Innovation, Growth and Competitiveness in the Knowledge Society

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Paper presented at:
Foro de la Innovación y Modernización en Andalucía
Málaga, 14 December 2004

This paper complements existing analyses and recommendations on achieving the Lisbon goals of growth and competitiveness in Europe. The paper emphasizes new approaches that might facilitate the realisation of the Lisbon goals and summarises research conducted at the DG JRC - IPTS FISTE[1] action in the area of information society technologies, new innovation models, ICT productivity impacts, and regional knowledge society development.

The author would like to thank Marc Bogdanowicz, Jean-Claude Burgelman, Clara Centeno, and Martin Ulbrich for useful discussions, comments and contributions. The author remains responsible for errors and omissions.

[1] Foresight for Information Society Technologies in Europe, http://fiste.jrc.es/.

Innovation, growth and competitiveness in the knowledge society

Several recent reports[2] and Commission documents[3] have reasserted the importance of the Lisbon strategy, emphasizing the role of information society technologies in creating growth and competitiveness in Europe. The objective of this paper is to highlight issues that complement existing analyses and recommendations, with a particular emphasis on new approaches that might facilitate the realisation of the Lisbon goals. The note summarises research conducted at the DG JRC - IPTS FISTE[4] action in the area of information society technologies, new innovation models, ICT productivity impacts, and regional knowledge society development.

There exists a vast body of reports and research that discusses innovation, learning, productivity, social and technical diversity, and changing consumption and production patters in the knowledge society. This paper does not attempt to review these areas. Instead, it tries to point out emerging new issues that may need more attention than they have so far received.

The paper discusses expected developments in five key areas: innovation, learning, productivity improvement, "networks of diversity," and consumption and value creation. The paper ends with a short concluding section that suggests some possible directions for future research and policy development. The paper is a working document. The policy proposals are given as starting points for discussion, and they are not intended to be final policy recommendations.

The new global innovation model

At present, ICTs are transforming the Industrial-Age logic of innovation. During the last century, globalisation of production was strongly constrained by the limited capacity for global communications. As a result, global production was organised around centralised planning and flows of raw materials, components, and subassemblies. This model created rapid growth in the global economy when jet flights, international telephony and telex networks enabled the coordination of production across regions.

Simple coordination, however, requires relatively little information and communication. The possibilities to truly integrate knowledge activities and organise global innovation processes have emerged only recently. At present, we are seeing a transformation of knowledge-intensive production into a mode where ICTs have a crucial role. Production and knowledge-creation processes are being modularised, reorganised, and recombined using information networks. We are moving towards a new mode of globalisation, and the dynamics of this world are different from the traditional Industrial-Age world, where material flows were the basis of globalisation.

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[2] "Facing the Challenge: The Lisbon strategy for growth and employment", report from the High Level Group Chaired by Wim Kok, November 2004; "Rethinking the ICT-agenda", PriceWaterhouseCoopers, August 2004; European Information Technology Observatory 2004.

[3] "Report from the Commission to the Spring European Council. Delivering Lisbon. Reforms for the Enlarged Union", COM(2004) 29 final/2; "Challenges for the European Information Society beyond 2005", COM(2004) 757 Final.

[4] Foresight for Information Society Technologies in Europe, http://fiste.jrc.es/.

The new challenges for policymaking include the development of new approaches that set the EU in the centre of the new global and networked innovation economy. Whereas policy has traditionally concentrated on regional development as it was seen from a national and geographic perspective, the new global innovation model requires a global approach. In the emerging network economy, competitiveness is becoming simultaneously location-independent and strongly dependent on local capabilities. Any region can become a hot-spot in the global economy. In the networked global world, remote regions are as close to the centre of the world as are the centres of the Industrial Age. At the same time, only the most competitive regions will gain a focal position. The core nodes in the networks will be the new growth centres.[5]

The global knowledge networks are supported by ICTs, but the underlying networks are social networks.[6] These social networks have been driving growth in many of the fastest growing regions around the world in the last decade. They have been particularly visible in Ireland, Taiwan, India, and Israel, where emigration has created the conditions for fast growth in the ICT industries.

Global networks require new policy approaches that cannot be created simply by scaling up the traditional regional and country-specific policies. Growth and competitiveness in the knowledge society requires that Europe is able to position itself in the high-value adding nodes in the global production networks. In particular, this means that EU has to become a leading global region in its capacity to utilize knowledge that already exists in other regions of the world. Only a small fraction of the knowledge that is created in the global innovation system is generated in Europe, the relative importance of knowledge absorption capacity is increasing, and efficient knowledge absorption processes are becoming a competitive advantage.[7] Innovation policies, therefore, need to facilitate knowledge sharing and utilisation also beyond the EU regional boundaries.

Transformation of learning

Informal and practice-related skill development has become an important form of creating strategic competences and competitiveness at the firm level. Whereas the Industrial-Age learning model was to a large extent aimed at generating and transferring skills for predetermined needs, knowledge-intensive industries require continuous learning. New learning models are emerging that focus on social learning and problem-centric knowledge creation.[8] ICTs have an important role in supporting these new social learning models. For example, the "communities of practice" learning model is increasingly being deployed in skill and competence development at the firm and regional levels. This networked learning model has a great potential in

[5] The regional dimensions of economic nodes vary, but they are often related to cities, cf. Hall, P.: *Cities in Civilization*, Trafalgar Square, 1998; Florida, R.: *Cities and the Creative Class*, Routledge, 2005.
[6] Tuomi, I.: *Networks of Innovation*, Oxford University Press, 2002.
[7] The importance of absorptive capabilities in innovation was emphasized by Cohen and Levinthal (1990), in their now classic article, "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35, No. 1; pp. 128-152.
[8] Tuomi, I. (2001) "The new landscape of learning". Guest editorial, Lifelong Learning in Europe, VI(3). Van Bavel, R., Punie, Y., Burgelman, J.-C., Tuomi, I. and Clements, B. (2004) "ICTs and social capital in the knowledge society", Technical Report Series, EUR 21064 EN. Seville, Spain: IPTS;

strengthening the European knowledge base by facilitating location-independent learning and continuous competence development across regional boundaries.

From the policy point of view, informal and continuous learning often remains invisible, as human capital development is conventionally understood to occur in formal educational contexts. In the networked knowledge society, an increasing share of competence and knowledge creation occurs outside formal systems of education. Management of these informal processes of competence and knowledge creation is becoming a source of strategic competitive advantage at the firm level.[9] Informal social learning also underlies the development of regional competitiveness and global knowledge networks. Indicators that focus on conventional knowledge and competence measures, such as educational attainment and research and development inputs, often miss knowledge assets that are created in social and informal learning processes. As these are becoming increasing important for the European competitiveness and growth, there is a need to both facilitate and legitimise informal learning and to make it visible as a key source of growth. This points to a need to integrate innovation, learning, industrial, and economic policies.

It also important to note that in the last decades economic growth was strongly dependent on the rapidly increasing share of well-educated workers in the labour force. Also job creation has increasingly concentrated on jobs with tertiary levels of education. As the employment levels of tertiary-educated population in the EU countries already are high and relatively uniform across the EU, the opportunities for increasing aggregate employment levels are limited unless major skill upgrading occurs in the less educated adult population. Without such upgrading, the rapidly shrinking demographic share of young and well-educated workers will lead to a decline in growth in many EU countries.[10] ICTs that support informal "learning-on-demand" will therefore have a potentially very important impact on future growth and employment levels.[11]

The new productivity paradigm

Several recent reports have noted that productivity growth has slowed down in Europe since the mid-1990s, that the productivity gap with the U.S. is growing, and that ICT investments have been an important underlying reason for the widening gap. Sometimes this has led to a suggestion that to close the productivity gap, Europe should invest more in ICTs and remove labour market rigidities. Such

[9] Tuomi, I. (1999) *Corporate Knowledge: Theory and Practice of Intelligent Organizations*. Helsinki: Metaxis.

[10] See Coomans, G. (2004) "The Demography / Growth squeeze in a Knowledge -based economy: the role of Education", Sevilla;, Spain, IPTS (forthcoming): http://fiste.jrc.es/download/Demography - Growth Squeeze - Coomans 2004 Final Draft.pdf.

[11] One should also note that high-impact policy initiatives need not only focus on traditional work-related skills. For example, one of the main drivers in the very rapid growth in the use of the Internet in South Korea has been its "Ten Million People Internet Education" project, which focused especially on housewives. In year 2000, one million housewives learned the basic Internet skills. This has been important partly because housewives often control the financial decisions within the family, but also, for example, because access to the broadband Internet has made continuous knowledge sharing and learning possible among housewives. The rapid diffusion of Internet in Korea has to an important extent resulted from a promotion policy that has successfully focused on this key decision-maker group. After the Internet becomes available, it, of course, can also be used by other household members for basic education and learning job-related skills.

recommendations probably only partially address the underlying challenges. As accurate understanding of the sources of productivity differences is central to policies that aim at growth and competitiveness, it is necessary to clarify some of the temporary and historical sources of productivity differences between the EU and the U.S. and to pinpoint areas where policies actually can make a strategic difference.

Since the beginning of the last century, the U.S. has had better labour productivity levels than Europe. The main reasons are historical. In particular, the land use rights in the U.S. have facilitated the development of highly productive agricultural, transport, and retail sectors. The historical lack of human labour in the U.S. put it on a mechanised and capital-intensive development path, where labour productivity is high. The large home market and linguistic homogeneity has led to efficient retail and consumer product sectors.[12]

Although the absolute level of labour productivity, measured as value added per work hour, remains lower in the EU than in the U.S., the gap has been closing rapidly since the 1950s. In the second half of the 1990s, the gap, however, started to grow again. Several studies claimed that an important reason was the inefficient way Europe is using ICTs, and proposed that to close the gap EU should increase its ICT investments.

Growth accounting studies that are used to establish the growth and productivity impact of ICTs have shown that ICTs have three potential ways to impact labour productivity. First, when ICT investments increase the share of capital in the production processes, they lead to a relatively lower share of labour. This "capital deepening" leads to higher measured labour productivity, other things being equal. The second route to productivity increase is through higher productivity in the ICT industry itself. When ICT industry becomes able to produce more output without increasing its inputs, its labour productivity increases. The third route is through a general increase in efficiency. When ICTs improve the general level of knowledge and lower the costs of doing business, labour productivity increases.[13]

Studies have shown that the sources of productivity increase have varied across countries, some EU countries having faster productivity growth than the U.S. also in the second half of the 1990s. In aggregate, the level of EU productivity has been lower than in the U.S. mainly because of lower productivity levels in Portugal, Spain, Italy, and Greece, where agriculture has a large share of total output. In the U.S., the most important factors underlying output growth have been the increase in labour

[12] Gordon, R.J. (2002) "Two centuries of economic growth: Europe chasing the American frontier", http://faculty-web.at.northwestern.edu/economics/gordon/355.pdf and Gordon, R.J. (2004) "Why Europe was left at the station when America's productivity locomotive departed" http://www.nber.org/papers/w10661.pdf.

[13] To avoid confusion, one should note, however, that macroeconomic labour productivity is not in any known way directly related to our common sense concept of work efficiency. Labour productivity is a number that shows how much output is generated per unit of labour input. There are many ways in which this number can change, and the economic concept of labour productivity is agnostic concerning the reasons why this number changes and to what extent the changes are related to work performance. It is useful to remember this, as labour productivity is often wrongly associated with worker performance. The same task efficiency can, for example, lead to different labour productivities when demand, prices, regulation, management methods, outsourcing patterns, capacity utilization, or competition change.

quality, as better educated workers have entered the labour force, followed by productivity growth in ICT manufacturing industries and in particular semiconductor production. In the second half of the 1990s, productivity also increased rapidly in the financial, retail, and wholesale sectors.[14]

The rapid productivity growth in the ICT producing sector in the U.S. results from a combination of factors. The main factor is the rapid decline of semiconductor prices in the second half of the 1990s. The reasons for this decline include technical advances in semiconductor scaling, increased competition resulting from the Asian currency crisis in 1997, internationalization of production networks, and scale effects from the Internet boom and Y2K investments. The productivity gap between the U.S. and the E.U., however, has also increased to an important extent because the decline in semiconductor prices is in practice interpreted as real output growth in productivity studies. This growth effect propagates from the semiconductor industry to the rest of the ICT manufacturing and also to some ICT using sectors of the economy. There exists an ongoing debate about the possibility that growth accounting studies have exaggerated the productivity growth differences between the U.S. and the E.U. because of this reason.[15]

Although value added is difficult to measure in services, the productivity increase in the U.S. financial sector probably results from the increasing efficiency in using organisational ICTs, the rapid growth of Internet-based banking and stock trading in the second half of the 1990s, and, for example, the increasing market share of the U.S. financial centres in the global economy. The value added probably also grew because of active merger and acquisition market and initial public offerings related to the Internet bubble. Some of the associated productivity growth differences between the EU and the U.S. have been temporary, but it is also to be expected that there will be structural changes in the financial sector in the next years in many EU member states. This process will lead to productivity improvements in the EU.[16]

The productivity increase in the U.S. retail sector was in the 1990s strongly concentrated in "big-box" retailers, such as Wal-Mart and Home Depot. The U.S. land use policies have facilitated the creation of very large-scale retail operations, where

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[14] The U.S. labour productivity growth has been faster than in the EU also in the first years of the current decade. Much of this growth has been driven by decreases in employment and the exit of non-productive start-up firms, resulting from the economic downturn. An important factor has also been the large expansion of government expenses related to security expenditure and the wars in Afghanistan and Iraq. This expansion has to an important extent been financed by public deficit, which makes accurate comparisons of EU and U.S. real growth difficult.

[15] For example, computer asset estimates used in productivity studies in the U.S. put their value to about six times their market value in year 2001. Moreover, as the average age of U.S. computer assets is less than two years, the growth rate that is used to weigh the assets in growth accounting calculations was extremely fast in the second half of the 1990s. Although the market value of U.S. computer assets have grown only little during the 1990s, the extremely rapid growth of asset estimates that are used in productivity studies have considerably amplified the measured impact of ICTs in the U.S. economy. See, Tuomi (2004) "Realising the Productivity Potential of ICTs", IPTS Report, Issue 85.

[16] In the financial sector labour productivity grew rapidly in the Nordic countries in the 1990s, as banks used ICTs to distribute their operations and reduce their labour force. A similar consolidation of the banking industry will probably accelerate across Europe due to the very rapid increase in broadband access, which has been strongly correlated with on-line banking. So far, however, productivity growth in the EU financial sector has been limited by regulatory obstacles, cf. http://europe.eu.int/comm/internal_market/speeches/2004/2004-11-12-schaub_en.htm.

ICTs can be used efficiently. Small retailers have shown little productivity improvement, however. It is probable that the EU cannot emulate the U.S. route to productivity in the retail sector, for example, because of different land use policies, traffic patterns, and historical urban structures. The EU, however, may have greater productivity improvement possibilities in retail and wholesale sectors as the costs of logistics decreases rapidly when technologies such as RFID and mobile Internet are fully taken into use, and as logistic costs now represent a higher share of the overall costs in the EU.[17]

The EU-US productivity gap, therefore, has both temporary and historical sources. The gap is probably also related to problems in measuring ICT productivity impacts. From the policy point of view, it is therefore useful to more explicitly consider those potential policy intervention areas that have a direct link to growth and competitiveness in the EU.

An important opportunity for closing the productivity gap with the U.S. is in the potentially rapidly growing productivity in the new member states. If existing knowledge can be effectively transferred to and utilised in the new member states, and if they can be linked to European and global production and knowledge networks, the growth rates in the new member states can lead to a very rapid growth in the EU. Although the per capita measures of economic output decrease as a result of the enlargement, it is possible that in an innovation based economy the absolute levels are less important for economic development than the growth rates. This can be seen, for example, in the very rapid increase of knowledge-intensive production in China, India, and the Republic of Korea. For example, the growth of the software sector in India has shown that the effective use of ICT networks has already become an important factor that often reduces the traditional requirements for foreign direct investment.[18] A similar low-capital intensive growth path is becoming available also in the EU if ICTs are effectively used.[19]

It is now generally accepted that ICT investments lead to productivity increase only under specific conditions. The productive deployment of ICTs requires systemic change where hardware and software investments are complemented by competence development, change management, work process development, information and knowledge content management, and new management approaches. As conventional productivity concepts are defined as the improvement of efficiency of existing economic activities, productivity studies often have difficulties in measuring or

[17] RFID (radio frequency identification) tags allow tracking of individual goods, and mobile Internet based on, for example, mobile phones with Internet access, enables real-time scheduling and routing of deliveries.

[18] Low labour costs, of course, have also played a role in India, Korea, and China. In the high-value adding sectors, labour cost differences, however, are not very big between the new member states and, for example, Korea. The labour cost usually plays only a modest role in investment and production location decisions. Investment, research and tax policies, and the social and policy environment also have an important impact.

[19] "Low capital" means here low physical capital combined with high human capital. In practice, this path would imply that investments focus on those areas that lead to accelerated development of the knowledge and innovation-based economy. In particular, high-impact investment policies should avoid investing in structures that were important in the Industrial Age but which are becoming redundant. Instead, policy could have an important role in facilitating change and in sharing risks associated with innovation and change. As historical interests and past successes always tend to dominate in decision-making, innovation-oriented policies should also specifically aim at balancing old and new interests.

analysing impacts of such systemic innovations. Growth in the knowledge economy, however, is to an important extent generated by a continuous stream of such systemic and societally transforming innovations. From the policy point of view, it is important to note that the constraints of growth, however, rarely are purely technical.[20] For example, studies have shown that a critical factor in the take-up of electronic banking and eCommerce services is trust in social institutions and information security.[21]

Therefore, although structural labour market rigidities have been suggested to be a major hindrance for the effective use of ICTs in Europe, in general, this probably is a second order problem.[22] On the contrary, labour market "rigidities" that facilitate organisational change, accelerate competence development, and lower the risks of innovation and social change are probably core competitive factors in the knowledge society. From the policy point of view, the relevant question is not about removing "structural rigidities," as such. Instead, the policy issue is about which institutional and social arrangements actually improve regional innovation capability.[23]

It is also useful to note that, from a strictly economic point of view, EU cannot achieve the US productivity levels simply by increasing its ICT investments. As the value added in the global ICT industry accrues to a large extent to U.S. firms, ICT investments in the EU will lead to an even larger growth in the US economy.[24] The productivity gap will therefore increase. To avoid this situation, EU should make investments in the complementary assets that are needed to make ICTs productive.

A fundamental policy challenge is that conventional definitions of economic growth and productivity are becoming too narrow in the knowledge society, and a new broader conceptual framework is needed to address economic development and growth.[25] In particular, to align the concepts of productivity and growth with the requirements of the knowledge economy, the role that ICTs have in expanding the

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[20] In fact, some recent studies show that managerial innovation is a particularly important source of competitive advantage and growth at the firm level, e.g., Hamel, G. & L. Välikangas (2003) "The quest for resilience", Harvard Business Review, September 2003.

[21] Centeno, C. (2004), "Adoption of Internet services in the Acceeding and Candidate Countries: Lesson from the Internet banking case", Telematics & Informatics, Vol 21(4), pp. 293-315.

[22] In fact, labour market rigidities seem to have very little explanatory force. See, van Ark, Frankema & Duteweerd (2004) "Productivity and employment growth: an empirical review of long and medium run evidence." Research Memorandum GD-71, Groningen Growth and Development Centre. http://www.ub.rug.nl/eldoc/ggdc/200471/200471.pdf.

[23] For example, the rapid automatisation of Japanese manufacturing industries has frequently been explained by the fact that Japan used to have "life-time" employment contracts. As innovation implies change and risk, policies that manage risks are potentially important in the innovation-based knowledge economy. From the social point of view, structures and policies for societal risk sharing are becoming more important than the traditional structures for income sharing, for example.

[24] It is difficult to accurately estimate how much of the global ICT value added is generated in the U.S. In 2003, the U.S. firms generated 48.3 percent of global semiconductor sales, and Japan accounted for 27.4 percent, according to Semiconductor Industry Association statistics. Over half of the semiconductors sold in the EU come from the U.S. In packaged software and operating systems the U.S. has an even higher market share.

[25] Tuomi, I. (2004) "Economic productivity in the Knowledge Society: A critical review of productivity theory and the impacts of ICT", First Monday 9(7) http://www.firstmonday.org/issues/issue9_7/tuomi/index.html. Elements of this new productivity paradigm could be based, for example, on the capability-based theory of economics, developed by the Nobel laureate Amartya Sen, cf.: Tuomi, I. (2004) "Knowledge society and the new productivity paradigm: ftp://ftp.cordis.lu/pub/ist/docs/productivity-paradigm.pdf

space of economic and socially meaningful activities is becoming increasingly important. Growth and development in the knowledge economy is fundamentally based on the continuous creation of new forms of valuable social and economic activity. The distinction between producers and consumers is blurring. Traditional aggregate indicators of growth are becoming increasingly difficult to interpret, as the economic and value creation processes become increasingly networked.

At the same time, important new growth opportunities are emerging. They, however, become clearly visible only if we understand growth and productivity from a broader perspective, where the focus is on socio-economic development. For example, eHealth applications that improve the quality of life and technologies that support learning and cognitive processes of aging people are emerging as important areas of growth both globally and in Europe. As quality of life is rarely measured in productivity studies and registered in growth accounts, the real impact of these applications will probably be underestimated by the conventional approaches.

Networks of Diversity as Strategic Advantage

The global information society developments highlight the increase of technical, economical, and cultural diversity of global networks. At the *technical level*, the emerging network architectures are heterogeneous and dynamically interconnected, and deep interoperability is becoming an important requirement.[26] At the *economic level*, traditional business models are being transformed into value creation networks, where complementary business logics interact and dynamic collaboration relationships dominate. At the *social level*, global networks integrate actors across cultural and linguistic boundaries, and connect actors that operate in different and sometimes incompatible systems of value and meaning.

This expanding field of socio-technical diversity changes some key factors of competition that have determined traditional business logics. In the industrial society, production was often optimized for mass production. Mass production presumed that product users form relatively stable and well-defined user groups. In this setting, scale effects were important for competitiveness.

This logic underlies the idea that the size of home markets is important for business success. When companies have a sufficiently large local home market, they can enter a product niche in a simplified competitive environment. In such home markets, managerial complexity is reduced, the competitive environment is relatively well known and predictable, and specific regional, institutional, and cultural knowledge limits competition, and can be used for competitive advantage.

The success of Japanese consumer electronics and car manufacturers and, for instance, Korean mobile phone and broadband equipment manufacturers are often given as examples of this competitive approach. The roots of the economic successes of many American multinational manufacturing and service companies can also often be found in the large unified markets in the U.S.

[26] "Deep interoperability" refers here to interoperability that goes beyond conventional interoperability that is based on standardised technical interfaces. It enables the creation of new technical functionality as modules that can be combined with existing systems.

The traditional advantages of large home markets, however, are rapidly diminishing in the networked reality of today. Information and communication technologies create networks of production and consumption where global competitive forces are felt across regional boundaries. In this new setting, product concepts cannot easily be developed according to the preferences of local customers. Instead, product concepts often have to be global and customizable for specific markets and market segments. Although the size of home market may still be important for some product groups, in general, home markets are too small and provide too little protection before products enter global networks of competition.

At the same time, new possibilities emerge for creating regional advantages. In particular, regions with sufficient cultural and institutional variety potentially become the new models of "diversified home markets" for the global economy. Global products, in the modern world, require development in "home markets" that have institutional and cultural complexity that approximates the global market itself. This could be seen as a major opportunity in the European context. If Europe is able to make this transition to the new global logic of production and innovation, its inherent diversity cannot easily be imitated in regions or countries where diversity does not exist to the same extent.[27]

At the social level, diversity is important both for economic supply and demand. Economic competition is increasingly driven by innovation, and innovation capability is known to depend on cultural diversity and effective combination and synthesis of alternative worldviews and interpretations. "Home markets" that have diversity have potentially large social capabilities for innovation. On the demand side, in turn, products that are developed for culturally diverse users have the inherent capability to become global products.

From a technical point of view, networks in the knowledge society consist of heterogeneous technical infrastructures, including multiple wired and wireless networks and application platforms. Networks of diversity need to adapt to such heterogeneous technical environments, and the underlying technical heterogeneity needs to be hidden from the users.

Technologies, product development methods, and knowledge that supports the creation of services and products for such technically, economically, and socially diversified networks, will provide important growth opportunities in the future.

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[27] This logic could lead, for example, to the argument that we are about to see the next major wave in the techno-economic paradigms when "technologies of diversity and translation" become key technologies for economic and innovation processes. As for example Carlota Perez has pointed out, the diffusion and improvement of a new key technology becomes a key driver in the economic transformation, which, however, is constrained by institutional, organisational, and other social changes. Perez (*Technical Revolutions and Financial Capital*, Edward Elgar, 2002) has extended her earlier argument by highlighting the role of global financial flows. Financial flows, however, are unique as they require very little translation from one cultural or value system to another. Value creation, however, occurs fundamentally only through social interaction, and one could therefore argue that ICTs have their main economic role in facilitating social interaction. Financial flows have a similar facilitating role. The actual value creation in the global knowledge economy, however, is strongly constrained by "technologies of diversity and translation," which emerge as the key technologies as the basic information and communication infrastructure is in place.

The management of technical diversity in modern networked environments requires, however, a broad concept of interoperability. In information society technologies, new products are introduced as elements of larger existing networks of interoperating systems. When new products are innovative—in other words, when they enable new functionality and activity that was not possible before—they often require both modification and reconfiguration of existing systems and introduction of new system elements. Standardized technical interfaces do not normally support such dynamic evolution of technical systems, and therefore, in practice, standardization often becomes a barrier for innovation. This can be seen, for example, in open source software development, which has shown that "deep interoperability" and technical transparency are often needed for rapid and efficient development and customization of technical systems.[28]

The modifiability and reconfigurability of technical infrastructures greatly influences the efficiency and social capabilities of innovation. When the underlying technologies can be easily reconfigured, new innovations can be easily developed and tested. In the knowledge society, many innovations rely on underlying information and communication systems, and innovations are often implemented using software. When technological architectures support diversity, societally and economically important innovations can be easily developed. From a policy point of view, this means that special attention should be given to the development of technologies that support continuous innovation in heterogeneous socio-technical settings.

Changing consumption patterns and the new sources of value

The knowledge economy transforms in important ways both the sources of value and the patterns of consumption. Products are becoming increasingly "informationalised." Businesses now use ICTs to develop products that combine services with mass-customized products. The "value proposition" that is offered to the customers is increasingly based on bundles that consist of material products, product upgrades and life-time service. The material basis of products is becoming a decreasing fraction in the value added, and often the actual material production is outsourced to firms that specialize in manufacturing services. The informational component of product and service bundles is becoming a key source of growth.

At the same time, consumption patterns are changing. During the last decade, a growing fraction of consumption has focused on immaterial values related to social differentiation, experiences, and social and personal meaning of consumption.[29] For example, product branding has become a key source of value added in many industries. Advanced product strategies take this communicative and information-based value creation approach even further, for example, by bundling products with communication systems that support user communities and product diffusion. We are moving towards an economy where the perceived value and the generated growth are strongly related to the meaning of products and services, and less directly related to pure functionality or immediate use value.

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[28] Tuomi, I. (2004) "The Future of Open Source," in Wynants & Cornelis (eds.) Building Our Digital Future (in print).

[29] This phenomenon has been called the "experience economy," see, for example, Pine and Gillmore (1999): *The Experience Economy: Work is Theatre and Every Business a Stage*, Harvard Business School Press.

One implication of this change is that the value added will increasingly depend on design, broadly understood. In general, to generate economic growth, technical and scientific knowledge needs to be combined with product creation processes that make new technical opportunities meaningful for their industrial and individual users. The efficient combination of technical knowledge with new product design approaches will be an important source of competitiveness in the knowledge economy. In the knowledge economy, value will be created by combining advanced technical knowledge with deep knowledge about those social factors that facilitate and constrain the adoption of new technologies. To convert this knowledge into economic growth, it also has to be integrated with new innovation models that fully embrace the global transformation of production and knowledge creation processes and which enable continuous organisational change.

Another important phenomenon is the extremely rapid rise of self-created content. Media industries are today viewing a revolution, on line. In December 2004, there were about 5 million active web logs (also known as blogs) on the Internet, and about 12,000 new blogs were launched every day. Blog writers created about 275,000 new entries a day, or about 10,800 updates every hour. The informal content creation that occurs in the blogs, where people write and share their thoughts, images, and other content, is now an important driver for Internet traffic and broadband diffusion all around the world.

Blogs are becoming centres for social communities. In the political sphere, they have already had important consequences for presidential elections in countries such as South Korea and the U.S.A. Blogs, however, are also changing the economics of media and content industries. They organise communities around specific consumption patterns, where shared interests, world-views and values are key drivers for consumption. This is rapidly leading to highly diversified and informationalised consumption patterns. Content industries were earlier strongly constrained by marketing costs. This lead to product profitability patterns where "best-sellers" created all the industry profits and where "block-busters" actually kept content industries alive. New electronic access and distribution models have a very different profitability pattern. For example, the U.S. bookstore Barnes & Noble typically carries about 130,000 book titles. These "top-130,000" books represent less than half of the sales of the electronic bookseller amazon.com. In other words, the market for books that are never sold in typical bookstores is larger that the traditional book market. Similarly, over half of the songs that the electronic music service Rhapsody sends over the Internet are below its "top-10,000" list. The extremely diversified "long tail" of content is the main part of the present electronic content industries, but it was impossible to realize without Internet-based distribution channels.[30] Instead of "super-hits," the content industry is now finding its main growth opportunities in "micro-hits" that address specific communities of consumers.

From a policy point of view, this will imply that the social and cultural dimensions of consumption and value creation need to be explicitly taken into account in the development of economic growth policies. Value creation in the knowledge society is

[30] Anderson, C. (2004) "The long tail," Wired 12.10. October 2004 http://www.wired.com/wired/archive/12.10/tail.html.

tightly linked with social and cultural practices. If this basis for value creation and economic growth is not explicitly made visible, there is a risk that policies miss important growth opportunities. In practice, this points to a need for joined policymaking where knowledge is integrated across research, learning, enterprise, and information society sectors.

Conclusion

The topics presented above point to major emerging areas where new sources of growth could be found in the future knowledge society. They obviously deserve more elaboration and detailed discussion. Here the goal simply has been to give entry points for such future discussions. Instead of expanding on these themes, we simply compress some of the main messages of this working paper into the following bullet points:

- Innovation and knowledge networks are global, and regions can be competitive only if they position themselves into the core nodes of these global networks; policy-makers need to develop strategies that put regional initiatives explicitly in a global context.
- Industrial and regional competitiveness increasingly depends on informal social learning processes that can effectively be supported by information and communication technologies; policy-makers need to make these informal learning processes a key element in innovation and human capital development policies.
- Productivity growth needs to be understood in a new broader productivity framework, where socio-economic development is the main policy objective; policy-makers should pay special attention to complementary investments that are needed to make ICTs productive, focus on realising the productivity opportunities generated in the ongoing socio-economic transformation, and invest in structures that facilitate institutional learning and change.
- The structure of European markets can provide a difficult to imitate strategic competitive advantage for firms that embrace technical, economic, and social diversity, and which move early on the emerging opportunity to use the European home markets for the creation of global products; policy-makers could complement market integration policies with "next-generation" policies that will explicitly address the European networks of diversity at social, economic, and technical levels.
- Economic growth and value added are increasingly based on non-material, informational, and meaning-based elements of product and service bundles; growth and innovation policies need to explicitly address the new sources of value production in the economy, and integrate social and cultural knowledge with industrial, research, and information society policies.

Research on the development of regional knowledge economies shows that a small number of key factors underlie rapid economic growth.[31] An important

[31] Bogdanowicz, M. et al. (2003) Identifying factors of success and failure in European IST –related national/regional developments", EUR 20825 EN, Seville, IPTS; and Bogdanowicz, M., J-C. Burgelman, C. Centeno, E. Gourova and G. Carat (2003) "Factors of regional/national success in Information Society developments: Information Society strategies for candidate countries", First

success factor has been the mobilisation of public and private actors around a shared vision of the future. This has often resulted from a society-wide crisis combined with a broadly perceived emerging opportunity that together have "unfrozen" institutional structures and led to an acute sense of a need to act. Ireland, Finland, and the Dresden region are prominent examples of this pattern within the EU.

In contrast, regions that do not face crisis often face the "boiling frog" problem.[32] They start to act when it is too late. They often turn their visions to past successes, historic strengths, and approaches that were appropriate for the yesterday's world. Shifts to new socio-economic models are fundamental crises in the society and the economy. Such crises provide major opportunities for social and economic development, but only for those who have the courage to face the crisis and turn it into an opportunity.

Monday, volume 8, number 10 (October 2003), http://firstmonday.org/issues/issue8_10/bogdanowicz/index.html.

[32] Frogs that are dropped in kettle that has hot water, jump out. Frogs that are put in a kettle when the water is cool allow the water to be heated slowly, staying in the kettle until it boils.