manually. Without unstructured, non-classified actions, it is not possible to get accurate definitions of actual organization workflows. The problem of alignment activity models with execution is completely disregarded by EM acquisition approaches, which depart from higher level of abstraction and collect data collection with manual techniques such as interviews or seminars rather than from action logs.

Conclusion

Organizational self-awareness is a pre-requisite for an effective action, decision-making and learning in organizations. Due to the dynamics of current environments, the development of this capacity entails a continuous communication effort among organizational agents. Current EM frameworks have proved to be effective communication means for system development ends. However, it is necessary to explore appropriate approaches in enhancing organizational self-awareness. This paper discusses the conceptual and methodological implications of extending EM for such purpose.

From a conceptual standpoint current EM frameworks need to be extended with agent-centric perspectives and concepts capable of capturing and representing specific human behaviour at personal, inter-personal, group and organizational levels. EM frameworks need also to be "context-aware" *i.e.* they need to include explicitly the notion of context in order to capture the particular situations in which the represented behaviour is displayed. Finally, it is important to acknowledge that activities and resources are abstractions, and as such they may have different meanings for different subjects making it necessary to separate such abstract descriptions from descriptions of concrete actions, tools and individuals in order to allow different representations (showing different viewpoints) of the same reality. The framework itself requires further development. More formal and detailed representations must be explored as an essential aspect of the automated support devised for our framework.

From a methodological standpoint it is essential develop ways of building representations from actual actions and interactions due to the limited introspective capabilities of human beings. In our work, we built representations from manually collected action logs. However, manual registers restrict the extension of case studies. In order enhance the volume of such logs it is necessary to draw on automatically collected logs. With the staggering amount of computer-mediated interactions, human interactions are increasingly leaving electronic "footprints". Developments in fields such as data mining (Witten and Frank, 2007) and semantic technologies (STC, 2007) are providing the analytical capabilities of discovering interaction patterns from both structured and non-structured information sources. The exploration of these technologies seems promising in providing automated support to methodologies aiming at enabling and/or enhancing organizational self-awareness.

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Innovation and regional development: Constructing regional advantage

Bjørn Asheim

Introduction

As a point of departure it is important that the contemporary phase of globalization, which can best be described as a globalizing knowledge economy, is recognized. The picture is not any longer only characterized by outsourcing/offshoring to developing economies such as China and India of labour intensive production of manufacturing goods and services but increasingly also by offshoring of R&D and innovation. Adding to this situation of an emerging global knowledge economy is investments in R&D organizations in Europe and North America by TNCs from India and China.

DG Research launched the idea of 'constructing regional advantage' (CRA) as the new way of taking on and combating these new challenges and problems, and presented perspectives of how innovation policies and strategies can resolve the tension between competition and cohesion (Asheim *et al.*, 2006). While building on the lessons from the dynamic principle of the theory of competitive advantage that competitive advantage can be influenced by innovation policies and supporting regulatory and institutional frameworks, the theory of constructed advantage recognizes the important interplay between industrial and institutional dynamics as well as calls for greater attention to multi-level governance. What is especially highlighted is the role of a proactive public-private partnership and impact of the public sector and public policy support by acknowledging to a greater extent the importance of institutional complementarities in knowledge economies. This approach represents an improved understanding of key regional development challenges as well as a better anticipation and response to the problems by addressing system failures of lack of connectivity in regional innovation systems.

Different paths to Constructing Regional Advantage thus, globalisation has to be at the core of understanding the dynamics of contemporary capitalism. Increasingly there is a strong agreement that innovation is the key factor in promoting competitiveness in a globalizing knowledge economy (Lundvall, 2008; Porter, 1990). Competition based on innovation implies choosing the high road strategy, which is the only sustainable alternative for developed, high-cost regional and national economies. For a long time such a strategy was thought of as being identical with promoting high-tech, R&D intensive industries in accordance with the linear view of innovation. More and more the recognition has evolved that a broader and more comprehensive view on innovation has to be applied to retain and develop competitiveness in the heterogeneity of Europe's regions. This implies that regional advantage has to be constructed more on the basis of the uniqueness of the capabilities of firms and regions than solely on the basis of R&D efforts (Asheim *et al.*, 2006; Malmberg and Maskell, 1999). This reflects recent research pointing to the complexity of modern products and their innovation processes (Lam, 2002), which requires a differentiated knowledge base perspective (*i.e.* distinguishing between analytical, synthetic and

symbolic knowledge) to be fully accommodated (Asheim and Gertler, 2005; Asheim, Coenen, Moodysson and Vang, 2007). Such a broad view on innovation is in line with the innovation system perspective of defining innovation as interactive learning.

According to the World Economic Forum Growth Competitiveness Report Finland, Sweden and Denmark have consistently the last five years been among the five highest ranking nations with Finland and Sweden most years among top three. This impressive performance of the Nordic countries is achieved with very different innovation policies and strategies. Finland has pursued a science-driven, high-tech oriented strategy focusing on radical product innovations, with especially good results in the ICT sector, and Sweden a technology-based strategy of process innovations and complex product improvements, with both countries ranking as the top two nations with respect to R&D investments (Sweden 4% and Finland 3.8%). Denmark has implemented a user-driven, market based strategy characterized by mostly non-R&D, incremental innovations heavy oriented towards consumer goods sectors (e.g. furniture), sometimes with a design orientation, but not as a general rule such as in 'made in Italy' products. These empirical facts and theoretical perspectives have a very important policy implication in that there is no 'one size fits all' policy formula, *i.e.* no optimal or best way with respect to innovation policy promoting competitiveness and innovation in various industries in different regions and nations in a globalizing knowledge economy (Tödtling and Trippl, 2005). Instead, innovation policies must be fine tuned to take into account actual differences in industrial structures and social and institutional environments.

As Finland has been one of the countries that most vigorously and with quite a lot of success has pursued a science based/push innovation policy, it is noticeable to see arguments for a more broad based innovation policy in the country's new innovation strategy which was presented in June 2008. It is argued that securing growth and competitiveness in a globalizing knowledge economy cannot any longer only be based on a sector and technology oriented strategy, but that a demand-based, user-driven innovation policy must be implemented alongside a supply-driven policy for R&D. For this to become publically and politically manifest it is also proposed to expand the Cabinet Committee on Economic Policy into a Cabinet Committee on Economic and Innovation Policy, and in a parallel move to rename, in terms of its tasks and composition, the Science and Technology Policy Council into a wider Research and Innovation Council (Ministry of Employment and the Economy, 2008). This reorientation towards a more broad based innovation policy is in line with the innovation system perspective of extending the definition of innovation from the traditional linear view of starting with science and ending up with new products to a view of innovation as interactive learning (Lundvall, 2008). This implies that all industries and sectors can be innovative, *i.e.* not only R&D intensive, high-tech firms and sectors but also medium- and low-tech firms. Innovation is not equal to but more than R&D intensity. This could, according to Lundvall and Borrás (2005), be referred to as a development from 'science' and 'technology' policies to 'innovation policy', which is illustrated by the new Finnish strategy.

This picture corresponds with the ideas of Lorenz and Lundvall (2006) about different but complementary 'modes of innovation'. One the one hand we can talk about a broad definition of the mode of innovation as D(oing), U(sing) and I(nteracting) relying on informal processes of learning and experience-based know-how. The DUI mode is a user (market or demand) driven model based more on competence building and organizational innovations and producing mostly incremental innovations. Such a mode is typically found in non-R&D

based economies (e.g. Denmark). On the other hand one finds a more narrow definition of the mode of innovation as S(cience), T(echnology) and I(nnovation) based on the use of codified scientific knowledge, which is a science push/supply driven high-tech strategy able to produce radical innovations (e.g. found in Finland and Sweden). These two modes of innovation will also be differently manifested with regard to regional innovation systems and clustering. Regional innovation systems can be defined in a narrow and broad way (Asheim and Gertler, 2005). A regional innovation system broadly defined includes the wider setting of organisations and institutions affecting and supporting learning and innovation in a region. This type of system is less systemic than the narrowly defined types of innovation systems. Firms mainly base their innovation activity on interactive, localised learning processes stimulated by geographical, social and cultural/institutional proximity, without much formal contact with knowledge creating organisations (*i.e.* R&D institutes and universities) (Asheim and Gertler, 2005). A narrow definition of innovation systems on the other hand primarily incorporates the R&D functions of universities, public and private research institutes and corporations, reflecting a top-down model of science and technology policies. The narrowly defined innovation system correspond to the STI mode of innovation mentioned above, while the more broadly defined system is more easily accommodated by the DUI mode (Lundvall, 1992).

This distinction is helpful in order to avoid a too one-sided focus on promoting science-based innovation of high-tech firms at the expense of the role of learning and experience-based, user-driven innovation. However, it also indicates limits of such innovation strategies in a longer term perspective and, thus, emphasizes the need for firms in traditional manufacturing sectors and services more generally to link up with sources of codified knowledge in distributed knowledge networks (Berg Jensen *et al.*, 2007).

An example of this could be SMEs which may have to supplement their informal knowledge, characterized by a high tacit component (*i.e.* the DUI mode), with competence arising from more systematic research and development (*i.e.* the STI mode) in order to avoid being locked-in a price squeezing, low road competition from low cost countries. Thus, in the long run, it will be problematic for most firms to rely exclusively on informal localised learning. They must also gain access to wider pools of both scientific and engineering knowledge on a national and global scale (Asheim *et al.*, 2003). However, the DUI-based type of innovations will remain the key to their competitive advantage, as strong tacit, context specific knowledge components, which is found in e.g. engineering knowledge dominating the DUI mode, is difficult to copy by other firms in different contexts, and, thus will be the basis for sustaining the firms' and regions' competitive advantage also in the long run (Porter, 1998).

New research confirms that combining the two modes of innovation seems to be most efficient with regard to improving economic performance and competitiveness, *i.e.* firms that have used the STI-mode intensively may benefit from paying more attention to the DUI-mode and vice versa (Berg Jensen *et al.*, 2007). The ability of firms to search and combine knowledge from different sources seems to be stronger associated with innovativeness than either interfacing predominantly with customers or suppliers applying a DUI mode of innovation, or with research system actors in STI oriented processes. (Laursen and Salter, 2006) Thus, on the firm level these two modes of innovation are coexisting, but they will be applied in different combinations depending on the dominating knowledge base(s) of the regional industry as well as the absorptive

capacity and cognitive distance between actors on the firm and system levels. The unanswered question is, however, how the capacity of combining the two modes of innovation can be further diffused to and implemented in less innovative firms as well as on the regional level.

Differentiated Knowledge Bases

As mentioned above, it is clear that knowledge creation and innovation processes have become increasingly complex, diverse and interdependent in recent years. There is a larger variety of knowledge sources and inputs to be used by organizations and firms, and there is more collaboration and division of labour among actors (individuals, companies, and other organizations). However, the binary argument of whether knowledge is codified or tacit can be criticized for a restrictively narrow understanding of knowledge, learning and innovation (Johnson *et al.*, 2002). Thus, a need to go beyond this simple dichotomy can be identified. One way of doing this is to study the basic types of knowledge used as input in knowledge creation and innovation processes. By way of suggesting an alternative conceptualization, a distinction can be made between 'synthetic', 'analytical', and 'symbolic' types of knowledge bases.

Following received wisdom from the philosophy of science, an epistemological distinction can be identified between two more or less independent and parallel forms of knowledge creation, 'natural science' and 'engineering science' (Laestadius, 2000). Johnson *et al.* (2002, p. 250) refer to the Aristotelian distinction between on the one hand 'epistèmè: knowledge that is universal and theoretical', and 'technè: knowledge that is instrumental, context specific and practice related'. The former corresponds with the rationale for 'analysis' referring to understanding and explaining features of the (natural) world (natural science/know-why), and the latter with 'synthesis' (or integrative knowledge creation) referring to designing or constructing something to attain functional goals (engineering science/know-how) (Simon, 1969). A main rationale of activities drawing on symbolic knowledge is creation of alternative realities and expression of cultural meaning by provoking reactions in the minds of consumers through transmission in an affecting sensuous medium (table 2):

Analytical (science based)	**Synthetic (engineering based)**	**Symbolic (arts based)**
Developing new knowledge about natural systems by applying scientific laws; *know why*	Applying or combining existing knowledge in new ways; *know how*	Creating meaning, desire, aesthetic qualities, affect, intangibles, symbols, images; *know who*
Scientific knowledge, models, deductive	Problem-solving, custom production, inductive	Creative process
Collaboration within and between research units	Interactive learning with customers and suppliers	Learning-by-doing, in studio, project teams
Strong codified knowledge content, highly abstract, universal	Partially codified knowledge, strong tacit component, more context-specific	Importance of interpretation, creativity, cultural knowledge, sign values; implies strong context specificity
Meaning relatively constant between places	Meaning varies substantially between places	Meaning highly variable between place, class and gender
Drug development	Mechanical engineering	Cultural production, design, brands

Table 2 - Differentiated knowledge bases. A typology
Source - Asheim and Gertler, 2005; Asheim *et al.*, 2007; Gertler, 2008

The distinction between these different knowledge bases takes specific account of the rationale of knowledge creation, the way knowledge is developed and used, the criteria for successful outcomes, and the strategies of turning knowledge into innovation to promote competitiveness, as well as the interplay between actors in the processes of creating, transmitting and absorbing knowledge. The knowledge bases contain different mixes of tacit and codified knowledge, codification possibilities and limits, qualifications and skills required by organizations and institutions involved as well as specific innovation challenges and pressures, which in turn help explaining their different sensitivity to geographical distance and, accordingly, the importance of spatial proximity for knowledge creation (Asheim *et al.*, 2009). Thus, the dominance of one mode arguably has different spatial implications for the knowledge interplay between actors than another mode of knowledge creation. Analytical knowledge creation tends to be less sensitive to distance-decay facilitating global knowledge networks as well as dense local collaboration. Synthetic and symbolic knowledge creation, on the other hand, has a tendency to be relatively more sensitive to proximity effects between the actors involved, thus favoring local collaboration (Moodysson *et al.*, 2008).

As this threefold distinction refers to ideal-types, most activities are in practice comprised of more than one knowledge base. The degree to which certain knowledge bases dominates, however, varies and is contingent on the characteristics of the firms and industries as well as between different type of activities (e.g. research and manufacturing). According to Laestadius (2007) this approach also makes it unnecessary to classify some types of knowledge as more advanced, complex, and sophisticated than other knowledge, or to consider science based (analytical) knowledge, characterizing the STI mode of innovation, as more important for innovation and competitiveness of firms, industries and regions than engineering based (synthetic) knowledge or artistic based (symbolic) knowledge, which is the dominating knowledge input in the DUI mode of innovation.

Regional Policy Challenges

Regional innovation systems have played and will continue to play a strategic role in promoting the innovativeness and competitiveness of regions. To achieve this, the RIS approach has to be strengthened by attention being directed towards the need – perceived by policy makers both at EU and regional levels – of *constructing* regional advantage. The 'innovation system' concept can, as already stated, be understood in both a narrow as well as a broad sense. A narrow definition of the innovation system is traditionally associated with *regionalised national innovation systems*, which constitute a supply (science push) driven model. A broader conception of the innovation systems incorporates the elements of a bottom-up, interactive innovation model which is referred to as *territorially embedded regional innovation systems* (or *learning regions*). This type basically represents a market-driven model, where demand factors determine the rate and direction of innovation. A combination of these two types of RIS is called *regionally networked innovation system* (Asheim and Isaksen, 2002). The networked system is commonly regarded as the ideal-type of RIS: a regional cluster of firms surrounded by a

regional supporting knowledge infrastructure. These systems have a more planned character than the territorially embedded systems involving public-private co-operation, and a stronger, more developed role for regionally based R&D institutes, vocational training organisations and other local organisations involved in firms' innovation processes.

There are different logics behind building regional innovation systems contingent on the knowledge base of the industry it addresses as well as on the regional knowledge infrastructure which is accessible. In a territorially embedded regional innovation system, the emphasis lies on the localised, path-dependent inter-firm learning processes often involving innovation based on synthetic knowledge. The role of the regional knowledge infrastructure is therefore mainly directed to industry-specific, hands-on services and concrete, short-term problem solving. In a regionalised national innovation system, R&D and scientific research take a much more prominent position. Innovation builds primarily on analytical knowledge. Linkages between existing local industry and the knowledge infrastructure are however weakly developed. Instead it holds the potential to promote new industries at the start of their industrial and technological life cycle. In this, the role of the regional(ized) knowledge infrastructure is a very central one as it provides the cornerstone for cluster development (through the precarious task of commercialising science) (Benneworth *et al.*, 2009). Similar to the regionalised national innovation system, in the regionally networked innovation system the knowledge infrastructure plays an indispensible role, however more territorially embedded. But in contrast to it, cluster development is not wholly science-driven but represents a combination of a science and market-driven model. In comparison to the territorially embedded regional innovation system, the networked RIS often involves more advanced technologies combining analytic and synthetic knowledge as well as having better developed and more systemic linkages between universities and local industry. While territorially embedded RIS are often found in mature industries and regionalised national innovation systems found in emergent industries, networked regional innovation systems can typically support various types of industries in different life cycle phases. Firms and knowledge infrastructure form a dynamic ensemble, combining ex-post support for incremental problem-solving and ex-ante support to counter technological and cognitive lock-ins. Table 3 shows combinations of different types of regional innovation systems and knowledge bases (Asheim, 2007).

Type of knowledge / Type of RIS	Analytical/scientific	Synthetic/engineering	Symbolic/creative
Embedded (grassroots RIS)		IDs in Emilia-Romagna (machinery)	'Advertising village' - Soho (London)
Networked (network RIS)	Regional clusters - regional university (wireless in Aalborg)	Regional clusters -regional technical university (mecanical in Baden-Württemberg)	Barcelona as the design city
Regionalised national (dirigiste RIS)	Science parks/ technopolis (biotech, IT)	Large industrial complex (Norwegian oil and gas related industry)	

Table 3 - Types of regional innovation systems and knowledge bases

Tödtling and Trippl (2005) have argued that the challenges and problems for knowledge creation and innovation differ considerably between regions with different RIS characteristics, e.g. institutionally thin, networked and fragmented regions. Policies for constructing regional advantage cannot be based on one 'best practice' model, as there is no 'one size fits all' strategy to cope with the variety of problems and challenges in European regions, and should, thus, reflect the different conditions and problems of the respective regions and their RIS. The design and success of such a policy differ between regions due to different knowledge bases, modes of governance and policy approaches taken, which can be described using their typology:

- Peripheral regions are characterised by being less innovative in comparison to more central and agglomerated regions; they have less R&D intensity and innovation, and have a less developed knowledge infrastructure (universities and R&D institutions) as well as suffer from organizational thinness;
- Old industrial regions represent another type of problem region characterised by negative lock-in due to a heavy dependence and specialisation on mature industrial sectors. If knowledge infrastructure exists, it is often also strongly specialized in training and research activities in support of the dominating industrial structure. The innovative activity of these regions is primarily concentrated on process innovations, and there is a lack of product innovations as well as entrepreneurship;
- Fragmented metropolitan regions. Metropolitan regions are normally regarded as centres of innovation with the presence of R&D organizations and universities, business services, as well as headquarters of international firms. As a consequence, R&D activities are usually above average. However, some metropolitan regions are lacking dynamic clusters of innovative firms due to the problem of fragmentation, *i.e.* the lack of innovative networks and interaction between universities-firms as well as among local companies. Such regions display an industrial structure characterised by so called 'unrelated variety', *i.e.* by having a diversity of sectors which do not complement each other, and, thus, do not produce knowledge spillovers. This may represent an important innovation barrier in such regions resulting in the development of new technologies and the formation of new firms often being below expectations.

Institutionally thin regions are often found in peripheral regions and lack a sufficient critical mass of clusters and knowledge organizations. For such types of RIS the DUI mode of innovation and external links and knowledge sources might be of key importance. In fragmented regions on the contrary we often find a high density of knowledge organizations and firms but which are characterized by weak connectivity between the elements of the RIS. Internally networked regions have well connected RIS, but either demonstrating negative lock-in (old industrialized regions) or positive lock-in. The latter is often secured by creating related variety in the local economy and by establishing non-local linkages to external knowledge sources avoiding cognitive lock-in through a 'local node of excellence in global networks' structure. Externally networked regions are characterized by having strongholds in one or two of the key actors in a RIS (a leading university or a strong industrial cluster or large industry), but need to be externally linked up either to international knowledge providers and sources or to competent industrial knowledge users through FDIs to compensate for the missing internal actor(s) in order to generate regional development. A critical challenge might here be the capability to absorb

and to integrate externally acquired knowledge by local firms as well as to embed TNCs in the region. Regional innovation policies need to take account of these differences in order to be effective. Often combinations of the above categories of regions will exist, e.g. that old industrial regions end up as peripheral regions and that fragmented metropolitan regions basically are old industrial regions. However, the point here is that these types of regions represent different problems and challenges, and, thus, require specific and individual approaches to innovation policies in order to correct problems and promote economic and social development.

Moreover, in order to further deepen the understanding of the role and workings of different types of regional innovation systems in a globalising economy the question of governance structures and supporting regulatory and institutional frameworks regionally as well as nationally has to be explored. Of special importance is the linkage between the larger institutional frameworks of the national innovation and business systems, and the character of regional innovation systems. In making these arguments about a general correspondence between the macro-institutional characteristics of the economy and the dominant form and character of its regional innovation systems a link is provided to the theoretical approaches of 'varieties of capitalism' and national business systems (Asheim and Gertler, 2005; Hall and Soskice, 2001; Lundvall and Maskell, 2000; Whitley, 1999).

Varieties of Capitalism

Hall and Soskice (2001) have convincingly demonstrated the importance of institutional complementarities between important institutional dimensions of a society such as financial regulation, corporate governance, innovation systems, labour market relations, and training/ education and employment on the one hand and the characteristics of the economy (*i.e.* dominant forms of innovation, industrial specializations, rate of growth etc.) and the social outcomes with respect to living standards and income inequalities on the other hand.

Soskice (1999) has argued that different national institutional frameworks support different forms of economic activity. Thus, while coordinated market economies have their competitive advantage based in diversified quality production, liberal market economies are most competitive in industries that are radically innovative. From a comparison of coordinated market economies (such as Sweden, Germany and Switzerland) and liberal economies (such as the US), Soskice suggested that the coordinated economies performed best in the production of "relatively complex products, involving complex production processes and after-sales service in well-established industries" (e.g. the machine tool industry). In contrast, liberal market economies performed best in industries producing complex systemic products, such as IT and defense technologies and advanced financial and producer services, where scientific knowledge is important (Soskice 1999, pp. 113-114). However, in the liberal market economies, such as that of the US, the low-end labour market, in low-tech, labour-intensive industries creates only unskilled, low-paid jobs, with workers suffering poverty, low living standards and alienation, a situation that has been recognized by both Porter (1990) and Lazonick (1994).

While coordinated market economies on the macro level support co-operative, long-

term and consensus-based relations between private as well as public actors, liberal market economies inhibit the development of these relations but instead offer the opportunity to quickly adjust formal structures to new requirements. Such institutional specificities both contribute to the formation of divergent national business systems, and constitute the context within which different organisational forms with different mechanisms for learning, knowledge accumulation and knowledge appropriation have evolved. Through its emphasis on institutional complementarities the 'varieties of capitalism' approach focuses on dynamic ensembles of mutually reinforcing sets of institutions rather than isolating individual forms and their impact. As such it pieces together consistent configurations of institutions and the implications for innovative performance (see table 4).

Varieties of Capitalism	Liberal market economies	Coordinated market economies
Financial regulation	Short-term financial market, equity financing	Long-term patient capital debt financing
Corporate governance	Shareholder value, limited business coordination: antitrust laws	Stakeholder value, strong business associations, intercorporate networks
Innovative Systems	Radical innovation, involving sharp breaks with extant processes	Incremental innovation involving continuos process development
Capital-labor relation	Decentralized bargaining, contentious workplace relations	Coordinated barganing statutory worker representation
Training and employment	Basic education and firm specific training, short tenure, high turnover jobs, high interfirm labor mobility	Vocational training, long tenure, low trnover jobs, low interfirm labor mobility

Table 4 - A summary presentation of varieties of capitalism

The institutional competitive advantage of coordinated market economies appears to be based in the constant upgrading of existing industries and technological trajectories (based on competence building). This upgrading is the product of interactive innovation that involves long-term cooperation – between workers and firms, between firms and between firms and the knowledge infrastructure – to promote interactive learning.

Types of Work Organization and Organizational Learning

The strategic role played by cooperation in coordinated market economies is underlined by the understanding of interactive learning as a fundamental aspect of the process of innovation (Lundvall, 1992). This broader understanding of innovation as a social, non-linear and interactive learning process puts new emphasis on the role played by socio-cultural and institutional structures in regional development. They are no longer vestigial remnants of pre-capitalist civil societies. They are necessary prerequisites for firms and regions to be innovative and competitive in a post-Fordist learning economy (Asheim, 2000). According to Lundvall 'what is at stake

is the capacity of people, organizations, networks and regions to learn' (Lundvall, 2004, 1). Furthermore, he emphasizes 'the enormous untapped growth potential that could be mobilized' in traditional sectors of the economy, if the necessary 'institutional reforms and organizational change that promote learning processes' were implemented (Lundvall, 2004, 1). This implies among other things that the introduction of new technology must be accompanied by (internal) organisational changes and competence building among the employees to achieve the expected productivity gains.

If these observations are correct, the implication is that new 'forces' are now shaping technological development in the coordinated capitalist market economies, modifying the nature and importance of competition between firms. Obviously, the contradictions inherent in the capitalist mode of production persist. But, as Lazonick (1993) has argued, "domestic cooperation rather than domestic competition is the key determinant of global competitive advantage. For a domestic industry to attain and sustain global competitive advantage requires continuous innovation, which in turn requires domestic cooperation" (p. 4). Cooke (1994) supports this view, emphasising that, "the co-operative approach is not infrequently the only solution to intractable problems posed by globalization, lean production or flexibilisation" (p. 32).

Important in this context is the fact that the traditional view of learning as only incremental (or reproductive/adaptive) is challenged. Ellström (1997) emphasizes that learning is not only reproductive or adaptive (resulting in imitation) but that it also can be developmental and creative. Ellström uses these categories to make a distinction between developmental learning which he sees as the 'logic' of knowledge exploration on the one hand, and reproductive or adaptive learning which represents the 'logic' of knowledge exploration in his view. The research by Lorenz on the relationship between forms of work organisation in EU and the impact on job stress, worker satisfaction, labour market flexibility, learning, innovation and patenting shows that not only does the learning form of work organization result in less job stress and greater worker satisfaction, it also implies more labour market flexibility, superior conditions for learning and innovation, and even a larger propensity for patenting (Lorenz and Valeyre, 2006). Thus, this confirms that learning also can be developmental and creative due to the high degree of work autonomy and learning dynamics found in learning forms of work organisation.

This micro level explanation focuses on the forms of work organization which dominate the respective economies. Lorenz in a study based on the third European survey on working conditions carried out by the European Foundation for the Improvement of Living and Working Conditions, identifies four main forms of work organisation across European nations (or EU to be precise): 'learning', 'lean', 'Taylorist' and 'simple structure'. The learning forms dominates in Scandinavia and the Netherlands (Norway is not part of this study being outside EU, but a separate study shows that this work organization also is the dominating in Norway), and is found least frequent in Southern European countries and Ireland; the lean forms are primarily found in the UK, Ireland, Spain and France, and are least dominating in the Netherlands, Denmark, Sweden, Germany and Austria; the Taylorist one in Southern Europe and Ireland, and not in the Netherlands, Denmark and Sweden; while the Simple one dominates in the Southern countries of Europe and is most seldom found in the Netherlands, Denmark, Finland and the UK. This study, thus, demonstrates a clear north-south dimension with regard to the dominating forms of work organization, with the Northern European countries dominated by learning forms of work organization, while Southern

European countries have a production organization characterized by either Taylorist or Simple forms of work organization. Among the Nordic countries, in Denmark, Norway and Sweden the production organization is dominated by learning forms of work organization, while Finland is just below and is found in the lean category.

The positive impact of this form of work organization on innovation is also confirmed by a study by Michie and Sheehan (2003) who reports that "'low road' practices – the use of short-term and temporary contracts, a lack of employer commitment to job security, low levels of training, and so on – are negatively correlated with innovation. In contrast, it is found that 'high road' work practices – 'high commitment' organisations or 'transformed' workplaces – are positively correlated with innovation" (Michie and Sheehan, 2003, p. 138).

How to Combine the DUI and STI Modes of Innovation

As was mentioned in section 2 combining the two modes of innovation seems to be the most efficient strategy for firms and regions to improve their innovativeness and economic performance. Firms that have used the STI mode intensively may benefit from paying more attention to the DUI mode and vice versa (Lorenz and Lundvall, 2006; Berg Jensen *et al.*, 2007). In this way, on the firm levels these two modes of innovation can (and should) co-exist, but they will be applied in different combinations depending on the dominating knowledge base(s) of the regional industry.

Here the perspective of cognitive distance becomes crucial (Nooteboom, 2000). If the cognitive distance between the two modes of innovation is perceived by key actors to be too wide, then it will not be possible to combine them. They will be seen as incompatible alternatives rather than complementary modes. There will be a lack of absorptive capacity within firms and regions to acknowledge and appreciate the potential gains of the other mode of innovation as well as to access and acquire the necessary competence for combining them. There are, however, two key 'bridging mechanisms' which could assist in achieving an optimal cognitive distance as a necessary condition for combining the two modes. The first of these deals with understanding that the STI mode is not only limited to an analytical knowledge base, but also includes synthetic and symbolic knowledge bases. In the case of the synthetic knowledge base this can be illustrated by reference to applied research undertaken at (technical) universities, which clearly must be part of the STI mode, but operates on the basis of synthetic (engineering) knowledge (drawing on basic research at science departments of universities creating new analytical knowledge), while the case of symbolic knowledge can partly be substantiated by the new tendency of changing design education from being artisan based to be placed at universities with research based teaching, and partly by the steadily increasing research in game software and new media, which in some countries is located at new, specialized universities. This broadening of what constitute the STI mode of innovation shows that also activities based on synthetic and symbolic knowledge bases needs to undertake new knowledge creation and innovation in accordance with an STI mode, and, thus, needs systemic relations with universities or other types of R&D institutes (e.g. in a regional innovation system context). The other

bridging mechanism is the recognition that partly learning is not only reproductive but can also be developmental, and partly the innovative potential that a learning work organization can display in being the operative context for such learning. Even the most science based company will obviously benefit from organizing its work in such a way that learning dynamics is created by giving their employees autonomy in their work. This has to build on the principles of broad participation of functional, flexible workers in accordance with the Nordic model of a learning work organization (Ennals and Gustavsen, 1999).

In order to illustrate the importance of these bridging devices even further we shall give a concrete example taken from a large, international company that is world leading within its area. This is an engineering company whose products are based on a synthetic knowledge base with all the typical characteristics of this knowledge base: problem-solving and custom production based on interactive learning with customers and suppliers. Knowledge is partly codified with a strong tacit component, and is clearly context-specific. Core competence of the company is to comprehend the complex construction process of the equipment in a holistic way. The point is not to understand the individual 'machines' being needed, but to understand the individual machines as part of a system. This is a very complicated process with more than 1000 different steps, which clearly underlines the problem-solving and custom oriented production of a typical synthetic, engineering based company. This is a good example of the importance of tacit, context (*i.e.* product)-specific knowledge as one of the most important sources for sustaining the firm's competitive advantage.

When asked about how they organized their innovation activity the R&D director of the company made an important distinction between *application* development and *technology* development. Application development means solving concrete problems in connection with building the specific equipment for customers. This is carried out drawing on internal engineering competence as well as in interaction with suppliers and customers, and is, thus, an example of the DUI mode of (incremental) innovation. In addition professional R&D firms (consultancy firms) domestically and abroad are used. Technology development means development of more general platform technologies, which represents the technological basic competence for carrying out application development. While the application development is only made in-house or in user-producer relationships, technological development takes place in cooperation with (technical) universities as applied research projects, and represents, thus, the STI mode of innovation but still based on synthetic knowledge. In cooperation with universities on applied research projects geographical proximity matters most, and instead of always accessing the best competence globally found at places such as MIT, the company chooses to focus on the geographically closest available competence. Thus, they prioritize building up research cooperation with the regional university (*i.e.* University of Agder, Grimstad campus) by among other things employing some professors in 20% positions in the company as a way of strengthening the competence at the university to be applied in collaborative research projects. In addition they take a central part in funding and using a regional, applied research organization (Teknova). The company called this form of carrying out applied research 'cooperation at the operational level', which, according to the company, is the right level of research collaboration for technological development. To achieve this, geographical proximity is of great importance. In addition the company cooperates with national (Norwegian Technical University in Trondheim) and international top universities

(e.g. Carnigie Mellon University, Pittsburg and Denmark's Technical University, Copenhagen) in research projects on technological development, which always involve company funded PhD's to secure a more long-term 'payback' for the company. In order to strengthen the relationship to the company they also make sure that one of the supervisors is coming from the company, which provides organizational as well as institutional proximity (Boschma, 2005).

This example illustrates how such a bridging mechanism can work to solve the problem of a too wide cognitive distance, and, thus, achieve a combination of the two modes of innovation. Furthermore, the example illustrates how 'second best' regional universities can be used and upgraded by large companies to become active partners in collaborative R&D projects in addition to the companies also using non-local, more internationally leading universities.

Conclusion

What kind of regional policy should be implemented to construct regional advantage? Research carried out in the SMEPOL project - SME policy and the regional dimension of innovation (Asheim *et al.* 2003) - demonstrated the need for a more system-oriented as well as a more pro-active innovation based regional policy. In the project, SME innovation policy tools were classified in two dimensions, resulting in a four quadrants table (Figure 3). The figure distinguishes between two main aims of the support tools. Some tools aim at giving firms access to resources that they lack to carry out innovation projects, *i.e.* to increase the innovation capacity of firms by making the necessary resource inputs available, such as financial support for product development, help to contact relevant knowledge organisations or assistance in solving specific technological problems, where the absorptive capacity of the firm is critical. The other type of instruments have a larger focus on learning, trying to change behavioural aspects, such as the innovation strategy, management, mentality or the level of awareness in firms, where the skill levels of the workforce are a major determining factor of the outcome (e.g. in the context of learning work organisations).

	Support: Financial and technical	**Behavioural change: Learning to innovate**
Firm-focused	Financial support Brokers	Mobility schemes Learning work organizations
System-focused	Technology Centres	Regional Innovation Systems

Figure 3 - Regional innovation policy: A typology (Asheim *et al.*, 2003)

An appropriate way to design and implement an instrument aimed at assigning lacking resources to firms (following an evolutionary approach to policy) is, thus, to do it according to a learning-to-innovate framework. In line with this perspective the objective of policy instruments

is not solely to provide scarce resources (such as financial assistance) to innovating firms per se but also to promote learning about R&D and innovation and the acquisition of new routines within firms, where highly skilled people and adequate skill provision in the regions are critical resources in order to increase the absorptive capacity. Lack of demand is often a bottleneck for financial incentives to innovation activity, *i.e.* that firms initially do not see the need to innovate, or alternatively, that firms do not have the capability to articulate their need for innovation. Some policy instruments should, therefore, also attempt to enhance demand for initial innovation activity of firms (*i.e.* apply a learning perspective), and, thus, must include an explicit behavioural aspect with an ultimate policy target of promoting the innovation activity of enterprises.

The other dimension includes the target group of instruments. Some tools focus on innovation and learning within firms, to lower the innovation barriers of firms, such as lack of capital or technological competence. Other instruments to a larger extent have regional production and innovation systems as their target group, aiming at achieving externalities or synergies from complementarities within the regions. The barriers may for example be lack of user-producer interaction or lack of relevant competence in the regional knowledge organisations to support innovation projects.

Instead of market failure, the rationale for policy intervention is to address system failures by reducing the interaction or connectivity deficits which lies at the core of the regional innovation systems approach (Cooke, 2004). This will require a platform-oriented regional policy as well as a new focus on learning aiming for behavioural value-added (*i.e.* learning firms to innovate) (Asheim *et al.*, 2003; Asheim *et al.*, 2006). The platform approach to regional innovation policy as a generic approach is not only applicable for high-tech industries, but can also be applied for industries drawing on different knowledge bases traditionally associated with medium and low-tech, manufacturing as well as service industries. One example of this could be using a platform strategy to upgrade tourism combining natural scenery with gastronomy, cultural events and historical heritage. In this way it represents a strategy for securing employment in a range of manufacturing industries and services with highly differentiated educational and skills requirements and gender profiles, and, thus, can provide the structural prerequisites for reducing social inequality and promoting regional cohesion in addition to regional competitiveness.

As a result of the growing complexity and diversity of knowledge creation and innovation processes, firms need to acquire new external knowledge to supplement their internal, core knowledge base(s). This implies that a shift is taking place from firms' internal knowledge base(s) to trans-sectoral and trans-local distributed knowledge networks (Smith, 2000). Such knowledge flows can take place between industries with different degrees of R&D intensity and different knowledge base characteristics. An example of this is when food and beverages firms (predominantly drawing on a synthetic knowledge base with a very low R&D intensity) produce functional food based on inputs from biotech firms (high tech firms predominantly drawing on an analytical knowledge base). This shows that distributed knowledge networks often transcend industries, sectors and the common taxonomies of high or low tech. This example provides a good illustration of how knowledge spillovers happen in distributed knowledge networks between firms with complementary knowledge bases and competences (*i.e.* related variety). It also demonstrates that major innovations are more likely to occur when knowledge spills over between related industries. This is especially facilitated where the knowledge spillover takes place

between industries involving generic technologies (such as IT, biotech and nanotech) (Frenken *et al.*, 2007). This emphasizes the potential importance of related variety within and between traditional sectors, combining the strength of the specialization of localization economies and the diversity of urbanization economies. Not the least for disadvantaged regions in developed economies the possibilities of upgrading and restructuring an old industrial structure by relating traditional manufacturing industries in food and metal working to emerging biotech based industries internally or externally to the region (green and white biotech) could represent a shortcut for firms and regions to becoming innovative and competitive.

The possibility of designing 'one-size-fits-all' regional policies is no longer valid. Copying of best practices is almost impossible when it comes to intangible regional assets that are the results of long histories in particular regional contexts. Therefore, platform policies have to be inspired by endogenous capabilities and capacities, as embodied in related variety (Asheim *et al.*, 2006). However, pursuing such region-specific policy is not to say that regional policy should rely on the region itself. Network linkages in general and non-local linkages in particular, are often found crucial for learning and innovation, in order to avoid cognitive lock-in. For firms, being connected may be as important, or even more so, than simply being co-located (Giuliani and Bell, 2005). This has further implications for regional innovation policies of constructing regional advantage.

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Cities as self-organizing innovative complexes

Peter Nijkamp

Cities: Proximity Matters

Cities are the seedbeds for creativeness, innovation and spatial competitiveness. They are characterized by product heterogeneity and behave according to the laws of monopolistic competition in economics (see Frenken *et al.* 2007). Modern cities try to offer the highest possible quality or image in terms of culture, arts, sports, innovativeness, entrepreneurship, financial markets, sustainability etc. Density and proximity are the key features of modern cities (or, in general, urban areas). The past centuries have been characterized by a structural trend towards urbanization. Some 200 years ago less than 20 percent of the world population lived in cities, whereas nowadays the urbanization degree is moving towards 80 percent. Not only has the number of cities increased rapidly, but also the size of cities. Our world gets more and bigger cities, with a tendency towards megacities which are large urban conglomerates with a global power and a high degree of local /regional economy (Sassen, 1991). Some people wonder whether this trend towards 'more and bigger' might come to a halt. However, from an economic perspective there is no valid argument that would convincingly demonstrate that there is a 'natural limit' to city size. It is plausible to argue that cities will continue to gain importance – in size and numbers – as long as the agglomeration benefits supersede the shadow sides of agglomerations.

When Barbara Ward (1976) held a passionate plea for a positive view on modern cities as 'the home of man', she meant to say that cities are the natural habitat for the human species in the post-industrial period, provided cities would offer favourable living and working conditions as a result of density externalities. Nevertheless, the phenomenon of modern large cities has sometimes prompted contrasting viewpoints and arguments. A clear illustration can be found in the following two quotations which convincingly exemplify diverging perspectives on the urban way of life (see O'Sullivan, 2000):

"Cities have always been the fireplace of civilization, where light and heat radiated out into the dark" (Theodore Parker).

"I'd rather wake up in the middle of nowhere than in any city on earth"(Steve McQueen).

The empirical fact that the majority of the world population is living in cities does not prove that cities are the human settlements par excellence. There are simply too many negative voices on the functioning and the future of our cities. And Glaeser (1998) has in an interesting survey article correctly questioned whether cities might be dying. His analysis shows a straightforward result: cities are able to generate unprecedented economies of scale, and as long as agglomeration advantages are higher than their counterparts, cities will continue to be magnets of human activity.

Clearly, the demarcation of different city concepts in various parts of our world may be problematic, and there may be significant differences between megacities, megalopolises, urban areas, urbanized areas, edge cities, metropolitan areas and the like. Most likely, it is not the statistical definition which tells us the full story, but the question how much citizens in a certain settlement configuration share an urban way of life. In other words, adherence to a certain life style (creativity, individuality, mobility, global orientation etc.) belongs to the human ecology of an urbanized world.

It goes without saying, that any urban way of life has to be supported by a proper set of values, cultural behaviours and infrastructures which act as determinants of an urban culture, not only for the residents of the city but also for business life. A city forms a complex ramification of many socio-economic forces that shape a seedbed for creative and innovative lifestyles. The relationship between business life and the city is often underrepresented in urban economics, but deserves full-scale attention. The growth and decline of business firms is critically contingent on urban seedbed and incubator conditions, knowledge production and adoption, creativeness and business potential, and adoption of a modern business lifestyle and culture in a digital economy (see also Acs, 2002; Bögenhold *et al.*, 2001; Romein and Albu, 2002; Sexton and Smilor, 1986).

In recent years, the ICT sector is often seen as a major initiator of new activities. We have witnessed an upsurge of entrepreneurial initiatives closely connected with the rapid growth of the ICT sector (see, e.g., Cairncross, 1997; Cooke and Wills, 1999; Ohmae, 1999). In the industrial organization and management literature, much attention has been given to participation in, and access to, formal and informal networks as strategic mechanisms for creating increasing returns in an uncertain dynamic urban business environment (see, e.g., Borgatti and Foster, 2003; Hoang and Antoncic, 2002; Malecki, 1997; Schiller, 1990). It is generally recognized that modern dynamic sectors of the economy, in particular the ICT sector, have the potential to generate high returns, though often in a risky business environment. Access to knowledge and information is usually seen as a key factor for success in a risky entrepreneurial context. Clearly, an urban environment offers often a reduction in business risks through a dense (formal and informal) information network.

It is now an important question whether, in our age of advanced telecommunication, contact intensity and business access is best served through physical proximity of people and firms, or whether modern ICT systems create virtual connectivity without the need for geographic proximity. There have been many speculations on the death of distance and on the space-opening character of the advanced ICT sector (for a review, see e.g. Cohen *et al.*, 2004; Van Geenhuizen and Nijkamp, 2007). But what are the empirical facts concerning the needs of business firms for geographic juxtaposition in the urban economy? And what are the costs of ICT-instigated urban sprawl (Travisi and Camagni 2005)? Does ICT favour footloose behaviour of firms, or will it reinforce urban agglomeration forces? How does urban infrastructure contribute to a better access or proximity? And what is the role of knowledge networks in proximity?

'Proximity' is a frequently used concept in geography, but it has different connotations. First, there is physical proximity in terms of a short straight-line distance or a short distance based on using a transport network. In fact, what matters in interaction is the time or efficiency in bridging such a distance. Geographic proximity is either a physical or a time concept, or both. However, in a social space there is also social proximity, *i.e.*, a perceived small distance as a result of impacts from social relationships, common habits and interests etc. (see, e.g., Gertler, 2003).

Clearly, both concepts may be intertwined in an urban area.

Cities can be seen as agglomerations of economic activities based on advantages of both kinds of proximity. In conclusion, the urban mode of living and working calls for an explanatory framework that is able to encapsulate the motives and behaviours of their citizens and firms. However, a single paradigm that would allow us to understand the complexity of urban life from an unambiguous perspective does not exist. The relationship between complex urban growth and urban infrastructure is also at stake here. Instead, as we will argue in the next section, there are rivalry paradigms that all aim to uncover (part of) the multi-faceted and complex urban reality, where cities exert both centripetal and centrifugal forces.

Cities as Magnets: Different Perspectives and a Systems Economics View

Cities are complex socio-economic systems that have been studied in the literature from various angles. We will offer here a concise overview.

Urban Systems Economics

In a modern and global network society cities have adopted the role of strategic hubs. The changing role of cities has also prompted various new concepts, such as 'global cities' (Sassen, 1991), 'global city-regions' (Scott *et al.*, 2001)) and 'world city networks' (Taylor, 2004). Many cities have witnessed an upsurge of vitality and innovativeness, whereas others have shown signs of decline or stagnation. Despite serious doubts expressed by scholars all over the world on the feasibility of an urban world, cities and their surroundings have become magnets of innovation, creativity, leadership and business activity. There is a great variety of analysis frameworks that have aimed to offer a motivation for the emergence of urban culture and urban agglomeration forces. We mention a few:

- A *market-oriented view*, in which the urban rent gradient is the spatial-economic representation of the supply and demand for urban land by different categories of users, while taking into consideration density externalities (advocated inter alia by classical authors like Alonso, Muth, Henderson etc.)
- An *ecological socio-cultural view*, in which a blend of sociological and organistic urban viewpoints is offered to explain the structure of urban living and working patterns (advocated in particular by the so-called Chicago School).
- A *clustering and industrial networks view*, in which urban dynamics is analysed from the perspective of a multiplicity of conflicting interests of urban stakeholders (outlined by advocates of the so-called Los Angeles School, such as Scott and Storper).
- A *politico-economic power view* on cities, in which in a globalizing world large cities act as global command centres with centripetal and centrifugal forces all over the world (advocated inter alia by Sassen).
- An *agglomeration advantage view*, in which urban agglomerations generate overwhelming

advantages of scale and scope, so that cities become by necessity strong players in the space-economy (advocated inter alia by Glaeser).
- A *creativity view* on urban life, in which cities are the source of rejuvenation, innovation, radical breakthroughs and permanent change, as a result of the leading role of the creative class (see e.g. Florida).
- A *virtual cities perspective*, in which in an emerging digital e-society cities act as key nodes in a virtual network and exploit all agglomeration benefits of their territory in a world-wide arena (advocated inter alia by Graham and Marvin).

This eclectic overview of various strands of literature is by no means complete and offers a varied and fragmented impression. And there is undoubtedly a clear need and scope for a more integrative perspective based on a systemic view on the city. Clearly, urban economics has become in the past decades a respected discipline with a rigorous analytical toolbox. But its weakness is its stylized focus and narrow focus coverage which reduces its operational meaning and its policy relevance. Taking the economics discipline as a nucleus surrounded by various other disciplines functioning as satellites, we may be able to create a theoretically sound and methodologically consistent analysis framework which might be coined a systems economics approach. Similar developments are nowadays found in systems biology, cognitive sciences and bio-physics. Systems economics would be characterized by various features:

- it offers a multi-disciplinary focus;
- it is multi-actor oriented with emphasis on interactions;
- it covers economic systems from micro- to macro-analytical perspectives in a multi-layer way;
- it is essentially dynamic and based on evolutionary complexity;
- it is analytical-quantitative in nature in order to map out key drivers and their impacts on complex systems.

Such an approach might have great merits for the analysis of cities as complex systems. Urban systems are – from the viewpoint of systems economics – characterized by three particular and distinct features, viz. the existence of density externalities, the dependence on its (physical and cultural) resource base, and the importance of interactive dynamics accruing from learning (including evolutionary and creativity) principles. These three features will now concisely be presented and discussed.

Density Externalities

In the history of urban economics much attention has been paid to density and proximity externalities (Hoover, Isard), where often a distinction was made between scale, localization and urbanization economies. The density externalities perspective takes for granted that urban size has no limits, as long as the economies of density overshadow the diseconomies. According to the density externalities framework, cities offer prominent socio-economic and cultural advantages that are far higher than any other settlement pattern. In particular, in our modern age cities offer spatial advantages related to knowledge spillover effects and an abundant availability of knowledge workers in the labour market (Acs *et al.*, 2002). Spatial concentration of activities, involving spatial and social proximity, increases the opportunities for interaction

and knowledge transfer, and the resulting spillover effects reduce the cost of obtaining and processing knowledge. In addition, knowledge workers preferably interact with each other in agglomerated environments to reduce interaction costs, and they are more productive in such environments (Florida, 2002). Following this argumentation, cities are the cradle of new and innovative industries. Companies in the early stages of the product and company life cycle - when dealing with manifold uncertainty - prefer locations where new and specialized knowledge is abundantly available for free (see e.g. Audretsch, 1998; Camagni, 1991; Cohen and Paul, 2005). Cities offer an enormously rich potential for a wide array of business opportunities.

Clearly, the spatial extent of knowledge spillovers is limited due to various kinds of geographic impediments, e.g., a wide daily activity system where people can meet easily and where people change jobs in the course of their careers, or smaller areas such as quarters in a central business district or university premises where people see each other often by chance (e.g. Rosenthal and Strange, 2001). The need for spatial proximity to benefit from knowledge spillovers seems, however, at odds with the impacts of the recent telecommunication revolution, *i.e.* the costs of electronic communication have drastically declined, while advanced ICT allows for long-distance videoconferencing, data-mining, virtual design, computer-assisted decision making, etc. ICT offers an unlimited spectrum of virtual communication opportunities. But does it affect urban size?

To understand this paradoxical situation on the geography of knowledge spillovers we need to look into the type of knowledge concerned (Howells, 2002). On the one hand, there is codified knowledge (partly just information) that can easily circulate electronically over large distances, e.g. prices determined at a stock exchange and statistical data. On the other hand, there is tacit knowledge and its context, and these are critical in innovation processes. The knowledge concerned is vague and difficult to codify and, accordingly, spreads mainly through face-to-face contacts of the persons involved. Tacit knowledge is transferred through observation, interactive participation and practice. Furthermore, there is contextual knowledge, which is achieved through long-term and interactive learning, often in relatively open (unstructured) processes (Bolisani and Scarso, 2000). All such density externalities present in a modern city offer a very powerful tool for cities to survive and to grow and to become hubs in a space-economy.

Resource Base

Cities are strongly dependent on their resource base. In the past, it was mainly the physical geography that determined the location of cities (riverbanks, seashores, strategic areas in a country, presence of natural resources such as coal or water). In the past decades, industries have become much more footloose, and consequently the meaning of the physical resource base for cities has declined. But in the meantime, cultural and knowledge resources have assumed a more prominent position.

According to the modern resource-based perspective, the local capabilities and urban seedbeds are decisive for the relatively strong position of cities, especially from a business perspective. In the view of resource-dependence theories, it are particularly young and innovative entrepreneurs who have articulated needs for new knowledge, *i.e.* knowledge about the technology concerned and knowledge to deal with the market, but they cannot generate this knowledge by themselves

(see e.g., Lockett and Thompson, 2001; Reid and Garnsey, 1998). In this context, Storper and Venables (2002) distinguish between various functions of tacit knowledge transferred in cities, e.g. for coordination, confirmation and checking, and for monitoring. In modern versions of resource- dependence theory it is taken for granted that companies make use of various bundles of resources on a temporary basis, including knowledge, capital, employees and networks, to generate profits. Success in generating profits depends both on their own capabilities and the supply of resources in their environment (e.g., Barney, 1991). The growth of companies is constrained if there is a shortage or weakness in the available resources, or in the capability to mobilize or generate adequate resources. Reid and Garnsey (1998) distinguish between different stages in growth, ranging from achieving access to resources to the mobilization of resources, and companies' own generation of resources. The use of the right combination of resources at the right time by young, innovative entrepreneurs enables them to undertake a jump in growth. Failing to use the right combination at the right time may cause a delay in growth and even a fall back into previous stages (Vohora *et al.*, 2003). In the early growth stages and after a fall back to such stages, companies may rely heavily on resources available in the environment, including the urban environment and its constituent infrastructure and suprastructure.

The resource-based theory prompts of course intriguing questions on footlooseness of firms. There is not much conceptualization of the situation in which companies are free from location constraints. The term 'footlooseness' is often used in this context, but it is poorly conceptualized with regard to companies. An early use of the term 'footloose' can be found in the work of Klaassen (1967). Accordingly, an industry is footloose, if its long-run profitability is the same for any location in an economy. However, this is quite a rigorous definition that excludes different degrees of footlooseness. Here, we may consider footloose as the situation at one end of a spectrum, with location- or place-bound at the other end. This makes it possible to distinguish various degrees of footlooseness and to emphasize the relative character of footlooseness. Thus, 'being increasingly footloose' means, in the discourse on agglomeration economies, that particular constraining factors that were active in the past, such as the need for proximity to knowledge institutes, specialized suppliers and specialized labour, decrease in importance, thus allowing companies to choose a location under higher degrees of freedom within a certain spatial area (see Van Geenhuizen and Nijkamp, 2007). Note that footlooseness is often relative to a particular area or scale under consideration. For example, companies may be footloose with respect to their city region, but not with respect to the national system or continent. Clearly, communication, transportation and transaction costs are decisive factors for firms to choose a logistic and locational option in a competitive spatial-economic context. In summary, resources – defined in a broad sense – are decisive for the city's location and performance.

Learning, Creativity and Evolution

The rationality paradigm has exerted a great influence in urban economic analysis, but has often failed to explain jumps and anomalies in urban systems. Research in the social sciences is at present increasingly influenced by evolutionary perspectives, notably learning perspectives. Since the early 1990s concepts such as learning regions, smart cities, creative cities, science-based

regional development, etc. have received an increased attention among regional economists, economic geographers and regional policymakers. This development marks the recognition that factors determining economic growth of regions (cities) are increasingly intangible, like institutions and culture, and increasingly mobile, like capital, codified knowledge, and – in part - human capital. It also reflects the awareness that innovation by companies is not a linear process, running from invention and commercialization to market introduction, but a cyclic and interactive process within networks of many different actors. In this view on innovation, emphasis is increasingly put on diversity of the networks and boundary-spanning activity of the network actors. Learning in this context not only means to adapt to new circumstances, like a stronger competition, but also to reflect critically on the own institutions and learning processes. In a positive scenario, the networks consist of loosely coupled relations that enable openness and integration, and create perspectives for action. In a negative scenario of "lock-in", however, networks become conservative and inward-oriented - thereby preventing any learning-based action - or they become subject to confusion leading to high transaction costs and inefficient adaptation (see also Acs *et al.*, 2002). In other words, the quality of the network dynamics strongly matters; but much remains unknown to date, like about key influences on network dynamics and turning points in the quality of the networks. This calls for additional and intensified social science research.

One of the first regional scientists who addressed the learning region as a paradigm is Florida (1995). Earlier seminal work underlying the learning regions paradigm was done by Aydalot (1986), Camagni (1991), Maillat (1991) and others, while the paradigm was fertilized from different angles in regional studies, like the ones on innovation systems, technology complexes (including knowledge spillover phenomena), post-Fordism and clusters, and the ones on technology policy, local and regional institutions and community action (see e.g., Benner, 2003; Morgan, 2002; Ratti *et al.*, 1997; Cooke, 1998; Maskell and Malmberg, 1999; Gertler and Wolfe, 2002). The learning regions approach has the advantage over other approaches that it explicitly addresses the quality of policymaking and of other institutional conditions in the regional economy and society. In particular, it is a regional development concept in which the emphasis is put on improving individual and collective learning processes of the regional actors involved through open and flexible networks (OECD, 2001). This concept does not implicate that the learning is exclusively taking place between regional partners. Regional actors (e.g., policy institutes and companies) learn through both regional (local) and global networks.

Many governments today deliberately try to enhance high-technology activity in their regions and often embrace the learning regions paradigm to improve policymaking. However, there is a long way to go and the path is littered with stumbling blocks. Barriers in policymaking reside in policy organizations themselves and in the nature of knowledge policies. A framework that can be used in clarifying these issues, is given by evolutionary approaches. Evolutionary thinking allows for an explanation of qualitative change, the rise of radical uncertainty, the role of institutions in reducing uncertainty, variation between organizations and technology, and it provides useful notions for a better understanding of policymaking under such circumstances (Saviotti, 1997; Van den Bergh and Fetchenhauer, 2001). Learning appears to become an increasingly powerful paradigm in understanding urban dynamics against the background of urban competition in a struggle for survival. Slow evolutionary dynamics and infrastructure provision are two closely connected phenomena here.

In conclusion, the rise and death of (mega)cities may be interpreted from different perspectives, each with its own merits and validity. These angles are not necessarily conflicting, but rather mutually complementary. But a critical question remains under which conditions urban growth – or urban revitalization – is a sustainable outcome. Which are the lessons taught by standard textbook urban economics? This will be the subject matter of Section 3.

Urban Economics

Urban economics is at the core of regional science and has contributed significantly to a better understanding of the urban system, thanks to the works of Von Thünen, Christaller, Alonso, Muth, Isard and many others. The straightforward economic analysis of urban land use in the presence of competing actors (various income groups, business life etc.) have led to a wealth of ideas and insights on price formation of urban land and the related location patterns of actors in the city (see also Capello and Nijkamp, 2005).

The interactive structure of the urban space-economy has generated many externalities which are decisive for continued urban economic growth (see also Smit, 2007 for a meta-analysis of the determinants of growth in cities). In the literature very often a distinction is made between three types of externalities in the city:

- Urbanization and localization economies often referred to as Marshall-Arrow-Romer (MAR) externalities; these externalities are closely associated with specialisation economies.
- Synergy economies that originate from cultural and socio-economic diversity in the city (often referred to as Jacobs externalities); such externalities are based on social learning mechanisms in an urban 'melting pot'.
- Competition economies that are related to the need to do novel things if there are many competing business actors in the same city, often referred to as Porter externalities.
- The various economies of density in the city do not only have direct economic dimensions (such as efficiency and productivity aspects), but also spatial aspects ('principles') in a broader regional and (inter)national context (Camagni, 1992):
- *Agglomeration principle*: the high density of production and residential activities in the city – based on physical proximity – creates special territorial forms of the city (e.g., on the basis of concentric patterns stemming from rent gradients).
- *Accessibility principle*: the interactions between transport costs and land use form the basis for urban mobility patterns.
- *Spatial interaction principle*: the intensive and frequent contact potential between urban actors induces various forms for density economies and related spatial implications.
- *Urban hierarchy principles*: socio-economic heterogeneity in the city creates a socio-economic and territorial division of labour and residential patterns and hence induces socio-economic disparity.
- *Competitiveness principle*: cities are breeding places of new ideas and call for permanent business innovations which require tailor-made spatial provisions in favour of urban efficiency mechanisms.

The number of research challenges on modern cities is vast and urban economic has developed a series on analytical methodologies to cope with these emerging issues. Examples are studies on 'optimal city size' (nowadays often referred to as 'efficient size'), functional specialization of cities in a global competition, the use of social capital in cities, spatial organization in the context of systems of cities etc. These new research directions are often summarized under the heading of '*New Urban Economics*' or '*Analytical Urban Economics*' (see Richardson *et al.*, 1996). The main novelty was to introduce more realistic assumptions and to address also urban policy issues (e.g., income distribution, consumer heterogeneity, congestion externalities, segregation, criminality, labour market and unemployment issues etc.). Furthermore, the scope of urban economics research was extended towards other domains, such as transportation (see e.g., Nijkamp and Reggiani, 1999), city networks (see Camagni, 1993) or environment (leading to a vivid debate on sustainable cities).

In the past decade, much attention has also been given to urban growth in relation to agglomeration economies, with a particular view to the determinants of growth in a complex spatial setting (e.g., industrial specialization, infrastructure endowment, central location in a network etc.) which are closely related to scale economies and non-linear spatial network phenomena. This may lead to unstable behaviour in urban development and even to multiple equilibria (see e.g., Krugman, 1991).

In the same vein we have observed an increasingly popularity of endogenous growth theory, in which knowledge, innovation and infrastructure play a key role in urban development (see e.g., Romer, 1986, 1990; Lucas, 1988; Nijkamp and Poot, 1998; Stimson *et al.*, 2002).

New methodological research directions in urban economic were addressing urban dynamics by using ideas from spatial complexity theory, in which inter alia non-linear evolution, chaos principles, synergics, evolutionary biology, and learning algorithms play a critical role (see Nijkamp and Reggiani, 1999). In this context, there is also due attention for innovation, creativity, entrepreneurship and leadership.

The various trends sketched above point at various directions in urban economic research: increase in realism, systemic complexity, and spatial networks orientation. There seems to be a need for a new wave of analytical efforts that would study cities from a computable equilibrium perspective, with a balance between (i) growth-inducing and growth-hampering factors, (ii) multiple (from micro to macro) layers of actors and structures in a city, and (iii) intra-urban and extra-urban force fields. Against the background of these observations, a plea for a complex urban growth theory seems warranted which may lead to the design of the above mentioned systems economics approach to cities, with sufficient attention for the negative externalities of urban development.

The Shadow Sides of Modern Cities

The previous sections have extensively argued that cities are based on the existence of a multiplicity of density economics, which generate a wealth of positive externalities inducing urban growth. But cities have clearly many shadow sides, such as congestion, low-quality environmental conditions, social stress and segregation, high crime rates etc. Such negative

externalities have to be coped with in order to keep the net balance between positive and negative externalities positive. From the perspective of urban policy, a new endogenous growth model may be developed in which the endogenous forces for enhancing growth potentials (e.g., knowledge infrastructure) and for reducing environmental threats (e.g., environmental taxation) are combined in one analytical framework (Verhoef and Nijkamp, 2008).

The attention for urban environmental conditions and the urban ecology has prompted a movement towards sustainable city development which would lead to a balance between positive and negative urban quality conditions (see Table 5).

+	–
Agglomeration economics Specialization and diversity R&D and innovation Physical capital (Spatial hub)	Urban deterioration Diseconomies of agglomeration Unemployment Exclusion and poverty Socio-economic inequalities Immigrants Criminality Congestion Poor-quality infrastructure

Table 5 - Sustainable urban development: a shaky balance between positives and negatives (OECD, 2006)

Table 5 confirms the need to identify and measure the relevant conditions (both positive and negative) that impact on local sustainability quality. It prompts challenging questions for urban policy-makers to arrive at optimal quality conditions for cities. Clearly, there is an enormous variety in environmental quality conditions world-wide. A series of interesting findings over a period of 15 years was recently published in a monitoring study of the Asahi Glass Foundation (2007). Table 6 maps out the most pressing local environmental problems as perceived by hundreds of interviewees/experts world-wide. This table leads to two important conclusions: waste and urbanization/transportation are generally regarded as the most important sustainability problems in cities in the industrialized word, while poverty is seen as a very prominent issue in cities in the developing world.

Next, Table 7 offers a further decomposition of Table 6 and indicates which items in local waste management deserve high priority. It appears that active recycling policy and active waste policy (incl. toxic materials) are seen as high priority areas, with only small variations in different regions of the world.

A further decomposition of priority areas is given in Table 8, where the second most pressing environmental issue is further analyzed, viz. urban transportation problems. Congestion, infrastructure design and use, and environmental decay from transportation are seen as the most important problems, with quite some variation in interest among the various world regions distinguished.

Finally, the most pressing environmental problems related to urbanization are presented in Table 9. It turns out that there are four prominent concerns, viz. waste, air and noise, natural systems and water, and urban sprawl. The first two items are mainly showing up as major concerns in Japan, Asia-4, Eastern Europe and the Middle East, while urban sprawl is regarded as a major problem in both Western Europe and the USA/Canada.

The previous observations have clarified that sustainable city development policy is a multi-faceted task which calls for a broad ecological view on the city in relation to its surroundings. Given the general trend of urbanization in the developed world, it is plausible that the ecological stress on cities will increase in the future, so that the challenge of urban sustainability will likely rise in the years to come. This development seems to prompt two routes for action: effective ecological policy for our cities (e.g., strict regulatory schemes on parking, industrial development, waste management, effective urban green policy etc.) and flanking policies supporting an innovative development of cities geared towards a high competitiveness (e.g., cultural and creativity policy, innovation and knowledge policy etc.). It is mandatory for a sustainable city policy to develop innovative perspectives, so that economic progress is not at odds with sustainability development, but supports an effective socio-economic and ecological resilience in modern cities. This challenge will be further discussed in the next section.

Region	Waste Management	Waste Management	Poverty	Other
Japan	**	*		
Asia-4	**	*		
East Eur	**	*		
Mid East	**	*		
West Eur	*	**		
USA/Can		**		*
Africa	*		**	
Rest Asia	*		**	
Lat Amer			**	*
Ocean				**

Table 6 - Most pressing environmental problems (2006)

Region	Active recycling	Active waste policy
Japan	*	**
Asia-4	*	*
East Eur	-	*
Mid East	-	-
West Eur	*	**
USA/Can	*	*
Africa	-	-
Rest Asia	-	-

Table 7 - Priorities of local waste management (2006)

Region	Congestion	Infrastructure	Environmental decay
Japan	**		*
Asia-4	*		**
East Eur	*	**	
Mid East	*	**	
West Eur	**		*
USA/Can	*	**	

Table 8 - Most pressing transportation problems (2006)

Region	Waste	Air and noise	Natural systems & water	Urban Sprawl
Japan	**		*	
Asia-4		**		*
East Eur		*	**	
Mid East	**		*	
West Eur		*		**
USA/Can	*			**

Table 9 - Most pressing urban environmental problems (2006)

The Counterbalance: Productivity is the Key!

Solid economic development of cities is a prerequisite for their sustainable development. But which factors are decisive for a flourishing and vital urban economy? In a recent OECD study (2006) several key drivers have been analyzed and identified. It turns out that productivity per worker in the city is a critical success factor. It outstrips other factors, such as efficiency of the local labour market (employment/unemployment ratio) and the activity rate (labour force with respect to total population). The OECD study concludes that urban productivity differences determine whether the per capita income in a given urban area falls below or stands above the average (see Van Hemert *et al.*, 2007). These findings are illustrated in Table 10. This figure demonstrates that in particular US cities have a relatively high productivity, whereas developing countries and semi-developed countries have a much lower performance. European cities appear to assume an intermediate position.

Winners	Intermediate	Losers
Boston	Frankfurt	Istanbul
San Francisco	Stuttgart	Krakow
New York	Stockholm	Ankara
Washington	Munich	Daegu
San Diego	Sydney	Izmir

Table 10 - Comparison between cities

The determinants of urban productivity differences are manifold, but two factors are generally assumed to be of decisive importance, viz. an advanced knowledge infrastructure and a high ICT orientation (see Black and Henderson, 1999; Brinkley and Lee, 2006, and Henderson *et al.*, 1995).

The previous findings are supported by Table 11, which presents the investments in knowledge in various OECD countries (1994-2002). Knowledge may be seen as a trigger of many new, vital and innovative developments in urban areas (which may in general be regarded as knowledge hubs in a knowledge-based society) (see also Glaeser and Mare, 2001).

% of GDP	1994	2002	CHANGE
WORLDWIDE			
US	5.4%	6.6%	+1.2
Korea	4.9%	5.9%	+1.0
Japan	3.9%	5.0%	+1.1
Canada	4.5%	4.7%	+0.2
Australia	3.9%	4.1%	+0.2
EUROPE			
Sweden	5.1%	6.8%	+1.7
Finland	4.7%	6.1%	+1.4
Denmark	3.7%	5.5%	+1.8
Germany	3.4%	3.7%	+0.3
Belgium	3.6%	3.8%	+0.2
Netherlands	3.4%	3.8%	+0.4
France	3.4%	3.7%	+0.3
UK	3.5%	3.7%	+0.2
Austria	2.3%	3.4%	+1.1
Spain	2.1%	2.8%	+0.7
Ireland	2.6%	2.4%	-0.2
Italy	2.0%	2.4%	+0.4
Greece	1.1%	1.9%	+0.8
Portugal	1.3%	1.8%	+0.5

Table 11 -Investment in knowledge in OECD countries

As mentioned before, cities are marked by a high degree of heterogeneity in terms of consumption behaviour, productivity, business profile or labour market conditions. Figures 4 and 5 present some comparative data on employment growth and growth in gross value added (GVA) in various European metropolitan areas during the period 2001-2004. There is indeed quite a disparity in employment growth and GVA growth among European cities. There is no doubt a backlog and catch-up effect, e.g., Dublin. Furthermore, a comparison between Figure 4 and 5 teach us, that these figures display of course some variation, but also a surprising correspondence between the rankings of various cities.

It seems plausible that investments in knowledge and human capital create vital cities. Urban revitalization and sustainability are necessary for European cities to keep up with major players in the world. Pro-active strategies to avoid path dependencies and lock-in situations are certainly necessary for cities in Europe (see Bock, 2006).

Infrastructure and suprastructure may be seen as two major push factors for urban dynamics, as has convincingly been argued in the literature. An optimal provision of infrastructure and suprastructure – sometimes also coined social overhead capital – is usually seen as critical success factors for economic growth, both nationally and locally. An important starting point for a thorough analysis of the above issues was given almost fifty years back by Hirschman (1958) who in his investigation into the strategy of economic development convincingly demonstrated that social overhead capital is a necessary but not sufficient condition for economic progress. The main task of public policy is to address the balance between directly productive inputs and social overhead capital, where an optimal allocation of both types of factor inputs can be based on neo-classical cost-minimizing production theory. Unbalanced growth may then be the result of a lack of fine tuning between directly productive capital and social overhead capital.

In Hirschman's view social overhead capital has a fairly broad meaning; it is usually public capital which is normally characterized by lumpiness and indivisibility and does not have an

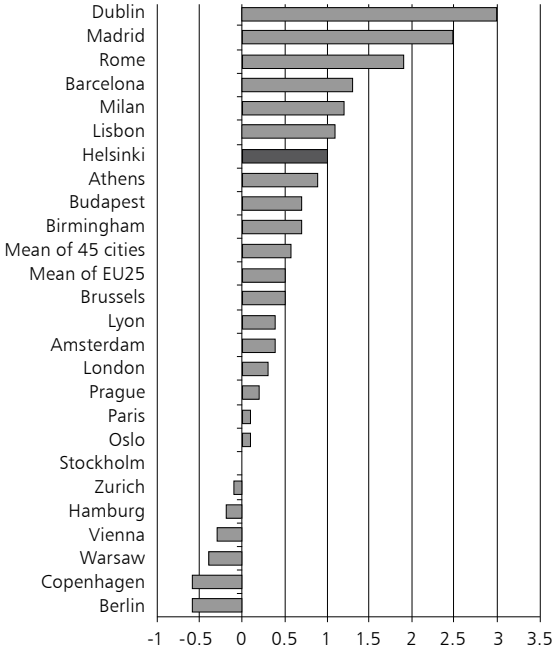

Figure 4 - Employment growth in European metropolitan areas (2001-2004)

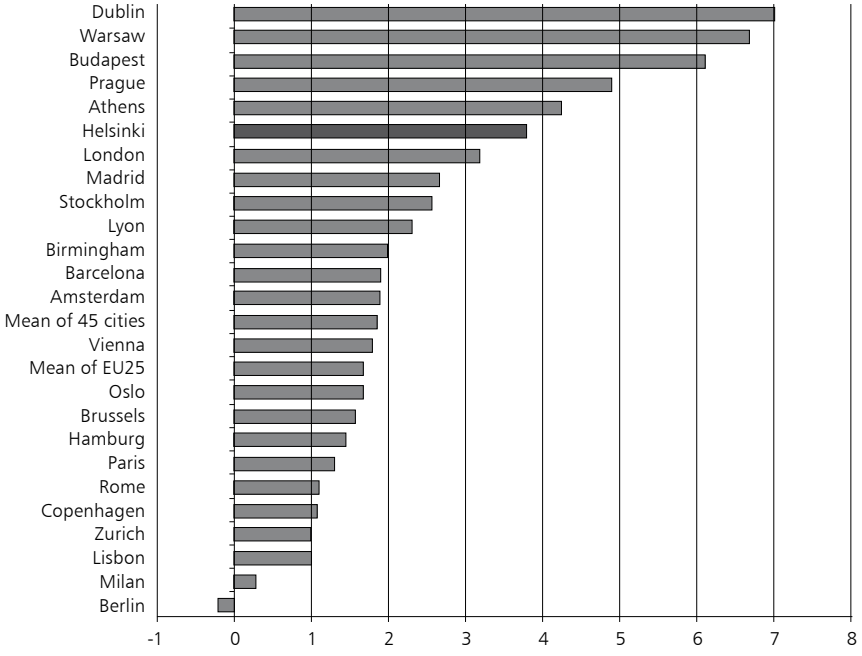

Figure 5 - Economic growth (GVA) in European metropolitan areas (2001-2004)

immediately productive character (in contrast to labour or capital). It may be either material in nature (roads, railways, (air)ports, pipelines etc.) or immaterial (knowledge networks, communication, education, culture etc.). The first class will be called here *infrastructure*, the second one *suprastructure* (see for an extensive overview of social overhead capital also Wilson *et al.*, 1966; Youngston, 1967; Nijkamp, 1986; and Lakshmanan, 1989).

In a more pronounced spirit than Hirschman, Rostow (1960) has argued that transport infrastructure is of decisive importance for economic development, witness the impact of railroads on economic growth in many US states. In regional development theory the main emphasis has been placed in the past decades on the physical (or material) components of social overhead capital, *i.e.*, on *infrastructure*. Several focal points can be distinguished in the analysis of the importance of infrastructure for regional and urban development. In the first place, a main focus is on the removal of *bottlenecks* in the development of a single region or city in order to improve its accessibility (e.g., the construction of a bridge, tunnel or railway connection) (see e.g., Mera, 1973; Looney, 1992; and Bruinsma *et al.*, 1996). Later on, the attention was also devoted to the instrumental role of infrastructure in removing structural interregional *inequality* conditions (see e.g., Blum, 1982; Nijkamp, 1986; Williams and Mullen, 1992; and Biehl, 1995). And more recently, this equity argument has been extended towards a broader analysis of *interregional and interurban competitiveness* conditions, in particular in view to the acquisition of foreign direct investments (see e.g., Conrad and Seitz, 1997; Van Geenhuizen and Nijkamp, 1998; Nijkamp, 1993 and Ozawa, 1992).

In recent years, also the relationship between infrastructure and suprastructure (in particular, overhead capital in favour of innovativeness and knowledge use) has intensively been studied (see also Acs *et al.*, 2002 and Capello, 1996). Suarez-Villa and Hasnath (1993) and Suarez-Villa (1996) have argued that in the US some convergence can be found between the long-term upswings and downturns of both infrastructural investment and innovative capacity, while they also identified a remarkable association between educational infrastructure provision and (both aggregate and corporate) innovative capacity. Apparently, the growth potential of an area is influenced by both infrastructure and suprastructure provisions.

The overall findings on the positive correlation between infrastructure and suprastructure supply and economic development are not always conclusive, although they seem to be more convincing at a macro level. An attempt at a systematic cross-sectional comparative study of such impacts based on meta-analysis is found in Button and Rietveld (1998), while a broad overview and various empirical case studies can be found in an interesting study of Rietveld and Bruinsma (1998).

Infrastructure and suprastructure are a complex and polyvalent phenomenon. The importance of *synergetic effects* between various types of infrastructure – which is based on network connectivity (intermodality, interoperability, e.g.), has sometimes been recognized at a theoretical level, but in operational multiregional economic models the occurrence of such synergetic effects is usually neglected. This synergy has more weight, if also the information and telecommunication sector offers an added value to advanced infrastructure.

Furthermore, most models have been formulated as tools for spatial impact studies: a change in infrastructure is supposed to lead to a change in the private sector in a given area. Infrastructure is then usually an exogenous variable in these models. This is not necessarily

an adequate way of modelling infrastructure. As shown in the *endogenous* growth literature, infrastructure may not only influence the private sector, it may also be stimulated by the revenues of the private sector after a first round of improvement. It is challenging to broaden the scope of such models by introducing the possibility of this two-sided relationship, e.g., in a CGE context.

It should be added that the assessment of the impact of suprastructure on urban growth is not easy. There are several studies on the impact of universities of educational institutions on urban development, but a more integrated analysis of a comprehensive suprastructure on the city is very rare. In the spirit of our above mentioned exposition, it is clear that urban agglomeration advantages reinforce the impact of urban suprastructure on urban development.

Finally, a particular kind of suprastructure that has gained much popularity in recent years is creativity suprastructure. Since Florida's ideas on the creative class, the creative industry and the creative city (see for an overview Florida, 2002), an avalanche of studies has been undertaken to study the features and success conditions of creative environments (see e.g., Gabe, 2006; Heilbrun and Gray, 1993; Hesmondhalgh, 2002; Landry, 2003; Markusen, 2006; Power and Scott, 2004; Pratt, 1997; Scott, 2003; Vogel, 2001). Despite several empirical studies, an operational conceptualization of creativity infrastructure and suprastructure has as yet not been developed and calls certainly for more profound applied research. This is once more important, as there is a growing awareness of and interest in the dynamics-enhancing impact of creative activities.

On the basis of the foregoing observations we may argue that modern cities exhibit an unprecedented dynamics in terms of their economic performance, functional hierarchy and linkage structure, and socio-cultural behaviour. But their role as central hubs in a dynamic space-economy has been remarkably robust. This phenomenon of stability and change calls for further intellectual efforts to come to grips with urban complexity. Such a systems-economic oriented perspective will be offered in the next section.

Cities as Self-Organizing Innovative Complexes

Urban developments exhibit complex change patterns, with sometimes irregular fluctuations and chaotic movements. These are not determined by anonymous forces, but are the result of a highly complex force field. In other words, urban resilience and sustainable growth are not the result of a rectilinear movement, but are influenced by a great variety of intra-urban and extra-urban factors. Dynamic cities are to be regarded as innovative species struggling for survival under conditions of internal threats and external challenges. 'Challenge and response' forms an adequate description of the dynamics of our urban world. In most cases, modern cities have to organize themselves in an effective and efficient way in order to cope with both regional and global competition. This means essentially that modern cities may be conceived of as 'self-organizing innovative complexes' (SIC) that are subject to the conditions of systems dynamics. The generic features of such urban or metropolitan SIC are:

- a reliance on creativity, innovativeness and leadership
- competitive advantages to be created by R&D
- productivity and competitiveness as critical success factors

- a market orientation determined by product heterogeneity and monopolistic competition
- a development path marked by evolutionary complexity and behavioural learning principles.

Despite the multidimensional complexity of modern cities in their struggle for progress and sustainability, we may distinguish a limited set of systematic factors that exert a decisive impact on the socio-economic and ecological performance of these SIC. These factors which call essentially for an urban systems economics perspective are summarized in Figure 6 in a so-called Pentagon model.

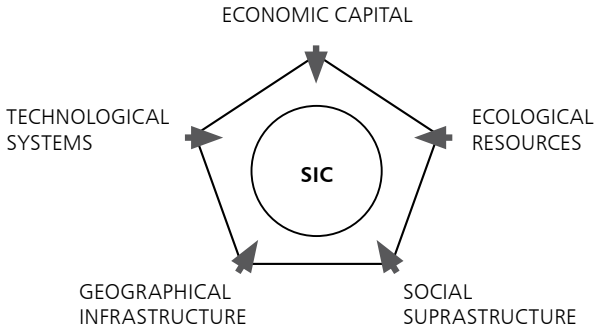

Figure 6 - A Pentagon model of critical forces for SIC

The Pentagon model has demonstrated its methodological power and empirical validity in various policy-analytical studies (see e.g., Capello *et al.*, 1999 and Nijkamp *et al.*, 1994). We will now concisely describe the five factors that are presented here. *Economic capital*: this component refers to the economic foundation that is necessary for an efficient operation of a sustainable urban area. In particular, two forces are relevant here:

- open competition among many actors (to induce a creative search for new decisions and courses of action)
- entrepreneurship in business life (to stimulate innovativeness)
- *Ecological resources*: this driving force is particularly concerned with eh environmental basis that is a prerequisite for ecologically sustainable development. Two elements are particularly important in this context:
- quality of life for urban residents (e.g., clear air, low noise levels, clear water and soil)
- provision of urban green (e.g., urban parks, supply of ponds, lakes and canals, an open space if order to offer a sufficient degree of biodiversity
- *Technological systems*: this concept is not only related to the technological advances, but in particular to soft factors, such as:
- the creation of an innovative culture by encouraging an active role of launching actors (both producers and consumers)
- the marketing of a sustainable image of the city of the city concerned (through pro-active public involvement)
- *Geographical infrastructure*: this notion addresses in particular the network character of cities (both physical and non-physical) and is particularly concerned with:
- accessibility (by exploiting the hub character of a city)

- connectivity (by stimulating the e-function of the city in a world-wide competitive setting)
- *Social suprastructure*: this factor represents the society's drivers which create a socially sustainable society, in particular:
- creativity (a potential human asset that forms the foundation of innovative ideas)
- diversity (a systemic notion that supports open mindedness, coping with stress etc.)

The fulfilment of these five Pentagon factors will most likely have a positive impact on the ecology and economy of SIC, in particular, productivity rise, feelings of well-being, creativity and innovativeness, and orientation towards scientific and educational literacy.

Conclusion

Cities are the geographical hubs (virtual and real) in a modern networked space-economy. They are the source of progress and global orientation, and hence deserve full-scale attention of economists, geographers, planners, sociologists, political scientists and urban architects. Thus, cities – and more generally, metropolitan areas – will continue to be engines of economic growth, creativity and innovativeness. Clearly, R&D and investments in education and knowledge will be essential in this context, as these elements are the key ingredients for productivity enhancement at local and regional levels. This calls for pro-active and open-minded governance structures, with all actors involved, in order to maximize the socio-economic and ecological performance of cities and to cope with negative externalities and historically-grown path dependencies.

The complexity of modern cities as SIC calls for a systems economic approach which should generate promising methodological and planning perspectives that favour the sustainability of urban systems. Elements of such a future-oriented research agenda are:

- A system of solid meta-analyses that would be able to identify growth-inducing and growth-inhibiting factors of dynamic cities, based on a series of quantitative impact assessment studies;
- The development of comparative efficiency studies on urban growth performance (including resilience factors) in order to generate lessons from urban efficiency differentials;
- The development of a system of computable urban equilibrium models, put in the broader context of complex urban systems;
- A thorough quantitative analysis based on testable models of the strategic position (including background factors) of cities on hubs ('leaders') in a global network system;
- A solid statistical analysis of creative future scenarios related to urban complexity in multi-actor networks, as a support tool for strategic policy-making;
- An analytical synthesis of micro-, macro- and socio-economic theory geared towards the explanation (anatomy) and policy strategy (therapy) of critical success factors for a globally sustainable development of cities.

The research challenges for modern cities are vast, but are justified by the following quotation: "*The city is not only the place where growth occurs, but also the engine of growth itself*" (Duranton, 2000). With more people living in cities, there is a need to look at the economic geography of our world from an urban systems economics perspective.

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On the concept of endogenous development: Diversity of interpretation or conceptual complexity?

António Vázquez-Barquero

Introduction

Since the early eighties the use of the term endogenous development has spread successfully, and has been widely accepted in the academic and professional world. What is perhaps most attractive about the term is its usefulness for interpreting the development processes of territories and countries, at a time when as a result of increased economic integration, great transformations in the economy and society in general are taking place.

On the other hand, it should be recognized as a term that is used by authors that work in different fields of the social sciences as well as by public actors, all coming from different schools of thought, and so, endogenous development is a term with a widely different significance. Many of these authors and actors probably share in their criticism of the traditional neoclassical growth theory, the approach that provided the arguments for the actions of international organizations devoted to development since WW II, and the following forty years. Yet, their conceptual differences are not to be ignored, since the policy proposals are conditioned by the conceptual view of development.

The purpose of this paper is to show that although different meanings are associated with the term endogenous development, in fact, it is a concept that interprets the complex reality of development, and so it can be argued in terms of the unity of the concept of endogenous development. The paper concludes that local development policy that appeared as a spontaneous response to increased competition and globalization, obeys to the logic of endogenous development.

Emergence of Endogenous Development Paradigm

A new scenario for development begins with the new phase of economic integration since the late 1980s; when the growth models inspired by the fundamentalism of capital are no longer explaining the new facts. This is so, not only because the breakdown of the Soviet Union and the fall of the Berlin wall proved the superiority of the market economy over a planned economy, but also because the policies carried out in many developing countries and implemented by international aid programs from the developed countries and international organizations failed, as Easterly (2001) points out.

Since the eighties, Schumpeter's ideas (1934, 1939) as well as those of others who contributed in the post-war years to what Krugman called "The High Theory of Development" return. Among

the different approaches that have emerged during the last twenty years is the reintroduction of Solow's growth model on behalf of the new generation of growth theorists like Romer (1986) and Lucas (1988). At the same time, as pointed out by Garofoli (1991, 1992), since the early eighties, a new approach appears, that can be called endogenous development. It considers development as a territorial process (not a functional process) that is methodologically based on case studies (not on cross-section analysis) and that considers that development policies are more efficient when carried out by local actors (not by the central administrations).

Giorgio Fua (1994), intellectually linked to Abramovitz, maintains that the development capacity of an economy depends on the immediate sources of growth, such as the size of the working population, the number of hours worked and the availability of equipment goods and social capital. Yet, what is really decisive for sustainable development are the factors that Fua defined as structural, such as entrepreneurial and organizational capability, labour training and skills, environmental resources and the functioning of institutions.

Philippe Aydalot (1985), a follower of Perroux and Schumpeter, adds that the development processes have three main characteristics: First, he refers to the fact that the development actors must be flexible productive organizations, as occurs with the small and medium size firms, capable of overcoming the rigidity of large Fordist organizations. In this way, the economies would obtain better results, particularly in times of rapid change in both the milieu and the market. Second, and more strategic, he defends diversity in techniques, in products, in tastes, in culture and in policies, which facilitates opening up various development paths for the different territories according to their own potential. Third and last, and more instrumental, he states that development processes are the result of having introduced innovations and knowledge through the investments made by the economic actors. This is a process that is territorial in nature given that it is a result of the forces that shape the milieu in which the firms are inserted; in other words, thanks to the interaction of the actors that shape what Aydalot calls innovative milieu.

This approach shows that development does not necessarily have to be focused in large cities, but rather is diffused in urban centres of different size, as explained by Giacomo Becattini (1979), a specialist on Marshall. The entrepreneur (both individual and collective), plays an outstanding role in industrial development and becomes the motor force of growth and structural change due to his creative capacity and innovative nature (Fua, 1983). Fua and Becattini add, however, that the firms are not isolated entities exchanging products and services in abstract markets, but are located in specific territories and are part of the productive systems, and are strongly integrated within the local society. In other words, society organizes itself for the purpose of producing goods and services more efficiently that give way to industrial districts and clusters of small and medium size firms that bring out network economies within the territory.

John Friedman and Walter Stöhr open up this approach and look at development policy from a territorial perspective. They give great importance to the local actors' initiatives through their investment decisions and participation in the definition and implementation of policies (Friedman and Weaver, 1979). They also point out that the economic progress of a territory is only possible when the firms and actors within the territory interact, organize themselves and invest with the view of developing the local economy and society. Following this line of thought, they put forward "bottom-up" development strategies that allow mobilize and channel resources and development potential within the territory (Stöhr and Taylor, 1981).

Self-Centred Development and Local Economic Potential

Endogenous development is often associated with the capacity of a local community to use the existing development potential within the territory, and so respond to the challenges at a given historical moment. At present, it is clearly due to the important effects that the globalization process is producing in the spatial division of labour. This view obeys a territorial approach to development and a positive, often optimistic, assessment of the role played by the existing development potential in all types of territories, that would allow the local communities give the adequate economic answer, and so satisfy the needs of the population (Vázquez-Barquero, 1988; Albuquerque, 2001).

Autonomous Development of the Territory

This is a territorial approach, based on the assumption that each local community has been shaped, historically, with respect to the relations and interests of their social groups, the construction of their own identity and their own culture that distinguishes it from other communities (Massey, 1984). Thus, the territory can be understood as the network of the interests of a territorial community, which allows us perceive it as a local development agent, as long as it is possible maintain and develop the integrity and the territorial interests in the development and structural change processes. This concept explains the reality in all types of territories, as Scott (1988) recognizes in pointing out the importance of culture and local identity in the development processes in the more dynamic metropolitan areas. Saraceno (2000) agrees with this when analyzing today's transformation and productive differentiation process in rural areas.

Therefore, at a specific moment in time, a territorial community, by its own initiative, may find new ideas and projects that will allow them use their resources and find solutions to their problems and their needs. The local actors, through their initiatives and investment decisions and participation in formulating and managing policies, contribute towards the development and productive dynamic of a locality, country or territory (Friedmann and Weaber, 1979). The "development from below" strategies that allow mobilize and channel resources and the existing capacities within the territory, lead to economic progress when the local actors interact, organize themselves and carry out their initiatives in a consistent and coordinated manner (Stöhr and Taylor, 1981).

This interpretation has received the support of those who believe that development is not imported, but rather is produced thanks to the economic and social work and effort of the local communities. To eliminate poverty and create jobs the most efficient strategy would be to re-establish an autonomous development model that would drive the local development potential and stimulate small agricultural production, small and medium size firms and handicraft industry, and so detain the massive urbanization process and involve the participation of the population in the development process.

Development, Solidarity and Democracy

This populist view of development has recurrently appeared, particularly after the three great technological revolutions: in the early XIX century, as a reaction to the dehumanization that industrialization and urbanization represented; in the first third of the XX century in industrialised economies, faced with unemployment and the effects of an economic and industrial crisis, that follow the electrical revolution; and at the present time, as a reaction to the impact of globalization.

This approach would explain why, in recent decades, socially sustainable development has received special attention to the extent that development strategies and policies stimulate, above all, the start-up and development of economic initiatives, based on solidarity, the autonomy of local communities and so, of countries, and the use of the local development potential. Giordani (2004) argues that the social economy approach overcomes the separation between capital and labour and introduces solidarity within the economic process, and he proposes a new development model that includes the public sector (government), the private sector (business) and the social economy sector for Venezuela. From this point of view, solidarity would be at the center of production, of accumulation, of distribution and of consumption.

This approach shows that the social economy appears spontaneously in answer to social deficiencies (in employment, housing, quality of life) that neither the market nor the State is able to attend. These are projects focused towards social well-being carried out by the cooperatives, the micro and small firms, the savings banks and non-profit organizations; where what counts is work done by the members involved in management, and the decisions are made democratically among its members. Social economy is a development culture that allows for the integration of population groups with risk of exclusion, takes advantage of the existing development potential within the territory, and spurs on production and employment.

Self-Development with Local Initiatives

In sum, this populist vision of endogenous development maintains that today, what is important about development is its autonomous character, based on the use of their own resources and can therefore be produced in any locality or territory, since all territories have a development potential. The point would be to use the local resources in projects designed and managed by the citizens themselves and the local organizations, in such a way that its inhabitants would control the process through the local development initiatives.

This is an optimistic interpretation of the development processes. It considers that the needs of the population would be well covered, and the success of the local initiatives guaranteed when the population defines, takes responsibility and controls the projects, no matter how limited the means available and/or investments made. Furthermore, it values the usefulness of the resources of all types available in a territory, and considers that what is important are the resources and potentialities of the territory and that constitutes the capacities on which income is based. It also considers that development policies should be implemented by local action groups, the most efficient public actions are those designed and managed from the bottom

up, which also gives a democratic value to development policy and to the citizens´ decisions for satisfying their needs.

This approach has, however, important limitations. Above all, it ignores the fact that the development process depends on capital accumulation, that savings and investment are required mechanisms for assuring long-term economic progress and a social transformation process; and that in any case they are mechanisms that will facilitate the economic sustainability of development.

The importance of introducing knowledge in the production processes is often ignored, and the importance of the role played by the institutions and the organization of production for obtaining increasing returns is not fully appreciated. Last of all, it is an autarchic approach to development, and ignores the fact that the local economies are integrated within the national and international productive systems, and that in one way or another, it is useful take advantage of its effect on these processes.

Human Development and Culture

Development processes are conditioned by the territory's institutions and culture, as acknowledged by sociologists (Weber, 1905; Putman, 1993), historians (Landes, 1998) and economists (Guiso *et al.*, 2006). Culture embodies the values, norms and principles that are transmitted from one generation to another through the family, religion and social groups, and can either facilitate or block the economic outcome. Economic development depends on cultural factors such as the work ethic, savings capacity, honesty, tenacity and tolerance, as well as the norms and institutions that regulate the relations between people and territorial organizations.

Development of People's Capability

Culture leads the people's behaviour; nevertheless, culture is something more than an instrument that facilitates and influences the development processes, because the mechanisms that favour the development processes have to do with the projection and use of individual and collective capabilities and with the creative and entrepreneurial capacity of the people. In other words, the core of the development process would lie in the development of human capabilities and in particular, in the population's creative capacity, which is one of the keys of the capital accumulation process and the economic progress of societies and territories.

Amartya Sen (2001) proposes an important change in the interpretation of development, when he maintains that the concept of development goes beyond economic growth and the per capita income of a country or territory, given that they are only an instrument for carrying out the capabilities of the population. What is really important is that people carry out the tasks and activities that they wish, and are capable of, carrying out. That is to say, economic development is achieved by using the capabilities that people have developed thanks to the material and human resources and to the culture that a territory has.

This concept shows the strong relationship that exists between development and freedom. Sen argues that what is important in the development processes is the capacity of people to decide what potentials they wish to use in carrying out their life project, and so, in their contribution to development. In other word, the point is that the citizens´ can choose, that the population should have the opportunities to undergo the activities they wish with the abilities and knowledge they possess. From this point of view, the citizen's freedom to choose would be central to the development process, and so Sen argues that the institutions, norms and rules, both formal and informal, should contribute to the exercise of the citizens´ freedom, and that freedom is an intercultural value, since it always allows the use of the population's capacities and abilities.

Development, Creativity and Entrepreneurial Capacity

Sen's approach presents development as an open process that feeds on the peoples´ opportunities and capabilities, which change and transform as the process takes shape. A city, a region and a country develop when the necessary mechanisms are created and when institutions that allow its citizens choose freely the capabilities they wish to develop are available. It is, therefore, a continuous transformation process of the economy and of society based on the development of potential and the capacities of the individuals and affects all types of territories no matter what level of development.

This perspective of development places man at the center of the economic and social transformation processes, and this has important implications. Above all, it is understood that the results of human activity, in a material sense, are never an end in itself, but rather an instrument for achieving the well-being of citizens in general. Furthermore, poverty (and therefore, low income levels) is no longer a restraint for development since what is important is not the amount of resources of a territory but rather the capacities of its inhabitants. A known fact, as shown by the migratory flows of the last century, is that people with few economic resources do not necessarily lack entrepreneurial and creative capacity, or a capacity to save and invest. Last of all, this view eliminates the false differentiation between development and underdevelopment, given that it considers development as a continuous process that changes and transforms the capabilities of the population in relation to the changes in the environment, that they also help transform.

The argument that the use of the population's capabilities is a critical element in the development processes leads, inexorably, to the consideration that man's creative capacity is a necessary condition for the development of a country or territory. Without it, the functioning of the economic system and the forces that motivate the processes of progress cannot be understood.

Creative capacity has permitted man create the mechanisms (economic, technological and institutional) that permit increased productivity, permit reach economic progress and change society. Creativity goes hand in hand with the entrepreneurial capacity of individuals and organizations since it facilitates its development, and thus, the urban, technological, organizational, productive and institutional transformations (Lasuen and Aranzadi, 2002). In conclusion, it is through the entrepreneurial capacity that people transform reality and create opportunities for development.

Entrepreneurial and organizational capacity is, therefore, one manifestation of the people's creativity, and that allows them produce something new and original within their environment. The creative process is produced with respect to the resources, potential and attractiveness that characterize a territory and which change from one place to another. Because of this, the entrepreneurial capacity is always conditioned by the cultural factors that explain the specificity of the territory. Therefore, development is produced thanks to the entrepreneurial creativity of the citizens in a specific cultural environment. In this way, development, creativity and culture relate differently to each other in each territory. A process of continuous interactions between them is produced as the territorial development process begins.

Culturally Sustainable Development

Territorial development is, ultimately, an interactive process. The economic and non-economic institutions are important in order for the economy to function, for the introduction of innovations and for technological change, as well as for the transformation of productive and monetary organizations (Polanyi *et al.*, 1957). Yet, the economic development process also produces the transformation of institutions and of culture, as sustained by Marxist thought when it argues that the productive structure determines beliefs and culture in general; although Becker (1996) points out that given that individuals and society have a limited control over culture, cultural change would be slower than those of social capital. Change in culture, institutions and social capital also exert an influence on the mechanisms that make productivity and territorial development more dynamic.

Human development is an interpretation that places man at the center of development, since transformation and change in the economy and society in general are produced thanks to its capabilities, and more specifically thanks to the creative and entrepreneurial capacities, and development makes sense when it benefits man. This allows us to deal with the question of poverty in a more natural manner, since even if the economic resources are few, human capacity may be used and developed so as to improve the well-being of the population. On the other hand, this view of development argues in terms of a culturally sustainable development model that interprets economic and social change as an open and continuous process and therefore conceptualizes the structural change and economic progress no matter what amount of resources or income levels are available.

However, this view does not consider the relevance of the development potential of the territory in the economic development processes sufficiently. Furthermore, this approach does not give the mechanisms and forces of development that condition the capital accumulation process its true value, which is why its proposed actions are usually restricted, and limit the possibility of self-sustaining development processes. Lastly, this approach can be termed as assisted development, and lacks the capacity for promoting development processes that are economically and socially sustainable.

The Evolutionary Approach to Development

From the perspective of the evolution and transformations of a country's or territory's economy, the central issue of development would be in identifying the mechanisms that facilitate growth and structural change processes. In this sense, endogenous development theory presents a useful interpretation, because it goes farther ahead in terms of the efficient use of the available resources, of the development potential and analyzes the mechanisms that regulate and control the accumulation processes that facilitate increasing returns, and thus explains economic development. These forces, that are endogenous to the functioning of the capital accumulation process, are, among others, the organization of production, the diffusion of innovation, the territory's urban development and the change and adaptation of the institutions (Vázquez-Barquero, 2002 and 2005).

Flexible Organization of Production

One of the central forces of the capital accumulation process is the organization of the productive system, as seen in advanced countries, in the late developed economies and in the emerging economies over the last two decades (Becattini, 1997; Pietrobelli and Rabellotti, 2006). The question lies not in whether the productive system of a locality or territory is formed by large or small firms, but rather in the organization of production system, and its effects on the behaviour of productivity and competitiveness.

Thus, clusters, local productive systems and industrial districts are forms of organization of production, based on the division of labour between firms and on a local exchange system that produces increased productivity and economic growth. They are organization models that allow generate increasing returns when the interaction between firms permit the emergence of external economies of scale, usually concealed in the productive systems, and ultimately one of the development potentials of the local economies.

Furthermore, the adoption of more flexible forms of organization in large firms, and groups of firms, makes them more efficient and competitive and stimulate new territorial strategies involving networks of subsidiary plants which makes them more autonomous and more integrated within the territory. The greater flexibility of large firm organization allow them make a more efficient use of specific local resources and assets, and so obtain competitive advantages within the markets.

The formation and expansion of networks and flexible firm systems, the interaction of firms with the local actors and the strategic alliances allow the productive systems generate scale economies (both external and internal, according to the case) in production as well as in research and development (when the alliances affect innovation), and so reduce the firms' negotiation and transaction costs.

Technical Change and Diffusion of Innovation

The introduction and diffusion of innovation and knowledge is, in turn, another mechanism for increased productivity and economic progress, for it stimulates economic growth and structural change in the productive system (Maillat, 1995; Freeman and Soete, 1997).

The adoption of innovations allows the firms to widen their range of products and create larger groups and build smaller plants, which are more efficient economically, and so reinforce the internal economies of scale. Furthermore, the innovations helps firms define and carry out strategies focused towards exploring and opening up new products and factors markets. The adaptation of technologies favours the differentiation of production and creates scope economies. Thus, the introduction and diffusion of innovations leads to the improvement in the stock of technological knowledge of the productive system, which creates external economies, for the benefit of all sorts of different firms within the system.

In sum, the diffusion of innovations throughout the productive fabric allows obtain internal and external economies of scale and economies of scope to each and every firm within the cluster or productive system. Thus, the productivity and competitiveness of the local firms and economies are increased.

Urban Development

In today's scenario, characterized by the globalization of production and exchange and greater service activities, cities continue to be a preferred space for economic development, because it is there where the investment decisions are made and where industrial and service firms are located (Lasuen, 1973; Scott, 1998).

Cities are a place for endogenous development. They generate externalities that lead to increased returns, they have a diversified productive system that enhances the economic dynamic, they provide space for networking in which relations among actors lead to the diffusion of knowledge, and they stimulate the innovation and learning processes of firms. Cities are places for the creation and development of new industrial and service spaces due to their capacity to generate externalities and allow hidden economies to emerge.

Yet, as Saraceno (2006) points out, the diversification of the economic activities of rural areas and the multiple forms of external integration contribute significantly towards the differentiated development of the rural localities and territories. The strength of these development processes is not so much rooted in the farms economies of scale, as in the enhancing of the scope economies, when the diversification of the farms production combines with different industrial and services activities. The diversification of the rural economy improves the performance of areas with low population density, and with small firms and farms, diffused throughout the territory; particularly when the local productive system is well articulated and is well connected to the transports and communications network in a dynamic urban region.

Flexibility and Transformation of Institutions

Last of all, development processes also have deep institutional and cultural roots (Lewis, 1955; North, 1990 and 1994). The development of an economy is led by local actors through the initiatives and investment and location decisions made in order for their projects to be carried out. Cities and territories stimulate the development of specific forms of organization and institutions, both formal and informal, which have been shaped as the productive system, culture and the society in general developed. The local organizational and institutional environment would facilitate or obstruct the economic activity.

Economic development, therefore, takes on strength and momentum in those territories with evolved, complex and flexible institutional systems. Its strategic relevance lies in that institutional development allows for the reduction of transaction and production costs, strengthens trust among the economic and local actors, it expands networks and cooperation between the actors and reinforces learning and interaction mechanisms. In other words, the institutions condition the behaviour of productivity, and so, the returns and the economic progress.

Economically Sustainable Development

Finally, as mentioned above (Vázquez-Barquero, 2002), development mechanisms become the economic capacities of the territory. They create an environment in which the economic growth and structural change processes are organized and also carried out. Capital accumulation processes require the combined action of each and every one of these development forces, to the extent that the effect of each one of them on productivity and returns is conditioned by the behaviour of the others. That is to say, the interaction of the forces of development and its synergic functioning stimulate economic development and social progress.

The evolutionary approach of endogenous development is an interpretation that goes beyond the proposals of traditional neoclassical growth theory, by using an analytical model that considers increasing returns focal for economic progress, considers that the introduction of innovation and knowledge is key in the development processes, and analyzes development from a territorial perspective. It also proposes a self-sustaining development model, based on the creation of a surplus that allows reinvestment and guarantee the continuous transformation of the productive system through the constant change of the forces of development. This approach is in itself a model for analysis and action.

Nevertheless, it is a partial view of the economic dynamic of a country or a territory for it does not point out the relevance of the macroeconomic system, but rather leans on the assumption that the economy maintains the macroeconomic equilibrium. Furthermore, even if it interprets economic growth under competitive conditions, it does not include an analysis of the functioning of the demand nor of the integration of the local economy within the system of international economic relations. Last of all, it is an interpretation that focuses, above all, on the economic conditions of change and transformations of the economy and society in general, and thus, does not include in the analysis important elements that affect the social, cultural and environmental sustainability of development.

The New Development Policy

The new development policy is characterized by its strategic view of economic development, providing local actors with the capacity to foster productive restructuring and, subsequently, improve the employment rate and welfare of local communities. Local initiatives are very diverse in nature (Aghon *et al.* 2001; Altenburg and Meyer-Stammer, 1999; Vázquez-Barquero, 1993 and 2002).

Fostering Firm's Development and Cluster

One of the objectives of local initiatives is the start-up and development of firms and the formation of firm networks.

In the first quarter of 1994, Guatemala's Ministry of Agriculture, Cattle and Food launched the Project for the Rural Development of the Cuchumatanes Mountain area (Cifuentes, 2000). The project affected 9,000 poor rural families, with a net income per family of less than $ 1,200 per year. In order to favor sustainable development and improve local well-being, the improvement of local entrepreneurial and managerial capabilities was encouraged. The experience and knowledge of self management that exists within the local population, and was lost during the civil war, were recovered, and cooperatives and associations of agricultural producers began to acquire full legal capacity. Moreover, more informally structured organizations, or Interest Groups were encouraged, and this brought people with common productive and commercial interests together.

Whereas in the Cuchumatanes region the process of local development was started by the Central Administration initiative by means of the decentralization program, in Rafaela, Argentina, an industrial district under productive restructuring was the municipality, who in 1996 define the local development strategy through a strategic plan (Ferraro and Costamagna, 2000). That same year, the Centre for Entrepreneurial Development was created, financed by the Inter-American Development Bank (IDB) as well as by local firms and the municipality. The Centre gives technical and financial assistance to local and regional firms, which will allow them to improve their production, have a greater presence in the markets, and increase the internationalization of small firms.

The social economy plays an important role for fostering entrepreneurial capability not only in rural and agricultural areas, as in the Cuchumatanes, but also in industrial places like the shoe production cluster in Marikina (Philippines). As indicated by Scott (2005), the Marikina Footwear and Leather Goods Manufacturers Cooperative, provides financial services to members of the cooperative; among which stand out "the right to take out loans, to purchase raw materials at a reduced price, and to discount letters of credit". The cooperative has a footwear brand (B&G) that the members may use when manufacturing their shoes. The cooperative provides distribution and marketing services to its members.

Finally, in order to facilitate integration within the international economic system, the government of Penang, in Malaysia, created the Penang Development Center (PDC), whose main objective was to promote socioeconomic development through the formation of a network of

local and foreign firms (Rasiah, 2007). The PDC played an important role in the creation of the electronic cluster in Penang with an important presence of multinational corporations (Clarion and National Semiconductors, Intel, Motorola, Hewlett-Packard, AMD, Hitachi), located during the seventies; and consumer electronic firms (such as Sony, Toshiba, Pensangko, Komag, Seagate and others) located during the eighties and nineties. PDC helped stimulate the formation of firm networks, and differentiate and diversify the productive fabric, particularly after the late eighties. A productive network has been created in which the domestic SMEs have established ties among themselves as well as with the MNCs.

Diffusion of Innovation and Knowledge

Another major axis of the new development policy is the diffusion of innovation and knowledge throughout the local productive fabric, as can be seen in the initiatives that work in territories with very different productive dynamics and levels of development.

A particularly interesting case is that of the Technological Centre do Couro, Calçado e Afins (CTCCA) of Novo Hamburgo, Rio Grande do Sul in Brazil. This is a private, non-profit institution established in 1972 and founded for the purpose of helping the shoe wear firms at the beginning of their export activity, by providing services that would allow them maintain the quality standards required by international markets. After thirty years it has become an institution capable of stimulating research activity and product and process development in the shoe industry of Brazil.

In Asia, both in developed as well as emerging countries, the technological policy is at the core of the development programs. In Japan, the policies in support of technology during the eighties were focused towards promoting structural change in underdeveloped regions, through the support of high technology activities in peripheral locations. In China, the Scientific and Technological Park Zhong Guan Cun in Beijing, has become, since 1999, an example of how to combine training with scientific research and both with the creation and diffusion of innovations. In its central area are located 2,400 firms and public centers, a result of the investments of multinational corporations like IBM, Microsoft, HP, Oracle, Siemens, Motorola, NTT, Fujitsu, Panasonic, Samsung and Mitsubishi, among others.

Last of all, in Malaysia, the Malaysia Technological Park, located within the "Multimedia Super Corridor", at the outskirts of Kuala Lumpur, was created in 1996 as an instrument for converting Malaysia into an economy focused towards the production of high technology and knowledge intensive goods and services. This complex provides firms with services and infrastructures that stimulate the creation and diffusion of technological innovation and knowledge. It gives technical and financial services to entrepreneurial initiatives that wish transform an innovative idea into a business; it helps in the implementation of research projects through its Biotechnology division (in the fields of molecular biology, biochemistry, pharmacology and food sciences); it provides training services in the fields of engineering, biotechnology and information technology; and it provides fully equipped floor space and services to firms that wish to locate in an environment focused towards a knowledge economy.

Building Up Infrastructures for Local Development

Initiatives targeting the build up of infrastructures and social overhead capital are traditional instruments for urban and regional development and they are also a tool for local development. And the reason is that they help both to make cities and territories more attractive for investment and, therefore, foster sustainable development. In Asia, during the last fifteen years important investments in infrastructures (such as international airports, ports, roads, underground, high-speed railways) have taken place in leading cities like Bangkok, Kuala Lumpur, Seoul, Beijing or Shanghai, making these global city-regions more attractive to inward investment and global capital (Scott *et al.*, 2001; Douglas, 2001). However, in Latin America, practically all the local development experiences involve improving accessibility, meeting the needs of social overhead capital and making cities and regions more attractive places in which to live and to produce.

Under certain circumstances, the question is to build up infrastructures, as in the Cuchumatanes Project, where in order to reach Guatemala City's and International markets a link from the mountain area to the Panamericana highway was built. Sometimes, the question is the creation of a town, as in the case of Villa El Salvador, located 20 km. South of Lima and close to the Panamericana highway. This is an initiative that allowed transform a deserted area into a city that at present has a population of over 400 thousand inhabitants. A Self-managed Urban Community was created, and one of the main projects was the building up of an industrial park in order to provide industrial land, equipment and the services required by micro-firms and small and medium-sized firms (Benavides and Manrique, 2000).

At times, the purpose is that transport infrastructures become a tool for sustainable development like that of Curitiba, Brazil (Cambell, 2001). During the late nineties, a project was launched that tries to integrate urban infrastructure actions (construction of a road that communicates fourteen neighborhoods in the periphery of the city) with business initiatives which use the premises (community huts) in which micro-firms and small enterprises can be located with the support of the services available through professional and entrepreneurial training. The urban transport system was transformed into a surface metro system and it became the strategic element for local development.

Finally, neighborhood restructuring in Caracas, Venezuela, is a good example of how to use urban policy instruments as a tool for local development (Baldó and Villanueva, 1996; Villanueva, 1998). The Catuche project, launched in 1993, is an initiative which relied on the Jesuit Fathers of the Pastora and the Caracas Municipal government, to provide this marginal neighborhood with the basic services and social overhead capital needed to improve the environment, living conditions of the population and social inclusion. Some of the most important actions of this initiative are the environmental clean-up of the Catuche River, the building or reconstruction of public services and new housing, the promotion of micro-firms to carry out the construction projects, and the improvement of neighbor relations. It was funded by the municipal government of Caracas, the national government, and non-governmental organizations.

New Governance for Local Development

At the center of the new development policy are actions aimed at improving the organization and management of development in cities and regions in order to give an efficient answer to the problems and challenges that lie ahead (Aghon *et al.*, 1991).

The development of a locality or territory is organized by the decisions made by the public and private agents. Frequently, as occurred in Bogotá, in Rosario or in Quezaltenango, in the early stages of the local development policy, local leaders stimulate the implementation of local initiatives, but they should count on explicit or tacit support from other local actors as well.

In Latin America, as in Asia, endogenous development policy is also based on initiatives where social and economic projects are coordinated and managed through new forms of governance such as partnerships among public and private actors, international agencies, or non-governmental organizations. In Villa El Salvador, the Autonomous Authority of the Cono Sur Industrial Park (Autoridad Autónoma del Parque Industrial del Cono Sur) was founded and brings together public and private agents working to develop the Industrial Park. In Jalisco, Mexico, local entrepreneurs, including executives of multinational corporations as well as the public actors, participate in the creation of local networks of suppliers. In Caracas, the Catuche project was managed by the Consortium of the Quebrada de Catuche, made up of members from the Catuche community, representatives from the group of promoters, and professional participants.

Thus, the development of new organizations and institutions has also become one of the characteristic features of new development strategies en Latin America (Costamagna, 1999). Furthermore, for the definition and design of local development initiatives and strategies, a new approach to economic planning, based on the local actors' negotiation and agreement was progressively adopted by planners and managers. This is an answer to the needs and demands for new forms of organization and policy management. Strategic planning helps cities and regions target precise goals with their initiatives. There are many examples as those of Rosario and Cordoba in Argentina, and regions in Morocco, Tunisia and other developing countries, where Local Economic Development Agencies (LEDA) were created for the purpose of promoting the economic activity and favor the improvement in the standard of living for the local population (Canzanelli, 2003).

Interaction and Synergy of Local Initiatives

As seen above, endogenous development policy meets a relevant function in the economic development processes, for it acts as a catalyst of the development mechanisms, through the local initiatives: it facilitates entrepreneurial development and the creation of firm networks, it encourages the diffusion of innovation and knowledge, improves urban diversity, and stimulates the development of the institutional fabric. In other words, the purpose of endogenous development policy is to act in a combined manner on all of the mechanisms and forces of development, trying to create and improve the synergy, in such a way that the conditions for the sustained growth of productivity are created, and the sustainable development of each locality or territory is stimulated.

Local development policy became a local answer to challenges and opportunities created by economic integration. It shows a strong analytical coherence, in so far local initiatives are consistent with the endogenous development approach, discussed above. Furthermore, the differences with the traditional industrial and regional policies are very distinct: local development policy responds to a territorial approach to development, and not to a functional one; it tries to stimulate the local development potential, and therefore the mobility of capital and labor is not its priority as occurs in the case of the traditional policy; the actions are implemented through specific intermediary agencies that supply services to local firms and people, and escape from direct financing to firms. Local initiatives, finally, are often promoted and managed by the local actors.

Nevertheless, local initiatives are in many cases, isolated actions that don't always obey a proposal for integrated development, that would allow exploit the synergy of the combined effect of complementary actions. Furthermore, the strategic coordination of private and public policy actions is always a challenge for local development policy. Finally, local development policy is not a welfare and redistributive policy, but intends to overcome the imbalances through the promotion of development in all territories, trying to built up the development capabilities of the territory.

Conclusion

The above discussion leads us to consider that endogenous development is an approach in which different views of development converge. The core of this interpretation lies in the territorial character of the growth and structural change processes that depend on the territorial resources and mechanisms on which development is based, and also on the laws that regulate and govern the growth and income distribution processes. It is not possible, however, to reduce the concept of endogenous development to a single general interpretation, given that the territorial base of development differs from one place to another, reality changes and the conditions under which development processes take place, also change. In this sense, the different approaches of endogenous development are not necessarily incompatible, but rather, can be integrated within a more complex interpretation.

The populist approach makes more sense within a wider interpretation of endogenous development, that considers that the entrepreneurship and the creative capacity of the population are mechanisms that spur on economic and social progress of places and territories. In turn, the evolutionary approach of development is an interpretation that states the mechanical aspects of the development processes and is useful for the analysis and actions. Therefore, it helps us to interpret today's development problems and guides the actor's answers to the challenges of globalization. Finally, the cultural approach of development, understands development as a culturally sustainable process. But, its sustainability requires support from the evolutionary approach of development, since the economic development processes are stimulated by human capabilities, as well as the territory's specific resources and assets that foster the forces of development.

Last of all, the concept of endogenous development has become an interpretation that helps define strategies and policies, that the local actors may implement by taking advantage of the opportunities brought about by globalization. Whichever interpretation is adopted, the

development policies must be based on the economic, social, environmental, institutional, political and cultural factors that combine uniquely in each locality, each territory. Because of this, the new development policy maintains that the development initiatives differ from one territory to another, from one locality to another; and it is the local citizens and organizations who decide how to answer the challenges that each place and territory face in the process of development.

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The geography of knowledge spillovers in Europe

Manfred M. Fischer

Introduction

In recent years, economic growth theorists have focused new attention on the role of knowledge capital in aggregate economic growth, with a prominent modelling role for knowledge spillovers (see, Romer 1986; Grossman and Helpman 2001; and Fischer 2009). For the purpose of this chapter, knowledge spillovers may be defined to denote the benefits of knowledge to firms not responsible for the original investment in the creation of this knowledge. It is convenient to distinguish two types of knowledge spillovers: spillovers embodied in traded capital or intermediate goods and services (so-called pecuniary externalities), and knowledge spillovers of the disembodied kind.

The focus in this chapter is on disembodied knowledge spillovers which arise because knowledge is a partially excludable and non-rivalrous good. Lack of excludability implies that it is difficult for firms to fully appropriate the benefits from their knowledge generation activities and prevent others from using the knowledge without compensation. While knowledge is subject to spillovers, it is only imperfectly excludable. Non-rivalry, on the other hand, implies that a novel piece of knowledge can be used many times and in many different circumstances.

Knowledge spillovers are notoriously difficult to measure, as pointed out by Krugman (1991, p. 53): "[k]nowledge flows… are invisible, they leave no paper trail by which they may be measured and tracked". But Jaffe, Trajtenberg and Henderson (1993) argue that knowledge spillovers may well leave a paper trail in the citations to previous patents recorded in patent documents.

This contribution lies in the research tradition that uses patent citations as a proxy for knowledge spillovers, and directs attention to knowledge spillovers within the high-technology sector. High-technology is defined in our context to include the ISIC-sectors (ISIC Rev. 2) pharmaceuticals (ISIC 3522), computers and office equipment (ISIC 3825), electronics-telecommunications (ISIC 3832), and aerospace (ISIC 3845). Though some firms may choose not to patent inventions, patenting in high-technology industries is commonly practiced and indeed a vital component of maintaining competitiveness. The European coverage of this paper is given by patent applications at the European Patent Office [EPO] that are assigned to high-technology firms located in the EU-27 member states (except Cyprus and Malta), and Norway and Switzerland.

The chapter summarizes previous research by the author and research associates published in recent years (Fischer, Scherngell and Jansenberger 2006, 2008). The structure is as follows. The second section explains in some detail the nature of patents and patent citations, briefly discusses how patent citations can be used as an indicator for knowledge spillovers, and elaborates on the patent citation data to be used. The third section shifts attention to the geographic dimension

to the spillover mechanism and tests for spillover-localization. This is a most difficult problem due to the difficulty of separating spillovers from correlations that may be due to a pre-existing pattern of geographic concentration of technologically related activities. The fourth section suggests that both geographic and technological distance attenuate interregional knowledge spillovers from innovative activity. The results presented here indicate a tendency for knowledge spillovers to localize conditional on the technological relation between spillover generating and receiving region.

Patents, Patent Citations and Knowledge Spillovers

A patent is a property right awarded to inventions for the commercial use of a newly invented device. An invention to be patented has to satisfy three patentability criteria. It has to be *novel* and *non-trivial* in the sense that it would not appear obvious to a skilled practitioner of the relevant technology, and it has to be *useful*, in the sense that it has potential commercial value. If a patent is granted, an extensive public document is created. The document contains detailed information about the technology of the invention, the inventor, the assignee that owns the patent rights, and the technological antecedents of the invention. Because patent documents record the residence of the inventors they are an important resource for analyzing the spatial extent of knowledge spillovers, as captured by patent citations.

Patent related data, however, have two important limitations. *First*, the range of patentable inventions constitutes only a subset of all R&D outcomes. Purely scientific advances devoid of immediate applicability as well as incremental technological improvements which are too trite to pass for discrete, codifiable inventions are not patentable. The second limitation is rooted in the fact that is a strategic decision. It may be optimal for inventors *not* to apply for patents even though their inventions would satisfy the criteria for patentability (Trajtenberg 2001). Firms balance the time and expense of the patent process, and the possible loss of secrecy which results from patent publication, against the protection that a patent potentially provides to the inventor (Jaffe 2000). Thus, patentability requirements and incentives to refrain from patenting limit the scope of our analysis based on patent data.

Patents from different national patent offices are not comparable to each other because of different patent breadth, patenting costs, approval requirements, citation practices and enforcement rules across Europe. This makes patent data from the European Patent Office [EPO] rather than national patent offices a natural choice for our study. Our data source is the EPO database. The data on patent applications that we use in this study were drawn from the universe of European patents. By *European* patents, we mean patents assigned to corporations located in Europe, regardless of the nationality of the inventors. Our sample of patents is limited to those that are related to inventions in the high-technology industries or in other words to those patents assigned to patent classes which match the high-technology sector, at the four-digit level of the International Standard Industrial Classification, ISIC Rev. 2. We used MERIT's concordance table (see Verspagen, Moergastel and Slabbers 1994) between the four-digit ISIC-

sectors and the 628 patent subclasses[1] of the International Patent Code [IPC] classification to identify the high-technology patents from the universe of European patent applications.

The database for this study contains all the high-tech patents applied at the EPO between 1985-2002, totalling 177,424 patents. Each patent application produces a highly structured public document containing detailed information on the invention itself, the technological area to which it belongs, the inventor and her/his address, and the organisation to which the inventor assigns the patent property right. By nature of the research question, we are interested in the geographical location of the inventor rather than the applicant and hence, use the postal code of the inventor address for tracing inventive activities back to the region of knowledge production.

For representing geographic space we use 188 regions that cover the EU-27 countries (excluding Cyprus and Malta) plus Norway and Switzerland. Their definition is based on the Nomenclature des Unites Territoriales Statistiques [NUTS]. The regions are essentially in line with the NUTS-2 level of the regional classification in the case of Austria, Belgium, Germany, Finland, France, Italy, The Netherlands, Portugal, Spain, Sweden and UK, and in line with the NUTS-0 level in all other cases.

Patent documents include references or citations to patents. These citations open up the possibility of tracing multiple linkages between inventions, inventors, firms and locations. In particular, patent citations enable us to analyse the geographical extent of spillovers. There are, however, also some serious limitations to the use of patent citation data. Patent citations capture only those spillovers which occur between patented inventions, and, thus, underestimate the actual extent of knowledge spillovers. Other channels of disembodied knowledge diffusion – for example, transfer of knowledge embodied in skilled labour, knowledge transfer between customers and suppliers, knowledge exchange at conferences and trade fairs – are not captured by patent citations. Patent citations do not always represent what we typically think of as knowledge spillovers. Some citations may represent only indirect knowledge spillovers since the patent examiner added them. This noise creates a bias against finding spillovers. Fortunately, bias in this direction is a problem of power which can be overcome with a sufficiently large sample size (Thompson 2003).

Patent citation is a phenomenon that derives from the relationship between two inventions or inventors as evidenced by a citing patent and a cited patent. The data on this relationship come in the form of citations *made* (that is, each patent lists references to previous patents). For identifying the citation flows we need a list of cited and associated citing patent applications. This requires access to all citation data in a way that permits efficient search and extractions of citations not by the patent number of the citing patent but by the patent number of the cited patent. In constructing the patent citation data set that forms the basis of our study we begin with the full set of issued patents that have their application year between 1985 and 2002. There are 177,424 high-technology patents. We then discard all patents that have not received any citations, leaving 101,247 patents which generate 210,667 citations.

The observation of citations is evidently subject to a truncation bias because we observe citations for only a portion of the life of an invention, with the duration of that portion varying

1. The IPC system is an internationally agreed, clear-cut non-overlapping hierarchical classification system that consists of five hierarchical levels. At the third level 628 subclasses are distinguished.

across patent cohorts. This means that patents of different ages are subject to different degrees of truncation. To overcome this problem we have used the approach of moving windows of five years and thus identified all the pairs of cited and citing patents where citations to a patent are counted for a window of five years following its issuance. This window of five years seems to be appropriate since the mean citation lag of 210,667 citations is 4.6 years. The analysis is, thus, confined to 1985-1997 in the case of cited patents while citing patents appearing in 1990-2002 are taken into account. This process reduces the number of patents to 69,814 that generate 155,462 citations. Next, we discard so-called self-citations, identified as assignee matches, because self-citations do not represent knowledge spillovers in the sense of externalities. This yields 98,191 citations or observations that link a citing patent to a cited patent.

The unit of analysis is the dyad 'cited patent-citing patent'. A single originating patent, for example, that has two inventors and is cited by three subsequent patents will generate six unique observations. Figure 7 displays the 98,191 observations where each patent is assigned to one of the 188 regions based on the home address of the inventors as reported in the patent document. The nodes represent the regions, their size is relative to their spillover generating power measured in terms of citations received.

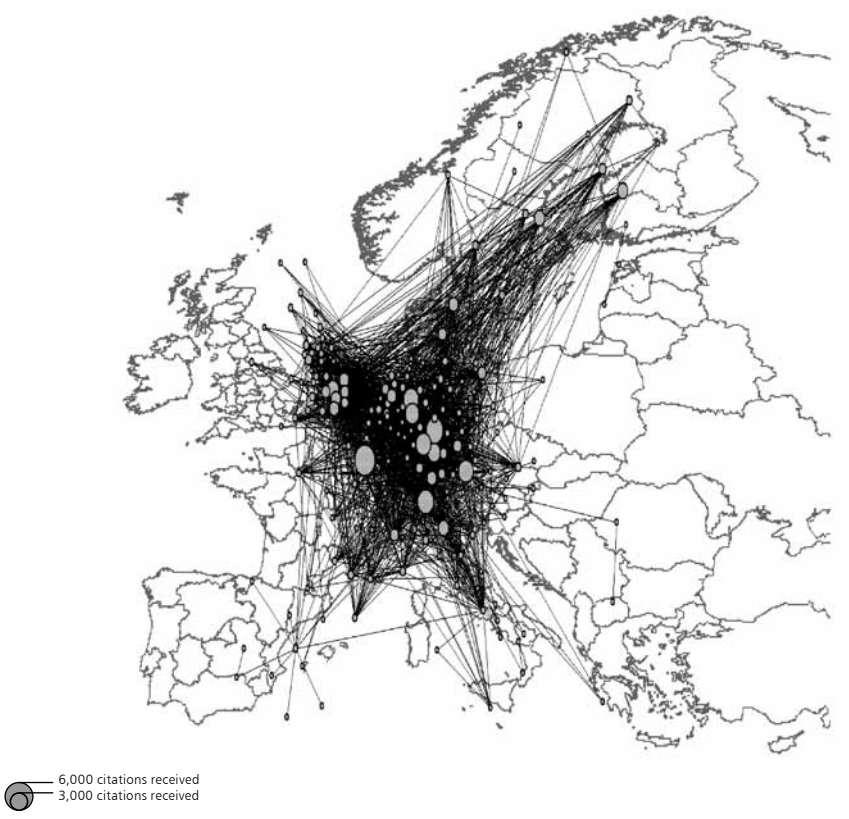

Figure 7 - Knowledge flows between European regions, as captured by interfirm patent citations in the high-technology sector, 1985-2002 [see Figure 2 in Fischer, Scherngell and Jansenberger 2008]

Geographic Localization of Knowledge Spillovers

It is widely recognized that knowledge – once generated – spills over among firms. But the geographical extent of such knowledge spillovers is greatly contested. In this section we make an effort to test for spillover-localization. This is a most difficult problem due to the difficulty of separating spillovers from correlations that may be due to a pre-existing pattern of geographic concentration of technologically related activities without resort to localization of knowledge spillovers (see Agrarwal, Cockburn and McHale 2003).

Patents linked by citations not only share a technology, but are often also developed by inventors working in a common industry. Patents linked by a citation are, thus, much more likely to share a geographic location than a pair of patents drawn at random from the entire pool of patents. To control for the tendency of inventive activities to be geographically clustered, we follow the case-control matching approach pioneered by Jaffe, Trajtenberg and Henderson (1993). The essence of this approach is to compare citing patents with control patents in terms of the frequency with which each is located in the same region as the originating patent. A finding of a disproportionate number of co-located citations relative to co-located control patents is interpreted as evidence of localized knowledge spillovers.

To derive a control frequency that is immune to contamination from localization based on the pre-existing concentration of technological activity, we went back to our patent database and identified a control patent to corresponding to each of the citing patents. For each citing patent, we identified all patents in the same patent class (measured in terms of the three-digit IPC code) with the same application year, excluding any other patents which cited the same originating patent. We then chose from this set of patents a control patent whose application date was as close as possible to that of the citing patent. This process generated, for each set of citing patents, a corresponding control sample of equal size, whose distribution across time and technological fields (defined by the 120 patent classes) is essentially identical to that of the citation data set.

Each control patent is paired with a particular citing patent. This allows us to compare the geographic location of the control patent with that of the originating patent cited by its counterpart in the citing data set. The frequency with which these control patents match geographically with the originating patent is an estimate of the frequency with which a randomly drawn patent which is not a citation, but has the same temporal and technological profile as the citation.

When we calculate the frequency with which the citations match the geographic location of the cited patents, we are estimating the probability of geographic matching for two patents, conditional on these being a citation link and conditional on the timing and technological nature of the citation. When we compute the frequency with which the control patents match geographically with the cited patents, we are estimating the probability of geographic matching for two patents, conditional on the timing and the technological nature of the citation. If the citation match frequency is significantly higher, this implies that citations are localized even after controlling for technology and timing (Jaffe, Trajtenberg and Henderson 1993).

We consider two cohorts of originating patents with corresponding sets of citing patents and control patents to test for spillover-localization. One consists of 1990 patent applications and the other of the 1995 ones. The 1990 cohort of originating patents contains 2,118 patents that have received a total of 2,362 citations including and 1,410 citations excluding self-citations by the

end of 1995. The 1995 cohort of originating patents contains 1,814 patents that have received a total of 2,387 citations including and 1,366 citations excluding self-citations by the end of 2000.

Table 12 summarizes the results for both cohorts of originating patents. Localization effects are reported at two spatial levels: the regional and the country level of analysis. 'Number of citations' corresponds to the number of citations cited by the originating cohort of patents. 'overall citation matching', 'citation matching excluding self-cites' and 'control matching' are the percentage of cited patents [with and without self-citations] and controls that belong to the same geographic location as the originating patent. The *t*-statistic tests the equality of the control proportions and the citation proportions (excl. self-citations).

	1990 - Originating Cohort	**1995 - Originating Cohort**
Number of Citations		
incl. Self-Cites	2,362	2,387
excl. Self-Cites	1,410	1,366
Matching by Country		
Overall Citation Matching [%]	60.1	61.2
Citation Matching excl. Self-Cites [%]	36.6	35.9
Control Matching [%]	21.9	25.4
t-Statistic (excl. Self-Cites)	8.68 ($p = 0.00$)	6.01 ($p = 0.00$)
Matching by Region		
Overall Citation Matching [%]	36.7	37.0
Citation Matching excl. Self-Cites [%]	13.7	14.8
Control Matching [%]	5.2	5.4
t-Statistic (excl. Self-Cites)	7.91 ($p = 0.00$)	8.27 ($p = 0.00$)

Table 12 - Geographic matching fractions [see Table 3 in Fischer, Scherngell and Jansenberger 2008]

Note: The *t*-statistic tests equality of the citation proportion excluding self-citations and the control proportion. See text for details.

The first column of Table 12 reports the 1990 results. Starting with the country match, we find that citations *including self-citations* are intranational about 38 percent points more often than the controls. Excluding self-citations cuts this difference roughly in half. The remaining difference between the citations excluding self-citations and the controls is strongly significant statistically. Looking at the 1990 results for regions (see the lower part of the table), we find that citations of patents come from the same region about 37 percent of the time. Excluding self-citations, however, makes a big difference. The proportions are cut to 13.7 percent. The matching frequency excluding self-citations is significantly greater than the matching control proportion.

The results for patent citations of 1995 patents, given in the second column of the table, are similar. For both cohorts of originating patents and for both geographical levels, the patent citations are quantitatively and statistically significantly more localized than the controls. The citation matching percentages (excl. self-cites) slightly rise at the regional level from 13.7 percent in 1990 to 14.8 percent in 1995, but slightly decrease at the country level from 36.6 percent to 35.9 percent. It is, however, impossible to tell from this comparison whether this represents a real change, or whether it is the result of differences in average citation lags. The average citation lag for the 1990 (1995) cohort of originating patents is 4.45 (4.57) compared to 4.14 (4.51) for the corresponding control patents.

The results on the extent of localization can be summarised as follows. For citations observed by 1,410 of the 1990 originating cohort of patents, there is a clear pattern of localization at the regional and country levels. Citations are about seven times more likely to come from the same region than control patents, 2.6 times more likely excluding self-cites. They are 2.7 times more likely to come from the same country as the originating patents, and 1.7 times excluding self-cites. For citations of 1995 originating patents, the same pattern emerges. All these differences are statistically significant at a level much less than one percent.

It is worth noting that localization of knowledge spillovers is not a universal phenomenon. European regions reveal different patterns in the local diffusion of knowledge externalities. Table 13 presents the results for selected regions including Île-de-France, Oberbayern, Switzerland, Noord-Brabant, Darmstadt, Lombardia and Bedfordshire which account for about one third of the inventive activities in high-technology industries in Europe, as measured in terms of EPO patent activities over 1985 to 2002. For the samples, there are significantly higher proportions of citation matches than control matches (except Noord-Brabant in 1995). Results that are significant at the 0.05 level or better are given in bold. These results indicate quite strongly that knowledge is localized at the regional level. In 1995 Île-de-France shows by far the strongest localization effect. The results for the German regions (Oberbayern, Darmstadt), Switzerland and Bedfordshire are also significant in 1990 and 1995.

	Number of Citations [excl. Self-Cites]		Citation Matching [%]		Control Matching [%]		*t*-Statistic[1]	
	1990	1995	1990	1995	1990	1995	1990	1995
Île-de-France	130	197	27.9	28.4	13.9	8.6	**3.30 (0.000)**	**6.05 (0.000)**
Oberbayern	82	88	12.1	10.2	2.4	2.4	**2.22 (0.009)**	**1.51 (0.037)**
Switzerland	73	81	17.8	28.3	9.5	6.1	**1.51 (0.046)**	**3.81 (0.000)**
Lombardia	68	43	26.4	16.2	7.3	11.6	**3.38 (0.000)**	0.70 (0.242)
Noord-Brabant	65	14	24.6	7.1	13.8	7.1	**1.72 (0.044)**	0.00 (0.500)
Darmstadt	53	76	11.3	28.9	0.2	3.9	**1.93 (0.029)**	**3.95 (0.000)**
Bedfordshire	36	13	46.1	23.0	5.5	0.0	**3.21 (0.001)**	**1.89 (0.042)**

Table 13 - Regional variations in localization: A test in selected regions [see Table 4 in Fischer, Scherngell and Jansenberger 2008]

Note:[1] Results significant at the 5 percent level of significance are in bold.

The Geographic and Technological Dimensions to the Spillover Mechanism

In the previous section we analyzed the extent to which citations by patents to previous patents are geographically localized, relative to a baseline likelihood of localization based on the predetermined pattern of technological activity. This section directs attention to the geographic and technological dimensions to the spillover mechanism and adopts a spatial interaction modelling perspective on knowledge spillovers as evidenced by patent citations (see, Fischer, Scherngell and Jansenberger 2006).

The spatial interaction modelling perspective shifts attention from individual patent citations to interregional patent citations, or in other words, from the dyad "cited patent – citing patent" to the dyad "cited region – citing region". Correspondingly, all citation data were aggregated into a region-by-region matrix, denoted by $[(c_{ij})]$, where c_{ij} denotes the number of patent citations from region j (j=1, ..., N, here N=188) to region i for i=1, ..., N. The rows of the matrix represent the origin location of the spillovers (in other words, the region of the cited patents) and the columns the destination location (the regions of the citing patents). Note that the matrix is asymmetric in nature, that is, for $c(i, j) \neq c(j, i)$ for $i \neq j$.

	Number of Matrix Elements*	Patent Citations				
		Number	Mean	Standard Deviation	Min.	Max.
All Elements	35,344	98,191	2.77	16.23	0	1,408
Intraregional Links	188	11,371	60.48	152.05	0	1,408
Interregional Links	35,156	86,820	2.46	11.14	0	351
Positive Interregional Links	11,468	86,820	7.57	18.49	1	351
National Interregional Links	3,952	25,341	6.41	20.02	0	351
International Interregional Links	31,204	61,479	1.97	9.31	0	290

* Elements of the region-by-region citation matrix

Table 14 - Descriptive statistics on the region-by-region patent citation matrix [see Table 1 in Fischer, Scherngell and Jansenberger 2006]

In the case of cross-regional inventor-teams we have used the procedure of multiple full counting that does justice to the true integer nature of patent citations, but gives – in comparison to the procedure of fractional counting – interregional cooperative inventions greater weight. Table 14 provides some basic information about the 188-by-188 citation matrix that contains 35,344 elements with a total of 98,191 citations between high-technology firms. The mean number of citations between any two regions (including intraregional flows) is 2.77, but the standard deviation is rather high. Interregional citations ($i \neq j$) show a highly skewed distribution. About two thirds of all pairs of regions never cite each other's patents. The frequency of patent citations gradually declines for more intensive citation links. There are only 90 pairs of regions for which the number of citations is about one hundred or more. The average number of citations for all interregional pairs is 2.46 and the average for those that cite each other 7.57. Table 14,

moreover, indicates that national patent citations are more frequent than international ones.

The elements of the *N*-by-*N* patent citation matrix denote observations on random variables, $c(i, j)$, each of which corresponds to flows of knowledge from region *i* to region *j*. The $c(i, j)$s are assumed to be independent random variables. They are sampled from a specific probability distribution that is dependent upon some mean, say $\mu(i, j)$. Let us assume that no a priori information is given about the row and column totals of the flow matrix $[c(i, j)]$. Then the mean interaction frequencies between origin i and destination j may be modelled by

$$\mu(i, j) = const\ A(i)^{\alpha}\ B(j)^{\beta}{}_{j}\ F(i, j) \tag{1}$$

where $\mu(i, j) = E[c(i, j)]$ is the expected flow, *const* denotes a constant term, the quantities $A(i)$ and $B(j)$ are called origin and destination factors or variables, respectively, α and β indicate their relative importance, and $F(i, j)$ is a separation factor that constitutes the very core of spatial interaction models. Following Sen and Sööt (1981), we specify the separation factor in form of a multivariate exponential deterrence function

$$F(i, j) = \exp\left[\sum_{k=1}^{K} \theta_k\ {}^{k}d(i, j)\right] \tag{2}$$

where ${}^{k}d(i, j)$ is the *k*th measure of separation between *i* and *j*, and θ_k the associated parameter. We assume that the observed flows follow a Poisson distribution with

$$P\{c(i, j)\} = \frac{\exp\left[-\mu(i, j)\right]\ \mu(i, j)^{c(i, j)}}{c(i, j)!} \tag{3}$$

where $P\{.\}$ denotes probability, and the expected value, $\mu(i, j)$, is given by Eq. (1). Equation (3) models patent citations flows between origin *i* and destination *j* as inter-point movement counts. Hence, this is the specification of a discrete distribution.

Subject to caveats relative to the relationship between patent citations and knowledge spillovers (see Section 2), this Poisson spatial interaction model allows us to identify and measure separation effects for interregional knowledge spillovers in Europe. Our interest is focused on K=4 separation measures. ${}^{1}d(i, j)$ represents geographic distance between regions *i* and *j* in terms of the great circle distance (in km) between their economic centres; ${}^{2}d(i, j)$ technological distance measured in terms of dissimilarity in a multidimensional technological space spanning 55 individual patent classes[2]; ${}^{3}d(i, j)$ and ${}^{4}d(i, j)$ are dummy variables representing border effects and language barriers between region *i* and *j*.

2. Each region is assigned a 55-by-1 technology vector that measures the share of patenting in each of the technological classes for a region. The technological proximity index, denoted by *s*, between region *i* and *j* is given by the uncentred correlation of their technological vectors. Two regions that patent exactly in the same proportion each patent class have an index equal to one, while two regions patenting only in different classes have an index equal to zero. This index is appealing because it allows for a continuous measure of technological distance by the transformation ${}^{2}d(i, j)$=1-$s(i, j)$.

The product $A(i)\ B(j)$ in Eq. (1) may be interpreted simply as the number of distinct (i, j)-interactions that are possible. Thus, a reasonable way to measure the origin factor is in terms of the number of patents in the knowledge producing region i in the time period 1985-1997, and the destination factor in terms of the number of patents in the knowledge absorbing regions j in the time period 1990-2002.

Table 15 reports the results from the estimation of the Poisson spatial interaction model by maximum likelihood (ML), using Newton-Raphson. The ML-estimates of the Poisson model specification given by Eq. (3) are reported in the first column, those of a generalized Poisson model specification in the second[3]. Standard errors are presented in parentheses rather than *t*-statistics to allow comparison with the precision of the generalized model specification. The reported standard errors all assume correct specification of the variance function. They are characterized by low significance levels.

	Poisson Spatial Interaction Model	
	without Heterogeneity	with Heterogeneity
Intercept	-10.278*** (0.051)	-10.881*** (0.124)
Origin Variable [α]	0.833*** (0.002)	0.915*** (0.006)
Destination Variable [β]	0.858*** (0.002)	0.885*** (0.006)
Geographical Distance [θ_1]	-0.270*** (0.005)	-0.321*** (0.014)
Technological Proximity [θ_2]	-0.928*** (0.032)	-1.219*** (0.130)
Country Border [θ_3]	-0.050*** (0.007)	-0.533*** (0.046)
Language Barrier[θ_4]	-0.238*** (0.014)	-0.031*** (0.043)
Dispersion Parameter [δ]	–	0.725 (0.014)
Log-likelihood	-51,801.10	-37,235.05
$\{\text{Corr}\ [c(i, j), \text{predicted}\ c(i, j)]\}^2$	0.686	0.783

*** denotes significance at the one percent level.

Table 15 - Estimation results of the Poisson spatial interaction model with asymptotic standard errors in parentheses [see Table 2 in Fischer, Scherngell and Jansenberger 2006]

Note: All independent metric variables are expressed log form in order to lessen the impact of outliers.

3. The Poisson model specification given by Eq. (3) does not allow for individual (i, j) effects, given the exogenous variables $A(i)$, $B(j)$ and $F(i, j)$. It is clear, however, that the existence of fixed effects at the individual level of (i, j) pairs is likely to exist in interregional patent citation relationships. This individual effect problem can be partly solved by introducing a heterogeneity term in the mean $\mu(i, j)$ of the Poisson distribution such that the multiplicative heterogeneity term follows a gamma distribution with mean one and variance δ. This modification yields the so-called heterogeneous Poisson model of interregional patent citations that allows for overdispersion (*i.e.* $\delta > 0$) and subsumes the Poisson model specification given by Eq. (3) if $\delta = 0$.

The estimated value of the dispersion parameter δ indicates that the basic Poisson model specification has to be rejected (H_0: $\delta = 0$, $G^2 = 29{,}256.6$, $p < 0.01$). The rejection of this model version is due to the situation of overdispersion, which is associated with unobserved heterogeneity among (*i*, *j*)-pairs of regions. Therefore, the Poisson model specification with heterogeneity is preferred. The variance-mean equality assumption of the basic Poisson model is too restrictive to adequately describe the patent citation flows.

This model specification with heterogeneity yields highly significant effects. Both α and β estimates are – in accordance to expectations – close to one. Geographical distance between inventors has a strong and negative effect on the likelihood of high-technology patent citations. The parameter estimate, $\hat{\theta}_1 = -0.321$, indicates that for any additional 100 km between regions *i* and *j* the (*i*, *j*)-mean patent citation frequency decreases by 27.5 percent. This suggests spillovers between high-technology firms are impeded by geographical distance.

Not only distance, but also border effects matter. The point estimate of the coefficient $\hat{\theta}_3$ is nearly twice times as large as that of $\hat{\theta}_1$, showing that border effects are more important than distance effects. Citing patents are much more likely to come from the same country as the cited patents. High-technology related knowledge flows much more easily within than between countries. Note that language barriers, though significant, have only a rather small effect ($\hat{\theta}_4 = -0.031$) on interregional knowledge spillovers.

The variable technological proximity controls for spillovers that are stronger between technologically similar regions. The point estimate for the variable shows an effect that is about four times larger than the distance effect even though the estimate is not very precise. Interregional patent citation flows tend to follow particular technological trajectories as defined at the three-digit level of the IPC classification system. This indicates that patent citation flows are industry-specific and occur most often between regions not too far located from each other in technological space. Technological proximity matters more than geographical proximity.

Conclusion

It is widely recognized that disembodied knowledge – once generated – spills over among individuals, firms and regions. But the geographical range of such knowledge spillovers is greatly contested. This chapter lies in the research tradition that uses patent citations as a proxy for knowledge spillovers, and directs attention to knowledge spillovers within the high-technology sector in Europe. The European coverage is given by patent applications at the EPO which are assigned to high-technology firms located in Europe.

Using the case-control matching approach – pioneered by Jaffe, Trajtenberg and Henderson (1993) – we find strong evidence of geographic localization at two different spatial levels (region, country) even after controlling for the tendency of innovative activities in the high-technology sector to be geographically clustered. The findings not only indicate that knowledge localization exists in the aggregate, but that there are also variations of localization by region.

The results obtained in a spatial interaction modelling framework indicate the tendency for knowledge spillovers to localize is conditional on the technological relation between spillover

generating and receiving firms and regions. The analysis results presented in Section 4 are consistent with intuition and existing empirical evidence which suggests that both geographical and technological distance attenuate knowledge spillovers. But it is important to note that disembodied knowledge flows more easily within European countries than across and that technological proximity tends to overcome geographical proximity. Interregional knowledge flows seem to follow particular technological trajectories and occur most often between regions with similar technological profiles.

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Innovative profiles and regional actors in the Algarve and Andalusia: An exploratory approach

João Guerreiro
Hugo Pinto

Introduction

Regional Development strategies currently have an important focus on innovation issues. This aspect is illustrated by numerous regional innovations strategies that were conducted in recent years in European Regions. European programs such as the Innovative Actions of European Regional Development Fund (ERDF) had an important contribute in defining and consolidating the mechanisms to promote innovation. In the creation of these strategies the concept of Regional Innovation System (RIS) was often used as a reference to structure its components. When a region is trying to consolidate its innovative performance one of the important activities is to benchmark what similar territories have done successfully.

The following article was based in the work carried out in the context of TECHNOPOLIS, project co-financed by INTERREG III B *Méditerranée Occidentale*. This project was developed by a partnership constituted by the Municipality of Lagos (PT), Municipality of Tavira (PT), PTA - Technological Park of Andalusia (ES), Societé Sviluppumbria (IT), Science and Technological Pole of Sicily (IT) and Sidi Tabet Technopole (TN). The central aim of the project was the consolidation of networks between the technopoles of the participant regions, with the exchange of best-practices and experiences, creating important linkages between the innovation actors of Mediterranean area.

The study "Regional Diagnosis for Innovation and Technological Profile in Medocc Regions" has the general objectives of analyzing the innovative activities in the participant regions, understanding the role of interface infrastructures in the creation and attraction of new technology-based companies and identifying main themes for cooperation between science and enterprises in the regions involved. The specific objectives were to identify key-areas of scientific and innovative development in each one of the participating regions and between them; compare the regions through a set of relevant statistical indicators for innovation in a common analytical matrix and identify main innovation actors in each territory.

This paper will discuss the interest in applying the RIS concept to regions so different like the Algarve or Andalusia. Both regions assume a peripheral characteristic in relation to Portugal and Spain and the EU, are important tourist destinations, and have conducted strategies to incentive development through innovation. A general overview of the regions and the analysis of some specific issues essential to the creation of a RIS, like the innovative profile, the identification of regional governance and research, higher education and technology transfer actors is done. Two recent innovation planning initiatives (PRIAlgarve and PIMA) will be referred.

The Interest in Focusing Regional Innovation Systems

The critical impact of technology and innovation on growth is clearly showed in the economic theory since the emergence of *growth accounting theories*, Solow (1956, 1957), Denison (1967) Abramovitz (1962). More recently the *new growth theory*, Romer (1986, 1990), Lucas (1988); stress the importance of factors related with a deeper understanding of the 'residual'. Innovation remains an unclear concept and has been an area under discussion in transdisciplinary approaches but it is seen as the key factor to growth and competitiveness and gaining importance within the current political agenda, OECD (1990, 2005), European Commission (2004, 2007).

The chain-linked model of Kline and Rosenberg (1986) underlined that innovation is not a casual phenomena and that some measures can increase its appearance. This notion is the basis of the innovation system approach. The innovation system reflects the understanding of a large number of components having an influence on all innovating process, which interact, learn, depend on and change their external environment. This approach facilitates the analysis of the economic, institutional, organizational, social and political factors related to innovation. The Innovation Systems view is well synthesized in Edquist (2005). The Innovation System (IS) is presented as the determinants of innovation processes, all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and the use of innovations. The constituents of IS are the components and the relations among those components. The components are organizations (formal structures that are consciously created and have explicit purpose – the players or actors) and institutions (set of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups, and organizations – the rules of the game). The activities of the IS are the factors that influence the development, diffusion and the use of innovations and are the determinants of the function of the IS (pursue of innovation processes, *i.e.* to develop, diffuse and use innovations). Freeman (1995), Lundvall (1992) and Nelson (1993) were the developers of the National Innovation System approach. The growing meaning of smaller territorial contexts gave relevance to regional scale. Doloreaux and Dione (2007) refer that the studies of innovation systems stress the meaning of the region and its particular resources, such as learning capability, corporate attitudes or existent infrastructures, for the support of innovation between enterprises and territories, are factors of development. Porter (2003) shows that competitive advantages have a relevant local character, coming from the concentration of high-specialized knowledge and expertise and from the existence of institutions, competitors, partnerships and consumers, The last edition of Oslo Manual, OECD (2005), underlines an identical view. The RIS concept emphasizes the character of the region as a territory of association between technology, market, productive capital, culture and representations. The region is not only the framework to resource allocation but the environment producer of endogenous resources and specific dynamics. The region is a satisfactory scale to put into practice developmental policies for the promotion of a knowledge-based economy. To exemplify this interest we can refer to the multiplication of innovation strategies and planning in the European regions. Several studies contributed to identify similar characteristics of localization of productive systems based in the use of technologies to clearly understand a

RIS, Doloreux and Bitard (2005), Asheim and Gertler (2005). These studies allow the analytical framework to understand the concept, showing how the spatial concentration of companies and organizations induce innovation through interactions and collective learning.

Methodological Notes

The regional scale appears to be a relevant on analyzing the innovative processes. In this context is interesting to understand some main dimensions of the regional innovation systems. In the next section the regions of Algarve and Andalusia will be compared. The interest in comparing both regions arises from the geographical proximity and some similarities regarding for example the importance of tourism, but separated (of course by the Guadiana river and) by other factors like dimension, critical mass and or productive structure.

Figure 8 - The Algarve and Andalusia Map
Source - Own elaboration

The main dimensions analyzed are illustrated in figure 9 and refer to six important issues.

- Generic Features of the Region – the proximity dimensions of the region regarding decision-making centres, the density of enterprises and the productive structure are important grounds to innovative activities;
- Innovative profile – the Educational level, the Research and Development inputs (employment and expenses) and outputs (patents and creation of new technology-based enterprises).
- Innovation Planning – the relevance and coordination of mechanisms that regional actors designed and putted in action to consolidate a common strategy in terms of development based on innovation.

- Regional Governance – the existence of a regional structure that coordinates/promotes innovative activities are usually stressed as a central issue to the maturity of a RIS.
- Research and Development and Higher Education Poles – both activities are central to two of the main drivers of innovation, knowledge creation and learning capabilities.
- Interface Organizations – the world of Research and Enterprises has an important gap. Organizations, like knowledge transfer offices or science and technology parks that try to make bridges between both realities are crucial to take inventions to market and materialize innovations.

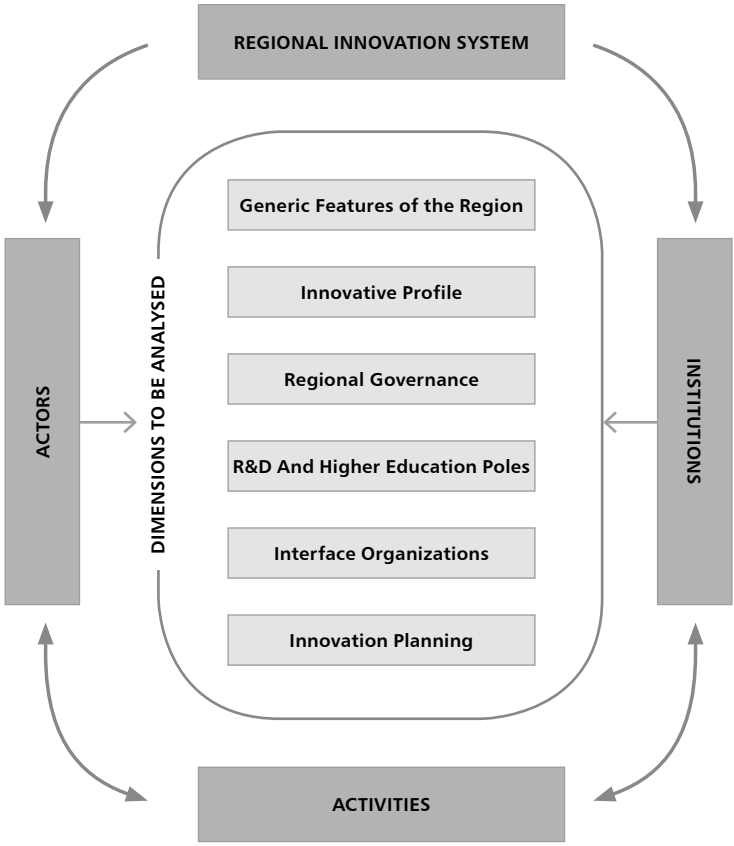

Figure 9 - Analytical Dimensions
Source - Own elaboration

The considerations of these six important dimensions give us a snapshot of the reality of each one of the regions and show some aspects linked with the actors, institutions and actors that characterize the Regional Innovation System.

The Approach to Regional Innovation Systems in Algarve and Andalusia

Synthetic Presentation of the Algarve

The Algarve is a Portuguese region located in the south of the country, limited in the north by the Alentejo region and in the east by the Spanish region of Andalusia, specifically, the province of Huelva. In the south and west, the Algarve is bathed by the Atlantic Ocean. Here the Atlantic is softened by the influence of the Mediterranean. The region is constituted by the district of Faro (the region capital) divided in sixteen municipalities. It corresponds to around five percent of the Portuguese national territory.

The geography confers the Algarve a peripheral characteristic in the Portuguese and the European context. This characteristic brought some difficulties to the promotion of the development. Nevertheless, the last three decades witnessed a major structural transformation. The region, considered one of the poorest with low levels of life quality, massive emigration; economy based in traditional agriculture, fisheries and manufactures of these activities, was transformed in an attractive region with the highest population growth rates of the last decade (1991-2001) in Portugal. Currently the Algarve has around 410.000 inhabitants. In terms of economic development, the region left the group of "convergence" regions on the framework 2007-13 structural funds. The phasing-out status of the Algarve brought significant cuts in the financial aids but underlined the strong growth of the past decade. The Algarve, compared with the other Portuguese regions (the NUTS II level – characterized by the presence of a governance structure - CCDR), is the runner-up in terms of GDP per capita and in terms of purchasing power, coming only behind Lisbon. Four of the municipalities of the Algarve, Albufeira, Faro, Loulé and Portimão are in the list of the best fifteen regarding purchasing power in Portugal.

The development of the Algarve reflects the growth of a vibrant tourism sector, increased by the establishment of the International Airport in Faro, which impacted in other important sectors like construction or real-estate. On the other hand, the over-specialization in tourism-linked activities created high opportunity costs to investing in other sectors, which brought the fall of non-tourism activities. The massification of tourism in some areas, incremented by the fast development and construction, created a chaotic organization of the urban areas, in particular those in the coast with tourism vocation. Besides the importance of sun and beach product, the Algarve has an interesting portfolio of other products, with relevance to Golf, which was distinguished several times as the best Golf destination of the World, by the international associations in the sector. Other relevant product is the nautical tourism, with several important competitions being carried on and well-equipped marinas and tourism ports.

The rural Algarve suffered a process of abandonment (human desertification, ageing issues, very low levels of income and no access to collective equipments and services), contrasting with the very dense occupation of the coast. In fact, "two Algarves" can be considered. Almost 2/3 of the Algarve population lives in 20% of the regional territory, a linear metropolitan area, from Tavira to Lagos.

The Algarve as around 64.456 enterprises (18.697 societies) and the most relevant sectors in the region are tourism, construction and commerce, concerning the employment it creates and the percentage within regional production, INE (2006). Nevertheless the economic activity

transcends these sectors, where traditional activities like agriculture, fisheries or industry assume notorious importance. Besides these activities, others are becoming gradually of more interest to entrepreneurs, such as biotechnology (in particular, the green biotech and the blue biotech) and agro-food industries.

Innovative Profile

In the Algarve, the last two years have been important in the implementation of regional planning processes (Regional Development Strategy 2007-13, PROTAlgarve – Territorial Plan, Operational Program Algarve 21 and the Regional Innovation Plan). All these documents converge in giving innovation a central role in reducing the mono-production of the tourism that characterizes the development of the region.

The major problem regarding innovation in the Algarve is the very low level of education. Only 13,9% of the individuals between 25-64 years old have an high education degree (compared to the 22,4% of European average). In terms of the low educated people, the Algarve faces a very concerning situation (69,2% face to 29,1% European average). This reality causes important limitations in terms of the main driver of innovation, the learning process, restraining the entrepreneurial capacities, risk aversion and appetence to cooperate. Analyzing the behaviour of the companies, a small capacity to innovate is recorded. The indicators available at regional level show the predominance of incremental process innovation. The inputs of innovation, R&D personal or expenses are quite low. Recent data by Pinto (2006) showed that the expenses in R&D represent approximately 0,26% of the regional GDP, extremely far from the 3% percent goal of the Lisbon Agenda. There is another problem regarding R&D, apart from the insufficient scale that limits the creation of innovation, which has to do with who executes it. In the Algarve, R&D expenses are majority concentrated within the University (82,7%,). Enterprises represent only 8,8%. The financing of R&D is mainly coming from public funding (the national average shows that the private sector only represents 31,5% of the total investment), a situation contrasting with the OECD average, where the private sector accounts for about 60%. This factor is a limitation, as it is known that private R&D has a stronger impact in innovation when related with applied science. Projects of applied science are more likely to generate innovation outputs, such as patents or technology-based start-ups and spin-offs, two indicators where the Algarve is in a very weak position. Only larger enterprises (a minority) show slightly more innovative behaviour. Adding, to those indicators, the economic structure, where some company owners are too much focused in short-term profits, are risk adverse and very reluctant in adapting to change, a situation that will lead the Algarve to a continuous loss of competitiveness might be created, as referred by the CCDR (2006: 16). There is a growing attention to economic and social actors, to promote an adequate environment to innovation. One of the problems underlined is the inexistence of knowledge-based enterprises that stimulate the demand and supply of innovation creating technological markets. Another problem is the lack of relations between the main regional actors; in particular the relation between industry and academy is still inconsistent. This gap is a major restriction to knowledge and technology transfer. To overcome the problem, the university and some associations are developing several initiatives to stimulate this linkage, for

example, the creation of an interface organization like CRIA (Regional Centre for the Innovation of the Algarve). The excessive Portuguese bureaucracy is one of the most cited limitations to innovation, as it strangulates the decision-making process.

In Portugal, the funding of innovation is still limited, with the traditional banking sector being risk adverse and focusing the loans on the credit to consumption or housing. Solutions related to micro-credit or loans for productive investment are needed for the Algarve. There is a lack of risk capital (in particular seed capital adequate to entrepreneurial activities) and actors in general do not trust the mechanisms of risk capital solutions (for example, the Finicia program). Other limitation is the inexistence of interesting financing support from business angels.

The identification of sectors with the capacity to induce a sustainable regional growth, with a diversified economic base, was made in the process of creating a regional innovation plan, UAlg (2007). These refer to sectors with an important economic expression, like tourism, agro-food, sea - fisheries and aquaculture, and sectors where the region has specific potential based on natural resources or on R&D carried out by the University (renewable energies, life sciences, ICT, multimedia and intelligent systems). Tourism (the Algarve is responsible for 2/3 of tourism incomes in Portugal) and sea (the region has accounts a significant percentage of Portuguese fisherman (28%) and aquaculture farms (71% licensed units, 80% of area, 55% of production in quantity and 68% in value, INE (2006), have both strong scientific and economic dynamics. For their success, the other sectors are dependent on the complementarities to be created in the future.

There are important limitations regarding Science and Technology infrastructures; there are no science and technological poles in the Algarve and no science and technology incubators. This problem is currently being partially addressed by the development of science facilities, *e.g.*, the Algarve Science and Technology Park (project lead by the University in the scientific expertise domains), the Technopole in Tavira (lead by Câmara Municipal de Tavira related with Renewable Energies) and the Technopole in Lagos (lead by the Câmara Municipal de Lagos).

Innovation Planning

The Regional Innovation Plan was designed to contribute towards the building of answers adjusted to the ambition/strategic design of the Algarve and the conception of a strategy to create a Regional Innovation System. The process of the PRIAlgarve – Algarve's Regional Innovation Plan, was based on the analysis and critical review of a set of documents, with prominence in the Ettirse project (1999-2001), INOVAlgarve programme (2002-2003) and the Regional Development Strategy 2007-2013. The plan defined six key-sectors: Tourism (central sector of regional economy), Agro-food sector (crucial to diversification of the economic base), ICT (consolidate the information society), Sea (Algarve's strategic resource), renewable energies (latent regional competitive advantage) and Life Sciences (an investment for the future).

The PRIAlgarve seeks to establish a strategic commitment between vectors of intervention in the innovation processes and the generation of critical mass infrastructure, as well as to finance the conditions for the creation and the development of innovative enterprises, the incubation and launching of start-ups and incentives to internationalization; scientific employment and the training of advanced competences relevant for enterprise modernization and regional specialization. The

establishment of networks for regional, interregional and international cooperation between Universities and above all regarding University-Industry are also worth to mention.

This context envisions four programs:

- Innovation Support Structures and Environment (main projects: the creation of the Algarve Science and Technology Park and a Regional Risk Capital Fund);
- Regional Innovation and Enterprise Initiative (main projects: program to support new technology based companies, technological modernization of existing companies, Regional Innovation Forum, strategic services to support the activity of companies the industrial zones of the Algarve);
- New Regional Abilities (main projects: insertion of Masters and Doctors in regional companies; fellowships for science and researchers);
- Cooperation for the Development of Regional R&TD (main projects: promotion of trans-border laboratories)

It is expected that the execution of these projects occur through public-private partnerships developed in the region, granting the access to funds from the CSF 2007-2013, from Regional Operational Program and Thematic National Programs and also from European Programs, like the 7th Research Framework Program or the Competitiveness and Innovation Framework Program.

Regional Governance

The CCDR Algarve (*Comissão de Coordenação e Desenvolvimento Regional do Algarve* – Regional Development and Coordination Commission) created by the *Decreto-Lei* number 134/2007 is a service of the direct administration of the State, in the context of the Ministry for the Environment, Spatial Planning and Regional Development, with financial and administrative autonomy, with the mission of executing environmental policies, spatial and urban planning, regional development, in its specific geographic area, promoting coordinated actions of the scattered services in regional context and technically supporting the municipalities and their associations.

The CCDR presented the Operational Program Algarve 21, for the period 2007-13, which intends to strengthen the Algarve as a dynamic, competitive region in the context of Knowledge Society. To achieve this ambition is important to prosecute priorities and objectives that lead to:

- Qualification, innovation and diversification of the economy;
- Human resources valorisation and creation of competences;
- Promotion of a balanced and competitive territorial model;
- Consolidation of a sustainable environmental system.

The OP is inserted in QREN – National Strategic Reference Framework with a budget of ERDF – European Regional Development Fund of 175 million euros oriented to the investment in three main axes:

- Competitiveness, innovation and knowledge;
- Protection and Environmental qualification;
- Territorial valorisation and urban development.

Research and Development and Higher Education Poles

As a thirty years old institution, the University of Algarve has now achieved its majority, deservedly recognized on account both of the growth of its physical structures and of the maturity evidenced in its teaching, administrative and research structures.

With its headquarters in Faro, the University enjoys spacious facilities: two Campi (Penha and Gambelas) and two teaching sites (Portimão), which all provide excellent conditions for the entire academic community. Ocean Sciences, Earth Sciences, Business Studies and Humanities at the University of Algarve enjoy a privileged environment for developing and widening the horizons of the builders of the Future.

As for specific skills, the University of Algarve is equipped with modern laboratories, used for research and experimentation in the most varied areas of knowledge, committed to research and development. A proof of this is the extensive list of Centres, Laboratories and Research Associations distributed by various areas, such as Ocean Sciences, Marine and Environment, Biomedical Sciences, Environmental Chemistry, Chemistry of Natural Products, Biochemistry, Biotechnology, Chemistry of Matter and Catalysis or Horticultural Sciences, which whether subsidized or not, develop a variety of activities and project the image of a university of high standards.

Among such R&D units some can be stressed, *e.g.*, the Centre for Ocean Sciences of the Algarve (CCMAR), the Centre for Marine and Environmental Research (CIMA), the Centre for the Development of Sciences and Techniques of Vegetable Production (CDCTPV), along with other research areas like Astrophysics and Space Physics, History and Archaeology, Tourism and Regional Economics, Econometrics, Chemistry, Electronics and Telecommunications, Signal Processing and Sub aquatic Acoustics, Experimental Particle Physics or Marine Geosciences, that are supported by the University.

Interface Organizations

The Regional Innovation Centre (CRIA) was born in 2003 from a partnership of University of Algarve (Research), CCDR Algarve (Regional Authority for Planning and Coordination) and ANJE Algarve and NERA (enterprise associations), as an answer to identified problems in the region: gap between research and enterprises and adverse environment to innovation. The mission of CRIA was the promotion, transfer and commercial approach to technology and knowledge in the academy, consolidating the linkage University-Enterprise. The three first initiatives of CRIA were: a Innovation Fair – a Public presentation of 75 innovative projects of the University to regional enterprises; a Tech-based Idea Contest – which resulted in 12 winning projects awarded Business Plans by well-known consultancy enterprises and the creation of GAPI (Industrial Property Rights Office) in the University. The activities of GAPI focus on patents and utility Models. Currently there are ongoing around 200 processes of trademarks, 10 patents and 30 logo registration processes.

CRIA is increasing the technology and knowledge transfer generated in the university. For this purpose, a section of CRIA called OTIC – Office for Technology and Innovation Transfer - was created. OTIC developed the following activities: characterization of R&D capabilities and

existent networks; inventory of competences, services, equipments and laboratories of the university; presentation of services to enterprises; launching of new laboratories and studies on regional innovation.

The support to tech-based entrepreneurship was funded by the CRIATech project. The main activities developed were the support to implementation of the winning ideas from the first idea contest, support to proposals for incentive programs, detection of financing opportunities and support to proposals for entrepreneurship contests. In this context, several new enterprises were supported, mainly in the field of marine sciences. The interface university-enterprise (U-E) is being reinforced with some consortium U-E projects. An R&D nucleus in enterprises (NITEC) was developed within Inesting (in collaboration with the Faculty of Economics).

CRIA participates in the regional FINICIA Platform. This is an initiative promoted by the Portuguese institute of support to small and medium sized corporations – IAPMEI – that has developed regional platforms to select entrepreneurial projects that are likely to receive financial support. This platform is composed of regional relevance institutions, with responsibilities in the field of supporting entrepreneurship and start-up creation. This is an important instrument to increase the social capital among the involved organisms.

CRIA is also proactive in participating in networks related with innovation, industrial property, science and technology parks and technology transfer. At national scale, GAPI, OTIC and Tecparques networks can be referred, and at international level, the Proton, ASTP and IASP networks. An important protocol was established with University of Texas in Austin to start collaboration to benchmark and train CRIA personnel with the expertise of IC2 of the last two decades. CRIA is also concerned with the need for incubation and science & technology areas. For this purpose, several projects are being carried out: the Algarve's Science and Technology Park (STP), the Sines CIBT (Technology-based Incubation Centre) and Incubation areas within the *campi*.

In 2007 and 2008, CRIA prepared a set of important initiatives. The first was the Algarve's Regional Innovation Plan. A second main initiative was the launching of the Regional Innovation Forum, *i.e.*, regular meetings with the main actors for regional innovation. A new Technology-Based Idea Contest was launched in 2007, originating fifteen new start-ups. Furthermore, a major event was prepared to approximate enterprises with applied research projects - INOVA 2007.

Synthetic Presentation of Andalusia

Andalusia is a Spanish region considered a natural crossroad between the Mediterranean countries and the Americas, and between Europe and Africa. Andalusia has a population of 7.3 million inhabitants (18% of Spain's population). It is localized in the extreme south of the country. The north of Andalusia is characterized by the *Sierra Morena* and in the west the Guadiana River separates the province of Huelva from Portugal. In the south, the Atlantic Ocean baths the coast of Huelva and Cadiz, and the Mediterranean Sea in Cadiz, Malaga, Granada and Almería. The east is limited by Levante. With 87.268 km^2 (17% of Spain), Andalusia is the second more extense *Comunidad Autónoma* of Spain with an area similar to that of Portugal. The Guadalquivir River has created a fertile valley that configures the region and is important for the economic activities in the adjacent territories. Half the territory of Andalusia is mountain

and a third is above the 600 metres sea level (46 peaks are above 1.000 metres - Mulhacen and Veleta the 3.400 metres - Sierra Nevada). The region is well served by motorways and highways (more than 24.000 km), railways and high-velocity trains (Sevilla-Córdoba-Madrid – since 1992 – and the recent Malaga-Cordoba-Madrid). The air transportation is guaranteed by international airports in Malaga, Almeria, Sevilla, Jerez, Granada and Córdoba. The sea ports assume a strategic role, in particular in Algeciras – one of the main ports in the world for maritime transportation. Other ports like Huelva, Cádiz, Málaga and Almería are important in terms of transport routs. There are several sportive and fluvial ports in Seville.

Besides agriculture and tourism, the main regional economic sectors are chemical industry, auxiliary car industry, electronics, telecommunications, aerospace and agro-food. In terms of labour force, the agricultural sector has experienced a decline, while the industrial and services sectors have increased in importance. In recent years, the GDP growth rate in Andalusia has been very intense, almost three times the average values in Portugal or Italy. Currently the region is above the 75% of GDPpc level that defines the Convergence regions but remains in a worst situation than the majority of Spain. The employment has grown in a very fast pace, more than 600.000 new jobs transformed the region in the *Comunidad Autónoma* with the highest employment growth (22,5%) and among the 268 EU27 regions the best-performer. In the Euro Zone, only Germany, France and Italy (country level) have created more jobs that Andalusia itself. Andalusia created more jobs (2004-2008) than the United Kingdom. Nevertheless the growth in employment and activity rates and the diminishing of unemployment, relevant regional problems remains. The quality of the work created was also target of criticism, especially in the intensive agriculture provinces like Almeria. Another problem to solve is the intense illegal immigration that uses the region as the gateway to the European Dream.

The dynamics of Andalusia is expressed in more than five hundred thousand enterprises (511.728 in 2007), (Andalusian Ministry of Innovation, Science and Enterprise, 2007a), a growth of 42,37% in the number of enterprises since 1999. Larger enterprises (more than 50 workers) had a more intense increase. The productivity grew (14,6%) and the competitiveness was influenced by the exportations of the region growing 160%, more than world average (134%), or other open economies like Germany (113%), USA (77%) or Japan (46%). The supply side growth is based on a diversified economy, where six of the ten highest growth sectors are industries since 2000, and the services other than construction. The demand side reflects the high investment rates in the regional economy (around a third) and the internationalization of the local enterprises and Foreign Direct Investment. Other important issues are the growth of women employment and of education level. Andalusia's economy has as one of key characteristics - its variety. As referred by IRE (N/D), the traditional image of Andalusia linked to agriculture and in recent years to tourism, is changing to several industrial sectors, such as:

- Chemical industry - the most important sub-sector, basic chemistry, is concentrated in Huelva (petroleum derivatives, organic chemistry and derivatives of iron pyrite), Cadiz (petrochemicals) and, to a lesser extent, Seville;
- Automobile industry - vehicle manufacturing process and automobile components suppliers for different European car manufacturers are well-established in the region (Renault in Sevilla, General Motors and Ford in Cádiz).
- Computer industry - there are three computer manufacturers in the region together

with nearly 50 software development companies, about 130 distribution companies and various computer-related services, for example, consultants, data processing centres and maintenance;

- Information and communication technologies - the region hosts a number of communications companies, specialized in the production of telephone and communications network equipment, however, most local companies are dependent on multinational companies of the sector;
- Aeronautics industry - Andalusia's aeronautics industry dates back to the 1930s. Nowadays, there are a few factories (EADS-CASA, AIRBUS and GAMESA) and companies providing structure assemblies, sheet metal working, composites and the production of small runs.
- Agro-food industry - the agricultural tradition is deep-rooted in Andalusia for centuries. The main agro-food activities are baking, oils and alcohol; combined with vegetable canning and meat industries, which accounts for 70% of the turnover in this sector.

As referred by Porras Gómez (2007: 3-4), in Andalusia, the attraction of Foreign Direct Investment (FDI) through multinationals has a special importance regarding the technological weaknesses of the region, since multinationals usually invest a greater proportion in R&D and have a spill-over effect. In fact, much of the technological development in Andalusia and Spain, in the second half of the 20th century, is due to the FDI. Since its admission to the European Union, a time series show that Spain has experienced a great increase in the attraction of Foreign Direct Investment (FDI), and Andalusia has attracted an important share of that FDI. Nevertheless, multinationals mainly invest in relatively low technological sectors to take advantage of the lower salaries, like Agro-food (international purchases of Andalusian companies like Koipe), Beverages (especially in the sherry sector, with international companies like Allied Domecq, and the beer sector, through the purchase of Cruzcampo Beers by Heineken), mining and the iron-steel industry, due to the historical importance of mineral deposits in Andalusia (multinationals like Boliden).

Innovative Profile

Based in the data of the *Consejeria de Innovacion, Ciencia y Empresa*, (Andalusian Ministry of Innovation, Science and Enterprise, 2007b), with respect to innovation efforts, the research budget was, in Andalusia for 2005, around 1.051.028 million euros (0,84% of regional GDP) against 1,13% of national average. The absolute growth of the indicator is does not seem very relevant (in 1993 it was 0,64% of the Regional GDP), it represents an huge effort when the regional GDP grew from 49.018,31 million euros to 126.283,84). In Andalusia, a 32,3% of R&D expenditure is financed by private organizations and 67,7% of the expenses are related to public investment. This situation reflects the excessive importance that public actors still have in the Science, Technology and Innovation system. Even when compared with the whole Spain, the situation is relatively worse once the private expenses represent, in this case, 53,9%. The education has gone through an important quality and quantity improvement, as the major regional cities have universities and currently there are ten public universities, with about 240 thousand students. In relation to the number of researchers, in 2005 it ascended to 18.803 representing around 5,47‰ of the active population. In the whole Spanish territory this figure

is more expressive (8,37‰). The percentage of full time equivalent researchers in Andalusia-Spain ratio is stable (with a small) growth, evidencing that the region is able to cope with the technological intensification and growth of scientific jobs in Spain, as an average. In relation to scientific production, Abascal (2006), Andalusia has shown important growth, from 3.629 to 4.632 total documents in ISI. In terms of contracts between enterprises and universities, it has grown from a value around 200 in 1990 to more than 1600 contracts in 2004. One of the main innovation outputs, the number of patents, has registered an increase from a total around 150 in the nineties to 340 patents in 2004. This situation expresses a more adequate situation in terms of inputs than outputs. The same author, analyzing the number of years to converge, showed that Spain will catch-up with EU15 in 6 years, France in 9 and Germany in 9, in relation to researchers and publications, but in terms of patents (EPO and USPO) it will need, respectively, 71-69 years to converge to EU15 average, 78-40 years to France and 131-101 to Germany. Andalusia is currently under the process of updating and developing its innovation system. On the basis of different initiatives carried out in the last few years, the regional government has put together a strategy to promote a framework for public and private R&D and to find ways of improving the innovation and technology transfer system. Andalusia evidences interesting quality and capacity of research potential, increasing the creation of patents and the companies are starting to invest in R&DI due to the growing competitiveness of the productive sector. In relation to financing innovation, different instruments were being developed since 1999, in particular the creation of Invercaria –a public company, 100% owned by the Andalusian Ministry of Innovation, Science and Enterprise, with the objective to promote and develop instruments to assure financing of enterprises in Andalusia. Andalusia shows an interesting existence of the most important types of actors to create a Regional Innovation System, as it has an impressive internal market and critical mass to support a wide variety of initiatives.

Innovation Planning

The Innovation and Modernization Scheme for Andalusia (*Plan de Innovación y Modernización de Andalucía / PIMA*) is an instrument of strategic planning that defines the framework, the strategies, the objectives and the actions to impel the transformation of the social and economic culture of the region. It was assured by the Andalusian Government, with a budget that overcomes the 6.000 million euros.

PIMA was created as a consequence of the commitment of the Andalusian regional government to promote increasing development of social and economic welfare in the region. This document – of political strategies of innovation and modernization for Andalusia – comprises both a project to build the Andalusia of the future depicted by social welfare, equal opportunities, cohesion, sustainable development and intercultural nature, and a Specific Plan of Action of the Regional Ministry of Innovation, Science and Enterprise for the present legislature.

The Innovation and Modernization Scheme for Andalusia should be regarded as:

- A guide to transverse (or horizontal) strategic orientation to development governmental policies and actions, with innovation, creativity, transparency and participation as key factors of success;

- A basic tool for coordinating the available resources of support to innovation in Andalusia, towards a leadership position in the society and to an international and global projection of knowledge;
- A planification instrument for the Regional Ministry of Innovation, Science and Enterprise, that is coherent and complete but not closed, and facilitating the integration of aims, strategic lines and actions to be developed during the present legislature.

Regional Governance

The Andalusian Autonomous Government (*Junta de Andalucía*) is a huge organization, comprising 14 departments, 7 independent bodies, and around 210.000 public employees, covering a whole range of competencies. In terms of innovation, the creation of the *Consejería de Innovación, Ciencia y Empresa*, reflects the political strategy of defining a unique structure which affects the main actors in the innovation and knowledge development. Innovation has a crucial value for the economic and social model in Andalusia. For the first time in Europe, a government has included all the competences concerning to the universities, the technological development, the information society, the entrepreneurial development, the energy and the entrepreneur culture in a political and administrative single entity. The competences of the Consejería de Innovación, Ciencia y Empresa, are:

- Higher education in Andalusia, in all the extent, saving the universitary autonomy;
- Coordinate and incentive to scientific and technical research, innovation and technology transfer;
- Technological development in enterprises, specifically the incentive to private R&D;
- Innovation policies related with ICT;
- Information systems and telecommunications related with information society in Andalusia;
- Social economy, in particular cooperatives;
- Industrial, energy, mining activities, economic cooperation and incentive to activities in those areas;
- Initiatives related with entrepreneurship.

Research and Development and Higher Education Poles

Andalusia has a relevant network of public universities, with important research centres in all domains of scientific knowledge. The priority fields of research, established by the Research, Development and Innovation Plan of Andalusia (PAIDI), reflect the strategic priorities of the Andalusian R&D system. The areas of regional expertise, according to Porras Gómez (2007: 10-11), are: Aeronautical, Space, Biotechnology, Agro-industrial and Food, Exact and Experimental Sciences, Health, Social, Economic and Legal Sciences, Humanistic and Artistic Creation, Technologies of Production, Nanosciences, Nanotechnologies and Materials, Natural Resources, Energy and Environment, Information and Communication Technologies, Social Integration, Immigration, Globalization and Cooperation, Violence and Social Behaviour, Historical and Artistic Patrimony, Territorial Integration, Transport and Intermobility, and Tourism.

1.University of Almería
2.University of Cádiz
3.University of Córdoba
4.University of Granada
5.University of Huelva
6.University of Jaén
7.University of Málaga
8.University of Seville
9.University Pablo de Olavide (Seville)
10.Universidad Internacional de Andalucía (UNIA)

Interface Organizations

In Andalusia all universities have technology transfer offices called OTRIs (*Oficinas de Transferencia de Resultados de la Investigación*). OTRIs are focused on the promotion of the relations between the university departments and the research groups and the business world. All OTRIs belong to a national network of transfer offices in universities and public research centres, coordinated by the Spanish Universities Rector´s Office. The role of OTRI is, in each university, to determine the actual R&D demand of companies and address it to the appropriate departments and research groups, to identify the transferable results of research groups, disseminate the results among the enterprises and facilitate the transfer. Other important aspect is the promotion and negotiation of R&D or technological support, and guidance contracts or patent licensing agreements between university and companies. The OTRIs have then to manage the contracts and support the university administrative services. OTRIs also play an important role in supporting project proposals to European or national R&D projects, promoting the cooperation and the networking.

The Agencia de Innovación y Desarollo de Andalusia (IDEA) contributes to the economic development of the region by supporting business, entrepreneurs and the regional government on the promotion of entrepreneurial behaviors, innovation and cooperation in the Scientific-Technological-Entrepreneurial system, and by improving the competitiveness of the productive structure. The Agency for Innovation and Development of Andalusia has been appointed as the instrumental executor for the policies of promotion and for economic and social development, as the regional development agency of the Andalusian Government, under the aegis of its *Consejería de Innovación, Ciencia y Empresa*. The agency provides advanced services, infrastructures and equipment, advises companies and manages incentives, in order to ensure that innovation becomes one important driver of the regional development, and that it catches-up with the levels of the most advanced regions in Europe.

IDEA is encouraging the increase the technological level of the enterprises by:

- promotion and creation of collaborative networks in order to drive and encourage innovative processes among the regional actors;
- technology advice on research results protection, technology transfer in the business field and technology watch;

- incentive and encouragement of RTD&I in productive sectors;
- technology-based start-ups and spin-offs;
- incentive and encouragement of information society into SME;
- incentive and encouragement of cooperation and collaboration among different partnerships and institutions from different countries to encourage R&D level.

In recent years, the Government of Andalusia has made major efforts to provide the infrastructures, innovative means and technology to increase the competitiveness of its economy, and to favour convergence with other main European regions. The FDI Atlas (N/D) refers that the Andalusian Network of Technological Parks has recently been constituted, in an effort to build synergies from the cooperation and collaboration among the various agents involved.

Amongst the main existent technological parks in Andalusia, the following must be highlighted:

- Parque Tecnológico de Andalucía (Andalusian Technology Park) PTA (Málaga).
- Parque Tecnológico de Ciencias de la Salud (Health Science Technology Park) (Granada).
- Parque Tecnológico y Aeronáutico (Technology and Aeronautical Park) AEROPOLIS (Sevilla).
- Cartuja '93 (Sevilla).
- Parque de Actividades Medioambientales de Aznalcóllar (Aznalcóllar Environmental Activities Park) (Sevilla).
- Tecnoparque Bahía de Cádiz (Bay of Cadiz Technology Park) (Cadiz).
- Parque Científico y Tecnológico del Aceite y el Olivar (Oil and Olive Science and Technology Park), Geolit (Jaen).
- CIT de la Piedra Natural (Natural Stone CIT) (Almería).
- CIT del Plástico Industrial en Martos (Martos CIT of Industrial Plastic) (Jaén).
- CIT Adesva (Agroo-food CIT) (Huelva).
- Technology Parks and Centres of Innovation and Technology projected:
- Rabanales 21 (Córdoba).
- Parque de Innovación y Tecnología de Almería (Almería Innovation and Technology Park) (Almería).
- CIT de la Madera y del Mueble de Lucena (Lucena Wood and furniture CIT) (Córdoba).
- CIT del Textil (Textile CIT) (Córdoba).

The Centres of Innovation and Technology (CITs) are sites of innovation and technological development, promoted by the *Junta de Andalucí*a, to improve the competitive capacities of key sectors of the Andalusian economy, to help with the technological requirements of the businesses, to promote cooperation between these and to facilitate the transfer of research.

Conclusion

The regional scale is currently a broadly-used concept for theoretical and empirical analysis when the innovation is in the spotlight. Nevertheless the Regional Innovation System approach still requires a robust framework as a concept or as a practice.

There are several dimensions relevant when trying to understand a specific RIS. The ones

proposed in this paper can serve as guidelines to a better comprehension of the specificities of each regional profile. It can be interesting in future research trying to understand in depth the differences between regions, in particular what concerns the institutional arrangements that restrict and promote the innovative performance.

Analytical Aspects of RIS		Performance of Regions	
		Algarve	Andalusia
Generic Features of the Region	Critical Mass	-	++
	Transportation Networks	+	+
	Economic Diversity	--	+
	Potential Areas with High Added Value	++	++
Innovative Profile	Educational Level	-	-
	Innovative Inputs	-	+
	Innovative Outputs	+	-
	Innovation Actors	-	+
	Innovation Institutions	-	+
Innovation Planning		+	+
Regional Governance		-	++
R&D and Higher Education Poles		+	++
Interface Organizations		-	+

[Classification: - - (bad); – (poor); + (acceptable); + + very good]

Table 16 - Qualitative of Relevant Aspects for the RIS
Source - Own elaboration

The table 16 synthesises the performance of the Algarve and Andalusia for each one of the dimensions.

The comparison carried out between the Algarve and Andalusia underlines the discrepancies between these neighbouring regions originating, in our opinion, at least three different branches of reflection. The first is that even when we compare European regions in the same level of analysis (in this case NUTS II) we can find major differences in terms of dimension. Andalusia is a huge region while the Algarve is a small one. This situation, more population, more enterprises creates a relevant market, attracting more FDI and a sort of relevant organizations. This is the problem of critical mass.

The second branch is linked with the capacity to create, attract and retain qualified people to work in the region. If this creative people can live in a region they will attract more innovation inputs and increase the transformation in successful outputs. Qualified people will attract more investment, will do more research, develop more successful enterprises, will create more partnerships, and will be enrolled in society at a deeper level. A competitive region depends in the learning capability. The lack of possibilities in careers and qualified employment opportunities

in firms and public organisms is originating a decrease of qualified jobs in the Algarve and a relevant brain drain. This is the problem of Education.

The third and final branch is related with the governance. Territories to flourish need to create modes of governance that facilitate share between its components. In this way is crucial to have the actors and the institutions that promote an innovative environment. The Algarve is deficient in terms of innovative actors but is even worse when we understand the level of cooperation between the existent ones.

Several challenges… And solutions?

For branch 1 we could say that the challenge is to create networks and partnerships that permit the diminishing of the problems related with critical mass. For branch 2 we recommend a massive investment in Education, not only in qualifying people but retaining this people (for example, with scientific fellowships and specific support for start-ups creation). For branch 3 it is important to inform and cooperate. Actors should trust each other. An increase of social capital is really necessary in the Algarve. Enterprises cannot continue to doubt public bodies and vice-versa. The density of relations needs to be upgraded.

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ANNEX I

Region			PT15	ES61	ES	PT	EU27
			Algarve	Andalusia	España	Portugal	EU27
Population	Total population (1000 inh.), 2004		408	7612	42692	10502	489671
	Population density (inh./km^2), 2004		81,9	86,9	84,4	114,2	116,0
	Population growth (average annual % change), 1995-2004		1,7	0,8	0,9	0,5	0,3
Economy	GDP/head in PPS (Index, EU27=100), 2004		77,1	77,6	100,7	74,8	100,0
	GDP/person employed, in Euro (Index, EU27=100), 2004		59,4	85,9	91,7	57,8	100,0
	GDP growth (average annual % change), 1995-2004		3,4	3,8	3,7	2,6	2,3
	Employment by sector (% of total employment), 2005	Agriculture	6,7	9,2	5,3	11,8	6,2
		Industry	20,7	25,8	29,7	30,6	27,7
		Services	72,6	65,0	65,0	57,6	66,1
	R&D expenditure (% of GDP), 2004		0,2	0,8	1,1	0,7	1,8
	R&D expenditure in the business enterprise sector (% of GDP), 2004		0,0	0,3	0,6	0,3	1,2
Labour market	Employment rate (%), 2005	Ages 15-64	68,0	55,4	63,3	67,5	63,3
		Female 15-64	59,9	40,7	51,2	61,7	55,9
		Ages 55-64	54,2	34,9	43,1	50,5	42,2
	Unemployment rate (%), 2005	Total	6,2	13,8	9,2	7,6	9,0
		Female	7,7	19,4	12,2	8,7	9,8
		Young (15-24)	15,7	24,5	19,7	16,1	18,8
		Long-term unemployment (% of total unemployment)	32,7	25,3	24,5	48,2	46,0
Age structure	% of the population aged:, 2004	< 15	14,7	16,9	14,5	15,7	16,3
		15 - 64	66,7	68,5	68,6	67,4	67,3
		65 +	18,7	14,6	16,9	16,8	16,4
Education	Educational attainment of persons aged 25-64 (% of total), 2005	Low	69,2	59,6	51,2	73,5	29,1
		Medium	16,9	17,8	20,6	13,6	48,6
		High	13,9	22,6	28,2	12,8	22,4
Economic Lisbon Indicators (average of re-scaled values relative to the EU27 mean), 2004-2005			0,45	0,35	0,53	0,42	0,51

Table A.1 - Statistical Socio-Economic Indicators
Source - European Commission (2007)

In table A.1 we can see some interesting figures comparing Algarve, Andalusia, the Portuguese and Spanish national averages and the European Union average (with twenty seven member states).

ICT Diffusion, inward foreign direct investment, and entrepreneurship in developing countries: A research note

Rui Baptista
Pedro M. Faria

Introduction

The last decades have established the fundamental importance of technological progress for economic growth and wealth creation. Most new technology is created in developed countries. For these countries, the fundamental problem for growth is to harness the economic value of new inventions by converting them into new products, processes and organizational means. Entrepreneurship plays a fundamental role in this course of events (Shane 2001; Michelacci 2003; Acs *et al.* 2004; 2009).

In developing countries the diffusion of new technologies plays an essential role in fostering growth. However, entrepreneurial skills are also required in order to convert the acquired knowledge into wealth. In this paper, we argue that, besides contributing to general economic growth by improving productivity, information and communication technologies (ICTs) may represent, together with inward foreign direct investment (FDI), an important driver of entrepreneurship, by serving as channels for the transmission of knowledge spillovers that widen the awareness of business, opportunities and making it easier for small businesses to increase their market reach.

The paper proceeds as follows. The next section discusses the role played by ICTs and entrepreneurship in the process of economic growth. Section 3 examines the role played by ICT diffusion in developing countries and discusses how inward FDI can contribute to technology transfer. Section 4 considers how ICTs and inward FDI can act as a driver of increasing entrepreneurial activity. Finally, section 5 concludes.

ICTs, Entrepreneurship and Economic Development

The Impact of ICT Diffusion on Development

In developing countries, the increasing dependence on the acquisition of technology for growth means that economic policies must be conceptualized with special attention to issues related to technology diffusion. While the concept of "digital economy" is too wide to be characterized, and the technological dynamics associated to it are far from being established, one fact is undisputed: the emergence of technological platforms of ICTs is determining significant and unprecedented changes in many aspects of our social and economic life (Corrocher and Ordanini 2002). In view

of this evidence, Castells considers that social development is driven by the ability to establish a synergistic interaction between technological innovation and human values (Castells 1998).

There is a lack of consensus in the literature with regard to the impacts of ICTs diffusion on social and economic development. An often debated issue is the effect of ICTs on productivity. On one hand, some authors hold that this impact is of little significance. Gordon (2000) presents a skeptical view of the real effects of ICTs on society, arguing that the dynamic burst of productivity growth that took place in the last decades was only noticeable in the manufacturing of computers and semiconductors sectors themselves and was insignificant in the rest of the economy. In an overview of the available evidence on the importance of ICTs for productivity growth in the Euro area, Vijselaar and Albers (2002) conclude that the positive spillover effects of the use of these technologies on general efficiency in the economic process were very limited. On the other hand, a significant stream of literature holds that the diffusion of ICTS has had a significant positive impact on productivity and development. In an examination of the contribution of computers and related inputs for growth, Oliner and Sichel (2000) conclude that ICTs have been the key factor behind the improved productivity performance of the U.S. economy in recent years. Gong and Keller (2002) argue that these technologies have diffused relatively faster in the United States and this fact might help explaining why the US lead in per-capita income over Japan has increased from 10% in 1990 to 20% by 1999.

Another significant issue raised by the diffusion of ICTs is the generation of skill-bias technological and organizational change (see Piva *et al.*, 2005). Krueger (1993) examines whether workers who use a computer at work receive higher incomes than non-users finding that workers using computers as part of their job earn 10 to 15 percent higher wages. Moreover, this author notices that the expansion in computer use in the 1980s could account for up to one-half of the increase in the rate of return to education. Results of empirical studies focusing on this issue are, however, also mixed. For instance, DiNardo and Pischke (1997) replicate Krueger's analysis using data on German workers. Their estimates of the computer wage premium are similar to those found by Krueger. However, since their data contain much more detailed information on the tools used by workers on their jobs, they apply the same techniques to estimate the wage differentials associated with the use of a calculator, a telephone, writing materials like pen or pencil, or sitting on the job. They find that the measured wage differentials associated with these executive tools are almost as large as those measured for computer use. They also find a wage penalty associated with the use of labor-intensive tools. The wage differential could, therefore, be explained by a variety of factors beyond computer use. These authors suggest two alternative explanations for the wage differential associated with computer use: i) that computer users possess unobserved skills which might have little to do with computers but which are rewarded in the labor market; ii) and/or that computers were first introduced in higher paying occupations or jobs (DiNardo and Pischke 1997).

Entrepreneurship and Economic Growth

The wide acknowledgement of the role played by technological progress (through the introduction and diffusion of innovations) on economic growth has been a product of the

evolution of economic theory. Ever since Solow (1956) based his model of economic growth on the neoclassical production function with its key factors of production - capital, labor, and exogenous technological progress - economists have relied upon the model of the production function as a basis for explaining the determinants of economic growth. Romer's (1986) critique of the Solow approach was not with the basic model of the neoclassical production function, but rather with what Romer perceived to be omitted from that model – knowledge. Not only did Romer, along with Lucas (1988) and others argue that knowledge was an important factor of production, along with the traditional factors of labor and capital, but because it was endogenously determined as a result of externalities and spillovers, it was particularly important.

The endogenous growth model perceives knowledge as an internal variable – *i.e.* technological change takes place because of intentional actions taken by profit maximizing actors in response to market stimuli. Any agent performing some form of knowledge-generating research and development - including any creative, systematic activities intended to increase the stock of knowledge and the use of this knowledge to devise new applications - contributes to the creation of a good that can be shared with few bounds, meaning that the production of knowledge has increasing returns.

Increasing returns arise because the creation of knowledge also generates opportunities for third-party firms (Jaffe *et al.* 1993; Thompson and Fox-Kean 2005), which are often entrepreneurial start-ups (Shane 2001). This occurs through knowledge spillovers. However, endogenous growth models fail to incorporate the actual mechanism of transmission of knowledge spillovers (Acs *et al.*, 2004). Knowledge by itself is only a necessary condition for the exercise for successful growth. To convert knowledge into wealth requires a set of skills, aptitudes, insights and circumstances that is neither uniformly nor widely distributed in the population. Entrepreneurial ability is therefore also a necessary condition for growth (Acs *et al.*, 2009). Entrepreneurial activity involves both arbitrage of opportunities (Kirzner 1973) and exploitation of new opportunities created, but not appropriated by incumbent firms (Schumpeter 1934).

ICTs, Inward FDI, and Developing Countries

The Role Played by ICT Diffusion

In the context of developing countries, widespread diffusion of new technologies is an essential process for social change and economic growth. Diffusion is a type of social change, defined as the process by which alteration occurs in the structure and function of a social system (Rogers, 1995). This author speaks about the innovativeness-needs paradox, through which those individuals who most need the benefits of a new idea, (the less educated and less wealthy) are the last ones to adopt an innovation. This paradoxical relationship tends to result in a wider socioeconomic gap between the individuals of higher and lower socioeconomic status. Thus one consequence of many technological innovations is to widen the socioeconomic gaps in a social system.

Extensive investment in ICT allows countries to leapfrog stages of economic growth by being able to modernize their production systems and increase their competitiveness faster than in the

past. However, those economies or (sub-sets of the population) that are unable to adapt to the new technological paradigm have little chance of development. The astonishing development of ICT and the creation of a global technological infrastructure required the world to function as a unit, making possible the existence of a multidimensional globalization (Castells 1998). Knowledge transfer associated to technology diffusion plays a major role in the relationship between countries and especially from the less developed countries point of view.

The implications of the Internet revolution on third world countries are deep, being both an opportunity and a threat - on the one hand, it allows countries to leapfrog stages of economic growth but on the other, for those that are late, their retardation becomes cumulative. The Internet presents the occasion to set communications into a new level, a level that goes beyond voice communications and incorporates entirely new applications and services. By allowing small companies to internationalize their operations, the internet presents the chance to improve social and economic conditions, and has the potential to foster convergence in the social and economic status of nations. However, while some developing countries may have the prospect to begin a path of convergence, most are hindered by social and economic constraints, low connectivity and environments that delay participation in the Internet revolution.

Archibugi and Pietrobelli (1999) argue that developing countries can benefit from globalization of technology if they implement active policies planned to increase learning and improve access to knowledge and technology. However, successful cases of ICT integration in these countries represent an exception, not the rule. These authors argue that the import of foreign technology, either embodied or disembodied, has a negligible learning impact per se, unless when accompanied by local policies to promote learning, human capital and technological capabilities.

Mayer (2000) argues that globalization has drastically improved access of technological latecomers to advanced ICT and, despite the large cross-country discrepancies in technology upgrading within the low-income countries, developing countries as a group have substantially increased the ratio of technology imports to GDP over the past decades. To raise the benefits reaped from globalization, governments might need to make additional efforts towards a simultaneous increase in technology imports and the skill level of the domestic labor force. The opportunity for technological integration offered by globalization should help to reduce the technology gap and to raise the level of total factor productivity and per capita income in developing countries.

Sachs (2002) examines the relevance of technology diffusion, defining three groups of countries: i) countries enjoying endogenous growth (innovative activity takes place on a significant scale, and patented products and technologies are produced and sold domestically and on world markets); ii) technological diffusers (countries that absorb new technologies developed in the endogenous growth countries); and iii) excluded countries (the level of penetration of new technologies, the rate of diffusion, and the extent of use of new technologies in domestic production, are all extraordinarily low). Considering that the divide between the technology innovators and the non-innovators is considerably wider than the global divide in terms of income, and that there are few countries that successfully converted from low to high innovative capacity in the last few decades, technology diffusion represents the dominant paradigm for developing nations. These countries need to master their process of technology diffusion since they do not have the competence to develop competitive technologies (Papageorgiou 2002). In order to understand the real impact of the diffusion of ICT in poor nations Pigato (2001)

examined the patterns of utilization, ownership and affordability of ICT in sub-Saharan Africa and South Asia, reaching results that confirm the Sachs perspective.

Rodríguez and Wilson (2000) build an index of technological progress in which information on five indicators of technological outputs is combined – personal computers, mobile phones, internet hosts, fax machines, and television sets. Based on their empirical investigation, these authors find that economies which have evolved technologically differ from the laggards in two vital ways: an economic environment favorable to investment, and a climate of civil liberties conducive to research and spreading out of telecommunications. As a result, they argue that substantial support for diffusion of ICT to underdeveloped countries is necessary (Rodríguez and Wilson, 2000).

The Role Played by FDI as a Channel for Knowledge Spillovers

Inward FDI represents one of the most important links between developed and developing countries and therefore plays a central role in the process of technology transfer and diffusion. Inward FDI is playing an increasingly important role in global economic growth rates (Al-Qasem 2001). Multinationals that undertake the bulk of the world's industrial research and development (R&D), are key actors in the international diffusion of technological knowledge.

Loungani and Razin (2001) argue that, in addition to reducing the risk faced by investors by allowing them to diversify their investment, the global integration of capital markets can contribute to the spread of best practices in corporate governance, accounting rules, and legal traditions. Also, the global mobility of capital limits the ability of governments to pursue bad policies. In addition to these advantages, FDI is an instrument for technology transfer – particularly in the form of new varieties of capital inputs – that cannot be achieved through financial investments or trade in goods and services. Recipients of FDI may provide employee training that contributes to human capital development.

Borensztein *et al.* (1998) examine the role played by FDI in the process of technology diffusion and economic growth in developing countries. These authors find that multinational companies possess advanced knowledge which allows them to introduce new capital goods at lower cost, but the application of these more advanced technologies also requires the presence of a sufficient level of human capital in the host economy, *i.e.* the stock of human capital in the host country limits the absorptive capacity of a developing country.

Saggi (2000) surveys the literature on trade and foreign direct investment examining in particular the role played by wholly owned subsidiaries of multinational firms and international joint ventures - as channels for technology transfer. He finds that the benefits that developing countries can take from technology transfer depend on three factors: i) how well educated and well trained is the country workforce; how much will be invested in research and development; and how much protection is offered for intellectual property rights.

Xu (2000) finds that, while MNC by American firms abroad investment is an important conduit for technology spillovers towards other developed countries, the intensity of technology transfer is much less significant for developing countries. The author explains this disparity with the gap on the level of human capital. technology transfer of US MNCs is found to increase host country productivity growth only when the country has reached a minimum human capital threshold.

ICT Investment, Inward FDI, and Entrepreneurship

According to Baumol (1968:p.69), public policies should be directed to "induce the appearance of increased supplies of entrepreneurial skills" and the policy-maker should be "interested primarily in what determines the supply of entrepreneurship and in the means that can be used to expand it."

The attraction of FDI plays an important role in public policies for entrepreneurship promotion since the presence and activity of MNCs have been argued to impact positively on indigenous entrepreneurial activity (Acs *et al.*, 2009). FDI is also associated with technology transfer and knowledge spillovers, channelled through product and process technology, management practices, information about access to foreign countries and intensified competition (Rasiah, 1995; Blomström and Kokko, 1997; Markusen and Venables, 1999). Several authors have argued that the economic activity of a foreign investor will help to accelerate technological development in the host economy to some degree (Hunya, 2000; Lim, 2001; Dyker and Stolberg, 2003).

ICTs promote economic growth and act as a technological driver that 'pulls' both technological and non-technological innovations associated with FDI (Leitão e Baptista, 2009). Antonelli (1998) analyzed the co-evolution of ICT and the knowledge intensive industries, finding that ICTs affect the actual conditions of information, in terms of their basic characteristics of appropriation and tradability, by favoring the role of business services as forces of interaction amongst knowledge components in the generation of new technologies.

There is noteworthy empirical evidence linking inward FDI and entrepreneurship. De Backer and Sleuwaegen (2003) study the relationship between FDI and domestic entrepreneurship, and their findings are in line with theoretical occupational choice models that predict FDI would crowd out domestic entrepreneurs through their selection in product and labor markets. Nevertheless, other studies find that this crowding effect may be moderated or even reversed in the long run due to the long term positive effects of FDI on domestic entrepreneurship as a result of experience, learning, demonstration and networking effects between foreign and domestic firms (Rodriguez-Clare, 1996; Markusen & Venables, 1999). Barbosa and Eiriz (2007) examine whether FDI had a positive impact on entrepreneurial activity in the Portuguese economy. They find that the impact of the first wave of foreign investment by a MNC is, in general, positive, but that the marginal impact of additional investments appears to be negative. These authors also argue that the weak evidence of positive effects of MNCs on entrepreneurial activity may hide their role as levers of technological development and industrial re-structuring.

Evidence of the relationship between ICT investment and entrepreneurship is less profuse. Leitão and Ferreira (2009) analyze the impact of the liberalization of European telecommunications markets on the business ownership rate. In the case of Portugal, the business ownership rate seems to "pull" for additional investments in ICT. Leitão e Baptista (2009) find that, for the case of Portugal, FDI plays an important role in the long term, since it impacts positively on investment in ICTs which are a catalyst of sustainable and inclusive technological change. However, no evidence is found that both ICT investment and inward FDI impact positively on entrepreneurship.

Conclusion

According to Silveira (2001), there is a need to understand the mechanisms and approaches that may characterize innovation and technical change in developing countries, to define the managerial practices and skills required to accomplish this task in that context, and to gather empirical evidence on cases and practices of innovation there.

While the existent of a global "digital divide" that is significantly wider than the income gap between developed and developing countries is an irrefutable fact, evidence on the benefits and drivers of ICT investment, and their relationship with another important source of technology diffusion - inward foreign direct investment - remains mixed. One important aspect that seems to condition developing countries' capacity to absorb the diffusion of new technologies is the lack of human capital capable of taking advantage of these technologies. In this context, it is essential to implement policies oriented to bridge this knowledge gap.

One element associated with human capital and technological knowledge which may contribute significantly towards economic development is entrepreneurial ability. Entrepreneurship represents an important channel for developing countries to take advantage of the technologies being diffused through ICT investment and inward FDI. Developing countries with greater degrees of entrepreneurial ability and a better environment for new venture creation are more likely take advantage from knowledge spillovers and create new wealth.

There is a lack of work connecting the two spillover sources discussed here - ICT investment and inward FDI - and entrepreneurial activity in developing countries. Evidence for developing countries is mixed. Human capital is likely to play an important role in this transmission mechanism. It is impossible to take advantage of knowledge spillovers if one is unable to understand and absorb them. However, entrepreneurial ability also plays a role. Like human capital associated with education and technological knowledge, entrepreneurial ability - the set of skills, aptitudes, insights and circumstances that favor the recognition of opportunities through new venture creation - is neither uniformly nor widely distributed in the population. In developing countries, where most small businesses are born out of necessity rather than opportunity, entrepreneurial skills and motivation are likely to be dormant, needing greater general human capital (*i.e.* education) to arise.

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Regional competitiveness, technological adjustments and employment

Teresa de Noronha Vaz
Marisa Cesário

Introduction

Economic globalisation is leading firms to face an increasingly openness to rival producers, whatever their original location of production. Not only firms but also industries and regions are now much more vulnerable to price and quality competition.

Camagni (2002) suggests that regions compete on the basis of absolute competitive advantages, arising when a region possess superior technological, social, infrastructural or institutional assets, which are external to firms but of their benefit. The author assumes that territories compete with one another and both attractiveness and local competitiveness depend on similar common factors, which goes beyond physical conditions and refer to relational capital and the learning capacity expressed by the territory. This approach and other similar ones stress the discussion on how important is geographic proximity for the strategic positioning of firms.

In spite of the fact that some authors claim that the notion of distance is "dead", arguing with the increasing globalisation processes as a tool for all over spread acquisition and diffusion of knowledge, other scholars assume the role of space and territory in creating competitiveness and better economic performance.

Bramanti (1999), for example, points out the interaction of four building blocks (innovation processes, learning mechanisms, governance structures and networking relations) in the process of innovation that presumes great relevance for the geographic space as a determinant variable.

Also recognising that individual companies are the ones that compete in the market, Camagni, 2002, remembers that most of the small and medium sized companies and respective entrepreneurs are to a large extent generated by the local context and, in order to face changing and uncertain economic conditions, their decision-making process is firmly based on socialised practices, thereby stressing the of geographic proximity as a mediating factor.

To the first group of authors belong Maskell and Malmberg (1998, 1999) who have used the term 'ubiquitification' as the outcome of the ongoing globalization process and meaning the process whereby former tacit knowledge gradually becomes codified. As they explain, in open markets and when knowledge of new technologies and new organisational designs become globally available, firms in low-cost areas become more competitive.

Nevertheless, the authors also recognise that no firm can build competitiveness on ubiquities alone. Most firms learn from close interaction with suppliers, customers and competitors and knowledge processes are deeply influenced by local resources, institutions, social and cultural structures (localised capabilities). When considering innovative activities, for instance, the importance of geographic proximity promoting interaction, has been defended by authors like Gambardella and Malerba (1999), Arndt and Sternberg (2000) or Cassiman and Veugelers (2002).

Inter-firm linkages, in the form of regional networks, are proven to be important prerequisites for successful innovation activities in firms. Similar approaches can also be found in Malmberg and Maskell (1997), Kirat and Lung (1999). In Vaz, Cesário and Fernandes (2006), the argument has been stressed even further up to the extent of detecting which exact factors of geographic proximity would be more responsible for innovative attitudes within the firm and why.

Indeed, the dead of geography' thesis cannot be sustained, since it wrongly assumes that the rapid diffusion of information and codified knowledge means the rapid diffusion of understating, and that is not correct (Morgan, 2004). Although organisational proximity is important, it does not substitute direct face-to-face communication. Another aspect is that some types of knowledge travel more easily than others. While analytical knowledge, which results from the application of scientific laws, has a relatively constant meaning by location, the same is not true for the synthetic or symbolic knowledge[4], whose meaning is substantially variable (Gertler, 2008).

That is why, as explained by Scott *et al.* (2001) and Scott and Storper (2003), unlike the idea that globalization means the diffusion and spreading of economic activities, this phenomena has been accompanied by the affirmation of agglomerative tendencies as sources of economic growth. According to the authors, the most remarkable agglomeration forms are the, so called, 'city-regions', that act as locomotives of national economies as sites of dense interrelated economic activities with high levels of productivity and innovative potential. This is happening in both developed countries, where metropolitan areas are growing faster than others, and in the less-developed ones, where the effects of agglomeration on productivity are strongly apparent. These results support the idea that globalization and its consequent market opening and technological progress tended to reinforce urbanization, not the contrary. Both large-scale agglomeration and regional economic specialisation are persistent and growing phenomena: Firstly, the geographic proximity eases the dynamics of backward and forward inter-linkage of firms; Secondly, it allows the formation of dense local labour markets around multiple workplaces and third, it facilitates the emergence of localised relational assets promoting learning and innovation effects. The reasons for location proximity go beyond transactional efficiencies, and include various kinds of externalities, such as knowledge spillovers and dependence on human relations, rules and customs that enable firms to coordinate under conditions of uncertainty.

This is even truer when considering the specific case of small firms. Contrarily to big firms, SMEs interact intensely with the territory in which they locate, as a signal of their embeddedness. The particular tight links they develop with the external environment also reduce uncertainty risks. In general, SMEs do not only locate nearby the residence of their owners but also the geographical and sociological proximities constitute their main sources of assets and information (Julien, 1995). This fact determines the perspectives and strategic choices of the firms, because most of the market perception arises from the inputs that the territorial institutional context supplies them (Vaz, 2006). Growth determinants as competition capability, political understanding and knowledge of consumption behaviour do result from the external environment of the firm. Not surprising that the attributes of such environments become, therefore, a crucial factor for the

4. By synthetic knowledge the author mean the application or combination of existing knowledge, mainly through interactive learning with customers and suppliers; symbolic knowledge means creating meaning trough highly context-specific learning-by-doing processes.

development of different entrepreneurship profiles.

Nevertheless, such external links by themselves are not sufficient to produce technological learning. Internal factors dealing with human capital and networking aptitudes within the firm are also important variables as demonstrated by Cesário and Vaz, 2008. This kind of approach had been much earlier developed by Cohen and Levinthal (1990) who argued that 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. The authors label this capability as a firm's absorptive capacity. Also a similar idea is given by Julien *et al.* (1999) for whom the main factor distinguishing SMEs using new technologies from those continuing to use traditional equipment are the management quality and the organisation's ability to obtain and process technological information. The author define technological scanning as an activity through which the external information needed for technological change is gathered, analysed and disseminated in the firm. As proven by Cesário, 2009, as a result of different regional settings' attributes, entrepreneurs may develop different abilities allowing different entrepreneurial strategies, namely regarding technological adjustments.

Empirical surveys often mention the importance of entrepreneurship in helping peripheral areas (such as in Bennetworth, 2004), or the role of innovation in small firms to the competitiveness of rural environments (North and Smallbone, 2000).

The Agent-Centred Perspective on Regional Competitiveness

Also pointing out the insufficiencies of neoclassical models Clark and Tracey (2004) reject the idea that economic agent's options are completely bounded by their regional sets. The agent-centred perspective, as labelled by the authors, assumes that agents or firms' strategic choices are not tightly dependent and derived from their contexts, but can be developed either through interaction or complete independent from those sets. Although not ignoring social, political and economic structures, as framing variables, the authors clearly reject that economic agents are chained to their historical or geographical conditions as they have the cognitive capacity to interact with them. One important presumption of this approach is the rejection of rational maximising behaviour theories. Facing the need of generalising and summing up individual behaviours, economic theory tends to marginalize the scope and nature of human decision-making process. The assumption of rationality means that all people choose the optimal according to their goals. To suppose otherwise is to suppose irrationality or, at least, inconsistency. The need to better understand empirically how and why people make their decisions, led to the acceptance of the fallibility of rationality[5].

5. According to Herbert Simon (1955) an 'economic man', as postulated by the traditional economic theory, is assumed to have clear knowledge of the relevant aspects of his environment and a well-organised and stable system of preferences. For the alternative courses of action available, he is able to choose the one that will permit him to reach the highest attainable point on his preference scale. This concept was a matter of drastic revision. In substitution, he suggests a 'choosing organism' of limited knowledge and ability, placed in an environment with which he interacts. The author use the concept of 'bounded rationality', explaining that rationality is bounded when there are failures in knowing all the alternatives, uncertainty about relevant exogenous events and inability to calculate consequences (Simon, 1979: 502). In order to characterise the mechanisms of choice under conditions of bounded rationality, he uses

At the end, this approach is all about recognising the importance of humans' cognitive skills. Although also recognising the influence of institutions on agent's choices, as the institutional-centred approach, the big difference between both is that the agent-centred model treat institutions only as resource endowments, so different regions, with different institutional settings, have different resource endowments affecting agent's decision-making and regional competitiveness (Clark and Tracey, 2004).

Accepting that different territories may provide different competitive conditions and following the arguments of the agent-centred perspective, agents should have the cognitive capacity to move from their inherited institutional contexts when these ones are not providing favourable conditions[6]. Hence, '*…the concept of embeddedness may neglect the capacity of agents to understand the world of which they are part*' (Clark and Tracey, 2004), as it implies that firms are passive in terms of their choices. As seen by Granovetter (1985) the argument of embeddedness applied to economic behaviour means that agents and institutions are so constrained by ongoing social relations that to consider them as independent is a serious misunderstanding (Granovetter, 1985: 482). Although recognising the importance of the concept, the agent-centred perspective rejects such constraint in agents' capacity.

Another important input from this approach regards the concept of inheritance. Contrarily to Arthur's assumption that social capital results from the positive feedback generated by the region-industry specific path accumulation process, Clark and Tracey (2004) explain that national and regional institutions and practices can be inherited rather than simply accumulated in a growth and development process.

While recognising the utility of the embeddedness and path dependence concepts, the present work is sympathetic with the agent-centred approach as it admits the possibility of the interaction between agent's cognitive capacities and their place-specific inheritances and endowments.

The capacity of agents to strategically adapt to European integration and globalisation is very much the result of that interaction. Given the importance of technological changes in this context, and having in mind the vulnerability of labour-markets in regions highly dependent on such sectors, the next section continues providing an overview on a set of empirical exercises analysing the impacts on employment deriving from firms' technological adjustment processes.

Firm Behaviour and Regional Employment Structures

Social and institutional aspects impose the assumption that labour markets are not 'perfect': the new Keynesian economics recognizes that local labour markets are different from other markets focusing on spatial disparities in unemployment, wages or job conditions to create

the concepts of search and satisficing: 'If the alternatives for choice are not given initially to the decision maker, then he must search for them…As soon as he discovered an alternative for choice meeting his level of aspiration, he would terminate the search and choose that alternative.'

6. Keeble's (1997) exercise on British regions allowed confirming the arguments that small firms, in less endowed regions such as the peripheral ones, may actively try to overcome environmental constraints by conscious strategies, perhaps involving greater R&D efforts.

local adjustments in demand and supply, while technological shocks are being processed in an unstable equilibrium (Martin, 2000).[7]

After recognising the existence of a two way flow of influences between agents and environmental sets, elsewhere argued, this section deals specifically with the impact on regional employment structures deriving from firms' technological adjustment processes.

More specifically, the next section reviews the theoretical discussion around the effects of technical change on employment and labour skills.

The Impact of Firms' Technological Adjustments on Employment

The effects of technical change on employment have increasingly interested researchers. More even since unemployment is the greatest economic problem faced by developed countries.

For the public in general, and although recognising that innovation is a major driving force behind job creation, the concerns about the future of work as the diffusion of information technology proceeds, are present.

Chennells and Van Reenen (2002) survey the data on the effects of technical change on skills, wages and employment by examining the micro-econometric evidence at industry and firm level. The results from different countries were widely variable. Overall, the authors found consistently evidence for positive effects of proxies for product innovations on the growth of employment.

An example (Van Reenen, 1997) was found in the British firm-level panel data on innovative activity. The study identified the effects of technical change on jobs and confirmed the positive association between proxies for technical change and employment.[8]

Also, similar results were obtained by Enfort, Gollac and Kramarz (1999) when studying the effects of new technologies on employment in French firms or by Blanchflower and Burgess

7. With regard to labour force adjustments, the work of Greenwald and Stiglitz represent an important theoretical reference. In 1989 the authors argue that, risk-averse firms tend to prefer changes in employment than changes in wages or hours. They explain that there is greater uncertainty associated with wage/hours decisions than with employment decisions. While changes in wages/hours affect all workers in unpredictable ways and generate uncertainty about profits (namely trough changes in turnover derived from people quitting, changes in workers' effort, etc) in contrast, changes in employment seem to minimize the resulting uncertainties. Later (Greenwald and Stiglitz, 1990), the authors developed their argument by examining the implications of imperfect information for firm behaviour, namely firm adjustment behaviour in the labour market. Again they conclude that, firm output and investment spending (with the inevitable consequences on employment) respond directly to changes in firm wealth as well as to environmental uncertainty. A more in-depth advance concerning labour-market adjustments is given in Greenwald and Stiglitz (1995). According to the model developed, firms may be in one of three regimes: hiring, firing or doing neither. Over the course of a business cycle, they tend to move from the hiring regime to the intermediate regime (where firms rely primarily on hours and wages adjustments) to the layoff regime. This happens because, as firms' net worth decreases, their risk aversion becomes higher. Since wages/hours reductions are the adjustment variables associated to greatest uncertainty, firms will prefer to engage in layoffs. The authors explain that the sequence of observed adjustments should be the sequence of hiring reductions, followed by hours' reduction, and only after an interval, layoffs.

8. Other important remarks were: a) the greater is the sensitivity of consumers to price changes the more likely it is that an innovation will raise employment; b) the easier it is to substitute capital for labour the more likely it is there will be positive employment effects from technical change and c) if the firm has some degree of market power not all of the reduction in cost will be passed on in the form of lower prices. This will blunt the output expansion effect and make positive employment effects less likely.

(1998) who concluded that the introduction of new technology in UK and Australian plants was more associated to job growth rather than to job decline.

Zimmermann (1991) used data for German firms in order to evaluate the relative importance of three driving forces: technological advance, declines in demand and increases in labour costs, for the employment decline in manufacturing industries. The results pointed out that the lack of demand is a dominant factor in employment decisions. Technological advances appear in second, while labour costs place third.

Smonly (1998) used micro-data from West German manufacturing firms to estimate a model on the impact of innovations upon the output, capacity utilisation, employment and prices. The conclusions were that firms which implemented product innovations increase prices, exhibit a higher utilization and grow faster. Product innovations also affect positively the growth and volatility of employment, being this volatility higher with the lower price elasticity of demand, which favours employment adjustments against price adjustments to technical change[9]. Regarding process innovations, the results also indicate positive effects on output and employment, but not conclusive effects on prices and sales. The results point towards that both types of innovation generate positive effects on employment but do not indicate which effect is stronger.

Greenan and Guellec (2000) enriched the debate by explaining why product innovation produces lower effects than process innovation. Using French data, the authors found that innovating firms and sectors in general create more jobs than others and that process innovation, in particular, is more about job creation than product innovation. This is explained with the fact that product innovation creates more uncertainty than process innovation, as the reaction of consumers to a new product is highly unsure. Employment decisions are consequently affected, accordingly to the authors.

Different results come out when considering organisational innovations. Osterman (2000) found that measures of new organizational practices are associated with higher layoff rates of production workers, even within firms that have been experiencing net employment gains. A confirmation on these results was obtained by Black, Lynch and Krivelyova (2004) when examining the relationship between what the authors called HPWPs - *High Performance Workplace Practices* and employment changes: "Some practices, such as self-managed teams, are associated with greater employment reductions, whereas other practices, such as the percentage of workers involved in job rotation, are associated with lower employment reductions" (Black, Lynch and Krivelyova, 2004: 65). The work also suggests that there are significant differences between unionized and nonunionized employers in the impact of organizational change.

The use of R&D measures as proxies of innovation, generate negative correlations: Brouwer, Kleinknecht and Reijnen (1993) used R&D data from Dutch manufacturing firms to analyse the influence of innovation on growth rates of employment. They conclude that the growth of the R&D intensity of firms has a slightly negative impact on employment, whereas firms with a high share of product-related R&D experienced an above average growth of employment. The same was the case with Klette and Førre (1998), for Norwegian manufacturing plants, were no positive relationship between net job creation and the R&D-intensity of a firm were found.

These results clearly indicate that the effects of innovation depend critically on the type of

9. Similar relations were found in Van Reennen's (1997) model.

innovations being produced. While technological advances more product and process oriented are generally associated with job growth, even if with different intensities, organisational changes and R&D intensity produce frequently negative impacts in the growth rates of employment.

The Impact of Firms' Technological Adjustments on Labour Skills

The idea that technology could lead to a *de-skilling* of workers, with mass production factories symbolising the destruction of skilled artisans, is being contested by recent economic debates, focusing on whether modern technologies are generally biased towards more skilled workers.

Berman *et al.* (1994) investigated the shift in the demand from unskilled toward skilled labour in US manufacturing over the 1980's. The authors conclude that this shift is mostly due to technological adjustments (e.g. investment in computers and in R&D) rather than shifts in product demand due to trade competition. Very similar results were obtained by Hansson (2000) for Swedish manufacturing firms.

Also Doms, Dunne and Troske (1997) found evidence of skill bias when examining the relation between technological advances and the demand for work. Also using computer investment as a measure of technology use, the authors found a positive association between this indicator and the growth of skilled workers during the period of observation.

Autor, Katz and Krueger (1998) corroborated the importance of technical change (especially computer use) in accounting for the increase in the proportion of skilled workers. The analysis of US industries indicates that the rate of skill upgrading has been greater in more computer-intensive industries.

Machin and Van Reenen (1998) compared the U.S. results in terms of changing skills structures with six other OCDE countries (Denmark, France, Germany, Japan, Sweden and the UK). Using R&D intensity as a measure of technical change, the results indicate a significant association between this measure and the demand for skilled workers across the different countries.

Also using R&D intensity as well as technological capital intensity, Aguirregabiria and Alonso-Borrega (2001) analysed a panel of Spanish manufacturing firms and conclude that the decision of adopting new technologies is countercyclical and has a much strong effect on the occupational structure of the workforce than the accumulation of technological capital by old innovative firms.

Considering organisational changes, Caroli and Van Reenen (2001) examined a panel of British and French establishments and found that organisational change reduces the demand for unskilled workers as well as leads to greater productivity increases in establishments with larger initial skill endowments.

Independently of the measure of technology used, there is considerable empirical evidence supporting the idea that technological related strategies favours the increase in the demand for more skilled labours.

Conclusion

Against the theoretical trend defending the idea that agents simply respond to their environmental conditions, with little or no capacity for strategic choice, the agent-centred approach consider agent-environment interaction as a two-way flow of influences: the behaviour of agents can influence their context, such as environmental conditions can promote or not pro-active attitudes towards innovation.

Local settings influence firms' choices, as their strategic options are encouraged or inhibited by their contexts. Although is very difficult for small firms (for instance) to control those contexts, is also argued that firms' strategic decisions can '...shape the boundaries of its environments...' since decisions with regard to location, markets explored, customers pursued, technology adopted or training provided can, in fact, manipulate aspects of the environmental sets (Clark and Tracey, 2004) .

The recognition of firms' capacity to strategically respond and adjust to new economic conditions, with the consequent influences on regional sets, is followed by the discussion of the impacts on employment and labour skills resultant from firms' technological strategies.

The observation of several empirical exercises suggests that technology is, on average, biased towards skilled labour. The evidence on the effects of technology on total employment is more mixed, with some measures (diffusion-based) suggesting a positive association and others (R&D-based) being more negative (Chennells and Van Reennen, 2002).

Vaz *et al.* (2006) and Vaz and Cesário (2008) confirmed that such interactions may have positive effects that go beyond the firms themselves, and influence the broader socio-economic context in which they operate. Using data for a set of European regions (INNOVALOC, 2000) the authors conclude that a two-way flow is established for which regional or local characteristics influence innovation in small firms while the regional economic development is affected by the innovative behaviour of the firms themselves. In the case of lagging regions, technological change can only be discussed in a context of interface between institutional interaction and historical local development. The main reason for this is the strong role that SMEs play in their socio-economical structures and in particular in employment and skills development. Therefore, the dynamics of local development are closely related to entrepreneurial strategic choices and vice-versa, small firms have their roots deep within the environmental local conditions.

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Santander Totta


UAlg
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