Going Global: The Challenges for Knowledge-based Economies

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Abstract

The present volume aims to provide a comprehensive and systemic overview of the challenges that going global poses to knowledge based economies. Its focus is four-fold.

1) Firstly, it investigates why companies, especially high-tech firms, go global, i.e. which are the drivers that push companies to locate – R&D facilities in particular – elsewhere than in the home country.
The analysis of the competitive advantages that enterprises seek in the host countries also includes the new techno-economic geography that emerges. Attention is devoted to the time frame of these phenomena and to features such as the development stage of the home and host country, the characteristics of both firms and industries, and the Product Life Cycle of the latter.

2) Secondly, it analyses the impact that the various corporate relocation phenomena might have on intellectual capital, innovative output and the labour market, and growth and development. (Re)locating in fact impacts on knowledge creation, exploitation – including the use of IPRs – , absorption, circulation and spillovers. In turn, these play a fundamental role in shaping the productivity, competitiveness, and ultimately growth and development of both enterprises and countries.

3) Thirdly, it addresses the questions of if and to what extent the current and prospective global dynamics call for new types of governance. Such a need arises if different policy domains have to converge towards common strategic welfare enhancing objectives. Attention is also devoted to the various policies put in place by small open economies that 'go global', such as Finland.

4) Fourthly, it addresses the sustainability aspects of going global by investigating how to better share the social, economical and ecological benefits and responsibilities arising from globalisation, technological change, and innovation. It analyses the impact that globalisation and the knowledge-based paradigm might have on both developed and developing countries.

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Foreword

Globalization and the dynamics of knowledge and innovation are at the root of current socio-economic transformation. This book is intended to contribute to our understanding of globalization of knowledge-based economies. Its content is based on the conference *Going Global – The Challenges for Knowledge-Based Economies*, held in 21–22 September 2006 in Helsinki, Finland. – Why to organize a conference and compile a book of such complex issues as globalization of R&D, arising challenges for knowledge economies, and impacts of changing environment on national policies?

In rapidly changing global business environment, dominated by knowledge and innovation, nations and policy-makers must examine and improve their understanding of on-going trends and phenomena. The trend towards knowledge society and interdependent world economy increasingly complicates our operational environment, and its governance is not possible without a profound understanding based on scientific analysis. Although the influence of single nations to global developments is limited, we need a dialogue on what governments could and should do together, to be better equipped to changes of the world economy. Such a dialogue is especially needed among the EU Member States to ensure the effective and successful implementation of the Lisbon strategy for growth and employment, in which knowledge and innovation are playing an important role. For all these reasons globalisation was one of the priority issues of EU Presidency agenda of Finland, besides having been an overarching theme in EU´s Competitiveness Council and the European Council for several years.

In this book we wish to take a broad view on globalization. Globalization has entered a new phase due to the impact of knowledge-based paradigm over economies and societies and also to the development of large Asian economies. Transnational corporations remain among main drivers of globalization and internationalisation of research and development. The impacts of globalization on welfare and sustainable development challenge innovation systems and policies in any country irrespective of their development phases. The negative effects of globalization on welfare in developing economies were also discussed without ignoring the positive aspect that the growth of the world economy entails a potential towards higher welfare for all countries and people.

The contributions of high-level experts from all over the world from industries, government and research give new insights of the current state and future developments of globalization. With this book we wish to disseminate these insights to all interested communities and stakeholders. The book hopefully serves as a step to-

wards more in-depth understanding of globalization of economies and knowledge creation as a phenomenon. We hope that it will breed further dialogue of globalization of knowledge-based economies.

On behalf of the Ministry of Employment and the Economy I would like to express my gratitude to the sponsoring organizations of Helsinki conference, DG Enterprise and Industries of the European Commission and the international innovation network Six Countries Program. I acknowledge all the authors producing articles to this book, and thank the VTT team for organizing the conference and editing this book.

Mr. Sakari Immonen
Industrial Counselor
Chairman of the Advisory Board of the Conference
Ministry of Employment and the Economy

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SECTION 1

A Broad Overview

1 Globalization and the Challenges for Knowledge-Based Economies

1.1 Introduction

Globalization and the dynamics of knowledge and innovation are at the root of socio-economic change. This is true regardless of the specific development phase countries are undergoing or of their location. Intense worldwide relations make local happenings shape and being shaped by events occurring elsewhere. Examples of our globalised world are the international production and trade of goods and services; the global mobility of capital and investments; the mobility of labourers, know-how and intellectual capital; and the global flow of data and information, also facilitated by the Internet and the Information and Communication Technologies (ICTs). Global are also concerns as the worldwide security, as well as aims such as eradicating poverty and preserving the environment. In our intertwined world science and technology (S&T) and innovation have become all the more inherently global and have the potential to increase local, national, regional and global welfare by satisfying global needs and by offering new solutions to global problems.

Globalization is a complex multidimensional and multifaceted phenomenon, whose drivers, components and effects are far from being fully understood. Still, globalization is not a new phenomenon, as market and trade had become increasingly international since the 19th century. The same happened to production factors and settings – including the acquisition of energy and raw-materials –, to investments and financial markets, and to industrial R&D and innovation. Especially since the 1980s global scientific co-operation, international collaboration of firms, universities and R&D institutes, and research co-operation along the production chain has also been growing. These and other trends currently characterizing globalization may give right to argue for a new "development phase" of globalization.

1.2 "New phase" of globalization

In recent decades globalization has reached a new phase. On the one hand this has been due to the impact of ICTs and the new knowledge-based paradigm over economies and societies. On the other hand, the sustained development that some large Asian economies have been experiencing since the late 1990s has profoundly shaped globalization dynamics. In this new phase, companies' internationaliza-

tion, and in particular the role and behaviour of transnational corporations (TNCs), remains among the main drivers of globalization.

Globalization as product of the knowledge-based economy

The current traits of globalization are shaped by ICTs and the new technologies. As Thurow (2000) argues, this new phase of globalization is a product of the knowledge-based economy and just one of the ways in which new technologies will reshape the economies of the third millennium. Worldwide ICT networks and tools enable fast communication for all purposes, including the effective division of labour, as well as research and product development, around the clock and the globe. This gradual although unbalanced shift from a resource-based economy to a knowledge-based one occurs to different degrees and at various speeds in both developed and developing countries.

This is why the knowledge-based global paradigm – also and especially enabled by ICTs – offers opportunities while posing serious threats, irrespective of the development phase of countries and societies. ICTs and the new technologies contribute to modify the structure of industries and spur the change towards the knowledge economy. These may in turn affect productivity, while triggering radical changes in both employment patterns and skill requirements.

Knowledge and innovation have become strategic assets for the success of enterprises and nations alike. Economies are gradually although continuously shifting from tangible manufacture-based structures to intangible and knowledge- and-service based business models.

Changes of foci and dynamics of global economy and innovation

The current phase of globalization is also characterized by the growth of some large Asian developing economies. The patterns followed by countries like China and India are changing the foci and dynamics of the global economy, including markets, investments, finance, production, business strategies and innovation systems. Besides offering affordable cost levels and fast growing markets, these economies are characterized by dynamic "region-states", which are able to absorb foreign investments also thanks to their increasingly attractive S&T systems (e.g. Zhou and Leydesdorff 2006). Chinese and Indian multinationals have thus gradually proved to be strong new contenders for global markets, and increasingly so also for R&D activities.

More generally though, as far as techno-economic development is concerned, regions are acquiring an ever-growing importance. Region-states are even predicted

to gradually replace nation-states (Ohmae, 2005), thus making global competition among innovation systems all the more fierce.

In such a dynamic global environment, education, S&T, R&D and innovation are of paramount importance and may drive or hinder growth. In particular, when it comes to R&D activities, it is the globalization process of multinational enterprises' (MNEs) R&D that plays a major role worldwide. MNEs in fact account for a remarkable share of global business R&D (OECD 2006). According to UNCTAD's World Investment Report, trans-national corporations (TNCs) account for a major share of global R&D, with 310 billion US $ spent in 2002. In this same year, the 700 world largest R&D spending firms – 98 % of which are TNCs – accounted for close to half of the world's total R&D expenditure and for more than two-thirds (69 %) of the world's business R&D. As examples, it may suffice to note that, according to UNCTAD's (2005) figures, Ford Motor's R&D expenditures surpass the R&D expenditures of Spain or Switzerland, and Daimler-Chrysler or Siemens' R&D expenditures are greater than the overall R&D expenditures of Belgium or Israel.

According to the UNESCO Science Report 2005, the global annual budget devoted to R&D will soon exceed one trillion US $. From a geographical point of view though, R&D is still mainly concentrated in developed countries. In 2002 the world devoted 1.7 % of its gross domestic product (GDP) to R&D, with R&D investments amounting to 830 billion US$. These were allocated as follows: 37 % in North America (of which 35 % in the U.S.); 31.5 % in Asia (with 12.8 % in Japan, 8.7 % in China and 2.5 % in India); 27.3 % in Europe (with 6.7 % in Germany, 4.2 % in France and 3.5 % in the UK); 2.6 % in Latin America and the Caribbean (with 1.6 % in Brazil); 1.1 % in Oceania, and 0.6 % in Africa (with 0.4 % in South-Africa).

The role of big Asian developing countries, especially of China, is however increasing. According to OECD's projections, China was predicted to spend over 136 billion US $ on R&D in 2006, with an annual growth rate in R&D expenditures of over 20 %. Doing so, China should have surpassed Japan's forecasted 130 billion US $ and position itself right behind U.S.'s predicted 330 billion US $ (STI Outlook 2006, OECD). The EU-15, including France, Germany and the UK, was predicted to spend over 230 billion US $ in 2006. China's R&D intensity, i.e. its R&D spending as a percentage of GDP, has more than doubled over the last decade, passing from 0.6 $ of GDP in 1995 to just over 1.2 % in 2004. At current prices, this represents an increase from just over 7 billion US $ in 1995 to 94 billion US $ in 2004. China's R&D spending is growing at an even faster pace than its impressing overall economy growth, showing annual rates between 9 % and 10 % (ibid.).

1.3 Globalization challenges innovation policies

The current trends of globalization are shaping the structure of the markets and agents' competitiveness. To face the new challenges posed by globalization and the knowledge-based economy all countries, whether big or small, need to implement the most suitable strategies, as no player can afford to stay out of the game or, worse, lose it. Of paramount importance hence is to carefully re-think and re-formulate innovation policies, being innovation a key component of countries' competitive strategies.

Knowledge-based economies like the United States, the Pacific Rim countries led by Japan, and the European Union are already doing so. Europe, as well as other players around the globe, is in fact increasingly relying on the creation and exploitation of knowledge, held as the key competitiveness asset at the root of S&T. This need to reshape S&T policies is felt even more compellingly by the EU member States, faced by the challenge of Europe willing to become the most competitive knowledge-based economy in the world by 2010.

Regardless of past and present economic performances though, the global-and-knowledge-based paradigm calls for synergic actions.The achievement of long term growth objectives calls for new economic and societal frameworks. Science and technology policies are no exception in this respect, especially when it comes to dealing with pressing issues as the mobility of scientists and the exploitation of knowledge and know-how.

Sustainability and globalization

In the past, globalization has mainly been driven by the economic actors and their strategies, implemented in order to fulfil the interests of their stakeholders. While attempting to combine the desires of all players involved, markets may however fail and have often failed to meet the needs of those that are not able to shape the decision process. This is true for companies – especially Small and Medium-sized Enterprises (SMEs) – lacking, for instance, the necessary technological capabilities or managerial expertise, as well as for individuals and poorer societies. Poverty, social exclusion, digital divide, security threats, environmental concerns and brain drain are to name but a few clear symptoms of the market failures determined, also although not exclusively, by globalization.

If globalization undermines the pillars on which economies have traditionally relied upon, it also opens up new opportunities of development and growth. Knowledge-based economies are in a privileged position to harvest globalization's best fruits, but should be prepared to share its costs and behave responsibly. This entails

pursuing the best socio-economic outcomes for all human beings while preserving nature and the environment, both at present and in the future. Economies that are truly knowledge-based should, as the concept itself implies, seek innovative solutions to socio-economic and environmental problems, and aim to increase global welfare.

Eradicating poverty, protecting natural resources, and changing unsustainable production and consumption patterns constitute self-evident although difficult objectives to pursue. The need hence arises to call for a more active role of governments in conjugating economic, social and environmental needs. Heterogeneous past and present characteristics and development trajectories make in fact unsuitable the application of "standard" innovation and technological-change models. One size simply does not fit all: the kaleidoscopic variety of worldwide contexts calls for a variety of approaches and actions, if global welfare is to be maximized.

1.4 Helsinki's Going Global 2006 conference

The Helsinki conference took a holistic approach to globalization and the knowledge based paradigm. The event addressed globalization's main drivers, dynamics, threats and opportunities and encompassed the main challenges facing knowledge-based economies and societies.

The leitmotiv of the Helsinki conference was that globalization is not be feared but rather understood. Although many aspects of globalization are known, it is still very difficult to clearly picture cause-effect relations, as well as to exactly forecast possible impacts and ascertain interrelations. Besides, as globalization is a dynamically changing phenomenon, the questions we pose and conclusions we draw today may not necessarily be the right or relevant ones for tomorrow. Hence the necessity to have a holistic and proactive approach to globalization. Problems can be solved and opportunities seized when awareness and knowledge are paired with willingness, capacity and capability.

To this end, the conference approached the challenges that globalization poses to the knowledge based economies from various economic, policy and sustainability perspectives. Besides, the event considered various interrelated aspects characterizing S&T globalization. The analysis, both theoretical and empirical, encompassed the R&D dynamics related to enterprises, socio-economic development and the broader national innovation systems.

The conference began by shading light over the main traits characterizing corporate international (re)location and knowledge dynamics, including Intellectual

Property Rights (IPRs). Whether Multinationals (MNEs) or SMEs, firms in fact show an ever growing propensity to become more "ubiquitous". It is then fundamental to understand why is it so, i.e. which are the drivers that push companies to locate production plants and R&D facilities elsewhere than in the home country. The analysis of the competitive advantages that enterprises seek in the host countries entailed industries in general and high-tech firms and R&D divisions in particular, given their relevance to knowledge based economies. The trajectories that corporate relocations take were also analyzed, thus highlighting the new techno-economic geography that emerges. The time dimension of these phenomena was also addressed, from the perspective of the development stage of the home and host country, the characteristics of both firms and industries, and the Product Life Cycle of the latter.

Once understood the drivers of globalization, the conference addressed the impact that the various corporate relocation phenomena might have on intellectual capital, innovative output and the labour market. The analysis of the possible cause-effect links, and of the interrelations and feedbacks that might exist, took into account many elements. On the one hand, (re)locating affects intellectual capital formation and exploitation, as well as knowledge creation, absorption, circulation and spillovers. These depend on the absorptive capacity of the agents – whether countries or firms – and are also moulded by the educational system, the labour market and, more generally, the broader institutional framework. In turn, intellectual capital and knowledge creation, exploitation and circulation play a fundamental role in shaping the development and growth of both enterprises and countries. On the other hand, internationalization phenomena – especially those entailing the (re)location of R&D – directly affect innovative output in both the host and the home country and shape the ability/capability of firms and systems to innovate. In turn, innovative output contributes to shape productiveness and competitiveness, thus either boosting or depressing trade. Last but not least, the technological and socio-economic impact of going global is shaped by the relationships and loop mechanisms that might exist between intellectual capital formation, innovative output, productiveness and competitiveness. These can in fact either amplify or reduce the impact that the knowledge based global dynamics might ultimately have on growth and development, at all levels.

After the socio-economic analysis of the drivers, dynamics and impacts of corporate R&D relocation and globalization the conference addressed the questions of whether and to what extent the current and prospective global dynamics call for new types of governance. Such a need arises if different policy domains have to converge towards common strategic objectives like, for instance in the case of Europe, the Barcelona and Lisbon targets. Attention was also devoted to the impact of the various policies put in place by small open economies that "go global" – such as the Finnish global economy program – as well as to international challenging

initiatives like the European Research Area. The aim was to shed light on those policies that can catalyse innovation and strengthen innovation systems, thus improving the competitiveness of both member States and the European Union as a whole vis-à-vis their international competitors.

Finally, some sustainability aspects of going global were addressed. The rationale behind this session was to discuss how to better share the social, economical and ecological benefits and responsibilities arising from globalisation, technological change, and innovation. It investigated the impact that globalisation and the knowledge-based paradigm might have on both developed and developing countries (e.g. India versus Europe), at various geographical levels (regional, national, etc.). Past, present and future needs and shortcomings were also addressed, in line with the Helsinki Process (started in 2004). The session also explored sector-specific dynamics, with particular attention devoted to high-tech industries. A crucial part of the debate was represented by the role of all socio-economic agents – whether public or private – and their responsibilities.

1.5 Structure and content of the volume

The Going Global 2006 experts discussed selected issues while framing their analysis in the broader contest. Their contributions were thus never narrow, but they rather dealt with specific topics while offering each time coherent although different perspective over the challenges that going global poses to knowledge based economies.

The present volume mirrors such a feature of the conference and is divided into five chapters. After the introduction (Chapter 1), Chapter 2 gathers together the contributions related to the drivers and dynamics of globalization and the knowledge based economies. Chapter 3 is instead made of six contributions discussing the implications of globalization for science, education and innovation policies, as well as governance. Chapter 4 encompasses those analyses reporting specific countries' and firms' experiences and strategies, vis-à-vis the challenges posed by globalization. The first three of them relate to some "countries under the spotlight", i.e. countries that are currently looked at as engines of change. The remaining three instead unveil the global strategies of some MNEs corporations. Chapter 5 summarizes the knowledge value-added of the conference and draws some conclusion and policy implications.

Section 1.5.1 below contains a brief summery of all the contributions included in the present proceedings, per chapter.

1.5.1 Chapters' content and contributions' outline

Chapter 2 encompasses various aspects, drivers and dynamics of globalization and the knowledge based economy.

David Audretsch considers globalization, knowledge and new growth strategies. He first offers a brief historical overview of the impact of globalization, especially on industries and employment in Germany. He then considers the "European paradox", questioning the reason why Europe sees high investments in knowledge leading to low returns in terms of economic growth and employment. Although investments generate new knowledge, the latter does not spill out of universities and does not (or, at least, not sufficiently) become the object of commercial activities. This impinges upon Europe's expected returns, especially growth and jobs. In the traditional economy, investments in new plants and equipments resulted in growth and jobs. This does not happen with investments in knowledge, as they have to go through the "knowledge filter" to become valuable and to be commercialized, thus bringing results and returns. The missing link between knowledge investments and returns is entrepreneurship. Entrepreneurship serves as a mechanism, a conduit by which knowledge investments bring the expected fruits. Given that universities are important sources of knowledge, Audretsch calls for a more entrepreneurial role of universities. This would facilitate the transfer of knowledge and its commercialization and thus result in economic growth and higher employment.

Francis Gurry discusses globalization, intellectual property (IP) and knowledge policy. He analyses the radical transformations of IP rights during the last 15 years. The IP system, he argues, is currently under stress, due to the massive expansion of demand for IP rights (as in the case of patent protection for new inventions), and to ever-growing piracy and the need of new innovation models (e.g. the open source approach). Gurry illustrates the recent geopolitical shift happening in the generation of technology, and in particular the new role of North-East Asia. He also highlights how ICTs have led to the worldwide democratization of the ability to access new technologies. Examples are the various world patent collections, i.e. the historical record of humanity's technologies, which are available online and are in a searchable form. Gurry then moves to analyse the IP rationale itself. As IPRs represent a policy tool intended to encourage innovation and creativity, he proposes to broaden the discussion on IP and to consider other models of innovation. He also advocates a broader policy focus, encompassing not only IP but the broader knowledge policy, and proposes possible pathways that might help solving some of the tensions the IP system is currently experiencing.

Torbjörn Fredriksson considers the internationalization of TNCs' R&D, being trans-national corporations among the key drivers of globalization. He relies on

the UNCTAD 2005 survey and presents some evidence about the current globalization dynamics. TNCs account for 46 % of the total R&D expenditures worldwide and for 69 % of business R&D expenditures, figures that confirm TNCs to be key players in global R&D. Although R&D is among the least internationalised business functions, TNCs have started recognising the attractive conditions offered by some developing countries. This is why R&D, which remains one of the most strategic corporate functions, is becoming more and more global. Among the drivers of R&D globalization there are the needs to innovate, to keep costs down, and to access new talent pools.

Jean-Eric Aubert encompasses some of the global trends characterising knowledge based economies. Being competitive in the knowledge economy requires the ability to develop more complex communication skills and expert thinking, rather than carrying out routine tasks. The ability to use, create, and adapt knowledge are becoming fundamental determinants of the global competitiveness capability of countries. The question hence arises of how to measure knowledge-based economies. Aubert deems that both quantitative and qualitative indicators are needed and describes the knowledge assessment methodology (KAM) of the World Bank. The KAM is an analysis tool developed for benchmarking purposes. With respect to the qualitative assessment, country performances are framed within the broader anthropological context. Innovation systems are pictured within the broader development systems, and the latter within the societal systems, which are related to cultural dimensions. This qualitative approach has a lot of implications, in terms of both culture and society, and may pose political challenges.

Pierre Mohnen deals with cross-border technology flows, knowledge spillovers, and the globalized world. Knowledge spillovers refer to the unintended transfer of knowledge, in which no payment is involved. Evidence is robust with respect to the existence of significant R&D spillovers, at different levels of aggregation. Generally spillovers are found to represent positive externalities. Econometric studies find the social rate of return to R&D investments to exceed the private rate and spillovers to be the difference between private and social rates of return. This argues in favour of policy intervention, by which governments offer incentives to push firms to invest in R&D up to the point where social benefits equal social costs. However, in order to be able to benefit from spillovers, agents must posses the necessary absorptive capacity, as in-house R&D and incoming spillovers are complementary. Moreover, geographical proximity, networking and labour mobility do matter for spillovers. Mohnen argues that we are still far away from being able to offer normative guidance to governments with respect to spillovers. We are neither able to measure the exact amount of spillovers that is created, nor we know for sure which channel of transmission spillovers use. Conversely, very clear is the necessity to build absorptive capacity, also and especially in developing countries, and to increase interactions, networking and knowledge exchange. Mohnen finally

concludes suggesting that would we have perfect markets where selling and purchasing knowledge, there would no longer be spillovers.

John Zysman considers the changing dynamics of innovation and information technology (IT) in the global transformation of services. Knowledge becomes especially important for development in what he calls "the global digital era". Knowledge has become digitized and more rapid and IT tools create new possibilities to convert information into knowledge and to employ knowledge in the economy. The critical step has been the discovery that IT users made of how to employ their ever greater and cheaper computing power, to do what previously was impossible. The network-based transformation of services represents a critical part of the story of the global knowledge economy. Services are embedded in the structure of social regulations, and the reconfiguration of services alters the value creation in services. We are in the midst of the fourth service transformation, "from revolution to delusion". This change begins to influence the character of innovation. The advantage lies in being able to innovate business models, and in the blurred boundaries between products and services as a source of innovation. Service production requires more knowledge than manufacturing, and this knowledge is embedded in the IT tools, now available as commodity products. Zysman concludes that the key question for corporate strategy is how to reorganise routines. The policy task is instead to create an environment enabling experimentation and innovation. The ability to reorganise the service sector becomes critical.

Chapter 3 focuses on the implications of globalization for science, education, innovation policies and governance.

Daniele Archibugi discusses the recent changes in the development of public science and takes a stand in defence of public science. He argues that public science is increasingly moving away from basic science to become an instrument supporting the achievement of medium to short-term industrial R&D and competitiveness' objectives. Even academic jobs are becoming progressively more related to individuals' ability to raise research funds. Archibugi offers some evidence about how the relative proportion of public and business R&D expenditures has been changing in the OECD countries, leading to a situation where business R&D represents the leading component. This change is considered good by many, both within the OECD and the EC. South Korea and Japan are among the countries with the lowest amount of government R&D. Those countries having a traditionally large public research sector (US, UK, France) are also shifting towards a situation where business-financed R&D dominates. In the OECD countries the share of academic R&D is less than 20 %, with more than 80 % of R&D being done outside academia. Archibugi describes the present situation as a consequence of an agenda aiming to link science and industry, where science parks, academic entrepreneurs, etc. would contribute to improve the commercialization of science. As a consequence, univer-

sities are getting less money for research and depend more on external contracts, and this triggers many problems. Archibugi suggests that universities should be strongly integrated in the societal context and the market economy. He advocates the integration between public and business R&D resources, but deems that the public sector should pursue its own scientific priorities, i.e. to develop knowledge and offer it to the citizens. Academia should be forced to socially justify its activity and scientific research should be funded through general taxation, as it provides a public good. Archibugi concludes that we would need business and academia to work together, but academia should not work for business".

Heikki Salmi analyses globalization and the knowledge-based economy from a European perspective. Europe can only rely on its knowledge capacity, as its inherent strengths are not in competing through low costs. Comparing the innovative performance of Europe, the U.S. and Japan Salmi argues that Europe's strengths are in the ability of university R&D to be financed by business, in design and in trademarks. Conversely, Europe looks comparatively weak in terms of patents, population with tertiary education, ICT expenditures, and in protecting and commercializing R&D. Although some European industries are strong in global markets, manufacturing is dominated by medium-high technology sectors. Innovative companies go where innovation can flourish, workforce is well-educated, R&D labs excel, and strong clusters exist. He briefly mentions the objective of what he calls the "Revised Lisbon Agenda" as well as other EU activities that aim to increase the attractiveness of Europe. Among them the 7th Framework Programme (FP) with its Joint Technology Initiatives (JITs) and the 25 national reform programmes, all aiming to increase the share of EU R&D in from 1.9 % to 2.6 % of the GDP in 2010. Salmi holds that the key ingredients needed to "put knowledge into practice" are: education, competitive internal markets, favourable regulatory environments, clusters and knowledge transfer, a modernised university system, and a European Institute of Technology (EIT). Salmi also presents some results of a study investigating the implications of R&D off-shoring on the innovative capacity of the EU Firms. Among other findings, the study suggests that firms anticipate a relative growth of off-shored R&D in the future. In Europe R&D off-shoring happens from the old to the new member states. Effective IPR protection, quality of the education system and developed infrastructure are highly valued variables in the decision to off-shore R&D, but public support is not crucial. Salmi concludes that R&D off-shoring benefits home activities and European R&D productivity in general. Hence Europe should try its best to become a good destination for incoming off-shored R&D but also look for opportunities to off-shore R&D to other countries.

András Siegler discusses Europe international scientific cooperation (ISC), especially in the context of the 7th Framework Program. He offers three main arguments in favour of ISCs. The first relates to Europe's competitiveness in the global

scenario. The second is that scientific challenges become progressively bigger and more global, and without cooperation it is simply impossible to pursue them. Thirdly, he underlines the need to underpin other policies of the EU based on international relations as trade, development, environment, energy, and so on. The EU promotes ISCs in order to carry out better science and to pursue broader policy goals via scientific achievements. Specific strategic objectives have been defined accordingly for ISCs. The first is to make world-wide scientific excellence available for Europe via circulation and not via brain-drain. The second is to support sustainable European competitiveness through strategic partnerships with third countries in selected science fields and, through this, to explore new markets (e.g. through European Technology Platforms). The third objective is to address specific problems on the basis of mutual interests and benefits with third countries or regions where Europe has particular interests (for example, poverty-related diseases, environment issues, etc.). The fourth objective is to address global scientific challenges, e.g. big science projects (fusion reactor, high-speed information networks, etc.). To accomplish the strategic objectives of ISC the EU has proposed a segmented and focused approach, based on strategic reference frameworks. They may either have a thematic focus or concentrate on specific regions, or both, depending on the issue. Siegler also describes the steps to be followed in the implementation of the strategic frameworks. He concludes stating that the main challenges of ISCs rest on the ability of Europe to effectively coordinate ISC, in the budgetary commitment to the ISC actions, and in pursuing a geographic and thematic variety of ISC actions with third countries.

Dominique Foray, discusses the political economy of how to organize a public goods policy response in the light of the Lisbon strategy and reports the work of the EC Expert Group "Knowledge for Growth". The Expert Group suggests four policy axes for the development of the European knowledge economy. First, Europe needs to dramatically change its resources allocation and to focus on the critical domains of the knowledge economy, i.e. education and research. As the private sector responds only to incentives, these must be changed in order to make investing in R&D profitable. Second, Europe needs to orientate the economy towards the right fields of specialisation. Each region and country should think about what makes its knowledge base unique and distinctive. Third, Europe should think about transforming its economic institutions and its modes of governance. Fourth, Europe would need to adapt the "other" policies to the knowledge economy, above all the macroeconomic policies. These should act in a countercyclical fashion during depressions, when companies have problems in funding their R&D. Unfortunately this is not obvious at the EU level. Foray concludes that the governance and coordination of national actions in Europe is not effective because the Lisbon Strategy is based on voluntary coordination and on a soft message of coordination. There is a mismatch between the soft method of governance and the nature and objectives of the R&D policy. Member countries may free ride in order to get benefits

from community actions without making own investments. Moreover, Europe has a low budget at the central level and high national budgets. As a result, a dissipated effort of the national states echoes the weakness of the centralized EU capacity. Europe needs to ensure sufficient resource allocation, given that the allocation process is decentralized, and that knowledge has the characteristic of a semi-public good. Finally Foray proposes some policy suggestions aimed at helping Europe in the global knowledge game.

Otto Toivanen discusses the economic rationale behind innovation policies, from the point of view of a small open economy such as Finland and in the light of globalization. Innovation policy is generally justified on the basis of the assumption that R&D investments not only benefit inventors but also others, i.e. the whole society. Social benefits thus offer an argument in favour of closing the wedge between private and socially optimal investments in innovation, and this wedge calls for active innovation policies, with taxes or R&D subsidies. The implicit assumption of the analysis is that the society is all mankind. The story changes when we look at a small open economy in a global community, or the mankind. The invention benefits now the inventor, the users and the companies of a small open economy, but also the whole mankind. For example, Finns are only 0.08 % of world population, and most of the gains to consumers and spillovers to other firms are somewhere else. Toivanen concludes that if innovation is to be justified according to economic theory, the reasons to support private innovation by public means are much less strong in a small open economy than they would be if we had a world government. However, Toivanen presents the results of a research project supporting the idea of innovation policies being desirable also in small open economies. The research relies on data regarding R&D projects and firms' applications for R&D subsidies in Finland and shows that the benefits of R&D projects to firms (profits) are large. R&D projects also benefit society, but less so than firms. Toivanen draws two main policy implications. Firstly, the need to coordinate R&D policies at higher levels, like the EU, in order to internalize more spillovers. Secondly, a small open economy should nurture its absorptive capacity to benefit from knowledge created elsewhere.

Manuel A. J. Teehankee discusses the trade rules of the World Trade Organization (WTO) and how development is related to international rule-making and technology transfer. Rule-making at the WTO can be future and development oriented and geared towards poverty alleviation. However, development is related in many ways to capital and technology. Teehankee describes the various phases of the development cycle in which investments in S&T, research funding, and intellectual assets play important roles. He reckons technology transfer should also involve developing countries, if poverty eradication is to be achieved. Teehankee describes how, since the 1970ies, technology transfer and R&D and S&T have become development goals of both developing countries and international organizations, as

the WTO, the UN, the OECD and others. He surveys the technology related provisions of the WTO, which all have a significant meaning in the international rule-making. Teehankee also refers that the WTO's discussion about technology transfer has widened and currently includes investment flows, competition rules, IP regimes, and limits to IPRs. Teehankee calls for a multilateral set of rules regarding technology transfer, where recognising the role of technology absorption and adoption, and encouraging domestic and multilateral fiscal incentives and funding for R&D and S&T. He wishes the focus of intellectual property protection to shift towards a win-win situation where, without prejudicing IPRs, technology, cooperation partnership and dynamism would benefit development.

Chapter 4 presents some countries' experiences and industries' perspectives vis-à-vis the challenges posed by globalization. The countries under the spotlight are China, India and Malaysia, whereas the companies that present their experiences are Valio (FI), Unilever (NL) and Honeywell Specialty Materials (US).

Max von Zedwitz, besides dealing with knowledge creation and use in China, hints at a somewhat little explored issue, i.e. Chinese multinational corporations as new contenders in global R&D. von Zedwitz pictures the growth of the Chinese knowledge pool by looking at the entry and exam figures of Tsinghua University. On the one hand, the number of graduate students has been increasing exponentially over the last years. On the other hand, there are heavy investments in building up university infrastructures and in hiring and educating professors. China is trying to gradually move away from imitating, while pursuing an endogenous and innovative use of knowledge (as, for instance, the worldwide patent figures show). Some Chinese companies come up as aggressive global players but, in general, internationalisation is not as a strong driver as it is for Western companies. Some Chinese companies, like Haier and Huawei, have established R&D centres in Western countries. One of the reasons why they do so is that Western companies are reluctant to send the latest technology to China, due e.g. to home security reasons. Chinese companies have hence decided to go westward, for example to the U.S., and to become part of Silicon Valley or of the Cambridge-Boston phenomenon. They also invest in research in Western universities to become legal owners of the IP being created. The main barriers for the internationalization of the Chinese companies are currently represented by their scarce resources, little experience in foreign markets, lack of history of product innovation, and lack of R&D resources and management expertise. Conversely, the cost of doing R&D in China is relatively low. von Zedwitz concludes that Chinese companies are good in learning, imitating, and at picking up and absorbing skills, and they will likely be strong competitors in R&D as well in the near future. If technology does not go to China, Chinese go to the sources of the technology and get it right there.

R.A. Mashelkar analyses India's emergence as a global innovation hub, surveying both drivers and consequences for society, culture, policy, the economy, and the country's future strategies. India has undergone four science based revolutions, the last of which is the Grey Revolution and is related to the emergence of educational and engineering institutions. The Grey Revolution has helped India to move in areas like software, where 600,000 professionals will generate 35 % of the Indian export by 2008. India's performance has remarkably improved since the country opened up globally in 1991. India's development happened in three main waves: first came foreign direct investments, then technology, R&D and manufacturing, and then foreign nationals got to work in India. The brain drain situation has also changed, as the number of graduated that migrate abroad has dramatically decreased. India's strategy to strengthen its position as a global R&D hub is twofold. On the one hand, the supply side strategy relies on the massive expansion of high-quality education and research systems. On the other hand, from the demand-side, India has put in place many policy measures aimed to enhance competitiveness and R&D, also through government support. Mashelkar also discusses some of the problems the country needs to solve in the future, like primary education. He also refers to global challenges and mentions the Global Research Alliance (GRA), established by public research laboratories from both developing and developed countries to address global problems.

J.M. Jarjis illustrates Malaysia's transformation from an agriculture-based into a knowledge-based economy and describes the various phases of its economic development. Malaysia's transformation into an industry-based economy in the 1960s led to major changes in its infrastructures, finance and education. Among other actions, the Government developed incentives to attract foreign investments. These investments generated substantial export earnings from manufactured goods, in particular electrical and electronic products, and succeeded in attracting foreign direct investments (FDIs). Today Malaysia is the 18th largest trading nation although it faces growing competition from countries such as China and India. Recognising the increasingly critical role of knowledge, Malaysia had already introduced in 1990 a national plan called "Vision 2020", aiming to attain the developed nation status by 2020. The country has since been gearing itself towards the transformation into a knowledge-based economy. At present, the Ninth Malaysia Plan states the development strategies and measures for 2006–2010, of which Jarjis gives a detailed description. The Government is aware of the possibility that, while attempting to transform Malaysia's economy, it may create economic and social divide among regions and the population. ICT have an important role to play in this respect and may help overcoming socio-economic inequalities. This is why ICT policies are at the core of the strategy pursued to achieve Vision 2020's objective.

Jan Maat from Unilever, the Netherlands, explains the company's global R&D structure. For Unilever, which is a fast moving consumer goods and common household product business, understanding consumers' needs is of key importance. Unilever spends about 2 % of its turnover in R&D, and the company has recently simplified its R&D structures in order to speed up innovation and strengthen its global market position. Unilever has now an aligned global innovation and R&D organisation in which projects, as well as resources and competences, are global. Such competences obviously require excellent management capabilities in order to avoid duplication of R&D. Unilever R&D in Europe is carried out in three main research centres, located in the UK and the Netherlands. In addition, Unilever has one lab in India, one in China, and various technology centres worldwide. Besides describing Unilever global R&D approach, Maat draws some conclusions regarding the national Dutch and the European innovation policies.

Tiina Mattila-Sandholm illustrates Valio's approach to R&D and open innovations. Valio is a dairy industry company, born in Finland 100 years ago. Innovation-wise Valio is a very successful firm and has a long history of R&D, its top name being that of Virtanen, who won the Nobel Prize in chemistry in 1945. Mattila-Sandholm stresses the importance of the traditional respect of research within Valio and of the belief that long-term research investments pay back. Valio board concluded already in 1916 that "Only such a country whose entire economy is based on science can attain and keep the first place in the economic war between nations". The board had already understood the importance of the knowledge-based economy a long time ago, before the locution itself was introduced. Valio's innovation strategies are dictated by consumer-driven, competition-driven, vision-driven, technology-driven and curiosity-driven factors. Valio invests in consumer and competition-driven sectors more than 50 % of its R&D resources. However, the challenge is to find the right balance between all these components. Mattila-Sandholm talks about open innovations and networking. In order to have open innovations and to co-operate, firms need people to do in-house research. Although many hide their strategies, what matters is who is coming out first and with a different approach. Alike the Dutch technology top institutes, Finland is developing top leading institutes, and different industries, including the food industry, are competing for building such institutes. Fundamental is to rely on partnerships and to adopt win-win strategies.

Bernard Pellereau illustrates Honeywell Specialty Materials' international R&D activities and then makes recommendations about how to encourage innovation in Europe. He first explains the reasons why Honeywell Specialty Materials is globalizing its R&D. Among these, the willingness to benefit from the world's best talents, to use all the available 24 hours for research, to adapt to customer needs, and to take advantage of reduced R&D costs. Pellereau discusses how Europe could improve its innovativeness, from the perspective of the main actors necessary to

succeed: businesses, government, academia and the labour market. Businesses should provide funds to develop new and innovative products and business models, while at the same time committing to safeguard environment, health and safety. They should also take advantage of new legislations to create new business opportunities. Governments should protect and enforce intellectual property and make of it a top priority in free trade talks. The European system should be simplified, bureaucracy eased and regulations become simpler. The measures needed to strengthen the competitive advantage of Europe are collaborative platforms, R&D fiscal incentives, R&D coordination and sector foci. Pellereau also stresses the importance of having competitive energy prices and energy efficiency regulations. As for academia, he sees universities as incubators for entrepreneurs, but more so in the U.S. than in Europe. He hence suggests to support students interested in taking ideas into the marketplace. Besides, academia should seek to work closely with governments and businesses to ensure that R&D is carried out in specific area and provides the most benefits. Academia must also avoid the silo approach whereby disciplines rarely cross. Finally, the labour market should enable life-long learning to ensure that skills meet the current global demands. The supply of a deep and wide talent pool is critical to success and the labour market has a central role in ensuring opportunities for talent growth. The workforce needs to be flexible and mobile, in order to better face the change forced by global markets and economic circumstances. Pellereau concludes arguing that globalisation and globalisation of R&D are changing the way firms operate, but far from being a threat they constitute an opportunity.

2 Knowledge Based Economies Going Global: an Economic and Competitiveness Perspective

2.1 Globalisation, knowledge, entrepreneurship and new growth strategies

D. B. Audretsch

Introduction

The first congress that I participated in about globalisation took place in the late 1980ies. We were all wondering what globalisation is about. One of the speakers, the chairman of Daimler (then it was Mercedes-Benz), addressed the audience saying that Mercedes had always been a global company. I suppose by that he meant Mercedes had been selling its automobiles all around the globe for decades and, as the chairman indicated, it had done very well with internationalising its markets. Back then people had not really used the word globalisation very much and it was probably the first time I myself heard the word as well. However, the internationalisation process that had taken place subsequent to World War II had served not just Mercedes-Benz very well, as it sold its automobiles all around the world, but also Germany as much of Europe. Later, when the Berlin wall fell, people realized pretty quickly that this was going to positively affect the peace prospect and the integration of Europe, unprecedented of course since the war. I also recall that most scholars, economists and policy makers alike, anticipated that the expansion of internationalisation – what we now call globalisation – would not only certainly benefit companies like Mercedes-Benz, but Germany and Europe as a whole. The idea was that – as the chairman of Mercedes-Benz had implied – if they succeeded in selling to the Americans surely they could sell to their neighbours, i.e. the Czechs, the Hungarians, not to mention Asia and the rest of the world.

However, as we know, it did not quite work out that way. Probably what was not anticipated as much as the Berlin Wall fell is that it was not just a continuation of internationalisation Europe, Germany and Mercedes-Benz had experienced in this post-war era. There was a fundamental shift, including a new low-wage competition. What changed with globalisation was wage disparities between the OECD countries, the Western countries, Europe, North America, Japan, and the countries of Eastern and Central Europe, India and China. The wage gaps were really substantial, so that Europe could not succeed pursuing a low-wage strategy (see Figure 1).

Hourly wages in $				
Country	Factory Worker	Engineer	Accountant	Middle Manager
Poland	3.07	4.32	4.03	6.69
Czech Republic	2.81	5.38	4.10	6.81
Hungary	1.96	5.09	4.62	7.44
Slovakia	2.21	4.15	3.37	5.48
Romania	1.41	2.58	1.23	3.23
Bulgaria	0.73	1.43	0.83	2.80
China	0.80	3.50	3.20	4.42
India	0.43	2.40	1.93	3.13
Germany	18.80	38.90	26.40	40.40
United States	14.18	30.32	27.48	38.77

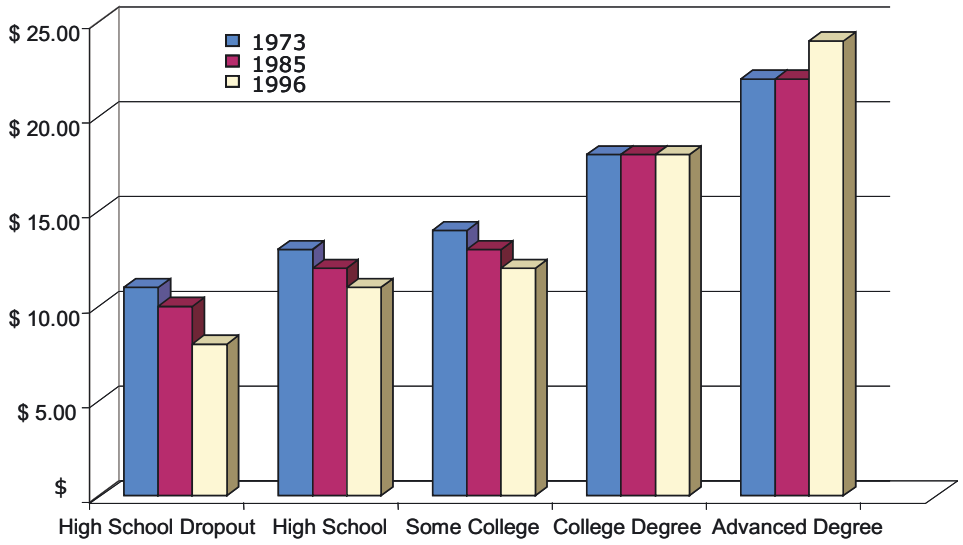
Source: Audretsch (2007)

Figure 1. Hourly wages in various countries

It thus became clear that competitiveness and the comparative advantage of Europe would not be based on what, for instance, drove the auto industry, i.e. large-scale manufacturing production based on physical capital, machines and factories. Europe's competitiveness had to rather be based on ideas, on knowledge.

Investing in knowledge and human capital

Throughout Western countries investing in knowledge has always paid.

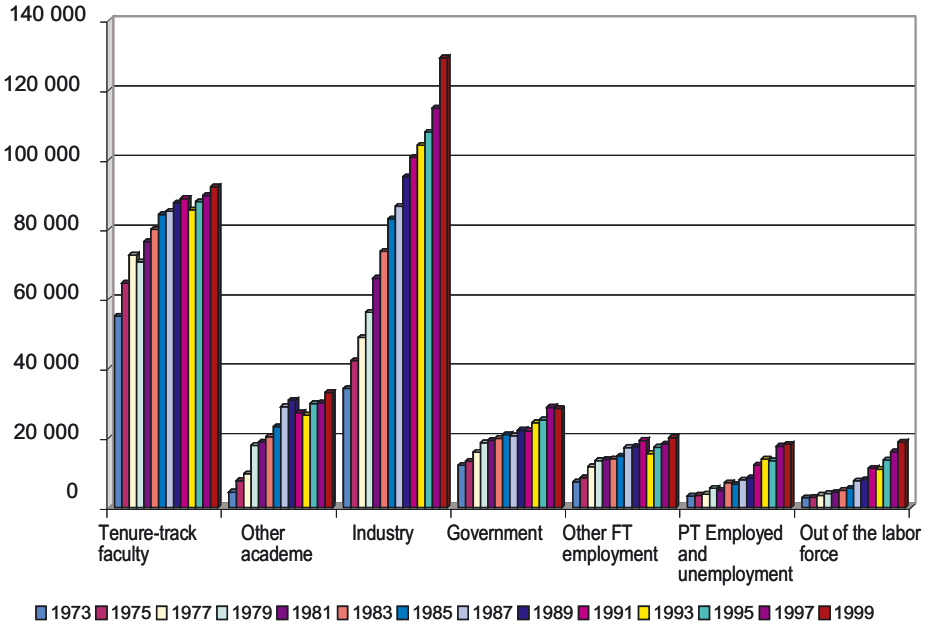


Source: Economic Report of the President, various years

Figure 2. US income gap based on educational attainment over time

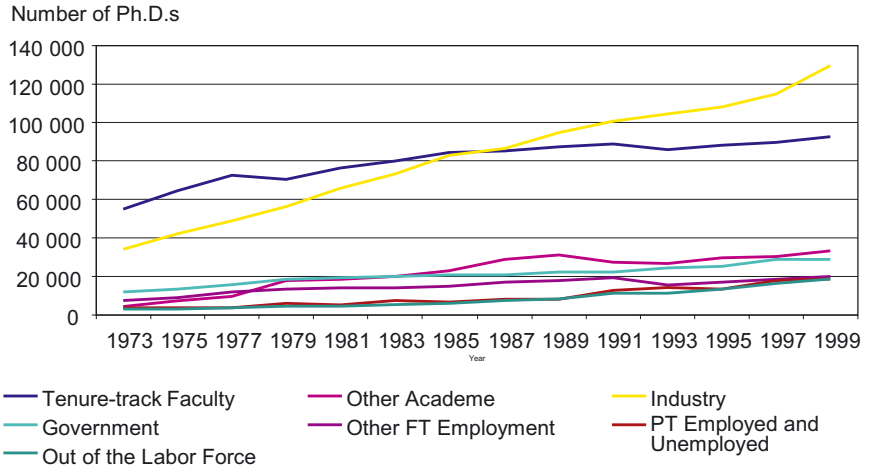
As can be seen in Figure 2, if we look for instance at the returns to investments in human capital in the United States over time, we immediately realise that returns to investing in more human capital and more education have been progressively greater over time. In fact, the income gap existing between the different levels of education, i.e. between high-school dropout and high school graduates up to having advanced degrees, has grown over the last three decades.

If we compare the number of Science and Engineering PhDs employed in the United States in the early 1970ies and in the turn of the century, we see the figures exploding over time, especially in the case of PhDs employed by industry.



Source: Stephan, 2006

Figure 3. Increase of Ph.D.s in the U.S, 1973–1999



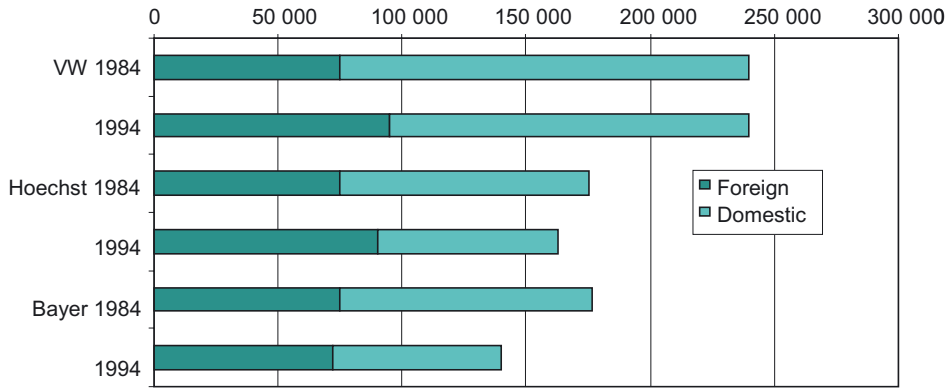
Source: Stephan, 2006

Figure 4. Number of Ph.D.s by sector, 1973-1999, all science & engineering by fields (5 or more years since Ph.D., 65 or younger)

This again supports the idea that knowledge counts and that it does even more so as economies become globalised. Europe realised the existence of shift and that knowledge would be more important for competitiveness than it was in the traditional capital-based economy of manufacturing and large-scale production. Europe seemed to be in a very good position in this respect. At least in the post-war era, Europe had very strongly invested in knowledge. This is true whether one wants to measure those knowledge investments in terms of universities, secondary education, trainee and apprentice systems, research, research institutes (such as the Max Planck Institute and a plethora of other types of research institutes), or even more broadly in terms of investments in social capital, relationship capital and culture. However, when globalisation truly took off, Europe found herself facing a tough problem: job creation at the local level.

Knowledge, globalisation and job creation

Let us continue with our Germany example to look at what actually happened in the country's leading firms. This figures are extracted from a study done at the Ministry of Economics, in Berlin, and show employment at the advent of globalisation, before the Berlin Wall fell, and then right after the fall of the wall. The study looks at the employment figures of the thirty largest German companies. For example, let us consider three eminent cases, namely Volkswagen, Hoechst and Bayer. The trends we observe in their cases resemble those of the other companies in the study.



Source: Audretsch 2007

Figure 5. Employment in large German firms

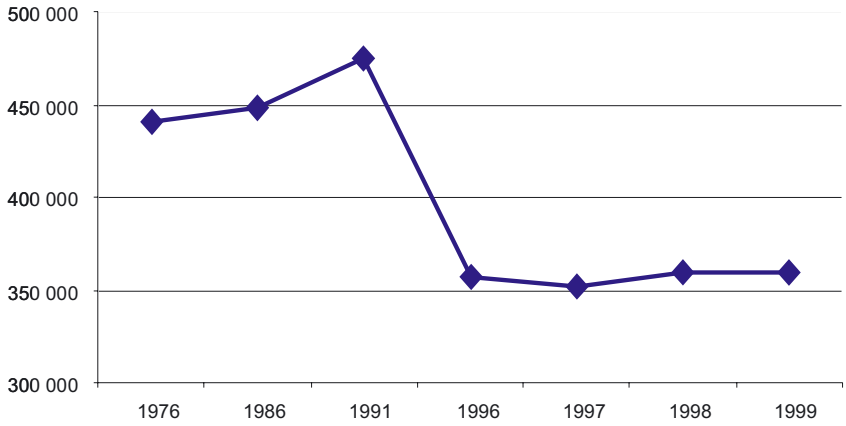
We see that in the case of Volkswagen, one of the German and European flagship companies, total employment basically remained the same between 1884 and 1994. Hence, one might be led to think that there was really no effect. However, when one looks at that darker area of the bar, i.e. employment outside Germany, one realises that employment within Germany in fact decreased. In the case of Hoechst, instead, we observe that total employment decreased over the period considered. And this contraction basically affected Germany alone, as the out-of-Germany level of employment actually rose. Last, in the case of Bayer, we see that the firm's job creation mainly favoured countries other than Germany. More generally, when we look at the chemical industry as a whole we see that right after the Berlin Wall went down jobs were created outside of Germany while 80,000 were lost in Germany.

Table 1. Change in employment in Germany and foreign subsidiaries (1991–1995)

	Manufacturing	Chemicals	Electrical engineering	Autos	Mechanical engineering	Textiles
Foreign	+ 189,000	+ 14,000	- 17,000	+ 30,000	+ 16,000	- 6,000
Domestic	- 1,307,000	- 80,000	- 198,000	- 161,000	- 217,000	- 68,000

Source: Audretsch 2007

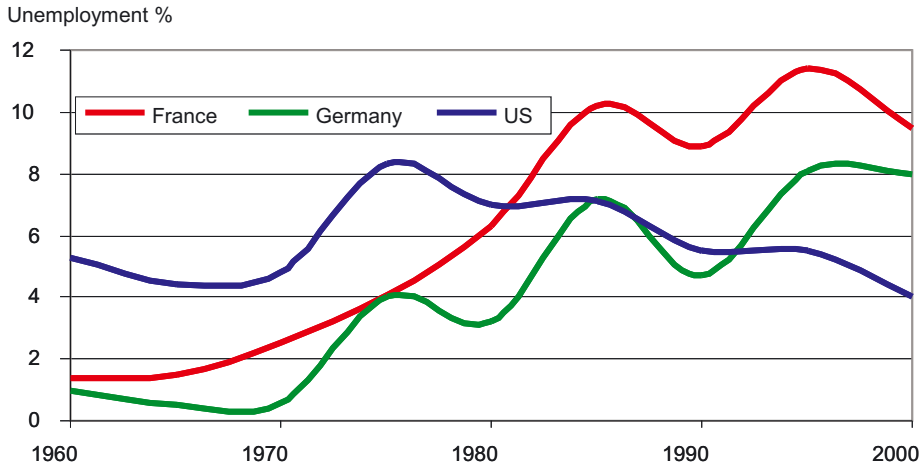
The same happened with respect to sectors like electrical engineering, automotive and mechanical engineering. Overall 1.3 million jobs were lost in manufacturing in Germany, while jobs were going up outside of Germany. German companies, as well as the other companies in the West, were learning – some more than others – to take advantage of the opportunities offered by globalisation. Evidently, this caused problems at the level of individual locations in Germany. What appeared to be good for the competitiveness of the companies ended up certainly not favouring the competitiveness of specific regions and locations. Those people that had been working in the automotive or chemical companies, really the traditional stronghold of Germany, saw their jobs in peril.



Source: Audretsch 2007

Figure 6. Number of manufacturing employees in Stuttgart 1976–1999

Figure 6 shows the manufacturing employment dynamics observed in Stuttgart, which is at the heart of Baden-Württemberg and really the heart of German manufacturing. One can see that manufacturing increased from the 60ies until the 80ies, crashed when globalisation took off and never recovered afterwards. The Stuttgart figures are unfortunately in line with what has been observed throughout Europe.



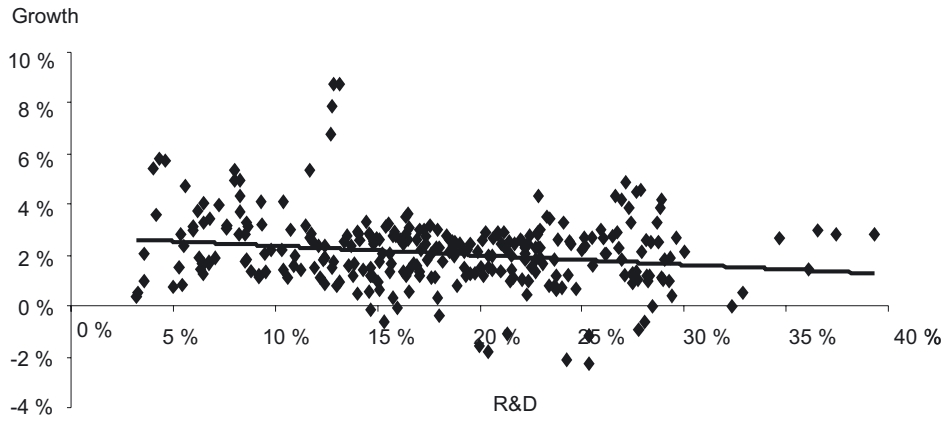
Source: Audretsch 2007

Figure 7. Rise in European unemployment (France and Germany) VS US trend (1960–2000)

For instance, in the case of France and Germany, unemployment rose from levels below 2 % in 1960 to levels above 8 % in the 1990ies. Besides, from figure 7 one realises the divergence in the unemployment trends of North America and France and Germany. Evidently, it was not just France and Germany, it was the whole of Europe to suffer from unemployment.

Five years ago or so I was in Sweden, at a meeting held by the Minister of Economics, discussing what Sweden could with respect to globalisation. The question was how the country could get out of its stagnant growth and how to address its unemployment problems. I had become a kind of a born again disciple of the endogenous growth theory of the new economy. The mantra there was knowledge, invest in knowledge, in research, in universities, in human capital, facilitate patenting and so on. I delivered this message and I remember that our host, the minister of economics, pointed out the difficulty of putting in practice such an advice in Sweden. Sweden had the highest investments in knowledge by any measure, whether using patents, R&D as a share of GDP, human capital and so on. It indeed can be difficult to say that, well, the solution is to invest in knowledge when you are talking to one of the economies with the highest investments in knowledge.

Moreover, when one looks at the simple correlation between one type of investment in knowledge, i.e. R&D, and the growth rate of countries, there is no obvious relationship, no positive correlation emerges. This can be seen in figure 8 where such patterns can be observed for the OECD countries over the 1990ies.



Source: Acs, Audretsch, Braunerhjelm and Carlsson, 2005

Figure 8. Correlation between growth and R&D

This is what the Swedes called the Swedish paradox: if knowledge is so important as a response to globalisation, where is the growth, where is job creation?

Globalisation seems to help the competitiveness of the companies, who are able to outsource R&D and go where there is the knowledge they need. However, going abroad they take the employment with them in many cases. The Swedish paradox was later renamed by Romano Prodi as the well known "European paradox". The question that arises is: if knowledge is so important, why has growth remained so elusive in the European countries? Why is unemployment higher and higher?

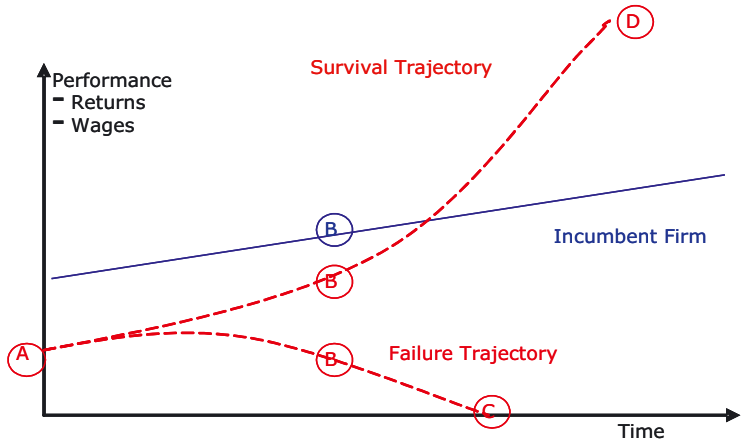
The "European paradox" and the knowledge filter

In fact, if one looks at the other side of the Atlantic the paradox is by no means a European phenomenon only. The senator Birch Bayh observed way back in 1980 that huge investments in knowledge, a wealth of scientific talents, as well as numerous innovative scientific breakthroughs, were going to waste as a result of bureaucratic red tape and illogical government regulations. He questioned the rationale of spending billions of dollars each year in government-supported research and then prevent new developments from benefiting the American people. Basically Birch Bayh was observing the same phenomenon that was also observed in Europe. Nobody called it the American paradox, but it really was. The basic problem lies in the fact that, although the investments generate knowledge, there is not enough commercialisation. Not enough knowledge is spilling out of the university, thus leading to growth in the economy. The concern hence is whether the public will really be willing to continue investing in knowledge if it cannot experience a return in what matters to people. By return I mean jobs, growth, what the Germans call the "Volkstand" a kind of standard of living and security.

This is what we call the knowledge filter, i.e. an elusive phenomenon by which, in the present global economy, investments in knowledge are a necessary but not sufficient condition of job creation, growth and competitiveness. Investing in knowledge is different from the traditional investments in new plants and equipments. These used to sort of automatically result in growth and jobs. Conversely, investments in knowledge go through the filter as knowledge is essentially about ideas and nobody is really sure of whether an idea is good or not. The advantage of Western countries is their knowledge. This implies that we need institutions, policies and a society that can deal with ideas. Asymmetries exist by which people are not quite sure of which idea is valuable. What one person thinks is a good idea another person might think is not. Besides, explaining why an idea is good is not trivial either. This implies that transaction costs are also high.

Entrepreneurship: Exploiting knowledge to sustain growth

Having the knowledge is simply not enough. Somebody actually has to take action and start a new business. Figure 9 shows a simple picture highlighting the possible trajectories that incumbents and newcomers might follow.



Source: Audretsch, Keilbach, Lehmann 2006

Figure 9. Entrepreneurship as conduit of knowledge spillovers

As can be seen, in an incumbent organisation – it could be a firm, a university, a research institute – somebody might have an idea about how to do something differently. She might be able to realize that idea in that very context, in that organisation. Often though, due to uncertainty, this might not be possible. Let us take the example of IBM. A few years ago three young IBM German staff came up with the idea that IBM should produce business software. IBM was not sure about the value of this idea and preferred not to proceed. Had those three young men stayed in the context of that incumbent organisation B, they might have done a little better. What they did, instead, was to jump out of B, go to A, and start SAP. SAP went on trajectory D and the rest is history.

It was entrepreneurial action, i.e. taking the knowledge from one context – in this case it was IBM – and commercializing it by starting A, that made the difference. SAP has since then generated a lot of growth and many jobs for Germany, as well as for Europe.

I believe this is why entrepreneurship serves as a conduit, as the mechanism by which those investments in knowledge – whether cultural of social knowledge, and Europe has invested substantially in people, as well as in science and technology – bring fruits.

An obvious question that arises is what happens when new ideas are not accepted. Either they get lost and just disappear or, as we saw in the case of SAP, somebody actually pursues those ideas in the context of a new organisation. This, in a way, is an important mechanism, a conduit of these knowledge spillovers. Knowledge by

itself is not sufficient, it is a necessary condition but one also needs the conduit that facilitates the spillover of knowledge from the context where it was created. New ideas must be commercialised. Obviously entrepreneurship is not the only possible conduit, but it certainly is an important one. It seems to be the missing link in economic growth and it implies a very different way of carrying out (small) businesses.

For instance, in the old German "Mittelstand" approach (see table 2) the focus is on traditional sectors. In the entrepreneurial model we instead see that emphasis in on new, emerging sectors, where new ideas are important. The mittelstand tradition had also a focus on the family group. The entrepreneurial model envisages a diversified range of managerial and ownership assets, has a focus on high R&D – compared to low R&D –, and emphasis is on high human capital, scientists, and cutting-edge research. We also observe high wages compared to lower wages. Rather than stability we see much more turbulence: people try out new ideas and many times those ideas simply do not work. However, it is only through that experimentation, through the investment in new ideas, that high growth can ultimately be generated.

In Schumpeter's theory of creative destruction entrepreneurship does play an important role. New entrepreneurs drive out of the market the existing firms through what he calls creative destruction. Possibly talking about destruction made sense in the old economy, over the last century, but I believe that perhaps Schumpeter's definition is not so adequate to the new global environment. Entrepreneurship does not cause destruction. When it comes to job destruction, for instance, it is globalisation that triggers it in the developed countries. What society can do, what policy makers can do, given the high levels of investment in research, universities, education, culture and so on, is to support those mechanisms that may help harvesting the fruit of knowledge. And possibly it will be society itself to ask such mechanisms to be put in place.

Society might be willing to continue making those investments if she gets what she wants, which is secure, sustainable jobs and a secure, sustainable future.

As Romano Prodi noted, with respect to the EU – Lisbon Mandate of 2000: "Our lacunae in the field of entrepreneurship needs to be taken seriously because there is mounting evidence that the key to economic growth and productivity improvements lies in the entrepreneurial capacity of an economy" (Romano Prodi, 2002). Entrepreneurial capacity means the ability to take those investments and get something out of them, to facilitate this conduit that exploits ideas and generate new jobs and growth.

An entrepreneurial role for universities?

Last, some considerations are needed with respect to the role of universities. Certainly, their role might be different in an entrepreneurial economy from what it used to be in a traditional economy. Universities have been fundamental in generating the capacity for cultural understanding, for society as a whole and, ultimately, for civilization. They have also been engines for democracy. However, with knowledge becoming all the more important, and with universities being important sources of that knowledge, it becomes fundamental to let knowledge spill over. The existence of the knowledge filter suggests that those investments in knowledge societies have made do not automatically spill over to commercialisation. Conversely, the knowledge filter impedes that knowledge would flow out, it keeps it within universities' boundaries. Something has to be done to facilitate that spillover, to transfer knowledge.

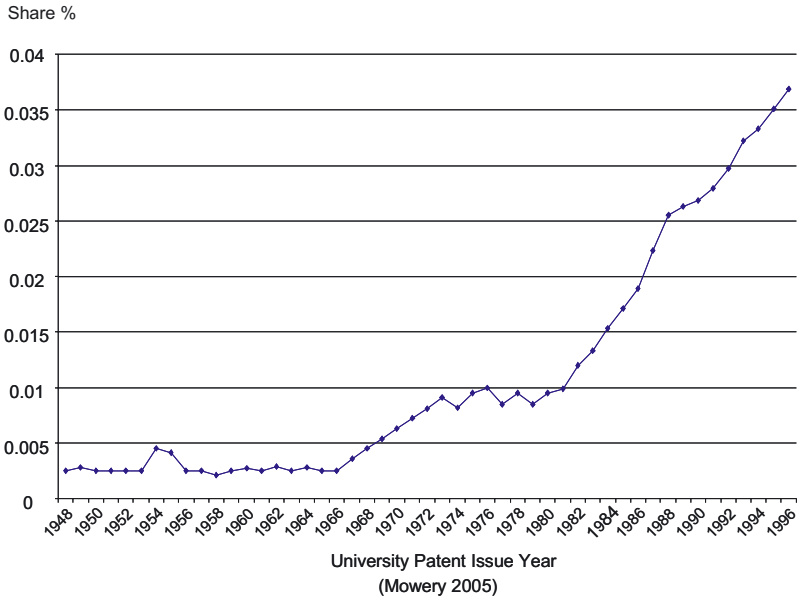


Figure 10. Impact of 1980 Bayh-Dole Act

Figure 10 shows the number of patents from universities as a share of the total number of patents, in the United States. As can be observed, the trend was pretty stable throughout the whole post-war period, and suddenly in 1980 it took off almost exponentially. Some argue it is because of the Bayh-Dole Act that was passed in 1980, which gave universities the property rights of federally- and government-funded research. It may as well be, but I believe the issue is more complicated than that. It might as well have been the Bayh-Dole Act, but certainly some-

thing changed within universities. Traditionally, universities were almost totally funded by the government. Professors spent almost all their time teaching and ended up almost all earning the same salaries. Although they did carry out research, nobody talked about commercialisation in the 1970ies. What one sees at present is instead a completely changed picture. There exist a tremendous heterogeneity in the personnel of universities, there are very different organisational assets and types of governance. The focus is much more on trying to set knowledge agents – i.e. researches and scientists – free, let them get out in the economy. Evidently, this requires a completely different kind of university.

A recent study investigated the results of the National Cancer Institute (NCI) grants, awarded over the period 1998–2002. Overall, 1,693 scientists were given $ 5,350 million NCI grants. They match NCI awards to patents and see that there have been 398 distinct patentees, holding 1,204 patents (1998–2004). Besides, one over four scientist, and these are elite scientists, started her own firm.

These university scientists are receiving support from a multitude of sources. One of the most significant sources is the Small Business Innovation Research (SBIR) program of the United States government, a program designed to enable entrepreneurship. Under this 1982 law, federal agencies reserve 2.5 % of their budget for small and innovative firms to do research on projects that are likely to lead to commercializable innovations. Two and a half percent may not seem like much, but in 2003 that represented $ 2 Billion worth of federally funded research, along the way stimulating significant innovation and entrepreneurship. Often these grants have gone to University professors and researchers encouraging them to trade their lab coats for suit jackets – pursuing careers as small businessmen, creating opportunities for economic development opportunities. These scientists are at the forefront of the entrepreneurial university.

Universities are uniquely positioned and skilled at the task of creating economic growth: with new knowledge and localized expertise a university with an entrepreneurial orientation will be at the heart of a localized cluster. This begs the question: what form should a university take as it fosters economic growth. Traditionally universities have focused, nay fixated, on the growth of basic knowledge: philosophy and the natural sciences, for example. This Humboldt style university was prevalent in Europe and the United States, however American universities started shifting, adding a layer of applied research. The earliest evolution came with Land Grant Universities which were given a mission to improve agriculture in the United States. This unusual focus beyond the traditional disciplines to agriculture later evolved to include public administration and business schools, as well as applied research in physics, chemistry, biology and pharmacology – to name a few. Once this layer of applied research was added to universities – applied research dependent upon the core basic knowledge sources – universities kept looking out-

ward. Technology Transfer Offices facilitated the use of university generated knowledge by outside firms, both pre-existing and start-up. Once the knowledge is absorbed outside the university, firms could commercialize it and grow, creating jobs and economic growth that benefited the surrounding community, region, state, and, ultimately, country. At the heart of it was the university and its basic knowledge generating traditions – but to fulfil this economic growth job, the entrepreneurial university had to grow beyond its traditional core to encompass applied research and technology transfer.

The entrepreneurial society

As research has found, entrepreneurship is the missing link in the knowledge economy. It is not enough to generate knowledge and put it out there: there needs to be a catalyst to transform it from static book based information into dynamic job generating economic growth and entrepreneurship is that missing link. As it was realized that entrepreneurs were driving job creation and economic growth, policy facilitating entrepreneurship evolved, promoting growth, employment and global competitiveness. One source of competitiveness turned out to be right next door in the hallowed halls of the local university: globalization helped universities exemplify exactly what their role in society was: a key source of competitive advantage that can help individual cities and regions make significant economic growth. This evolution of the university's role started long ago in the United States, but the evolution accelerated and was aided by the expansion by universities beyond their traditional Humboldt role of increasing basic knowledge to include applied research and the spillover of newly created knowledge, via technology transfer, to the private sector for commercialization. This role for entrepreneurial universities at the heart of the entrepreneurial society will only magnify over time.

2.2 Intellectual property, knowledge policy and globalization

F. Gurry

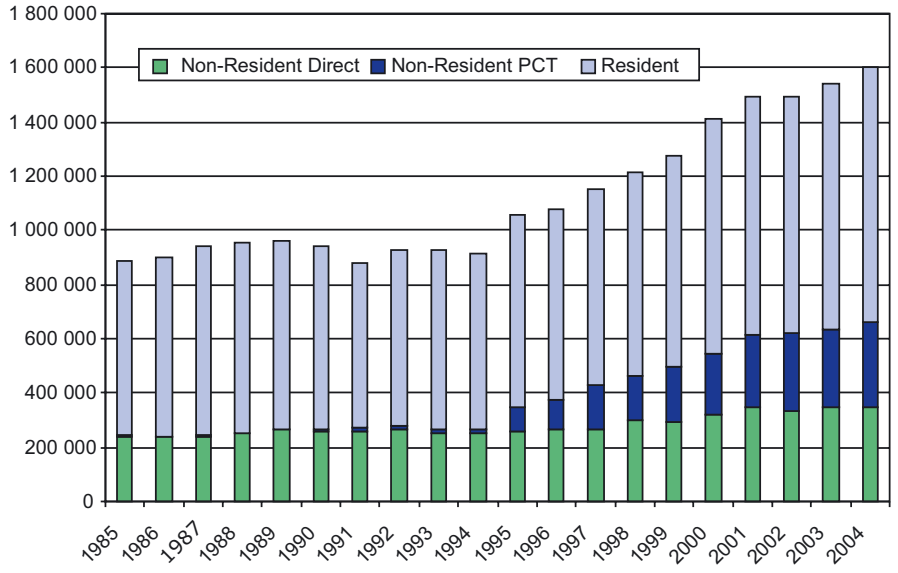
Introduction

That Intellectual Property (IP) has been globalised is fairly obvious. In fact, intellectual property itself is both among the causes and the effects of globalisation. On the one hand, it is one of its causes, due to the inherently international character of intellectual property. This intangible asset facilitates the establishment of enterprises as well as the intellectual structure of enterprises, throughout the world. All that one has to build upon it is its physical elements, co-determined by the local environment. On the other hand, IP is one of the consequences as we have, for instance, ubiquitous global marks. Nowadays we have fairly global fashion, cultural, sporting, entertainment icons and phenomena. Intellectual property has become a matter of universal – as opposed to local – interest. However, while technologies of communications have been converging, communication about IP has not.

Radical changes in the world of intellectual property

Whatever the perspective one might want to take with respect to intellectual property – whether economic, political, legal, geographical or technological – one finds that there have been very radical transformations, in the course of the last fifteen years in particular.

Economically we have witnessed a massive expansion of the demand for intellectual property rights. This is a result of the heightened awareness of intellectual property and about the value of intellectual property. It is also the consequence of the desire, on the part of enterprises and intellectual property owners, to achieve protection across a broader geographical range. We are currently running at about 850,000 new inventions per year for which patent protection is sought. It translates into an overall figure of about 1.6 million patent applications around the world.



Source: WIPO 2006

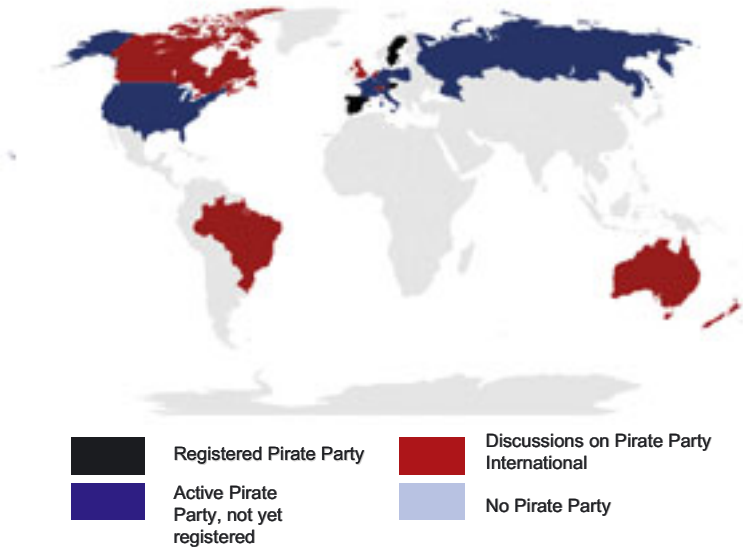
Figure 1. Number of patent applications worldwide by residents and non-residents 1985–2004

The component of those 1.6 million that is increasing the most in any country is the one reflecting non-resident patent applications. The expansion of demand is not just a question of numbers. We have also seen a demand for new rights and new legislation in the field of intellectual property rights. In the area of information technology, for instance, we face demand for IP concerning layout designs and integrated circuits (TRIPs) as well as database protection. We are also experiencing an expansion of rental rights, communication rights, whereas broadcasters' rights are under discussion. Likewise, expansion to new constituencies – such as traditional knowledge and traditional cultural expressions – and a desire for expanded coverage of geographical indications are also under consideration. In the course of the last fifteen years the extremely frenzy legislative activity in the field of intellectual property has resulted in ten new multilateral treaties, of which the TRIPS (Trade-Related aspects of Intellectual Property Rights) agreement is one example. Within the European Union, for instance, we have seen seven new copyright directives, one biotech directive and one (but failed) Computer Implemented Inventions Directive.

If one moves away from the economic side of IP and looks at the political aspect, one sees similarly radical transformations. These are largely the result, I believe, of the empowerment of a much broader range of participant groups. This, in turn, is the result of the networked society and the policy debate about intellectual prop-

erty and the emergence of horizontal global alliances. These imply non-governmental organisation and interest groups in one particular country allying themselves, or allying themselves with states in other parts of the world.

We hence have a very changed political scenery discussing intellectual property at the international level. At the same time we also see experimentation in new innovation models, open source, open publication, the creative commons, and an anti-intellectual property movement as well.



Source: English Wikipedia 2006

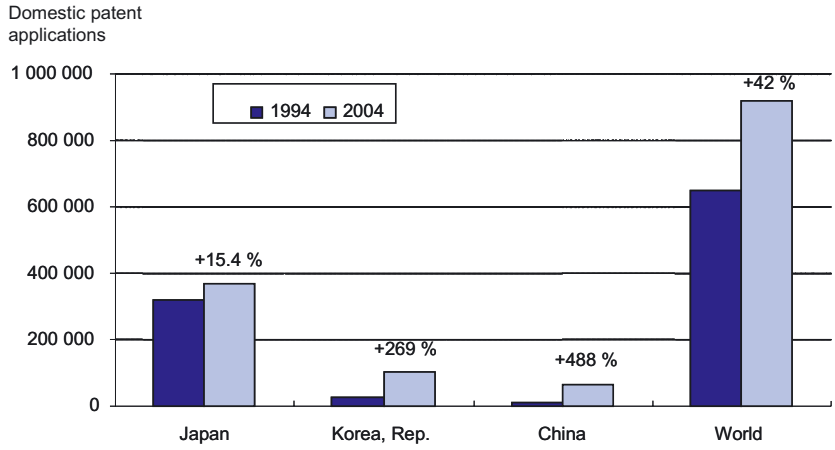
Figure 2. Pirate parties

Figure 2 shows a mapping of a latest phenomenon, which is a Scandinavian phenomenon in origin: the Pirate Party. It is a political party essentially based on its opposition to intellectual property. As can be seen, it is gaining ground around the world. I would not expect that we will see governments constituted by pirate parties, but this is nevertheless a new phenomenon.

I believe that legally there has been a quiet revolution with respect to intellectual property. For the first hundred years of its existence, which we can call the "Single Model Phase" (1886–1992), intellectual property was really a self-enclosed world on its own. It answered to its own policy imperatives. The highest level of complexity was the national level, with emphasis put on competition policy, ordre public (morality) and national security.

During the period 1992–1998, we instead saw that intellectual property took notice of its impact on other areas of public policy, notably with respect to exclusions for patentability. More attention was also devoted to international instruments dealing with intellectual property.

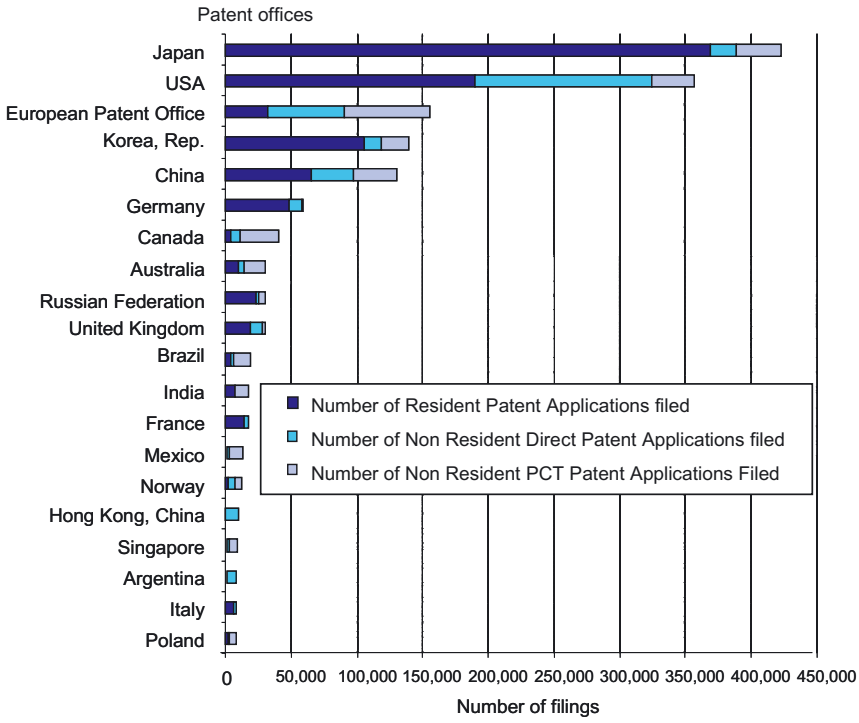
Since 1998 we have stepped onto yet another stage where there is a much more interactive relationship between intellectual property policy and other areas of public policy. We find that at the international level. It is not just the WIPO and the World Trade Organisation that are concerned with intellectual property, but there are programs on intellectual property in the World Health Organisation (WHO), UNESCO, the Convention on Biological Diversity (CBD), the Food and Agricultural Organisation, the International Telecommunication Union and so forth. Currently, intellectual property is being scrutinized from the perspective of other public policies. Geographically, we have had also enormous changes, and the one in particular I would like to point out is the geopolitical shift in technological generation. In terms of resonant patent application, we see an enormous change coming out of North-East Asia, in particular Japan, the Republic of Korea and China.



Source: WIPO

Figure 3. Geopolitical shifts in technology generation: resident patent applications in North East Asia

Resident patent application filed within the country have increased by nearly 300 % in the Republic of Korea over the last ten years and by nearly 500 % in China. If one indeed looks at the top patent offices around the world she finds that of the first five, three come from North-East Asia. In terms of applications received it is first Japan, then United States, the European Patent Office (representing now 32 countries), the Republic of Korea, and China, which are very close behind the European Patent Office.



Source: WIPO Statistics database

Figure 4. Top 20 offices of filing (2004)

Internationally the same development is reflected in the patent cooperation treaty, at the level of international patent applications. The growth rate from Japan in 2005 was 22 %, 32 % from the Republic of Korea and 46 % from China. Hence currently those three countries, aggregated simply on the basis of this surge of growth and their geographic proximity, generate one quarter of the new technology for which property rights are being applied internationally. The same has happened with the respect to the output of science and technology articles, where China is now the sixth biggest producer of science and technology (S&T) articles and the Republic of Korea the twelfth largest producer of S&T articles.

Source: National Science Board, Science and EngineeringIndicators 2006

Figure 5. Scientific and technical articles, by country/region (1988–2003)

Finally, with respect to technology itself, we observe a big transformation. I will selectively choose two examples. One is in terms of quantity. We are currently generating around the world 850,000 new inventions for which patents are being applied, as I mentioned, and 1.3 million peer reviewed science, technology and medical articles per year. This mirrors an enormous increase in technology and the technological base. As (Audretsch, ibid.) highlights, technology is reaching further back into science, particularly in the biomedical area, and university's patenting and licensing is growing enormously. One can measure these phenomena through the references in granted patents to non-patented technologies, to what we call the "non-patented literature", or science and engineering articles. The times these articles are cited as prior art or pre-existing technology is rising very rapidly in terms of universities' own activities. In 2003, 1 billion dollars was earned in gross royalties by United States universities.

Intellectual property: A system under stress

As can be easily guessed on the basis of the facts highlighted, the intellectual property system is a system that is under enormous stress.

On the one hand, there is functional stress, as there are growing backlogs in the system. Patent offices do not have the capacity to deal with the demand well at this stage. Quality is being put at stake and there are complaints about "bad patents". Moreover, we have been changing business models and litigation. Besides we observe the emergence of patent holding companies whose aim is not to exploit patented technologies for e.g. manufacturing purposes. Their aim is solely to use patents, amongst other devices, to generate either royalties through licensing or through litigation. On the top of all these sources of tension, we have been observing an explosion of counterfeiting and pirating, largely as a result of the invention of technologies of perfect imitation, biotechnology and digital technologies.

On the other hand, we also have a great deal of political stress in the system. Internationally, one of the consequences of this is that we really have two competing agendas out there. An agenda, very much pushed by the industrialised countries, concerns the functionality of the system. The other agenda, mainly backed by developing countries, is mainly political. Basically their argument is that they did not create the increase in demand that we observe, which is causing this functional stress, and they do not want to use valuable policy time, at the international level, to discuss simple functionality. They want to look at the impact of intellectual property rights on areas of public policy such as health, the environment, agriculture and so forth.

One of the big questions and challenges will hence be how and to what extent making these seemingly parallel agendas actually converge in the future.

Looking for solutions: Possible pathways

I believe there are no easy solutions to any of the issues at stake, as they are very radical ones. Still there might exist pathways that might lead to resolve some of the tensions. I would, in particular, envisage five of them.

Broadening the policy focus

Firstly, it is necessary to reconsider the very basis of intellectual property, that is the underlying policy incentive for the encouragement of innovation and creativity. Indeed there are other issues at the basis of IP. However, a fundamental aim of the patent, design and copyright systems is trying to encourage innovation, that is invention and the commercialisation of the invention and the creativity involved. As such, IP is really and simply a tool. Perhaps we should shift the focus a little towards this underlying interest and allow for an inclusive discussion about other models of innovation rather than intellectual property alone. This does not imply underestimating the importance of intellectual property but, as we know, there are other models. Besides, what we are increasingly talking about is not intellectual

property policy, but knowledge policy, i.e. a broader policy concerning the generation, transmission, and the use of knowledge, in particular new knowledge.

Geography

Secondly, in relation to the geographical changes that have occurred in the system, there are three features we need to pay attention to. One is the accessibility of technology. In fact, the increasing linguistic diversity in the technological base is a major issue for us all. As far as WIPO is concerned we have two measures under way. One is that we actually provide, for any international patent application and regardless of the language of filing, a summary in English and in French. Moreover, our website offers online access to the full back file of those 1.3 million international patent applications. We are also constructing a multi-lingual search system based on a terminological database, which will use automatic translation tools to get the application. Linguistic diversity also raises an important question about the comprehensive nature of an international search of prior art. Of course, talking about bad patents means talking about patents that should not have been granted as the idea, the invention, already existed in what we technically call "prior art", i.e. pre-existing technology. However, the increasingly linguistically diverse prior art or technological base put in question the comprehensive nature of the search itself. At WIPO we have put forward a technical proposal for cooperation between patent officials in this regard, but certainly this is an issue to which we should pay a significant amount of attention.

Development

A third piece of the broader pathway I would like to highlight is the issue of development. Although development constitutes an immensely complicated problem, I would like to put forward a couple of points about the issue. The first is that we often fail to contextualize the role of intellectual property. Let me compare apples and oranges for a moment. In 2004 five corporations spent more on R&D than the individual GDPs of 53 countries in the world. These are Microsoft ($ 7.8 billion), Pfizer ($ 7.7 billion), Ford ($ 7.4 billion), DaimlerChrysler ($ 7 billion) and Toyota ($ 7 billion)[1]. This implies that each of these firms spent more on the creation of new knowledge than 53 countries each did with respect to their whole infrastructure, health system, education and, more generally, public expenditures. Moreover, the top 1000 public corporate spenders on R&D spent more in 2004 ($ 384 billion) than the GDP of Sub-Saharan Africa in 2002[2]. Evidently, this is just one

1 Sources: Booz Allen Hamilton Global Innovation 1000

2 World Bank, World Development Indicators 2004

way of contextualizing intellectual property. Still, I believe we often get stuck at the international level because developing countries have a more political agenda rather than an economic concept. Moreover, there exist massive diversities in the economic circumstances of the various developing countries and treating them as a whole group is a disservice. A disservice to them and to the broader international ability to create a more differentiated system of intellectual property rights.

	Population	GNP $ Billions	Rank	Per Capita Income (PPP)	Rank
Brazil	174	494.5	12	2,830	91
India	1,049	494.8	11	470	161
Kenya	31	11.2	85	360	174
Laos	6	1.7	153	310	176
Mozambique	18	3.6	128	200	195
PNG	5	2.8	140	530	158

Source: World Bank, 2004 World Development Indicators

Figure 6. Differences in conditions among developing countries

Secondly, a much underestimated issue is that there has been a quiet democratization of the access to technology. Merely ten years ago the world's patent collections – which by the way constitute the most comprehensive systematic and organised record of humanity's technologies – were only available in paper format. One had to go to the place where the paper collection was stored in order to have access to the technology sought. They are now available online in fully searchable form. It should not be neglected that unlocking the technology available through the patent system is an enormous task. This is justified by the very rationale of the patent system, that is to encourage the disclosure of technology. Let me give you just one example, the rollerblade. It may not be the most socially useful invention, but the rollerblade was patented in the United States of America in 1932 and it fell into the public domain in 1949. And that is probably about 30 or 40 years before the commercial trend of having rollerblades started. In fact, there are many such examples available.

Functionality and the management of demand

With respect to functionality, I believe that the present model, whereby an invention and a patent application are searched repeatedly in patent offices around the world, constitutes a misallocation of resources. Besides, this very inefficient allocation of resources does not produce the best results. A network approach could instead produce much more interesting results. It is simply not possible for small developing countries with scarce resources to have 6000 post-graduate examiners to

examine patent applications as the United States Patent and Trademark Office or others do. Our challenge is thus to find ways to intensify international cooperation and to oil the mechanics of the system, while at the same time leaving some public policy flexibilities in areas that are sensitive at the national level. Unfortunately, we are not succeeding in doing so, at the moment.

Multilateralism

We have observed a very radical change in the architecture of the intellectual property system in the course of the last fifteen years. We used to have an "à la carte" system whereby one was able to choose from a variety of possible solutions. That was the system enabled by the Paris convention and the Bern convention, each of which had articles envisaging the possibility of concluding special agreements between certain members. We have many examples of that, with treaties differing also in the numbers of contracting parties. Now, after the TRIPS agreement, the system has rather become a system of "menu de jour", that means that there is no other way of approaching the matter. It is a vastly different system, and a lot of the tension we have seen is a result of this change. I think we need to reflect a little bit about the sort of system architecture that we need for the future.

2.3 Transnational corporations and the globalization of R&D

T. Fredriksson

Introduction

The globalization of research and development (R&D) is attracting increased attention from policymakers in both developed and developing countries. This article highlights some of the main findings of the work conducted by the United Nations Conference on Trade and Development (UNCTAD), notably as reported in the World Investment Report 2005: Transnational Corporations and the Internationalization of R&D (UNCTAD, 2005). It starts by reviewing recent data that shed new light on this phenomenon. It goes on to consider possible explanations to the trends observed and concludes by considering possible implications for developed and developing countries.

R&D internationalization is accelerating

Transnational corporations (TNCs) are major actors within the R&D universe. They account for the bulk of global business expenditures on R&D and are the world leaders in terms of creating new technology and diffusing it internationally. Some firms have R&D budgets matching the R&D expenditures of entire countries. For example, six TNCs (Ford, Pfizer, DaimlerChrysler, Siemens, Toyota and General Motors) spent more than $ 5 billion on R&D in 2003. By comparison, among developing economies, only Brazil, China, the Republic of Korea and Taiwan Province of China had larger R&D expenditures. TNCs also dominate new patent registrations and lead innovation in management and organization. As TNCs are the dominant players in the creation of new technology, it matters where they undertake their R&D. Most countries are eager to attract R&D by TNCs in order to connect their national innovation systems effectively with the TNCs' global R&D systems.

R&D – probably the most strategically sensitive business function – remains among the least internationalized corporate activities. There are several reasons for this "stickiness" of R&D location (Lall 1979). The often complex and tacit nature of advanced technical knowledge makes it difficult and costly to locate the different segments in different places. Research skills tend to develop in a cumulative manner, so that centres that start early often retain or increase their lead. Such factors tend to confine innovative activity to specific locations or clusters within an economy (Patel and Pavitt 1991). Moreover, foreign direct investment (FDI) theory implicitly assumes that R&D, the source of the most important advantage of

TNCs, would remain at home. Nevertheless, most large companies, particularly those with multi-plant operations and diverse products, have dispersed R&D units.

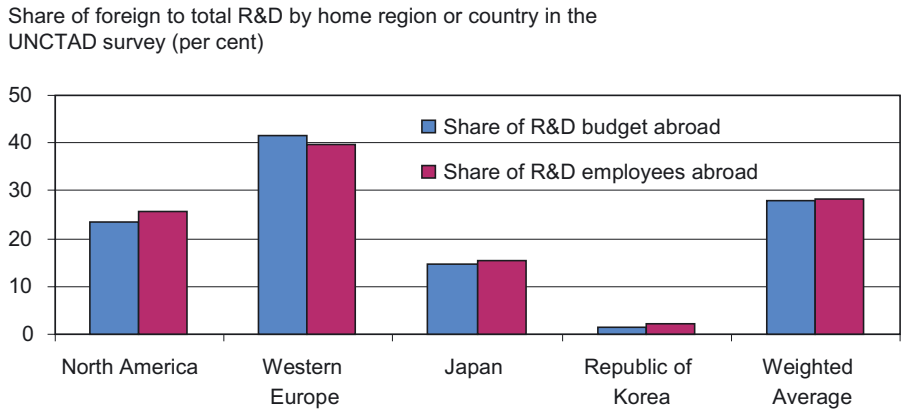
In fact, R&D internationalization is not a new phenomenon. In some form, it may date back to the earliest days of FDI as investors have always had to adapt technologies (often through local R&D) to sell successfully in host countries (Safarian 1966, Brash 1969). However, the process as it is now evolving contains some interesting new features.

The data situation related to R&D internationalization is generally unsatisfactory. Still, available data for the past ten or so years paint a rather clear trend: the internationalization of R&D is gaining momentum. For example, R&D by majority-owned foreign affiliates in total R&D by United States TNCs, rose from 11 % to 13 % between 1994 and 2002. For Swedish TNCs, the share of R&D conducted abroad rose from 22 % to 43 % between 1995 and 2003. German firms established more overseas R&D centres in the 1990s than in the preceding 50 years combined (Ambos 2005). In a cross-country survey, foreign to total R&D rose from 15 % in 1999 to 22 % in 2001 (Roberts 2001), a trend that has been confirmed also in other studies (Edler et al 2002, von Zedtwitz and Gassmann 2002).

The picture varies considerably between different home countries (figure 1). An UNCTAD survey of the largest R&D spenders in the world found that European TNCs generally have the highest share of R&D abroad[3]. Within Western Europe, the foreign part is particularly large in the case of companies from the United Kingdom (66 %) and Switzerland (61 %). Conversely, Asian TNC's are the least internationalized in this respect; TNCs from Japan and the Republic of Korea have only 15 % and 2 %, respectively, of their total R&D abroad[4].

3 Foreign is defined as the investment in countries outside home country, thus German investment in the United Kingdom is considered foreign even if both of them are within the category of Western Europe.

4 Previous studies (Roberts 2001, Edler et al. 2002, von Zedtwitz and Gassmann 2002) have also found that Western European firms are the most internationalized. In the Edler et al. survey (p. 158), European firms were estimated to spend one third of their R&D budget abroad in 2001, followed by companies from North America (32 %) and, distantly, by Japanese firms (11 %). In Roberts' survey, Western European firms were estimated to spend 35 % of their R&D budget abroad, followed by the North American firms (33 %) and the Japanese firms (10 %). The discrepancy with the UNCTAD survey is due to the fact that the survey by Roberts treated intra-European and intra-North American R&D flows as domestic.



Source: UNCTAD 2005

Figure 1. Share of foreign to total R&D

Another way of measuring the increased internationalization of R&D is to consider the role of foreign affiliates in global R&D investments. According to UNCTAD (2005), the share of foreign affiliates in global business expenditures R&D increased from 10 % to 16 % between 1993 and 2002. Even more interestingly, in the case of developing countries for which data exist, the share of foreign affiliates increased from 2 % to 18 % during the same period – a much more rapid growth than in developed countries. This is but one indicator of the growing role of developing countries in the context of R&D globalization.

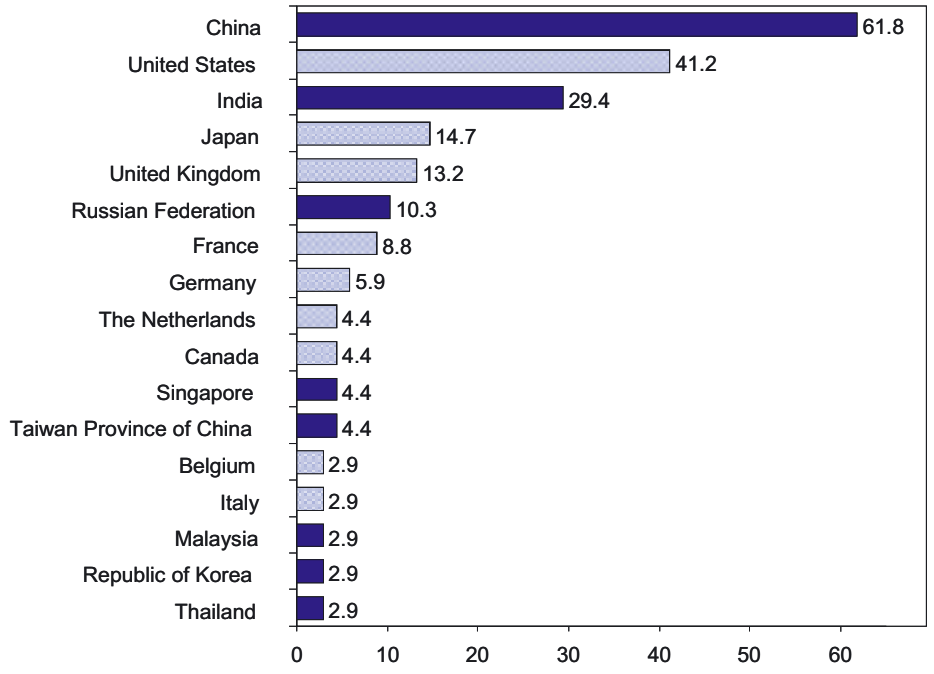
Growing role of developing countries

Traditionally, when R&D was done abroad it typically involved developed countries only. When developing countries occasionally were involved as host countries for R&D investment, the R&D conducted served primarily to adapt products and services for the local host-country market. Even if such observations still apply for most developing countries, an acceleration has been observed in the amount of R&D that is being undertaken by TNCs in selected developing countries. For example, between 1994 and 2002, the share of developing economies in the total R&D spending by majority-owned affiliates of United States TNCs increased from 7.6 % to 13.5 % (UNCTAD 2005).

A few developing economies have attracted the bulk of this R&D activity. Developing Asia is the most dynamic recipient. In the case of R&D expenditures by majority-owned foreign affiliates of United States TNCs, for example, the share of developing Asia soared from 3 % in 1994 to 10 % in 2002. The increase was particularly noticeable for China, Singapore, Hong Kong (China) and Malaysia. In the

foreign R&D activities of Swedish TNCs the share of countries outside the Triad more than doubled, from 2.5 % in 1995 to 7 % in 2003. Various data on TNCs from Germany and Japan confirm a growing importance of developing countries and some economies in transition as locations for R&D (UNCTAD 2005).

Recent data on FDI projects suggests that the expansion of R&D to new locations is gaining momentum. Of 1,773 FDI projects involving R&D worldwide during the period 2002–2004 for which information was available, the majority (1,095) was in fact set up outside the developed economies. The survey of the world's largest R&D spenders conducted by UNCTAD during 2004–2005 also found a growing importance of new R&D locations. A large proportion of the TNCs surveyed already had an R&D presence in China, India or Singapore. The same survey predicted a further shift in terms of R&D locations towards some developing economies (figure 2). China was mentioned by the largest number of respondents for future R&D expansion, followed by the United States. In third place was India. The Russian Federation was also among the top 10 target locations. Other developing economies mentioned as candidates for further R&D by some respondents were the Republic of Korea, Singapore, Taiwan Province of China, Thailand and Vietnam. Few respondents indicated any plans to expand R&D to Latin America or Africa.



Source: UNCTAD

Figure 2. Prospective locations for new R&D during 2005–2009 by the world's largest R&D spenders, (per cent of respondents citing the location)

R&D in developing countries is becoming more complex

The sectoral distribution of R&D conducted in different locations varies considerably by region and economy. In 2002, three-quarters of the R&D of United States majority-owned foreign affiliates in developing Asia were related to computers and electronic products, while in India over three-quarters of their R&D expenditure went into services (notably software development). In Brazil and Mexico, on the other hand, chemicals and transport equipment together accounted for over half of all R&D by United States foreign affiliates.

TNCs carry out different types of R&D abroad. Foreign affiliates of TNCs may undertake *adaptive R&D*, which ranges from basic production support to the modifying and upgrading of imported technologies. *Innovative R&D* involves the development of new products or processes for local, regional or (eventually) global markets. *Technology monitoring* units are established to keep abreast of technological development in foreign markets and to learn from leading innovators and clients there (UNCTAD 2005).

While it is difficult to quantify R&D by type, among developing host economies evidence points to the predominance of Asia in innovative R&D for international markets. R&D activities in selected Asian economies such as China, India, the Republic of Korea and Taiwan Province of China are becoming increasingly important within the global R&D networks of TNCs. Some of the innovative R&D conducted is cutting edge, as in the semiconductor industry (Ernst, 2005). One of the earliest to move *production* into developing countries, this industry has also been among the first to move *advanced design* to Asia. In the case of chip design, the share of developing Asia has increased from basically zero a bit more than ten years ago to 30% of all investment in chip design.

TNCs have so far located limited R&D in Latin America. Relatively little FDI in this region is in R&D-intensive activities; when it is, the R&D conducted is mostly confined to the adaptation of technology or products for local markets, called "tropicalization" in the Latin American context. Some important exceptions exist e.g. in Brazil and Mexico. In Africa, the R&D component of FDI is generally very low; with the exception of some countries such as Morocco and, especially, South Africa, R&D by TNCs is virtually non-existent. This is partly because of weak domestic R&D capabilities, and the absence of institutional mechanisms that create sufficient incentives for investors to devote resources to R&D (UNCTAD 2005).

Why is it happening now?

This new wave of R&D internationalization is both expected and unexpected. It is *expected* for two reasons. First, as TNCs increase their production in developing

countries, some R&D is bound to follow. Second, like other services, R&D activities are "fragmenting", with different activities being performed in separate locations according to their comparative advantages. It is *unexpected* in that R&D is a service activity with very demanding skill, knowledge and support needs, traditionally met only in developed countries with strong national innovation systems. Moreover, R&D has traditionally been taken to be one the least "fragmentable" economic activities because it involves knowledge that is strategic to firms, and because it often requires dense knowledge exchange between users and producers within localized clusters. So why is it happening now?

The process is driven by a complex interaction of push and pull factors.

On the *push side*, intense competition is forcing companies to innovate more, while keeping their costs down. A combination of increased complexity of the R&D work, rising costs and an insufficient number of certain engineering and scientific manpower in industrialized countries compel firms to explore new sources of low-cost and highly qualified researchers. On the *pull side* are a greatly improved availability of scientific and engineering skills at competitive costs, the continuing globalization of manufacturing activities, and fast growth in some key emerging markets. Contrary to previous research on R&D internationalization, recent studies have found cost reduction to be one of the main drivers of expanding TNC R&D in countries like China and India (Ambrecht 2003, Reddy 2000).

The expanding pool of talent in selected developing countries and economies in transition is particularly important, especially for companies that fail to find a sufficient number of skilled human resources in their home countries. The global supply of skilled people has increased rapidly thanks to a dramatic rise in the number of students enrolled in higher education outside the developed world. At the turn of the century, China, India and Russia together accounted for almost a third of all tertiary technical students in the world. Even if the quality of education varies, the fact that the number of tertiary students in these and other economies continues to grow rapidly is bound to have an impact on the way companies source skills for their future R&D activities. In addition, more scientists and engineers working abroad are returning to China and India to perform R&D in foreign affiliates or local firms.

The current trend can be expected to continue. First, the competitive pressure on firms is likely to remain intense, requiring more innovation. Second, the need for greater flexibility in R&D in response to rapid technological change requires sizeable numbers of research staff with a range of specializations, and necessitates locating R&D activities where such pools of researchers are available. Third, ageing populations in many developed countries may limit the supply of specialized, up-to-date skills, forcing TNCs to look elsewhere for talent. Fourth, developing

countries that take part in the internationalization of R&D will progressively enhance their own ability to conduct more R&D. At present however, it appears that only a few developing countries led by China, India and some economies of South-East Europe and the CIS can effectively meet the conditions required to participate.

What are the implications?

Innovative activity is essential for economic growth and development. Greater openness to trade and capital flows increases the imperative of local technological effort. Liberalization has made it necessary for firms – be they large or small, in developed or developing countries – to acquire the technological and innovative capabilities needed to become or stay competitive. R&D is only one source of innovation, but it is an important one. In the early stages of technological activity enterprises may not need formal R&D departments. As they mature, however, they find it increasingly important to monitor, import and implement new technologies. The role of formal R&D grows as a firm attempts significant technological improvements and tackles product or process innovation. For complex and fast-moving technologies it is a crucial part of the learning process.

No single country can produce all the knowledge needed to stay competitive and to grow in a sustained manner. Countries are therefore eager to connect with international networks of innovation. Outward and inward FDI in R&D are two ways of doing so. R&D internationalization opens up new opportunities for developing countries to access technology, build high-value-added products and services, develop new skills and foster a culture of innovation through spillovers to local firms and institutions. R&D internationalization can help countries strengthen their innovation systems and upgrade industrially and technologically, enabling them to perform more demanding functions, handle more advanced equipment and make more complex products.

So, the process of R&D internationalization means important opportunities for those developing countries that become better connected to the global R&D systems of TNCs. As noted above, it is mainly selected economies in Asia that have seen major benefits from this globalization process. A review of the policies applied in these economies shows that they – in different ways and to varying degrees – have adopted dedicated policies in many areas in order to become more competitive from a knowledge perspective and to improve their national innovation systems. Various approaches have been used, but throughout there has been a strong focus on developing human resources, public research activities and IPR protection. Moreover, they have also actively sought to leverage the activities of TNCs. This has been a powerful combination.

Developing countries that remain de-linked from the global R&D networks of TNCs may risk falling further behind in terms of innovation performance. Countries with relatively weak innovation capabilities should not expect any immediate influx of R&D by TNCs. However, that should not be an excuse for a lack of action. Rather, they may consider how to begin a process through which economic and technological upgrading could be fostered. For latecomers, an essential first step is to ensure that a process is initiated aimed at strengthening their national innovation systems. The policy experience of several Asian economies over the past decades may provide useful inspiration in this context.

For developed countries, the new trends imply both opportunities and challenges. The national innovation systems in developed countries as well are in a position to benefit from new possibilities to collaborate with firms and institutions in developing countries, and to alleviate some of the shortage of skills that currently characterizes certain industries in developed countries. The possibility to allocate more R&D activities in new locations may help them to stay competitive. It should be underlined that R&D investments in India or China does not automatically imply a reduction of R&D investments in developed countries. Rather, given the rising need for innovation, R&D could be expected to increase in both developed and developing countries.

At the same time, globalization of R&D also means greater competition for R&D investments. The overall implication is that, for countries at *all levels of development*, it becomes increasingly important to pay attention to the strengths and weaknesses of their national innovation systems, and to see how those innovation systems can connect in the best way with the activities of both their own companies and foreign companies that may want to invest into the countries. For the world as a whole, this recent trend of R&D internationalization should help speed up the innovation process and facilitate more cross-border flows of knowledge and technology. More R&D can be performed and in new ways, hopefully helping to find new solutions to various problems.

2.4 Knowledge economies: a global perspective

J.-E. Aubert[5]

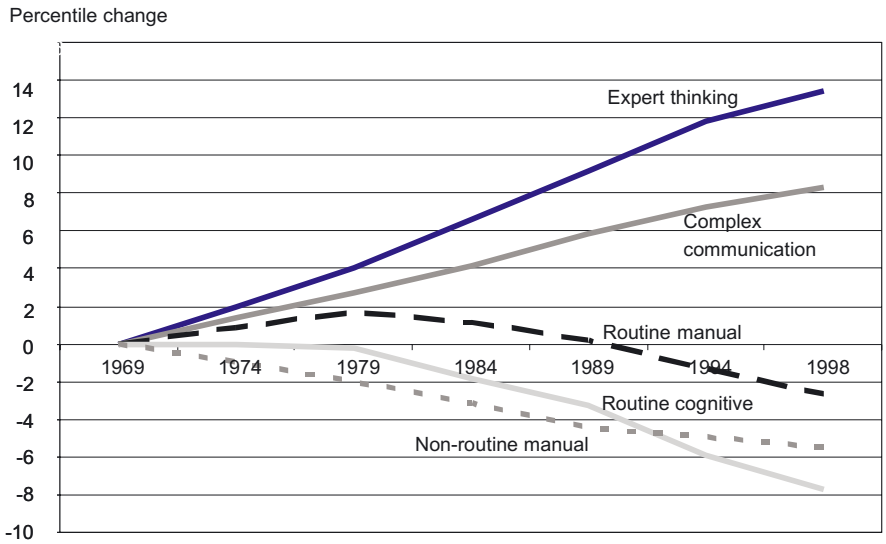
Introduction

It is generally held that what cannot be measured does not exist. Hence, would we not use indicators about the knowledge economy we might end up thinking that it does not exist. However, we are not sure that indicators mirror reality, that they capture what the economy really is. Still, qualitative features are impossible to measure, and they might not reflect reality either. It is therefore necessary to document the quantitative aspects of the knowledge economy vis-à-vis some benchmarking elements, while offering some socio-cultural and qualitative perspectives. This is exactly what we have been doing at World Bank Institute, within the Knowledge Development Program.

Defining knowledge economies

Since the first day of mankind, it has been knowledge to make the difference between, for instance, apes and humans. It is hence puzzling why we currently speak so much about the so-called "knowledge economy". It has always been there. Possibly the reason why we do so is because we use more of our grey matter, more of our brain than in the past. Many are the catchwords used to reflect some of trends characterising our era: information society, post-industrial era, knowledge economy, intellectual capital, and so on. These trends are in fact best illustrated by figure 1.

5 The views expressed in this article are those of the author and should not be ascribed to the World Bank and its Member Countries



Source: Autor, Levy, and Murnane, The Skill Content of Recent Technological Change: An Empirical Exploration Quarterly Journal of Economics, 2003

Figure 1. Changes in job task-skill demands, USA, 1960–1998

In US all the routine cognitive and manual tasks were declining over the 90's and before. They were substituted by more complex communication skills and expert thinking. This is what is behind the knowledge economy. Of course, in addition there is the globalisation process, also enabled by the information, communication and telecommunication revolution. Increased global knowledge and development of new technologies, rapid speed of innovation, shorter product life cycles, greater importance of intangibles, productivity and up-skilling of labor force, as well as intensified globalization and competition, have all characterized the "Knowledge Revolution". Ultimately, it is this ability to use, create and adapt knowledge that is really making the difference in the competitiveness capability of countries.

Measuring knowledge-based economies

The question is how to measure the knowledge-based economy. If what matters is the intangible foundation of the economy, then we have to measure the components of this intangible base. And that includes, of course, education, which in turns relate to the information infrastructure and, more broadly, the national innovation system. Here I join David Audretsch (ibid.) in stating the importance of entrepreneurship and of the broader economic and institutional framework, in which all the investments in knowledge and information can yield results. Such a framework is fundamental, and we need to capture it through indicators related to governance, the rule of law, the business environment and so on. This is what we are try-

ing to do at the World Bank Institute, through a benchmarking methodology based on existing databases. We have built a "KAM", i.e. a knowledge assessment methodology[6] based on 80 structural/qualitative variables. These aim at benchmarking performance over four main pillars. Variables are normalized from 0 (worst) to 10 (best) for 128 countries. The benchmark is based on ranking and not on absolute values. The basic scorecard entails 14 variables measured at two points in time, 1995 and 2004 (most recent available). We thus obtain an aggregate Knowledge Economy Index (KEI).

Let me offer some examples, for instance the Finish scorecard.

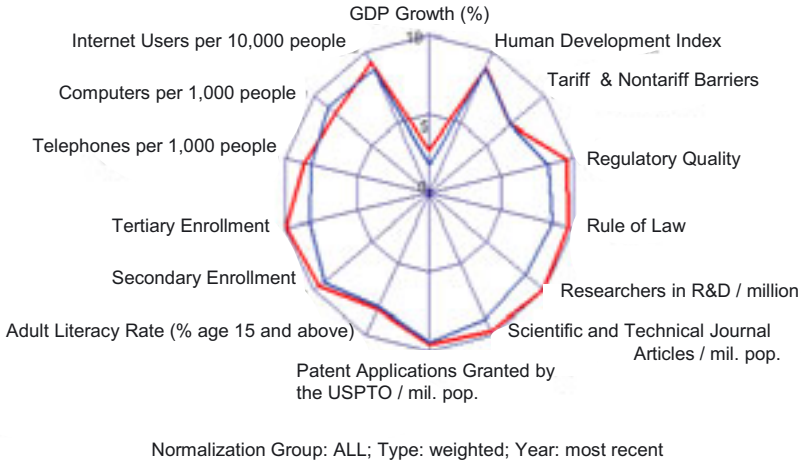


Figure 2. Basic scorecard: Finland and G7

As can be seen from figure 2, we can, for instance, compare the G7 and Finland. There are two variables at the top, which are related to the performance of the economy, GDP growth and the Human Development Index. Then you have three variables related to the economic and institutional framework, including trade barriers, regulatory quality and rule of law. There also are three variables related to the R&D system. We do not use data for measuring innovation, but refer to research and R&D, publications in scientific and technical journals and patent applications. Three variables are related to education: tertiary enrolment, secondary enrolment and the literacy rate. Last we include three variables related to the information infrastructure, namely: Internet users, computer owners and telephone owners. The

6 The database is accessible at www.theworldbank.org/wbi/kam

country's position is mirrored by the red line: the closer it is to the outside circle the better off the country is, i.e. the better ranked in the world it is.

As can be seen, the variables we use are in fact basic variables that can be found in all database. To calculate the Knowledge Economy Index we then simply average the 12 knowledge economy variables mentioned.

CGI WEF		KEI WBI	
Country	2005	Country	Rank (most)
Finland	1	Sweden	1
USA	2	Finland	2
Sweden	3	USA	3
Denmark	4	Denmark	4
Taiwan	5	Norway	5
Singapore	6	Canada	6
Iceland	7	Australia	7
Switzerland	8	Switzerland	8
Norway	9	Netherland	9
Australia	10	UK	10

Figure 3. Competitiveness and the knowledge economy

Figure 3 compares the rank of countries according to, respectively, the World Economy Forum and the Knowledge Economy Index. As it can be noticed, there are some important overlaps.

Another interesting feature of the Knowledge Economy Index is the possibility to relate it to the economic performance and the GDP per capita.

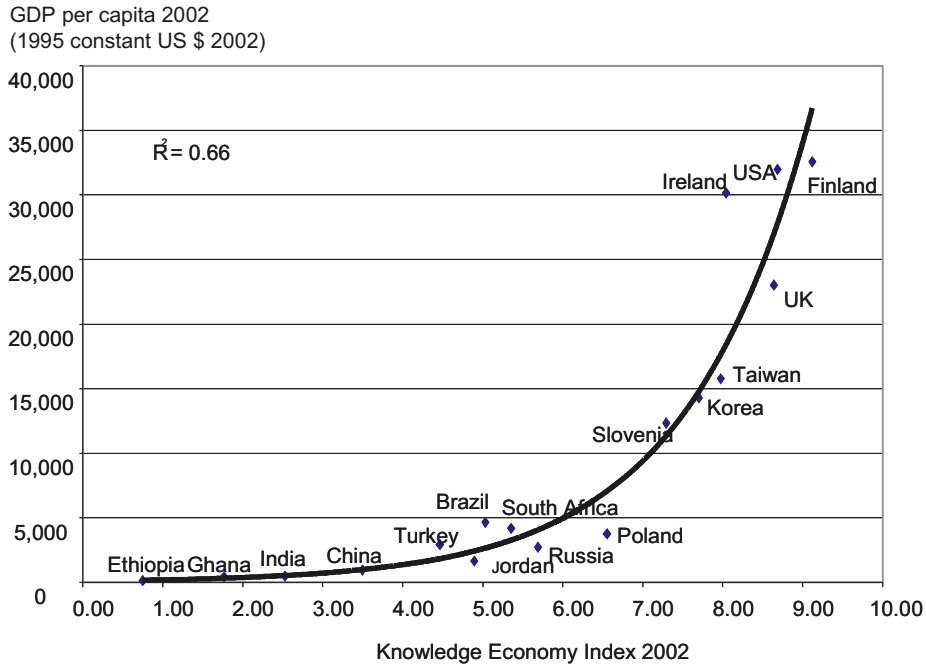


Figure 4. Knowledge economy index (KEI) and GDP per capita

As it emerges from Figure 4, there exists a strong correlation between the Knowledge Economy Index and the GDP per capita. Knowledge is hence critically linked to economic performance. However, correlation does not mean causality. Nevertheless, we have the link between knowledge related investments, the Knowledge Economy Index and future economic growth. The results we have are, in fact, positive. There seem to exist a strong correlation, whatever the level of development considered, and this is an important result that we have obtained. In fact, beyond a simply correlation, there seem to be a causality between the knowledge economy investments, performance and the future economic growth. I here show only two charts where we compare the situation of ten years ago with the most recent data we have (2003–2004 data).

The first one, in figure 5, concerns the Knowledge Economy Index. The countries above the 45-degree lines are those that have improved their relative ranking over the ten year period considered. Below the diagonal are instead those countries whose relative ranking has declined. By relative ranking we mean that a country is shown below the 45 degrees line even if it has made strong investments in its knowledge economy performance variables, but its effort is relatively less important than the rest of the 120 countries in database.

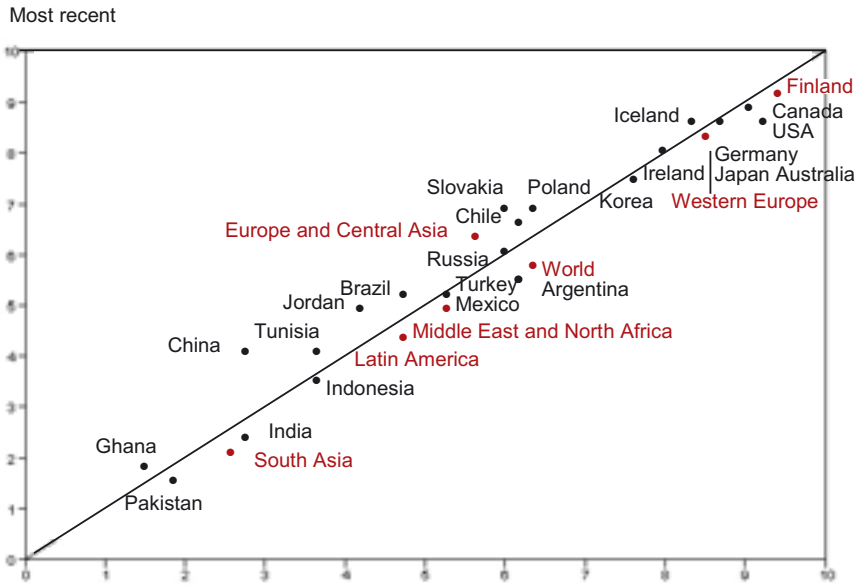


Figure 5. Knowledge economy index

The 45 degrees line points out the general knowledge economy trend of countries: invest more and more in education, research and so on. However, some are investing more or improving more their economic and institutional frameworks than others. This is exactly what we try to capture. For instance one sees that China has made substantial improvements. Evidently, the more advanced a country the less it needs to invest, compared to a developing country. This is the reason why many developed countries show a relatively declining pattern. But this is due to the existence of catching up processes and these are the ones we are mostly interested in capturing at the World Bank.

For instance, we also see that India's competitive position has declined slightly, with respect to that had in 1995, despite all the progresses made in terms of, for instance, education and ICTs. In any case, these indicators have to be considered with great carefulness.

The type of graphs shown allows us to have a very general idea of where countries are going. Moreover, data are updated every six months or every year, in order to better support the analysis of both strengths and weaknesses. It can, for instance, be seen that, the best performers among the advanced Economies are Finland, other Nordic Countries, Canada, Australia. Conversely, the US shows a slight decline and Japan is somewhat behind, although in a stable position. Among the tran-

sition economies, the best performers have been the EU accessed countries, while Russia is recovering from its crisis (keeping its rank compared to 1995). In the case of developing countries, we see China catching up quickly (more than India). In Latin America, we observe Brazil moving up, whereas Argentina is declining (due to EIR). In the Middle East and North Africa we observe good performances, as for instance those of the United Arab Emirates, Jordan and Tunisia. Finally South Asian and African countries are generally lagging behind, with few countries undergoing a catching up process (e.g. Bangladesh, Ghana, Madagascar, Mozambique).

A qualitative perspective on knowledge economies

Over the last century we have observed a general trend whereby Western countries have been the main source of scientific progress. The Far East as well as North and East Asia have been leaders in applying technologies, whereas the Southern countries have mainly lagged behind. The question hence arises of how to put these countries' performance in an anthropological context.

In fact, if one wants to approach such qualitative aspects, she needs to put the innovation system into the broader development system, which relates to finance, industry, economy, education and so on. In turn, all these aspects have to be framed within the broader societal system, which is related to various cultural dimensions.

We can, for instance, compare two different types of approach, which would contribute to explain the differences between Western and Eastern production systems. Great differences emerge with respect to the way the East is functioning as compared to the West, notably in the relationship between science and technology.

Table 1. East-West behavioural contrasts and innovation climates

West	East
Behavioural Contrasts	
Western distancing	Eastern immersion
• Science separate from technology • State separate from society • Individualistic exploration of the unknown	• Science and technology as a single notion • State as part of society • Collective adoption of the known
Innovation Climates	
• Importance of science-based innovations • Technology leaders (radical innovations…) • Public/private system with "rule of law" • Stock exchange bubble-induced recession, durable slowdown	• Technology/production-driven innovations • Technology followers (FDI, licenses) • Connection-based system (Guangi) • Financial crisis (induced by connection-based economy)

The way the state is integrated into society and the approach to knowledge are completely different. The distinction that exists is clear and, in a certain sense, holistic, as the different dimensions are connected by the same type of views and mindsets: one more distant from reality, the other more merged with reality. Such differences are fundamental and they might also help explaining the current emergence of Asia, where the state is part of the society and hence powerful industrial policies can be put in place. This also contributes to explain why Asians have shown an enormous capacity in achieving new scientific and technological developments, and the way these are more and more interlinked. We should be aware of such issues as the trends we are currently observing might continue over the long run. Besides, the anthropological features mentioned may for instance also have implications in the way financial crises emerge in those countries.

Table 2. Western profiles and development systems

	Anglo-Saxon	Latin-Mediterranean	Rhine-German
Ethos	Exposed individualism	Protected individualism	Co-operative individualism
Industry	High tech/ res. nat	State based high tech	Medium size industry
Education	Elitist, in-equalitarian Concrete	Democratic, but in-equalitarian Abstract	Dual (school-enterprise)
Research	Broad	Math/phys specialization	Eng. Specialization
Finance	Stock exchange/ venture cap	Bank	Bank/industry

When it comes to Europe, we can observe several societal models and, in particular, the Anglo-Saxon, the Latin-Mediterranean, the Rhine-German and the Nordic one. Basically the way society is organised has been extremely individualistic in the Anglo-Saxon countries. Conversely, the Latin Mediterranean envisage the protection of individuals by means of institutions, governments, trade unions and so on. The Rhein-German ethos is instead more related to cooperative individualism and has a lot of implications in the way industry, education and research are organised. One must be aware of all these feature also because European integration is not going to happen "overnight". The way European integration is going to be implemented will change according to the specific culture considered.

The relevance of the cultural factor can also be deduced by having a look at the success stories of the past 20–34 years as Finland, Taiwan, Ireland, Israel and South Korea. What do they have in common? First of all they are islands, either geographically or culturally speaking, and they have in the past experienced enor-

mous pressures such as crisis, threats of various type, etc.. Secondly, they have shown a genuine capability to mobilize their inner resources, both human and financial, and to take advantage of external inputs, knowledge inputs in particular. Econometric evidence confirms that being an island, geographically or culturally, is a growth booster. Hence creating a sense of island under pressure may be a key successful policy drive for development and growth. This could apply not only at the national level, but also at the infra national level – regions, cities – as well as the supra national level.

The above mentioned elements can, for instance, can all be encountered in the case of Finland. The World economic Forum ranks Finland as the most competitive nation in the world. Finland also ranks first in education (OECD), governance (WB) and innovation (UNDP). A feature that characterises this country is its exceptional pragmatism and its communitarian sense. Besides, Finland has undergone a strong crisis in the early 1990s (after the fall of the of URSS) and constitutes a “cultural lone wolf”, made of both Western and Asian cultures (B. Lewis).

2.5 Cross-border technology flows in a globalised world

P. Mohnen

Introduction

To begin with it is important to make a fundamental distinction between spillovers and technology transfer. Technology transfer refers to trade in technology. It happens when an agent sells a piece of technology with a price attached to the transaction. A spillover, on the contrary, refers to a transfer of knowledge in which no payment is involved. Moreover it must be unintended, because as soon as an agent is able to internalize the knowledge spilt over, it is not any longer strictly speaking a spillover.

It is also important to distinguish two kinds of spillovers: pecuniary and knowledge spillovers. Pecuniary spillovers, also called rent spillovers, relate to a transfer of rents. They arise as a result of imperfect price discrimination and imperfect information. For instance, when buying a computer, the price one pays does not reflect the real value of the computer to the buyer, as the seller is not able to extract the full value of the computer to the buyer. The impossibility of implementing a perfect price discrimination scheme implies that the buyer obtains some rents out of the innovation done by the first agent. Knowledge spillovers, instead, relate to the transmission of knowledge and to the fact that knowledge is a non-rival and partly non-excludable good. Hence, it is not possible to prevent somebody from using part of the knowledge that somebody else has created, and knowledge can be used by two different persons without losing any of its content.

Knowledge spillovers and channels of transmission

In order to understand how spillovers occur, one needs to understand how knowledge gets transmitted. There are various channels of transmission. First of all, spillovers can occur as a by-product of trade. They can be proportional to the amount of trade taking place between two countries, which can be trade in goods, intermediate inputs, capital goods, commodities and so on. The idea is that knowledge gets transmitted when two parties interact, or when the knowledge is incorporated in the object that is being transacted. Spillovers can also be the result of Foreign Direct Investments (FDIs). For example, by investing in an underdeveloped country, one may transmit some knowledge to the host country itself. Furthermore, spillovers can be proportional to the movement of personnel. They can occur at meetings, fares, conferences and, more generally, at any social event. Collaboration in research, Research Joint Ventures (RJV), are natural candidates for

spillover transmission. Finally, purchases of know-how, licenses and patents can produce spillovers to the extent that the prices of these technological transactions do not reflect the full benefit for the buyer, in the sense that more knowledge is purchased than paid for.

Knowledge spillovers may occur at different levels. There might be within-firm spillovers, i.e. between teams/groups within a certain firm, as well as between firms spillovers. Spillovers may occur between firms belonging to the same industry but also between industries, within a country or between countries, and so on.

Modelling spillovers

Looking at the history of the literature on spillovers, in the early work of Griliches (1979) and Mansfield (1965) the idea was to estimate a production function, where output (Q_{it}) is explained by means of a certain number of inputs (X_{it}):

$$Q_{it} = f(X_{it}, R_{it}, S_{it}, T_{it}, \varepsilon_{it})$$

where

$$S_{it} = \sum_j a_{ji} R_{jt}$$

R_{jt} denotes the own stock of Research and Development (R&D), a proxy for the stock of knowledge. S_{it} is the stock of knowledge of all the other agents from which i benefits, i.e. spillovers. There also is an index of technological change T_{it} and some random component ε_{it}. Spillovers are then measured as a sum of the R&D of all the other agents, with $j \neq i$, where the R&D from the other sources is weighted by a factor a_{jt}. Initially, the idea was to simply sum up and give the same weight to all originators of knowledge. However, as it was misleading not to attribute more weight to those knowledge sources from which one learns more, weighting factors were later used to better mirror the relevance of the various channels of knowledge. It does indeed make a lot of sense to suppose that one gains more from someone else the more one purchases from this agent, sells to her, cooperates with her and so on. Weights can also reflect direct and indirect effects like, for instance, with the Leontief inverse matrix. The weighting factor can mirror the FDI flows between the sender and the receiver, or be proportional to patent citations – that is, the more you cite a patent, the more you are supposed to get knowledge from that patent. The weighting can be proportional to cooperation agreements, R&D personnel, innovation and so on. It can also be proportional to proximity.

Proximity and spillovers: Some stylised facts

When saying proximity I refer to a position or a proximity in a certain space. However, space can be defined in various ways. One type of space could be the patent space, i.e. the idea that the more two agents patent in the same patent classes, the closer they are to each other, the more they may benefit from each other. Space can also be defined by the type of research that is carried out. Hence proximity in space in this case may mean that you hire the same kind of scientists and engineers, with the same kind of degrees, or that you have the same kind of specialisation, basically because you work in the same lines of business. A whole literature has looked at the different ways of measuring spillovers. Then, in 1998, came this article by Keller where he simply used random numbers as weights. He found that, with this kind of weighting, one basically gets similar results to those obtained by using input-output coefficients. In other words, his results point to the fact that the particular type of weighting used may not be that important.

Significant spillovers of R&D or innovative activity in general have been observed at different levels of aggregation: at the project level, the firm level, the industry level, or the country level. Given these findings, few people would disagree that spillovers exist. Besides, knowledge spillovers are generally found to be positive, although there are also arguments to believe that spillovers can be detrimental. Evidently, in the same way as one may benefit from the R&D done by one's competitors (by learning from them or extracting rents from their R&D), one may also suffer losses of market shares. Generally, however, spillovers have been found to be positive, thus ending up having a positive sign in the equation explaining productivity.

In this respect, an important stylised fact has emerged regarding private and social returns to R&D. It has been estimated that the social rate of return to investing in knowledge exceeds the private rate, the difference between the private and social rates being determined by the spillover phenomenon. As an order of magnitude, estimates suggest that the social rate exceeds the private one by about 50 %, but quite a bit of variation exists among different firms, industries and so on.

Another stylised fact that has been observed regards the absorption hypothesis and, in particular, the complementarity of spillovers and own R&D activities. This implies that agents have to perform some R&D to be able to benefit from spillovers.

The studies that have investigated the existence and the direction of spillovers in general do not explain how spillovers occur.

How and why: Explaining spillovers

Evidence suggests that R&D spillovers are set to vary. In line with the absorption hypothesis, they vary, for instance, with the size of the firm, the technological advancement of the receiver and so on. Differences in spillovers also exist depending upon the type of research carried out, the institutions involved and the level of intellectual protection granted.

For instance, more spillovers arise from academic R&D than from defence R&D. This may be due, as some have argued, to intellectual property rights being imposed too early in a research venture. Indeed, there exists a trade-off between protecting knowledge and fostering R&D when giving incentives for R&D by granting intellectual property rights. Doing so confers a monopoly right, a right to restrict knowledge flows from being transmitted to, and used by, others.

In any case, whatever the quantity and type of spillovers we observe, the question remains: how do spillovers occur? In particular: does proximity matter?

Proximity

A branch of the literature has addressed this interesting question by investigating the geography of spillovers. The field was inaugurated by Adam Jaffe (1989), who used patent data to track spillovers. Although his results are somewhat mixed, he found that there were signs of spillovers between firms located close to universities and the universities themselves, i.e. spillovers from the academic world to the business world. The paper was followed by a response from Acs, Audretsch and Feldman (1992). They used innovation data from the SBIR dataset, in the US, and found evidence of geographically bound spillover effects. Almost contemporaneously, Jaffe, Trajtenberg and Henderson (1993) inaugurated a research path that has since been used quite extensively by many researchers. They used patent citations data and found evidence of research spillovers. For instance, they found that firms are more likely to cite the patents of other firms or individuals that are located close to them than they are to cite patents belonging to firms located far away.

Networking

Other studies instead find that location does not matter that much, but it is rather the relational, the networking effect, that makes a difference. Basically, when two agents are located in the same region, it is not because of location that they benefit from spillovers, but rather because they are part of a network. The relevance of such relational effects has been, for instance, underlined by Audretsch and

Stephan (1996) and by Zucker, Darby and Armstrong (1998). For instance, they find that, within a certain industry, the work of scientists coming from western universities might have an effect on the east coast researchers. It is not location per se that matters in this case, but rather the fact that scientists have contacts with persons from the business world on the other side of the country. There also is an important piece of work by Breschi and Lissoni (2001), who look at networking effects among Italian firms. They find that networking is probably geographically concentrated, but it is the networking activity, not the location, that matters. The above studies are all examples of the work that has been done to understand how spillovers occur.

Labour mobility

Another part of the literature looks at labour mobility as a channel through which spillovers may occur. Using matched employer-employee data, Møen (2005) tries to trace knowledge flows from employees creating spin-offs from subsidized IT research. He finds that, although spillovers from IT research and labour mobility is not that great, there exist spillovers that are internalized in the wages of the R&D workers. The idea is that employers know that the R&D workers, in which they invest, might leave or work for another company and such possibility is reflected in a lower wage. In a paper in which I am involved with Maliranta and Rouvinen (2006), we use Finnish employer-employee data. We find that hiring young educated R&D experienced workers increases productivity. All these results point out that labour mobility is certainly one way of transmitting knowledge.

Spillovers from science

There also is a part of the literature that looks at spillovers from science. For instance, there is the work of Squicciarini (2005) that looks at Science Parks in Finland. She finds that spillovers occur when firms join the science park: the very fact that you are part of that geographical concentration, or cluster of enterprises, helps increasing productivity or innovativeness. There is also some work, like for instance that of Cassiman and Veugelers (2002), that uses the information contained in the Community Innovation Survey (CIS) data. There the question concerns the various sources of knowledge for innovation, whether competitors, suppliers, clients, universities. In fact, in empirical studies universities often come out as affecting positively and significantly innovativeness.

The economic policy of spillovers

Knowledge spillover are ultimately a leakage of knowledge, and that leakage can create disincentives to perform and invest in R&D. If the knowledge one creates

goes somewhere else, this leakage of funds may make the investor less willing to train the personnel, to invest in human resources, and so on. Now, several devices have been created in order to restore this incentive to invest in R&D. Among them, intellectual property rights, tax incentives and public laboratories. Besides, the government may directly finance research or give permissions to, for instance, create R&D joint ventures. However, the question arises of why should policy makers intervene. According to the neoclassical theory (see figure 1) agents should consider their private marginal cost and benefit of carrying out R&D and stop investing when the two are equal (intersection of private benefit and marginal cost curves).

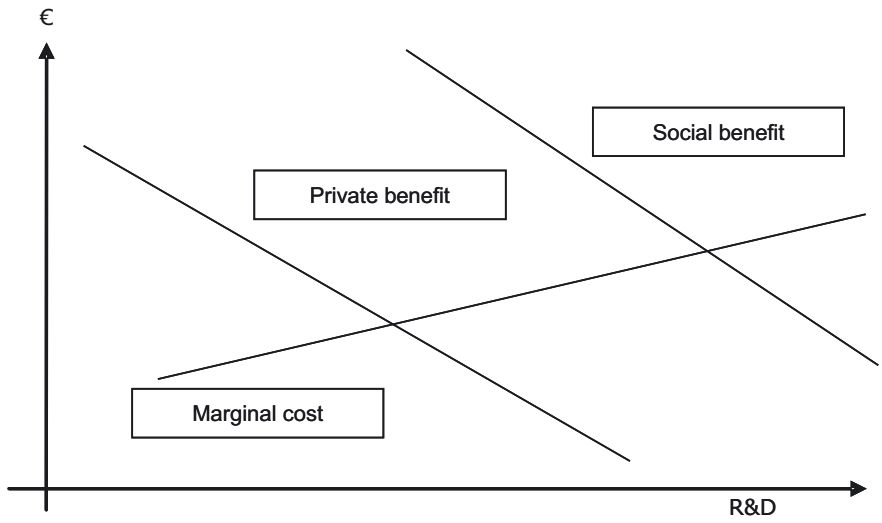


Figure 1. Source of market failure: insufficient R&D

The intersection point represents the private optimal amount of R&D to perform. However, when doing so, firms do not take into account the fact that, because of spillovers, the social benefit arising from investing in R&D might be higher than the private benefit. The pursuit of the social optimum would in fact require investing beyond the privately optimal level. Hence, governments have to intervene to get firms to invest more, in order to achieve the socially optimal amount of R&D. This explains why governments have a role to play with respect to innovation. The reason is spillovers.

Whereas the existence of spillovers is hardly questioned, as there is a lot of evidence pointing out their existence, it is not clear how spillovers occur. This makes managing spillovers a wishful thinking. In fact, I believe we are far from being able to suggest to governments specific measures aiming to achieve the social opti-

mal. We are not able to clearly measure the exact amount of spillover generated or available, nor it is clear which channel of transmission spillovers use.

A few policy measures can, however, be suggested for countries to better exploit knowledge spillovers.

Possible ways forward

Firstly, it is important to build absorptive capacity, as we saw that there exist complementarities between own knowledge and knowledge spillovers. Increasing the absorptive capacity is, for instance, extremely important for developing countries, as that puts them in a better position to be able to benefit from the research done by others. Secondly, to the extent that knowledge is tacit and spillovers are localised, there is the need to increase interaction, networking and to create loci where knowledge can be exchanged. The ultimate aim is to internalise spillovers and this can be pursued by locating close to universities, partnering with Higher Education Institutions (HEIs) or other potential spillover providers. Thirdly, it is important to create markets for technologies. Once you have a market for a technology, then you can also attach a price tag to it. In a way, this implies following a path similar to that followed in the analysis of productivity. There you have the Solow residual, i.e. the part of growth that cannot be explained through labour and capital accumulation. One may try to reduce the Solow residual and explain it in terms of quality, returns to scale and so on. By decreasing that residual there will be less left, and that is somehow what we are doing here: we are trying to decrease the amount of spillovers. Ideally, that could be a way to solve the problem, i.e. having markets where selling and purchasing knowledge: once you have markets for technologies there are no longer spillovers.

Finally, let me hint at negative R&D spillovers. Examples of negative spillovers are the duplication of R&D activities, occurring when firms are in a patent race and all agents want to be the first to achieve the desired result. This leads to the situation where several firms perform the same kind of R&D. On the one hand, this can be socially beneficial as it may encourage the competing agents to work harder, invest more and possibly achieve results in a shorter time. This may even lead to ex-post cross-licensing with the other contenders. However, this also constitutes a social waste of resources, as the same R&D activity is carried out twice. Another example of negative spillovers is the use of R&D as a strategic weapon. What I am referring to is the literature on strategic decision-making. Negative R&D spillovers are, in that case, intentions to block or discourage new entrants, or to deliberately send wrong signals about the research directions pursued. Such dynamics are also of relevance to the analysis of mergers and acquisitions and, more generally, competition policy. However, I still believe that R&D is mostly used in order to advance knowledge or, at the very least, to keep up with competitors.

2.6 Creating value in a digital era: the next chapter in the IT revolution

J. Zysman

Introduction

The notion of a global knowledge economy has become conventional and often misleading. Although the economic world grows ever more interconnected, it is certainly not flat (Zysman in Zysman and Newman, 2006). Rather, it involves a sequence of national and local stories played on a larger stage, giving the world a spiked development dependent on national choices. Moreover, while knowledge has always mattered to economic growth, the place of knowledge has only been recently affirmed in theories of growth[7]. "Tools for Thought" are at the core of the Digital Revolution. They have radically expanded our ability to manipulate information, underscoring the potentials in knowledge and information. Steve Cohen, Brad DeLong and I (2000) have argued that we should conceive information technologies, data communication and data processing technologies as "tools for thought that amplify brainpower in the way the technologies of the industrial revolution amplified muscle power…. They are tools to manipulate, organize, transmit, and store information in digital form. …At each point in the last 40 years the critical step in the transformation of technological potential into economic productivity has been the discovery of IT users of how to employ their ever greater and ever cheaper computing power to do the previously impossible." These tools for thought have been central to growth over the past decade. Demand for this tool set has made Information Technology the leading sector in the economy. The pervasive application of information processing has transformed the economy and how it operates.

We here consider the IT enabled Service Transformation as the next chapter in an evolving story (Zysman and Newman, 2006). We will consider four core issues.

- How has the problem of creating value been changed in the global digital era,
- Why the IT enabled Services Transformation is so critical,
- How the Service Transformation changes the process of innovation,

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7 Warsh, David. Knowledge and the Wealth of Nations. New York W.W. Norton, 2006. This is a remarkably lucid popular treatment of the place of knowledge in economic theory, told a bit as an intellectual adventure story.

- Whether the Service Transformation changes the dynamic of international trade and competition.

Let us situate the current chapter, the Algorithmic Revolution in services, by briefly setting the historical context and tracing the evolution of competition at the end of the 20th century (Zysman and Newman, 2006). Mass production, really an American innovation, was a core part of American industrial primacy. That industrial primacy was challenged by the Japanese innovation of lean production in which volume production was reconceived and reorganized. Production became a strategic tool and gave Japanese firms, particularly in complex mechanical and electro-mechanical goods, considerable advantage in global market (see Tyson and Zysman, 1989, in this respect). An American and European comeback followed. The American comeback was built on the emergence of new consumer electronics, digital electronics from PCs through mobile phones, and a reconfiguration of industrial production. Component driven competition facilitated vertical de-integration of companies and gave decisive market power to suppliers of critical elements in final products. It was a period in which the winners were companies like MicroSoft with its Windows operating system and Intel with its processors, hence the designation as the Wintelist era. This Wintelist era was a transition to a global digital era (Borrus and Zysman, 1997).

The global digital era

The fundamental feature of the current era has been that the unexpected, constant disruption has become routine. The levers of competitive advantage have shifted constantly and new mechanisms of value creation have appeared. In the 1980s the strategic focus of major corporate consultants was on definable sectors with clear targets for creating advantage and value. Today the clarity is gone. There is an ambiguous language of "spaces", a word from the dot-com era, and "domains", a more recent word expressing the ambiguity of the completive playing field[8].

The global and digital developments combine to generate new products and services, new entrants, and new strategies. Consider the global. One classic view of the global is that the world is flat, that IT tools have radically reduced costs of communications and coordination, facilitating operations spread across the world. In fact, the story really is one of national innovations, such as Japanese production systems, played out on a larger stage. There are then a series of national stories, each changing the terms of competition for all the rest. Could the Finnish firm Nokia have reached its stature without European and global markets? No, but Nokia's success was part of the broader Finnish move away from supplier to the

8 Thanks to Erkki Ormala and Emilie Lasseron who, very differently, made this point to me.

Soviet Empire to technology based innovator in a global economy (Zysman, 2004)[9]. Similarly, China and India could not succeed without global markets and production systems, but each is a separate and powerful national story. The sequence of national stories produces a sequence of challenges in the form of new competitors and new competitive strategies for companies and countries. The result is an enduring tension between the dislocations and challenges of the global against the adaptations and adjustments of particular firms and places.

Consider next the digital. The bloc of plastic with electronics we carry as a cell phone could just as easily be a television or a PDA or an MP3 player[10]. Services make the story messier and harder to locate the sources of value. Is accounting a product or a service? Hire an accounting firm and you buy a service. Buy Quicken, a shrink wrapped software package for personal accounting, and you have purchased a product. But buy the same functions on Quicken from an online accounting service, and once again you have bought a service[11].The leverages of marketplace advantage are constantly being reshuffled. Is the advantage in the product? Is the advantage in the service? Which functions can be outsourced as commodities? Which functions are central strategic assets? The answers will vary by sectors and across the lifetime of the product. The strategic objective is to avoid the realm of the commodity, the undifferentiated good or service that competes principally on price. The classical strategies for differentiation endure; for many goods, digital tools facilitate quality design or branding as well as market segmentation. The decisive corporate edge then lies in systems integration and innovation, the national advantage in the fluidity and flexibility to adjust to the shifting terms of competition.

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9 This paper was part of the project, See in particular, Finland in the Global Economy, steering group, chairman Anne Brunila, vice-chairman Vesa Vihriälä. "Finland's competence, openness and renewability – The final report of 'Finland in the Global Economy' Project Prime Minister's Office, 2004. http://www.vnk.fi/hankkeet/talousneuvosto/julkaisut/julkaisu/julkaisu/.jsp?oid=130669
Zysman, John. "Finland in a digital era: How do wealthy nations stay wealthy?" Prime Minister's Office, 2004. http://www.vnk.fi/hankkeet/talousneuvosto/julkaisut/julkaisu.jsp?oid=130644

10 Again, thanks to Erkki Ormala and Emilie Lasseron who argue the same point from very different vantages.

11 GM's onstar service is a key source of profit, blurring the service product line in the core of the industrial economy. Is the iPod a product or a vehicle to deliver a service? For the moment there are only 6 Itunes songs sold for every Ipod (that's about 60 cents made for 6 Itunes songs vs. almost 100 dollars for each Ipod. I believe Apple makes 10 % profit off every Itunes song sold, while it reaps 20 % off every Ipod. Additionally, its worth noting that the Ipod was wildly successful for a year, perhaps longer, before the Itunes music store service was ever introduced. But these are early days.

Services: The next chapter in the IT revolution

The latest chapter in the IT revolution is the Services Transformation. Let us properly frame the story. The story is not the growth in the quantity or value of the activities we label services. As Steve Cohen and I argued two decades ago (Cohen and Zysman, 1987), it is not a shift from agriculture to industry to services.The current chapter is the service transformation driven and enabled by the application of rule based Information Technology tools. The crucial issue is the reconfiguration of the service sectors and the recreation of value creation in services as a result of the global and digital developments.

Services were once seen as a sinkhole of the economy, immune to significant technological or organizationally driven productivity increases (Baumol, 1967). Now the IT enabled reorganization of services, and business processes more generally, is seen as a source of dynamism in the economy that will change the structure of employment, the division of labor, the character of work and its location (Bosworth and Triplett, 2004). Firms are being reorganized, markets reconfigured, business models transformed, and entirely new service offerings generated[12].

The conventional discourse emphasizing the importance of services in the economy often conflates and confuses four interconnected stories (Zysman, 2006). The first service story is an accounting error, or perhaps better a matter of financial engineering. Activities outsourced from manufacturing were relabeled as services; it is a transformation in where the activities were housed (Cohen and Zysman, 1987)[13]. The second story is about changes in what consumers buy and what businesses use to produce and distribute their products and services[14]. The third service story is about household outsourcing, the transformation in and changing role of women in the workforce and, with that, the conversion of unpaid domestic work – washing floors, watching babies, and delivering groceries – into commercial services bought and sold in the market[15].

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12 Archibugi et al. (1994) criticized the European Community Innovation Survey, one of the pioneering studies into service innovation, for only examining technical innovations. They countered by distinguishing between different types of innovation, i.e. “innovation of product,” “innovation of process,” “innovation of organization,” “innovation of design,” etc. Today, the services innovation literature is mainly dominated by discussions on how services distinctly innovate in organizational structures, business models, process, knowledge management, and external relations with other firms and universities.

13 The argument Cohen and I made twenty years ago hinges on the beginning of outsourced services and the blurred lines between many products and services.

14 This is shown by per-capita income and personal consumption figures constructed from U.S. Department of Commerce, Bureau of Economic Analysis, July 2001

15 For a complex and interesting analysis of this transition see Thistle (2006).

The fourth service story, our focus here, is the digital transformation. Service activities themselves are changed when they can be converted into formalizable, codifiable, computable processes, processes often with clearly defined rules for their execution. Much of the innovation then is around the adoption and effective implementation of IT tools. This IT enabled service transformation is driven by the advantage that can be captured from private and public entrepreneurs reorganizing firms, administrations, reconfiguring markets, inventing new business models, reconstructing existing services and generating entirely new service offerings. Certainly business processes from finance and accounting through to customer support and CRM are altered when they can be treated as matters of information and data management. Routine and manual functions are automated, and fundamental reorganization of activities is enabled. Likewise, sensors and sensor based networks change many personal services. For example, with sensors and communications, some services such as the monitoring aspects of the home care for the ill, the convalescent, or the elderly can be transformed fundamentally from highly personal activities requiring a continuous presence to a distance activity with sensor data signaling a need for attention. As service activities are conducted by and with IT tools, the worker skills required change as well. Long-term nursing in a home is rather different from data monitoring and intervention, and even more distant from the skills to develop the systems in the first place. Different people in different places trained different ways will be involved. And of course, as information moves, many activities which were previously tightly linked to particular places can be moved (Cohen and Zysman, 1987).

How does the business or social science researcher interested in the services evolution, not the tools themselves, follow a diffused technical discussion or a focus on an ever-shifting array of "tools"? Assume that in considering the evolution of the technologies transforming services there are then two sets of IT developments; envision two technical stacks. One stack defines the networks and the other stack defines the evolution of the tools that result in service applications. Francois Bar and Michael Borrus (1997) proposed a generation ago, that the network stack consisted of an infrastructure layer, a control layer, and an applications layer. As networks migrated from analog to digital a generation ago the possibility of multiple functions on a single network and an independent control layer became critical. The first data network revolution with the creation and liberation of the control layer meant the emergence of virtual private networks and their innovative application by sophisticated corporate users. Their research at the time involved a systematic comparison of major users in a set of sectors in different countries.

The current service revolution involves both the continued evolution of networks and the maturation of the "services" stack. That tool set results in the significant and radical reorganization of work as well as the diffused ability of small users to build content and value for both non market and market applications. The "ser-

vices stack" can be imagined as a platform, middleware layer, and a layer of direct applications tools[16].

A crucial aside is necessary. Of course the core of information technology tools is the information that is being gathered, processed, stored, and transmitted. The crucial matter then is often not the IT tools, or precisely how they are deployed, but the information on which the service activities are based. And the question often then is the definition and control of the information. Competition amongst service providers will turn on control of the information of information products, offerings will be differentiated by control and packaging of information.

The Algorithmic Transformation

The Algorithmic Transformation brings an avalanche of innovation, innovation in the tools behind the service transformation and innovation in the services themselves. But a delusion lurks within the revolution. Let me explain. IT tools may open possibilities for value creation (Barras, 1986)[17]. But capturing those possibilities, and creating value, means reorganizing social and business activities, processes, and strategies. The IT enabled Algorithmic Revolution, clearly, in that service activities once defined as computable routines with clear algorithms can be automated. The hypothesis would be that the first introduction of tools would be to automate what can be routine processes. Here the notion of an algorithmic transformation is most applicable. The Delusion is that the entire process of development and delivery, of value creation, will become a computable algorithmic process, that the algorithm and the IT tool can replace human insight and knowledge. My view is that the crucial innovations, including business model innovations that often underpin and realize value from the Services Transformation do not emerge logically from the nature of the routines. They emerge, rather, from an innovative process of experimentation and discovery (Zysman and Newman, 2006). The effective use of human insight, intelligence, and knowledge in the choice, development, application, and effective use, of these tools will remain central. Managing and exploiting tacit knowledge, as well as explicit knowledge that can stay within a firm, will be the principle source of innovation and competitive advantage; this is particularly true as digital tools and globalizing markets can accentuate the risk of

16 These layers are available in the presentations of Jonathan Murray, Microsoft, and Stuart Feldman, IBM at the BRIE/ETLA session at the CITRIS/Tekes seminar in Helsinki. They can be found on line at http://www.citris-uc.org/files/2006-06-20-CITRIS_Europe/8.0-Jonathan-Murray.pdf

17 Richard Barras posited this as a reverse product cycle whereby new technology adopted by a firm first leads to service process improvements, then to process innovation (which leads to a betterment of service quality, not just efficiency), and finally an improvement in service innovation. As we can see here the technology adopted opened up the possibility for value creation and innovation, which Barras emphasized as being uniquely true for services.

knowledge bleeding away from the firm[18]. This is both a matter of skill development and of understanding how the routines can be segmented and make place for the innovative and the entrepreneurial.

The subtler understanding, more intuitive and creative, involved in creating new strategic models and generating significant new value comes after the first automation, as it did in the era of early data networks. The creative development and implementation of new strategic directions is a separate process, not an extension of computable routine. It is a story of choices about how information is gathered and deployed, about how knowledge is developed and exploited. Consider two related propositions. First, automation of basic routine will NOT create enduring market advantage. There are two reasons: routinized steps can be copied, or the equivalent steps with equivalent outcomes defined; automated routine involves usually marginal gain on existing arrangements. Second, the real value capture comes in the second step, transforming and reinventing activities, in short innovation in services.

Most powerfully, capturing the possibilities of the Algorithmic Revolution becomes a story of innovation in business models, competitive strategies, and organization[19]. Let us review the argument. Tools always embed much of the know-how required for production in their functions. We hypothesize that more of the know-how required for service production is embedded in tools available as commodity products than is the case of manufacturing. Arguably, increasingly more of the tools required for configuring new services will be available on the market, thus potentially altering the possibilities for innovation. At an extreme, the huge investment in innovation in tools – networks, software tools, and the hardware on which it runs – is invisible to the user. One might also argue that the remarkable and rapid emergence on the world stage of firms such as Wipro, and the capacity of firms outsourcing IT and services development, hinges critically on the availability in the market of IT infrastructure and equipment. The critical question, as a result of the core infrastructure and tools being available as commodities, is how to use the tools to create new productive ways of reorganizing or generating social

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18 That leads us to ask not just how information is coded, or how it is embedded as tacit knowledge in communities, but how it comes alive as an interplay of different vocabularies and vantages within the community of the firm or the polity. The conversion of activities into algorithmic and computable processes changes not only the underlying flow of work, but the dynamics of knowledge and innovation in the firm. See for example; Nielsen and Nielsen in Zysman and Newman, 2006.

19 The broader services innovation literature focuses on process-, organizational-, external-relation-, knowledge/ information management-derived sources without detailing out how the character of each of these are situated in varying regions as well as transformed by the Algorithmic Revolution. How we conceive of innovation in comparative regional contexts, as well as how modules can be moved because of the Algorithmic Revolution, are aspects to this new story and can be a standalone strategy generator.

processes and the rules that guide them. The capacities to experiment with new services and to adapt to rules and generate productive changes in organization and social process are critical. The service innovations constructed with the tools depend on what can be imagined and the capacity to implement the imagination.

If the capacity to imagine innovative applications is critical, an understanding of the social rules defining the space for experimentation and the processes of social evolution is central. Services are deeply rooted in social rules, conventions, and regulations; consequently, capturing the value possibilities in the algorithmic transformation inherently means recasting the rules, regulations, and conventions in which the services are embedded. Variations in national or sub-national rules and conventions that shape how services are organized mean that the service transformation will follow diverse national paths. Consider that the health care story is different in the United States, with its mish mash of payers and providers than it is in Britain or France with more centralized systems of payment and provision. The technical problem is not the same in the three places, and hence the question of how to use data, the routines of delivery and accounting will not be the same. The flow of medical information is not a neutral matter. In the US one may want one's doctor to know a potential risk condition, but not if that also means the insurance company cuts you off. In a centralized system early treatment may reduce total system costs, so information about patients leads to preventative treatment not the cancellation of coverage. Or consider that reorganizing services touches the privileges of certain professions and will influence labor markets. Inevitably these will be significant political struggles.

Despite the variety, one might propose that, at a very granular level, many of the modules of routine and activities are similar. Or better still one must ask, which issues and modules are common across systems and applications, in the same sectors across countries, and which modules must be unique? Will the national variation in service deployment be a matter of different modules in each place, or a strategy of common set of modules orchestrated differently in different places? Thus, for example, how transportable and transferable are the solutions developed in one health care system to another?

Let us express this same question a different way. Will the reality of global suppliers of IT technologies and service tools, of the modules and tools for service, override the reality of enduring national patterns and character of services usage? We know that technological trajectories and patterns of innovation reflect the character of demand in lead markets. Hence the very technologies developed in different national systems for different purposes in banking or health will reflect the distribution of gain and risk to the varied actors from reorganizing particular service activities. Once we imagined trade between firms in advanced countries to reflect advantage by national firms created by their differences in local markets. One fea-

ture of globalization has often been an integration of many national markets. With the fragmentation of production structures, the national and regional differences often express themselves in terms of where the firms in a country or region insert themselves into international supply chains. Rather than direct rivalries, regional strategies will increasingly be about careful crafting of distinctive capacities and strategic positioning (Breznitz, 2007). In services by contrast, national differences in patterns of demand and delivery are likely to persist and to express themselves as product offerings and technology trajectories.

Strategy policy and trade

Where does this leave us? For the corporation, automating existing processes is just the beginning. Innovation comes in the imaginative reorganization of existing business and reinvention of business models and strategies. It is a matter of automating the routine to leverage existing knowledge and facilitate innovation.

For policy, the task is to create the environment for experimentation and innovation. And since service innovation is often about recasting fundamental social processes, this is never an easy task; such change always has winners, losers, and political bargains.

And, finally, what does Services Transformation mean for the problems of growth and trade? This is a more complex story. Certainly there is trade in the enabling tools of the Services Transformation, the hardware and software tools. We know that leadership in data network implementation and network standards, as well as standards more generally, can advantage equipment producers. Global standards are often set as a rivalry of national standards stories, whether that is a market rivalry or a political rivalry or a standards body influenced by both. But what of the service offerings themselves? As important, as we argued, services are embedded in national social processes, rules, roles, conventions, and regulations. The consequence is that national markets remain potential launching pads for innovative service offerings, and potential traps if the national standards processes lead to isolating the local service offerings from the standards in the global market place.

In sum, the IT enabled service transformation, the algorithmic transformation, has converted the supposed sinkhole in the economy, the services sector, into a potential source of dynamism and of new tradable goods. Capturing those possibilities though involves imagination and innovation in business models and public policy. As important, even as the communications capacity of "tools for thought" contributes to globally interlinked markets and distributed production, national markets with their distinctive processes, rules, roles, and conventions can be both sources of innovation opening to new global business or potential traps isolating firms in their home base.

SECTION 2

Discussing Globalization: Micro and Macro Perspectives

3 Going Global: Challenging Technology and Innovation Policy and Governance?

3.1 In defence of public science

D. Archibugi

Introduction

In modern capitalist economies, both the public and the business sectors contribute to funding and performing Research and Development (R&D). In the business sector, R&D is funded for commercial applications, it occurs in a competitive process and should secure appropriable economic returns. In the public sector, on the contrary, R&D aims to provide public benefits, it is based on cooperation and disseminates freely its outcomes. Public and business R&D have been considered complementary assets in a successful strategy for human welfare and economic development.

Over the last quarter of a century, however, the public component of R&D has been more and more under stress. This paper explores two related issues:

- The first is the quantitative decline of public R&D: over the last twenty years, it has declined from 44 per cent to 30 per cent in the OECD area. This trend has affected most countries.
- This quantitative trend has been matched by a changing qualitative mood. Universities and other public institutions have somehow been invited to profit from their knowledge, either selling it to the business sector (as with the US Bayh-Dole Act), or by being prepared to accept research contracts from other organizations.

If the quantitative trend and the qualitative pressure will continue, public R&D as we know it today will disappear in a generation.

What is the rationale behind this new science policy agenda? And, above all, is it in the public interest? In this paper, the intellectual origins of this counter-revolution are explored. It is argued that these trends are against the public interest and that a substantial change in science policy is needed. Some suggestions are also provided for the governance of the public knowledge system.

The past and the present of science policy

The origin of science policy: the linear model. Once upon a time, there was the linear model. Simplicity was its main advantage. Actually, it was so simple that any politician could understand it. According to the linear model, it is possible to draw an almost automatic and direct linkage from the generation of basic knowledge to its market exploitation. The generation of knowledge can be subdivided into several stages, all of them in a clearly defined time line.

If the linear model is accepted, it becomes rather easy to distribute the various tasks between public and business players. The function of the public sector should be confined to develop knowledge which can be identified, classified and measured as "basic research", a term applied and popularized by the OECD Frascati Manual. Basic research can be potentially useful to everybody: it is not confined to a single product development, to a specific firm or to a single industry. Already Kenneth Arrow (1962) defined "basic research" in the most elegant way: activities that can be used as input in further research only.

The linear model dues quite a lot to an impressive scientific venture: the Manhattan project. During the war, and in wars time and resources are scarce and precious, the US government invested massively in a scientific experiment that, if successful, would guarantee the victory. Thousands of scientists and engineers were confined in a single location, and because of military secrecy, they were asked of not interacting with anybody. The bet was successful: science produced its Golem. It was also expected that the Golem would generate substantial spill-overs: in the post-war period, many industries explored the potential economic applications of the atomic discoveries, although the benefits ended up to be much more confined than hoped. Nonetheless, the science policy lesson drawn was that science can deliver what is requested, provided that governments fund generously the academic communities.

The science policy agenda in the US followed the same pattern under the assumption that the same story could be replicated. Two main targets were outlined in the 1960s: defeat cancer and land on the moon. In the first case, cancer research got probably over-funded compared to the available scientific opportunity. In the second case, the target was successfully achieved. Moreover, space programs generated a variety of by-products which proved to be relevant in many industries: aeronautics, consumer electronics, telecommunications, mechanical engineering, new materials and even food and beverages benefited from them.

To develop these new technological opportunities commercially, however, companies had to invest their own money and, as usual when innovating, this was a risky business. Even when the new knowledge worked quite well for the purposes

of the public venture, it was not obvious that it could be successful in the market. Costs of mass production were sometimes far too high, consumer preferences were harder to predict than expected, companies did not manage to acquire adequately the knowledge, often because they did not master the tacit component.

Public institutions were also in an uncomfortable position when dealing with the business sector: if they developed a preferential tie with some companies, they were breaking competition rules. If they did not, the lack of face-to-face interaction with the few companies with real absorbing capacity was often detrimental to commercial outcomes. Therefore, the choice that public institutions had to face was between advantaging one company and infuriating all the others, or put their knowledge in the public domain, making it more difficult to provide benefits to the taxpayers.

Knowledge transmission in a global economy. Another aspect soon emerged which fits under the rubric "going global": the fact that a national government was funding massively R&D did not necessarily imply that companies of the same country would benefit from it. On the contrary, it emerged that the companies which took most advantage from the colossal US government-funded programs in defence and space were often not American. In many areas and for many years, Japanese and German companies were much more successful than American companies to turn into competitive consumer electronics products some scientific and technological openings originated by defence and space programs. The US technological leadership was progressively eroded.

Statistics on the world distribution of patents and high-tech products consistently showed the rise of new economic powers which did not rely on large academic research. Japan and Germany in the 1970s and 1980s, and South Korea and Taiwan in the 1990s, showed that a country could catch up in technology even without spending too much public money in R&D. Attention started to be focused on the differences across countries in the composition of R&D expenditure. And it was quite clear that the three empires with a substantial defence-space technological complex, the United States, the United Kingdom and France, were spending much more public resources than Japan and Germany. The latter relied on the resources invested by their companies and managed to increase their competitiveness and their market shares.

The Neo-Schumpeterian tradition. In line with these hard facts, the Neo-Schumpeterian tradition, developed by thinkers such as Chris Freeman, Richard Nelson and Nathan Rosenberg, started to be more and more dominant in science policy and in the economics of technological change. As somebody who belongs to this tradition, I am happy to emphasize its contribution to the understanding of the knowledge economy. In particular, this tradition has convincingly shown that:

- The transmission of knowledge between individuals, organizations, companies and countries is a very demanding process. The traditional assumption that knowledge is costly to generate but that can be transferred at zero or negligible costs was falsified.
- The motivations and incentives of public and business researchers are much more similar than generally expected.
- Interaction is a crucial element for the generation, transmission and diffusion of knowledge.

These statements have been somehow codified in what has replaced the linear model, the so-called chain-link model suggested twenty years ago by Kline and Rosenberg (1986). I do not repudiate any of these statements. On the contrary, any successful science policy should inscribe them in the golden book of learnt lessons. However, as I will suggest later, these lessons have somehow been over-learnt. In particular, the linear model has been over-killed, and this has led to the belief that, since the innovation process does not necessarily begin with basic research, it is less needed to fund and perform it. In turn, this has also lowered the significance of public R&D.

On the other hand, too much emphasis has been placed on interaction, as it happens, for example, in the so-called triple helix model. This model rightly stresses the importance of interactions between academia, business and government. But, on the other hand, it requires Universities to become entrepreneurial: interaction is interpreted as a need from the public sector to change its vocation and to comply with market rules.

The Neo-liberal revolution. The last but powerful ingredient has been the neo-liberal revolution and the corresponding attack to all forms of public expenditure. In spite of the reiterated statement that the investment in knowledge and innovation is a crucial component for economic development, governments have failed to expand and often instead reduced public expenditure for R&D.

Even in Europe, a continent that has somehow resisted the Neo-liberal revolution originated in the United States, it is now given for granted that a good balance of public/business R&D should be based on a quantitative prevalence of business resources. Take, for example, the Lisbon strategy outlined by the European Council in 2000, and reiterated in Barcelona in 2002. It has been stated that the European Union should become the largest knowledge-economy of the world. This has been quantified in a target: R&D expenditure should become as much as 3 % of the total European GDP by 2010. But when indicating who should provide the resources, the European Council has stated that 2/3 should come from the business sector and 1/3 only from public sources. In other words, governments call for an expansion of

European R&D, but they put the burden to expand it on the business sector's shoulders.

The consequences

These trends have very serious consequences on the augmentation of knowledge. We live in a period with a pace of change that has no historical precedent, and the generation of knowledge is certainly at the front bench. But it is equally very relevant who is producing knowledge and for which purposes. The fact that an increasing share of the R&D budget is profit-seeking implies that some areas are over-expanded and others are unjustly neglected.

Consequences on basic research. These trends will inevitably lead to a decrease of basic research investment. The way in which R&D is classified into "basic", "applied" and "development" is often tentative, and does not necessarily reflect the relative importance and significance. But much of technological advances rely on knowledge developed by humans just for their curiosity, when they did not anticipate at the time of investigation any useful outcome. Findings often anticipate applications. It is certainly true that public institutions are not the only organizations to perform basic research. Also companies perform it, and often with great success. But statistical evidence indicates that the portion of basic research funded by the business sector follows the efforts carried out in the public one. Economically, this can be explained by the fact that companies fund basic research when they can follow-up some already available knowledge, while they are less willing to explore completely new frontiers. The reduction of the public investment in basic research will therefore lower also the private one.

Consequences on Universities. For more than one thousand years, Universities have been designed to share knowledge freely. Members of Academia often interacted with the outside community, and it was rare that the results of scientific investigation were kept confidential. If Universities should more and more search for funds from the business sector, it is very likely that they will change substantially their nature. The key aspect that distinguishes academic life will be transformed. Not surprisingly, it does not seem that, so far, Universities have managed to cope with the requested changes. Many Universities have, in fact, opened industrial liaisons offices, they start to protect their own inventions through patents and so on. But work carried out in this field indicates that the changes have mainly been a maquillage to please a general mood. In substance, the income generated though selling their knowledge to the business sector has been rather small. In the UK, it has been estimated that the income generated from commercializing R&D outcomes has been smaller than the income associated to renting real estate facilities.

Consequences on teaching. The fact that teaching institutions are changing their nature also affects the quality of teaching. Young researchers start their carrier in institutions that do not have any longer the possibility to outline their long-term scientific priorities. Rather than exploring "external reality" in the field which is more likely to provide knowledge advancement, Universities have to deal with the possibility to collect money on the market. In the long run, this will develop a new class of scientists that use their intuition to anticipate market demand rather than to expand the frontier of knowledge. There is not anything wrong in doing so. Actually, there is a vast social category that does this job everyday: the entrepreneurs. The issue at stake here is: should scientists become entrepreneurs?

In a nutshell, the changes that have already occurred in public research institutions, and the revolution requested by a new intellectual climate, may lead to a tragedy of the anti-commons. The lack of investment in public R&D may end up in spending money in fields that do not necessarily produce more knowledge and in the right places. For example, business companies will have more interest in funding R&D for hair re-grow and removal (for men and women, respectively) rather than for vaccines for tuberculosis and malaria. This is simply associated to the fact that the potential market is larger for the former than for the latter. This is not only a problem of obvious social justice (if we think that tuberculosis and malaria kill about 3 millions a year), but also of augmenting the basin of knowledge. Paradoxically, it seems to be more likely that a successful vaccine is found for these diseases than a proper cure for men's baldness or women's leg hair. In other words, a purely profit-driven allocation of R&D expenditure is far from expanding the frontier of knowledge.

What to do?

The discussion above may lead to a plea for increasing public resources made available to publicly performed R&D. I think that the trends that occurred over the last twenty years should be reversed. But, on the other hand, I do not think that this will neither be useful nor possible without changing the system of financial allocation. Traditionally, the academic community has self-governed the process of allocating public resources. Boards, Councils and Committees are generally composed by scientists. Even when there are politicians, they should rely on the opinion of experts in the hard moment to decide if funds should go to X or Y.

The academic community has not always ruled itself in the most efficient way. Very often, disciplinary logic has prevailed over targeted research, scientists are not very keen to change their area of investigation and they are likely to persist stubbornly over their own agenda for all their life. In comparison, it is true that business R&D is much more flexible and problem-oriented.

In order to be effective and suitable, an increase in resources made available for public institutions should be accompanied by a radical difference in the evaluation systems and procedures. In general, this will require a move from funding provided to the institutions to project-based funding. In particular, to prevent that the academic community goes back into a comfortable ivory tower, the request of funding from taxpayers should be justified in front of the taxpayers themselves. I am thinking to introduce some evaluation panels based on a two-tier system: on the one hand, the academic community should assess the quality and the feasibility of the projects, on the other hand, the general public should assess their societal relevance.

The public budget for R&D could experiment some forms of direct democracy, by selecting a sample of statistically significant ordinary citizens to which it is conferred the task of assessing the societal relevance of the various projects. These citizens should be briefed on the expected benefits of each research proposal and take into account the result of the scientific evaluation. The reason why a sample of citizens should be preferred to public servants or elected representatives is that they will be less likely to be under the influence of academic lobbies.

There is, of course, also the problem to provide the results achieved by the publicly funded institutions to everybody, including the business sector. This achievement is very important and often the need to obtain a commercial exploitation reduces the possibility of disseminating the results *urbi et orbi*. For this reason, it seems that plug-in centres, i.e. spaces where academic scholars can interact with the business community, are a much more fruitful strategy to expand the benefits of public research than what has so far been provided by the new trendy academic offices for the commercialization of intellectual property.

3.2 Globalisation and knowledge-based economies: European perspectives

H. Salmi

Introduction

Understanding the dynamics of globalisation and the challenges it poses to the knowledge based economies is of paramount importance for the competitiveness of Europe. We all know examples of how globalisation has changed the overall environment in which European enterprises and, more generally, the various EU actors operate. Certain industries have faced difficulties and found it hard to compete on the global scenario, whereas other firms/sectors have been able to exploit new markets and possibilities that were not open to them beforehand.

The underlying question hence is to find the right approach for Europe as a whole. We need to understand how to face the increased competition and all that globalisation really brings.

My answer to these question is clear: the only way forward for Europe is to build upon our knowledge and our innovative capacity. It is by reinforcing these strengths that we can move ahead vis-à-vis our global competitors. Trying to compete through lower costs and wages is not an option. That is not where our inherent strengths lie.

Europe must build on its knowledge and innovation to succeed. I do believe that Europe has the capacity to innovate. Possibly more than most other countries. Historically we have thrived in a world where knowledge and innovative capacity is what counts. It is hence a matter of building upon and reinforcing our traditional strengths. Evidently, competing is hard and innovation cannot be the only factor enabling us to compete. Still, the capacity to innovate constitutes a major competitiveness asset.

Innovation in Europe

To design the most suitable policies it is in the first place necessary to verify where Europe stands. We need to understand if we are good at building and exploiting knowledge and innovation as we could and should be. My answer is unfortunately not if we compare EU as a whole with our main competitors, i.e. United States and Japan. As can be seen from the map in Figure 1, innovation capability and innovative performance in Europe are very heterogeneous. From the European Innovation Scoreboard – instrument that we use in our innovation policies – it emerges

that the most innovative and best performing countries are Sweden, Finland, Germany, and Switzerland – and the latter is not even a member of the European Union.

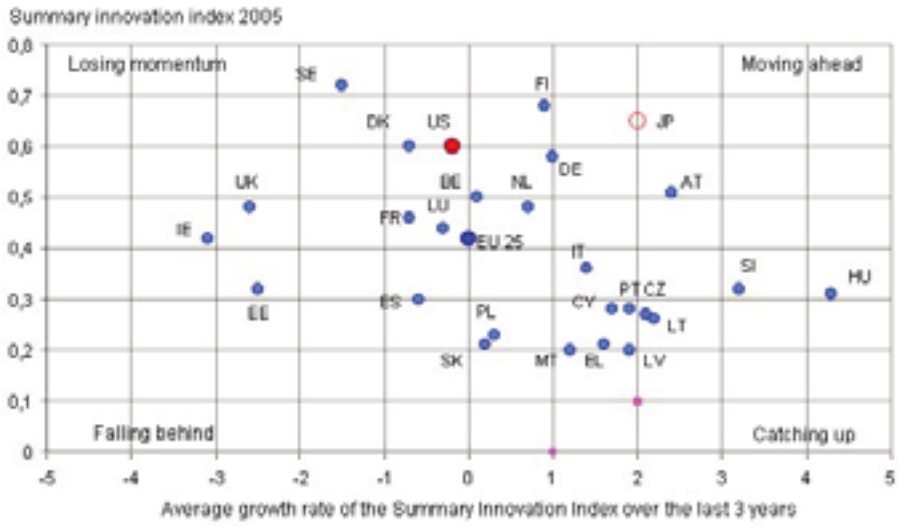
Source: European Commission / DG ENTR D1

Figure 1. EIS 2005 – Innovation performance in Europe

Among the least performing, instead, there are big member countries as Spain and Poland, but also countries like Slovakia and Estonia. The countries currently approaching Europe, i.e. Romania, Bulgaria and Turkey, are unfortunately lagging behind. As emerges from the picture, some of the countries are really still losing

ground. This is the case, for instance, of Estonia. This country is doing very well in other respects but not performing well in terms of innovation inputs. It is also interesting to see that some new member states are already catching up. The picture that emerges is, in any case, very much heterogeneous.

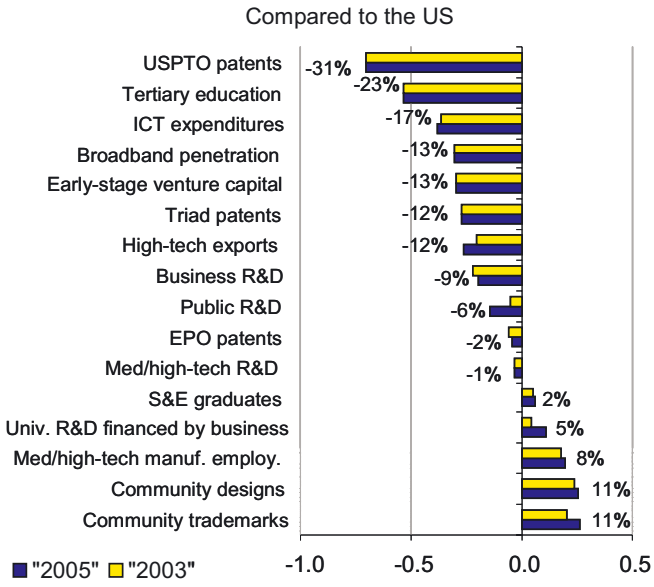
Another very important notion is that of "innovation efficiency", i.e. comparing innovative inputs and outputs. In this case, the picture that emerges is somewhat different. The best performing countries in terms of innovation efficiency are Germany, Luxembourg, Ireland and Malta.



Source: European innovation scoreboard 2005

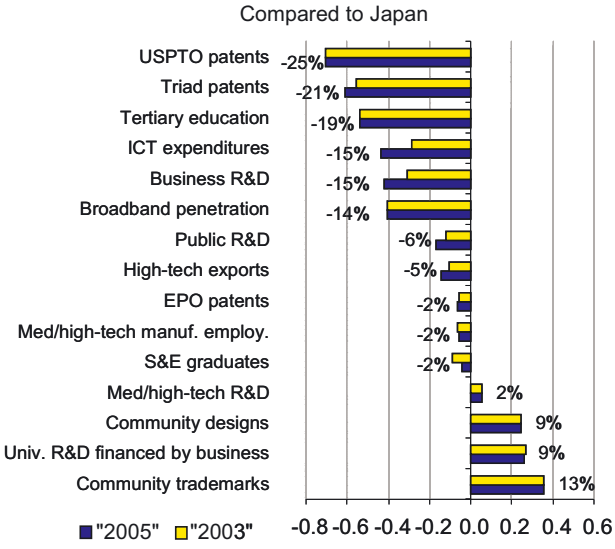
Figure 2. Innovation performance in the EU with respect to the USA and Japan

As figure 2 shows, the gap between US, Japan and Europe is big. With respect to Japan the gap is actually increasing. Moreover, there also are emerging economies – in particular China and India – that are shaping the broader picture through their ever higher investments in innovation and knowledge. Figures 3a) and 3b) offer a more detailed picture of the main sources of Europe's innovation gap.



Source DG ENTR/D

Figure 3a. Main sources of EU innovation gap



Source: DG ENTR/D

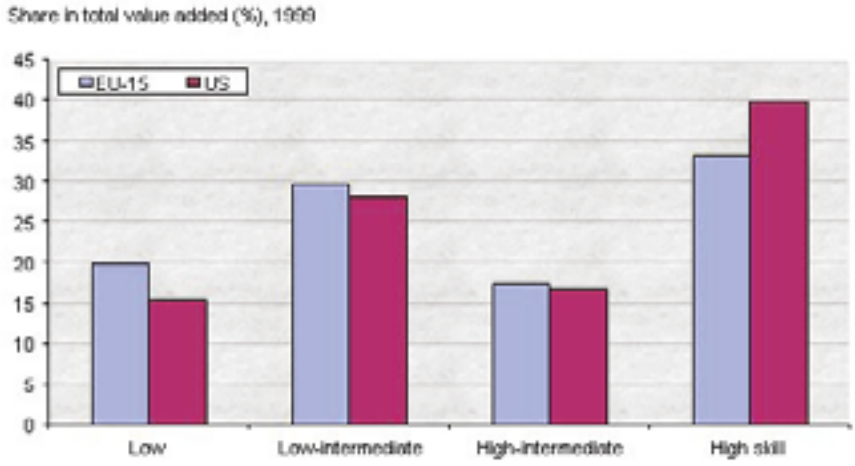
Figure 3b. Main sources of EU innovation gap

Europe is performing well compared to United States and Japan in terms of university R&D financed by business, community designs and community trademarks. Conversely Europe is not living up to expectations in terms of patents, population with tertiary education and ICT expenditures. On the one hand, the economic interpretation of these differences has to be conducted with care. In fact, patenting performance does not only reflect the difference in innovation performance, but also in terms of business usage and sector coverage. On the other hand, though, the data suggest that the EU is doing less well than US and Japan in protecting its R&D and transforming R&D into commercial products.

These differences are even more striking when public research organisations are singled out. EU public research organisations are far less active in protecting their intellectual property rights or sharing their rights than their United States' counterparts. This does not imply that the EU is becoming less innovative, but rather that our competitors are not, so to say, standing still.

In a way, those sectors where Europeans once felt safe are now open to global competition. To face this challenge, we need to innovate more and faster. Just look at the pharmaceutical industry, where Europe was the unchallenged leader in the 1990ies. We are now the second, after the US, but our competitive position can still change.

Europe has still a lot of potential to improve. We are good at exporting, and some industries are strongly positioned in the global markets. However, Europe's manufacturing industries are still concentrated in sectors with medium-high technologies and low to intermediate labour skills.



Source: O'Mahony and van Ark (2003)

Figure 4. Share of low skill VS high-skill production

Such an overall picture needs being "upgraded", both in terms of technology and labour skills. Policy makers need to invest in the knowledge-based economy. Globalisation has raised the question of whether local conditions for companies are still important. The answer is yes, more than ever. Globalisation has actually increased the relative importance of location. While in the past choice was limited, location is now a key tool for companies to compete and innovate. What is sure is that innovative firms choose to go where innovation can flourish. They choose to go where the workforce is well-educated, where R&D labs are excellent and where strong clusters exist. The aim is to facilitate networking with universities and other enterprises.

Innovation does not happen in isolation, but most often in cooperation with others. States and regions all play a leading role in creating favourable conditions for such cooperation at the local level. Regional competition does not happen just with respect to the neighbouring regions, but worldwide.

R&D off-shoring and the innovative capacity of the EU firms

The Director General of DG Enterprise and Industry has undertaken a survey on the so-called implications of R&D Off-shoring on the innovative capacity of the EU Firms. The work has been done by the Finnish Research Institute of LTT, which is part of the Helsinki School of Economics.

The study is mainly based on interviews of 160 European enterprises, both SMEs and big companies, all having off-shoring experiences. It also includes in-depth case studies and some econometric analyses. What the study particularly focuses on is the development phase, i.e. the so called "D" part of R&D processes. In fact the enterprises said they did not carry out research abroad, but only development.

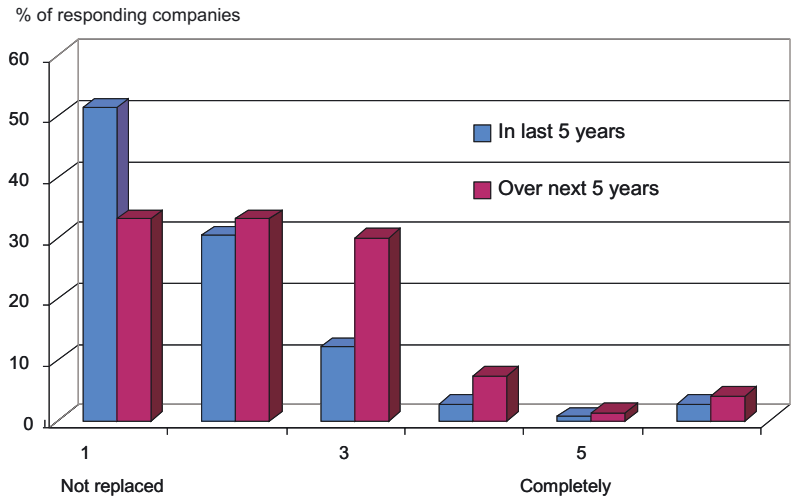


Figure 5. R&D off-shoring VS domestic R&D: replacing domestic R&D?

Both R&D spending and R&D off-shoring have increased over the last five years. However, as can be seen from figure 5, off-shored R&D has only limitedly replaced domestic R&D. However, firms do anticipate a relative growth of off-shored R&D compared to domestic R&D over the next 5 years. This might imply that companies are basically off-shoring R&D to innovate in a new field or to work anyway at something new. Furthermore, R&D off-shoring usually happens between member states still and not so much beyond Europe. At present the trend is from the old member states to new member states.

The fraction of off-shored R&D conducted out of the EU is still small, at least for the 160 companies studied. However, the R&D off-shored to Asia is associated with a higher level of replacement. The study also shows that the more important product and process R&D are for a firm, the lower is the replacement of domestic R&D. Strategic R&D is normally done at home. With respect to deciding how much R&D to off-shore, LTT's analysis shows that the percentage of R&D that is off-shored is not affected by variables like the country of origin, firm size or R&D intensity. It is also interesting to note that the higher the number of European patents, the higher the percentage of R&D that is off-shored. It's not possible of course to say anything about the causal relations, but this seems to be the fact. It also seems that the percentage of R&D off-shored varies with the region to which R&D is off-shored. Those firms that have off-shored their R&D to non-European countries have off-shored a higher percentage of it.

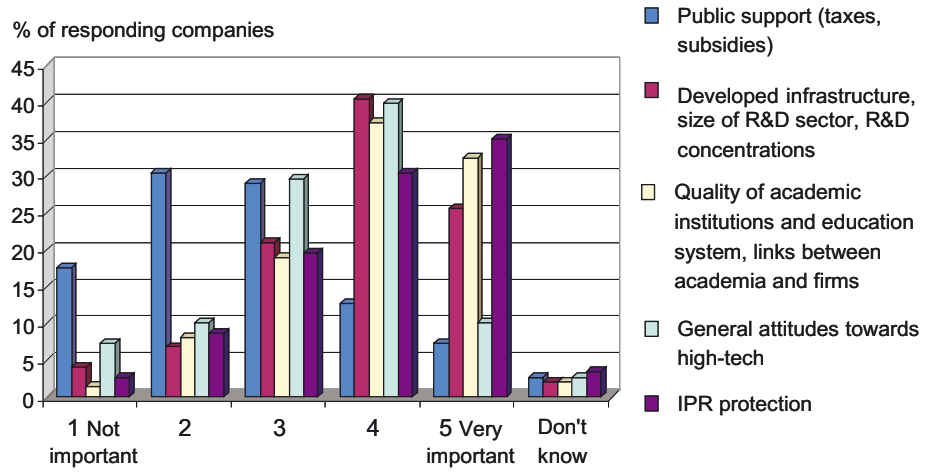


Figure 6. Reasons to choose where to off-shore R&D

A basic question is of course how companies choose where to locate the R&D they want to off-shore. The study shows that public support, i.e. subsidies and tax schemes, is not crucial in this decision. Conversely, efficient IPR protection, quality of the education system and developed infrastructures makes it more likely for a firm to be willing to locate in a place rather than another. Among the most important determinants of R&D off-shoring there certainly are the quality of the academic institutions, and the links between firms and academia. Important are also the availability of cheap labour and the possible strategic benefits that may arise as a consequence of off-shoring. The latter corresponds to the possibility of networking with other companies, institutions, competitors or customers. A well-known result from previous studies is also the fact that companies are interested in the possibility to save costs and to be closer to their target markets, as well as the possibility to acquire new technologies. The LTT study also shows that off-shoring has had a clear positive effect on the export of the firms. They also perceive off-shoring to have had a general positive effect on their capability to innovate.

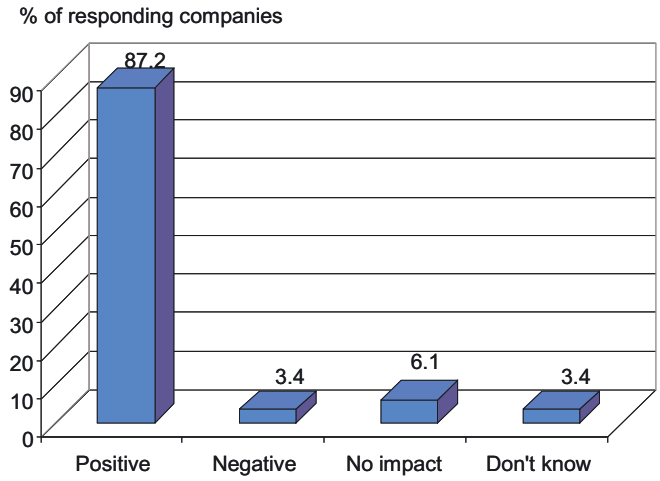


Figure 7a. R&D offshoring and general innovative capacity of the firms (magnitude of the effect)

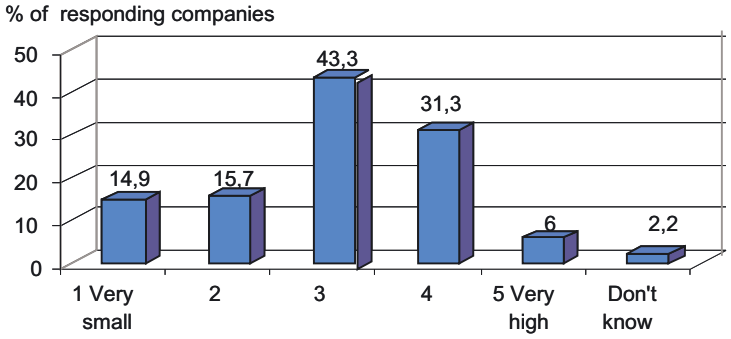


Figure 7b. R&D offshoring and general innovative capacity of the firms (magnitude of the effect)

They observe that the number of locations in which the patents have been invented is positively correlated with the overall number of patents. This would imply that successfully off-shoring, as measured by innovations being produced in several locations, has a positive effect on the overall innovative performance of the firm. It basically means that the more locations you have the better and successful business you have.

Concluding, R&D off-shoring is a type of FDI that countries certainly want to attract. Hence we can expect sharp competition as countries in Europe and elsewhere try to adapt their structures to offer the best opportunities to the firms off-shoring R&D. However, it should be kept in mind that R&D off-shoring is of benefit also to the home activities of the off-shoring enterprise. Hence it should not be seen as a game where one country or region loses what someone else gains. Rather Europe must do its best to constitute a good destination for incoming off-shored R&D and to exploit the opportunities that open up when foreign enterprises off-shore R&D. The R&D off-shoring rationale lies in enterprises aiming to reap the benefits possibly arising from being present on each other's knowledge markets. So far it has largely been an affair between developed countries, but all signs indicate that the stream of off-shoring will increase in all directions. Evidence from the study suggests that off-shoring benefits European R&D productivity. The main policy conclusions would therefore be that R&D off-shoring is a phenomenon that needs not to be feared, but understood. EU, both its citizens and its firms, have already and will continue to benefit only if EU maintains and improves its science base and the quality of its workforce, along with deregulating its labour market.

Europe's agenda: What next?

Many initiative are being undertaken in order to foster Europe's competitive positioning worldwide. DG Enterprise has proposed a bold revision of the way we conduct economic reforms in Europe to address the challenges posed by globalisation. This is the so-called "Revised Lisbon Agenda" (RLA), which is a device conceived in order to ensure Europe's competitiveness. It reflects EU's determination to carry out some necessary reforms, also taking into account that economic growth will more and more depend on our productivity and that our working age population is shrinking. In the RLA, the key message is that in order to create growth and jobs we have to increase the attractiveness of Europe as a place where to invest and work. We have to invest on knowledge and innovation for growth and create more and better jobs. It means investing in research, innovation, using information technology, but also keeping and developing a strong European industrial base. The main elements to implement the new Lisbon Strategy are, on the one hand, the Community Lisbon Programs, stating what should be done at the community level. On the other hand, we have 25 national reform programs, and that's a novelty of this new and revised program. So each member state's policy response to the key challenges they face has to envisage these two instruments working in tandem to have the best effect. First concerning the EC Community Lisbon Program, much progress has been made. The Commission has already put forward proposals for most of the actions foreseen. Among the key actions related to knowledge and innovations there are the seventh Framework Program for research, technology development and the demonstration activities, and also the competitiveness and innovation framework program. The Commission has also set

out concrete initiatives to improve research and innovation environment in Europe. The seventh Framework Program introduces a new model of research support called Joint Technology Initiatives in the form of public-private partnerships. These aim to back promising new research and to give European industry a head start in areas ranging from hydrogen and fuel cells, aeronautics and air transport to innovative medicines and nano-electronics. We have now 25 national reform programs in place since 2005. Each national reform program sets out what will be done with respect the challenges faced at the macroeconomic, microeconomic and employment level. Figure 8 illustrates the major challenges the EU faces according to its member states.

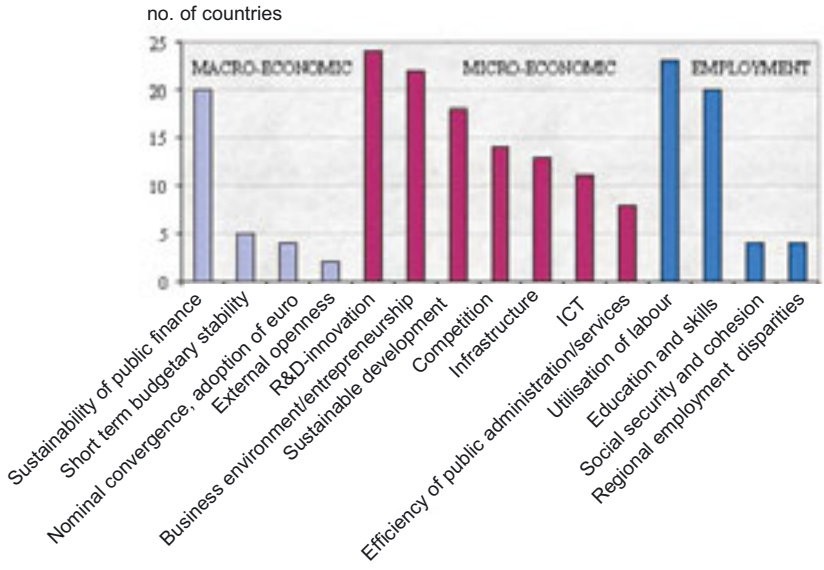
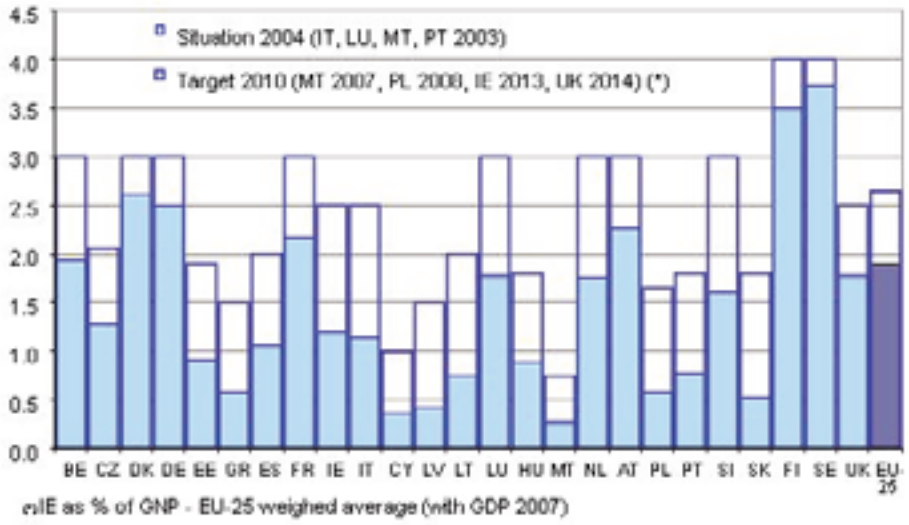


Figure 8. Key challenges envisaged by the 2005 national reform programmes

As it can be seen in figure 8, 24 member states have mentioned R&D as a key challenge. Also education and skills is a key challenge for 20 countries. So in that respect there is a strong commitment from all member states to improve, but another question is implementation. And that is the problem with Europe. We have very good plans, political commitment, but we are not implementing enough. Councils in Europe make decisions, endorse, support, acknowledge but should also do.



Source: Eurostqat, Structural Indicators, Innovation Research - OECD / NRP's of the Member States

Figure 9. R&D targets

All member states have now set R&D targets. If all these targets are reached, the EU will increase its overall share of R&D in GDP from its current 1.9 % to about 2.6 % in 2010. This would be an important step to increase its competitiveness. But how close China and India will be to that level in 2010 is a real challenge for Europe. China is nowadays at the level of 1.31 %, but it's increasing 10 % annually, so they are catching up very soon. And India is following an analogous pattern.

One can see also the heterogeneity of Europe, there are so many countries with very, very, very low levels, and there are only two countries, namely Finland and Sweden, that are above 3.5 % already. We know that Finland has put the target for 2010 to 4 %.

"Putting Knowledge into Practice"

Building upon the work I have just described, the Commission has in September 2006 adopted a new broad-based innovation strategy for the EU, called "*Putting knowledge into practice*". This strategy presents a coherent framework to make use of all existing policy instruments at the EU and the member state level, in support of innovation. This requires the full commitment from member states and regions. So called "ten actions" are listed in Table 1.

Table 1. The Lisbon strategy for growth and jobs: 10 actions to support innovation

10 Actions to Support Innovation
Action 1 : Better education systems to promote an innovation friendly society.
Action 2 : A European Institute of Technology should be established to help improve Europe's innovation capacity and performance. The EIT should be operational starting from 2009.
Action 3 : Develop a strategy to create an open, single, and competitive European labour market for researchers.
Action 4 : The Commission will publish voluntary guidelines for Member States and stakeholders to promote knowledge transfer between universities and other public research organizations and industry.
Action 5 : The EU's cohesion's policy for the period 2007–2013 will be mobilized in support of regional innovation by 'earmarking' a large proportion of the 308 billion € available for investing in knowledge and innovation.
Action 6: A new framework for State aid to research, development and innovation and new guidance for the design and evaluation of tax incentives for research and development will be presented.
Action 7 : A new patent strategy and a more comprehensive IPR strategy to facilitate the circulation of innovative ideas will be presented.
Action 8 : An initiative on "copyright levies", will facilitate new digital products, services and business models.
Action 9 :The Commission will, after public consultation, test a strategy to facilitate the emergence of innovation-driven "lead-markets" in Europe.
Action 10 :The Commission will publish and distribute a Handbook on how pre-commercial and commercial procurement can stimulate innovation.

This innovation strategy brings together all the policy areas that are innovation related and exploits the full range of EU and member states' policy instruments to support innovation. Education is a precondition for a more innovative society. A competitive internal market, free from internal barriers and open to the world is the main stimulus to innovation. This in turn needs a favourable regulatory environment, including an effective and balanced intellectual property rights framework to stimulate investments in creativity. Innovators find great support through clusters, through well-managed knowledge transfers and from the ideas that can spill out from a modernised university system. In particular from a European Institute of Technology that brings excellence from business, research and education together, and addresses the challenges of leading edge technologies.

At present, there is a hot discussion going on about the European Institute of Technology, which should constitute the European counterpart, or the same kind of high-level university, of the MIT in United States. The aim is creating some knowledge elite type of working in Europe. And all this goes with better access to

finance to help turn investments in research into new products and services. Governments cannot ignore the importance of their role in this. Preparation of standards, market regulations and planning ahead on public procurement can ensure that new technologies are judged on their merits and not undermined by out-of-date market conditions based on different approaches. But what is the real innovative capacity of the EU firms and how R&D off-shoring impacts on the Innovative Capacity of the EU Firms?

3.3 Towards and integrated European community policy on international cooperation in science and technology

A. Siegler

The Seventh Framework Program (FP) also envisages international cooperation. International cooperation" refers to the collaboration happening among the full participants of the FP, i.e. the member states, as well as the "associated countries" and the rest of the world (which we used to call "third countries").

Supporting international cooperation implies acknowledging that Europe needs to generate, absorb and apply new knowledge, and to do this in a sustainable way if it wants to succeed in being competitive also in the future. Not cooperating with the rest of the world would make it impossible to pursue EU goals, as scientific challenges are becoming more global, bigger in scale and certainly more difficult to tackle. Examples are the Millennium Development goals and the scientific challenges related to it, and other big science projects that are currently underway on at the world scale. Moreover, the need to cooperate stems from the necessity to underpin other EU policies as, for example, international relations, trade, development, environment, energy and info-communication.

The approach of the EC envisages pursuing broader policy objectives through the achievement of scientific goals. To this end, specific strategic objectives have been defined. Firstly, to make world-wide scientific excellence available to Europe, i.e. accessing excellence via circulation and not via brain drain. This implies enabling the access to globally available knowledge and promoting knowledge circulation, providing training and facilitating researchers' mobility. Secondly, to sustain Europe's competitiveness through strategic partnerships with third countries, in well-defined fields of science. Doing so Europe should also be able to explore new markets. For instance, the European technology platforms could also be open to third countries' participation, on the basis of mutual interests and Europe's particular interest. Examples are poverty-related diseases, environment issues,and scientific challenges lacking of immediate utility. Cooperation represents the way forward also in the pursuit of big science projects as, e.g., building a fusion reactor, enabling high-speed information networks and the GEAM (Geographical Economic Agglomeration Model) program. Thirdly, to reinforce the Community's external relations and international commitments.

To accomplish such complex tasks, the European Commission has proposed an approach based on segmentation and focus and the set up of so-called "strategic reference frameworks". These may have either sector / thematic foci, or indeed

concentrate on a certain region, or both, depending on the targeted issue. The strategy entails three major steps. Europe must first identify its own interests and priorities, also in terms of country or region. Among these, we then need to see which interests also shared by the other party, and which are equally beneficial to our third-country, third-region partners. This further implies the necessity to be selective and focus on the implementation of a limited number of priorities. For instance, the Euro-Mediterranean partnerships with some Mediterranean partner countries has delivered a lot in terms better cooperation and better mutual understanding. Likewise, the Asia-Europe Aquaculture platform is achieving important results in very broad and important issues related to aquatic sciences and fisheries.

Following the above mentioned approach, the EC has structured the seventh FP into four main specific programmes. The novel feature of the FP is that the bulk of cooperation with third countries takes place within the thematic priorities, in a Specific Program (SP) called "cooperation". This happens in two ways. On the one hand, the program is open to third countries. The participation of certain regions of the world is to be even promoted in some calls for proposals. On the other hand, specific cooperation actions are designed to address specific problems and are specifically budgeted for the purpose.

To implement this strategy there is a "Capacities SP" in place, which uses various coordination means to identify concrete priorities and launches the relative calls for proposals. The Capacities SP is open to the participation of third countries through Research Infrastructures, SMEs and Science in Society. It also has "Dedicated International Cooperation Activities" that support the policy making and priority setting, to be used to shape the approach of the themes.

The "People SP" keeps the good tradition established with the Marie Curie international fellowships and S&T agreements with various countries. In the People SP of the 7th FP the return aspect is more important than in the past. Outgoing fellowships are to be in fact granted with mandatory return, i.e. the reintegration of European researchers gone abroad.

Moreover, in the 7th FP attention has been devoted to European researchers who are active in third countries. To this end, there are host-driven actions, incoming individual fellowships, schemes for neighbouring countries, S&T agreement and actions to address the scientific "Diaspora" of Europeans abroad and foreigners in Europe. The Ideas SP also offers the possibility for individual research teams to invite third country researchers on the merit of their scientific excellence.

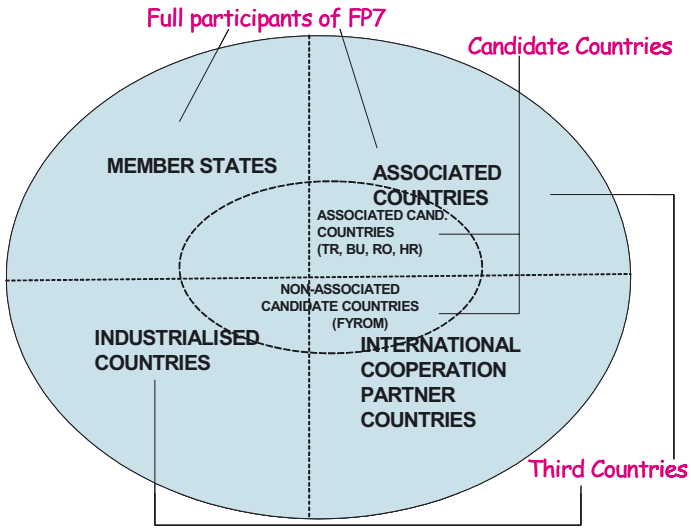


Figure 1. FP7 – participating countries (situation at Sep. 2006)

Figure 1 shows the way countries are segmented. Extremely important is the group in the lower right part, the so called "international cooperation partner countries". These are the ones entitled for funding, if they participate in EU programs (always based on shared interests and benefits).

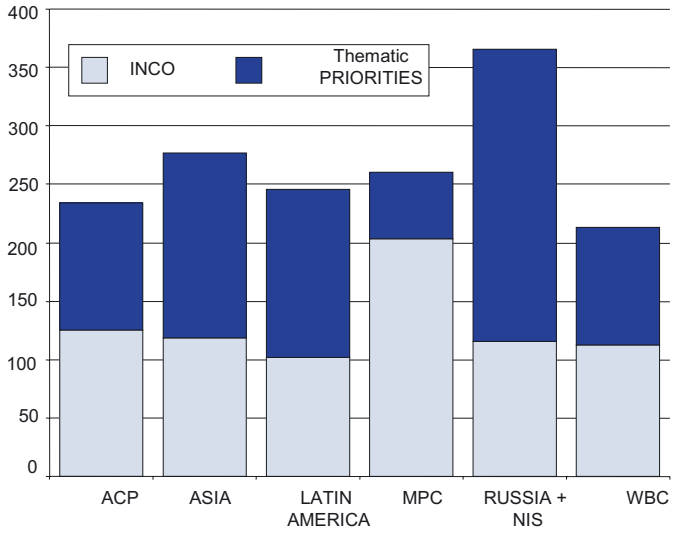


Figure 2. Number of participations of INCO group of countries in INCO (specific actions) and in thematic priorities opening (contracts) overall (02/2006)

Figure 2 gives a flavour on what has been done in FP6. A big difference emerges with respect to the ability of different parts of the world to participate in the mainstream European research (in dark blue). Mainstream research is now the thematic priorities. From Figure 2 it can be seen that Russia, for instance, has gone a long way ahead to be a full partner in many of our projects. Conversely, a lot needs to be done with our neighbouring countries.

Concluding, as mentioned the organising element is the Capacities Program. This has the aim to strengthen overall coordination and to ensure a coherent approach, while finding synergies with other community policies, such as external relations, development, trade or environment services.

The means we have for that are policy dialogues, S&T Cooperation Partnerships and also coordination of national policies through ERAnets. We are also planning an open method of coordination. The indicative budget for the CP is 182 million Euros over the seven years of the FP.

Important challenges await FP7. Firstly, how to effectively coordinate the international cooperation activities. Secondly, how to ensure (specific calls, dedicated quota ?) the budgetary commitment for specific international cooperation actions in Cooperation SP. Last, how to maintain the geographic and thematic diversity of third country collaborations (collaboration only with selected countries?).

3.4 Prioritization and engagement: The political economy of organizing «Public goods» policy responses

D. Foray

Introduction

I would like to report some of the results of the work we are doing within the expert group on "Knowledge for Growth", set by Commissioner Potocnik.The first report we have produced deals with the globalisation of R&D. In particular, it investigates how to better link the European economy to the 'foreign' sources of knowledge and how to make EU a more attractive place for R&D investments (Foray, 2006)..

The "Knowledge for growth" (KfG) proposal

The Knowledge for growth proposal has suggested to Commissioner Potoènik a four policy-axes plan for the development of the knowledge economy. This would entail dramatic changes in the way resources are allocated to the critical domains of the knowledge economy, i.e. to education and research. However, both the private and the business sectors do not respond to political messages but rather to incentives. Hence, the problem is to change the incentives and the pay-off structures of our economies so that investing in R&D becomes a highly profitable investment. I do believe this represent the main point.

The second policy axis we propose regards the orientation of the economy towards the right fields of specialisation. In addition to this, economic institutions need to be transformed and modes of governance changed in such a way as to support the implementation of two axes previously mentioned. For example, if we want to have an intensively innovative economy we need some labour market flexibility. And this is something that most of continental Europe simply does not have. Finally, we need to adapt and coordinate the other policies to those of the knowledge economy. Competition policy, but also and above all the macroeconomic policies. In this respect, Philippe Aghion stresses the important role that macroeconomic policy may play in the different phases of the business cycle. Especially during depressions, when firms have problems to fund their R&D, macroeconomic policies should aim at counterbalancing the negative trend and act in a countercyclical fashion. How to pursue such an objective, also and especially at the European level, is not obvious though.

As for the second policy axis proposed, the KfG group deems fundamental for Europe to choose and fast move towards the "right" specialisations in Europe. This is extremely important because not all innovations have the same value. Some may have a huge impact over productivity, like for instance happens in the case of the Information and Communication Technologies (ICT). Some others simply have not. The knowledge base, with its different specialisations, is a key driver of growth. Unfortunately, Europe is penalised precisely by having missed the new economy. Apart from some obvious examples, like Finland, in general Europe did not really commit to the new economy. Therefore, although Europe is strong in some areas, these last end up having complex effects in terms of productivity.

All this said, however, we are aware that moving towards the right specialisation(s) is not straightforward, nor it is obvious how to get there. Creating a clear vision of the next areas that will be blessed by greater productivity potentials is not trivial. The issue, I believe, is more complicated than simply selecting the most exciting fields. Technology foresight exercises unfortunately tend to produce the same priority rankings, regardless of the context and the country for which they are produced. So it happens that all countries move towards those that are currently considered as the best high-tech sectors, such as nanotechnologies, biotechnologies, etc.. However, this scarcely imaginative way to choose the next areas where to commit the countries' strategic resources results in the dangerous uniformity of the various national knowledge bases and the deterioration of their originality and distinctiveness. I do not think that Europe can afford, for instance, to have too many centres of excellence in the biotech field.

Each region, each country, should carefully reconsider what makes its knowledge base original and unique. It is extremely important to carry out what we call a "particularisation" process, i.e. to identify the next focus areas while maintaining the originality and distinctiveness of the knowledge base. Particularising entails the ability to find the intersection(s) between some kind of important generic technologies and what makes the various national/regional knowledge bases original and distinctive. I further deem the particularisation process to represent a very good mechanism to reconcile conflicting objectives. I believe it could help for instance reconciling competitiveness and regional cohesion. In fact, although regional cohesion is a very important objective for the European Union, it often conflicts with competitiveness. This happens because in any kind of growth process there exist positive feedbacks, polarisation, and the consequent selection of a few winners. This winner-takes-all type of equilibrium means that not all regions can and will be world-renown centre of excellence in high-tech. R&D may also involve indivisibility, which means that R&D projects always have a minimum efficient scale, which makes some regions unable to get this kind of critical mass. Besides, there are agglomeration economies and scarce resources. This means that, in a sense, the intra-European distribution of resources among regions aiming to in-

crease regional cohesion can lead to bad results. These consist in the dissipation of a significant part of the agglomeration economies, with the consequent inability for any region to achieve the critical mass needed to progress. Therefore, even in a growth process where selection, polarisation and winner-takes-all issues are at stake, competitiveness and regional cohesion can be reconciled. This might happen if each region innovates according to its particularisation process, thus generating useful technological knowledge for the benefit of the whole European community.

Governance and policy processes

Table 1 shows a simple taxonomy of the various «public goods» policy responses, i.e. the different modes of governance and coordination of national actions put in place in Europe.

Table 1. Organizing the "public goods" policy responses

Delegation to a unified actor EC, ECB	Hard coordination with sanctions Stability and Growth Pact
Voluntary coordination OMC, Lisbon strategy	Soft coordination by guiding rules Luxemburg and Cardiff Process

Source: Collignon (2003)

For instance, the Lisbon Strategy is based on voluntary coordination. This constitutes a very "soft" way to push a policy agenda forward, as it is confined to the production of reports and benchmarks, as well as to peer pressures, but no hard coordination and sanctions are involved.

I reckon this is not an appropriate way to pursue such fundamental policy objectives, as this kind of open coordination proves to be effective only in presence of strategic complementarities between the different national actions. This means that countries will be able to benefit from collective achievements only if they as well make the adequate national efforts. This is the case, for instance, of standard setting but certainly not that of R&D. R&D is a sort of a public good and countries do hope to reap some benefits from collective efforts without investing too many resources of their own. Given the existence of spillovers, there always exist an incentive to free ride. Hence, we have a mismatch between governance – which is very soft and not mandatory – and the economic nature of the goods that are involved. This can certainly represent a problem. We would rather need strong and

vigorous initiatives from the centre, aimed to increase and generate more incentives and leverage effects.

In Europe we also experience a second type of problem. Our situation is in a certain sense opposite that of the US, where the budget is very low at the central level and very high at the state level.

Conclusions

I believe the Lisbon Strategy is somewhat trapped between these two problems. On the one hand, there exists the incentive for national states to free ride, simply because of spillovers. On the other hand, the weak centralised capacity of the EU makes it unlikely that individual states commit and act in the sought direction. I do believe we need new policy processes, involving original models of research funding able to ensure an efficient and sufficient allocation of resources. This does not entail changing the current EU modes of coordination, as they will always be extremely decentralised. Member states are and will be the main responsible for the achievement of the targets set by the Lisbon Agenda. Still, this can be done according to a suitable particularisation process. New areas of integrated knowledge and technological services may emerge out of the particularisation process, thus offering opportunities and creating competitive advantages. This is especially true in areas like healthcare, environment, energy as well as many others, where the centrality of R&D is emerging as cross-sectional solution to structural problems. In such areas one can expect to build coalitions, sub-coalitions of countries or other stakeholders in favour of credible commitments to R&D. I believe such type of governance should work. If particularisation is well-made, spillovers can be internalised within clubs of countries or people, thus avoiding to represent a problem when trying to ensure national efforts and commitments to R&D. Evidently, the particularisation process needs to be carried out at the EU level and there is room for common ground rules for the formation of such coalitions (like transparency, time origins, openness to all EU fronts, etc.). Still, I would envisage such a process to constitute a suitable way forward to achieve EU goals.

Finally, I would like to emphasise the importance of prioritising and of avoiding uniformity, sub-critical mass and dissipation of agglomeration economies. To do so it is necessary to clearly identify the (possibly unique) knowledge base of a certain region/country. It is also necessary to find the best way in order to invest in it, modernise it, forming coalitions and maximise the absorption of spillovers. In this way, strategic complementarities can be obtained between national and regional actions.

3.5 National innovation policy in an international world – perspectives from Finland

O. Toivanen[20]

Introduction

It has long been recognized that innovation is central to economic growth. Contemporaneously well appreciated have been the twin facts that private inventive efforts rely on inputs from other actors in the society, and that innovators seldom if ever are the sole beneficiaries of their innovations. Public policies to foster innovation derive their justification from these observations and have after WWII come to prominence and taken centre stage, for example, in the Lisbon strategy of the European Union[21]. An almost trivial observation that seems to have escaped wider public discussion of its policy consequences is that, in today's increasingly internationalized market place, the other beneficiaries from a given inventor's innovation are not within the same national borders. In this article I will first review the main justifications for innovation policy and then proceed to an analysis of how a small open economy should reassess the implications of economic rationales. In the third section of the paper I then review recent Finnish research that tries to quantitatively assess the value of innovations to the whole society. I conclude in the fourth section by offering my views on how to take the lessons of theoretical and empirical work into account in designing European innovation policy.

Economic rationales for innovation policy

a) The basic argument

As is well known, economic theory offers a solid foundation for state intervention in innovative activities, this being quite unlike most other spheres of human activity. The basic motivation for state intervention – this need for an activist policy – comes from the following two observations: First, inventive activity by its very nature necessitates upfront investments that are at least to some degree sunk. As an example, somebody spending her time trying to come up with a new drug for malaria will not be able to use that time in any other way. Second, once successful, the inventor is not able to reap all the benefits from her invention. In the malaria example, it is highly unlikely (some would claim impossible, as we are talking of human

20 I would like to thank, without implication, Mariagrazia Squicciarini, Tuomas Takalo and Tanja Tanayama for discussions.

21 See http://europa.eu.int/comm/enterprise/innovation/communication.htm

life) that the inventor is able to price her newly invented drug in such a way that everybody who buys it pays as high a price as he is ever willing to pay. Besides users, it is important to keep in mind that, to continue the example, the strides that the malaria researcher makes may help researchers developing other drugs to get forward in their quest. Thus other inventors and firms may benefit from research efforts and investments done elsewhere.

We all have plenty of experience from buying new goods and services that we consider enhancing our living standards by a vastly higher amount than what we paid for them in the first place. An inescapable conclusion from these twin observations of sunk costs and the inventor not reaping all the benefits is that there will always be inventions that we as a society would want to take place, but which generate private benefits to the inventor that fall below the costs of inventing, thereby rendering investments into these inventions privately unprofitable. The conclusion is that we as a society would want to compensate the would-be inventors of those innovations for whom the private benefits fall below private costs in order to reap the benefits from their innovations.

b) The small economy version

How is this sound logic affected by the fact that the human race and policy makers are fragmented into many, mostly small, nations? The view of economic theory is that, at best, domestic politicians should strive to maximize the well-being of their domestic citizenry [22]. This, at least as a first approximation, must be then taken to include the direct benefit that the citizens of a country get from a product after we have taken into account the price they pay for it, and the profits of the firm from its world-wide sales.

I first consider "only" the consumer surplus-justification for innovation policy, the reason being that the same argument applies to many other justifications. I will then turn to these other justifications.

It is however a well-documented fact in the economics literature[23] that the benefits of innovations made in a given country are not confined to that country alone. To take a European example, a large part of the inventive activity that lead to the mobile phones we all use was made by European firms in European countries.

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22 There is naturally a large literature on how things change when we model politicians as self-motivated economic agents, but I am on purpose not taking this into consideration. The justification for this approach is that one may assume that incentive problems of politicians may well be to a first approximation of the same size irrespective of the size of the economy.

23 See e.g. the work of Jonathan Eaton and Samuel Kortum, 2002.

However, all kinds of people from poor Bangladeshi villagers to New York investment bankers have benefited from these inventive efforts. If one takes the view a European politician that strives to maximize Europeans' well-being ought to take, the benefits of individuals in Bangladesh and New York should not be taken into account when designing innovation policy, e.g. R&D subsidies. Narrowing down to nation states, the politicians designing Finnish innovation policy should not take into account the benefits that accrue from Finnish innovations to Swedish individuals or firms.

It is important to understand that this observation may have profound impacts on the currently used motivation for innovation policy. To illustrate, take again Finland as an example. Imagine a Finnish firm planning to invest in research into a new product and that if successful, that they would be able to sell this product to every human being on the planet. The CIA factbook www-site estimates that there were 6,525,170,264 people on this planet as of July 2006. The same source estimates the Finnish population to have been 5,231,372 at the said point in time. The Finnish population is thus some .08 % of the world population. To proceed, let us make two assumptions: First, the benefit per a Finn from this new product is on average the same as for everybody else's. Second, the firm and an individual share 50/50 the benefits from the product. Third, let each individual's benefit from the product be 1 €.

These assumptions lead to the following outcomes: 1) World benefits from this innovation to the value of 13,050,340,528 €, 2) the value of the innovation to the Finnish society is 6,525,170,264 € (=firm profits) + 5,231,372 € (=the Finnish consumers' benefit), in sum, 6,530,401,636 €.

The inescapable conclusion is that 1) 99.02 % of the benefits that the firm does not get are outside Finland, 2) the Finnish society gets almost exactly the same benefit as the firm, the difference being only .08 %, as the firm's profits are in this example exactly as large as the benefits of all consumers around the world (this is what the firm gains) and the Finnish society gains these firm profits and the improvement in the living standards of its own citizens.

It follows from this exercise that there is very little reason for the Finnish society to support the firm in its inventive efforts. The reason is that the firm's interests and the Finnish society's interests are almost exactly the same, and therefore the Finnish politicians can rest assured that whatever the firm decides to do is (almost) optimal for the Finnish society at large, not the firm alone. Thus, the standard economic justification for innovation policy completely evaporates in the case of a small open economy.

Innovation policy is often justified not only by consumer surplus arguments, but one or more of the following, too: positive knowledge spillovers to other (domestic) firms, tax benefits to the society, firm profits and risk aversion by the firms. The key observation is that as long as firms are risk-neutral, being a small open economy has the same impact on these arguments as it has on using consumer surplus as the justification for innovation policy. By this I do not mean that there are no justifications for innovation policy in a small open economy that have a solid background in economic theory, but that many of the justifications most often put forward may not stand up to scrutiny.

However, if firms are risk-averse, it no longer is the case that firm profits and taxes lose weight as justifications for innovation policy. A small open economy should practice exactly the same policy as somebody designing global innovation policy, as long as the profits and ensuing taxes go to the home country of the firm.

There is a problem with this justification, too: There is, to my knowledge at least, little if any evidence suggesting that firms are risk-averse. In fact, the theoretical literature provides sound arguments for the opposite case. Because of limited liability which limits the downside a firm faces, and competition by other firms, firms may well have strong incentives to choose as risky (R&D) projects as possible[24].

The foregoing raises considerably the importance of understanding how large knowledge spillovers are within a national economy. It is to this question that I turn to in the next Section.

How large are domestic benefits from R&D?

This question has attracted a lot of attention, but in the interest of space, I will concentrate here on a single study that has looked at it with a new methodology and using data from a small open economy, namely Finland. In recent work, Takalo, Tanayama and Toivanen (2005) study the R&D subsidy granting process in Finland. R&D subsidies are the main policy tool of innovation policy and therefore of direct interest.

They develop a method that allows one to use the decisions of the subsidy granting state agency (Tekes) to evaluate the monetary value of a given R&D investment to 1) the firm undertaking the investment and 2) to the rest of the Finnish society. What they find is that the value of private R&D projects to the rest of the society

24 See e.g. Klette, T., and de Meza, D., 1986, Is the market biased against risky R&D?,The RAND Journal of Economics, 17, pp. 133–139.

(excluding the firm making the investments) is small in comparison to the profits the firm makes.

This is what one would expect in a small open economy. Importantly, for policy purposes, they measure these spillovers (to Finnish consumers and other firms) to react to R&D subsidies. For the median firm, if their estimates are correct, the R&D subsidies that Tekes actually granted nearly double the benefits from a given innovation to the rest of the Finnish society. This result suggests that even in a small open economy, there may be a role for an activist innovation policy, even though one must add that a social cost-benefit analysis clearly needs to be executed.

Conclusions and policy implications

I have above argued that while economic theory provides a sound rationale for innovation policy, the usefulness of these arguments, or the conclusions one draws from them, need to be heavily adjusted when considering a small open economy in a globalized world. As to European decision making on innovation policy, the implications are equally clear: While a small open economy to a great extent should neglect the benefits from domestic inventive effort on other countries, this is no more true if a number of open economies design innovation policy together. Then they ought to take account the benefits (and costs) accruing to their joint citizenry and to each countries' firms. There is thus a clear role for policy coordination within EU in terms of innovation policy.

The second, at least equally important implication is that a small open economy should strongly consider investing in those parts of the innovation system that best allow it to benefit from research and development efforts in other countries.The obvious examples of such societal investments are education and basic research.

3.6 The role of international trade rules in promoting development and technology transfer

M. A. J. Teehankee [25]

Introduction

I would like to share with you my experience as Chairman of the Working Group on Trade and Transfer of Technology (TTT) of the World Trade Organization (WTO). In particular, I will deal with trade rules, how development is related to international rule-making and technology transfer, and how trade and technology relate to each other. I will then proceed to briefly illustrate the work of the WTO itself and, in particular, that of the Working Group on Trade and Transfer of Technology. Along the way, I also hope to provide some historical framework, i.e. how the TTT Working Group was born, the North–South perspective and the debates that are currently on-going within the WTO. Finally, I will make some recommendations and concluding remarks, which have been gathered from the discussions of the Working Group that have taken place over the last few years.

International rule-making on technology transfer

International rule-making can be said to have both a reflective or positive role and a normative role. On one hand, domestic and international rule-making may be said to simply reflect historical practice, traditions or customs, as well as past norms. In this case, it may not be of great interest to many science-based organisations or to the private investment sector, as the laws or rules would just mirror past practices. On the other hand, legislation or rule-making may also reflect contemporary or up-to-date norms, as it happens for instance with respect to technology, subsidies and investment-related policies. If done quickly enough, this kind of rule-making may have quite an impact.

In addition, legislation or rule-making may be future-oriented, visionary and geared towards development and the solution of real social problems. This is the case when laws are used as an attempt to alleviate poverty or when rule-making processes are pursued for purposes of designing coherent policies to address social and development goals. For instance, we could consider the Bayh-Dole Act (35 USC 200–212), passed in 1980, to be an example of a visionary type of rule-making – whereby universities were encouraged to maximize their ability to exploit the knowledge they helped creating. This is the hope and vision we have with respect

25 The views expressed in this paper are those of the author and should not be ascribed to the World Trade Organization or to the Government of the Philippines.

to the rule-making we are trying to do at the WTO, i.e. future-oriented and development-oriented, that these rules would ultimately have a real social impact. In this sense, rule-making is and can be normative.

Another important role accomplished by international rule-making is to increase the harmonisation of domestic systems and of the different rules in place in various jurisdictions. This is the case, for instance, in the harmonisation of laws at the European Union level, which is instrumental in order to achieve more harmonised and coherent economic policies in the ultimate pursuit of the European Union's common development goals.

Transfer of technology and development

To fully understand the relevance of transfer of technology for the development of countries we should consider how capital and technology flows relate among themselves. Essentially capital, wealth and savings allow countries to invest in Science and Technology (S&T), to fund research and to accumulate intellectual assets and intellectual property. This brings economic benefits, as new enterprises are created, trade and exports are spurred and employment increased. Society hence benefits in terms of both the knowledge and the employment that are created. Besides that, enterprises generate profits, dividends and royalties and, more broadly, new wealth. These feed into the system and trigger new cycles of investments, thus contributing to reinforce the virtual circle and cycle of knowledge and technology creation and exploitation.

Unfortunately, developing countries are often excluded from such a cycle. The goal of the TTT Working Group is therefore to try and expand the cycle in such a way as to include more developing countries. Our ultimate goal is to support development and thus address poverty eradication.

The working group on trade and technology transfer: A brief historical perspective

The WTO TTT Working Group has its roots in the activity of many developing countries' negotiators pursuing technology transfer and development goals. It all started in the 1970ies, when there was an attempt by the United Nations to adopt a draft *international code of conduct on transfer of technology*. This attempt failed and the negotiations terminated in 1985. There is an interesting work by Patel, Roffe and Yusuf (2000) on the impact and the aftermath of the failed negotiations for the draft code.

Then, in 1992, at the Rio Earth Summit, some concrete rule-making took place within the United Nations Framework Convention on Climate Change. In particular, Article 4, paragraph 1(c) expressly stated the mandate to "*Promote and cooperate in the development, application and diffusion, including transfer of technologies, of practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol…".* The mandate of paragraph 4 is further concretised in the provision contained in paragraph 5 of the UN Climate Change Convention. This achievement in Rio represents a major step towards international cooperation on technology transfer, since it had taken many years of debate and discussions to encapsulate the concept in this one paragraph and to reach an international consensus on it. Paragraph 5 states that

> *"The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies."*

The provisions contained in the 1992 convention constitute the first international rule-making consensus on the importance of transferring technologies. This in part relates to the commonly perceived urgency and societal benefit at the global level in relation to environmental concerns and explains in part why it was possible to achieve such a consensus in Rio. Conversely, there is no consensus or common perception, as of yet, with respect to other technology-related issues, such as its role in development.

At the environmental policy level, progress has also continued over the years. In 2001, an expert group on technology transfer was established, during the conference session of the Climate Change Convention. The group is composed of twenty experts, three of whom are from Africa, three from the Asia-Pacific area, three from Latin America, one from the Island States, seven from developed countries and three from international organisations. Hence, progress has been made in the realm of environment-related technology transfer issues, although these are still at the level of a framework and much work remains to be done.

Another example of consensus being reached, related to technology transfer, is in the field of trans-national investments as contained in the 2000 OECD "*Guidelines for Multinational Enterprises.*" These are **voluntary** guidelines that the OECD encourages its member multinational corporations to adopt or observe. In particular, Guideline VIII on Science and Technology contains five main mandates, 1) to ensure compatibility with host state S&T policies; 2) to permit the transfer and rapid diffusion of technologies; 3) to perform S&T development work in the host state; 4) to agree upon reasonable licensing terms for intellectual property; and 5) to perform cooperative research projects with local universities and industry.

As regards the WTO, in 2001, the origins of the TTT Working Group started with the proposal by twelve developing countries to study the relationship between trade and technology transfer. The proposal (WT/GC/W/443) was reported to the Doha Ministerial Conference. This resulted in paragraph 37 of the Doha Ministerial declaration, which now serves as the legal basis for the establishment and the work of the TTT Working Group at the WTO. At Doha the Ministers of all the Member States of the WTO agreed:

> *"to an examination in a Working Group under the auspices of the General Council, of the relationship between trade and transfer of technology, and of any possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries."*

This is a short paragraph, but in international law and rule-making one cannot discount its importance as it has taken many years to reach a consensus on this issue. The operative word used in the Doha Declaration, "examination," denotes the level of commitment that developed countries were ready to agree to, while developing countries had urged more than just an examination and more active rule-making to be done. The Doha Declaration does mention the examination as well of "any possible recommendations" and "steps that might be taken" but it was left ambiguous as to whether the Working Group could or would in fact make any such recommendations. Still, out of this compromise, at least the Working Group was born in Doha and the work did commence in 2002.

WTO: Technology-related provisions

The mandate and activity of the TTT Group has to be framed within the other WTO provisions related to technology. Some of them are contained in the GATS, the General Agreement on Trade in Services. These are quite important, since a lot of progress is taking place in the service sector and it is one of the areas with the

highest growth rates. In particular, there are existing provisions aimed at strengthening the services sector of WTO member countries through access to technology. The Technical Barriers to Trade (TBT) Agreement contains provisions encouraging countries to agree upon and implement international standards. More precisely, the TBT Agreement encourages the formal acceptance of the standards of other countries through explicit agreements, as well as the use of international standards. Other important provisions are contained in the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). The ultimate aim of this agreement is to improve or protect human and animal health, as well as the phytosanitary situation of all WTO member countries. It applies to all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade and states both rights and obligations. Among other provisions, of particular importance to our topic is Article 9 of the SPS Agreement, where it is explicitly stated that members agree to facilitate the provision of technical assistance to other countries, especially developing countries, in the areas of, inter alia, processing technologies, research and infrastructure.

Another extremely important WTO agreement is the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), which includes provisions on trade in counterfeit goods.The TRIPS Agreement resulted from the acknowledgment by all member countries that the varying standards applied in the protection and enforcement of Intellectual Property Rights (IPRs) and the lack of multilateral frameworks, principles, rules and disciplines dealing with international trade in counterfeit goods had become a growing source of tension in international economic relations. The TRIPS agreement hence addresses the applicability of basic GATT principles and those of the relevant international intellectual property agreements. It also encompasses the provision of adequate IPRs and effective enforcement measures for those rights, multilateral dispute settlement, and transitional arrangements. Of particular interest to us is Articles 7 and 8, for the general principles they contain. Article 7 states that -

> *"The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations."*

To this statement of general development and welfare objectives, Article 8 adds –

> *"Appropriate measures, ... may be needed to prevent the abuse of intellectual property rights by right holders or the resort to practices which*

unreasonably restrain trade or adversely affect the international transfer of technology."

The TRIPS agreement was much criticised as bowing to much to the demands of intellectual property owners in the developed world and was amended in December 2005 in order to address the compelling public health crises relating to HIV, AIDS, tuberculosis and malaria (WT/L/641) and to allow for the creation of an exception to the general protection of IPRs. This amendment arose out of a major decision that had already been reached in 2002, which officially created a waiver allowing for compulsory licensing and export of drugs done consistently with domestic regulation. The decision had addressed the manufacturing capacity constraints of developing countries for generics, as these countries were unable to make full use of compulsory licenses due to their limited manufacturing capacity. This amendment and the waiver before it arose out of the great debate that public health ought to take a higher priority than intellectual property protection.

The provisions of all these WTO agreements are quite important and significant in the international rule-making context, as the WTO is an international institution where rules, once agreed upon, have some real or effective bite. This arises because of the unique dispute settlement system of the WTO which has been crafted to allow for actual commercial and legal impact when its rules are violated. This ensures that WTO rules are internationally enforceable. Violations leading to dispute resolution could result in billions of dollars of penalties being imposed through tariffs, as has already been the case in several occasions.

The TTT group: IPRs and the North Versus South focus

Different perspectives can be observed within the WTO Working Group on Trade and Technology Transfer. On the one hand, we have the position of the Northern Countries, who focus on non-prescriptive aspects. Their activities primarily aim at examining relationships while, at the same time, ensuring the avoidance of any weakening in the protection of intellectual property rights. Among the Northern Countries, the United States, the EU, and Canada have been especially active. They have consistently maintained their position that the TTT Working Group should: avoid duplicating the role and prerogatives of the World Intellectual Property Organization (WIPO); guard against any weakening of IPRs; and preserve the protections granted in the TRIPS. For them, the debate on technology transfer and potential decisions taken could constitute a possible loophole or back door that could affect the protection of intellectual property rights.

On the other hand, the Southern perspective has been to seek the adoption of recommendations that will make the mandate for technology transfer more effective and meaningful. These countries argue that the TRIPS is riddled with all sorts of

qualifiers, even when it comes to simply acknowledging the possible benefits of technology transfer to developing countries. Among the most outspoken developing countries there are Brazil, India and Pakistan. Brazil, for example, among developing countries has been able to develop effective technology transfer programmes. It has consistently criticised developed countries' refusal to move on technology-related issues.

To support the discussion, several studies have been presented by Members and expert organizations to the TTT Working Group. Among these, case studies on the aircraft industry in Brazil, pharmaceuticals in India and automotives in South Africa, as well as a survey of home country measures, taxation policies related to technology and their impact on economic or business development. Various developing country proposals have also been discussed (W/6, W/10), including a recent one calling for the adoption of the OECD voluntary guidelines.

Although the discussions on trade and technology transfer used to be a North-South debate, the TTT Working Group has progressively shifted its focus to the sharing of specific experiences, and countries have been generous in this aspect. The TTT Working Group has in effect attempted to enlarge its focus to take into account the dynamic interplay of the many factors that can lead to the effective transfers of technologies.

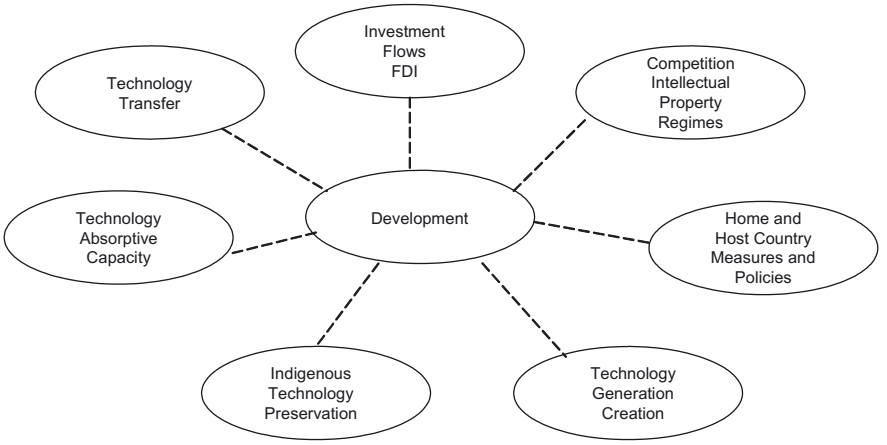

Figure 1. TT and the development goal

Technology transfer, like trade, is not an end in itself, but a gateway to growth and development. To this end, specific issues need to be taken into account such as investment flows, competition rules and, certainly, intellectual property regimes. In this respect, the consideration of the home and host country's measures is of paramount importance. For instance, indigenous technology preservation is an issue

within the Convention on Biological Diversity. Technology generation and creation is another fundamental issue at stake when it comes to analysing how domestic technologies are created. Korea, for instance, is an example of a country where a lot of technology creation happens as a result of certain result-oriented and concrete policy decisions. Another fundamental issue is the absorptive capacity of countries and regions.

Given the high rhetoric that ultimately led to the creation of the TTT Working Group, it has been extremely difficult to make progress on the myriad of issues that should be considered and discussed in relation to the vital importance of technology transfer policies in promoting trade enhancement and development. However, with the passage of time, the discussions have becoming more mature. There are less and less black or white or two-sided debates or arguments, and there have been improvements, especially over the past two years, in the deliberations aimed at providing recommendations to all Member countries on what would be the best practices related to technology transfer policies. Also the developed countries, including the United States, have shown some willingness to discuss or analyse, for example, tax incentive measures concerning trade and transfer of technology.

Still, it is very challenging. Countries and negotiators, as humans, are often very easily ready to be at the opposite side of the fence and at each other's necks, and less ready to put aside differences, and to view things from a broader and mutually or bilaterally beneficial perspective, even within the international setting of the WTO. Annexed herewith for reference is a summary of the work of the TTT Working Group, until 2006, and it still remains to be seen how far the work and discussions will go in order to arrive at a consensus that can deliver more concrete results which will make technology transfer serve the trade, economic and development goals of all countries.

Looking forward: Our vision

My own vision of the way forward for the debate on transfer of technologies and the TTT Working Group is made of four fundamental approaches:

Firstly, that there ought to be more consensual recognition of the necessity to pursue the establishment of multilateral rules for technology transfer. Secondly, along with this recognition there is the necessity that these rules, if any, also recognize the primary role of home country measures and policies in making effective transfers of technologies and concerning the absorption and adoption of technologies in the home country. Thirdly, I would encourage domestic and multilateral fiscal incentives and funding for R&D and S&T. Fourth and last, the focus and energy should shift away from intellectual property protection towards win-win technology partnerships.

Evidently, to do so there is the need to first identify the benefits for firms that invest in R&D (with or without the assistance of their governments). Moving towards a win-win position does not imply prejudicing intellectual property rights, but rather encouraging cooperation and partnership, for the benefit of development and for mutual benefit as well. And by development I mean the progressive development of societies, increased incomes and prosperity,and poverty eradication, which would in turn benefit and make more dynamic the global economy and the global village we live in.

Although some governments do aggressively protect intellectual property, I believe still that things are changing. On the one hand, developed countries' policy-makers are putting increasing emphasis on cooperating with developing countries, as Part VIII of the OECD Guidelines for Multinational Enterprises shows.

On the other hand, developing countries are also adopting a more balanced approach, focusing less on questioning the need for IPR Protection while stressing the need to cooperate in R&D, S&T and technology transfer (as can be seen in a proposal tabled by India, Pakistan and the Philippines in October of 2005, WT/WGTTT/W/10). The submission highlights the crucial role of technology and technical know-how in improving productivity, promoting export growth and attaining developmental goals. It also introduced some possible recommendations that the Working Group could make. The proponents believe that, in order to facilitate technology transfer, the development of clear implementation and monitoring processes, including fiscal support, is very important. Such mechanisms, as those in multilateral environmental agreements (e.g. the Montreal Protocol which mentions transfer of technologies needed to phase out the use of ozone depleting industrial substance), could serve as models. The recommendations contained in this developing country submission included:

(i) Expanding technical assistance under the TRIPS Agreement by linking Article 67 to Articles 66.2 and 7. to include institutions and firms in developing countries, especially LDCs.

(ii) Formal adoption of voluntary guidelines, such as those of the OECD to Multinational Firms. Governments could provide incentives to their multinational firms to "perform science and technology development work in host countries", grant licenses "on reasonable terms and conditions", and adopt "practices that permit the transfer and rapid diffusion of technology and know-how" to developing countries.

(iii) Provision of help to developing countries to improve or implement competition policies capable of monitoring and discouraging use of restrictive business practices by technology owners and by ensuring firms adopt similar or better practices at home and abroad.

(iv) Developed countries could encourage licensing and subcontracting, and support firms in developing countries access technological information and drafting of contracts.

(v) Establish mechanisms of helping developing countries' standard monitoring authorities acquire the necessary technology needed to achieve a level that is internationally recognized, at least at sub-regional level. Such a mechanism could be tailored along the model for national bio-safety clearing houses.

(vi) Expanding or encouraging the mobility of scientists, technologists and technicians under GATS, develop science and technology agreements to promote international scientific and industrial R&D collaboration, and encourage firms and public institutions to employ, at least temporally, fresh graduates and offer consultancy services or contracts and attachment to experts from developing countries to facilitate the transfer of knowledge.

(vii) Identifying ways to encourage exchange of information on investment and technology-related incentives provided to firms, develop mechanisms to disseminate such information and ways to encourage best practices in technology transfer, as well as in encouraging R&D investments or expenditures, and creating new technologies.

The submission was welcomed by the Members as a positive contribution, even though some concerns were expressed and further clarifications were requested and are ongoing. Members generally welcomed the submission because of its focused and pragmatic approach.

The TRIPS Amendment and the earlier TRIPS Waiver Decision is another example of the possible new convergences between the North and the South.The WTO stands very proud as an institution of having succeeded in getting the consensus of all countries to agree to the TRIPS Agreement revisions. The TRIPS Amendment has managed to pair IPR protection with flexibility. In fact, while ensuring that those countries violating WTO agreements can be punished, it grants enough flexibility as to avoid that developing countries would be too easily hailed to court for alleged IPR violations.

In sum, therefore, I believe win-win results and new convergences can be attained in the area of trade and transfer of technology with devoted hard work, good faith, a belief in the doable and maintaining a level of pragmatism that does not prejudice the ultimate goal of development for all countries and the prosperity that should be delivered to all peoples.

ANNEX A:

Summary of the work of the WTO WGTTT

As knowledge increasingly becomes a key strategic resource for national economic development, technology and innovation are recognized as crucial global means for job creation, income generation, and value-addition and for shared prosperity in an interdependent world.

The impact of technological improvement on economic growth and development results from a complex long-term process involving a number of factors and actors, both at the national and international level. In this context the role of governments, businesses, academia, research and development institutes as well as international institutions cannot be overemphasized.

Issues related tothe transfer of technology on the one hand and international trade liberalization and foreign direct investment on the other are of great importance. Acquisition, adaptation, and diffusion of technology help improving competitiveness across sectors, and this is very important for developing countries, in their effort to become equal partners in the world economy.

It is generally viewed that appropriate international understandings and guidelines, particularly in the area of technology transfer may have the potential to facilitate efficient and effective generation, application, transfer, and diffusion of technology.

The Marrakesh Agreement of April 15, 1994, that established the World Trade Organization (the "WTO"), recognized the need for positive efforts designed to ensure that developing countries, and especially the least developed among them, could secure a share in the growth of international trade commensurate with the needs of economic development[26]. The achievement of this goal may be facilitated, among others, by narrowing the technology gap between developed and developing countries. Accordingly, various WTO Agreements contain provisions related to technology transfer, for example:

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26 The Preamble to the Marrakesh Agreement Establishing the World Trade Organization reads in part: Recognizing that their relations in the field of trade and economic endeavour should be conducted with a view to raising standards of living, ensuring full employment and a large and steadily growing volume of real income and effective demand, and expanding the production of and trade in goods and services, while allowing for the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doingso in a manner consistent with their respective needs and concerns at different levels of economic development, ...

- the General Agreement on Trade in Services[27],
- the agreement on Trade-Related Aspects of Intellectual Property Rights[28],
- the agreement on Technical Barriers to Trade (TBT)[29],
- the agreement on Sanitary and Phytosanitary (SPS) Measures[30],

all contain a number of provisions, which relate to, or encourage the, transfer of technology to developing and least developed countries.

In July 2001, a Group of developing countries tabled a proposal[31] in the WTO General Council, which proposed that the 4th Ministerial Conference of the WTO to be held at Doha, Qatar, to establish a Working Group on Trade and Transfer of Technology. The demandeurs proposed that the Working Group, among others, would: explore the relationship between trade and transfer of technology; collect and assess information on existing flows of transfer of technology to developing countries; examine legal and administrative frameworks, particularly in technology-exporting countries and existing financing mechanisms; as well as carry out assessment of needs of developing countries for transfer of technology.

The Ministers at Doha in their Declaration adopted on 14 November 2001 agreed to establish the Working Group on Trade and Transfer of Technology. Paragraph 37 of the Doha Ministerial Declaration states:

> *"We agree to an examination, in a Working Group under the auspices of the General Council, of the relationship between trade and transfer of technology, and of any possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries. The General Council shall report to the Fifth Session of the Ministerial Session [Cancun 2003] on progress in the examination."*

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27 GATS Articles IV, XIX and the Annex on Telecommunication

28 TRIPS Agreement Articles 7, 8, 40 and 66

29 Agreement on TBT, Preamble Tirets 8 and 9, articles 2 and 11

30 Agreement on SPS measures, article 9

31 WT/GC/W/443, Communication from Cuba, Dominican Republic, Honduras, India, Indonesia, Kenya, Malaysia, Pakistan, Sri Lanka, Tanzania, Uganda and Zimbabwe.

Since the Doha Ministerial Conference, and keeping in line with the mandate and the Work Programme adopted[32], the work in the Working Group on Trade and Transfer of Technology has focused on the examination of the relationship between trade and transfer of technology, as well as on any possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries. Initially the work was of an educative nature with the WTO Secretariat assisting the work of the Working Group by producing a number of background papers on trade and transfer of technology as well as providing a bibliography of reference materials on the subject of trade and technology transfer.[33]

Members also found it useful to invite other intergovernmental organisations to make presentations on the work they were doing in the area of technology transfer. So far, presentations have been made by the World Bank, UNCTAD, the Institute for New Technologies of the United Nations University and UNIDO.

UNCTAD shared three cases studies on Transfer of technology for Successful Integration into the Global Economy. The case studies focused on the aircraft industry in Brazil, the pharmaceutical industry in India and the automobile industry in South Africa. The focus of the three case studies is on industries where the selected developing countries have demonstrated their ability to create new productive capacities and successfully participate in the world market. Each industry represents an example of created comparative advantage; that is, where a country's factor endowments were modified through investment in physical capital, human resources and the building up of capacities to develop and use new technologies. Establishing new lines of productive activity is the essence of the catch-up process and the bridging of the gap between developing and industrial economies. The case studies illustrate how this was done in three sophisticated and relatively capital – and technology – intensive industries.

Another UNCTAD study on "Facilitating Transfer of Technology to Developing Countries: A Survey of Home-Country Measures", highlighted the important role of home-country measures in encouraging flows of technology to developing countries.

In another study titled ''Taxation and Technology Transfer: Key Issues'' UNCTAD has examined the implications of various tax instruments on technology transfer from the perspective of both technology importing and exporting countries, besides identifying tax policies that could promote technology transfer.

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32 Annex I of document WT/WGTTT/5.

33 WT/WGTTT/W/1 and Add.1 and WT/WGTTT/W/3.

While national tax policies can be used as an effective tool to attract FDI and technology by the host country, these can also provide incentives to encourage the export of technology as has been done by India and Japan. The mitigating effects of excessive corporate income tax, high import duties, excessive taxation of dividends, royalties and technical fees and high withholding taxes on technology transfer were also highlighted.

More recently an UNCTAD presentation based on findings in the World Investment Report 2005 highlighted a number of means including foreign direct investments in research and development, payments for intellectual property, royalties and licensing fees and volume of trade in capital goods etc., which could help in estimating the quantum of international technology flows. The study found that, although the benefits of technology transfer are concentrated in a few countries and limited to few sectors, the knowledge, skills and techniques are increasingly being transferred internationally. The case study on the 'Salmon Industry in Chile' by UNCTAD also found that as a result of concerted efforts by national and international partners in the transfer, adaptation, development, and diffusion of technologies, there were distinct gains in this sector. The existence of national institutions that help firms acquire and use technology, support emerging firms and encourage the use of technical standards have also played a pivotal role in the rapid development of this industry.

UNIDO presentations have focused on UNIDO's role in facilitating transfer of technology. Some of the barriers to such transfer and UNIDO's approach and response in this regard and UNIDO's investment activities and initiatives with respect to technology transfer were also mentioned. Another UNIDO study on 'Technology Transfer & Trade: The Toy Industry in India' underscored the vital importance of technology and innovation for achieving economies of scale and creating competitiveness; development of skills and local capacity; conformance to international standards through technology upgrading; innovative designs; quality; and the application of IT for enhanced competitiveness in the development of small scale industry.

The World Bank also shared with the Working Group the studies which it had carried out on the impact of trade-related technology diffusion on total factor productivity. These studies pointed to the importance of openness for north-south technology diffusion. Factors which could influence technology diffusion such as regional integration, level of education, national policies and protection of property rights were discussed. The question of what developing countries should do to attract technology transfer and foreign direct investment was raised.

A number of national experts have shared their country's experiences and perspectives on technology transfer, such as Brazil, China, Korea and Canada. Submis-

sions have also been made which highlight their experiences with technology transfer and possible ways in which to provide incentives to increase technology transfer to developing countries. Sharing country experience Brazil highlighted some of the problems that it had faced in ensuring flow of appropriate technology as well as pointing to some of the critical issues relating to technology transfer, including in the context of FDI flows and regulatory IPR regimes. Canada explained the function and operation of its Industrial Research Development Program and highlighted critical issues relating to technology transfer especially with respect to the ownership and transfer of intellectual property rights.

A number of submissions have been made in the Working Group. These include issues that should be considered in the examination of the relationship between trade and transfer of technology, such as the consideration of provisions relating to transfer of technology in WTO agreements, and examining the extent to which they have been effectively implemented; and possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries.

A large number of issues have been touched upon during discussions on the various submissions, presentations and background papers. The broad themes discussed include the definition of transfer of technology; the importance of the enabling environment; the role of home and host countries; the linkages with intellectual property rights and with foreign direct investment; transfer of technology provisions in the WTO Agreements; and the role of technical assistance in this area. The deliberations in the Working Group have contributed to a better understanding of the multifaceted nature of technology transfer and the crucial role played by various elements and actors in this process.

With regard to the Working Group's mandate pertaining to "possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology to developing countries," the discussions have focused on a submission by a group of developing countries[34]. The proponents believed that the suggested recommendations, which by no means were exhaustive, in the paper could constitute a good basis for concrete and practical steps that Members might take in line with the second part of the mandate dealing with possible recommendations to facilitate transfer of technology to developing countries. The submission highlighted that for developing country Members, transfer of technology was not an end in itself but a means to an end, the end being developmental objectives and the recommendations in the paper were important with a view to ensuring that technology transfer served as a means of promoting development as envisaged in

34 WT/WGTTT/W/6.

the Doha Ministerial Declaration. The suggested recommendations included that the Working Group should undertake examination of –

(i) different provisions contained in various WTO Agreements relating to technology transfer with a view to making these provisions operational and meaningful from the point of view of developing countries including least-developed countries (LDCs).

(ii) those provisions of various WTO Agreements, which may have the effect of hindering transfer of technology to developing countries and come up with recommendations as to how to mitigate the negative effects of these provisions.

(iii) the Working Group should examine the restrictive practices adopted by MNEs in the area of transfer of technology and come up with recommendations as to how to prevent MNEs from taking recourse to such restrictive practices. Simultaneously, recommendations could be made as to the methods through which MNEs could be made to effectively use the licensing route for transfer of technology.

(vi) the impact of tariff peaks and tariff escalation in developed countries on technology transfer and come up with recommendations to remove the adverse impact.

(v) the difficulties faced by the developing countries in meeting the standards set by different agreements because of non-availability of the relevant or required technology. It should also make recommendations as to how to overcome these difficulties by facilitating transfer of the relevant technology on terms which could be considered reasonable from the point of view of developing countries.The Working Group could also deliberate on the practicality of developing an early warning system with regard to standards and a mechanism to facilitate adjustment by developing countries to meet the new standards.

(vi) the need for and desirability of internationally agreed disciplines on transfer of technology with a view to promote trade and development and come up with appropriate recommendations. In particular, the Working Group should examine and come up with recommendations regarding possible internationally agreed commitments in the field of transfer of technology to developing countries and LDCs in areas such as expanding global technological exchange and special treatment for developing countries.

The proponents have argued that one of the objectives of the Agreement was that the protection and enforcement of intellectual property rights (IPRs) should contribute to the technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge. There was a widespread recognition, that the developing countries were facing more hardships than benefits because of the TRIPS Agreement and that the balance between private profits and public policy objectives had not been properly reached in the Agreement. In the light of this, it was necessary to examine carefully those provisions in different WTO Agreements including the provisions in the TRIPS Agreement, which hinder rather than facilitate transfer of technology. For example, the stringent provisions relating to compulsory licensing in the TRIPS Agreement as well as the provision relating to the term of protection (20 years from the date of filing of patent applications), were generally believed not to be particularly conducive for easy or quick transfer of technology.

Similarly, in this age of globalization of resources, multinational enterprises (MNEs) adopted a number of restrictive policies on transfer of technology. In the past licensing was a route through which at least some transfer of technology took place. However, the onset of globalization has removed barriers to investment. As a result, MNEs set up their own production facilities in developing countries and are reluctant to transfer technology through licensing because of the fear that such an approach will create competition for their own subsidiaries. There are also situations in which MNEs put restrictions on the export of products which are manufactured utilizing the technology transferred.

It is also recognized that the continued existence of tariff peaks and tariff escalation in developed countries limit the scope for technology transfer and reduce opportunities for learning and innovation in developing countries.

In addition developing countries faced a number of problems in knowing about and meeting the new trade standards set within the WTO. In this regard t sanitary and phytosanitary standards and technical standards often add to the se difficulties as it was basically the technological backwardness of developing countries, which come in their way in meeting the required technical or SPS standards. Although there were provisions in the SPS AND TBT Agreements relating to technical assistance (Article 9 of SPS and Article 11 of TBT Agreement), in reality, developed countries did little to initiate concrete action to help developing countries in terms of these provisions.

More recently the Members have been engaged in a useful and constructive discussion on a new submission[35] tabled by India, Pakistan and the Philippines. The submission highlights the crucial role of technology and technical know how on improving productivity, promoting export growth and attaining developmental goals, and also introduced some possible recommendations that the Working Group could make. The submission, among others, argued that technology transfer often involved transactions in technology products and services. Such transactions included the assignment, sale and licensing of industrial property and the provision of know-how, technical expertise and technological knowledge necessary to acquire, install and use machinery, equipment, intermediate goods and/or raw materials, among others. Most of the trade-related policies, such as competition, incentives, export, and taxation policies as well as intellectual property rights, among others, affect technology transfer. More importantly, the market for technology was not even and the buyer often had very little information on the technology product or service. Several trade-related barriers, such as technical standards, price undercutting and tariff peaks and escalations among others, also affect technology transfer. Standards could also be too high for firms to upgrade at an economic price within a short time, tariffs may encourage the export of raw materials and price undercutting may deter technology advancement. Taken together, they can discourage technology transfer. Further, as TRIPS recognised in its first preambular paragraph, it might be possible that measures and procedures taken to enforce IPRs could themselves becomes barriers to legitimate trade. Therefore, trade could affect the flow of technology and vice versa. On the other hand, the literature pointed out clearly that absorptive capacity was a pre-requisite for effective transfer of technology particularly in developing countries. It was exactly for this is reason that several WTO agreements contained provisions relating to the transfer of technology. However, most of these provisions lacked financing, implementation, monitoring and technical assistance mechanisms in the area. To facilitate technology transfer, development of clear implementation and monitoring processes, including fiscal support, was very important. Such mechanisms as those in multilateral environmental agreements (e.g. the Montreal Protocol which mentions transfer of technologies needed to phase out the use of ozone depleting industrial substance) could serve as models. The recommendations contained in the submission included:

(i) expanding technical assistance under the TRIPS Agreement by linking Article 67 to Articles 66.2 and 7. to include institutions and firms in developing countries, especially LDCs.

35 WT/WGTTT/W/10

(ii) formal adoption of voluntary guidelines, such as those of the OECD to Multinational Firms. Governments could provide incentives to their multinational firms to "perform science and technology development work in host countries", grant licenses "on reasonable terms and conditions", and adopt "practices that permit the transfer and rapid diffusion of technology and know-how" to developing countries.

(iii) provision of help to developing countries improve or implement competition policies capable of monitoring and discouraging use of restrictive business practices by technology owners and by ensuring firms adopt similar or better practices at home and abroad.

(iv) developed countries could encourage licensing and subcontracting, and support firms in developing countries access technological information and drafting of contracts.

(v) establish mechanisms of helping developing countries' standard monitoring authorities acquire necessary technology needed to achieve a level that is internationally recognized, at least at sub-regional level. Such a mechanism could be tailored along the model for national bio-safety clearing house.

(vi) expanding or encouraging the mobility of scientists, technologists and technicians under GATS, develop science and technology agreements to promote international scientific and industrial R&D collaboration, and encourage their firms and public institutions to employ, at least temporally, fresh graduates and offer consultancy services or contracts and attachment to experts from developing countries to facilitate transfer of knowledge.

(vii) identifying ways to encourage exchange of information on investment and technology-related incentives provided to firms, develop mechanisms to disseminate such information and ways to encourage best practice in technology transfer, as well as in encouraging R&D investment or expenditure, and creating new technology.

The submission was welcomed by Members as a positive contribution to the work of the Working Group. Though some concerns were expressed, Members generally welcomed the submission because of its focused and pragmatic approach. The United States did raise the issue of the appropriateness and competence of the Working Group in taking up some of the issues raised in the submission, noting that these issues should ideally be addressed in the relevant WTO bodies which were equipped with the necessary knowledge and expertise to do so. Members

agreed to discuss the submission in further detail at the next meeting of the Working Group.

In response to questions asked by some developed Members with regard to the objective and content and the issues raised in the submission, the proponents provided detailed responses at the meeting held on 13 July 2006 of the Working Group. These questions related, among others to issues on ''the meaning of formal adoption of voluntary guidelines''; ''the intent of the establishment of mechanisms for the formation, assessment and implementation of technological standards''; and ''the development of mechanisms to disseminate and exchange information on investment and technology-related incentives and best practices''. The open-minded engagement of Members in discussing the proposed recommendations as contained in the proponents' submission was positive and, perhaps, bodes well for the work of the Working Group in the months ahead.

The work in the Working Group shows that the relationship between trade and transfer of technology is complex and of a multifaceted nature. Since technology and innovation is a powerful tool for development, the discussions in the Working Group have a continuing relevance and importance, in particular, for developing countries. The discussions held so far have shown that a host of factors play a role in technology generation and its transfer. A better comprehension of the relationship between trade and transfer of technology can be facilitated only if the issue is viewed in a holistic manner. Members seem to broadly acknowledge the fact that both private and public sectors in the home and host countries, play an important role in the process of technology transfer through cohesive partnerships. Members will continue to explore further the relationship between trade and transfer of technology in parallel with discussing the possible recommendations on steps that might be taken within the mandate of the WTO to increase flows of technology transfer to developing countries.

Indeed, in an increasingly knowledge- and technology-based business and economic environment, the significance of international rule-making and intergovernmental policy-making, particularly in areas governing international trade in services and intellectual property, investment and intellectual property protection, assumes a greater socio-economic role and impact as they inevitably define the standards by which knowledge, technology and the movement and transfer of the same by multinational corporations are to be conducted that serves both the interest of protecting intellectual and proprietary knowledge while at the same time promoting access and greater and more diffused utilization and absorption of information and technology by developing and least developed countries to foster more rapid global economic development and poverty eradication.

4 Growing Global: Countries' Experiences and Firms' Strategies

SECTION A)

Countries under the Spotlight

4a.1 The Chinese: New contenders in multinational R&D?

M. von Zedtwitz

Introduction

Until very recently, the Western world perceived China as an enigma, a populous but underdeveloped country, isolated politically and underachieving economically, limited by a plethora of domestic problems including scarce natural resources, natural disasters, poor educational standards, lack of innovation, and many others.

Much of this is still true. But since the economic and, to some extent, political reforms started around 1980, China has dramatically improved its economic situation. Much of this was achieved by focusing on education and opening the economy to foreign technology and investment. Within twenty years, China has become the de facto choice for cheap manufacturing and production of all kinds of goods, ranging from plastic toys to laptop computers. Foreign direct investment has increased to more than US$70 billion in 2005 alone. Whole cities with millions of inhabitants were created to accommodate manufacturing centers in China's South and along the Eastern coast. The contribution of Chinese workers to global production is immense; their efforts felt in every country around the world.

However, what is still missing are global Chinese firms and Chinese contributions to global technology. Locally grown multinational companies (MNCs) and invigorated science and technology (S&T) seem to be inevitable consequences of a rising global importance in manufacturing and business. For instance, it happened during the emergence of the United States in the early 20th century, Japan in the 1950s and 1960s, and Korea in the 1980s. Are we seeing any signs of this in China? If so, how strong a development, in terms of S&T and Chinese MNCs, can we expect within the next five to ten years? What would these developments spell out in terms of opportunities and challenges for Western countries and firms investing in China?

In the following, these questions are explored in the context of recent research on China and its changes in terms of science, technology and innovation. The objective of this paper is to summarize some of the relevant developments in China and to present some key propositions for further analysis by more specialized researchers and China experts.

Investments in science and technology education

Renown for its famous "Mandarin" system of educating government leaders and officials, China has always been a prime protagonist of Confucian values of learning and education. Known as Needham's paradox (Needham, 1954), it has been long discussed why China has not been able to benefit from this advantageous predisposition and during the middle of the second millennium lost technological leadership to Europe. Huff (2003) summarized some of these reasons as pertaining to the detrimental effects of centralization, leading in particular to the stifling of entrepreneurial activity and standardization of technology throughout China, and the failure to develop universities and independent academic institutions. China's recent history includes foreign occupation and a tumultuous 20th century mostly focusing on ideological/political issues unconducive to technological progress and innovation. Only with the economic opening of the 1980s did China reinvigorate its own science and technology.

In the 2000s, English has been made mandatory at even the elementary schooling level, and most young people speak English relatively well. Every year in June, nearly 9.5 million high school students take a nation-wide exam to qualify for about 2.3 million available undergraduate college student seats. The most reputed universities such as Tsinghua, Peking and Fudan, select a few thousand from this pool of millions, concentrating brain power in a few centres of higher learning and research China-wide. But education in other universities is improving rapidly, too. Foreign textbooks or translations thereof are used widely. Many universities, particularly those selected by the prodigious 211 program focusing on developing about one hundred Chinese universities to international standards, have been hiring Chinese returnees educated in America and Europe. Nearly 750,000 scientists and engineers graduated from about 3,000 universities in China in 2004, second only to the US.

The rise in the number of graduate students is particularly illuminating (see Fig. 1). Between 1998 and 2004, it has risen from about 70,000 students to about 330,000 students, i.e., it grew by a factor of 3.7 within six years. Only about 5% of China's youth currently has access to tertiary education, five times less than European or American students. Provided that universities are allowed to expand as they did for the past decade, we can expect a continuation of this trend for some time before demand for college education abates.

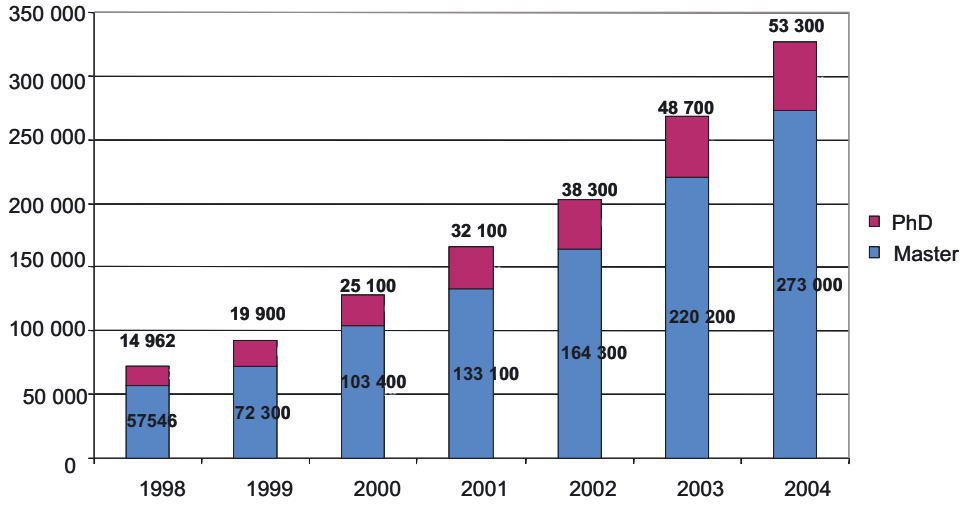


Figure 1. Number of graduate studendts (Ph.D. and Masters) at Chinese universities between 1998 and 2004

The 2020 policy plan promulgated in 2006 states China's ambition to become a top-5 country in terms of science-citation indexed publications. Universities and national institutes started to assess the performance of their professors and research staff by international publications. As a result, the number of papers submitted to international journals jumped, and the quality of research proposals submitted for funding also increased (as they warrant a higher chance of subsequent publication). The annual share of investment in S&T is expected to top 2.5 % of GDP by 2020, up from 1.3 % in 2005, and below 1 % during the 1990s. Money is increasingly made available to achieve these high-flying scientific goals.

Thus, while it may still be too early to assess the quality of scientific publications and graduates from science and engineering programs in China, the S&T input in China's system of innovation is certainly impressive. We thus propose:

Proposition 1: China will experience a relative shift from physical labour to intellectual labour.

This by no means assumes that China will not continue to play a dominant role as a manufacturing site for some time to come, but in relative terms in the mid-term China's intellectual (scientific and technological) contributions will rise faster than its contributions to global manufacturing and production.

Attraction for foreign R&D

Partly in response to the investments in local S&T, which leads to a growing pool of engineers and scientists, but perhaps more importantly due to the rise of China as a market demanding Western products, foreign MNCs have invested in China-based research and development (R&D).

China's demand for Western products is not independent from its investment in science and education. A more educated workforce demands higher salaries which in turn creates a growing class of people with an income that allows consumption of more expensive Western products. But other factors more directly related to China's opening have also led to changes in the way most industries and markets in China operate, thus increasing the interest of foreign firms to invest. This can be seen in the rise of FDI from around $ 4 billion in the early 1990s to the present levels of more than $ 60–$ 70 billion in the mid-2000s.

The establishment of foreign R&D started in the early 1990s but took off only in the late 1990s and around 2000. By 2006, the Chinese Government estimated the number of foreign R&D units in China to be around 750 to 800. Most of those were established in Shanghai, Beijing, Guangzhou and Shenzhen, but large differences in attraction exist between industries (Fig. 2) and type of R&D activity (Zedtwitz, 2004). The rationales for foreign R&D in China has been the subject of much speculation and some research. Gassmann and Han (2004) found that the main reasons to come to China included product localization, product development for China, global product support, and – increasingly – technology research. Walsh (2003) noted that the establishment of foreign R&D centers followed certain stages, mapped along opportunistic/experimental R&D units to fully developed global R&D network nodes. Costs, which are a major factor attracting production to China, are a frequently mentioned but actually inadequate measure of foreign R&D attraction to China (Zedtwitz et al., 2007). Patent research also indicated that the share of Chinese invention patents were rising as fast as foreign inventions, and much faster if all forms of Chinese patents were considered.

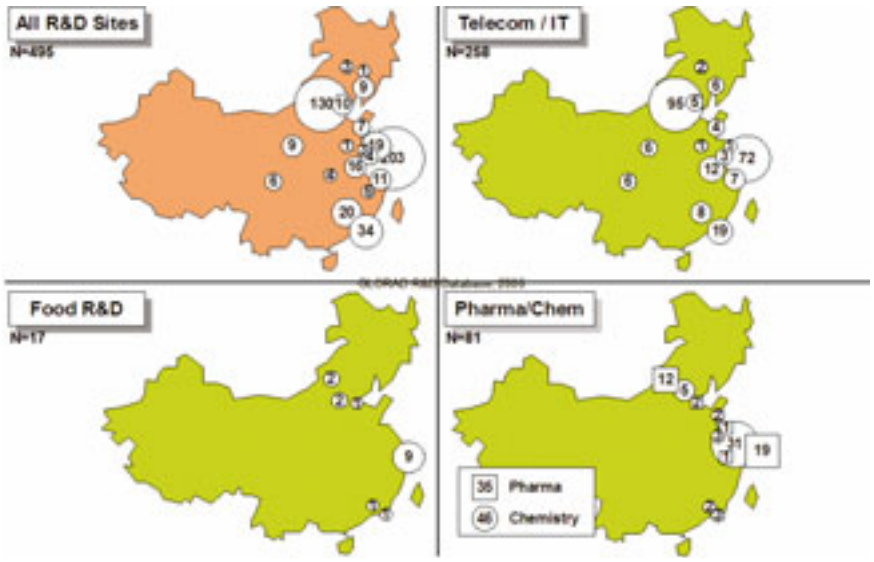


Figure 2. Locastions of foreign R&D in China (GLORAD database)

In sum these results suggest that human factor inputs become increasingly important to attract R&D to and retain R&D in China. If the S&T capabilities of locally hired engineers do not develop further in quality and quantity as expected by foreign MNCs, their Chinese R&D centres will be closed down or remain at a small scale. If S&T capabilities continue to be developed as they have been for the past two decades, foreign R&D in China will expand. Given the political and scientific ambitions of China, we suggest another proposition:

Proposition 2: China will increasingly become a source of innovation.

This proposition predicts the rise of Chinese innovation both in foreign-sponsored/owned R&D labs and research laboratories of Chinese universities and Chinese firms.

Internal R&D efforts

Given the interest and rationales of foreign MNCs to invest in R&D in China, one would expect Chinese firms to do the same. However, there are a number of important differences to consider (see Fischer and Zedtwitz, 2004).

The first is that China did not have – and to a large extent, still does not have – a private or national industry capable of investing in meaningful R&D. This is due to the fact that China's economic systems are in transition from an old-fashioned communist planned economy towards a more entrepreneurial capitalist/mar-

ket-oriented system. Many resources are used to execute this transition rather than being spent on long-term R&D and future profits. Also, it precludes the existence of a functioning domestic private industry with experience in privately-funded R&D.

Second, private as well as state-owned Chinese firms have shown little interest to invest in R&D by themselves. As long as diversification is a more profitable pursuit of revenues, and as long as hyper-competition favours short-term investments in business development rather than long-term investments in more uncertain R&D, there is little chance that this will change.

Third, it also appears that Chinese institutions are not capable of attracting a calibre of scientists and engineers necessary to produce cutting-edge R&D. Reviewing evidence from recruiting offices, it seems that the best S&T graduates – those who presumably are the best educated and the smartest – are offered PhD scholarships to foreign universities. At the top universities it is estimated that up to half of their graduates leave for the US or Europe after completing their studies. Also, among those who chose to remain in China, or those without the option to go overseas, seeking employment with a reputed foreign firm is very attractive, as they offer interesting financial packages, overseas training and travel, unique learning opportunities, and social status. Chinese firms and their R&D departments thus can often only access a filtered pool of engineering recruits.

Still, the human input to Chinese R&D is improving because of so-called "Chinese returnees", i.e., Chinese people who were educated in the West and return to China to start up new companies, or to work in Chinese universities or firms, often bringing along important scientific ideas or technologies. Also, it is improving because R&D engineers of foreign R&D labs in China are leaving for Chinese firms such as Haier, Huawei, ZTE and other increasingly strong Chinese brands. Last but not least, even the presumably third-rate engineers are still of respectable quality, and very well capable of advancing innovation in Chinese R&D departments.

Part of China's new 2020 policy is to become a leading country in science and innovation. National R&D intensity is to be raised to 2.5 % of GDP, putting it on par with most advanced European countries. Foreign technology contribution to China's economy is to be lowered to less than 30 %, and the worldwide rank of Chinese-invented patents is targeted for place among the top-5. The focus on more indigenous innovation and R&D cannot be achieved independently from other national efforts. Key to this development is the internationalization of Chinese firms.

One of the Chinese companies investing heavily in R&D and internationalization is Huawei. Based in Shenzhen, Huawei manufactures next generation telecommunications networks. By the end of 2006 it served 31 of the world's top 50 operators,

along with over one billion users worldwide. Huawei had grown by 30 % in sales per year since 1999, and 110 % in international sales alone. With over 44,000 employees, of whom 48 % were dedicated to R&D, Huawei generated contracted sales of US $ 8.2 billion in 2005, of which US$ 4.76 billion from international markets. In the late 1980s Huawei set up R&D first in Shenzhen, then Beijing and Shanghai and other major cities in China. As Huawei entered foreign markets, R&D centres were established in Bangalore (India, 1999), Stockholm (Sweden, 2001), Dallas (USA), Silicon Valley (USA) and Moscow (Russia). Smaller R&D units were set up in Israel, Amsterdam, and Bangkok. Each of those locations were set up with clear missions, relating either to technology acquisition or market support and business development (see Zedtwitz 2007 for more detail). Haier, already one of China's most recognized brands, also maintains R&D sites in London, Silicon Valley, Syndey and Hong Kong. Recent research revealed about 40 R&D sites of Chinese companies outside China (see Zedtwitz, 2006).

Huawei, Haier, and many other Chinese companies are considered to be pioneers of China's internationalization, and their progress and experiences are carefully observed and analyzed. Still, as logical and as necessary as China's corporate internationalization may appear, there are a number of steep challenges to overcome: the general lack of internationally-trained and experienced managers, the lack of English language skills, the absence of a high-margin home-base, the lack of size of most Chinese MNC contenders, and the lack of brand recognition – positive brand recognition in particular. Furthermore, Chinese firms are relative latecomers, and most attractive markets are already heavily contested and entry barriers have been built up against any new entrant. Also, with respect to Chinese R&D, there are no cost advantages for Chinese MNCs to set up R&D abroad, not even temporary ones that foreign firms may enjoy when they invest in R&D in China. In addition, Chinese R&D is typically following the diversified pattern of their parent companies, and a high degree of diversification usually leads to insufficient R&D depth in any particular technology field, disabling Chinese firms to become technology competitors. For the time being, Chinese MNCs seem to rely on their domestic cost advantages and their ability to survive despite thin profit margins. Given the strong desire to build global Chinese firms, and given their demonstrated ability to learn from foreign competitors, however, it would be foolish to discount Chinese MNCs as future global players. Thus we formulate at last:

Proposition 3: Chinese MNCs will internationalize further, but at high costs and not as fast as generally projected.

Conclusions

In summary, we have developed three proposition as follows.

- China will experience a relative shift from physical labour to intellectual labour.
- China will increasingly become a source of innovation.
- Chinese MNCs will internationalize further, but at high costs and not as fast as generally projected.

There is early trend evidence and policy intention that China is headed in the directions that those propositions suggest. Further research is necessary to determine how these trends can be further expanded and managed, with benefits for China, foreign investors in China, and consumers of Chinese products around the world. If those propositions turn out to be unfulfilled, not only China but the rest of the world will suffer from the consequences.

4a.2 India's emergence as a global innovation hub: the phenomenon and the consequences

R. A. Mashelkar

Introduction

The emergence of India as a global innovation hub calls for a deeper analysis of the fact itself and its consequences. A thorough understanding of how this all happened should allow to better forecast which may be the consequence of this phenomenon in social, cultural, political, economic and strategic terms.

In recent times, India has developed a reputation of being the fastest growing democracy in the world. This is even more remarkable if one thinks that, at the time when India became independent (1947), the country was extremely poor and deprived and had a large number of illiterates. The architect of what India is today has certainly been our first Prime Minister, Panditji Jawaharlal Nehru. He strongly believed in science and technology. He was convinced that "*it is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably mankind's greatest enterprise today*". In our impoverished country he had the wisdom to set up scientific institutions, engineering colleges and, more broadly, to invest in science and technology. Today it seems that this strategy has paid off.

The "Indian Revolutions"

In India we tend to talk about several revolutions. One is the "Green Revolution". Before that, India was a country that used to go begging the rest of the world for food. Then, thanks to our progress in agriculture and the leadership provided by the scientists, the green revolution came and India became a surplus country. Entirely because of science and technology.

Another important revolution has been the "White Revolution" or, as it is called, the "Operation Milk Flood". Thanks not only to scientific and technological innovation, but also to social innovations, we became the biggest milk producing country in the world.

India has also experienced the "Blue Revolution", as we not only design, fabricate and launch our own satellites, but assemble satellites for other countries too, e.g. Germany and Korea. Evidently, this has had a tremendous impact in India.

And finally, of course, our "Grey Revolution". We call it this way as it refers to the grey matter, the brain. The educational and engineering institutions that came up and the related workforce that got created over time has helped India moving forward in areas like software, for example. At present, the software industry in India constitutes a real massive phenomenon. Around 600,000 professionals are in the sector, i.e. the .06 % of Indian population. By 2008, these software professionals would generate around 35 % of Indian exports. And the remarkable thing about them, is that those who have created prestige as well as wealth for India are on average just 27 years old.

From brain drain to brain circulation

There is a change that is taking place in India, which is all the more evident every day. And this is that, at present, India is attracting people from around the world. As also Business India has highlighted, we are experiencing a third wave of influx. The first wave was represented by Foreign Direct Investments (FDIs), whereby money was sent and invested in India. Then came the technology, the R&D and the manufacturing. And now foreign nationals are coming to India to work. For instance, in one of the drugs and pharmaceutical R&D set up, we are close to having 25 % of foreign nationals. This is certainly something that we would not have expected earlier. Besides, one new trend India is particularly happy about is that approximately 30,000 R&D professionals have returned to the country over the last three years. Beforehand we were suffering from brain drain but finally we are starting to enjoy some brain gain followed by brain circulation.

When it comes to education and the creation of knowledge, our best institutions are the Indian Institutes of Technology. To begin with, it is very difficult to get into an IIT institution: 200,000 students apply every year but only 2,000 succeed in being accepted. In the past, many of these IIT students (around 70 %, ten years ago) would migrate after graduating to countries like the United States of America. India used to be described as a land of ideas, but when it came to land of opportunities, this was the USA and, therefore, people used to migrate. At present the proportion of IIT graduates that emigrates has gone down to 30 %, as new opportunities are now getting created in India.

Skill-based competition

India is seen as a global research and development hub. According to recent figures, 150 companies have set their R&D centres in our country. These are not small companies and the number of R&D personnel they employ in India is quite remarkable as well, as can be seen from table 1.

Table 1. Multinational R&D centres: Snapshots of employment

Company	# India R&D jobs
Texas instruments	1 300
Motorola	1 500
Cummins	400
GE	5 000
Bosch	2 000
Cisco	1 000
Adobe	800
Cadence	500
Intel	2 900

Source: CLSA Asia-Pacific markets 2006

I used to believe in the possibility for India to become a global R&D platform. Already in 1995, I remember I gave the "Lala Karam Chand Thapar Centenary Memorial Lecture", presided by the at that time Finance Minister, currently our Prime Minister, Dr. Manmohan Singh. The title of my lecture was "India's Emergence as a Global R&D Platform: the New Challenges and Opportunities" and people did not believe this can really happen. My hypothesis was very simple. I believed – and I still do – in skill-based competition, whereby skills and not products are the critical asset. Products are just transients, they draw value for the company through the market. But the key issue is how do you put that product together. The real problem is getting the best skills together in the smartest and cheapest possible way. It is this skill gap that plays a critical role. I must admit that it is nice to see something like this happening in one's lifetime.

India as an R&D hub: Driving forces

I believe that the dynamics we currently observe are driven by a number of forces. One is certainly the globalisation of both the economic and the trading system.The digital revolution and the enormous changes we have been experiencing in global communications have also helped enormously. Other fundamental driving forces are that, at present, product development is very much science-based and that the mean time between technologies has been reduced. Finally, skills as enduring competences and the and high cost and risk of R&D have also contributed to offer India some competitive advantages.

Besides all these, there is another very important factor that is contributing to India's success: its demography. Some comparative figures can help understanding the deep implication of India's demography. For instance, recent data (NSF, 2003) show that in the United States of America 85 % of the working doctors in Science

and Engineering are above 55 years of age. The percentage of the same workers above 60 years is 76 %. Now, consider these numbers vis-à-vis India's: 55 % of the Indian population has an average age of less than 30 years. This gives an idea of the importance of the demographic factor. Hence, what we are talking about is a large country, which is young as well as democratic (a characteristic not be neglected).

Given this global framework, one might ask what happens to enterprises and to their research and development endeavours. I believe there will be a new role for in-house R&D. The key game will be to move around, to manage innovation networks. Companies will get engaged in monitoring external developments and capabilities. In terms of technology, their challenge will be to balance creation and access: how much to create in-house, how much to access from outside. At present, the dependence from external sourcing has increased from 5 % to 15–20 %, and this is anticipated to grow to 40–50 %.

However, the question remains of why should companies decide to buy R&D or perform R&D in India rather than elsewhere. Jack Welsh, when he inaugurated the Jack Welsh R&D Centre in Bangalore, put it in this way "India is a developing country, but it is a developed country as far as its intellectual infrastructure is concerned. We get the highest intellectual capital for dollar here."

This was his simple answer, but scientific publications, citations and patent figures support such a view. I here offer some evidence based on David King' s Nature article 2004. Although the indicators regard only the period 1997–2001 and there is indeed room for further refinement, still they are indicative of India's attractiveness.

Table 2. Scientific publications

Country	SCI Publications (1997–2001)	GDP per capita	SCI Publication per GDP per capita / per year
India	77 201	487	32
China	115 339	989	23
USA	1 265 808	36 006	7
Germany	318 286	24 051	3
United Kingdom	342 535	26 445	3
Japan	336 858	31 407	2
Canada	166 216	22 777	1
Italy	147 023	20 528	1
Rep of Korea	55 739	10 006	1
France	232 058	24 061	2

Basic source: David King, Nature, July 2004

Table 3. Citations

Country	SCI citations (1997–2001)	GDP per capita	SCI citations per GDP per capita / per year
India	188 841	487	77
China	341 519	989	69
USA	10 850 549	36 006	60
United Kingdom	2 500 035	26 445	19
Germany	2 199 617	24 051	18
Japan	1 852 271	31 407	12
Canada	1 164 450	22 777	10
Italy	964 164	20 528	10
Rep of Korea	192 346	10 006	4
France	1 513 090	24 061	1

Basic source: David King, Nature, July 2004

Table 4. Patents

Rank	Country	US patents	GDP per capita	US patents per GDP per capita
1	USA	50 000	36 006	1 389
2	Japan	36 889	31 407	1 175
3	India	444	487	0.913
4	China	742	989	0.732
5	Germany	12 960	24 051	0.539
6	Rep of Korea	4 246	10 006	0.424
7	France	4 906	24 061	0.204
8	Canada	4 368	22 777	0.192

Basic source: David King, Nature, July 2004

The figures shown in tables 2 to 4 look even more impressing when considering that India does not invest much in R&D, compared to other countries. India spends less than 1 % of the GDP, whereas Europe and the US spend about 2–3 %. Besides, even if patents represent a new phenomenon as far as India is concerned, looking at the 2003 rankings' data one finds US first, Japan second, and India and China in third and fourth position. Now, although these numbers may look very small, I deem that key issue is the "power of the exponent". That is, one may start from a small base, but if there is rapid expansion (e.g. figures are doubling every year), one might be hopeful about the future.

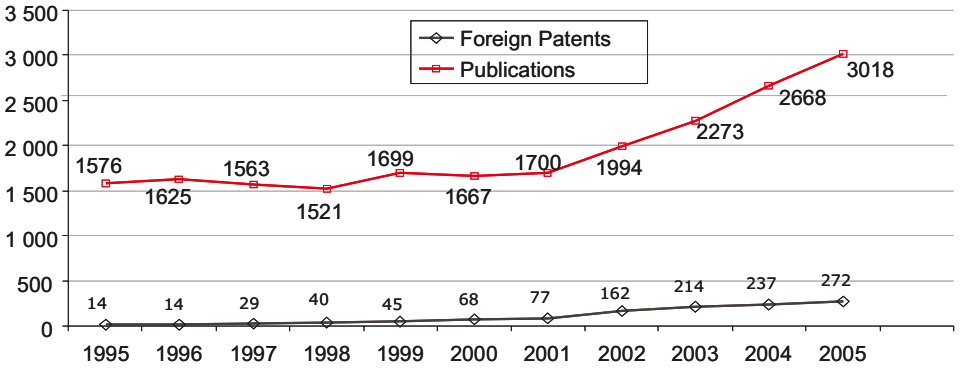


Figure 1. "Power of the exponent" - CSIR foreign patents and SCI publications

Figure 1 shows the number of US patents and the number of publications obtained by the Indian Council of Scientific and Industrial Research (CSIR) during the period 1995–2005. It can be seen that, for instance, in 1995 the Council had only 14 patents in portfolio, whereas the same figure for the year 2005 has risen to 272. Evidently, it is not only a matter of getting US patents, but the way of licensing them, the value they generate. For instance, in August 2006, the CSIR sold its unique clot specific streptokinase, which was licensed to a company for five-million dollars plus 3 % royalties. Talking about a billion-dollar drug implies around 30 million dollars of royalties. These are massive sums for an institute like the Institute of Microbial Technology, having a yearly budget of four to five million dollars. Hence, we are not only experiencing a rising trend in terms of number of patents granted, but we are trying to become smarter when it comes to licensing them.

R&D spending is also following an expansion path analogous to those of granted patent and number of publications. I believe this is one of the greatest strengths of India.

India's development strategies

Currently, India is following two main strategies in order to spur its growth and development.

On the one hand, on the supply side, we are trying to massively expand high-quality education and the research system. We started from having 3.4 million students enrolled in the various Indian Universities in 1985. In 2005 the students enrolled had already reached 10.3 millions, 350,000 of which are in engineering. The number of postgraduates students has also been rising sharply over the last decade. Our forecast is that, by the year 2015, we should have 18.5 million students enrolled,

1.4 million of which will be in engineering. That is the kind of expansion of the system that is taking place.

On the other hand, with respect to the demand-side, India's policy has been to try and create measures enhancing competition and hunger for R&D, coupled with a judicious government support for R&D. Examples of this strategy are the creation of three new institutes of science, and then maybe three more, so they might become six during the next five years. In the past, we just used to have one Indian Institute of Science. We are also creating an autonomous National Science and Engineering Foundation, similar to the National Science Foundation (NSF) of the USA. Besides, the funding of basic research is going to go up within one year by a factor of four, that is a planned 400 % increase. There also are innovative schemes intended to get young people and scientists back from the countries where they emigrated to.

Besides, and in order to stimulate innovation and creativity in enterprise, a number of initiatives are being taken. One is, of course, to have intellectual property laws complying with the WTO's TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreement. Hardly anybody would had believed that India would make herself TRIPS compliant, but India actually stuck to its obligations. In addition to complying with the TRIPS agreement, many innovative public-private partnerships were launched.

There also are new policies that have been progressively put in place, of which I will offer a couple of examples related to sectors that are fast moving ahead. One is definitely the drugs and pharmaceutical industry. In the past, we use to copy molecules but, thanks to reverse engineering, also new molecules came up. Hence, anticipating the changes that were going to happen in November 2005, a lot of these companies actually improved their portfolios and got engaged into discovering new molecules. The top ten pharmaceutical companies in India have in fact increased their R&D spending by a factor of four during the last five years. A lot of interesting breakthroughs are currently coming up. One for which India is particularly proud regards tuberculosis (TB). In fact, the last molecule to be discovered in this respect was dated 1963. India recently succeeded in discovering a new molecule that, instead of taking six to eight months to clear TB – as it used to be the case – , does it in two months. This molecule is currently undergoing clinical trials. This is evidently an example of the fact that, when it comes to innovation, changing the rules of the game makes the game change. The other example I would like to make regards the automotive industry. At present we have indigenously designed new models that are being launched globally. Our problem in the past was especially one of lack of capacity, of lack of skilled innovators and R&D. Besides, we were not able to make external acquisitions with respect to specific technologies. Now these are problems that belong to the past. India has finally been able to start ac-

quiring the technology and skills it needs. In addition, India is learning from doing, thus further improving its technological innovation capabilities.

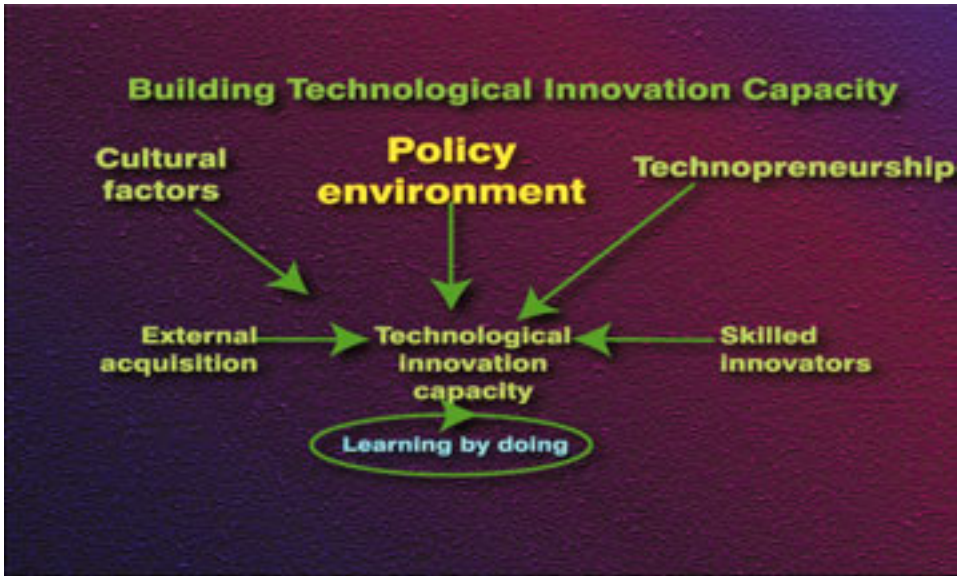


Figure 2. Building technological innovation capability

Evidently, cultural factors play a major role, but I deem the policy environment to represent the most critical factor in ensuring India's progress. In 1947 we had our political freedom, but it has been in 1991 that we had our second freedom, because we opened up globally. I in fact believe that India's performance should not be analysed over the last 60 years, that is after our policy freedom in 1947, but rather since 1991. The effects of that event were enormous.

Emblematic is, in this respect, the case of Tata. For example whereas Henry Ford used to say "Let the customer have any colour of the car, as long as it is black", previous to 1991 the Indian government used to say "Let the customer have any car, as long it is Ambassador or Fiat". In 1991 the situation changed and Tata was allowed to make cars. JRD Tata is known to have said, already in February 1978, "If Telco had been allowed to develop as it should have been, I have no doubt that we would have been making cars in India. And a Tata car would have been as dominant as the Tata truck is today." But Tata was simply not allowed to. Back in 1978 there was a completely different environment. The moment Tata got green light things changed. In the fifties, it was the British Morris Oxford which was sold as Indian Ambassador and circulated on Indian roads. Today, thanks to the opening up, it is the Indian Indica that is being sold as City Rover and circulates throughout Lon-

don. Before 1991 Indian designers and developers were simply not allowed to take up challenges like these. But not that India is open to global markets, we can measure ourselves. For instance, going back to the Tata example. They have recently launched a 2000 dollar car that incorporates technological breakthroughs as, for instance, high performance adhesives instead of welding. This represents a total innovation towards a new paradigm of low-cost transport.

A new geography of science

The geography of science is changing at last. We are experiencing the internationalisation of public research. Research centres around the world are uniting their efforts for the benefit of the whole society. This is, for instance, the case of the "Global Research Alliance" whereby CSIR (India), CSIRO (Australia), CSIR (South Africa), VTT (Finland), DII (Denmark), TNO (Netherlands), SIR (Malaysia), FGG (Germany) and Battelle (USA) and others have all come together. Each of the institutions involved is supposed to take care of its own country's interests. The aim is to use the global talent pool to create global goods through global funding. The big challenges that lay ahead, for instance in the energy and health sectors, will be tackled in a new cooperative and global way.

Looking at the history of science and the geography of science, it is immediately evident that big changes are happening. For instance, the chart relative to the percentage of the science generated in the world over the period 1990-2004 shows that the US relative share has somewhat declined, the European Union's share has increased, whereas the Asia-Pacific area's share is continuously increasing.

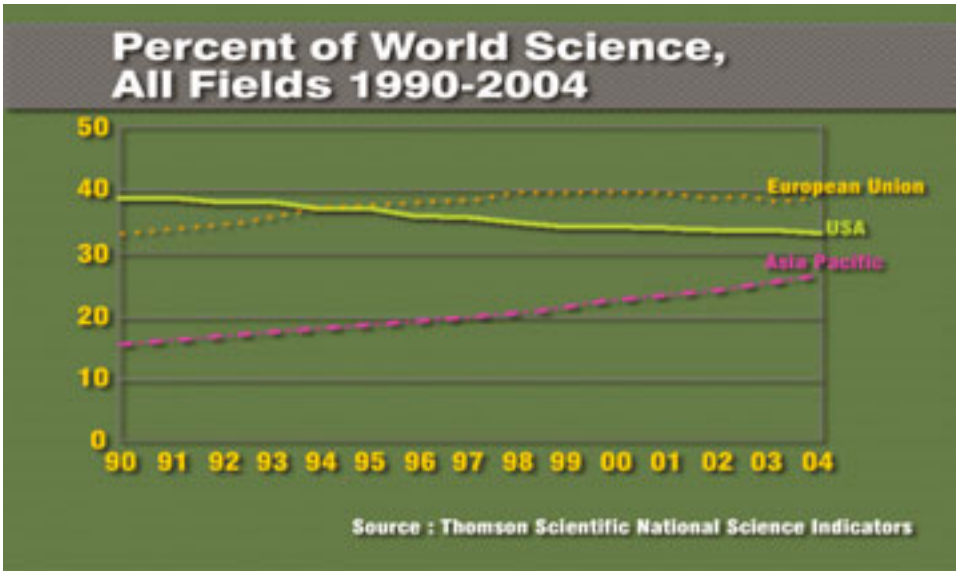


Figure 3. World science shares, 1990–2004

Analogous or even more remarkable patterns can be observed in the different sectors, whether engineering science (figure 4), physics (figure 5) or material science (figure 6).

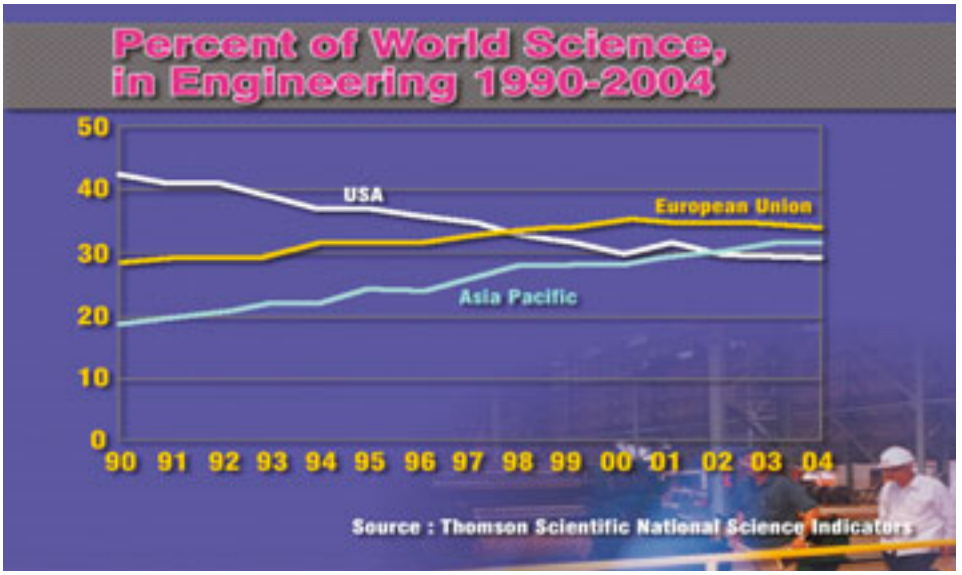


Figure 4. Percent of world science in engineering, 1990–2004

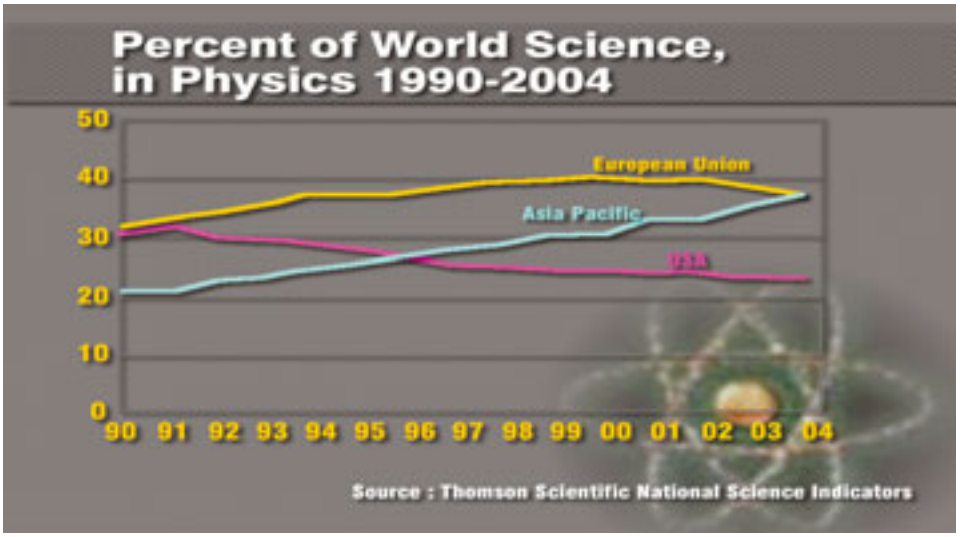


Figure 5. Percent of world science in physics, 1990–2004

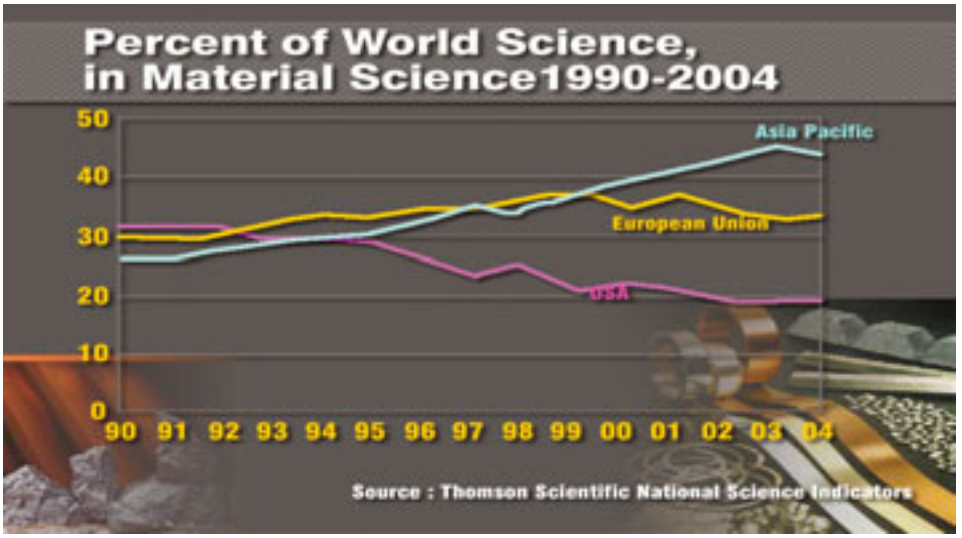
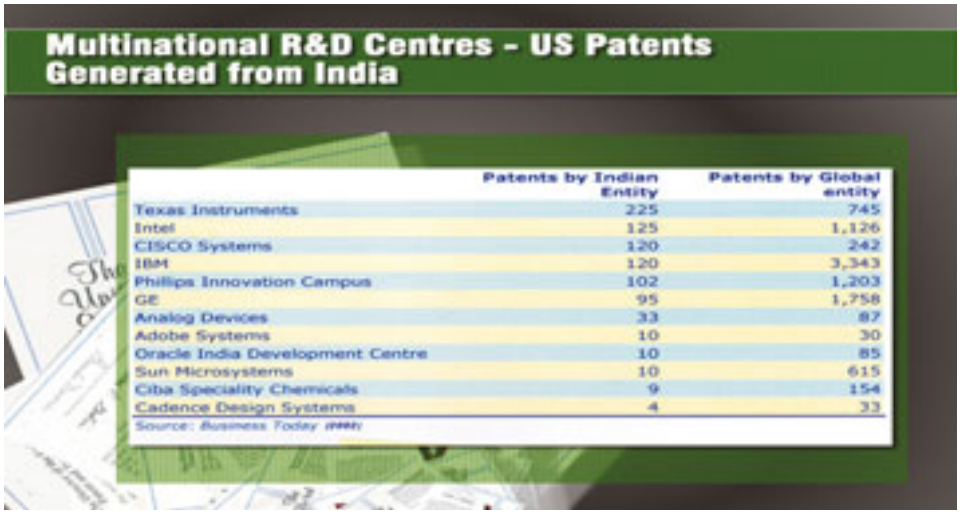


Figure 6. Percent of world science in material science, 1990–2004

Another recent phenomenon that deserves attention is that of the multinationals' R&D centres and the share of knowledge they create. Whether IBM, Texas Instruments or others, the common trend is one where greater and greater knowledge is generated in countries like India and China.

Table 5. Multinational R&D centres – US patents generated from India (2002)



The huge challenge that lies ahead is, however, to increase productivity. In fact, as stated in the report "Creating an Innovative Europe" following the Hampton Court Summit in January 2006, "The 3 % challenge is one representing an input, rather than an outcome, or even an output". The real issue goes well beyond the 3 % investment in R&D. It is the returns on that investment and how to measure concrete outcomes and outputs. The real challenge is to generate intellectual capital, accumulate it and valorise it. This generation and accumulation is going to take a different form, for example that of distributed knowledge production centres.

Conclusions

Evidently, there is a lot of expectation about India for its being the possible next super power. There also is a lot of speculation about what can stop India and China.

The Indian science and technology system, whether working to obtain vaccines for pennies or preparing missions to the moon, is aiming to help the people that are at the bottom of the social pyramid. The ultimate goal is to create new technologies for them and for all those 4 billion people around the world whose average income is less than 2 dollars a day. That is the India of my dreams. When we talk about India, the emergence of India as a global innovation hub, we are not only talking about multinationals coming and setting up R&D centres, but we are talking about something far beyond that. India that looks at the global good.

4a.3 Transformation into a knowledge-based economy: the Malaysian experience

J. M. Jarjis

Introduction

As Minister of Science, Technology and Innovation, it is central to my Ministry's responsibility to implement policies and programmes that will enable Malaysia's transformation into a knowledge-based economy. "As we are undoubtedly aware, the world economy is undergoing a revolutionary structural change. The traditional drivers of economic growth and wealth creation – land, labour or capital – have lost some of their dominance. More recently, knowledge, technology and innovation, have replaced them as the new, key drivers of economic growth and wealth creation."[36]

In Malaysia we are currently dealing with many issues and facing important challenges associated with the knowledge-based economy. Among the latter the possibility that the gap between developed and developing countries would widen.

On the one hand, the transmission of knowledge, know-how and technology across national borders is growing and is facilitated by the advances in Information and Communication Technology (ICT). This in turn is manifested in the growing trend of the internationalisation of scientific and technological activities. On the other hand, countries differ in their capacities to capitalise on the opportunities derived from scientific and technological advancements. Those that do not have the capability and capacity to access global knowledge and new technologies and utilise them for their productive activities will remain marginalised.

This is why Malaysia has developed a vision and a set of strategies for the development of the knowledge-based economy. These should also allow Malaysia to meet the challenges that the country will face in its development path.

Malaysia's Journey to the Knowledge Economy

Malaysia has come a long way, starting with an economy dependent on agriculture and natural resources. In the early years the export of raw materials, namely rubber and tin, was the main source of national income. For these sectors, land and low skilled labour were the main factors of production. Tertiary education was almost

36 YAB Dato' Seri Abdullah Haji Ahmad Badawi, Prime Minister of Malaysia, IDB Conference on Knowledge and IT for Development 2005, 23 June 2005.

non-existent and only a small group of the population with the necessary financial capacity was able to acquire tertiary education abroad.

Malaysia's transformation into an industrial or production-based economy in the 1960s led to major changes in physical infrastructure, financial system and education system. The Government invested in transportation infrastructure to move goods and services, financial and fiscal incentives to attract foreign investments, and education and training systems to supply the industries with skilled labour and technical workforce. Malaysia's investments in providing world-class infrastructure, attractive incentives and sound education system have paid well in terms of export earnings from manufactured goods, in particular electrical and electronic products as well as foreign direct investments (FDIs). During the period 1991–2005, Malaysia's exports grew at an average annual rate of 13.5 % and today Malaysia is the eighteenth largest trading nation. The FDI inward flows have been substantial.

Malaysia's efforts so far may be adequate if it can continue to leverage on low-cost skilled and technical workforce as a major comparative advantage. Unfortunately, this is not the case, as it faces growing competition from countries with abundant workforce such as China and India. At the same time, the role of knowledge is becoming increasingly critical in the new economy as technology becomes more complex and economic growth is driven by knowledge-intensive industries.

Malaysia's leadership is fully committed to develop a nation that is progressive, resilient and competitive. Malaysia's national vision, namely Vision 2020, was introduced in 1990 with the goal of attaining a developed nation status by the year 2020. One of the key challenges of Vision 2020 is to develop a strong foundation for science and technology such that Malaysia will not only be a user of but also a contributor to scientific and technological advancements.

Malaysia has a bit more than ten years to go to achieve its national vision. It is gearing itself for the transformation into a knowledge-based economy or "K Economy", that is, an economy driven by knowledge and innovation. Strategies and approaches for a K Economy would have to be different from those adopted to develop an industrial or production-based economy. Physical infrastructure that is critical for an industrial economy is no longer a major determinant for success in the K Economy. Instead, the K Economy requires investments in the Knowledge Infrastructure.

As knowledge is the most critical factor for competitive advantage in the K Economy, the infrastructure must enable knowledge generation, acquisition, and the utilization of knowledge to produce goods and services that are competitive in the

global market. Thus, Malaysia would need to invest in the Knowledge Infrastructure that consists of:

(i) an education system designed to produce a large pool of qualified and skilled workforce in science, technology and engineering and other innovative, creative and enterprising professionals;

(ii) a research and development (R&D) system able to generate knowledge at the frontiers as well as new technologies demanded by the production and services sectors;

(iii) a strong intellectual property (IP) regime that provides effective protection and appropriation of intellectual property rights;

(iv) a technology transfer system that ensures efficient transfer of knowledge and technology from the R&D system to the industry and business sectors;

(v) a critical mass of innovative firms and entrepreneurs to exploit knowledge to produce goods and services for the local and global market;

(vi) a financial system that promotes investment in high risk ventures; and

(vii) an eco-system that facilitates knowledge flows and promotes interaction between and among the systems mentioned above.

The Ninth Malaysia Plan (2006–2010)

In 2006 Malaysia launched its Ninth Malaysia Plan, which sets out the development plan and strategies for the period 2006–2010. This is the first step in the next fifteen years' journey towards a developed nation status. The strategies and measures that have been identified in order to implement the national development plan are the following.

Figure 1. The multimedia super corridor (MSC) vision until 2020

Firstly, Malaysia will focus on strengthening the National Innovation System (NIS). The National Innovation Council (NIC), with the Prime Minister as Chairman, will provide the leadership to set the direction and the implementation framework for the National Innovation Agenda.

A strong NIS will facilitate Malaysia's integration into the global technology and knowledge creating networks. As technologies become increasingly complex and the cost of creating new knowledge and technology rises, firms adopt strategies to reduce cost through outsourcing some of their innovative activities. Developing countries with relatively low cost but highly qualified human resources can take advantage of this opportunity to undertake the outsourced activities. In this respect, Malaysia is developing the infrastructure and capability to take advantage of these outsourcing activities.

In the ICT sector, cost competitiveness, highly educated and skilled workforce, a pro-ICT government and world class infrastructures make Malaysia an obvious choice for activities such as shared services and outsourcing (SSO). A.T. Kearney ranked the SSO cluster in the Multimedia Super Corridor (MSC) at number three in the world after China and India. The MSC initiative launched in 1996 was aimed at attracting leading ICT companies to locate in the MSC and undertake research, development of new products and technologies and export from this base. A set of innovative incentive package comprising fiscal and non-fiscal incentives are provided to MSC status companies.

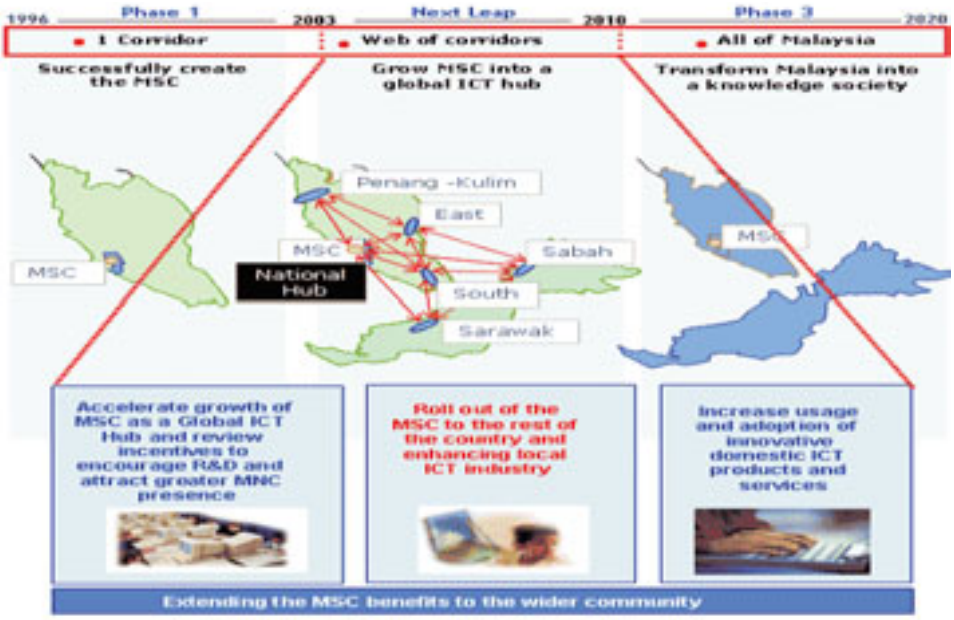


Figure 2. The MSC strategy

As an 'open economy', Malaysia has attracted large inflows of FDIs and trans-national corporations (TNCs), especially in the electrical and electronic sectors. The infrastructure and incentives to attract FDI in the knowledge based industries are different from that required for the production economy. It is vital for Malaysia to strengthen its NIS in order to compete with countries such as China and India for FDIs. Recent trends that point to increasing internationalization of R&D activities of the TNCs will benefit those countries that have the enabling environment. In particular of paramount importance is the availability of human capital and R&D infrastructure, as well as the ability to offer incentives for TNCs to conduct their R&D in the host countries. In this regard, human capital development is central to Malaysia development plan, in particular the human capital needed to enable effective harnessing of science and technology for wealth creation and societal well-being.

At present Malaysia lacks the critical mass of qualified scientists, engineers and related professionals that are much needed to drive the K Economy. In 2004, Malaysia had only 21 research scientists and engineers (RSEs) for every 10,000 workforce. The target set in the Ninth Malaysia Plan is to achieve 50 RSEs per 10,000 workforce by 2010. The shortage of RSEs will be somewhat mitigated, in the short term, with the implementation of the National Brain Gain Programme. The objective of this Programme is to attract scientists and engineers worldwide to conduct R&D in Malaysia.

Malaysia views international strategic partnerships as an effective means to access frontier knowledge and accelerate scientific and technological advancements. In this regard, Malaysian universities and research institutions have been actively engaged in collaborative research and technology development with centres of excellence, in both developed and developing countries. We look forward to enhancing our cooperation with the EU.

At present, we not only expanded the acquisition of knowledge through collaborative R&D projects as well as attachments of Malaysian scientists and researchers in renown research centres. We also devote significant resources to developing Malaysia's own centres of excellence in areas of strategic importance. For example, three new centres of excellence in genomics, agriculture biotechnology, and pharmaceuticals and nutraceuticals have recently been established. The aim is to catalyse the development of a strong scientific base in biotechnology. In the second half of 2006 the Government of Malaysia launched the National Nanotechnology Initiative.

The Government of Malaysia realizes that building a strong scientific base and increased investments in R&D are not sufficient to drive the transformation of the K Economy. An equally if not more crucial requirement is to promote the creation of a large pool of innovative firms and entrepreneurs. It is private enterprises that have the capacity and business aptitude to exploit knowledge and new technologies for economic gains. It is therefore crucial allow private enterprises to exploit the knowledge and technology generated from research laboratories, to generate new products and services for the local and global market.

Three Grant Schemes to Move the Economy up the Value Chain

The Government of Malaysia provides various types of fiscal and non-fiscal incentives to private enterprises to promote their involvement in R&D and innovative activities. The R&D and commercialization funding mechanism was recently restructured to plug the financing gaps, in particular financing for development and pre-commercialization activities. Three new funds have been created, namely Science, Techno and InnoFund. These funds are open to both public institutions and private sector enterprises. Firms that undertake R&D are also eligible for double tax deduction.

The lack of entrepreneurs has been identified as one of the weaknesses of the Malaysian innovation system. The Government of Malaysia has introduced various programmes to address this weak link in the NIS. For example, in the ICT sector, a "technopreneur" development programme has been implemented in the MSC. With respect to the technology-based sectors, technology incubator facilities have

been provided by the Government to create the critical mass of entrepreneurs as well as to catalyse the creation of new technology based firms.

Table 1. Malaysia's grant schemes

Fund name	SCIENCEFUND	TECHNOFUND	INNOFUND
Objective	• Generate new knowledge through basic and applied sciences • Develop laboratory proof of concept • Enhance research capability and increase number of researchers	• Stimulate the growth and successful innovation of Malaysian medium and large enterprises by increasing the level of R&D to market or commercialisation • Increase capability and capacity of Malaysian IHL and RI to commercialise the R&D findings through spin-offs / licensing	• Individual, Micro and Small Enterprises: Development of new or improvement of existing products, process or services with elements of innovation • Community Groups: Conversion of knowledge / idea into products / process / services that improve the quality of life of communities
Endowment (under the 9th Malaysia Plan)	RM 1.2 Billion	RM 1.3 Billion	RM 0.2 Billion

While attention is turned to developing new technology based enterprises, the Government gives equal attention to small and medium enterprises (SMEs), which make up more than 90 % of enterprises in Malaysia. With respect to SMEs, the emphasis is on upgrading their technological capabilities to enable their integration into the global production network. One of the measures taken is through support programmes that enable SMEs to use new and advanced technologies, including ICT, in their production and business processes. A new element in the SME blueprint is the development of SMEs in the knowledge-based industries.

ICT: Overcoming the Social Divide

In transforming Malaysia’s economy to one driven by knowledge and innovation, the Government of Malaysia is fully aware of the possibility of creating economic and social divide among regions as well as its population.

It has been recognised that ICT have an important role to play in overcoming socio-economic inequalities, provided appropriate mechanisms are implemented to ensure that ICT are used for this purpose. Developing countries should not only invest in connectivity and access to ICT but give equal emphasis on socio-economic inclusion programmes. Accordingly, Malaysia has developed a Framework that focuses on the value that ICT are capable of delivering to underserved sections of the Malaysian society. This Framework will address the digital value divide, seen as "that which prevents certain sections of Malaysian Society from being able to benefit from a more equitable share in the socio-economic value that ICT are capable of generating."

Malaysia's policies for ICT-based growth have been in place for some time and are at the core of the country's ICT strategy in realizing Vision 2020. The focus so far has been more on infrastructure development than on the issues of e-inclusion. A revised approach targeting e-inclusion implies the adoption of key socio-economic development objectives by ICT programmes in areas such as health, education, agriculture and rural enterprise development and local content development. The Framework for digital value divide, when fully implemented, will be a key vehicle to attain e-inclusion in Malaysia, which in turn will have the effect of accelerating Malaysia's progress towards attaining the developed nation status by the year 2020.

SECTION B)

Global Strategies: The Experience of Some High-Tech Multinationals

4b.1 Why and where companies in Europe go global? A Unilever perspective

J. Maat

Introduction

I offer here the views of Unilever on technology access and how we manage it, why its main research divisions are still in Europe. To this end, it is necessary to first understand what kind of company Unilever actually is. Unilever may in fact not be known in itself, as people normally know our brands, like Dove, Knorr, Omo, Slim Fast, and so on. Each of these brand is a global one and is possibly worth over 1 billion euros.

The variety of brands belonging to Unilever encompasses what we call "fast moving consumer goods". The products we sell have, on average, a unit cost of maybe up to four euros and the price can be as low as one cent, if sold in Africa. Our products are really common household products, as for instance Knorr soups. What sometimes people do not understand is that there is a lot of science and technology behind those products. They are the result of continuous innovations, which often represent evolutions and sometimes even technological revolutions.

Our products are very knowledge-intensive, also and especially on the consumer science side. Understanding what a consumer desires is a very important aspect for a fast-moving consumer goods company. One needs to really anticipate consumers' needs.

A "Multi-Local multinational": Unilever's organisational setting

Unilever is a real multinational, which is present all over the world. Overall, Unilever's turnover is something like 40 billion Euros; we are present in 150 countries and the company has 206,000 employees. We started out in Europe and still have our main stake there, with a turnover of 16.2 billion Euros, i.e. 41 % of the total. Our business in the Americas, Asia and Africa is smaller, but especially Asia and Latin America represent the biggest growing regions.

Unilever is indeed a global company or, as we say, a "a truly multi-local multinational". Our deep roots in local cultures and markets around the world give us strong relationships with the consumers. These are the foundation of our future growth, what makes us able to bring our wealth of knowledge and international expertise to the service of local consumers. Often our local enterprises are quite independent, so that we can best understand consumer needs.

Recently Unilever underwent a reorganisation aiming to considerably simplify our structure and make us much more agile and innovation-oriented. This was needed in order to speed up innovation and our market propositions, given that our growth is limited as compared to our main competitors.

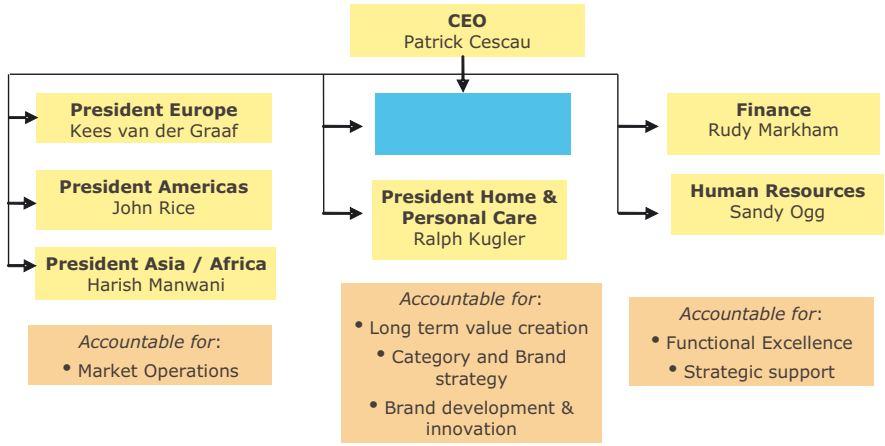


Figure 1. Unilever organisation

We have a clear accountability of the market operations and this is region-based. However, the global brand, i.e. the long-term value creation - which also encompasses innovation - is taken care of at the central level and subdivided into two main areas: food on the one hand, and home and personal care on the other hand. They define what needs to be done innovation-wise at the global level. In the past, such strategies were somewhat modified on a country-based level, but this does not happen anymore and all is defined at the global level.

Another important step was taken by splitting what we call our “Global Virtual Lab” into programmes and resources. The former define what to do, the latter who is going to do what.

At present, we have one aligned global innovation and R&D organisation. This represents quite a difference from the way we used to operate in the past. It actually means that our global virtual lab is defined at the level of projects and is endowed with considerable global resources and global competences. We make sure that competences are mastered at the global level, thus avoiding duplicates. Evidently, brand strategies, market strategies and R&D strategies are co-defined. This also implies that we have to define very well what capabilities we need to develop ourselves, and what capabilities we want to develop externally.

Unilever foods – Home & Personal Care's & Corporate Research

At present, within Unilever we have three main research centres located in Europe. The HPC one is very close to Liverpool, in Port Sunlight (UK). We also still have a corporate research laboratory in Colworth (UK), which takes care of new business developments. The centre is not too big and carries out about the 10 % of our total research, in terms of R&D spending. The third centre we have in Europe deals with food-related research and is located in Vlaardingen (NL). Each of these laboratories counts around 1000–1200 people.

We also have other two research laboratories outside of Europe: one located in Mumbai, in Bangalore (India) and one in Shanghai (China). We have had the India centre for the last thirty or forty years, as Hindustan Lever is Unilever-owned by 49 %. Conversely, in Shanghai we have only been present since 1997.

All in all, we spend one billion Euros in R&D (1,040 million Euros in 2005), which is maybe about 2 % of our turnover, and have 8,000 R&D employees. For a pharmaceutical company this sum would be small, but for the food and HPC market it is a substantial sum. Besides the centres I mentioned we also have global technology centres scattered all over the world, from South America to Japan, from South Africa to Canada. These actually constitute our continuum, making sure that the innovation flow goes well.

R&D and the role of policy

Although the R&D setting I just described is quite remarkable, still there are elements that we cannot do ourselves. We clearly have to rely on knowledge that comes into the company from the outside world. We try to tap into that knowledge to further develop our innovation potential.

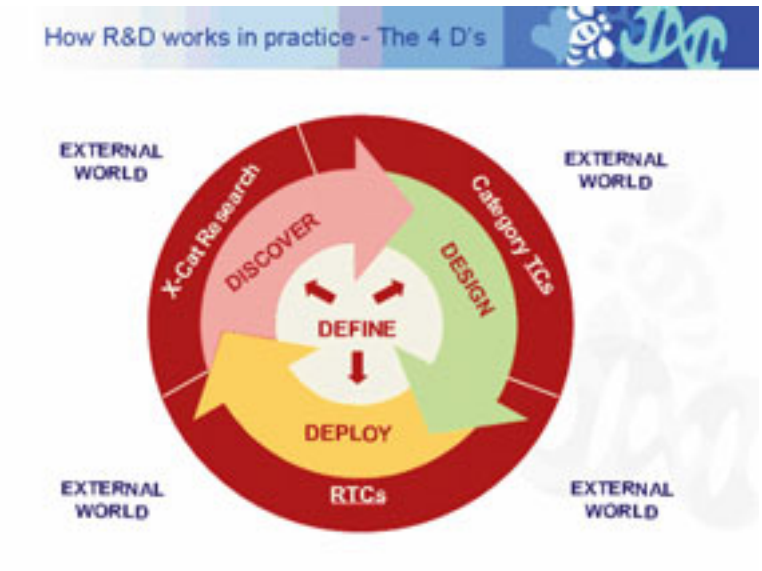


Figure 2. R&D in practice at unilever: the 4 Ds

In this framework I believe governments play an important role, as they may anticipate the needs of companies like Unilever, even if they operate on a global scale. In particular, there are three elements that governments can shape: the base of the knowledge infrastructure, the legal environment and the social environment.

Within the knowledge infrastructure education is of course of paramount importance. It is fundamental that governments take care of education, intended not only as higher education, but also as primary schools. In fact, we noticed that the science orientation is less well developed in primary schools. Therefore, Unilever, together with some other multinationals, like e.g. Shell, DSM and Philips, are making efforts to address primary and secondary schools. We show the youngsters what kind of science and technology is in our products and what it could actually mean to be in industrial S&T later on in their careers. At school it is where people make decisions about what education to go to next, what to do in the future and I think we, as industrie,s have taken up the responsibility to address the issue. Still, we deem that governments should take care of this aspect and ensure that quality of education is high.

A second element that government may address is to stimulate specific research areas. Policy makers need to ensure that these are co-aligned with industry needs. First of all we believe that the government can help us in the more high-risk, longer-term knowledge investments. Although this already happens within the European area and the European framework, there is still room to optimize the policy on

grants. Secondly, I believe governments can play an important role in partnering, e.g. bringing together partners that normally would not be together, for instance through subsidies and so on. We see both in the Netherlands and in Europe that governments can play this role. Sometimes they do not realise that, but we regard it as a very important role to play.

With respect to the legal environment, it is necessary to have an adequate level of Intellectual Property (IP) protection and a good IP Rights (IPRs) system. In that sense, Europe is in the strange position that there is no European patent yet. This is a problem that is really hampering progress in Europe.

Finally, some remarks about the social environment and the mobility of human resources. As mentioned before, about 30 % of our staff comes from countries other than the Netherlands. We really have an international laboratory already, with people having something like forty different nationalities. However, mobility of people e.g. from China into Europe, should be further facilitated. At present it is not so easy to get people from those countries. Being able to attract high talents is very important. In this respect we had a very good Marie Curie system for industrial placements during the Fifth Framework Programme (FFP) and a considerable number of those students remained in our laboratories. I think that it was a very valuable element, but the EC decided not to continue it, and this has created a considerable reduction in the industrial participation in this scheme. Adaptation of especially the paperwork is hoped for in the 7-th Framework program. In conjunction to the big number of foreigners entering into our countries, the government should insure good international schooling and mobility within the country.

The industrial innovation chain

Figure 3 shows our industrial innovation chain, i.e. the way we capture and organise knowledge as part of innovation. Our chain is very much R&D based. We have segmented it to run from fundamental sciences to applied sciences, applied technology and product development. For illustrative purposes, figure 3 pictures the chain as being a very sequential one, but is not quite that way.

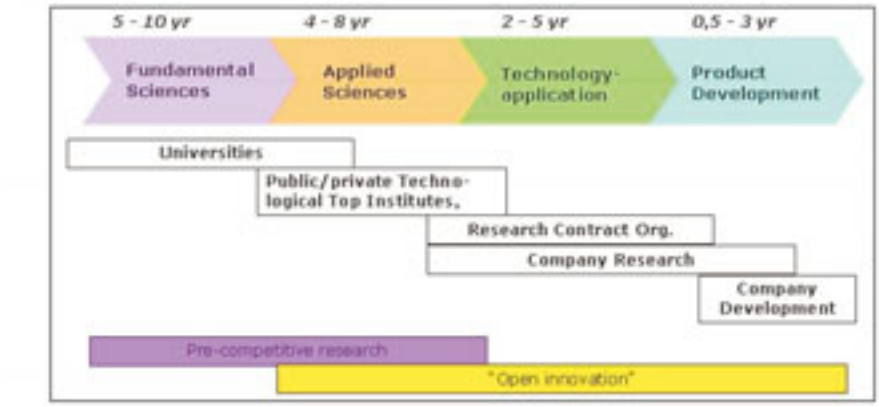


Figure 3. Industrial innovation chain

At present, Unilever's company research is in the area of applied technology. We cannot afford anymore to take care of fundamental research or for several areas to deal with applied sciences. We need others to do that. In the Netherlands, for instance, we have organised ourselves with several other industrial partners and knowledge providers similarly to what one now sees in the joint technology initiatives. Basically we tried to organise and develop a way by which making applied science fit our sector's needs. We call it the area of "pre-competitive research". This is overlapping with the open innovation part, which here is defined as more shorter term.

An example might help clarifying the concept. For instance, the Wageningen Centre for Food Sciences (WCFS) is what we call a leading technology institute. What we did, in 1997, was to build an alliance between industry and academia, as can be seen in table 1.

Table 1. Wageningen centre for food sciences (WCFS)

• Alliance of industry & research organisations to strengthen Dutch food industry through innovative technology • Leading technological (virtual) institute; founded 1997 • Public-private investment: Industry-Academia-Government (30/20/50)	
Participating research organisations	Participatig industries
• Nizo food research	• CSM
• TNO Nutrition	• DSM
• Wageningen University & Research Institute	• Unilever
• Maastrich University	• Netherlands Dairy Industry
	• Avebe (till 2008)
	• Cosun (till 2008)
	• Sovion (from 2007)

The WCFS is a public-private investment, where the government brings in the 50 % of the budget and the rest is supplied by both industry and academia. The interesting part is that it is industry that defines what needs to be done, that shows the market orientation. The research institute contributes by means of creating knowledge. Given the substantial amount of money involved, the institute benefits in terms of ability to pursue longer-term competence developments, in order to safeguard its infrastructure. The government supplies money for a period of four years, on the basis of a business plan. Projects are of up to 5 million Euros in size and this guarantees the possibility of having a real impact. The government does not discuss how you handle your activities and the programming and execution and are left to the partners. Government is measuring output.

At present the European Technology Platform Food for Life is evaluating this option for wider implementation in Europe.

The European Technology Platform "Food for Life"

The European Union has come up with a novel concept that goes under the name of European Technology Platforms (ETP). This concept brings stakeholders together, giving a vision of what one would like to achieve. The ETP subsequently is supposed to set a strategic research agenda, and make sure that implementation can take place. I believe this is a very interesting way of making sure, from a European point of view, that knowledge is actually built up and applied.

As the food sector is the largest manufacturing industry in Europe, the EC has embraced the European Technology Platform "Food for Life" initiative to make sure that its competitiveness is increased. Unilever is a big proponent of that, because it

also helps building up a very good knowledge infrastructure. It gives us the possibility to enhance the added value of our sector.

At present, there also is a much better alignment between the framework programs and the European technology platforms. However, it would be important to make this alignment even more visible. Besides, it would be helpful to reduce the bureaucracy characterising the framework programs. In this way, it would truly be possible to build a European knowledge infrastructure.

Centres of excellence: Making industry – Academia partnerships work

There are a few lessons that we have learnt with respect to bringing together industry and academy within an excellence centre.

Firstly, the success of the initiative depends on trust: establishing a multi-partner institute with other firms requires that you trust also your competitors. Trust is an element that you cannot build overnight: you really need to develop it and you need time to do so. However, it is important that the necessity to know one another well in order to work together well does not end up creating a closed shop, both at the national and the international level.

Secondly, you must clearly define a research program, which normally is an extension of your own company's program. Besides, governments need to be clear and state what they are trying to achieve from this initiative, in terms of long-term objectives and economic development.

Thirdly, for the programme to be successful, there must also be something in it for the academics. On the one hand, scientists should be involved in setting the program, so that they fully understand the type of scientific achievements sought. This certainly implies, for them, that some freedom is lost. On the other hand, though, as researchers are interested in publishing in top journals, publications should not be restricted. This, in turn, helps attracting top talents.

Fourthly, for industry to be sitting in the "driving seat", they should have enough absorptive capacity, otherwise academics may end up pursuing their personal interests regardless of concrete applicability. This is why only the larger companies and not the small or medium enterprises are present in the WCFS, as the latter lack the absorptive capacity needed. As a possible solution to this problem, a plan called Food & Nutrition Delta has been developed in the Netherlands. This gives small and medium enterprises the possibility to tap into the knowledge developed in the longer-term pre-competitive activities, as well as in the more application-oriented ones.

Fifthly, when developing a lot of capacity like a leading technology institute, there is the risk that, while pulling the team together across the country, you are widening the distance existing between the country itself and Europe. Hence the initiative needs to be expanded at the European level, but in a gradual way: I believe it cannot be done in any other way. It may take time, but all forefront initiatives are longer-term investments.

Finally, it is fundamental to focus on few areas, as one needs a critical mass in order to have an impact.

4b.2 Going global – Open innovations at Valio R&D[37]

T. Mattila-Sandholm

Open Innovations are one of the company's strengths today

Valio R&D has been strong on innovations throughout its entire history. The Nobel Prize in Chemistry won by our R&D director A.I. Virtanen in 1945 cast a winning spell on our approach to research in general. Valio has always been a front-runner, first with AIV butter salt and AIV silage in the 1920's. In the 1970's we were first again with a UHT ready-to-feed infant formula called Tutteli. Valio was certainly ahead of its time with probiotics in 1990 – the first company in Europe to launch the probiotic Lactobacillus GG (LGG®), a model for open innovation, which today has more than 290 scientific publications backing its history and proven effects. We have to remember that this was 5 years before the major probiotics were launched in Europe. Valio has a strong history of technological innovation in lactose free products, now with product families and concepts we call Hyla and Lactose-free. Lactose-free products are an example of a closed innovation. It all started as a research curiosity within the company. Researchers were interested in lactose in general and started to study enzymatic hydrolysis of lactose. This research started in 1970, and the product appeared in the market later, in eight or ten years. Gradually these Hyla products became a brand in Finland and Finns started to drink them. Hyla is enzymatically degraded lactose that has a sweet flavour. Researchers decided to continue with the research and established a method for totally eradicating lactose with chromatography and later on with a membrane technology. It came on market in 2000 and ended up being a massive market success. Besides all this Valio has many product categories in low-fat cheeses – Finnish consumers will not accept the high fat and salt content of European cheeses – this is a first step in the fight against obesity!

There is 'no zero-risk' in real innovation

In both academic and applied research, there is always the possibility that results do not come out as expected, which of course may be a risk depending on the investments made. One should also understand what a real innovation means and that not everything can be turned into an innovation overnight. Creative ideas and concepts do not all necessarily become success stories when they reach the production line. Sometimes the innovation can simply be too early for the market.

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37 The present article is presented in its original version, as written by the author, and has not undergone any revision by the editors.

Valio's innovation strategies can be divided into five main categories: consumer-driven, competition-driven, vision-driven, technology-driven and curiosity-driven. Evidently, the company does not invest the same amount of money in all the areas. Consumer- and competition-driven strategies absorb more than 50 % of the budget, whereas the vision-driven, technology-driven and curiosity-driven ones get the rest. Marketing produces concepts linked to the Valio brand and product development for competition- and consumer-driven markets. R&D establishes innovations through technology driven and vision driven approaches. R&D invests in curiosity driven research through its academic networks as well. Among others this has led to the next generation of LGG, building on the strengths of its research, which will be released next year. Our newest innovation Profeel milk is an example of a weight control product where both the concept and milk has been structured from technology innovation components at Valio aiming at satiety.

'Valio R & D – the future is international'

Although Valio has focused on what we call our home market around the Baltic Sea including Russia, we are already widening our horizons and will continue to do so. Markets in Finland have also become international so there is no place for single ownership any more. It's important to be competitive and stand out from the crowd. R&D works hand-in-hand with International Sales. Valio R&D strategy is built for both our home market area and a broader international market, and takes a truly international perspective. And in all cases differentiation is the core issue.

We have today some 20 companies around the world licensing our technology. Most of them have licensed the rights to our probiotic LGG® for their dairy products. There are dairy products with LGG® on the market in 36 countries worldwide. Some of our customers are also active in food supplements and one of our licensees is specialized in infant foods. Licensing of Valio's Evolus® technology has taken off in Europe where products are available in Iceland, Spain, Portugal and Switzerland. We have also licensed our technology for lactose free milk to some markets in Europe and recently to South Korea. Different parts of the world naturally have different requirements but there are many similarities, too. Europe has many common trends just as the Nordic countries do. Asia and the US offer many possibilities for co-operation both ways.

Licensed products are normally developed and manufactured locally (and also under local brands). This ensures that the needs of the local market are taken into account. Very often it is actually more a question of local consumption habits than really different nutritional needs. Of course the ways in which products are used can be very different as well: for French consumers fruit yoghurt is a dessert while for Scandinavians it's a breakfast product and a "snack" between the meals.

Is there enough 'real innovation' in dairy ?

The dairy industry has been accused of looking too much within what it sees as its own boundaries and simply cannot do so any more and certainly will not. One could argue whether or not the dairy industry has succeeded in investing enough in the 'R' part of research and development, since it seems that while people talk about R&D they only do the D. Valio has the unique and rare combination of both research and development bound to marketing, production and the pilot markets of Finland with the curiosity of the country's consumers – this is an interesting example of an innovation pipeline – and all in one location.

The word 'Innovation' has suffered from inflation becoming a trendy phrase used everywhere in the public and private sectors, and not always with much thought.

I do not consider me-too products to be innovations and in my opinion there are always too many me-too products out there. Valio's aim is to be different, effective and driven by curiosity.

Preventive medicine is food

Valio has led in launching several technologies that other companies have followed. A good example is Evolus®, the first dairy product in Europe to lower blood pressure. In 2005, other companies became interested and active in this segment as well. But because Valio technologies have been patented, the products cannot be exact copies.

Evolus® has been on the market since 2000 and is already licensed in Portugal, Spain, Switzerland and Iceland as you know. Of course its efficacy has been tested and proven, in clinical trials, in cooperation with university hospitals and research institutes, through our networking with the academic community. Valio's success with Evolus® has benefited from experience with our best known international innovation and the products that have stemmed from it. Lactobacillus GG better known as LGG® can be found in, at the last count, 36 health promoting products. And just as with Evolus® the number of products and licenses is growing all the time. Like LGG®, Valio Evolus® is much more than just a brand – it's a genuinely valuable technology. The way we are now commercialising our lactose free technology in for instance South Korea, where 80 % of the population is lactose intolerant, shows the human value of branding an innovative technology. And then there's Gefilus, too. Let us not forget the science behind the marketing. Valio has strong national and international scientific networks consisting of multidisciplinary expertise in the medical, physiological, molecular and biological fields. The technology and product development expertise is kept very much in-house since most of our patents rely on in-house technology.

Knowledge-based economy is part of Valio's history

It is interesting to see the motivation offered by the Valio Board, in 1916, when establishing Valio's Laboratory: "Only such a country whose entire economy is based on science can attain and keep the first place in the economic war between nations". This sentence shows that the board had understood the importance of the knowledge-based economy, and did so quite a long time ago. They just did not name it knowledge-based economy, but they certainly understood that knowledge is important and that you need to invest in knowledge to compete. Valio will continue to focus on innovations that cannot be copied easily and are truly for the benefit of the global consumer!

4b3. The challenges of globalization for R&D: Honeywell's perspective

B. Pellereau

Introduction

Although I am currently not part of an R&D organization, I am responsible for driving business innovation and business growth in the wider European region, which for Honeywell includes Europe, Middle East, Africa and India. In that context I would like to share my thoughts on the challenges of globalization to R&D. I will first illustrate the globalization of R&D activities carried out within Honeywell Specialty Materials and then make a number of recommendations to encourage innovation, especially in Europe.

Honeywell specialty materials (HSM) and its R&D centres

Honeywell Specialty Materials is not always known as a chemical company, but we are active in a wide range of industries. Honeywell Specialty Materials is a $ 4.5 billion unit of Honeywell, the $ 30 billion multinational company. We are a chemical company active in a wide range of industries and providing customers with high performance materials. For example, we make bullet-proof materials with advanced fibres and composites based on Spectra Technologies. Spectra Technologies is committed to innovation and to providing powerful materials for armour used by soldiers and police officers around the world, so that they may survive. We also produce environmentally friendlier refrigerants for air conditioners and refrigeration units. Besides, we provide non ozone-depleting blowing agents for closed-cell spray foam. These are used to build homes with higher energy efficiency and improved indoor air quality.

HEM is a leading supplier of chemicals and metals for the semiconductor industry. We have a Specialty Chemicals Business, which is an established leader in the production of high purity Life Science and Research Chemicals and therefore an important partner of R&D labs throughout the world. We also make additives for plastics and other applications, high barrier films, nylon resins and fertilizers. Our UOP Business Unit is a leading supplier and licensor of processing technology, catalysts and adsorbents, process plants and technical services to the Oil, Gas and Petrochemical industries.

With respect to our R&D labs, as you can see from figure 1, we have established a global R&D position, meant to support and speed up product development throughout the world.

Source: Honeywell

Figure 1. Honeywell specialty materials research locations

In the US we have a number of R&D labs: one in Sunnyvale, California, for electronic materials; one in Buffalo, New York, for fluorine products; another one is in Des Plaines, Illinois. This last belongs to the UOP business units and focuses on process technology for oil and gas cleaning and petrochemical plants. In Europe, our main laboratory is located in Seelze, Germany, close to Hannover. This is a centre focused on specialty chemicals, electronic chemicals and security pigments, called Lumilux. Seelze is our centre of excellence for Europe. It is located in our main production site for Specialty Chemicals and Security Pigments and serves the Global Product Development needs in these areas. It focuses also on the development of specific European products and local application expertise. In Asia, and more precisely in Shanghai, we have an application focused lab, where no fundamental research is carried out. The Shanghai centre is meant to develop applications and products that are suitable for the needs of the Asian markets. The Shanghai R&D Centre of excellence was opened in 2004 to support our Asia Growth Strategy. It provides critical mass for the business in Asia, contributes to a better product alignment with local market needs and customer preferences and reduces the costs of product development. Besides, we are establishing very strong collaboration programmes with universities throughout the world, including India.

The R&D we perform is primarily for our own purpose. When working with other companies we create partnerships aimed at developing specific industry solutions. For instance, we work a lot in the area of brand protection, in order to be able to detect counterfeited products and to protect our brands. Besides, most of the R&D carried out internally is not only focused on developing new products but more and more on developing solutions. Honeywell has the advantage of being a company

that is very active in many different industrial and consumer segments. And we can use synergies between the different divisions of the company.

Honeywell's R&D going global: Drivers and challenges

As far as Honeywell is concerned, performing R&D at the global scale brings many advantages to the company. To begin with, one of our main drivers is the will to benefit from the world's best talents. Besides, we want to have more diversity when it comes to the generation of ideas.

Secondly, we want to make sure that we get more research capabilities, and use the available 24 hours a day for our research. At Honeywell R&D never goes to sleep, so to say.

Thirdly, we want to take advantage of the new market opportunities arising worldwide, while achieving a better alignment with the local market needs. It is in fact well known that a product developed in the US or in Europe is not necessarily a product that can be successful in China or in India. We have to adapt to the customer needs and preferences.

Fourthly, we also want to take advantage of the reduced cost of new products' development.

I would say that two points, i.e. a stronger R&D portfolio and a higher speed to market, constitute the main benefits of Honeywell global R&D capabilities. Doing so our R&D portfolio becomes much stronger, thanks to the diversity of ideas. We also enjoy a better time-to-market, as the number of hours spent in R&D is higher.

Honeywell SM's motives and drivers that push the firm's R&D more and more globally are mainly 'horizontal', i.e. additional research capabilities, portfolio widening, speed up the time to market, and defining customer-specific applications for the different markets. Although we are also located in low cost countries, to take advantage of their competitive and talented workforce, the major benefit of our lab in China, for instance, is to deliver solutions that are better suited to the customers' needs. The same applies to Honeywell as a whole. For instance Honeywell has developed a campus in Bangalore where we have today more than 4500 people. These people work for most of the Honeywell divisions for instance in the area of software development and business analytics. We are recruiting in India at the pace of more than 100 people a month. Our limitation is to find enough talents. India is a low cost country but the driving force is not only the low cost per se, but rather getting the right talent at the lowest possible cost and obtaining the best results.

Becoming a global R&D organization also implies facing a number of challenges. To begin with, it is not always easy to attract and retain local talents in emerging markets. This requires a pro-active human resources policy based on training and local management, links with local universities and head-hunters, investments in corporate brand building, understanding salaries and local benefits, local career planning and so on. Other challenges include of course building or finding the necessary infrastructures, appropriately dealing with cultural issues and effectively communicating within and outside the company. Last but not least, patent protection and the respect and enforceability of intellectual property rights are central to Honeywell and its innovation activities. We reckon they should represent a top priority, as we make more and more progress in global free trade negotiations.

How Europe could improve the innovation game

As both business and research become all the more globalized, Europe must take some action to encourage and nurture innovation. To do so, I believe it needs to rely on four main elements: businesses, governments, academia and the labour market, as they all have important roles to play.

Figure 2. Collaborating to innovate

By investing in research, **businesses** provide private capital that helps creating new and innovative products and services. Businesses also develop new business models that allow regions to thrive in the global economy. In fact, the biggest "risk" for innovation is providing too much stability: new business models must be supported but also allowed to fail. In this respect, I do believe that access to more venture capital in Europe would help enhancing innovation.

Innovation can also be improved through the development of innovation clusters that would enable small and medium sized companies to be more productive and innovative than they could be in isolation (similarly to the Silicon Valley model). As businesses focus primarily on the market, success is linked to their innovation capacity and their ability to meet the changing needs of customers. Evidently, businesses must have a commitment to health, safety and protecting the environment. We say in the chemical industry that this is our license to operate. Industry actually should take advantage of new legislation. I think in particular to the new chemical legislation called "Reach". We often see regulations as a threat, but they also create new business opportunities by triggering the development of products with less impact on human health and the environment.

As for **governments**, they can foster innovation in many ways.

Firstly, governments must have robust systems for recognising and protecting patents and, more generally, intellectual property and make sure that these are also seen as top priorities in free trade negotiations. Besides, simplifying the European patent system would help enhancing innovation.

Secondly, I deem that simpler and better regulations in Europe, in line with the Lisbon agenda, would have a positive impact on innovation, economic growth and jobs.

Thirdly, I believe that collaboration platforms aimed at increasing the interaction between business, government and academia can strengthen innovation by sharing ideas, knowledge and expertise and improve the commercialisation of research. Governments can certainly play an important role in helping these platforms to develop.

Fourthly, governments should provide R&D fiscal incentives and coordinate R&D funding to focus on key sectors that are sources of competitive advantage in the region considered.

Finally, competitive energy prices, access to a wider spectrum of energy sources as well as energy efficiency regulations would all contribute to enhance the competitiveness and innovation potential of Europe.

Academia can also play a major role in fostering innovation. In fact, Universities can be and often are incubators for entrepreneurs (more so in the US than in Europe). This must be enhanced even further to support faculty and students interested in taking ideas to the market place and to help produce graduates who can lead this type of activity. Academia tends to reward people comparatively more for their academic achievements and tends to ignore those achievements that have a commercial impact. I believe this must change. Besides, academia should seek to

work closely with both governments and businesses to ensure that its R&D activities are focused on the most promising and strategic areas. Academia should avoid the "silo" approach to science, where disciplines rarely cross, e.g. engineering and business. I would further suggest that education curricula should also deal with innovation.

Finally the **labour market**. As innovation obviously depends on good ideas and talented people, the labour market should be structured in such a way as to encourage and support life-long learning. This, in turn, would ensure that skills remain in-line with global demands. I believe the supply of a deep and wide talent pool is critical to success. The labour market certainly plays a fundamental role in ensuring opportunities for talent growth. Besides, we do need to grow talent through exposure to other disciplines, for instance through collaborative programs. Finally, labour legislation should be somewhat more flexible and ready to more easily adapt to the continuous change that the global markets and the economic circumstances determine. That means that our workforce needs to be more flexible and mobile, which is not always the case.

Conclusions

I do believe that globalisation, and especially the globalisation of R&D, should be not be seen as a threat. R&D globalisation is truly an opportunity. Being able to reap its benefit simply depends on changing the way we operate. We would all benefit if there existed better links between academia, businesses, users and the governments, especially when it comes to new and emerging technologies. New technologies are not always competitive, and one needs to make sure that the development work done by the universities has some commercial significance and that businesses support the commercialisation of these ideas. In turn, businesses need being supported by the government when dealing with emerging technologies. This is why I would certainly like to see more coordination along the value chain, as there are sectors in which universities are leading and others where businesses lead. To accelerate growth and innovate more and better we have to work together more intensively: being the first to bring an idea to the marketplace increases one's chances to make this idea profitable. People always talk about numbers, but what matters is not the number of people, but rather the number of talents. It is not the number of patents, but the amount of money you get out of your patents. It is not the size of R&D, but what comes out of the R&D funnel.

If we do not cooperate and innovate more in Europe somebody else will do it in other regions. This is why I believe that we need to accelerate cooperation in Europe. in particular with respect to emerging technologies. Collaboration with the various actors in the value chain will accelerate the chances of technology scale up and successful commercialization.

SECTION 3

The Institutional Perspective

5 Conclusions and Policy Implications

Concluding: Policy implications

The Going Global 2006 conference offered quite an array of interesting elements related to knowledge and innovation policy. We here proceed to explicit and contextualise the most important policy implications highlighted both in the literature and by the GG2006 contributors.

We begin by synthesising the main features of the current "new phase" of globalization and then analyze globalization and the knowledge-based economies vis-à-vis the challenges they pose (Section 1). In Section 2 we briefly review the discussion concerning the recent global trends characterizing companies' R&D and innovation. Section 3 highlights the possible implications for the innovation strategies and policy-making of both the EU and of selected emerging economies. Section 4 points out possible developments and issues for further analysis and puts forward a more "compact set" of policy implications.

5.1 Implications of main traits of globalization and knowledge-based economies

We here overview the current trends of globalization and knowledge-based economies, looking at science, technology and innovation as strategic assets for the success of enterprises and nations. Our aim is also to look at the implications of fundamental issues as:

(a) the measurement and performance of knowledge-based economies;

(b) the structural transformation of the economy into a service economy driven by the IT, innovation and knowledge;

(c) the changes happening in the global IPR regime;

(d) the relevance of cross-border knowledge spillovers;

(e) the increasing role of technology transfer and science and technology within global trade rules; and

(f) the pressure globalization exerts over national innovation policies and how it may shape the underlying economic theory.

Measuring the performance of the knowledge economy

The ability to use, create, and adapt knowledge is held to be a fundamental determinant of the global competitiveness of countries as well as an indicator of how well countries may perform. Still, the fundamental question remains of how to measure, evaluate and compare the performance of knowledge-based economies. **Jean-Eric Aubert** proposes to use a methodology that relies on both quantitative and qualitative indicators, as the World Bank's Knowledge Assessment Methodology (KAM) and Knowledge Economy Index (KEI). Evidence supports the hypothesis that strong correlations exist between knowledge related investments and economic growth, regardless of the development level considered. The existence of such links between knowledge-related investments, countries' performance and prospect economic growth certainly has important implications for innovation policy and calls for careful investments in knowledge.

Countries' performances should be framed in a broader anthropological context, innovation systems within their broader development systems, and the latter understood within the broader social systems. As Aubert points out, most of countries' success stories of the past decades, such as Finland, regard geographic or cultural "islands" that have experienced severe pressure and threats and overcome deep crises. These islands have been able to develop a genuine endogenous capability and to mobilise their human and financial resources. The questions thus arise of whether it could be possible (and desiderable) to replicate such phenomena, vis-à-vis the implications of these development models at national, local and international level.

Structural changes: Towards an IT knowledge-based economy

The current knowledge and innovation driven development has been also and especially spurred by ICTs and by the transformation of the manufacturing sector these are triggering. **John Zysman** argues that we are living in a "global digital era" and that the service transformation has been globally driven by innovation, IT and digitalization. Some of the main features of the global digital era are the importance of component producers, the shift towards modularity and outsourcing, and the ability to decompose production into cross-national supply chains. Outsourcing is transforming many traditionally internal functions of the companies, including R&D, into tradable goods or tradable tasks, as Grossman and Rossi-Hansberg (2006) point out.The network-based transformation of services has become a critical part of the global knowledge economy and the current algo-

rithmic transformation makes some aspects of the service activities convertible into quantifiable processes. In such a global digital era the main advantages lie in the ability of firms to innovate business models and to exploit the blurred boundaries between goods and services as a source of innovation. However, compared to manufacturing, service production requires more knowledge. Still, this knowledge, Zysman stresses, is embedded in the IT tools currently available on the markets. Such a feature explains why, for instance, firms like the Indian Wipro can quickly enter the global market.

The implications of the global transformation of services for corporate strategy and national policies are profound. There must be experimentation in what companies do and imagination in what they are going to be able to do, the key question being how they reorganise their routines. National policy is creating the context for experimentation. When previously untraded sectors start being traded, the role of national policy and international competition begins to shift. Data networks constitute a base where experimentation takes place and the ability to reorganise the service sectors becomes critical. Moreover, what is done at home may become the basis for competition abroad. This means that the "global" is not quite as global as we think, but there is a permanent tension between global and the national level. Much of what, say, Finland or Japan have accomplished in fact mainly rests on their national policies and contexts.

IPR: Recent changes and the global regime

The ever-growing strategic importance of knowledge is reflected in the relevance of intellectual property rights (IPRs) and in the challenges traditional IPR policies are facing. The underlying rationale behind IPRs is to spur innovation and creativity by attempting to solve the tension between knowledge diffusion and lack of appropriability. However, the IPR system is currently under stress, due - also although not exclusively - to the massive expansion in the demand for IPRs, to the broadening of IPR areas (new rights, legislations, layout designs, database protection, etc.), and to the challenges posed by piracy, new innovation models ("open innovations"), and anti-IP movements. This calls, as **Francis Gurry** does, for the need to rethink IPR policies and to find possible pathways to solve the tensions of the IP system. A more inclusive discussion about other models of innovation, rather than only IP, is needed. One should not talk anymore about IP policies, but rather about broader knowledge policies that concern the generation, transmission and use of new knowledge. Access to technology should also be improved, especially geographically, thus leading to the democratization of access to technology. Besides, a deeper consciousness about countries' development should be fostered, so that the role of IP could be suitably contextualised. The functionality and efficiency of the IPR model can be improved, thus being of better service especially to small developing countries with scarce resources.

Relevance of cross-border knowledge spillovers

The growing strategic role of knowledge and innovation for the competitiveness of businesses worldwide makes the cross-border transfer of knowledge and technology extremely important. Key is also the issue of whether knowledge is intentionally traded or it rather un-intentionally spills over. **Pierre Mohnen** argues for the need of policy makers to intervene. Governments need to incentivize firms to make their investments in R&D reach the socially optimal level, rather than stopping at the private optimum. Besides, agents need to invest in their absorptive capacity to be able to benefit from spillovers. Geographical proximity, networking and labour mobility also matter for spillovers, as they represent important transmission channels. Despite the limited knowledge about how spillovers truly work – which makes experts unable to provide governments with normative guidance - some clear policy implications arise. Among these, the need to build up absorptive capacity, and to increase interactions, networking and knowledge exchange. Developing absorptive capacity is extremely important also for developing countries, as this would put them in a better position in order to benefit from the research done by others.

Global trade rules: The increasing role of science and technology transfer

Global trade rules are attributing growing importance to S&T and to the transfer of knowledge and technology. **Manuel Teehankee** underlines that S&T investments, research funding, and intellectual assets are high on the agenda of both developing countries and international organizations like the WTO, the UN and the OECD. The discussion at present encompasses not only technology transfer but also investment flows, competition rules, IP regimes, and limits to IPRs. Teehankee advocates the formulation of multilateral rules that would recognise and regulate the role of technology transfer and adoption, as well as domestic and multilateral fiscal incentives and funding for R&D and S&T. Teehankee hopes for a change in the focus of intellectual property protection that, without prejudicing IPRs, would lead to a win-win strategy and thus benefit development.

Globalization and national innovation policies: Challenging economic theory

Traditionally, national innovation policies have aimed to promote and encourage domestic production, transfer and commercialization of new knowledge by enterprises, R&D centres and other private and public actors. Globalization challenges all this. As **Otto Toivanen** highlights, the economic rationale for innovation policy is the assumption that R&D investments benefit not only inventors but also others, i.e. the society as a whole. The prospect social benefits that may accrue hence justify closing the wedge between private and social incentives to innovate by means of active innovation policies, i.e. taxes or R&D subsidies. However, the

implicit assumption of such reasoning is that the society is all mankind. Hence, justifying innovation policy on the basis of economic theory gives small open economies fewer reasons to support private innovation by public means than a world government would have. This is why Toivanen argues in favour of the need to try and coordinate R&D policies within bigger units, like the EU, in order to better internalize spillovers. Alike Mohnen, Toivonen suggests that a small open economy should nurture its absorptive capacity, to benefit from the knowledge created elsewhere. On a basis of the small open economy argument Toivanen also casts doubts on the belief that public R&D subsidies would encourage firms to undertake riskier R&D projects than they would have otherwise.

5.2 Implications of enterprises' global R&D and innovation strategies

The current phase of globalization sees business dynamics and worldwide competition settings changing dramatically, also due to the internationalization of enterprise R&D and innovation. Emerging economies like China and India look increasingly attractive to enterprises - especially transnational corporations (TNCs) - in terms of science, technology and innovation.

Despite it is not proved or disproved that the internationalization of enterprise R&D hollows out domestic capabilities, the media often define such relocation mechanisms as a threat. Doing so, they also forget that R&D relocation and off-shoring constitute just one element of the broader enterprise R&D and innovation strategies. Besides, the latter vary a lot, depending upon the characteristics of the companies, their home country, their technological capabilities, their markets and so on.

We here focus on three main aspects. Firstly, on some evidence about R&D off-shoring and its impact on the innovation capacity of the EU firms, as offered by an UNCTAD survey and a study commissioned by DG Enterprise. Secondly, we discuss R&D relocation taking our moves from the experience of three companies: a Dutch and U.S. based TNC and a Finnish company. Thirdly we consider and discuss a relatively less explored issue, i.e. the R&D internationalization dynamics and possible impact of Chinese companies. Besides attracting FDIs, emerging economies' firms are in fact entering global markets following strategies that resemble those of their developed economies' counterparts. Among the newcomers, Chinese corporations are anticipated to be the new contenders in global R&D and innovation.

Transnational corporations: Driving of R&D globalization

The generation of knowledge through R&D and its exploitation are some of TNCs' strategic factors of competition. Important challenges hence become finding the most suitable place where locating in-house R&D and deciding to what extent and from where acquiring external knowledge. In fact, although R&D constitutes one of the least internationalised business functions, it is nevertheless becoming increasingly global, mainly due to firms' need to innovate, to keep costs down and to access new talent pools. TNCs in particular are progressively increasing the amount of R&D they carry out outside their home country and much of this relocation targets developing countries.

At the same time, the R&D performed in some developing countries is becoming more complex. In addition, more innovative R&D is also being undertaken in e.g. India and China, as well as in Singapore and Korea, thus signalling that the actual innovation process is getting transferred to some extent to these countries. Asian economies seem to be those that most benefited from the globalisation process. Through dedicated policies they succeeded to become more competitive knowledge-wise and to improve their national innovation systems. They also actively sought to leverage TNCs investments and activities, by focusing on human resources, public research activities, and IPR protection.

Thorbjörn Fredriksson underlines how these developments open up new opportunities, not only for developing countries but for the world as a whole, as they may lead to achieve win-win outcomes. In particular, as far as Europe is concerned, Fredriksson holds that R&D off-shoring is creating more opportunities than challenges. Many European and American companies often find it difficult in their home countries to find the sufficient number/quality of staff needed to undertake R&D. Through off-shoring R&D activities in new locations they may instead manage to remain competitive. This being the case, R&D investments in, say, India or China do not constitute a loss of R&D for Europe or the US, but rather a useful complement. Countries should therefore pay attention to the strengths and weaknesses of their national innovation systems if they want to select and support those companies' relocation strategies that bring the most benefit to the home country. The same applies with respect to attracting foreign companies' investments.

Such a perspective seems to be shared by **Heikki Salmi**, who points out that domestic R&D has been very limitedly replaced by off-shored R&D. This suggests that off-shored R&D differs from and complements the R&D carried out in the home countries. Only R&D off-shored to Asia seems to be associated with higher level of replacements. In general, though, R&D off-shoring happens between EU member states, from the old member states to the new ones, and not so much be-

yond EU. Strategic R&D is normally carried out in the home countries: the more important the product and process level R&D is, the lower the replacement of domestic R&D. Public support does not seem to be crucial in R&D off-shoring decisions, but efficient IPR protection, the quality of the education system and the development level of the infrastructures are highly valued. Among the top reasons for off-shoring there are cheap labour and strategic benefits, intended as networks with other companies, institutions, competitors or customers. Off-shoring seems to have a positive effect on export firms, and these perceive off-shoring to have a positive effect over their capability to innovate. Evidence suggests that the higher the number of locations where a firm patents, the higher the number of patents. Hence, successful off-shoring, intended as the ability to innovate in several locations, has positive effects over the overall innovative performance of the firms.

All this said, it becomes evident that R&D off-shoring is certainly a kind of FDIs countries want to attract. We can thus expect fierce competition in this respect, as countries mould their structures in order to better attract the R&D off-shored. R&D off-shoring in any case also benefits home activities and should not be seen as zero sum game, where one country or region loses what some others gain. Europe should do its best to attract incoming off-shored R&D, but also see the opportunities that open up when enterprises off-shore R&D in other countries. Off-shoring is not a one-way path, but rather depends of the ability of enterprises to reap the benefits accruing from being present on each other's knowledge markets. Evidence suggests that off-shoring benefits European R&D productivity. Salmi hence suggests that, instead of fearing R&D off-shoring, we should understand it: EU citizens and firms will be able to continue to benefit only if the EU maintains and improves its science base and the quality of its workforce, while deregulating the labour market.

Global R&D and innovation strategies of enterprises

The current phase of globalization is imposing new requirements on both the R&D and innovation strategies of firms, independently of their sector, market orientation or function within the global value chain. Location is just one of the issues to be dealt with, as R&D and innovation strategies must take into account important features such as technological capability, overall company structure, and so on.

Jan Maat (Unilever) underlines that it is the need to achieve long-term value creation to define what is to be done, also innovation-wise, at the global level. To speed up innovation and strengthen its global market position Unilever has thus built up an aligned global innovation and R&D organisation, "a global virtual lab" where projects, resources, and competences are global.

R&D relocation, as **Bernard Pellereau** (Honeywell) puts it, is not driven by the need to lower costs but rather by the necessity to acquire local knowledge, understand the market, and develop products suitable to the needs of the local customers. Low costs do matter, but the real driver is recruiting the right talents at lowest possible cost.

Besides, as **Tiina Mattila-Sandholm** (Valio) stresses, it can be difficult for any company, especially for a small company, to succeed in innovating. Hence the need to open up, to collaborate with top scientists and, most fundamentally, to build up the necessary absorptive capacity. Doing so, firms may be able to attract those researchers that are at the forefront of science. Mattila-Sandholm also highlights the importance of relying on win-win strategies: when all the parties involved perceive that they are in a win position cooperation in any innovation is fruitful.

Pellereau further underlines the necessity to intertwine more academia and research and to generate stronger interactions between university and business. If competencies can be brought together Europe might have a strategic advantage over its competitors: the capability to innovate and commercialise new ideas in a successful manner.

Enterprises of emerging economies as new contenders in global markets

While R&D and innovation bring foreign companies to the emerging Asian economies, the enterprises of these countries are entering both the markets and R&D and innovation systems of all countries, including developed economies. **Max von Zedwitz** anticipates Chinese corporations to be the new contenders in global R&D and innovation. Some of them have in fact already become aggressive global players, even if, in general, Chinese firms are not as internationalised as their Western counterparts. As the latter are reluctant to send their latest technologies to China, the Chinese are establishing R&D centres in Western countries and investing in the research carried out in Western universities, to become legal owners of the IP generated.

At present, though, some barriers exist to the internationalization of Chinese companies. These are represented by are the firms' scarce resources, their little experience of foreign markets, and the fact that they lack of both product innovation history and R&D resources and management's expertise. Besides, the cost of doing R&D in China is relatively lower than carrying our R&D elsewhere. However, as Chinese firms are good at learning, imitating, picking up and absorbing knowledge, they might soon become strong competitors in R&D as well. If technology does not go to China, Chinese will go to the sources of technology and get it right there.

5.3 Innovation policy strategies: Implication for EU and selected Asian economies

In what follows we analyse the links between globalization, national innovation policy-making and policy strategies by looking at the EU and at the dynamics of selected emerging Asian economies (i.e. India and Malaysia).

The EU is in fact responding to the challenges posed by globalization by attempting to increase its attractiveness and competitiveness. Four are the aspects that deserve particular attention in this respect. Firstly, building EU's knowledge and innovation capacity. Secondly, implementing a EU strategy in international scientific cooperation. Thirdly, renewing the European knowledge policy. Fourthly, strengthening European industrial innovation performance.

Globalization, new growth strategies and the role of universities

Unfortunately, the "European paradox" is still hunting the continent. **David Audretsch** highlights how, in Europe, knowledge investments do generate new knowledge but this knowledge does not spill out of universities. Not being sufficiently commercialised, knowledge does not bring the expected returns, in terms of both growth and jobs. Whereas investing in new plants and equipments traditionally resulted in growth and jobs, the current investments in knowledge do not automatically lead to results. Knowledge investments have to go through what Audretsch calls "the knowledge filter" in order to become valuable and bring returns, i.e. knowledge investments' outcomes need to be commercialized. Audretsch suggests that the missing link between knowledge investments and returns is entrepreneurship, which serves as a mechanism or a conduit by which knowledge investments bring the expected fruits. He therefore calls for a more entrepreneurial role of universities, as universities are important sources of knowledge. In this way the transfer of knowledge to commercialization would be facilitated, thus resulting in economic growth and employment.

Daniele Archibugi somewhat challenges Audretsch's view by asserting that university's main mission is to carry out basic research. It should therefore be financed by means of public money, as it provides a public good. Archibugi reckons that public science is becoming too instrumental, R&D too much targeted at specific aims, and too linked to industrial competitiveness. He finds that, in the past, linking research and industry, having science parks, and fostering academic entrepreneurship was justified by the need to support the commercial application of science. However, this process has possibly gone too far. As a consequence, universities are getting very few money for research and depend too much on external con-

tracts. Archibugi argues that, although universities should be strongly integrated in the societal context provided by the market economy, the public sector should follow its own scientific priorities. These are to develop knowledge and provide that to citizens. Academia should be forced to socially justify what it does but its research should be funded by general taxation, as it provides general goods. He suggests that the society needs business and academia to work together, but not academia to work for businesses.

EU innovation policy

To increase its attractiveness and competitiveness and thus respond to the challenges posed by globalization, the EU is putting new initiatives in place, among them the Revised Lisbon Agenda and the development of EU international scientific cooperation (ISC).

As **Heikki Salmi** highlights, Europe can only compete on the basis of its knowledge capacity, given that its inherent strengths do not lie in competing through lower costs. In order to "put knowledge into practice" he deems that key strategic areas to be tackle are: education, the competitiveness of the internal market, the regulatory environment, clusters, knowledge transfers, a modernised university system, and the European Institute of Technology (EIT).

Salmi's list of strategic priorities is backed and complemented by the set of actions **Pellereau** proposes in order to enhance the innovative performance of Europe. These actions would require the commitment of businesses, governments, academia and the labour market. Businesses should provide the funding to develop innovative products and to create new business models, while committing to preserve the environment, health and safety. Governments should instead create robust systems for patent protection and make of intellectual property protection a top priority in free trade talks. Such a perspective is also shared by **Maat**, who argues that the main problem of the legal environment of Europe is the lack of a European patent. When it comes to the creation of collaboration platforms, R&D fiscal incentives, and the coordination of R&D the two industry representatives agree on the necessity to focus on key sectors. As for academia, Pellereau advocates that universities should try to constitute incubators for entrepreneurs. Academia should also seek to work more closely with governments and businesses to ensure that R&D is focused on the areas that may provide the most benefits. This, however, should be done while ensuring the independence of academic research. With respect to the labour market, Pellerau as well as Maat underline the need to encourage and support life-long learning and to ensure that skills remain in line with global demand. As innovation depends on good ideas and talented people the supply of a deep and wide talent pool is critical to success. Workers, however, should

be more mobile and flexible to adapt to the changes forced by global markets and economic circumstances.

As for international scientific cooperation (ISC), the need for it principally arises from the fact that scientific challenges are becoming all the more global and big: it is simply not possible to face them without cooperating. Besides, as **András Siegler** underlines, there is a need to underpin other EU policies based on international relations (trade, development, environment, energy, etc.).

However, the main challenges that EU ISC face lay in the ability to coordinate these cooperation initiatives, as well as in the ISC actions' budgetary commitments, and in the possibility to maintain a geographic and thematic diversity with the third countries.

Another issue that, according to **Dominique Foray**, needs to be addressed in order to foster Europe's attractiveness and competitiveness is the way in which resources are allocated to critical domains of the knowledge economy, in particular education and research. As the private sector responds only to incentives, these must be changed in order to make investing in R&D profitable. Besides, Europe needs an economy orientated towards the "right" fields of specialisation, with each region and country focusing on the knowledge base that makes them distinctive and unique.

Fundamental for Europe is to transform its economic institutions and modes of governance, and to better coordinate and adapt policies, especially macroeconomic policies. The latter should in fact play a countercyclical role during depressions, but this does not happen at the EU level.

As Foray suggests, the governance and coordination of national actions in Europe is not effective possibly because there is a mismatch between the soft method of governance adopted and the economic nature of the good object of the R&D policy. The Lisbon Strategy is in fact based on voluntary coordination, which allows member countries to free ride on each other in order to get benefits from community actions, without making their own investments. Moreover, Europe has a low budget at the central level and high national budgets. As a result, a somewhat dissipated effort of national states echoes the weakness of the centralised capacity of the EU.

Foray's words are echoed by **Jan Maat**'s analysis of both national and European innovation policies. The latter says governments have an important role to play with respect to the knowledge infrastructure, especially when it comes to guaranteeing quality education and contributing to orientate schoolchildren to science.

Besides, governments should stimulate those research areas that are better aligned with industrial needs, while supporting higher risk and longer term knowledge investments. Governments should also work at bringing partners together and to support networking.

Innovation policies of emerging Asian economies

The challenges that Europe is currently facing are also although not exclusively determined by the growth of some Asian economies, whose successfulness seem to be largely due to their knowledge oriented education, science and technology policies.

India, for instance, is currently emerging as a global innovation hub. As **Mashelkar** points outs, the "Grey Revolution" helped India to move into areas like software. Since it opened up globally in 1991, India's performance has improved substantially, to the point of now hosting the R&D research centres of 150 large companies. The strategy India has pursued to achieve its development is twofold. On the supply-side India has seen a massive expansion of its high-quality education and research system. On the demand-side many policy measures have been put in place to enhance competition and R&D, measures also coupled with government support for R&D.

Another example of the successfulness of some Asian economies is offered by Malaysia. The transformation of Malaysia into an industrial production-based economy in the 1960s led to major changes in the physical infrastructures of the country, as well as into its finance and education systems. Among other initiatives, the Government developed an incentive scheme aimed to attract foreign investments. These investments have paid well in terms of export earnings from manufactured goods, in particular electrical and electronic products. The country is now preparing itself to face the challenges that lay ahead, in particular the growing competition from China and India. Given that, as **J.M. Jarjis** underlines, the role of knowledge is becoming increasingly critical, the Malaysian government is also investing heavily in ICTs, as they are deemed to represent powerful tools to overcome social and economic divide among regions and the population.

5.4 Not to conclude: Summarising some key policy implications

The wealth and depth of the contributions presented during the Helsinki conference makes it challenging to extract the most important policy implications without risking to leave aside important issues. Besides, the policy implications formu-

lated below can be looked at as possible policy recommendations only in so far as they remain duly contextualised in the analysis that generated them. In what follows, we – the editors – have proceeded to interpret and systematise the content of both the experts' presentations and the discussion that the Helsinki conference triggered. We therefore assume full responsibility for the conclusions drawn, whether the analysis entails the national or the international (e.g. the EU) policy making level.

5.4.1 Contextualising the analysis

The current trends of globalization are forcing (knowledge-based) economies to re-think and re-formulate their S&T and innovation policies as science, technology and innovation represent key components of countries' competitive strategies. Evidence in fact suggests the existence of a positive correlation between knowledge related investments and economic growth, thus making of knowledge and innovation strategic assets for the success of both enterprises and nations. The need for new S&T and innovation policies is felt compellingly especially by the EU, willing to become the most competitive knowledge-based economy in the world by 2010 and facing a global scenario where:

- Knowledge-based economies are gradually shifting from manufacture-based structures to intangible, knowledge-and-service based business models. This new phase of globalization is a product of the knowledge-based economy and just one of the ways in which new technologies are reshaping the economies of the third millennium. Such a shift from a resource-based to a knowledge-based paradigm occurs to different degrees and at various speeds in both developed and developing countries. This is contributing to modifying the distribution of both wealth and income and, sometimes, also to widening gaps and deepening existing unbalances.
- Multinational enterprises (MNEs) play a major role in shaping worldwide industrial and R&D activities, as they account for a major share of global business R&D.
- The development patterns of emerging economies as China and India are changing the foci and dynamics of the global economy. Besides featuring growing markets and affordable cost levels, these economies are characterised by dynamic "region-states" able to absorb foreign investments also thanks to their increasingly attractive S&T systems. Although global R&D is still geographically concentrated in the developed countries, the role of these big Asian develo-

ping economies is increasing. Moreover, the enterprises of these developing economies are gradually becoming stronger contenders for global markets and R&D activities.

- One of the biggest challenges laying ahead is ensuring a global socio-economic and ecologically sustainable development. The need arises to find the most effective ways to solve acute problems like poverty, hunger, health, and the protection of the environment. These can be pursued also and especially through global collaborations in education, science and technology, thus making of globalization a welfare-enhancing opportunity rather than a zero-sum game. Win-win solutions can be achieved. To this end, knowledge-based economies can and should rely on knowledge and innovation to ensure global sustainable growth and welfare.

5.4.2 Policy implications

The analysis of the above global scenario leads to the formulation of the following policy implications:

a) Intellectual property and global trade rules need to be further developed

The growing strategic and economic importance of knowledge amplifies the strategic relevance of Intellectual Property Rights and of technology transfer mechanisms. Innovation policy related rules hence need to become clearer and easier to follow than they currently are. Bureaucracy need to be simplified, rules made more transparent and laws certain and enforceable.

We need an inclusive discussion about different models of innovation, as for instance open innovations, and about broader knowledge policies encompassing the transmission, the generation and the use of new knowledge.

With respect to IPRs in particular, the need arises to rethink the rationale behind them and to find better ways to ensure appropriability while allowing for diffusion (including technology transfer). Doing so IPRs would become tools for growth and development, strategic elements of win-win strategies, rather than being pointed out as exclusion devices.

The global access to technology and patent related databases should also be improved, as should the consciousness of the links between IP and development: the

worldwide democratization of access to technology is, in this respect, of paramount importance.

Technology transfer, R&D and more broadly S&T are acquiring growing importance when global trade rules are discussed as well as in the agendas of both developing countries and international organizations like the WTO, the UN and the OECD. The discussion has been extended from technology transfer to investment flows, competition rules, IP regimes, and IPR limits.

Multilateral rules for technology transfer should come along with a blueprint for the future, with a more recognized role for the diffusion and adoption of new technologies. Domestic and multilateral fiscal incentives and S&T funding could also be encouraged.

b) Building absorptive capacity and exploiting incoming spillovers

The growing strategic role of knowledge and innovation for the competitiveness of both businesses and countries calls for a better understanding of knowledge spillovers' dynamics, i.e. the un-intentional cross-border transfer of knowledge, and of the role played by absorptive capacity. This is true also and especially because the existence of spillovers and the possibility to exploit them are used as arguments justifying government intervention and innovation policies.

As the knowledge-based global paradigm sees competitiveness to depend upon knowledge being generated and exploited, absorptive capacity becomes a key asset for growth. Absorptive capacity – which is created through education, R&D and, more broadly, investments in knowledge – in fact enables agents to profit from the knowledge generated elsewhere, to absorb incoming spillovers, and to seize the opportunities that may arise.

Unfortunately, researchers are still far from being able to offer normative guidance to policy-makers with respect to spillovers. However, one features emerges clearly: the necessity for both developing and developed economies to invest in building their absorptive capacity and to increase interaction, networking and knowledge exchange among the relevant actors of innovation.

Globalization not only challenges the traditional innovation policy-making but also the underlying economic theory. Would the justification for innovation policy be taken out of economic theory, small open economies would have much weaker reasons to support private innovation by public means than a world government would have. Coordinating R&D policies within bigger units, like the European Union, would make it possible for more spillovers to be internalised.

c) Global localization of enterprise R&D

Firm R&D, especially that of transnational corporations, is becoming increasingly global. This phenomenon opens up new opportunities and challenges, not only for developing countries but for the world as a whole. The arising challenges are where to locate in-house R&D, and why, to what extent, and from where to acquire external knowledge. Companies' top reasons for R&D off-shoring are held to be the search for cheaper labour and for strategic benefits, e.g. networking with other companies and institutions, or better managing competitors and/or customers. The company cases included in the present volume show that location is just one of the issues driving R&D and innovation strategies, whereas fundamental are factors such as the firms' technological capability, industry's dynamics etc.. The advantages that enterprises perceive they may gain through establishing a "global R&D laboratory" are: to benefit from the world's best talents, to carry out research around the clock, to better adapt to customers' needs, and to take advantage of lower R&D costs.

Some Asian economies seem to have enormously benefited from such globalisation processes, whereas other developing countries have not and should look at these countries to learn "how to".

As for Europe, such dynamics create both challenges and opportunities, although emphasis is on opportunities. R&D off-shoring in fact seems to benefit home R&D activities as well and, therefore, should not be considered as a zero sum game where one country or region loses what some else gains. Accordingly, R&D investments in India or China should not be considered as lost R&D investments for Europe or the U.S., but rather as complements, given that there is scarce evidence of substitution effects. Besides, off-shoring seem to have a positive effect over the export of companies and on their ability to innovate.

In any case, it is increasingly important for countries (at all levels of development) to pay attention to the strengths and weaknesses of their national innovation systems, and to see how the latter can best support the activities of their own country's companies as well as those of the foreign firms interested in investing in the country.

From a policy perspective it is also important to realise that, although public support is not crucial for R&D off-shoring decisions, efficient IPR protection, the quality of the education system and the development level of the infrastructures constitute highly valued factors.

Europe should therefore do its best to constitute a good destination for incoming off-shored R&D, but also to carefully evaluate the opportunities that open up when

European enterprises off-shore R&D activities to other countries, as in this way enterprises may reap the benefits of being present on each other's knowledge markets. Instead of fearing R&D off-shoring we should attempt to thoroughly understand it.

d) Promoting entrepreneurship to solve the "European paradox"

The knowledge investments made in Europe do generate new knowledge but the latter does not seem to (sufficiently) spill out of universities and research centres to become the object of commercial transactions. Traditionally, investing in new plants and equipments resulted in growth and jobs. Conversely, investments in knowledge have to go through "the knowledge filter" to become valuable, i.e. they need to be commercialized in order to bring returns. The missing link between knowledge investments and returns is entrepreneurship, which serves as a mechanism or "a conduit" by which knowledge investments bring the expected fruits. As universities are important sources of knowledge, the development of an entrepreneurial university culture is important in order to facilitate the transfer of knowledge and its commercialization. This would result in economic growth and the creation of new jobs.

Europe needs to rely on a more flexible, innovative and entrepreneurial economy and society, where mobility is facilitated also and especially when it comes to science and R&D. Firms need to be ready to adopt or create new business models and to fully exploit the potential of ICTs. New regulations – in particular those related to preserving the environment and ensuring sustainability – should be looked at as windows of opportunities rather than as constraints.

New ideas should be able to more easily reach the market in a more entrepreneurial society where risk (and therefore failure) is part and parcel of the innovation process.

e) Renewing the culture of the academic community

Globalization offers new perspectives to the academic community while calling for deep changes, and in particular for universities to be strongly integrated in the societal context provided by the market economy. However, although integration between public and business resources is needed, the public sector should follow its own scientific priorities, i.e. to develop knowledge and provide that for citizens. Academia should socially justify what it does, but scientific research should be still funded by general taxation because it provides general goods.

f) European agenda: Strengthening the knowledge base and global S&T cooperation

The EU is responding to globalisation challenges by trying to increase its attractiveness and competitiveness. As its inherent strengths do no lie in competing through lower costs, Europe must build on its knowledge capacity: innovative companies go where innovation can flourish, workforce is well-educated, R&D labs are excellent, and strong clusters exist. To this end, key strategic areas for Europe are: education, the competitiveness of the internal market, a favourable regulatory environment, clusters, knowledge transfer, and a modernised university system.

To increase Europe's competitiveness, many new initiatives have been put in place. Among these the Revised Lisbon Agenda (RLA) and the development of International Scientific Cooperations (ISC). Interesting are also the Joint Technology Initiatives (JITs) included in the 7th Framework Programme. The EU promotes ISCs in order to carry out a better science and to pursue broader policy goals via scientific achievements. The main challenges posed by ISCs relate to the capacity to effectively coordinate ISCs, to the countries' budgetary commitment to ISC actions, and to the ability to maintain a geographic and thematic diversity of ISCs with third countries.

g) European policies: Specialisation, coordination and governance

The development of the European knowledge economy calls for a dramatic change in the way resources are allocated to the critical domains of the knowledge economy, in particular to education and research. Incentives should be designed as to make investing in R&D profitable.

Europe needs its economy to be oriented towards the "right fields" of specialisation. Economic institutions and modes of governance also need to be transformed. Objectives need to be well specified and policy instruments carefully selected if policies have to be effective. From the point of view of S&T and innovation this implies being able to focus on and specialise in well defined areas, both geographically and sector wise. In this way, competitive assets can be preserved and new advantages created, at the benefit of the overall competitiveness of both member countries and Europe as a whole.

Besides, Europe needs to make other policies – not only R&D and innovation ones – support the goal of being a competitive knowledge economy. Macroeconomic policies, in particular, should play a countercyclical role during depressions, when companies have problems in funding their R&D activities.

Active and efficient coordination mechanisms are also needed in order to ensure that the variety of initiatives put in place converge towards the broader policy objective of increasing the competitiveness and welfare. More stringent coordination and a better alignment between the methods of governance and the nature, objectives and level of S&T and R&D policies would enhance the likelihood of success. Coordination and a better match between policy objectives and methods of governance would magnify the commitment of the various actors involved and reduce free riding problems. Europe needs to ensure a sufficient allocation of resources, given that the allocation process is decentralized whereas knowledge is a semi-public good.

5.4.3 Concluding remarks

The many linkages intertwining globalization and the knowledge-based economy give rise to a multifaceted and complex phenomenon that, in many respects, is not fully understood. Drivers, motives, dynamics and causal relations are still somewhat unknown. Besides, the global knowledge-based economy is continuously and dynamically changing, thus making today's conclusions and policy suggestions not necessary valid tomorrow. Scientists' ability to forecast future developments is also hindered by the scarcity of data they can currently rely upon. Indeed, a more systematic and wide collection of data, on a global scale, would enable the creation and use of indicators and statistics. These, in turn, would augment our knowledge and understanding of globalization and its challenges.

The complex dynamics of the global knowledge economy call for synergic actions. Public and private R&D investments, S&T policies, regulatory frameworks, the education system, and so on are to be intended as complementary. As such, the absence of some of them impinges upon the usefulness/successfulness of the others. Knowledge-based economies that want to be innovative and competitive on the global market need firms, academia and research institutions to work together. In this way knowledge could be both optimally created and maximally exploited.

The Going Global 2006 conference identified the global socio-economic and sustainable development as the main challenges lying ahead. Globalization is not to be seen as a zero-sum game, in which the improved welfare of some is counterbalanced by the reduction of welfare in other parts of the globe or for a different group of individuals. When discussing the contribution of global science, technology and innovation, the ultimate aim should be to identify the most acute needs and problems that require a science-based solution. Examples certainly are poverty, hunger, development, health and environment protection, as well as the distribution of income and wealth. The main challenge and mission for the knowledge-based economies thus becomes to reinforce the sustainable global welfare by means of creating and exploiting knowledge and innovation.

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Going Global – The Challenges for Knowledge-based Economies (Kansainvälistyvät taloudet)

Tiivistelmä

Julkaisun tarkoituksena on kuvata kattavasti ja systemaattisesti haasteita, joita kansainvälistyminen muodostaa tieto- ja osaamispohjaisille talouksille. Julkaisu tarkastelee neljää pääkohtaa:

1) Miksi huipputeknologian yritykset kansainvälistyvät? Mitkä tekijät saavat yritykset sijoittamaan kotimaansa ulkopuolelle toimintojaan, etenkin tutkimus- ja kehitysosastojaan? Analyysissä tarkastellaan yrityksen kohdemaasta tavoittelemia kilpailuetuja ja otetaan huomioon teknistaloudellisen toiminnan uudenlainen sijoittuminen. Huomiota kiinnitetään näiden ilmiöiden aikaperspektiiviin, koti- ja kohdemaan kehitystasoon, yritysten ja toimialojen ominaispiirteisiin sekä eri toimialojen tuotteiden elinkaariin.

2) Millaisia potentiaalisia vaikutuksia erilaisten yritystoimintojen siirroilla on osaamispääomaan, innovaatiotoiminnan tuloksellisuuteen, työmarkkinoihin sekä kasvuun ja kehitykseen? Toimintojen sijoittaminen ja siirtäminen vaikuttavat tietämyksen luomiseen, hyödyntämiseen – myös teollis- ja tekijänoikeuksien käyttämiseen – omaksumiseen, levittämiseen ja ulkoisvaikutuksiin (knowledge spillovers). Nämä tekijät puolestaan vaikuttavat olennaisesti sekä yritysten että valtioiden tuottavuuteen, kilpailukykyyn sekä viime kädessä myös niiden kasvuun ja kehitykseen.

3) Missä määrin maailmantalouden nykyinen ja tuleva dynamiikka edellyttää uudenlaisia hallintotapoja? Mikäli eri politiikanalojen on lähennyttävä ja muodostettava yhteisiä, hyvinvointia lisääviä strategisia tavoitteita, tarvitaan myös uusia hallintotapoja. Tässä yhteydessä luodaan katsaus eri politiikkoihin, joita Suomen kaltaisissa avoimissa ja kansainvälistyvissä pienissä talouksissa on otettu käyttöön.

4) Kuinka kestävää kansainvälistyminen on ja kuinka globalisaation, teknologian muutoksen ja innovaatiotoiminnan yhteiskunnalliset, taloudelliset ja ekologiset hyödyt voitaisiin jakaa paremmin? Tässä yhteydessä analysoidaan globalisaation ja tietopohjaisen paradigman mahdollista vaikutusta kehittyneisiin ja kehittyviin maihin.

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Publikationens syfte är att på ett ingående och systematiskt sätt beskriva de utmaningar, som internationaliseringen medför för informationsbaserade ekonomier. I publikationen granskas följande fyra huvudpunkter:

1) Varför företagen internationaliseras, speciellt inom högteknologi? Vilka faktorer får företagen att förlägga sina funktioner, i synnerhet sina forsknings- och utvecklingsavdelningar, utanför hemlandet? Analysen av de konkurrensfördelar som företagen eftersträvar i etableringslandet tar också upp den nya fördelningen av de teknisk-ekonomiska funktionerna i världen. I analysen fästes uppmärksamhet vid dessa företeelsers tidsperspektiv, utvecklingsnivån i hem-och förläggningslandet, företagens och branschernas särdrag samt vid produktcyklerna inom de olika branscherna.

2) Vilka konsekvenser har överföringen av olika företagsfunktioner med tanke på kompetenskapitalet, innovationsresultaten, arbetsmarknaden samt tillväxt och utveckling? Förläggningen och överföringen av funktioner inverkar på hur kunskap skapas, tillämpas, – också på hur tekniska rättigheter och upphovsrätter tillämpas – , tillägnas, cirkulerar och sprids (spillovers). Dessa faktorer inverkar å sin sida i väsentlig grad på företagens och staternas produktivitet, konkurrenskraft och i sista hand även på deras tillväxt och utveckling.

3) I vilken mån förutsätter världsekonomins nuvarande och framtida dynamik nya administrativa åtgärder? Om olika politiker måste närma sig varandra och bilda gemensamma strategiska mål, som ökar välbefinnandet, behövs nya administrativa åtgärder. I detta sammanhang ges en överblick av olika former för politik, som införts i öppna och internationaliserande små ekonomier såsom Finland.

4) Hur hållbar är internationaliseringen, dvs. hur kunde den samhälleliga, ekonomiska och ekologiska nyttan med globaliseringen, den teknologiska förändringen och innovationsverksamheten fördelas bättre? I detta sammanhang analyseras hur globaliseringen och den informtionsbaserade paradigemet inverkar på både utvecklade länder och tillväxtländer.

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Globalization and the dynamics of knowledge and innovation constitute complex, intertwined, and multidimensional phenomena, and are at the root of socio-economic change.

This volume aims to shed light on the challenges that knowledge-based economies face when going global and is motivated by the belief that such phenomena are not to be feared but rather understood.

The analysis proposed encompasses the main drivers, dynamics and impacts of corporate R&D relocation, framing them within the broader socio-economic context of globalization in the digital era. The volume also investigates if and to what extent the current and prospective global trends call for new types of governance.

It concludes by discussing some sustainability aspects of going global, i.e. how to better share the social, economical and ecological benefits and responsibilities arising from globalization, technological change, and innovation.

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