INNOVATION AND GROWTH

RATIONALE FOR AN INNOVATION STRATEGY

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Preface

Undoubtedly the capability to innovate and to bring innovation successfully to market will be a crucial determinant of the global competitiveness of nations over the coming decade. There is growing awareness among policymakers that innovative activity is the main driver of economic progress and well-being as well as a potential factor in meeting global challenges in domains such as the environment and health. Not only has innovation moved to centre-stage in economic policy making, but there is a realisation that a co-ordinated, coherent, "whole-of-government" approach is required. Many OECD member countries have adopted national strategic road-maps to foster innovation and enhance its economic impact. Even countries that have generally refrained from active industrial policy in recent years now seek new ways to improve the environment for innovation in order to boost productivity and growth. The United States, for example, came forward with the "Innovate America" strategy in 2005. The EU's "Lisbon Agenda", initiated in 2000, has now been updated and strengthened.

In addition to the rapid advances in scientific discovery and in general-purpose technologies such as ICTs and biotechnology, the accelerating pace of innovation is being driven by globalisation. These pervasive trends were picked up at the summit of the G8 at Heiligendamm in June 2007 which identified research and innovation as areas requiring high-level policy dialogue between the G8 members and major emerging economies.

A shorter version of this document was submitted to the meeting of the OECD Council at Ministerial level "Innovation, Growth and Equity" held in Paris in May 2007. It provided supporting evidence, based on the findings and recommendations emerging from recent OECD work, to underpin the Ministerial discussions on how policies should be updated to address the changing relationships between innovation and national progress. At that meeting, Ministers asked the OECD to develop a broad-ranging *Innovation Strategy* to build on existing work, address remaining knowledge gaps, and above all provide a cross-disciplinary mutually-reinforcing package of policy elements and recommendations to boost innovation performance.

Executive Summary

The challenge

Today, innovation performance is a crucial determinant of competitiveness and national progress. Moreover, innovation is important to help address global challenges, such as climate change and sustainable development. But despite the importance of innovation, many OECD countries face difficulties in strengthening performance in this area. Indeed, many OECD countries have seen little improvement in productivity performance in recent years despite the new opportunities offered by globalisation and new technologies, especially the information and communication technologies (ICT).

A reform agenda

Government policies can support innovation by continually reforming and updating the regulatory and institutional framework within which innovative activity takes place. In this context, reforms are needed to make public policy and regulatory framework more conducive to innovation in a range of policy areas from the general business environment — especially in the services, particularly in the network industries — to international trade and international investment, financial markets, labour markets, and education.

Governments can also play a more direct role in fostering innovation. Public investment in science and basic research can play an important role in developing ICT and other general-purpose technologies and, hence, in enabling further innovation. This highlights the importance of reforming the management and funding of public investment in science and research, as well as public support to innovative activity in the private sector. The latter calls for an appropriate mix of direct and indirect instruments such as tax credits, direct support and well-designed public-private partnerships, support for innovative clusters and rigorous evaluation of such public support.

In view of the changing environment for innovation, it is also important to consider whether the current system of IPR rules and practices continues to stimulate innovation while allowing access to knowledge. In certain cases the abuse of the control with which IPR owners are endowed could hamper competition, fair use and the diffusion of technology. However, regardless of issues related to the flexibility of the IPR system, stronger efforts are needed to combat counterfeiting and piracy, which are serious and growing problems.

The need for political leadership and resolve

Implementing reforms to foster innovation may prove difficult. Strong political leadership and efforts to develop a clear understanding by the various stakeholders of the problems and the solutions — including the costs they involve — can all help to communicate the need for reform and facilitate acceptance.

INNOVATION AND GROWTH

Policy issues and challenges

The role of innovation for growth is strengthened by advances in new technologies, and a greater focus on knowledge creation and use ...

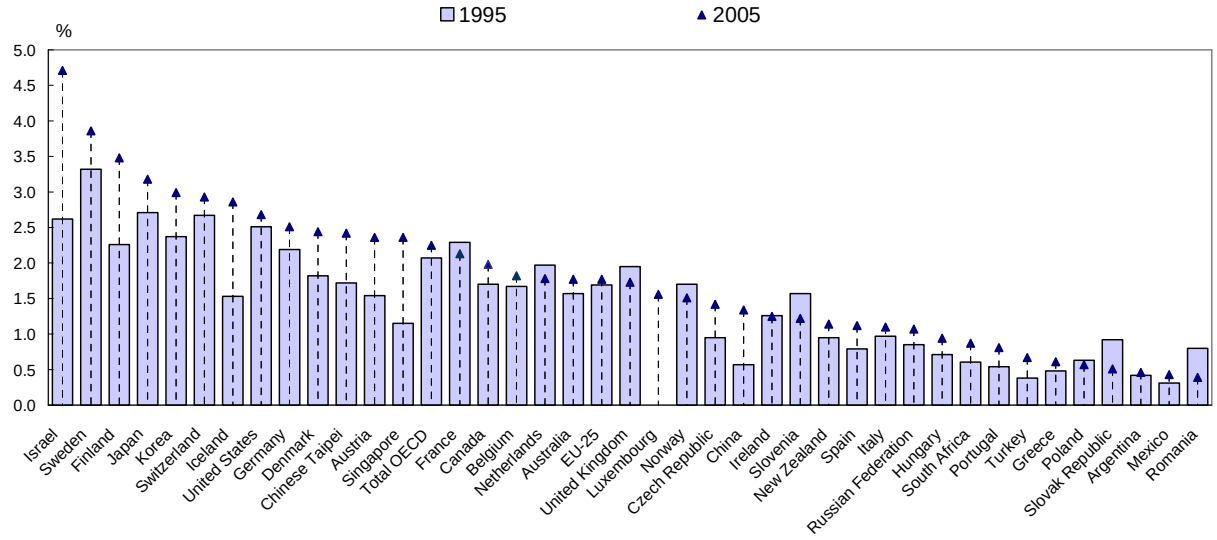
Much of the rise in living standards is due to innovation — this has been the case since the Industrial Revolution. Today, innovative performance is a crucial factor in determining competitiveness and national progress. Moreover, innovation is important to help address global challenges, such as climate change and sustainable development.

But it is the application of advances in technology, in conjunction with entrepreneurship and innovative approaches to the creation and delivery of goods and services, which translates scientific and technological advances into more productive economic activity. This results in economic growth if market structures and the regulatory environment enable the more productive activities to expand. This said, the innovative effort itself, including formal research and development, remains the *sine qua non* of growth.

Evidence suggests that innovative effort is on the rise as a share of economic activity. Investment in knowledge has grown more rapidly than investment in machinery and equipment since the mid-1990s in most OECD countries, and has surpassed the latter in a few countries such as Finland and the United States (OECD, 2005c). R&D intensity of the economy has risen significantly in a number of — smaller — OECD countries, but remains more or less unchanged in the OECD area as a whole since 1995, and important cross-country differentials remain (Figure 1).

But intellectual assets taken as a whole — a concept seeking to aggregate measures of human capital, R&D and capacity to conduct it, patent valuations as well as intangible assets such as brand value or firm-specific knowledge — are rapidly becoming the key to value creation through a number of channels. Improvements in the skill composition of labour play an important role in productivity growth. Studies suggest that investment in R&D is associated with high rates of return. And investments in software have also contributed significantly to business performance and economic growth, accounting for as much as one-third of the contribution of ICT (information and communications technology) capital to GDP growth since 1995 in Denmark, France, the Netherlands, Sweden and the United States (OECD, 2007a).

Figure 1. Growth in R&D intensity (GERD[1] as % of GDP), 1995-2005



1. GERD: Gross Expenditure on Research and Development

Source: OECD: Main Science and Technology Indicators database, December 2006.
2005 data for some countries are the latest available.

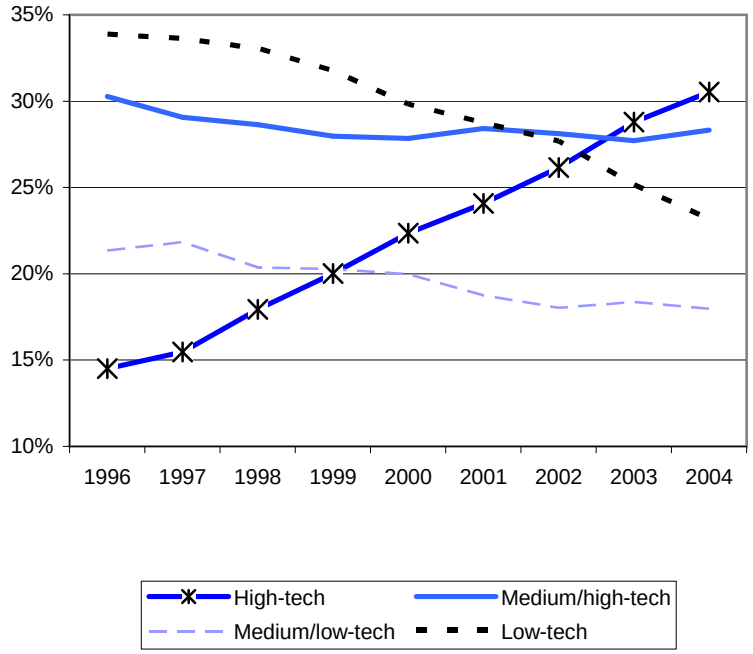
…as well as globalisation and the intensifying economic challenge from non-OECD countries.

More recently, the importance of innovation has been reinforced both by globalisation and by rapid advances in new technologies, notably ICTs, which have enabled new forms of competition and opened new markets for the creation and delivery of innovative products and services. Globalisation has also increased the pressure on OECD countries to move up the value chain and engage in a continuous process of adjustment and innovation.

There has been a significant increase in R&D effort in a number of economies outside the OECD area (Figure 1), and, albeit starting from a low base, the associated growth of R&D capabilities in a number of major emerging market economies is making them competitive destinations for cross-border R&D. At least China among them is now a key global player in R&D in terms of absolute size as well as growth rates, with Gross Expenditure in R&D reaching USD115 billion in 2005 (at PPPs), compared to USD227 billion in the EU (provisional) or USD118 billion in Japan in 2005 (OECD, 2006c).

As a result, major emerging market economies are no longer simply low value-added producers but are adding their weight to the creation and commercialisation of innovative products, processes and services. Trade data on the four most significant economies (Brazil, Russia, India and China; "BRIC") show that these have become more active in higher technology industries over the past decade. Figure 2 shows that between 1996 and 2004 the share of high technology goods has doubled to reach about 30 percent of total trade (exports plus imports) in manufactured goods by the BRIC countries. It should be noted that most of this rise is accounted for by China. Most of China's exports of high-tech products is due to foreign firms, however, that use China as a location for some elements of their overall production network. When seen against the background of increasing focus and capabilities in innovation, expansion of R&D and rising human capital in BRIC countries, in particular China, this suggests that the challenge to OECD countries emanating from major emerging market economies is likely to intensify. At the same time, the emergence of these economies offers major opportunities for OECD countries, as these countries offer new markets for innovative products and provide access to a new supply of highly skilled workers.

Figure 2. The changing structure of BRIC's[1] manufacturing trade by technological intensity



1. BRIC: Brazil, Russia, India and China.

Source: OECD, Bilateral Trade Database.

At the same time, many OECD countries face difficulties in strengthening innovation

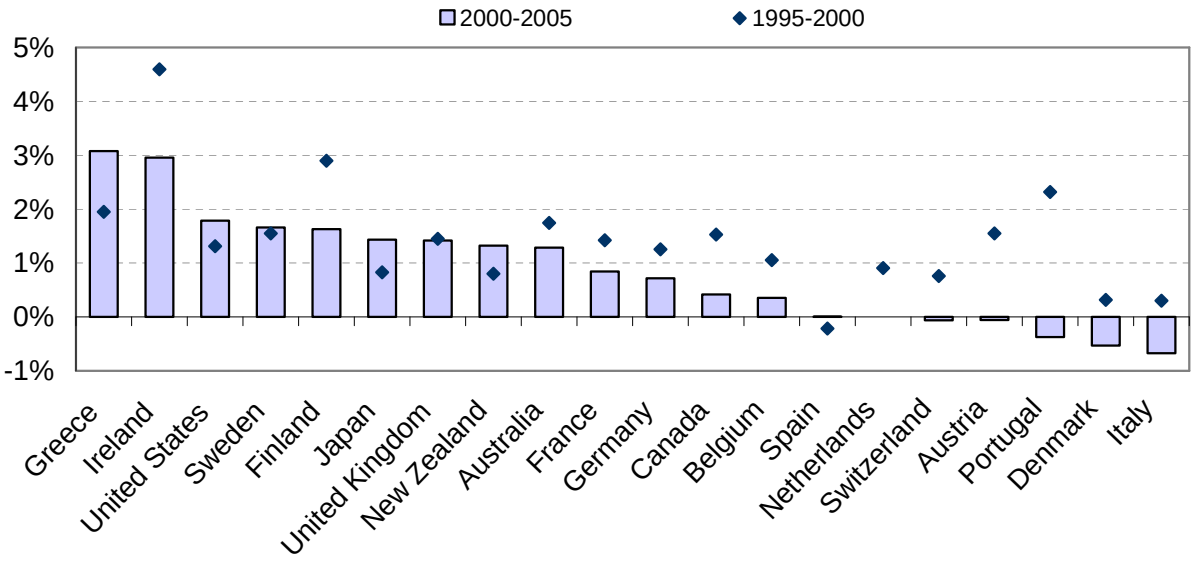
While these developments make it even more urgent for OECD countries to move up the value chain, many of them face difficulties in strengthening innovation performance. For example, progress along these lines under the aegis of the Lisbon strategy of the European Union has been slow. Nevertheless, the most recent evidence suggests that the renewed Lisbon Strategy may have had some success in helping to improve the European Union's performance in innovation and R&D. Earlier OECD analysis (Sheehan & Wyckoff, 2003) has shown the economic and structural implications of policy initiatives to increase the R&D intensity of the economy, which is one of the key elements of the Lisbon strategy, and underlined the difficulty inherent in using R&D targeting as an indicator where success requires implementing policies across a broad range of domains, from R&D funding and entrepreneurship to immigration and education, to product, financial and labour market regulation.

Indeed, recent OECD analysis has shown that increases in R&D intensity and innovation are driven by a wide range of factors (OECD, 2006b), including:

- Reduction of anti-competitive product market regulations, which stimulates business R&D and strengthens the incentives to innovate. Moreover, a low level of restrictions on foreign direct investment is important, as it can improve cross-border knowledge transfers.
- Stable macroeconomic conditions and low real interest rates which encourage the growth of innovation activity by creating a stable and low-cost environment for investment in innovation.
- Availability of internal and external finance.
- An expansion in public research, which can support business sector research, although expanding both at the same time will require efforts to raise the supply of human resources.
- Fiscal incentives, which can be effective in raising R&D, especially when firms face financial constraints. Tax relief for private R&D is often found to provide a stronger stimulus to business R&D than direct government support. This may be because much direct support for R&D is aimed at meeting government objectives, such as energy security or defence, and not at stimulating private R&D.
- Openness to foreign R&D, which is associated with higher productivity growth, especially when domestic R&D investment and capabilities are also high.

Indeed, the last few years have seen an increasing public policy focus on what promotes greater innovation. Nevertheless, many OECD countries have seen little improvement in productivity performance in recent years despite the new opportunities offered by globalisation and by new technologies, especially ICT. Figure 3 depicts the wide dispersion among OECD countries in terms of multi-factor productivity (MFP) growth over the past decade. Indeed, MFP growth rates have declined in many countries, including the larger Continental European economies.

Figure 3. Multi-factor productivity growth, 1995-2000 and 2000-2005



Note: Owing to data availability constraints, exact dates for the most recent period differ for some countries.
Source: OECD Productivity Database.

Intellectual property rights [IPR] pose a particularly important challenge

As knowledge has become an increasingly essential factor of growth and competitiveness, for companies as for nations, its market value has increased, hence reinforcing the value of protection for creators. There have also been concomitant changes in the economic context which tended to weaken the effectiveness of the IPR system as it operated previously:

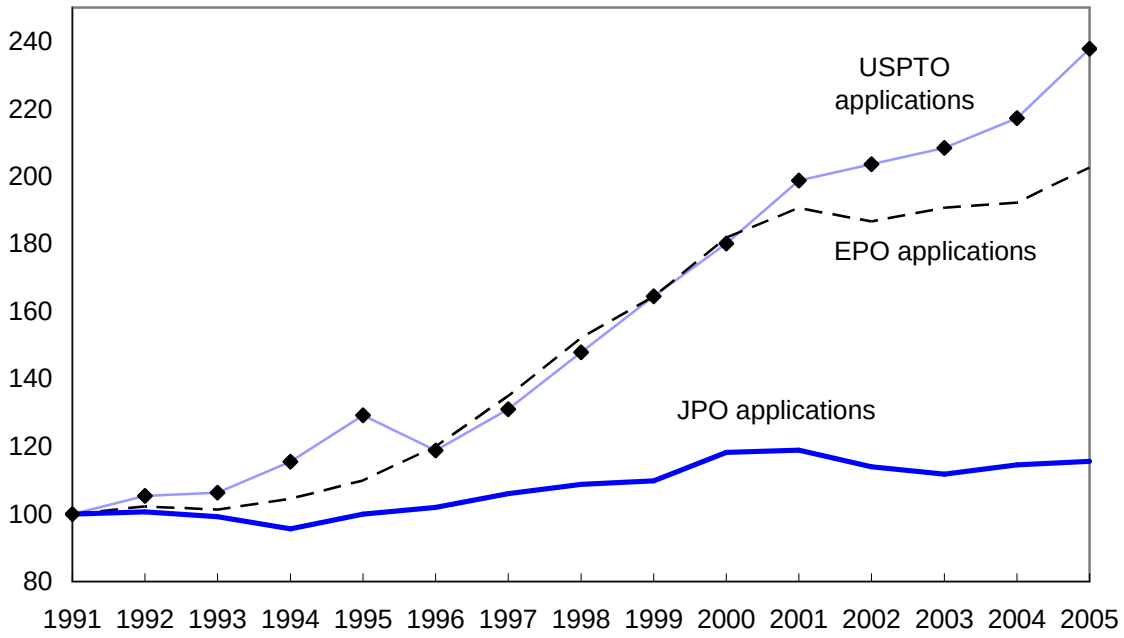
- New technologies, initially not covered by patent systems, have emerged, notably in the fields of software and biotechnology.
- Globalisation has made imitation and counterfeiting both more rewarding (in an expanded market) and more feasible, as a number of countries registered significant growth in technological capabilities, without a corresponding development in their IPR system.
- ICTs, and notably the Internet, have made copying of creative contents easier.

Governments have reacted to these changes by strengthening the rights of IPR holders. IPR laws and practice have evolved in accordance with this objective in many countries. The patent subject matter has been extended to genetic material and, with restrictions in certain jurisdictions, to software inventions. Many countries have set up a central court for addressing IPR cases in a more harmonised and effective way. Copyright protection has been lengthened (70 years after death of the author in Europe in 1993 and in the US in 1998) and extended to creations in digital form[1]. Last but not least, international standards for protection, notably in developing countries, have been raised through the TRIPs Agreement (1994).

In reaction to these changing conditions, and in view of ensuring a high return on their investment in creations, firms are increasingly applying for IPR. The number of patent applications and trademark applications, for instance, has increased markedly over the past two decades (Figures 4 and 5).

Figure 4. Number of patent applications (EPO, JPO, USPTO) by filing date

Index 1991 = 100

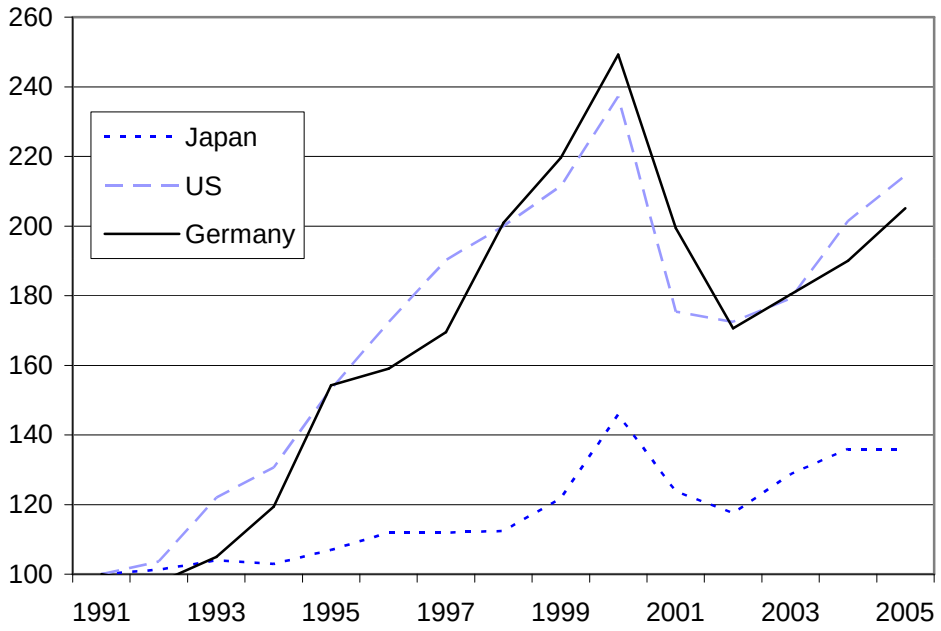


Source: OECD Patent Database and USPTO, EPO and JPO Annual Reports.

1. The US Digital Millennium Copyright Act (DMCA) of 1998, European enforcement directive of 2006. Databases have been the object of an ad-hoc IP law in the EU (1999).

Figure 5. Number of trademark applications (US, Japan, Germany)

Index 1991 = 100



Note: Data for Japan are adjusted to take account of a break in the series in 1997.

Source: WIPO, Statistics on Trademarks, Online data, www.wipo.int/ipstats/en/statistics/marks/

The key policy question remains how to strike an appropriate balance between providing incentives and rewards to innovators and providing access to new knowledge for users. Over the recent past the balance has been shifting more in favour of right holders, at least partly in reaction to changing conditions but also as a deliberate move towards "pro-IPR policies". These policies have resulted in certain achievements, such as the progress of technology transfers from universities in countries which have promoted patenting of public research results; the expansion of the biotech sector, which would have been hardly possible without patents on genetic inventions; and the multiplication of venture capital based start ups, which often rely on IPR.

As the policy, legal and economic environment are still evolving, the situation in the field of IPR is not stabilised. Public debates have turned around the efficiency and distributive effects of consolidating IPR regimes. If strong IPR are needed in order to give incentives for creative activities, they should not on the other hand endow the holder with such broad rights as to block all access to new knowledge. Difficulties have notably emerged in the following areas:

- Access to inventions for research use (biotech) or for further improvement or adaptation (software) have reportedly been hampered by patents in a number of cases, hence slowing down research.
- Establishment of standards for interoperability and other collective use of IPR have sometimes been delayed or made more costly by opportunistic strategies based on IPR.
- The backlog at most patent offices in the world has exploded (over 5 years pendency time in a number of cases), creating legal uncertainty on a vast scale, while there have been concerns about the quality of patents awarded.
- The extension of digital rights management (DRM) systems is meeting with resistance as they put strict restrictions on the rights of users, hence reducing de facto the scope of "fair use" of copyright law, for instance.
- No satisfactory formula has yet been found for ensuring that creators are rewarded while fully using the fluidity offered by the Internet.

Addressing the policy challenges

Product and labour market reform would promote innovation …

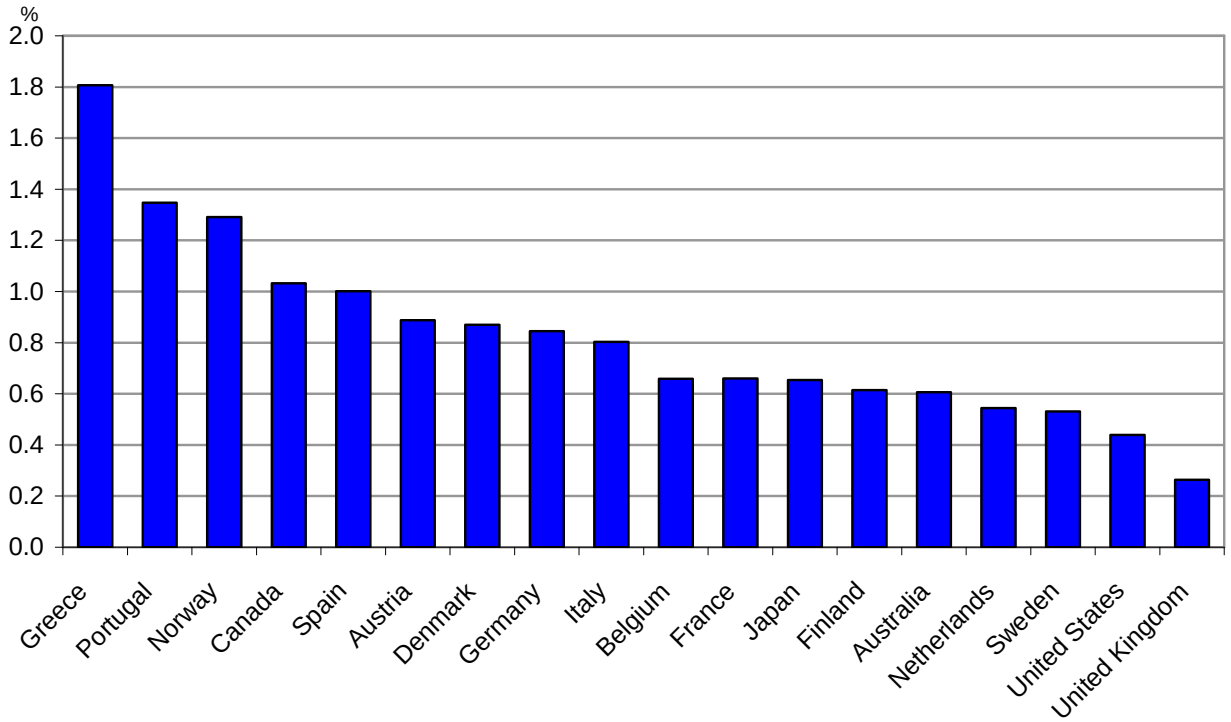
Policy reforms are needed to strengthen innovation and productivity outcomes. Improving the business environment for innovation is especially important, as business is the main driver of innovation. Further liberalisation of the services sector and of network industries could foster stronger innovation in these sectors, which account for over 70% of GDP in OECD economies. More innovation-friendly regulation, combined with lower barriers to trade and foreign direct investment would enhance competition and would foster the flow of technology and knowledge across borders. Reform of labour markets, notably through well-designed employment protection legislation, would help firms to adjust and allow them to draw greater benefits from their investment in innovation and technology.

OECD studies have established a broad negative link between the restrictiveness of economic regulations in product and labour markets, and productivity growth.[2] In the product markets limited competition among suppliers may increase the cost of inputs and make products supplied less innovative. It may discourage innovation, or make it costly to develop it or to defend the associated intellectual property. In turn, restrictive labour markets may curtail firms' ability to put in place the changes in the workforce and firm organisation necessary to reap benefits from new technology deployed.

More specifically, OECD empirical analysis shows that competition-restraining regulations slow the rate of catch-up with the technological frontier, where labour productivity is the highest. By implication, countries could have achieved significantly faster productivity growth over the 1995-2003 period if they had aligned their regulations in each non-manufacturing sector on the least constraining stance in the OECD area in that industry (Figure 6) (OECD 2007c).

2. See OECD (2007) *Going for Growth 2007*, Chapter 5 for a recent update of evidence.

Figure 6. Potential increase of annual business sector productivity growth over the period 1995 to 2003 if regulatory stance least restrictive of competition had been adopted[1]



1. Data are the average increase in annual business-sector productivity over the period 1995 to 2003 given an easing in the stance of regulation to the least restrictive of competition in the non-manufacturing sectors in OECD countries in 1995. The business-sector results are calculated as weighted averages of the sectoral productivity increases using value-added weights.

Source: Conway, P. *et al*. (2006).

In particular, investment in ICTs is positively correlated with uptake and diffusion of innovation (OECD 2004b). The use of ICT is closely linked to the ability of firms to innovate, *i.e.* introduce new products, services, business processes and applications. Moreover, ICT has helped facilitate the innovation process, for example by speeding up scientific discovery. ICT has also fostered networking, which has enabled informal learning and co-operation between firms, as well as outsourcing. But there is a large variation of ICT investment as a share of total investment in OECD countries — it is substantially higher in relatively lightly regulated economies, such as Australia, Finland, Sweden, the United Kingdom and the United States, than in Continental European economies (Figure 7).

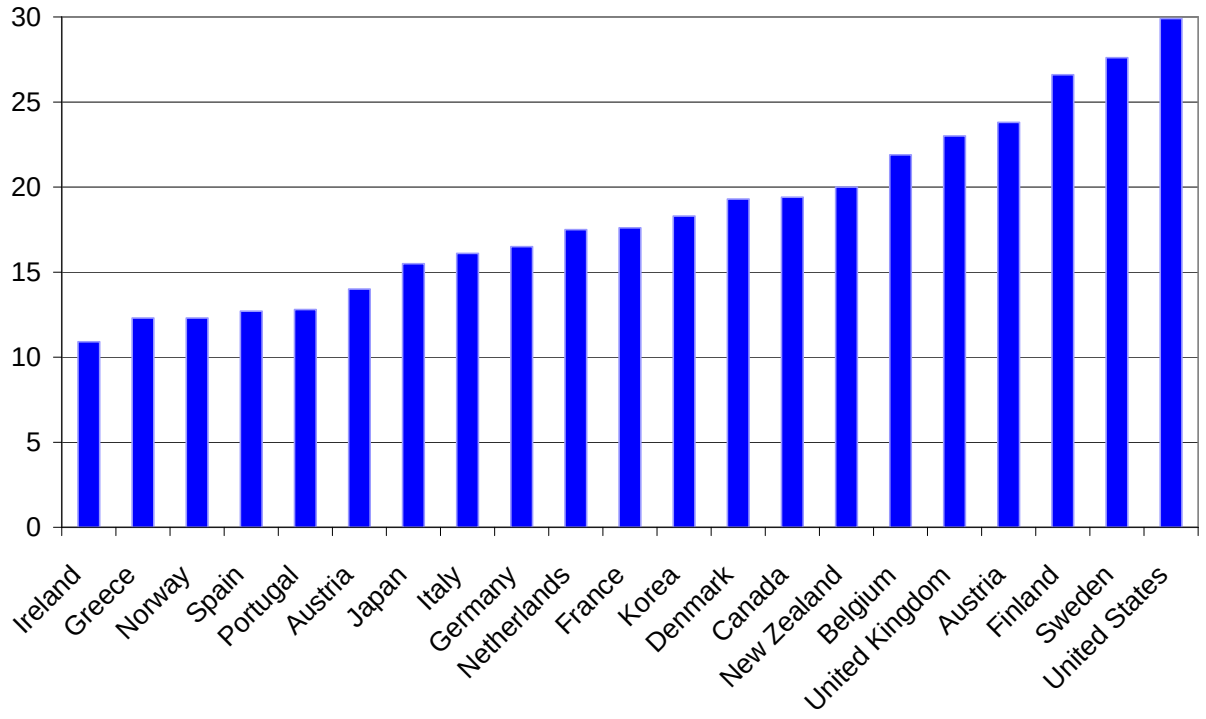
Other studies suggest that specific policy breakthroughs removing anti-competitive regulations, such as those associated with the unbundling of ICT software from hardware, break up of telecommunications monopolies, restriction of entry in parcel delivery or air transportation sectors, have often spurred major waves of innovation (OECD, 2005b).

That said, an innovation- and growth-friendly regulatory environment does not entail across-the-board de-regulation. Establishing appropriate regulation can be a key component of ensuring adequate competition and innovation in newly liberalised markets and in markets where technological convergence requires an update of the

regulatory framework (such as in telecommunications and broadcasting). Forthcoming work in conjunction with the OECD Ministerial Meeting on the future of the Internet economy[3] will develop policy options for appropriate regulatory reform to maintain the future Internet as a trusted, secure and reliable medium underpinning social and economic development.

Figure 7. ICT investment as share of total investment, 2000-2005*

* Average of 2000-2005 (or latest year)



Source: OECD Productivity database.

Reform of financial markets can also boost innovation and growth, including by helping to reduce the financing gaps faced by some innovative small firms. Empirical literature suggests that industrial sectors that are most dependent on external finance tend to grow faster in countries that have better developed financial systems. Furthermore, the sectors that tend to be the most dependent on external financial sources are generally the ones that invest the most in R&D (*e.g.* pharmaceuticals, electronic equipment and refined petroleum products).[4]

3. Seoul, Korea, 17-18 June 2008, *www.oecd.org/FutureInternet*.

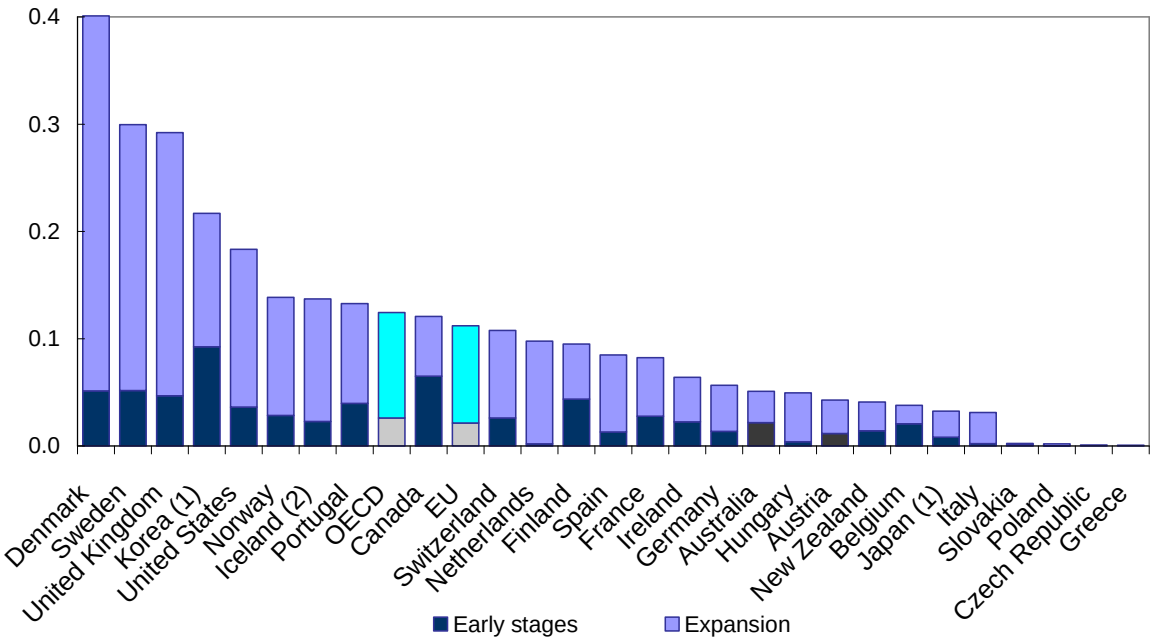
4. See OECD (2006b) Chapter 3 and in particular de Serres *et al*. (2006).

The market for high-risk capital, in particular venture capital and less formal sources of finance such as business angels' funds play a key role in the financing of innovation. Venture capital investment is relatively small in most European countries and Japan as compared with North America, the United Kingdom and the Netherlands (Figure 8).

Investment in innovation would be encouraged by deeper and more efficient venture capital markets and easier access to external finance. Differences in the availability and/or use of venture capital across countries may to some extent be rooted in different cultural attitudes towards entrepreneurship and risk taking, but they also reflect policies that discourage risk-taking and the supply of risk capital.

Improving disclosure of intellectual assets could also help improve the allocation of capital. Competition in financial markets already encourages companies to improve their reporting and managerial practices on intellectual assets. However, best practices have not been widely disseminated across companies and jurisdictions, and governments could encourage the diffusion of best practices, already pioneered by advanced firms, in a principles-based manner (OECD, 2007a).

Figure 8. Venture capital investment flows as a percentage of GDP, 2005 or latest available year

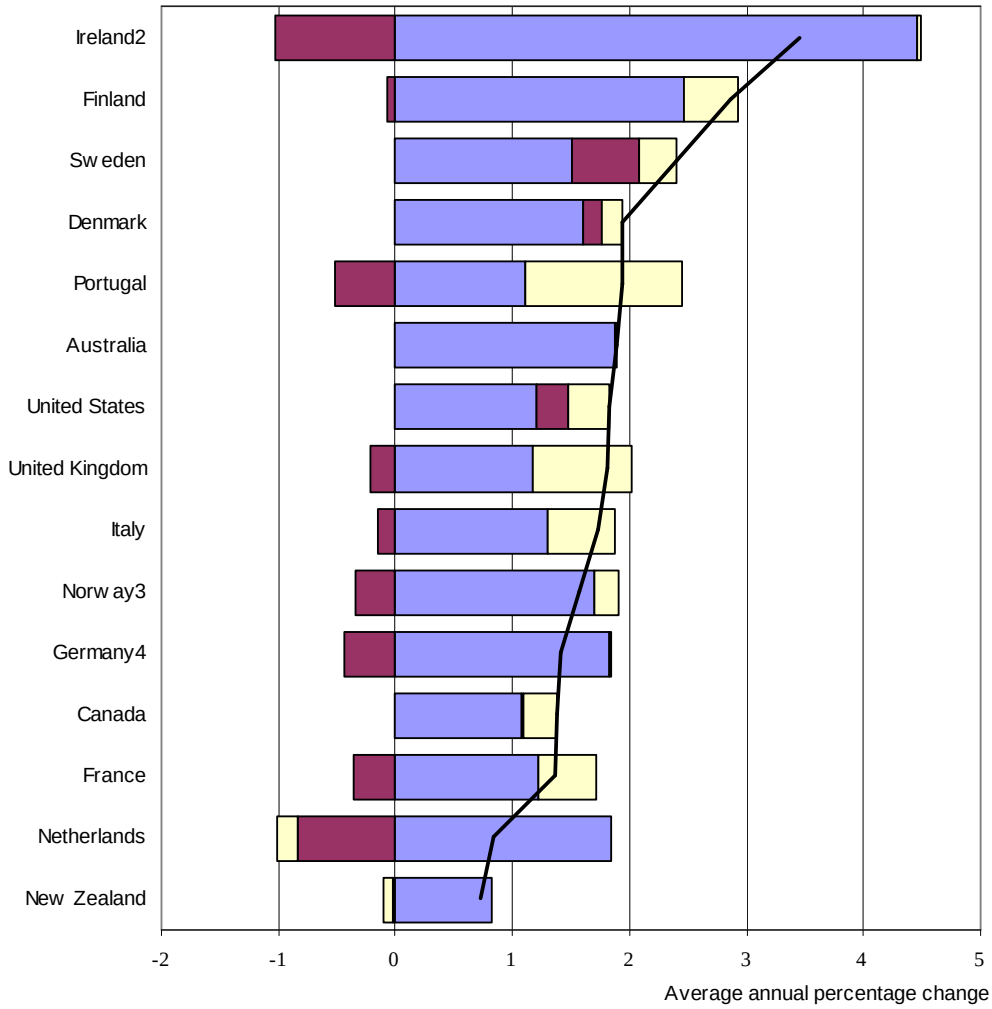


1. 2001 data.

2. 2002 data.

Source: OECD, Venture capital database. Quoted in OECD (2007d) *Science, Technology and Industry Scoreboard 2007*, forthcoming.

Figure 9. Enhancements in human capital contributing to labour productivity growth (1990-2000)



1. Based on the following decomposition: growth in GDP per person employed = (changes in hourly GDP per efficient unit of labour) + (changes in average hours worked) + (changes in human capital).

2. Year of reference 1990-1999.

3. Mainland only.

4. Year of reference 1991-2000.

Note that the negative contribution of human capital to MFP growth in the Netherlands is a statistical artefact, due to a large fall in the rate of unemployment, and reintegration into employment of a large population with relatively lower skills, during the period under consideration.

Source: see OECD (2005a) Education at a Glance, Chart A.10.2, p.150.

... and education systems.

Innovation also relies heavily on the creation of basic knowledge, through both education and science. A well-performing and broadly accessible education system facilitates the adoption and diffusion of innovation.

The contribution of education and human capital accumulation to economic growth is well documented. Some of this occurs through science and innovation. Investment in the education and training of researchers and other highly skilled workers is a major factor in determining the contribution that scientific research can make to scientific progress and innovation. Moreover, human capital is a key factor in the adoption of new technologies and the introduction of innovative practices. Much of the latter operates through growth in MFP arising from improvements in managerial practices, organisational change and inventions per se. Growth of skills and competencies embodied in workers and managers — or human capital — play a fundamental role in this process. Data available for half the number of OECD countries depicted in Figure 9 shows that growth in output per employed person is partly attributable to increases in the human capital of those in employment. The chart displays the impact of changes in the average human capital of workers on growth in cyclically-adjusted GDP per hour worked, including changes in average years of formal education, used here as a proxy for changes in the quality of labour.[5]

Creating, developing and diffusing new products and processes requires strong science and technology (S&T) skills as well as many non-research soft and entrepreneurial skills. There is an increasing emphasis on policy issues related to the availability of highly skilled labour, in particular highly skilled human resources in science and technology. Strong S&T skills facilitate the uptake and use of new technologies which drives innovation throughout the economy. This places a premium on both the "quantity" as well as the quality of highly skilled labour in the economy. But as, innovative activity may arise from any part of the production process, not only from the R&D lab, "softer" or more intangible skills such as entrepreneurial ability, communications skills, adaptability etc., also contribute strongly to innovation, especially in services and in organisational innovation. As a result, in many of the successful education systems there is now less emphasis on the reproduction of subject matter knowledge, which develops skills that are easiest to digitise, automatise and offshore, and more focus on teaching and evaluating skills in the context of real-world complexity, such as expert thinking — the ability to structure problems, complex communication , learning strategies and self-concept.

Education policy makers are paying increasing attention to innovation outcomes, and there is increasing emphasis to move towards a school environment which is less elitist, less compartmentalised between training for theoretical and practical understanding, and geared towards making a vast majority of students successful. There is greater scrutiny of the efficiency of education systems throughout the OECD, and a greater willingness to utilise international comparisons of outcomes in this area. As distinct from more spending in education as such, good education outcomes which can support a more innovative economy involve structural shifts in the way education is delivered, from uniformity in the system to individualising

5. For a more detailed analysis see OECD (2005a) *Education at a Glance*, Section A.10.

learning, from a focus on provision to a focus on choice, from managing inputs to education towards devolving responsibilities and enabling outcomes, from talking about equity to delivery equity. On the latter aspect, for example, OECD data (OECD, 2004a) show that many of the problems, particularly in Europe, originate from highly compartmentalised and stratified systems where learning outcomes closely depend on the social background of individuals and human potential therefore goes wasted. The OECD 2007 report *Going for Growth* identifies education reform (basic and/or tertiary, depending on the country) as a priority action area for 18 out of 30 countries.

Public funding of scientific research should focus on excellence and relevance

Public investment in science and basic research plays an important role in developing ICT and other general-purpose technologies and, hence, in enabling further innovation. Many high-technology commercial successes and fundamental innovations with deep and positive social impacts had their roots in public research and came from findings that were impossible to foresee. Fundamental innovations such as the World Wide Web and the Web browser emerged, not from competitive market processes, but largely from government-funded research conducted in universities, industry and government laboratories. Much of the R&D was conducted as part of government programmes, in some cases after the market had abandoned the research.

Reform of the steering and funding of higher education and science institutions, by providing incentives that focus on excellence and relevance, can help strengthen the contribution of public investment to scientific progress and innovation. Better governance of universities and public laboratories can be achieved through the use of new mechanisms, such as greater use of project funding (typically contracts and grants awarded through competition) as opposed to institutional block grants, selective increases of funding for research fields that are linked to social and economic needs, and the creation of multidisciplinary research centres or networks that serve both to concentrate expertise in particular fields of science and technology and to foster research at the nexus of several disciplines. It also often requires a greater commitment to evaluating researchers and research organisations, as well as changes in the way such evaluations are conducted. Evaluation criteria must recognise that excellence in research and training of graduates has become, at least in some disciplines, more tied to industry applications and contributions to addressing social problems.

However, the science system should not be made more responsive to identifiable opportunities at the expense of creativity and diversity in exploring the knowledge frontiers within a long time frame. Because changes in business R&D strategies generally strengthen longstanding disincentives for private industry to invest in fundamental research, the need for government support increases. Securing support for fundamental research is therefore a priority for many governments, even if some have found it difficult at times to meet this objective. It is also imperative to safeguard public knowledge in order to ensure the broad diffusion of the results of publicly funded research.

More can also be done to link science to business, including by enhancing the climate for innovative entrepreneurship. Many OECD countries lag behind in terms of modernising their science-innovation interface. Better management of IPRs in public organisations is essential in order to develop fruitful relationships between public research and industrial innovation. Efforts are also needed to boost exchanges of tacit knowledge between the public and private sectors, through the movement of human resources, for example. Low rates of researcher mobility between the private and public sectors remain a major bottleneck to knowledge flows in many countries. Regulatory reform related to labour mobility, IPRs and licensing can be complemented by measures that stimulate business demand for scientific inputs and improve the ability of public research organisations to transfer knowledge and technology to the private sector. Policies to enhance science-industry relationships must be part of an overall strategy addressing the business sector's demand for the results of public research.

Public support for business innovation can be made more effective

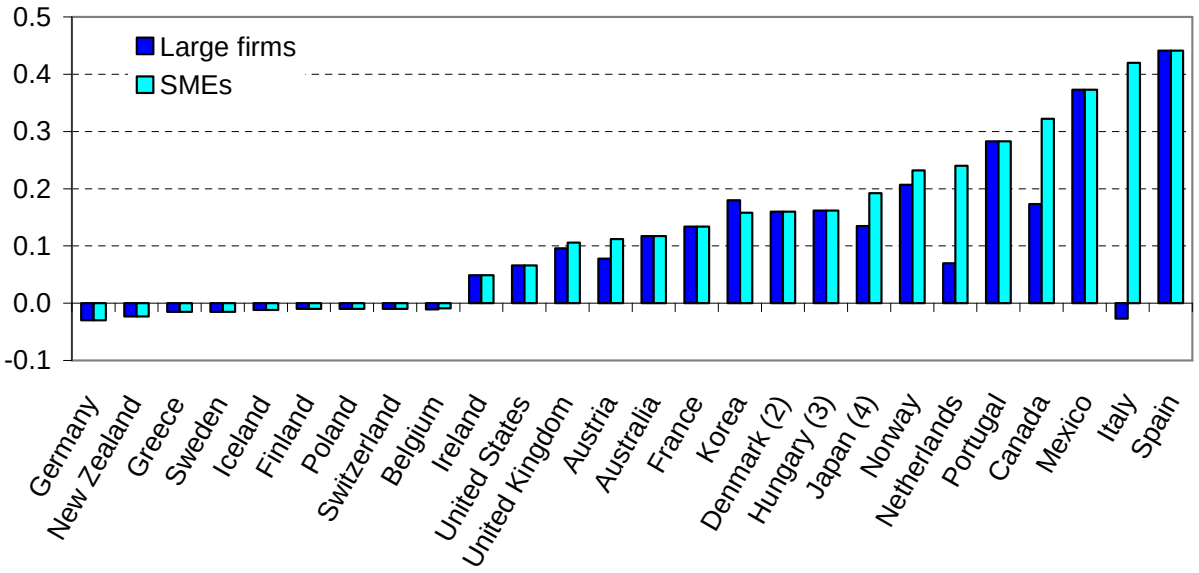
All OECD countries provide public support to promote innovative activity in the private sector. The effectiveness of such support can often be improved, by identifying an appropriate mix of direct and indirect instruments such as tax credits, direct support and well-designed public-private partnerships, support for innovative clusters and rigorous evaluation to ensure that public support achieves its goals in an efficient manner.

Direct support to business innovation in the form of competitive grants or subsidised or guaranteed loans remains important even if use of indirect schemes such as tax credits has tended to increase. Recent reviews of innovation policy have prompted reforms in countries such as Austria, Finland, the Netherlands, Norway and the United Kingdom. Several countries with numerous small programmes have recently attempted to streamline support and focus programmes on barriers to the innovation process, especially in the area of networking and co-operation (OECD, 2006d).

R&D tax concessions are extensively used by OECD countries as an indirect way of encouraging business R&D expenditures (Figure 10), on the understanding that R&D expenditures have benefits that cannot be fully appropriated by the investing firms so that firms are reluctant to invest in socially optimal levels of R&D. R&D tax credits can potentially benefit all firms engaged in R&D, although special arrange-ments may be needed for small innovative firms with little or no taxable income. Tax incentives are more flexible as regards the research to be undertaken and leave it up to firms to direct the funding. Direct support enables more focus in government intervention, and can be linked to public policy priorities in the area of science and innovation. The effectiveness of both instruments depends heavily on their design and implementation. International experiences with tax incentives for R&D show that they can, if well designed, induce additional private R&D efforts. Direct support is also important to foster innovation, but needs to be based on a competitive and merit-based selection of deserving projects that can provide high social returns. In both cases, a careful evaluation of policies to support business innovation is needed to ensure that the policies are effective and achieve their goals.

Successful experience in promoting rapid advances in the science and technology that underlie industrial innovation in strategic fields suggests that relevant R&D programmes need to involve industry closely in their funding and management. Public-private partnerships for innovation promote co-operation between the public sector (government agencies or laboratories, universities) and the private sector in undertaking joint research projects or in building knowledge infrastructures. They fill gaps in the science and innovation systems and increase the leverage of public support to business R&D through cost and risk sharing. Key challenges in the public sphere - delivery of health care, social services for ageing populations, environmental protection, sustainable transport, on-line security and privacy – offer promising opportunities to harness the creative capabilities of the private sector via public-private partnerships to achieve productivity gains and service improvements that can benefit society. Programmes of this kind should be directed to enhancing focus and mass in excellent research and valorisation of research, be it in innovation/ technology or in knowledge that is useful for solving societal issues.

Figure 10. Rate of tax subsidies for USD 1 of R&D, large firms and SMEs, 2005



Source: Warda (2006).

Complementing the IPR system with more flexible practices would enhance its relevance for future innovation

In view of the changing environment for innovation, it is important to regularly review the system of IPR rules and practices to assess whether it continues to stimulate innovation and provide access to knowledge, or if in certain cases the degree of control with which IPR owners are endowed could hamper competition, fair use and the diffusion of technology. The new innovation environment offers opportunities that could be seized more efficiently if the IPR system is adapted so as to become more flexible and play new roles in the economy. Recent evolutions in the IP environment include:

- The progress of various types of "open modes" of innovation, of open source software etc. where knowledge flows between firms and between firms and universities, has altogether increased the need for protection and strengthened the potentially damaging effects of excessive protection, which could hamper access by third parties. Essentially, sharing is easier when there is a predictable framework for remuneration/incentives.
- As companies rely increasingly on inventions made by others, the number and value of licensing deals has grown rapidly (Figure 11), which strengthens the need for the technology market to be built on solid grounds, notably in terms of validity and valuation of the titles which are traded.
- Progress in emerging technologies has benefited from start-up companies, which often have little assets other than their technology that they need to protect and use to raise capital. These companies help bring new ideas and inventions to the market.
- OECD governments, following the Bayh-Dole Act of 1980 in the US, have used IPR for leveraging the commercialisation of inventions by universities which might otherwise have stayed on the shelves.

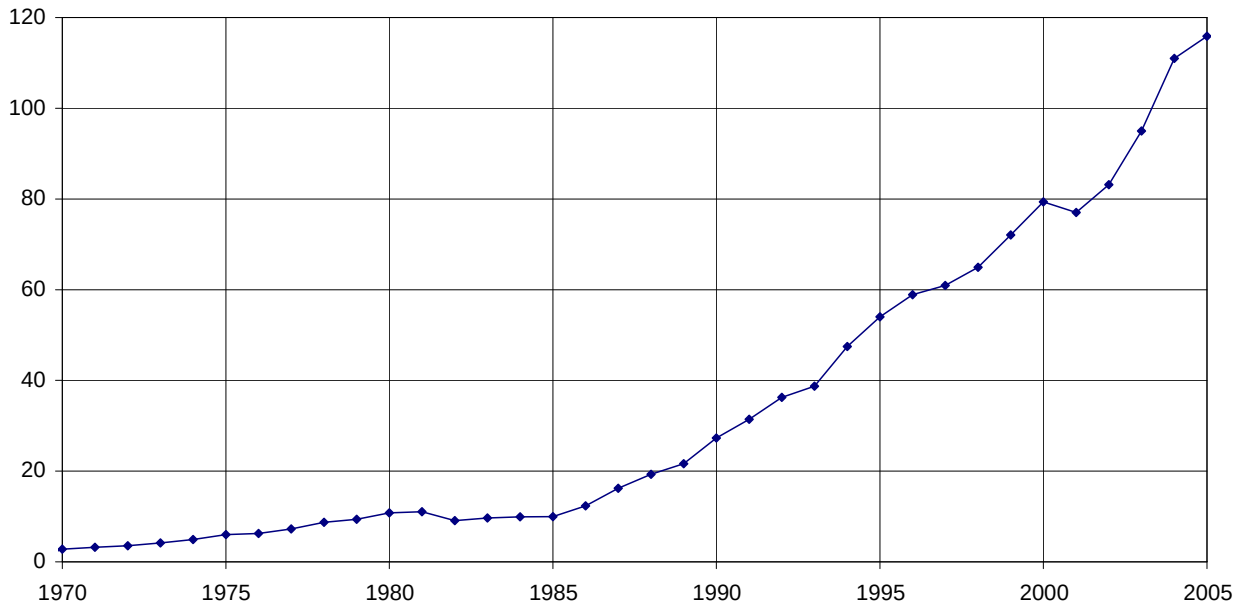
Therefore, in the emerging innovation environment the role played by IPR goes far beyond simply ensuring market exclusivity to the inventor as traditionally IPR would do. The central IPR policy challenge is therefore to design a system which would encourage both invention and diffusion in various ways and in a wide range of economic and technological contexts. In each particular field, a new balance should be struck between rights to control and to access, in terms of exclusivity, obligations on either party (holders and users), exceptions, sharing mechanisms, trading mechanisms etc. When rethinking IPR policies it is important to strengthen their link with other components of innovation policies, instead of the current tendency to conceive them in isolation.

In order to achieve this new balance, IPR policy should go beyond the design of the basic, essential legal framework which defines rights and obligations of IPR holders: it should also develop complementary instruments whose own flexibility would help the system work properly. Such a policy agenda implies:

- Reviewing and clarifying exemptions to copyright in the light of the internet's different uses.
- Reviewing and clarifying exemptions for research use.
- Promoting a more active and open commercialisation policy for universities.
- Encouraging the commercialisation and monetisation of IPR: *e.g.* draft licensing contracts, repository of IP owners, valuation standards.
- Access, standards: encouraging pooling mechanisms, platforms etc. when appropriate; "socially responsible licensing"; "patent misuse" doctrine, etc.

Accelerating patent processing while preserving quality (*e.g.* through international co-ordination).

Figure 11. Growth in non-US held patents and worldwide (cross-border) royalty and license receipts



Source: World Bank, *World Development Indicators* online database, accessed in April 2007.

Counterfeiting and piracy need to be addressed

Regardless of issues related to the flexibility of the IPR systems, stronger efforts are needed to combat counterfeiting and piracy. The problem is seen both by governments and industry as growing in complexity as there are potentially serious health and safety consequences associated with an expansion in the quantity and range of fake products being marketed internationally. There is also increasing concern that criminal networks (including organised and terrorist groups) are the principal beneficiaries of counterfeiting and piracy activities, with the proceeds from their activities being used to finance a range of illicit activities.

Governments and industry have both stepped up their efforts to fight against the illicit activities. With the support of industry, the Council agreed in mid-2005 to launch the OECD project on counterfeiting and piracy. Phase 1 of the project, which focuses on tangible products that infringe trademarks, copyrights, patents and design rights has found that:

- The scope of products being counterfeited or pirated is broad and expanding. There has been a disturbing expansion spreading out from luxury products (such as upscale watches, designer clothing and expensive perfume) to common articles such as food and drink (candy/sweets, drink, conserved vegetables), pharmaceutical products (treatments for cancer, HIV, malaria, prostate and infectious diseases), personal care items (toothpaste, shampoo), household products, toys, cigarettes, and automotive parts (engine parts, brakes, tires), to name a few. Infringing products are being produced and consumed in virtually all economies, with Asia emerging as the single largest producing region.
- Although the overall magnitude of counterfeiting and piracy cannot be measured effectively, information collected from enforcement authorities suggests that up to USD 200 billion of international trade could be in counterfeit/pirated products, this being more than the GDP of about 150 (out of 185) economies in the world. As a large amount of counterfeit/pirated goods never enters international trade the overall total amount of counterfeited and pirated goods can be assumed to be significantly higher.
- Counterfeiting and piracy have effects on *(i)* consumers, whose health and safety are oftentimes put at risk, *(ii)* rights holders, whose sales decline, *(iii)* governments, which suffer lost tax revenues, while facing the costs associated with fighting counterfeiting and piracy and *(iv)* society at large, in light of the resources that are channelled to the criminal networks that are often behind counterfeiting and piracy activities, and, last but not least *(v)* the innovation environment, as it diverts creativity, entrepreneurship and incentives away from genuine innovation.

The findings support the following recommendations:

- Data collection must be improved significantly to strengthen analysis and support policy making.
- Enforcement of laws needs to be stepped up and meaningful remedies/ sanctions need to be applied on a basis that deters the illicit activities.
- Programmes are needed to promote awareness of the existence of counterfeiting and piracy and the consequences and effects on stakeholders.
- Co-operation among governments needs to be pursued, with particular attention to those economies where counterfeiting and piracy are most pronounced; co-operation with industry is also critical.

Phase 2 of the project, which covers digital piracy will be undertaken as soon as sufficient funds have been made available, and Phase 3, will address other forms of infringement.

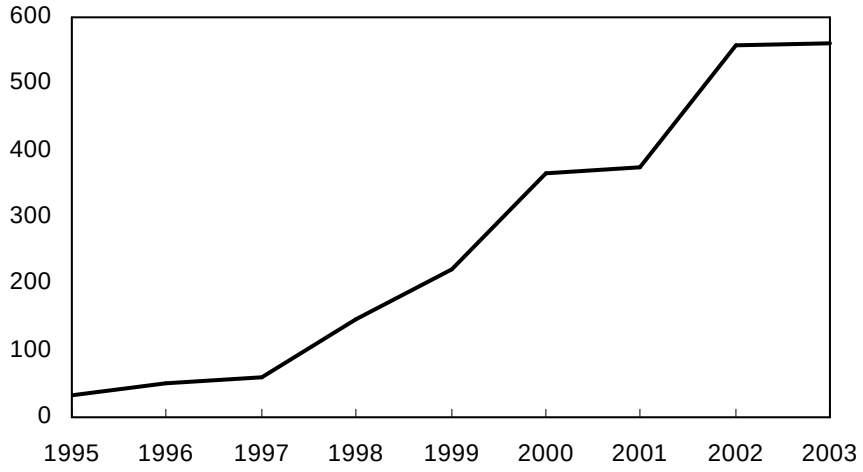
Innovation may also help address environmental challenges

Innovation can also contribute to resolving environmental challenges, such as climate change, when the right incentives are given. The use of flexible instruments including environmentally related taxes, emissions trading and technology-neutral performance standards should create incentives for innovation and enhance the international diffusion of clean technologies.

To take one example, innovation in energy technology is becoming increasingly important to meet growing demand for energy amidst concern about the security of energy supplies and calls for greater environmental protection. Governments across the OECD are investing considerable sums in R&D on new energy technologies, such as fuel cells, and seeking ways to speed their deployment and smooth the transition to a more sustainable, hydrogen-based economy. Recent OECD work on hydrogen fuel cells (OECD, 2006e), has reviewed national efforts in this area and has found that, innovative activity in this area is on the rise (Figure 12). But the level of investment in energy-related R&D may need to increase further, due to the growing importance of renewable energy since the return of high oil prices and the environmental objective of shifting away from fossil fuels.

Figure 12. Trends in fuel cell patent applications to the EPO

(Publications and EPO patent applications, 1990-1999/2000, worldwide)



Note: Patent counts are based on the earliest priority date, the residence of the inventor and fractional counts.

Source: OECD, Patent Database, September 2006.

A coherent, cross-government approach to fostering innovation will help strengthen its benefits

Strengthening innovation is often regarded as a challenging policy goal. As it places a premium on new and higher level skills and may involve significant adjustment, it may be perceived as conflicting with social objectives, including income distribution, job security and employment creation. Indeed policies to strengthen innovation cannot be conceived and implemented in isolation.

Policy co-ordination is essential — only a comprehensive and wide-ranging strategy to foster and strengthen innovation can help address social and environmental goals while building a lasting foundation for future economic growth and competitiveness. Governance of policies towards innovation is also important as innovation often requires efforts from many Ministries and government agencies, and from the national and sub-national levels. Coordinating policies at different levels is important to avoid duplication of efforts and ensure a coherence of policies at different levels.

Innovation does not need to go at the cost of employment performance. Several of the countries that have strongly emphasised innovation in recent years have also experienced strong employment growth, showing that these can go hand in hand. Indeed, several countries that have observed strong employment growth over the past decade, such as Ireland and Spain, are now emphasising innovation as the scope for further employment-led growth is becoming more limited and future growth will need to come from more rapid productivity growth, including innovation.

Implementing the reforms will require strong political leadership

Implementing reforms to foster innovation may also prove difficult. Some of the required reforms may affect vested interests, such as in universities and scientific institutions, as well as business sheltered from competition, benefiting from public support or confronted by technology-induced structural change. Strong political leadership and efforts to develop a clear understanding by the various stakeholders of the problems and of the solutions — including the costs they involve — can all help to communicate the need for reform and foster acceptance.

Ongoing work by the OECD

An "innovation strategy" at the OECD will contribute to more coherent and co-ordinated policymaking

As can be seen from the following list of references, not only has the OECD been working on various aspects of innovation and growth for many years, but by early 2007 there was new ongoing work in a range of groundbreaking areas such as measuring the determinants of innovation, its outcomes at the enterprise level, and understanding how so-called 'open innovation' models work.

Not only has innovation moved to centre-stage in economic policy making, but there is a realisation that a co-ordinated, coherent, "whole-of-government" approach is required. Many OECD member countries have adopted national strategic roadmaps to foster innovation and enhance its economic impact.

In addition to the rapid advances in scientific discovery and in general-purpose technologies such as ICTs and biotechnology, the accelerating pace of innovation is being driven by globalisation. These pervasive trends were picked up at the summit of the G8 at Heiligendamm in June 2007 which identified research and innovation as areas requiring high-evel policy dialogue between the G8 members and major emerging economies.

It is in this context that the meeting of the OECD Council at Ministerial Level, held in May 2007, asked the OECD to develop a broad-ranging Innovation Strategy. The OECD Innovation Strategy will add to the existing body of OECD work on innovation by *(i)* providing a cross-disciplinary mutually-reinforcing package of policy elements and recommendations to boost innovation performance, including non-technological innovation, both generally applicable and country-specific. This will include the identification of good policy practices, and where appropriate, policy guidelines. It will *(ii)* provide a framework that could be used to monitor and review the innovation environment and the performance of the innovation system. It will also *(iii)* enhance existing mechanisms and forums for international discussion and co-operation, including strengthened dialogue, especially with emerging economies and other important stakeholders. Moreover, it will *(iv)* provide analysis clarifying the links between the policy domains of a comprehensive strategy, such as those between innovation and entrepreneurship and how innovation contributes towards economic,

social and environmental goals and *(v)* develop better metrics to identify and benchmark innovation performance and the factors and policies influencing it.

The Internet will, more than ever, be a catalyst for globalisation and innovation

Last but not least, a catalyst for globalisation and innovation, ICTs (notably, the Internet) have become a fundamental component of the global economic infrastructure. Ensuring that the Internet is a positive agent for economic and social outcomes is the focus of OECD work as well as a Ministerial meeting on the *Future of the Internet Economy*, to be held in Korea in June 2008, a report on which will be made to Ministers in 2009.

References

Conway, P., D. De Rosa, G. Nicoletti and F. Steiner (2006) *Regulation, Competition and Productivity Convergence*, OECD Economics Department Working Papers, No. 509. *www.olis.oecd.org/olis/2006doc.nsf/linkto/ECO-WKP(2006)37.*

OECD (2007a) *Creating Value from Intellectual Assets*, Policy Brief, February.

OECD (2007b) *Synthesis Report on Global Value Chains*, forthcoming.

OECD (2007c) *Going for Growth 2007.*

OECD (2007d) *Science, Technology and Industry Scoreboard 2007*, forthcoming

OECD (2006a) *Compendium of Productivity Indicators 2006.*

OECD (2006b) *Going for Growth 2006.*

OECD (2006c), *Main Science and Technology Indicators* (MSTI).

OECD (2006d) *Science, Technology and Industry Outlook 2006.*

OECD (2006e), *Innovation in Energy Technology: Comparing National Innovation Systems at the Sectoral Level.*

OECD (2005a) *Education at a Glance.*

OECD (2005b) *Enhancing the performance of the Services Sector.*

OECD (2005c) *Science, Technology and Industry Scoreboard 2005.*

OECD (2004a) *Learning for Tomorrow's World: First Results from PISA 2003.*

OECD (2004b) *The Economic Impact of ICT.*

de Serres, A., S. Kobayakawa, T. Sløk and L. Vartia (2006) *Regulation of Financial Systems and Economic Growth*, OECD Economics Department Working Paper No. 506, August 2006. *www.olis.oecd.org/olis/2006doc.nsf/linkto/ECO-WKP(2006)34*.

Sheehan, J. and A. Wyckoff (2003) *Targeting R&D: Economic and Policy Implications of Increasing R&D Spending*, STI Working Paper 2003/8. *www.olis.oecd.org/olis/2003doc.nsf/linkto/dsti-doc(2003)8*.

Warda, Jacek, JW Innovation Associates, Inc. (2006) *Tax Treatment of Business Investments in Intellectual Assets, An International Comparison*, STI Working Paper 2006/4, OECD, Paris, *www.oecd.org/dataoecd/53/4/36764076.pdf*.