MICRO-POLICIES FOR GROWTH AND PRODUCTIVITY: FINAL REPORT

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FOREWORD

The 2001 OECD Ministerial report *The New Economy: Beyond the Hype* concluded, "Indeed, the evidence suggests that something new is taking place in the structure of OECD economies." This project is in response to the request by Ministers, at the OECD Council Ministerial in 2001, to strengthen benchmarking as part of the follow-up to the Growth Project and to strengthen the OECD's peer reviews of structural reform. It also responds to the 2002 Council Ministerial request to monitor the implementation of the policy recommendations of the Growth Study.

The project's objective has been to identify the critical areas of the business environment for each driver of growth and to identify effective micro-policies for each of these critical areas in order to develop a more coherent growth strategy for the micro level of the economy. While countries should specialise in areas in which they have comparative advantage, certain common structural elements should be part of their growth agenda.

The Committee on Industry and Business Environment (CIBE) embarked on the project, with inputs from the Committee for Scientific and Technological Policy (CSTP) with regard to the innovation driver, and from the Committee for Information, Computer and Communications Policy (ICCP) concerning ICT issues. The Directorate for Employment, Labour and Social Affairs and the Education Directorate provided input on performance and policies in the area of human capital. Anders Hoffmann was the principal author of the report. Important contributions were received from Günseli Baygan, Michael Freudenberg, Yukiko Fukasaku and Candice Stevens. Comments were received from across the OECD Secretariat. Drafts of the report were discussed at meetings of the main committees of the Directorate for Science, Technology and Industry and at four workshops organised jointly with member states (Finland, Norway, Sweden and the United Kingdom). Grants from the Danish and Swedish governments are gratefully acknowledged.

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Chapter 1

MAIN POINTS

The remarkable macroeconomic performance of some OECD countries in the late 1990s led to a debate about the existence of a "new" economy. Very high growth in multi-factor productivity (MFP) in some OECD countries attracted much attention. MFP, which is based on better utilisation of existing resources, can explain more than 50% of GDP growth in the last part of the 1990s in eight of the 14 countries with comparable data. The strong contribution of MFP to overall GDP growth suggests that understanding the drivers of MFP is the key to increasing GDP further.

In spite of the collapse of stock markets in 2000, the OECD Growth Study of 2001 concluded that "Indeed, the evidence suggests that something new is taking place in the structure of OECD economies" (OECD, 2001a; 2001b). The present high upswing in productivity in the United States suggests that this conclusion was correct and that some growth drivers still create an environment that enables the United States to outperform other OECD countries.

Good macroeconomic and structural policies had a great impact on growth in the 1990s by creating a stable economy in which firms can seize market opportunities. For example, a stable macroeconomic policy ensured low interest rates and created a good environment for investing in new technologies. An effective labour market policy ensured that firms could organise production in an optimal way. A good competition policy ensured that old, ineffective firms were driven out of the market.

However, the crucial barriers to MFP growth are often not linked to the overall functioning of the economy. MFP depends critically on the functioning of the micro level of the economy. Do firms use new technology efficiently? Are ideas generated at universities transferred to productive use in the marketplace? Do the highly educated use their knowledge to organise production more effectively? Do new firms enter and grow? Consequently, the important policies for MFP focus on the micro level of the economy. These micro-policies relate to various drivers of growth.

The OECD Growth Study identified four drivers of growth in the knowledge-based economy (OECD, 2001a; 2001b): seizing the benefits of information and communication technology (ICT); fostering innovation and technology diffusion; enhancing human capital and realising its potential; and fostering firm creation and entrepreneurship. The Growth Study also identified a set of fundamental policies related to labour markets and macroeconomic and financial stability that must be in place for countries to get the full benefit of these drivers of growth.

This report aims to identify the critical areas of the business environment for each driver of growth and to identify effective micro-policies. It provides policy makers with a prioritised list of the micro-policies needed to increase growth and productivity. It also supplies a framework that allows policy makers to identify strong and weak areas in their country's business environment. The policy insights should be seen as a first attempt to produce a coherent growth strategy for the micro level of the economy, as the field of micro-policies is new and no agreed methodology exists. The policy insights will develop over time as the analysis and the underlying data improve. Continuous updating of the data and analysis will allow countries to follow their progress, review the effects of policy reforms, and exchange information about effective policies.

The main conclusion of the project is that while a stable macroeconomic environment provides the overall basis for growth, the combined effects of four micro-drivers are needed for growth. Policy

priorities will differ across countries, but the report shows a need for a comprehensive growth strategy based on the key micro-policies identified (Box 1.1).

Box 1.1. Policy priorities and micro-policies for enhancing growth and productivity

Fostering firm creation and entrepreneurship

Increasing access to venture capital by: *i)* using public equity funds to leverage private financing and targeting financing gaps; *ii)* easing quantitative restrictions on institutional investors; and *iii)* developing competent venture investors and managers.

Ensuring efficient bankruptcy regimes by: *i)* reducing the time during which creditors have claims on assets; *ii)* introducing tougher regimes for bankrupt parties whose conduct has been irresponsible; and *iii)* removing the state's right to recover unpaid taxes ahead of other creditors.

Providing entrepreneurial education by: *i)* teaching entrepreneurial skills and attitudes in early education; and *ii)* integrating entrepreneurial education in university curriculum.

Seizing the benefits of information and communications technology (ICT)

Enhancing ICT skills at all levels of education by: *i)* defining a national strategy for integrating ICT in schools; *ii)* helping schools buy computers and get online; *iii)* providing ICT training for teachers, *iv)* developing educational software and online content, and *v*) working with the private sector to develop long-term strategies for developing the ICT workforce.

Stimulating competition in communication markets by: *i)* accelerating the process of unbundling local loops; and *ii)* increasing competition across different communications platforms.

Implementing e-government by: *i)* increasing online government services; *ii)* creating common government portals and standardised Web pages; and *iii)* ensuring online security and privacy.

Developing digital content by: *i)* clarifying intellectual property regimes for online content; and *ii)* clarifying ownership and pricing rules for digital content based on public sector information.

Exploiting and diffusing science and technology

Enhancing the quality of public research by: *i)* creating centres of excellence for research; *ii)* involving industry in the design and financing of the centres; and *iii)* developing competitive mechanisms to identify research areas.

Promoting industry-science links by: *i)* fostering spin-offs and licensing agreements from public research with flexible IPR infrastructure; and *ii)* promoting public-private partnerships with well-defined objectives and clear funding arrangements.

Fostering collaborative networks and clusters by:*i)* integrating a cluster approach when designing support programmes, *e.g.* at the regional level; and *ii)* focusing more on getting the right people together than on providing subsidies.

Stimulating demand for new products, processes and services by: *i)* public procurement of new products and services; *ii)* creating awareness and public acceptance of new technologies; and *iii)* fostering acceptance among the social partners of the long-term benefits of new technologies.

Enhancing human capital and realising its potential

Increasing educational attainment by: *i)* providing cost-effective support to tertiary education; *ii)* stimulating competition among educational institutions; and *iii)* linking higher education to the conduct of government-financed research and development (R&D).

Providing incentives for continuous training by: *i)* negotiating tripartite agreements to share the costs and responsibility for enterprise training; *ii)* offsetting costs and time constraints of individual investments in training; and *iii)* developing schemes to assist small firms to provide more worker training.

Fostering knowledge-based management and organisation in enterprises by: *i)* promoting flexible work approaches through labour market policies; *ii)* adopting knowledge-based management approaches in the public sector; and *iii)* upgrading managerial skills in small firms.

The contribution of the identified micro-policies to productivity growth are greater when they are combined . Certain countries may perform less well at the macro level in terms of overall productivity growth than their performance on some micro-drivers would suggest because of weaknesses in other areas. For example, analysis shows that several countries may not reap the full benefits of innovation since they lack entrepreneurs to exploit and diffuse science and technology (S&T), and these two micro-drivers – entrepreneurship and S&T – interact. Thus, some countries might not get the full benefits of S&T as they lack entrepreneurs to turn ideas into profit, while others may lack the S&T base needed to benefit fully from their many entrepreneurs. An integrated policy approach in which S&T is promoted together with entrepreneurship is needed to enhance overall performance.

Similarly, the successful exploitation of ICT requires skilled human capital. The micro-drivers ICT and human capital are highly correlated with MFP growth and with each other. Training and education are an important prerequisite for successful implementation of ICT. For example, the high level of ICT skills in the Finnish population is the likely reason for the very high uptake of information technology in small Finnish firms relative to other countries (OECD, 2004b). This is also supported by previous research suggesting that 10% of an investment in ICT in firms is spent on hardware, 15% on complementary technology and 75% on work practices, human capital and organisational restructuring (Brynjolfsson, 2003).

The analysis also shows high correlation between human capital and the exploitation of S&T. This is not surprising. Human resources in S&T are known to be essential to advancing science and innovation and generating productivity growth (OECD, 2004c). Globalisation and ICT play an increasing role in all sectors of the economy. The development and effective use of human capital has become essential to firms' ability to improve their competitiveness by developing new products, process and services. Human capital is also related to entrepreneurship and may in this respect be the fundamental building block for growth strategies in the knowledge-based economy.

Chapter 2

BACKGROUND AND METHODOLOGY

The 2001 OECD Ministerial report, *The New Economy: Beyond the Hype*, concluded that entrepreneurship, innovation, information and communications technology (ICT), and human capital were key elements for enhancing productivity and growth performance in knowledge-based economies (OECD, 2001a). The aim of the activity "Growth Follow-up: Micro-Policies for Growth and Productivity" was intended to explore further the main micro-drivers of growth and to identify effective policy practices. The project was initiated following the OECD Council Ministerial in 2001, at which Ministers asked the OECD to strengthen benchmarking as part of the follow-up to the Growth Project and to strengthen peer reviews of structural reforms. It also responds to the 2002 Council Ministerial request to monitor the implementation of the policy recommendations of the Growth Study.

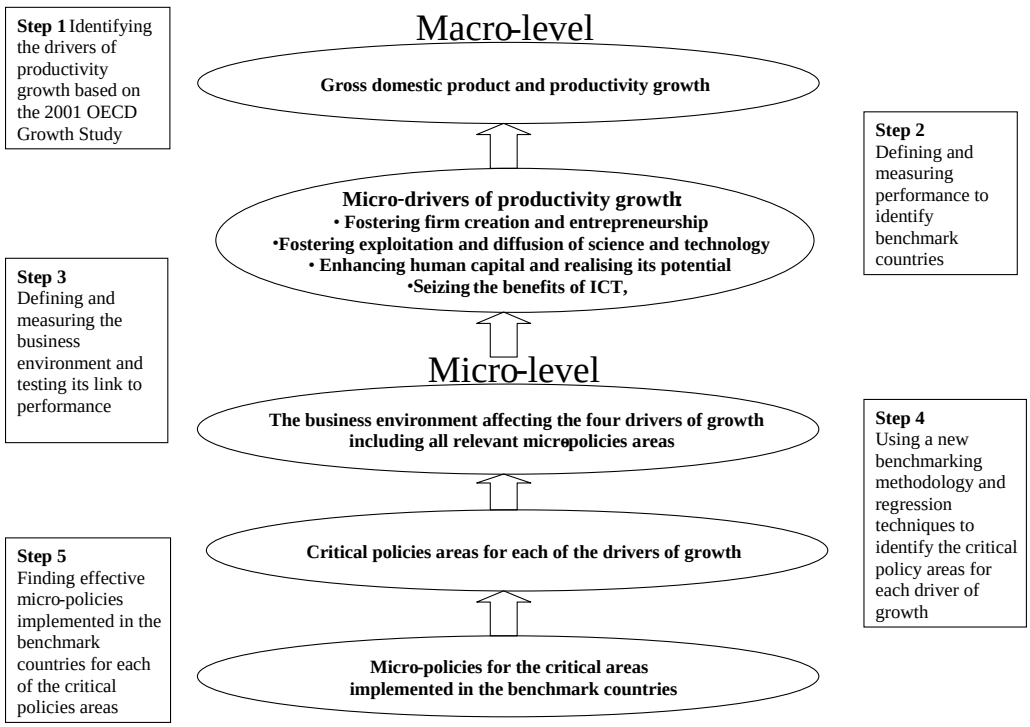
The project explores crucial areas of the business environment for each driver of growth with a view to identifying effective micro-policies for each. As the focus is on sectors that compete in the global market, the recommended policies should be supplemented by reforms in non-traded service sectors. Problems with fundamental macroeconomic policies or structures will also require attention. The analysis can allow policy makers to compare their business environment to that of the best-performing OECD countries. It also highlights the potentially most important policy areas for productivity growth and helps policy makers to prioritise policy actions. Finally, the micro-policies identified can point to policy actions to remedy identified deficiencies in important parts of the business environment.

The field of micro-policies is new and no agreed methodology exists. The policy insights provided are a first attempt to produce a coherent micro-level growth strategy. Policy insights will develop over time as the analysis and the underlying data improve. Continuous updating of the data and analysis will also allow countries to follow their progress over time, review the effects of their policy reforms and exchange information about effective policies.

The methodology adopted was developed for this project. It has five main steps (Figure 2.1), the first of which, the identification of drivers of productivity growth, was carried out in the 2001 OECD Growth Project. The subsequent steps are new. In the second step, performance for each of the drivers of growth is defined and benchmark countries are selected for further analysis based on quantitative and qualitative data. Third, indicators of the relevant business environment for each of the four drivers of growth are collected and analysed. Fourth, critical areas of the business environment are identified for each of the four drivers of growth using both benchmarking and regression techniques. Fifth, effective micro-policies implemented in the benchmark countries for the benchmark areas of the business environment are identified. Finally, the interaction between the drivers of growth and their links to MFP growth are explored.

Benchmark countries for each micro-driver of growth are selected in step 2, based mainly on qualitative performance indicators that are directly related to productivity growth. The number of benchmark countries varies from driver to driver, and the indicators can be used to create performance groups but not to rank the countries (Box 2.1). There is no prior information about the relative importance of the indicators, and some aspects of performance are hard to quantify. To compensate, national differences in economic performance, industrial structure, policy context and geographical/cultural dimensions are taken into account in designating benchmark countries.

Figure 2.1. Steps in the analysis



Box 2.1. The selection of benchmark countries

Identification of benchmark countries for further analysis is partly based on the weighted averages of the performance indicators. There are substantial methodological weaknesses in the construction of such weighted averages or composite indicators and they should be interpreted with caution.

The OECD and the Joint Research Centre of the EU Commission in Ispra are publishing a handbook dealing with all aspects of composite indicators (OECD, 2003a, 2005a), which is largely built on work developed for this project. It points to the four main problems for constructing composite indicators – selection of indicators, treatment of missing values, normalisation and weighting – with weighting as the most important.

There is no direct solution for selecting weights. A new sensitivity technique has been developed for this project, which assigns weights randomly to each of the normalised indicators. In this study the calculation was repeated 10 000 times and the weights were drawn from a uniform distribution (from 0 to 1) for each of the indicators. This gives a distribution of possible rankings for each country. The probability of being among the top three, top five or top ten performing countries can be calculated based on that distribution. The figures in this chapter are based on these probability calculations. To some extent, this sensitivity technique also addresses the problem of selection of indicators. The random assigned weights vary between 0 and 1 for each indicator, so the technique tests indirectly for the robustness of an excluded indicator. This implies that it is only necessary to test how unused indicators affect the ranking and this will be done here when alternative indicators exist.

This project adopts the simplest method of dealing with missing values, which is to ignore them, thereby implicitly assigning them a value equal to the average of all available indicators. Countries with missing values have to be examined more closely with respect to their rankings and are therefore examined in detail and discussed if relevant.

Normalisation is needed as variables are expressed in various units (*e.g.* number of PCs per 100 white-collar workers and investment in ICT as a share of total capital accumulation). The indicators have to be normalised to make them comparable. Several techniques can be used to standardise individual indicators, including the standard deviation from the mean, the distance from the mean (where OECD=100), the distance from the best performer (leader=100) and the distance from the best and the worst performing country (the “minimum-maximum method”). For this study, the “minimum-maximum method” (leader=100 and laggard=0) has been selected. Sensitivity analysis shows that the ranking of countries is robust to other methods of normalisation and this is not discussed further.

Countries' performance as analysed in step 2 depends critically on the functioning of the micro level of the economy. Does competition in communication markets lower prices of broadband to stimulate uptake? Do ideas generated at universities get transferred to productive use in the marketplace? Do bankrupt entrepreneurs get a second chance? Do governments provide support to students at universities? A mix of competitive market outcomes and government regulations and programmes creates the business environment at the micro level of the economy. The business environment is thus the combination of opportunities and obstacles that companies face in their day-to-day business.

In step 3, the different areas of the business environment that affect performance in each of the four drivers of growth are quantified. This relies heavily on indicators but qualitative information is used to evaluate areas of the business environment that cannot be quantified. A total of 143 indicators are used. A benchmarking methodology and spider diagrams are used in an attempt to identify similarities in the business environments of the top-performing countries for each driver (Box 2.2). Policy makers can enter their country's profile in the spider diagrams and compare their business environment to that of the best-performing OECD countries. Attempts are also made to link country performance on business environment indicators with their overall performance in the driver.

Box 2.2. How to read the spider diagrams

Spider diagrams are used to benchmark the business environment. The diagrams show all relevant indicators with reasonable country coverage (at least ten OECD countries of which at least three are top-performing countries). For each of the indicators, a choice is made as to whether more or less represents good performance in that specific driver of growth. For example, lower ICT prices are considered better than higher ICT prices, whereas higher investment in ICT is deemed better than lower investment in ICT. This does not address the implications for overall macroeconomic performance. Large government guarantees for loans to entrepreneurs will, for example, be measured as an improvement of the business environment for fostering firm creation and entrepreneurship, but they may not be desirable in the framework of government expenditures.

For each indicator, the diagram shows the average value of the countries identified as benchmark countries. The average is based on the standardised indicators (so the country with the most favourable environment is given a value of 100 and the country with the least favourable environment a value of 0). The average benchmark is compared to the average of the countries with the highest score on that particular indicator – called top environment. The countries included in top environment may change from indicator to indicator, whereas the benchmark countries remain the same for each driver. Indicators for which the benchmark countries are included among the top environment countries are potentially the most important for performance.

Not all areas are equally important for performance, which is the focus of step 4. Similarities in the business environment across the benchmark countries are used to identify the most important areas. Relative importance is also tested by regression techniques (Box 2.3). Qualitative analysis is also used in the driver for exploiting of science and technology.

Once the critical areas of the business environment for each driver have been identified, actual micro-policies in benchmark countries are examined (step 5). This micro-policy analysis is based on a qualitative approach and does not rely on quantitative indicators. The method used to assess policies can be compared to the case study method, as it focuses on how a few countries succeed. A policy implemented in a benchmarking country is not necessarily an effective policy in another country. The analysis highlights the main challenges for each policy area and then lists effective policy responses in the top-performing countries and emphasises national evaluation of policies and other quantitative and qualitative evidence of the effectiveness of the policies. The micro-policies identified may not be first-best solutions, but rather practical approaches to common policy problems.

Box 2.3. Methodology used to identify the critical areas of the business environment

The methodology is based on the novel idea that countries' performance can be measured at two levels and that correlating these performance measures with measures of the underlying business environment allows for analysis of the relative importance of policies. The first level of performance is the macro level, where GDP and productivity growth are the main indicators. The second level is the micro-drivers of productivity growth. These drivers are based on the OECD Growth Study which identified four drivers of productivity growth in the knowledge-based economy (OECD, 2001a; 2001b). Various indicators – labelled performance indicators – can measure performance in the micro-drivers. For example, the share of new firms relative to existing firms is a performance indicator for firm creation and entrepreneurship. These indicators allow grouping of the OECD countries by performance. Based on this grouping, a number of benchmark countries can be selected for further analysis in each driver.

Countries' performance in the micro-drivers depends critically on the functioning of the micro level of the economy (the business environment). Most aspects of the business environment can be quantified, but qualitative information, *e.g.* surveys, are also needed to judge relative performance. The business environment is a result of both structural factors and policy actions, so many of the indicators measure inputs that are not directly controlled by public policy, *e.g.* availability of private digital content or access to capital for new firms. However, these are likely to be affected by government policies. Other indicators are a direct quantification of government policies, *e.g.* e-government, restrictions on foreign ownership in telecommunications or bankruptcy legislation.

The analysis of relative importance is based on linking performance in the micro-drivers with the business environment. Two methods are used. First, a benchmarking approach is used to identify patterns in the business environment across the benchmark countries. The assumption is that the parts of the business environment in which the benchmark countries have values close to the best performers on individual areas may be more important for overall performance. Second, regression analysis is used to confirm the results by correlating the various parts of the business environment with performance in the micro-drivers. More advanced multi-variant regression techniques are also used when possible. Both types of linking analysis have to confirm the importance of an area for that area to be included in the policy conclusions.

Chapter 3

FOSTERING FIRM CREATION AND ENTREPRENEURSHIP

Country performance for this driver relates to entry and exit of firms and creation of high-growth firms, as former analyses link these two stages in the entrepreneurship process directly to productivity growth. Based on quantitative and qualitative indicators, the following countries are identified as benchmark countries: Canada, Finland, Korea and the United States.

An attempt is made to compare the business environment across all countries for firm creation and entrepreneurship using both benchmarking and regression analysis. This suggests the following three policy areas may be the most important: *i)* bankruptcy regimes; *ii)* access to venture capital; *iii)* entrepreneurial education. These conclusions may change as the method and data improve but the conclusions are the most robust possible given currently available data. Effective micro-policies implemented in the benchmark countries represent practical solutions to common policy problems and could be adapted by other countries to fit their own context and national situation. The most important micro-policies appear to be the following:

- *Increasing access to venture capital* by: *i)* using public equity funds to leverage private financing and targeting financing gaps; *ii)* easing quantitative restrictions on institutional investors; and *iii)* developing competent venture investors and managers.
- *Ensuring efficient bankruptcy regimes* by: *i)* reducing the time that creditors have claims on assets; *ii)* introducing tougher regimes for bankrupt parties whose conduct has been irresponsible; and *iii)* removing the state's right to recover unpaid taxes ahead of other creditors.
- *Providing entrepreneurial education* by: *i)* teaching practical entrepreneurial skills and attitudes in early education; and *ii)* integrating entrepreneurial skills in university curriculum.

The analysis also highlights five additional areas (loans and loan guarantees, secondary stock markets, administrative simplification for start-ups, income and capital taxation, and business services). However, the importance of these areas is not confirmed by supplemental analyses and they may therefore be less important for performance than the three policy areas mention above.

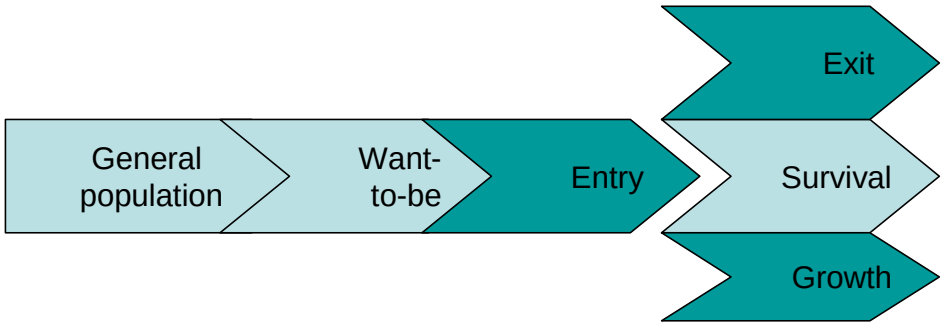
Selection of benchmark countries

There is no single definition of entrepreneurship, as entrepreneurship or firm creation cannot be seen as a single event. A new firm goes through several stages from being an idea in the mind of the entrepreneur to being a growing firm. Some fail on the way and exit while others never grow beyond being a one-person firm and focus on survival (Figure 3.1).

This study defines entrepreneurship in terms of entry and exit of firms and as creation of high-growth firms, as former analyses link these two stages in the entrepreneurship process directly to productivity growth (Audretsch and Thurik, 2000; Scarpetta *et al.*, 2002; OECD 2003b; Brandt, 2004a). This definition is narrower than those used in many OECD countries, where entrepreneurship is defined more as an attitude, "a willingness and ability to change" or "as the pursuit of opportunities beyond the resources one currently controls" (Stevenson and Lundstrom, 2001). Such a definition may better capture the many aspects of entrepreneurship but it cannot be measured and compared across countries, whereas entrepreneurship, according to the present study's definition, is directly

measurable. Furthermore, the main focus of this project is productivity growth, which is affected directly by these two stages, whereas the link between willingness to change and productivity growth is more difficult to measure.

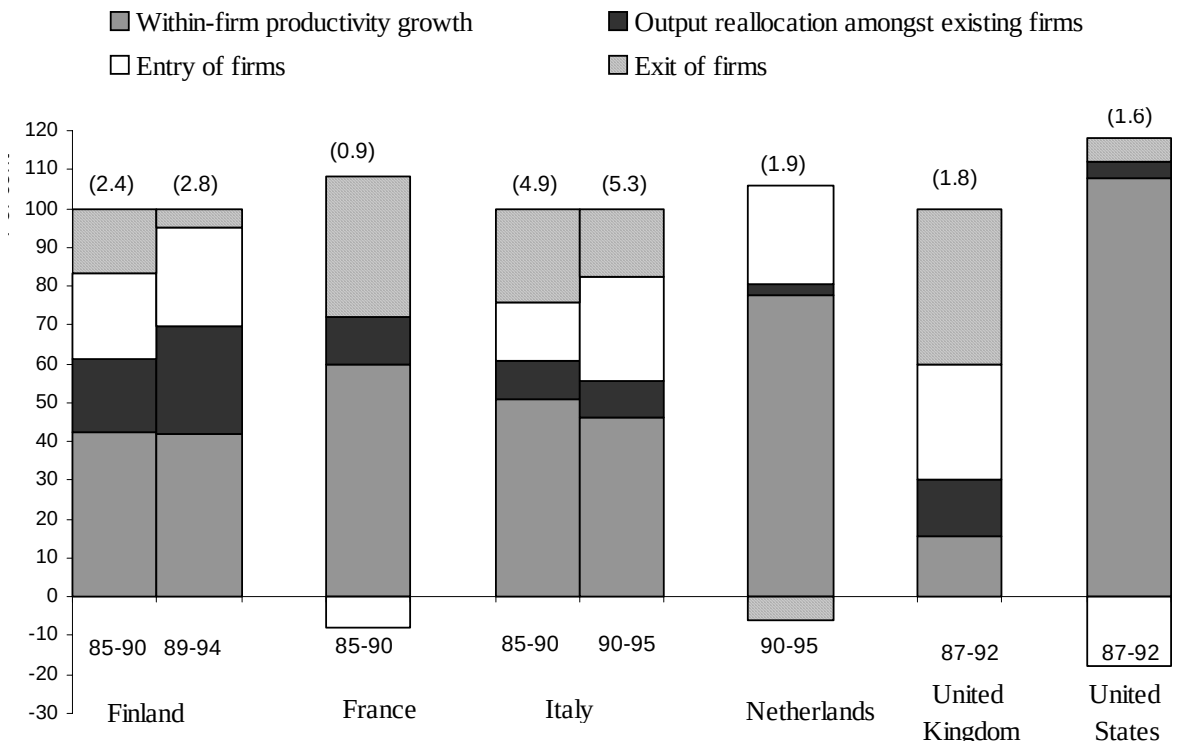
Figure 3.1. The process of entrepreneurship



Previous analyses show that about 30% of the population (16-60 years) in OECD countries respond that they would like to participate in some kind of start-up activity, Around 10% are engaged in some kind of start-up activity but only 1-2% realise their wish every year and actually start a new firm (GEM, 2003; Eurobarometer, 2000). Other studies show that of the new start-ups about 25% will exist within the first year, and 70% will survive but not grow, often referred to as "lifestyle entrepreneurs" (EU, 2003). Only 5% of the new firms will turn into high-growth firms, often called gazelles (NCOE, 2001).

The entry and exit of new firms can be shown to affect growth through a so-called growth accounting framework (Figure 3.2) (OECD, 2003b). A detailed OECD analysis of productivity growth in eight OECD countries over a ten-year period showed that between 20% and 40% of total labour productivity growth can be explained by entry and exit of firms. Normally, firms that exit the market have lower productivity than their competitors and thus directly increase average productivity in the industry. Firms that enter the market have labour productivity that is around the industry average and consequently a small effect on labour productivity growth. Effects on multi-factor productivity (MFP) are different. Existing firms play a very limited role in MFP growth but entry of new firms has made a significant contribution . New firms enter with innovating organisations that make better use of factors and thus increase MFP growth. Other OECD analysis confirms the connection between entry and productivity using quite different techniques by relating sectoral firm entry rates to sectoral productivity growth. This approach helps capture both firms' impact via their own productivity and any indirect effect on aggregate productivity that might occur, for example, as a result of the competitive pressure created by firm entry (Brandt, 2004a).

Figure 3.2. Entry and exit contribution to productivity growth in selected countries



Source: OECD (2003j).

New high-growth firms affect productivity almost by definition. Several studies have confirmed the importance of such firms, especially for job creation (OECD, 2002a). Their main contribution to productivity growth is through MFP, as they enter with innovative combinations of factors of production and new technologies. They can also more easily experiment with new organisational structures to take advantage of new information and communication technology (ICT) and grow quickly when they have found the right organisational structure (OECD, 2003b). High-growth firms constitute a very small share of the total number of start-up firms. For example, only about 41 000 start-ups, or 4.5% of all US start-ups in 1991, grew to 20 employees or more by the end of 1996. In the total stock of firms only 4.7% of all US businesses that existed in 1991 increased their employment by at least 15% a year or at least doubled their employment over five years from 1992 to 1997 (NCOE, 2001). These firms were responsible for about two-thirds of new jobs created between 1993 and 1996. Other studies find similar results (Schreyer, 2000; Birch, 1987).

The comparative analysis of entrepreneurship performance requires data on firms' entry, exit and growth (Table 3.1). These data are defined as performance indicators, as they measure the outcome of the entrepreneurial process and are directly linked to productivity. Alternative measures exist but are not included in the analysis as their link to productivity is less clear (Box 3.1).

Table 3.1. Performance indicators for fostering firm creation and entrepreneurship

Creative destruction	New high-growth firms
Firm entry rates, average 1998-2000	Change in employment from 1998 to 1999 in new firms
Entrepreneurial activity from GEM (2003)*	Share of young firms with more than 60% growth rates in a two year period, 1999 – 2002

Note: *The analysis is done with and without this indicator, as its quality is questionable.

Box 3.1. Alternative measures of entrepreneurship

Firm survival is also important for entrepreneurship. Some analysts maintain that firm survival is key, which means that professionals, rather than entrepreneurs, are more significant for sustained growth and economic performance. While entrepreneurs may be important in the early phases of growth and can kick-start the process, skilled professionals with high levels of education and training may be needed to implement and extend technological progress. On that view, firm survival is a perfect performance indicator for entrepreneurship. On the other hand, high survival rates may point to high entry and/or exit barriers rather than good economic performance. Barriers can lead to low levels of entrepreneurship if entrepreneurs do not perceive sufficient opportunities for innovation, growth and survival. Low churning is likely to be a feature of industries that are not contestable owing to high entry and exit costs. Firm survival might therefore not be a true performance indicator. Furthermore, survival rates are only available for a limited number of countries and are not included in the composite index.

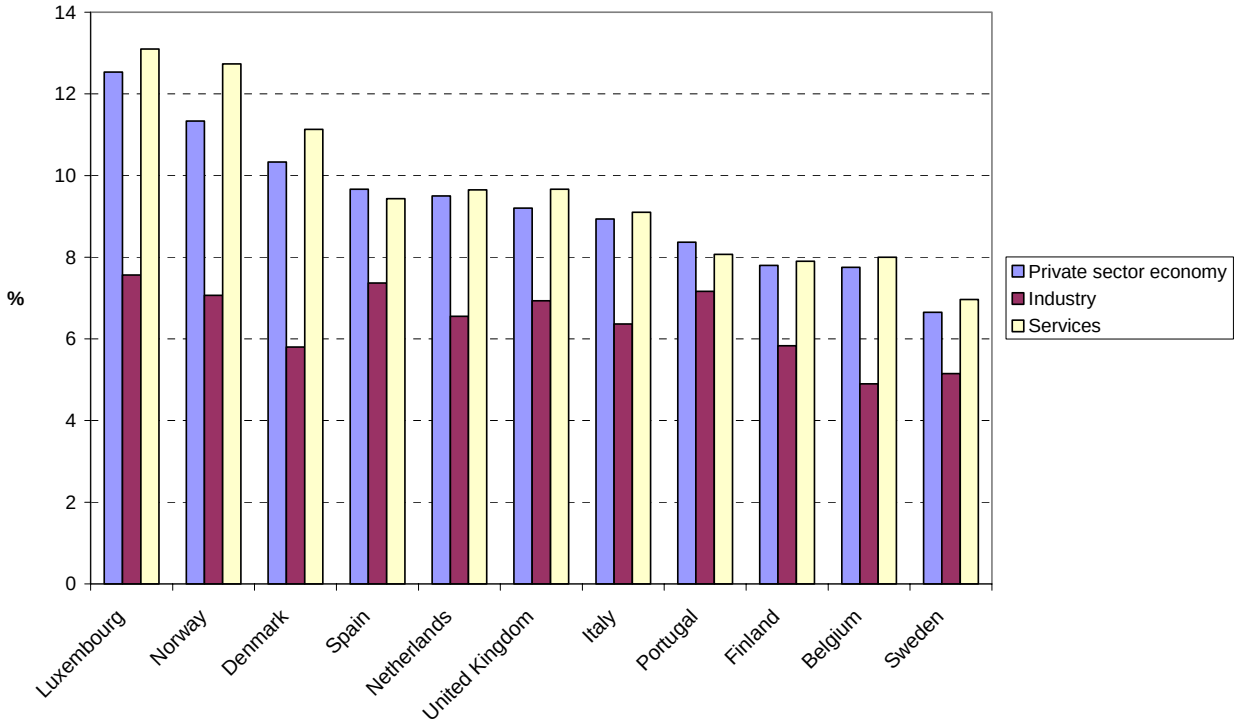
Measuring creative destruction

A systematic investigation of creative destruction requires, at a minimum, data on firm entry and exit. National data sets are limited in their coverage and international comparability is limited. Internationally comparable data for entry of new firms based on harmonised firm level data are only available for ten EU countries and Norway. An alternative source based on household survey data is often used to supplement these data.

EU harmonised firm level data on entry and exit cover ten EU countries and Norway over the period 1998-2000 and are available at a very fine sectoral breakdown. The data show that a large number of firms are involved in the process of creative destruction (the sum of firm entries and exits). In the manufacturing sector between 5% and 7% on average of all firms are new to the market every year. Exit rates vary in a similar range. Both entry and exit rates tend to be higher in services than in manufacturing industries.

Differences exist in firm entry and exit across countries but these are small compared to differences across sectors and regions. The entry rates in industry differ from 4.4% in Belgium to 7.1% in Spain (Figure 3.3); within Spain, they differ from around 5% in manufacture of wood and wood products to around 20% in manufacture of office machinery and computers. Similar patterns can be found for start-up rates in services, where Sweden has the lowest entry rates (7.3%) and Norway has the highest (11.5%). Within Norway start-up rates vary from around 6% in accommodation services to 33% in post and telecommunication. Regional data are not available from Eurostat but UK data show that the start-up rates are almost three times higher in London than in the northeast region. Similar patterns exist in other countries.

Figure 3.3. Firm entry rates, average 1998-2000



Note: Entry rates are calculated as the number of entering firms as a proportion of the total number of active firms in the same sector.

Source: Eurostat (2003).

The 11 countries in Figure 3.3 fall into three groups. Luxembourg, Norway and Denmark are top performers with an average entry rate of new firms above 10% in the period from 1998 to 2000. These three countries are followed by four others (Spain, Netherlands, United Kingdom and Italy) with entry rates between 9% and 10%. Portugal, Finland, Belgium and Sweden have the lowest entry rates.

Luxembourg, Norway and Denmark are top performers in all three years with comparable data, and the rankings of the other countries are also quite stable for the three-year period, with comparable data except for Italy. Italy experienced a large drop in the number of start-up firms in 1999 mainly in the service sector, which could be due to measurement problems in 1998 (Eurostat, 2003).

The United States and Canada also produce yearly start-up rates, compiled by a method very similar to that of the EU. These start-up rates show that the United States falls in the top-performing group with start-up rates around 10%. Canadian data shows much higher entry rates (around 14%). Despite these differences, studies comparing the United States and Canada conclude that start-up activities are quite similar in the two countries if employment in new firms and first-year survival are taken into account (Baldwin *et al.*, 2002) even though Canada tends to have a higher share of start-ups.

Data on exit offers a mirror image of the entry rates. Studies on firm dynamics consistently reveal that high rates of firm entry and exit coincide at all times even within narrowly defined sectors of the economy (Brandt, 2004b). As a result, changes in the total number of active firms are generally small despite high rates of entry and exit.

The Global Entrepreneurship Monitor (GEM) is a common measure of start-up activity. It estimates active participation in new business creation based on a survey of a minimum of

1 000 adults in each participating country. Participants are asked a series of questions about their participation in entrepreneurial activities. These include whether or not they have tried to start a new firm in the last 12 months ("start-up activity") or were the owner or managers of an active business less than 42 months old ("new firm activity"). The advantage of this indicator is that it is based on a standardised questionnaire for a large number of countries, rendering cross-country comparisons *a priori* less problematic. However, one of its major drawbacks is that it seems to measure individuals' "intentions" and "trials" as much as "real" start-ups. Therefore, the GEM indicator is not used in the selection of countries for further analysis (Box 3.2).

Box 3.2. Differences between GEM and other sources

The GEM is based on a survey conducted in 28 countries. It shows for example that 7.6% of individuals aged between 18 and 64 in the United Kingdom are either in the process of starting a new business or are the owner-managers of a new operating business that is less than 42 months old (GEM, 2001). This represents about 2.7 million people engaged in entrepreneurship in the United Kingdom. In 2000, about 183 500 firms registered for VAT, or less than 7% of the number of people engaged in starting up a new firm. However, the VAT threshold is high in the United Kingdom so a new firm does not have to register for VAT in order to start trading although most open a bank account. In 2000, approximately 400 000 new business bank accounts were opened in the United Kingdom (Barclays, 2001). This is less than 15% of people engaged in starting up a business in the GEM survey. US data show similar results. The GEM survey shows that about 19 million people were engaged in starting up a new business in 2000. However, official statistics only show 2.6 million new firms and only 23 million people reported some income from self-employment (based on information from the Small Business Administration's Web pages).

The GEM is consequently not used for the selection of countries although the correlation between the GEM data and the official start-up rates from Eurostat is significant at the 5% level. The GEM data are used when examining the interaction among the micro-drivers and MFP, as this analysis would be difficult on the basis of only 15 countries. The GEM data are consequently used to judge entrepreneurial performance in Australia, Ireland, Japan and New Zealand.

Another measure used is self-employment based on national labour force surveys, in which respondents classify themselves either as employees or as self-employed. Self-employed jobs are those in which individuals make operational decisions or are responsible for the welfare of the enterprise, and remuneration is directly dependent upon profits. OECD analyses find that the self-employment rate across countries is related to a range of explanatory variables, including GDP per capita, the size of the service sector, unemployment rates and average taxation levels. However, data on self-employment and business ownership capture a wide array of activities, ranging from fishermen to barbers to software designers, and mainly reflect differences in industrial structures. Consequently, the self-employment rate is not included in the analysis.

Measuring new high-growth firms

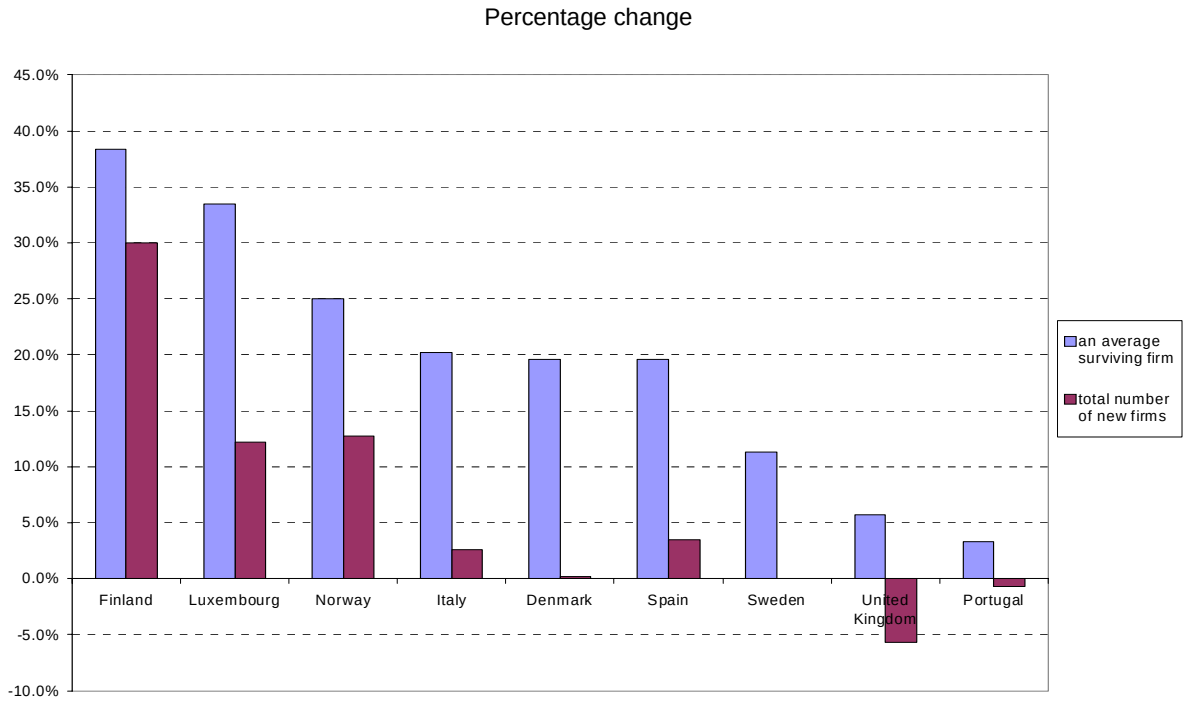
There is no internationally agreed definition of a high-growth firm. In some countries a high-growth firm doubles employment in a five-year period. In others, high-growth firms are by definition the top 10% of the economy's fastest-growing firms (OECD, 2002a). Statistics show for example that about 5% of all existing US firms doubled their employment and about 4% of all start-ups grew to more than 20 employees in a five-year period (NCOE, 2001).

Two different approaches are used here to measure relative performance in the creation of high-growth firms. The first is based on growth in employment in new firms, which can be calculated from EU demographic data. The second is based on a commercial database of company accounts, in which high-growth firms are calculated as the share of firms with a growth rate (in either employment or turnover) higher than 60% over a two-year period.

EU work on firm demographics shows that Finnish firms have the highest employment growth rate among the nine countries with comparable data (Figure 3.4). The total number of employees in firms started in 1998 increased by 30% in Finland and the total number of employees in an average

surviving firm increased by 38%. Growth rates in Luxembourg and Norway were also relatively high both for total and average firms. Similar results are found for changes in employment from 1998 to 2000. In that period total employment in firms started in 1998 increased by 46% in Finland. These data should be interpreted with caution. The period covered is only two years and it was a period of remarkable growth in countries like Finland.

Figure 3.4. Change in employment in new firms, 1998 to 1999



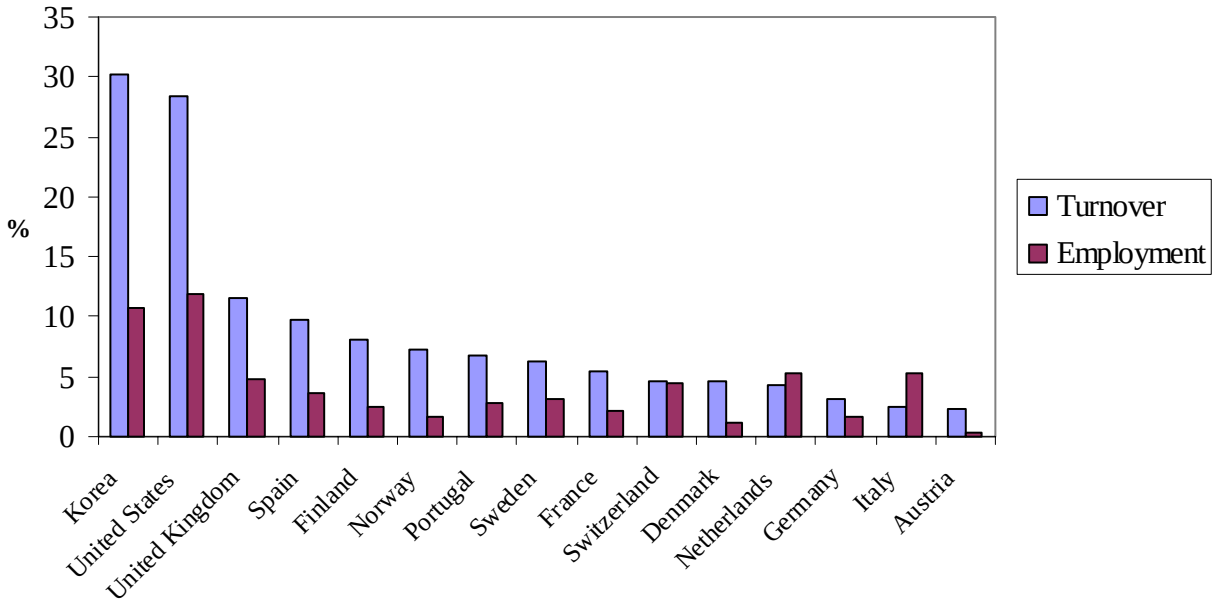
Source: Eurostat (2003).

The second set of indicators is based on a commercial database (Amadeus) of around 3 million company accounts, which holds information on Austria, Denmark, Finland, France, Germany, Italy, Korea, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The data for Korea and the United States are the least reliable as the database only contains a small sample of firms from these two countries. Two indicators are calculated based on these data: *i)* the share of young firms (less than five years old) with 20-100 employees and with employment growth of more than 60% in a two-year period; and *ii)* the share of young firms (less than five years old) with 20-100 employees and with turnover growth of more than 60% in a two-year period. These data are available for 1999-2002 and the indicator is an average over the available years.

The United States and Korea perform much better than the other countries (Figure 3.5). The good performance of the United States is also found in OECD work on firm demography based on firm-level data from the early 1990s. OECD work showed that US firms grow much faster and generate more jobs than European firms (Scarpetta *et al.*, 2002). Korea's performance cannot be confirmed by other sources as no alternative source exists. This is somewhat problematic as the Korean data are the least reliable. The total number of Korean firms in the database is around 1 500 compared, for example, to 524 018 French firms. The Korean data may thus be biased.

The United Kingdom, Spain and Finland perform well on both measures of growth. The high share of high-growth firms in the United Kingdom in this data set does not correspond to the low growth rate in the EU data, whereas Finland and Spain also perform well in the EU data.

Figure 3.5. Share of young firms with growth rates of over 60% in a two year period, 1999-2002



Source: Own calculations based on Junge and Kaiser (2004). Sensitivity analysis shows that the length of the growth period (currently two years) and the 60% cut-off point for high growth only has a limited impact on the results.

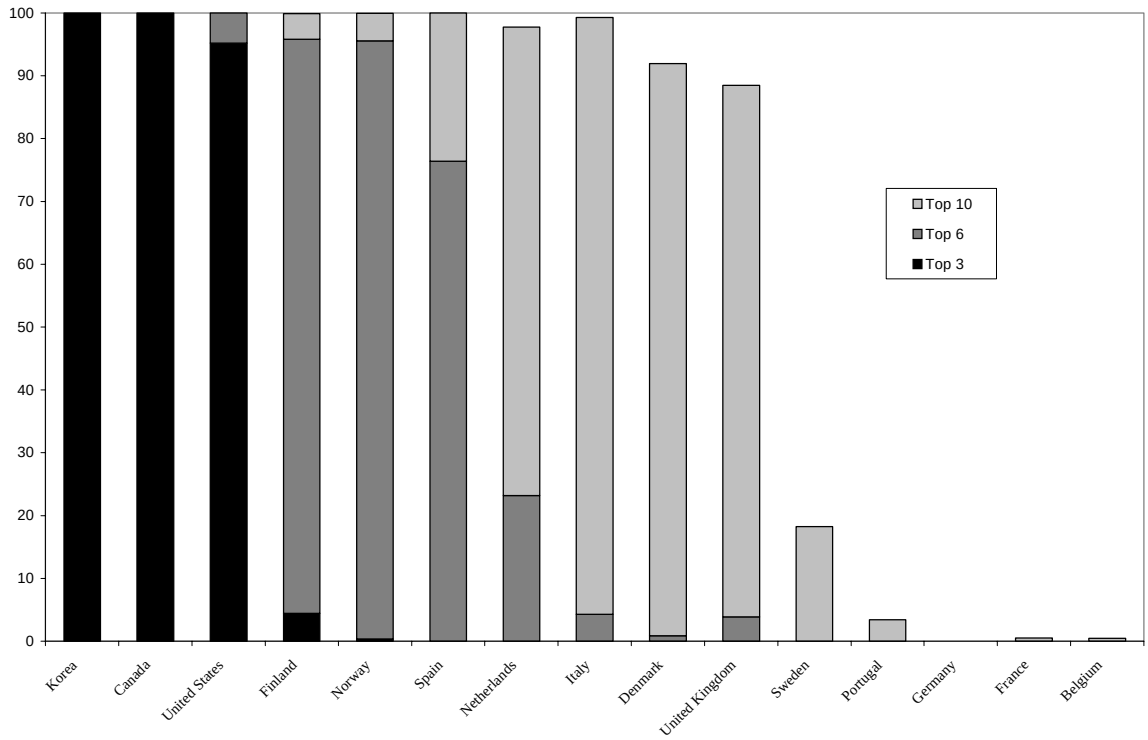
All in all, among the countries with available data, the United States, Korea and Finland appear to be the best countries to generate growth of new firms. The United States looks like a top performer in all data sets. As noted, Korea is only in the database of company accounts, where it is not very well covered. Finland looks like the best-performing European country but is still far behind the United States.

Selection of benchmark countries

Only about half of the OECD countries are covered by more than one of the indicators of firm creation and entrepreneurship. This makes the selection with the assignment of random weights less reliable. Because the relative importance of the indicators is not known, a distribution of possible composite indicators is calculated based on random weights for the 15 OECD countries with more than one indicator available (Figure 3.6). The distribution does not suggest specific country rankings but rather a division into four groups, which is robust when including the GEM indicator (Annex B). Korea, the United States and Canada are always among the top three. The next group consists of Norway, Finland and Spain. Italy, Denmark, Netherlands and the United Kingdom follow with a possible ranking among the top ten. The other OECD countries are either below or have no indicators available.

This analysis clearly points to Korea, Canada and the United States as interesting candidates for further analysis. Finland also does well and is included in further analysis mainly owing to its good performance in creating high-growth firms. However, the selection of Korea and Finland is less reliable as good performance cannot be confirmed by alternative sources. Further analysis should consequently test the robustness of the results with regard to Korea and Finland.

Figure 3.6. Probability of having a given rank with random assigned weights



Note: Based on 10 000 weights randomly assigned to the indicators shown above. The weights are drawn from a uniform distribution from 0 to 1 and assigned to the standardised indicators.

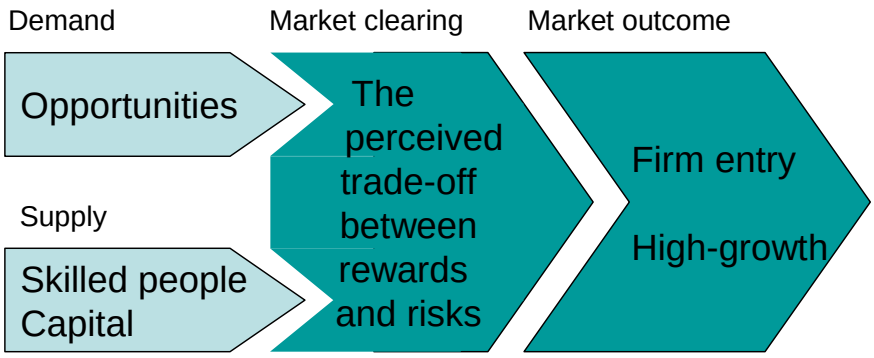
Quantifying the business environment

The number of new firms that enter the market each year and the share of new high-growth firms depend on a myriad of conditions in the business environment. In its simplest form, a new firm is created by a combination of three factors: skilled people, capital and perceived risk/benefit trade-offs. However, people with the right skills and capital do not necessarily seize an entrepreneurial opportunity if they do not think the possible benefits outweigh the risks. An additional factor that reflects entrepreneurs' perceived trade-off between the benefits of succeeding and the risk of failing is needed. The same factors affect high-growth firms. The skills are needed to manage the growth phase, the capital is needed for investment and the opportunities are needed for growth.

These four factors can be simplified into a demand-supply model for entrepreneurship. The supply side is represented by people with the right skills and capital. The demand side is the entrepreneurial opportunity offered in the country. An opportunity is an idea in the mind of an entrepreneur that promises genuine value in the minds of others (Smilor, 2001). The perceived trade-off between the benefits of succeeding and the risk of failing is the market-clearing condition (Figure 3.7).

The four factors of the demand-supply model of entrepreneurship can be affected by several different policy areas. In this case 16 policy areas were chosen for further analysis (Table 3.2). They cover all areas in which OECD countries have policies affecting entrepreneurship.

Figure 3.7. Demand-supply model of entrepreneurship



Note: The framework is quite similar to the framework offered by others which categorises entrepreneurship policies. See Lundström and Stevenson (2002).

The number of skilled people can be affected by entrepreneurial and management training but also by the availability of training, business and technology services, and the functioning of labour markets. Government loans and loans guarantees can affect the amount of capital available for entrepreneurs, and, for high-growth firms, venture capital and second-tier stock markets as well as taxation of wealth and bequests can also play a role. Opportunities are affected by regulations, *e.g.* regulation of entry into different sectors of the economy, government control on business activities, access to international markets, and regulation of transfers of knowledge from universities. Promotion campaigns, bankruptcy regulations and taxation also affect the perceived trade-offs.

Table 3.2. The business environment for fostering firm creation and entrepreneurship

Access to skills	Access to capital	Access to opportunities	Influencing the risk-reward trade-off
Entrepreneurial education	Loans and loan guarantees	Administrative simplifications for start-ups	Campaigns to promote entrepreneurship
Publicly supported training, business and technology services	Venture capital	Administrative simplifications of legal framework for existing firms	Bankruptcy legislation
Labour market regulation	Stock markets	Deregulation of protected sectors and competition	Business taxation
	Wealth and bequest taxes	Access to international markets	Income and capital tax
		Spin-offs and licensing from public research	

A total of 14 out of the 16 policy areas can be quantified, and 42 indicators are used to benchmark them. The indicators are a mix of market outcomes, such as the size of the venture capital market, and quantification of policies, such as how long creditors have claims on access after a bankruptcy. All indicators with reasonable country coverage (at least ten OECD countries of which at least three are benchmark countries) are included in the analysis.

Two areas (publicly supported business, training and technology services; and campaigns to promote entrepreneurship) cannot be quantified and will be evaluated using qualitative analysis and an evaluation of the emphasis the benchmark countries put on these issues in their policy formulation.

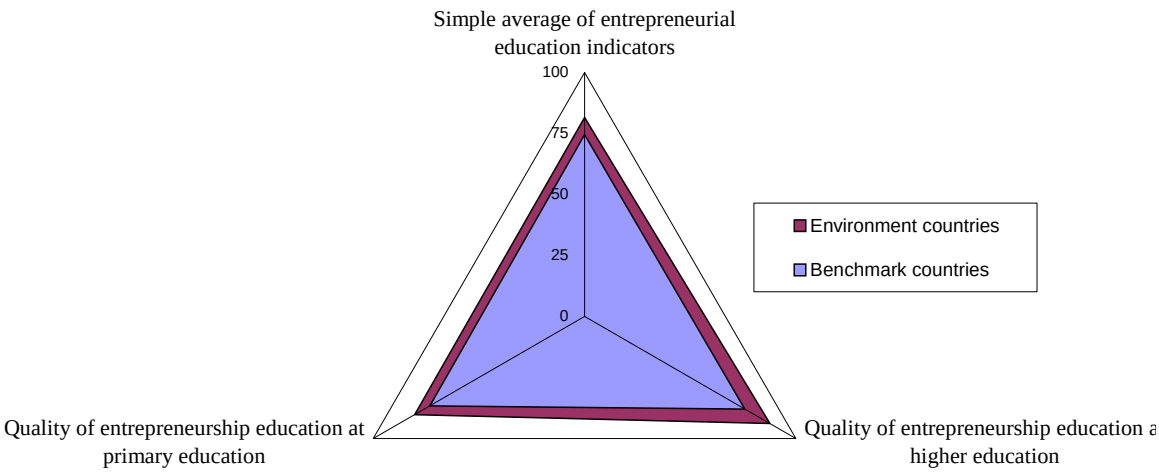
Access to skills

Education can contribute greatly to creating a more entrepreneurial culture, starting with young people at school. Education can also provide entrepreneurs with tools to develop and expand their business, for example through management training and business advisory services. Access to skills is also affected by factors such as labour market regulation.

Entrepreneurial education

No quantitative data are available on entrepreneurship education, mainly because of the lack of a common definition of entrepreneurship education. However, the GEM does ask national experts to evaluate the quality of their country's entrepreneurial education. The responses indicate a high quality of education in the benchmark countries, especially Canada and the United States. This suggests that the area is important for entrepreneurship, and this is supported by a qualitative analysis of the emphasis on entrepreneurial education in the benchmark countries. All countries mention the area as one of the most important for stimulating entrepreneurship. Entrepreneurial education is introduced both in primary schools and at universities (Figure 3.8 and Box 3.3). The United States has maintained entrepreneurship training in primary and secondary schools since the late 1970s.

Figure 3.8. Benchmarking entrepreneurship education in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Publicly supported management training, business and technology services

This area covers all public activities in the advice and training area. Most of the programmes were originally designed for small and medium-sized enterprises (SMEs), but several countries have reformulated their SME policy to place more emphasis on entrepreneurs and less on SMEs in general. The EU's Support Measures and Initiatives for Enterprises (SMIE) database shows that education and training are the objective with the second highest number of programmes in Europe after job creation. The focus of education and training varies widely. Finland differs from other European countries in that more than half of their training programmes are aimed at business development and growth (EU average, 25%). Finland has used its regional network of Employment and Economic Development Centres to advise and train entrepreneurs.

Box 3.3. Indicators of entrepreneurship education

The selected indicators are taken from the Global Entrepreneurship Monitor Expert Survey (GEM, 2003). National teams in each participating country carry out this survey. Experts complete a ten-page questionnaire that provides a standardised measure of their assessments. The United States is the leading country on both indicators.

The indicator of quality of entrepreneurship education in higher education is an average of the following questions: Do colleges and universities have enough courses and programmes on entrepreneurship? Is the level of business and management education truly world-class? Do the vocational, professional and continuing education systems provide good preparation for self-employment?

The indicator of quality of entrepreneurship education in primary education is an average of the following questions: Does teaching in primary and secondary education encourage creativity, self-sufficiency and personal initiative? Does teaching in primary and secondary education provide adequate instruction in market economic principles? Does teaching in primary and secondary education give adequate attention to entrepreneurship and new firm creation?

Similar data are not available for the other benchmark countries, but some information exists. The United States is quite active through the Small Business Administration (SBA). Canada has also been active through the Canadian Development Bank and supplies several interactive training tools for entrepreneurs over government Web pages. Korea's Small Business Administration runs several programmes aimed at innovation and use of new technology in small firms in general but has not focused any services on entrepreneurs.

Labour market regulation

Hiring of qualified people is a great challenge for new, growth-oriented firms. OECD analysis shows, for example, a negative relationship between entry of new firms and strictness of legislation on employment protection (OECD, 2003b). The indicators chosen measure administrative burdens relative to the recruitment of additional workers, firms' flexibility to hire and fire workers, and the level of restrictions on contracts. All benchmark countries except the United States perform around the OECD average on labour market indicators (Box 3.4 and Figure 3.9). The United States has one of the most flexible labour markets in the OECD area. Finland is the benchmark country with the least flexible labour market, with several burdensome regulations for hiring new employees, and Korea has a low score for the indicator measuring conditions of employment. All in all, average values for the indicators in the benchmark countries suggest that this area may not be among the most important for fostering firm creation and entrepreneurship.

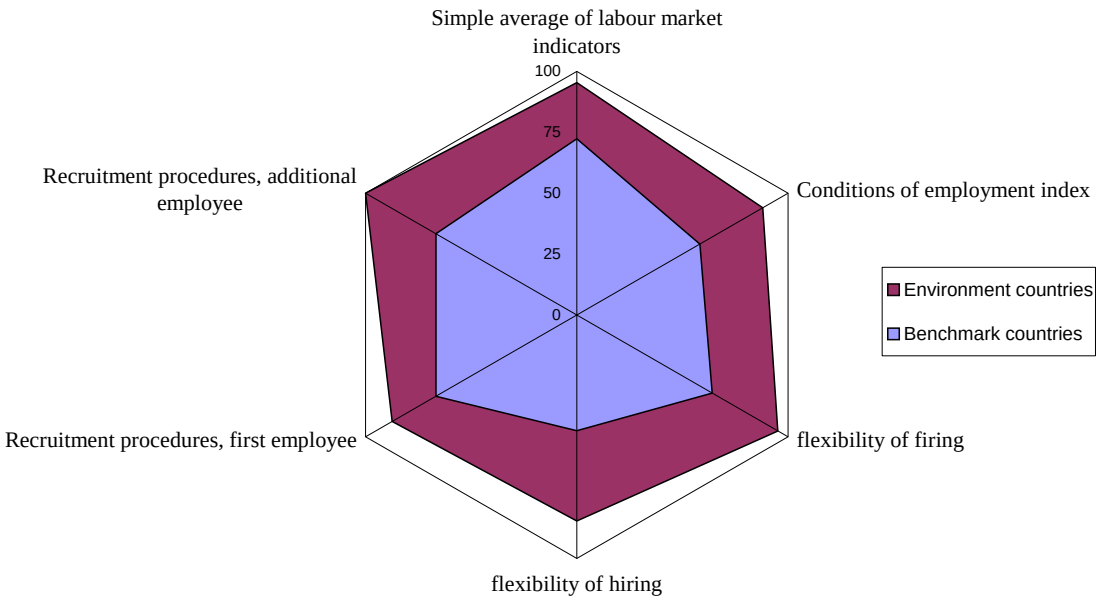
Box 3.4. Indicators of labour market regulations

Five indicators attempt to assess how difficult labour market regulations make it for new firms to have flexible work arrangements and to increase and decrease their workforce.

The first aspect is measured by the World Bank's conditions of employment index, which covers working time requirements, including mandatory minimum daily rest, maximum number of hours in a normal work week, premium for overtime work, restrictions on weekly holiday, mandatory payment for non-working days and minimum wage legislation (rescaled so that higher scores indicate higher flexibility). Denmark has the highest flexibility.

Four indicators (flexibility of firing, flexibility of hiring, recruitment procedures for first employee, recruitment procedures for additional employees) measure the second aspect. The flexibility of hiring and firing are components of the World Bank's Employment Law Index, which compares legal restrictions on employment practices. Both indices are calculated using the same assumptions for workers and employers across all countries. The flexibility of hiring index covers the availability of part-time and fixed-term contracts. Flexibility of firing covers workers' legal protection against dismissal, including grounds for dismissal, procedures for dismissal (individual and collective), notice period and severance pay. Constitutional principles dealing with protection against dismissal are also coded. Both are rescaled so that higher scores indicate higher flexibility. Recruitment procedures for first and additional employees measure the number of administrative procedures needed before and after the start of work (only available for EU countries). Both indicators are rescaled so that a higher score indicates fewer procedures. Sweden has the fewest procedures for hiring new and additional workers.

Figure 3.9. Benchmarking labour market regulation in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

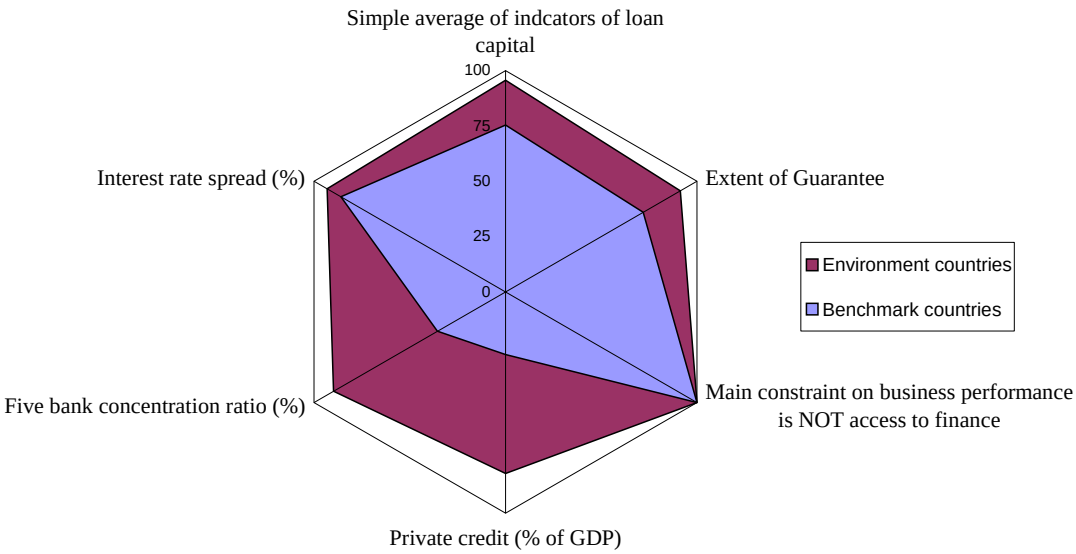
Access to capital

Almost all studies of entrepreneurship highlight access to capital as one of the most critical factors for success. The basic problem is the propensity for an enterprise to be subject to credit rationing that is not neutral with respect to firm size (Stiglitz and Weiss, 1981). Access to capital can be affected through loans or guarantees, venture capital or the stock market. However, founders finance many ventures, and wealth and bequest taxes are therefore important.

Loans and loan guarantees

Most new firms' capital is based on loans, and the great majority of OECD countries offer some form of government-backed guarantee covering loans to small firms (Box 3.5). Some countries even provide government loans directly to firms. The problem for many small firms is their lack of collateral or history. A government guarantee serves as a substitute for collateral. The benchmark countries have relatively high government guarantees compared to other countries and low interest spreads (Figure 3.10). The firms in the benchmark countries do not see access to capital as a major constraint. The size of the market and the concentration of large banks appear less important. The indicator on concentration will not be included in the analysis, as it is a weak proxy for competition. The good performance of all four benchmark countries suggests that this area is important for entrepreneurship. The result is confirmed by several other studies (EU, 2003).

Figure 3.10. Benchmarking loans and loan guarantees in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 3.5. Indicators of loans and loan guarantees

The five selected indicators measure availability of public guarantees and the size and efficiency of the loan market.

Extent of guarantee (% of the credit) measures the average guarantee rate in the government programme. Spain has the highest. This indicator should ideally be supplemented by a measure of the extent of government credit as this varies widely across countries, but such an indicator is not available. An alternative is a survey-based indicator of "finance as a constraint on business performance" and provides SMEs' point of view on access to finance (only available for EU countries). Finland is the country with the fewest number of firms viewing access to capital as the main obstacle.

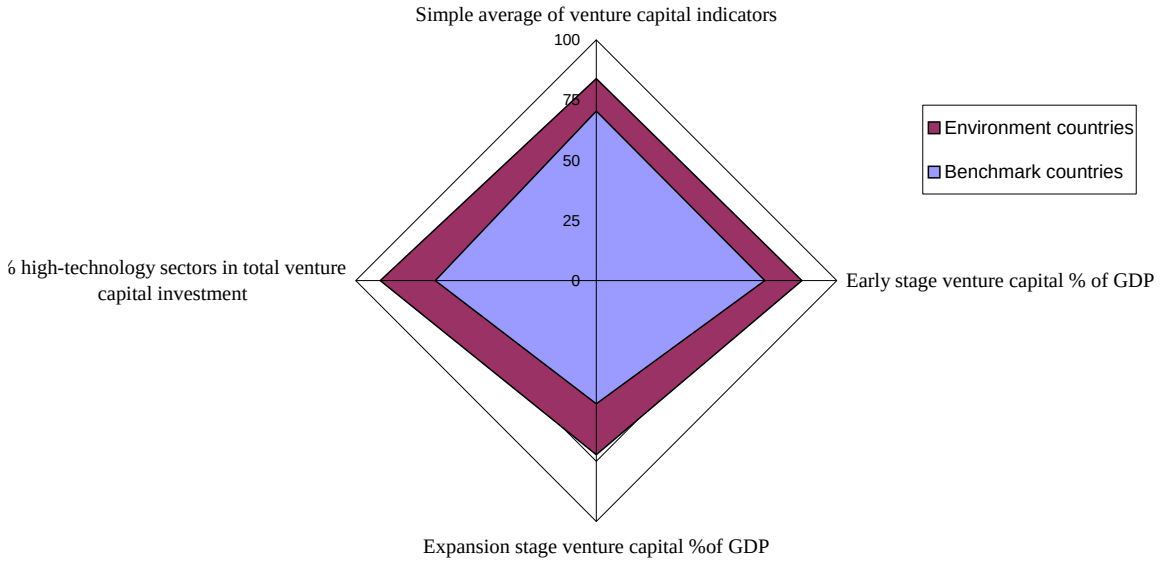
Private credit (% of GDP) measures the ratio of domestic credit (stock) provided by deposit money banks to GDP, average for 1997-2001. Switzerland has the highest share among the OECD countries. The five-bank concentration ratio (%) is the share of total lending held by the five largest banks as of July 2002. Concentration in lending is an indicator of less competition and is associated with less financial market depth (rescaled so that higher scores indicate less concentration).

Interest rate spread (%) measures the spread between deposit and lending rates. Interest rate spreads are an indicator of efficiency and competition in the banking system, with higher spreads indicating less efficiency (rescaled so that higher scores indicate efficiency). The United States has the lowest concentration and interest rate spread among the OECD countries.

Venture capital

Venture capital is a special type of equity finance, typically for young, high-risk and often high-technology firms. These firms need capital to fund start-up, product development or growth and they must, by the nature of their business, obtain this capital largely in the form of equity. Because they rely heavily on intangible assets, uncertain operating environments and negative cash flows, they are unlikely to be able to obtain bank loans or use other debt-financing instruments. The benchmark countries all have mature markets with significant early-stage venture capital (Figure 3.11 and Box 3.6). This suggests that venture capital is an important area for entrepreneurship.

Figure 3.11. Benchmarking venture capital in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 3.6. Indicators of venture capital

The three selected indicators of venture capital measure availability of venture capital (venture capital investment as a share of GDP) and specialisation of investment (investment in high-technology sectors as a percentage of GDP and of total investment).

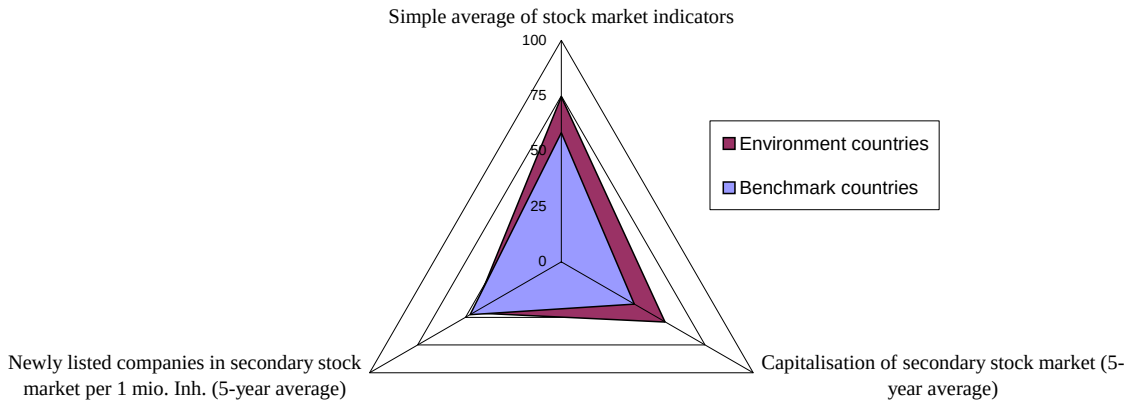
Venture capital investment as a share of GDP is divided into early- and expansion-stage investment and covers an average over the period 1999-2002. Canada has the largest early-stage market and the United States the largest expansion-stage market. Investment in high-technology sectors as a percentage of GDP covers both early stage and expansion in health, biotechnology, information and communication technology. This indicator is a proxy for how mature the venture market is. The high-technology sectors are the most difficult to invest in so high investments in these markets signal a mature market. Ireland has the highest share of high-technology investments.

Stock markets

The existence of an exit mechanism gives entrepreneurs an additional incentive to start a company. Investors are more willing to supply funds to start-ups if they can later recoup their investment through a public stock market offering. However, entry requirements for traditional stock markets may be too stringent and costly for smaller or younger companies that lack collateral or a track record. Thus, an alternative is secondary markets especially geared to smaller, technology-based firms.

The four benchmark countries have mixed results with their secondary markets (Figure 3.12 and Box 3.7). Canada and the United States have well-functioning secondary stock markets, whereas Finland is particularly weak in this area. The mixed performance of the benchmark countries questions the relative importance of secondary stock markets for entrepreneurship.

Figure 3.12. Benchmarking stock markets in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 3.7. Indicators of stock markets

Secondary stock markets are the most relevant for entrepreneurs so two indicators related to these markets are included (capitalisation of secondary stock markets and number of new offerings per million inhabitants). The capitalisation is the value of the stock market divided by GDP and is a proxy for the availability of capital for entrepreneurs. In order to level out differences in business circles across countries, the capitalisation is a five-year average (1998-2003). The use of average capitalisation instead of the latest available year has a great impact on the results, as secondary stock markets in Germany and Japan for example were closed in 2002 and 2003. The United States has the highest capitalisation. The number of new offerings shows how active the market is. Canada has the highest number of new firms in the OECD relative to population.

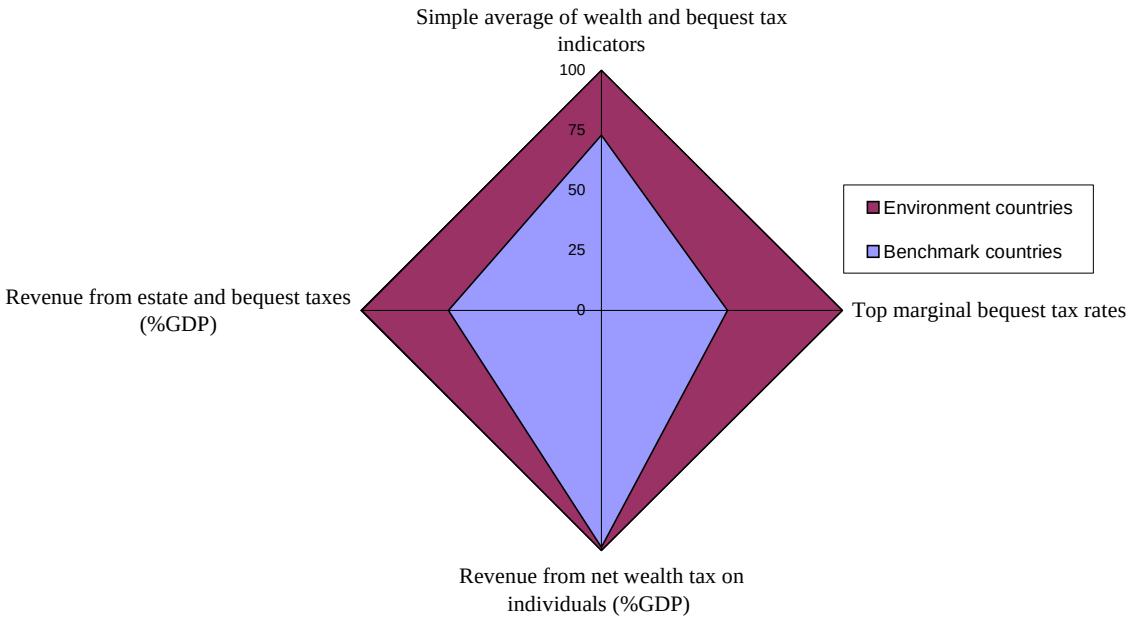
Wealth and bequest taxes

Wealth and inheritance taxes affect the available capital to be invested in new ventures. The two taxes do not, on average, appear important as the benchmark countries are far from being the best countries in the area. However, this covers great differences among the countries and tax instruments. Finland is the only benchmark country that taxes wealth, whereas the inheritance tax rates and revenue from inheritance are high in Canada. Korea and the United States have a low tax rate on bequests, but the revenue in Korea is above the OECD average (Figure 3.13 and Box 3.8).

Box 3.8. Indicators of wealth and bequest taxes

Wealth, estate and bequest taxes affect the capital available for starting up and investing in new firms. The relevant tax systems are very different across OECD countries so a direct comparison of rates is difficult (*e.g.* different rates apply to different brackets). Instead, revenue from the individual wealth tax and revenue from estate and bequest taxes, both as shares of GDP, are used to make the systems comparable. It is not possible to separate bequest taxes from estate taxes in the data. The bequest indicator is consequently supplemented with the top marginal bequest tax rate to ensure that the differences in performance are not driven by differences in taxation. All indicators are rescaled so that higher scores indicate lower taxes. Several countries do not have wealth taxes. New Zealand and the Netherlands have the lowest revenue from estate and bequest taxes.

Figure 3.13. Benchmarking wealth and bequest taxes



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Access to opportunities

Opportunities can be created, but also hampered, by regulation and entrepreneurship programmes. The first policy area relates to making life easier for those who want to start a firm and for existing firms through administrative simplification. The second area related to deregulation and competition, which provides larger markets for new firms. The third area, providing access to international markets, is another possible way of creating larger markets for new firms. Fourth, spin-offs and access to licensing from public research can be an important means of access to opportunities created by public research.

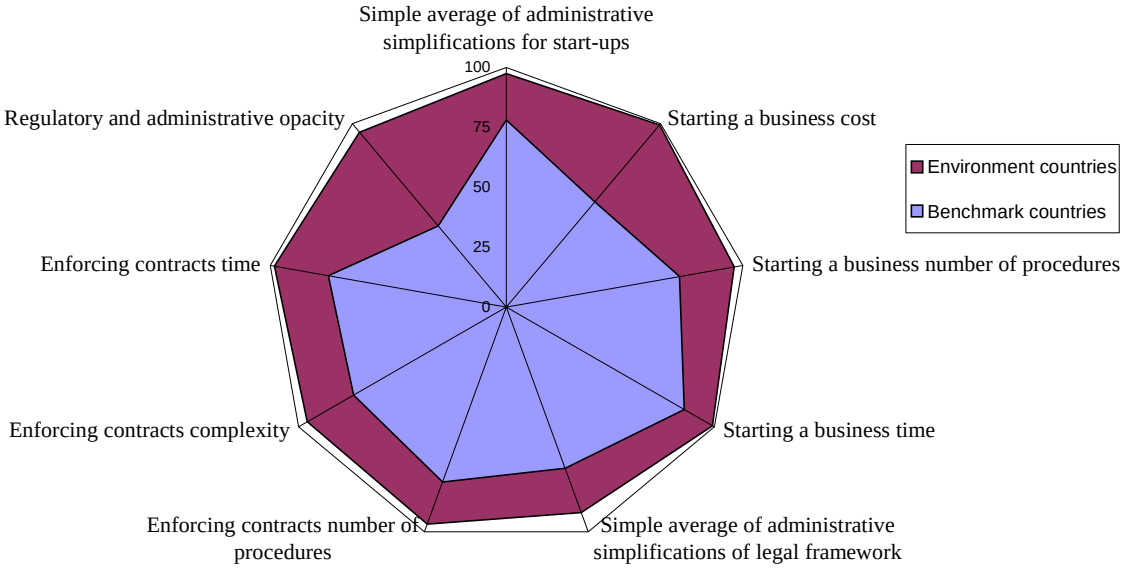
Administrative simplification

The regulatory and administrative environments profoundly affect entrepreneurial opportunities. Administrative procedures and regulations govern how companies are created and what information they must provide their governments. Owing to the fixed-cost nature of regulatory compliance, it burdens small companies disproportionately (OECD, 2001c). Business establishment procedures and time affect the number of start-ups. Studies show a clear negative correlation between the quantity of administrative barriers and MFP growth (OECD, 2001a). Several indicators are included. They are divided into two groups: one that affects start-ups directly and one that affects all firms.

The benchmark countries perform above the OECD average, but are not top performers in both areas of administrative simplification (Figure 3.14 and Box 3.9). Only in terms of the time to start a business do all four benchmark countries perform well. Canada is the only benchmark country that performs well on all the indicators. Finland and Korea have some temporal and procedural barriers for start-ups. The United States has some problems in their licence and permit system and the time it takes to enforce contracts. Korea also has large barriers in the legal framework affecting existing firms. The relatively weak performance of the benchmark countries in this area suggests that administrative

simplification may not be among the most important areas for fostering entrepreneurship even although it unquestionably affects entrepreneurship.

Figure 3.14. Benchmarking administrative simplification



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 3.9. Indicators of administrative simplification

The six selected indicators can be divided into: *i)* barriers for starting up a new firm; and *ii)* barriers for existing firms. The cost, number of procedures and time required for starting a business affect peoples' willingness to start new firms. The text of the company law, the commercial code, or specific regulations are used as a source for the costs associated with starting up a business (measured in terms of gross national income [GNI] per capita). Numbers of procedures are the minimum required of all businesses to get started. All indicators are rescaled so that higher scores indicate lower burdens. Time is recorded in calendar days and captures the average duration that incorporation lawyers estimate necessary to complete a procedure. Costs are lowest in the United States, the number of procedures is smallest in Canada and the time is shortest in Australia.

Barriers to firms' everyday actions are measured by one indicator from OECD regulatory database (regulatory and administrative opacity) and three indicators from the World Bank's Doing Business (enforcing contracts time, complexity and number of procedures). Regulatory and administrative opacity is a composite measure summarising how flexible the permit and licensing system is and how much communication and simplification of rules and procedures are part of a country's policy objectives. The United Kingdom has the lowest regulatory opacity. The three World Bank indicators are defined as follows. The number of procedures is the number mandated by law or court regulations requiring interaction between the parties or between them and the judge or court officer (rescaled so that higher scores indicate fewer procedures). Complexity is a composite measure of several sub-components, such as the written or oral nature of the actions involved in the procedure, from the filing of the complaint to enforcement and level of statutory control or intervention of the administration, admissibility, evaluation and recording of evidence (rescaled so that higher scores indicate less complexity). Time is measured as the number of days from the moment the plaintiff files a lawsuit to the moment of actual payment. This measure includes both the days where actions take place and waiting periods between actions. Number of procedures and complexity are lowest in Australia. The Netherlands has the shortest time for enforcing contracts.

Access to international markets

Access to international markets is mainly a problem in smaller countries. US firms can have substantial growth rates over many years by serving the home market, whereas Finnish firms are "forced" to develop foreign markets to sustain high growth rates. This area may be important for small countries but is likely to play a minor role in larger ones. The two available indicators only measure access to international markets for firms in EU countries. The data are only available for one benchmark country (Finland) and are not shown. Finland has a low share of SMEs exporting and an average share of SMEs with foreign affiliates compared to other EU countries. Based on the very limited availability of data it is difficult to judge relative importance but owing to Finland's low score based on the available data and an assumption that the values would be equally low in the United States owing to the size of the country, the area is not considered very important.

Box 3.10. Indicators of access to international markets

Internationalisation is measured by two survey-based indicators, which are only available for EU countries, Norway and Switzerland. The first indicator shows the share of SMEs that exported in 2001 and the second shows the share of SMEs with foreign subsidiaries. High shares point to active globalisation strategies and can affect the growth rates positively.

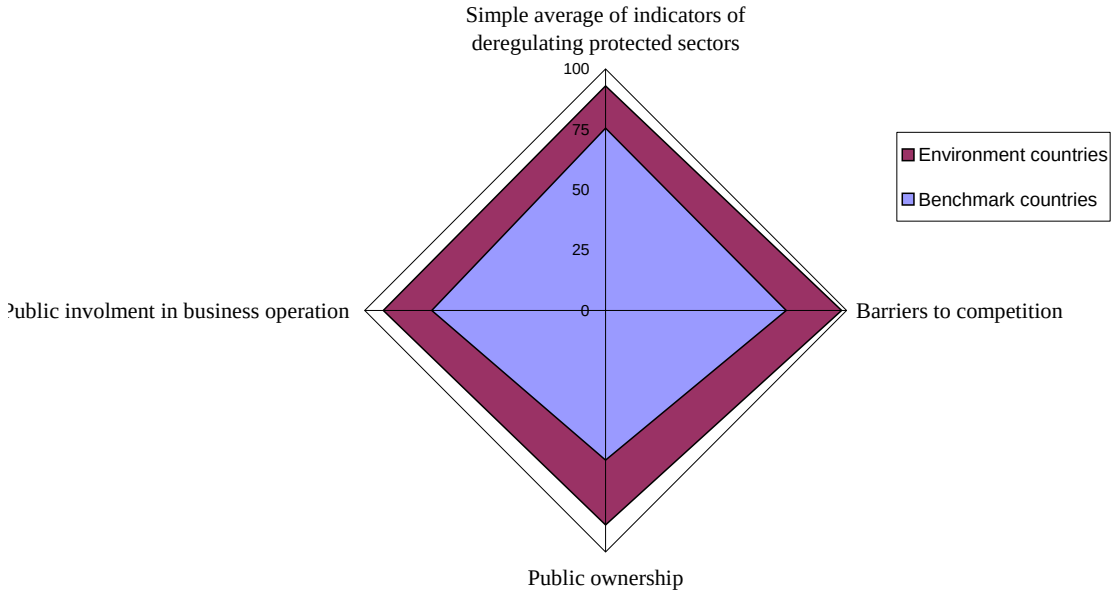
Deregulation of protected sectors and competition

Regulation can reduce entrepreneurship directly by not allowing or hindering entry in some protected sectors. Deregulation is different from the procedures described earlier, as it primarily concerns the degree of competition. Public ownership is one factor, but barriers to competition, such as unclear licensing and authorisation regulations, can play a role. The benchmark countries perform well on these indicators but all benchmark countries have a weakness in one of the indicators (Figure 3.15 and Box 3.11). The United States and Finland have relatively high barriers to competition. Korea has high public involvement in business operation. Canada is on average the best-performing of the benchmark countries in this area, but it still has more barriers to competition than the best-performing countries. All in all, the weaknesses in all benchmark countries suggest that this is not one of the most important areas for entrepreneurship.

Box 3.11. Indicators of deregulation of protected sectors and competition

Three indicators based on the OECD regulatory database were chosen to measure deregulation (barriers to competition, public ownership, public involvement in business operation). These indicators show different aspects of entrepreneurs' ability to start new ventures. Barriers to competition measure antitrust exemptions and legal barriers in the different sectors of the economy that reduce the ability to start new firms. Spain has the fewest barriers. Public ownership is a composite measure of the size of the public enterprise sector, the scope of the public enterprise sector, the control of public enterprises by legislative bodies and the use of special voting rights. A high degree of public ownership leaves less room for private ventures. The United Kingdom has the lowest public ownership. Public involvement in business operation measures the use of command and control regulation and price controls, which also preserve the current industrial structure and reduce entrepreneurship. All three indicators are rescaled so that higher scores indicate a more favourable environment for entrepreneurs. Ireland has the lowest public involvement in business operation.

Figure 3.15. Benchmarking deregulation of protected sectors and competition



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Incubators, spin-offs and licensing from public research

Incubators aim at creating new innovative firms, whereas licensing mostly involves established firms. Incubators provide entrepreneurs with: *i)* administrative and possibly financial supportive to get started; and *ii)* networking opportunities to create growth potential and technology-based ventures. The first reduces the cost and administrative difficulty of starting a new firm and has a positive effect on the number of innovative start-ups. The second is geared towards knowledge creation, technology diffusion and innovative capacity. Data are only available for Finland and the United States. Finland ranks high and the United States performs at around the OECD average.

No indicators exist on spin-offs and licensing. The few data available suggest that even if university spin-offs are small in number they can play an important role in some sectors (Box 3.12). In the Netherlands, for example, about 30% of all firms based on the life sciences started in the 1990s are spin-offs from public research (Bekkers and Steen, 2002). In Germany, about 40 000 technology-based firms are created each year, of which 2 500 are research-based. Spin-offs from public research institutions create about 2% of these research-based firms (FMET, 2002). The United States clearly produces more spin-offs per researcher than any other country (OECD, 2002g). This qualitative analysis suggests that this area might be very important for the creation of high-growth firms; it is discussed further in the section on exploitation of science and technology.

Box 3.12. Indicators of Incubators and spin-offs and licensing from public research

The only available quantitative indicator is number of incubators per small and medium-sized firms. This does not address the quality or the relevance of these incubators and should be judged accordingly.

Influencing the risk-reward trade-off

People evaluate the trade-off between risk and reward differently based on their degree of risk aversion and discount rates. Empirical studies of risk preferences show that people are risk-averse and that risk attitudes vary significantly with respect to several important socio-demographic variables (Harrison *et al*., 2004). Risk aversion may also vary among countries for cultural reasons. It is difficult to affect the cultural aspects through policy, but several countries have used campaigns to increase the entrepreneurial spirit. Bankruptcy regulations play a key role in judging risks and various taxes directly affect rewards.

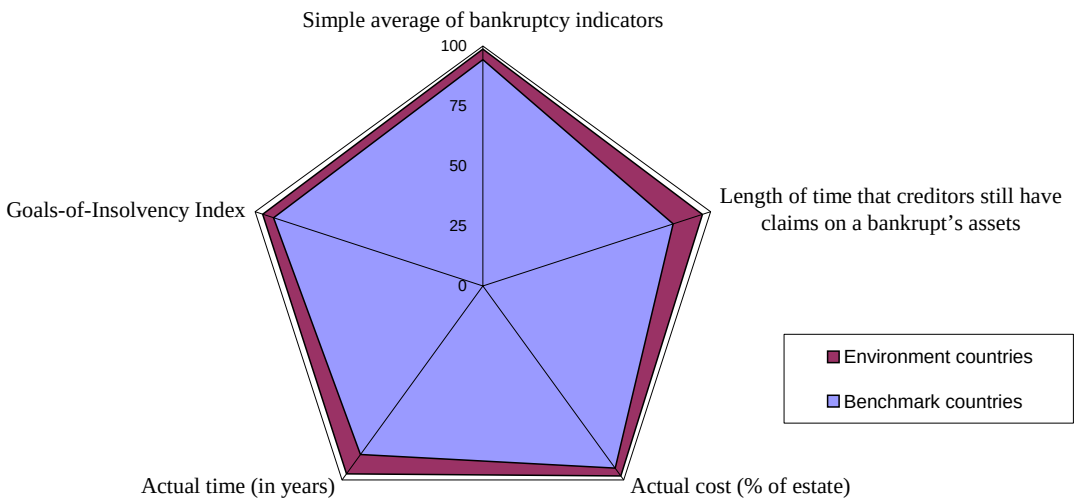
Campaigns

All benchmark countries have (or have had) campaigns and rewards to promote entrepreneurship. The campaigns are often viewed as important and supported by the president or prime minister. In the United States, for example, the president presents a Small Business Person of the Year Award. The Canadian government sponsors a weekly television show, Venture, on entrepreneurs. Entrepreneurship is one of four main focus areas for the current Finnish government, and several events and campaigns are planned. The importance of campaigns can also be illustrated by looking at the share of population that would like to be self-employed. The EU Commission has illustrated large differences between Europe and the United States in the willingness to start a business and suggests campaigns and the use of roles models to narrow the differences (EU, 2004a). However, the only available evaluation of the effects of such campaigns shows limited results (MTI, 2003). While campaigns can supplement other policies and are important for raising awareness, they are not a key driver of entrepreneurship.

Bankruptcy legislation

One of the policy conclusions of the OECD Growth Study was the need to ensure effective closure of unsuccessful firms (OECD, 2001a). In some Asian countries, for example, there is reluctance to declare firms bankrupt owing to the lack of protection for creditors. Potential entrepreneurs may also be discouraged by the difficulty of exiting a business. In many European countries, for example, people who go bankrupt are required to settle all their debts; this prevents them from using their experience and starting up a new firm.

Figure 3.16. Benchmarking bankruptcy legislation in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

The benchmark countries have well-functioning bankruptcy systems with an average of all indicators close to the best (Figure 3.16 and Box 3.13) and only minor weaknesses. In Finland, creditors have a rather long claim on a bankrupt's assets and it takes a long time to close a business in the United States. This area seems to be among the most important for fostering entrepreneurship.

Box 3.13. Indicators of bankruptcy legislation

The four selected indicators assess how easy it is for an entrepreneur to restart after a bankruptcy and the efficiency of the bankruptcy system in dealing with bankruptcy.

Length of time that creditors still have claims on a bankrupt's assets gives a good proxy for how easy it is for entrepreneurs to restart a business. A long time makes it hard for people to restart (rescaled so that higher scores indicate short time).

Actual cost (% of estate) gives a good idea of the efficiency of the system. It is defined as the cost of the entire bankruptcy process, including court costs, insolvency practitioners' costs, the cost of independent assessors, lawyers, accountants, etc. (rescaled so that higher scores indicate less cost).

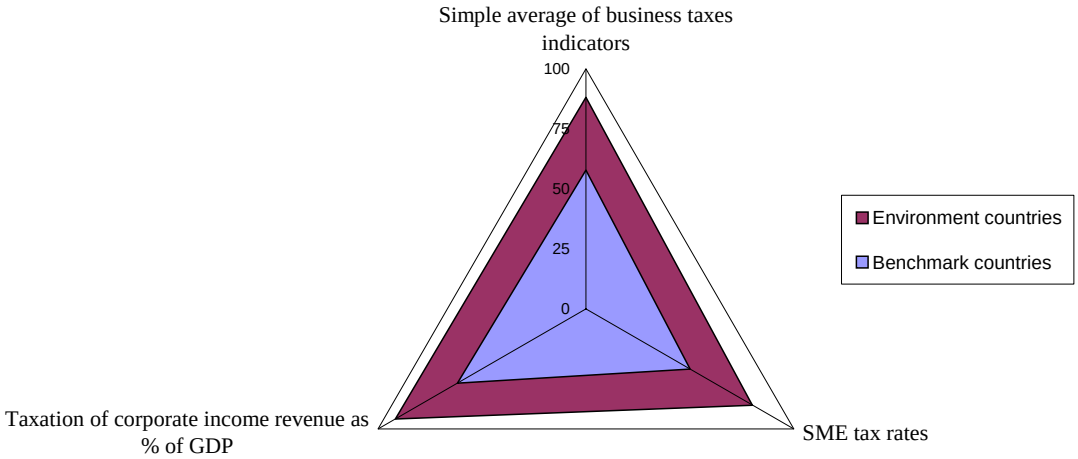
Actual time measures the average duration that insolvency lawyers estimate necessary to complete a procedure in years. If a procedure can be accelerated at additional cost, the fastest procedure, independent of cost, is chosen (rescaled so that higher scores indicate less time).

The Goals-of-Insolvency Index documents success in reaching an efficient insolvency system. It is calculated as the simple average of the cost of insolvency (rescaled from 0 to 100, where higher scores indicate less cost), time of insolvency (rescaled from 0 to 100, where higher scores indicate less time), the observance of absolute priority of claims, and the efficient outcome achieved. The total Goals-of-Insolvency Index ranges from 0 to 100: a score of 100 means perfect efficiency (Finland, Norway and Singapore have 99), a 0 means that the insolvency system does not function at all.

Business taxation

Taxation affects all stages of entrepreneurship. Tax rates and revenues are lower than the OECD average in three of the benchmark countries, and several countries have more favourable tax systems (Figure 3.17 and Box 3.14). This suggests that business taxation may not be a key area for entrepreneurship. The United States is the most favourable and Finland is the least favourable of the benchmark countries.

Figure 3.17. Benchmarking business taxation in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

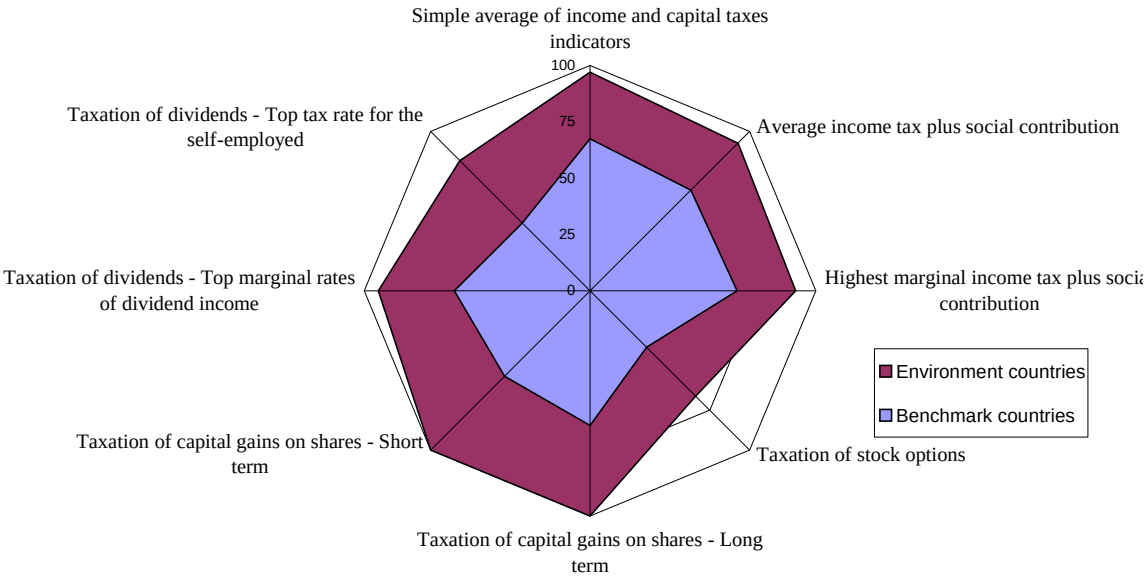
Box 3.14. Indicators of taxation

Business taxation is measured by the corporate tax rate for small firms and by total revenue from corporate taxation as a percentage of GDP (average of 2000 and 2001). The rates only tell part of the story as the situation varies widely among OECD countries. Mexico has the lowest rates, and Germany has the lowest revenue. All indicators are rescaled so that higher scores indicate lower taxes.

Income and capital taxation

Income and capital taxes are favourable in the benchmark countries but, except for Korea, are not among the lowest. Korea has the lowest tax rates for most indicators, whereas Finland has tax rates above the OECD average. The United States and Canada have below OECD average rates. The benchmark countries perform best with respect to marginal taxation (Figure 3.18 and Box 3.15). No clear picture emerges from these indicators, although taxation cannot be one of the most important areas as the four benchmark countries are surpassed by several OECD countries with more favourable tax systems. However, some aspects of the tax system may be important for entrepreneurship.

Figure 3.18. Benchmarking income and capital taxation in benchmark countries



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 3.15. Indicators of taxation

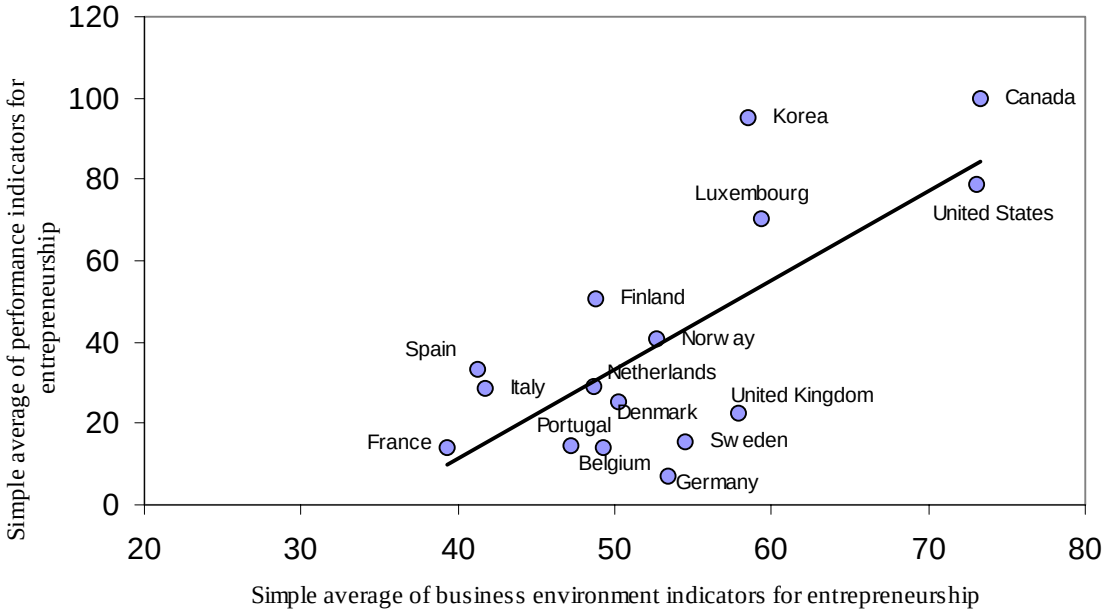
Personal taxation is described by the highest marginal income tax (including employee's and employer's social contribution), as it affects the reward for taking a chance and becoming an entrepreneur, and by the average tax rates (including employee's and employer's social contribution). The use of stock options is common among small high-growth firms, and the marginal tax on stock options is also included. Korea has the lowest rates for all.

Capital gains taxes are often quite complicated and depend, for example, on the size of the investment and how long the capital has been invested. Four different tax rates are included to capture some of the complexity (taxation of capital gains on shares – long term; taxation of capital gains on shares – short term; taxation of dividends – top marginal rates of dividend income; taxation of dividends – top tax rate for the self-employed). Korea has the lowest taxation of capital gains. Italy has the lowest tax rate for dividends, and the Czech Republic has the lowest tax rate for dividends for the self-employed. All indicators are rescaled so that higher scores indicate lower taxes.

From the business environment to performance

The differences in business environment indicators described above can explain large parts of the variation in countries' performance in the narrower domain of creative destruction and high numbers of new growth firms. A simple average of the indicators of the business environment shows a good correlation (0.70) with a simple average of the performance indicators (Figure 3.19). Sensitivity tests show that the choice of weights for the individual indicators plays some role in the analytical findings but that the correlation remains significantly different from zero even with large variations in the weights. In the sensitivity analysis, weights between 0 and 1 were assigned randomly 10 000 times to each of the indicators, both for business environment and performance. The correlation between the business environment and performance indicators varied between 0.55 and 0.79 in the 10 000 different indexes. The correlations were significantly different from zero at least at the 2% level in all cases.

Figure 3.19. The link between business environment and performance indicators in firm creation and entrepreneurship



Note: All indicators are described in Annex 1. R^2 equals 0.51 and the slope is significantly different from zero at the 0.1% level.

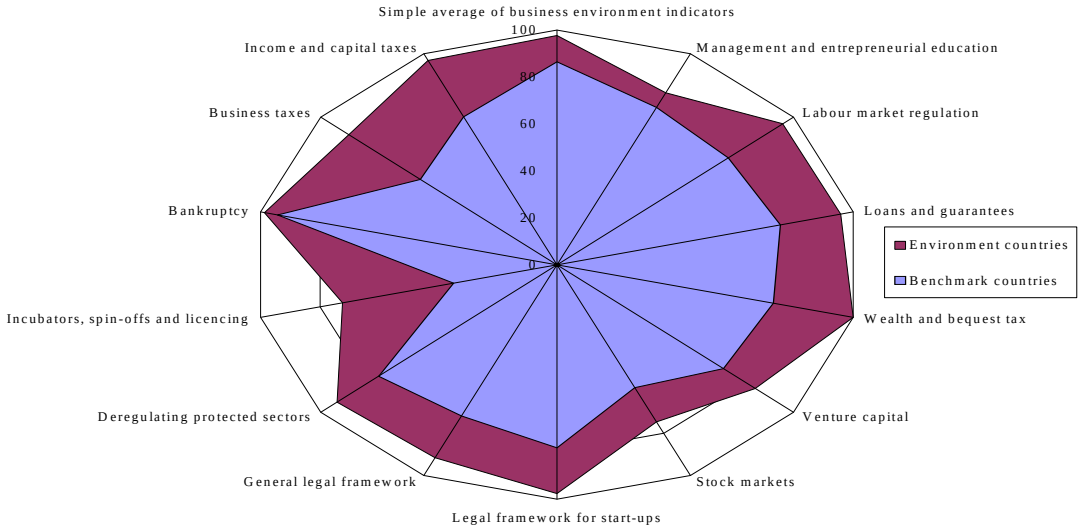
Critical policy areas

The policy areas in the business environment examined are not equally important. This section identifies the areas that are potentially the most important for performance. Two approaches are used to determine the most important areas. First, the benchmarking methodology and spider diagrams found some similarities across the four benchmark countries (Canada, Finland, Korea and the United States), which can be summarised by looking at the 13 quantifiable areas in the business environment (Figure 3.20). This can be seen as a first attempt to prioritise the policy actions useful for fostering firm creation and entrepreneurship. The assumption is that the parts of the business environment for which the four benchmark countries have values close to the best performers on individual areas of the business environment may be more important for overall performance. Second, regression analysis can be used to determine which policy areas have the highest correlation with performance in this driver. Interaction between policy areas can also be examined.

Based on the benchmarking approach, the 13 areas seem to fall into three groups. The first, entrepreneurial education, loans and guarantees, venture capital and bankruptcy may be the most

important for entrepreneurship, as the distance between the four benchmark countries and the best in these areas is small. This group is closely followed by simplification of legal framework for start-ups and deregulation of protected sectors. Taxes, labour market regulation, simplifying the general legal framework, stock markets and incubators seem to be less important. Finally, the discussion of the non-quantifiable sub-areas showed that business services should be included in the second group.

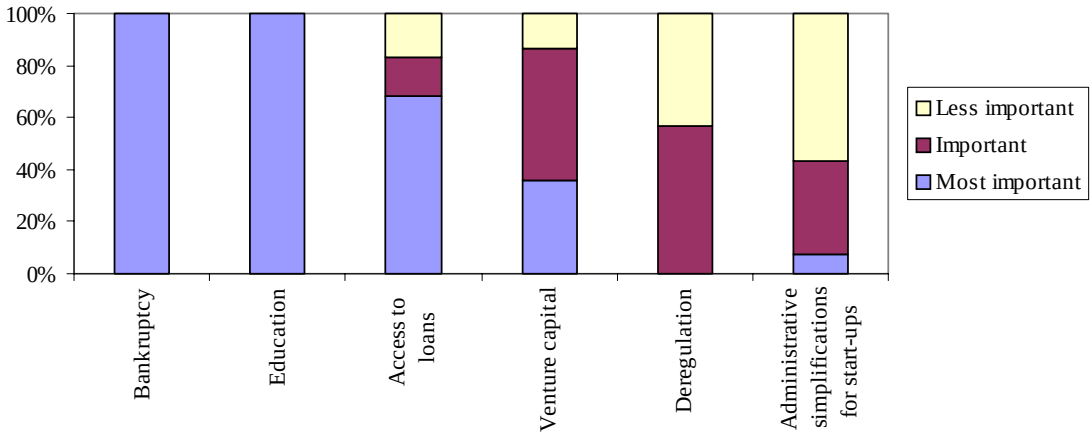
Figure 3.20. Benchmarking the overall entrepreneurship business environment



Note: The spider diagram compares the average ranking of the four benchmark countries (Canada, Finland, Korea and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

The analysis of relative importance can depend on the choice of weights for the underlying indicators in each policy area. However, the sensitivity tests show that most areas are robust to changes in weights. Bankruptcy and entrepreneurial education are the most robust (Figure 3.21) and will always be among the most important areas for entrepreneurship. Access to loans is also relatively robust to changes in weights. Venture capital is less robust to changes in weights and may be less important than the other three. The areas of simplification of legal framework for start-ups and deregulation of protected sectors are not very robust to changes in weights. Only in around 50% of the outcomes of the randomly calculated indices are these two areas among the most important.

Figure 3.21. Sensitivity of the results when weights are assigned randomly



Note: The distance between the benchmark countries and the environment countries determines whether an area is less important, important or most important. The figure shows the share of 10 000 randomly calculated composite indicators for each area in these three groups. The weights to the underlying indicators are drawn randomly from a uniform distribution (0 to 1).

Various correlation analyses show that four policy areas are significantly correlated with the average of the performance indicators (Table 3.3). Three of the four areas are identical to the areas identified in the benchmarking analysis (venture capital, entrepreneurial education and bankruptcy). The benchmarking analysis also showed that loans and loan guarantees were important but the correlation analysis does not confirm this. This is because countries like Germany and France have high values for most indicators for loans and loan guarantees but do not perform well in establishing and growing new firms. Stock markets are also correlated with the performance indicators although this was not found important in the benchmark method. The correlation is robust to changes in the performance indicators included (Annex B)

Table 3.3. The correlation with entrepreneurial performance of the various policy areas

The business environment			
Providing skills	Providing capital	Providing opportunities	Influencing the risk-reward trade-off
Management and entrepreneurial education	Loans and loan guarantees	Administrative simplifications for start-ups	Campaigns to promote entrepreneurship
Public business, training and technology services	Wealth and bequest taxes	Administrative simplifications of legal framework	**Bankruptcy legislation**
Labour market regulation	**Venture capital**	Access to international markets	Business taxation
	Stock markets	Deregulation	Income and capital tax
		Spin-offs and licensing from public research	

Note: The areas in bold are significantly correlated with the performance indicators at the 5% level and those en bold and italics are correlated at the 1% level.

Regression analyses performed at the indicator level and with more advanced techniques show that some aspects of simplification of the legal framework have a significant impact on entry of new firms, suggesting that they should be included among the important policy areas (Annex B). Furthermore, the indicators of income taxes are also significantly correlated with performance. Expanding the analysis with multi-variant regression analysis is difficult owing to the small number of countries with performance data.

All in all, the benchmarking and the regression analysis point to three out of the 13 quantifiable areas as being most important (entrepreneurial education, venture capital and bankruptcy). The benchmarking approach also showed that loans and loan guarantees are an important area but this was not confirmed by the regression analysis. The correlation analysis showed that stock markets are important. The regression analysis at the indicators level showed that income and capital taxes were important and indicated a negative impact of administrative barriers; the importance of both areas was only partly confirmed by the benchmarking approach. These four (loans and loan guarantees; stock markets; income and capital taxes; administrative barriers) are consequently considered somewhat less important than the three areas mentioned above. Finally, the qualitative analysis showed that business services should be included as an important area although the role for government is unclear.

The analysis suggests Canada, Finland, Korea and the United States as the benchmark countries but several other countries could be used to identify interesting policies. The United Kingdom has recently introduced several very interesting new policies, and several UK regions have firm entry and growth rates equal to the best-performing countries. Policy examples from the United Kingdom will consequently also be mentioned in the following discussion of micro-policies.

Policy benchmarks for ensuring efficient bankruptcy regimes

Changes in bankruptcy legislation affect entrepreneurship in two ways. First, they can increase or decrease the risk attached to failure, which directly affects the incentive to start and grow a new firm. Second, they can affect the possibility for starting again after a failure. Several studies show that experience gained in a first failure can increase the possibilities of success in a second venture. Firms started by "re-starters" also grow faster and generate more jobs (BCG, 2002).

However, bankruptcy legislation is also about trade-offs. On the one hand, creditors' interests need to be protected. There is therefore a certain length of time during which creditors have claims on a bankrupt's assets. On the other hand, an entrepreneur's willingness to take chances and start a new business can be negatively affected by this claims period. There is no simple solution, and the countries examined here have taken different approaches (Table 3.4).

Table 3.4. Bankruptcy legislation in examined countries

	Canada	Finland	Korea	United States	United Kingdom
How is bankruptcy initiated?	Voluntarily and involuntarily	Mostly involuntarily but voluntarily is possible	Involuntarily and voluntarily	Almost all are voluntarily filings by managers	Mostly involuntarily but voluntarily is possible
In the case of involuntary bankruptcy, the burden of proof lies with:	The managers	The creditors	The managers	The creditors	The managers
Who decides initially between liquidation and reorganisation?	Creditors can liquidate the firm but normally a reorganisation plan is suggested	Existing managers or creditors. The court has to agree	Existing managers but the creditors have to agree	Existing managers	Outside official or bankruptcy judge
Who proposes the reorganisation plan?	Managers through a trustee	Outside bankruptcy official	Depends on who initiated the bankruptcy	Managers during exclusivity period	Outside bankruptcy official
Length of time that creditors have claims on a bankrupt's assets (for personal bankruptcy)	1 year the first time otherwise it is up to a judge	No maximum but normally 10 years and can be renewed by notification to the debtor.	1 year	1 year	3 years

The United States emphasises the willingness of entrepreneurs to take chances. US laws consequently discourage involuntary bankruptcy. Bankruptcy must be initiated by three or more creditors. As a result, more than 96% of bankruptcies are initiated voluntarily. In Finland, the interest of the creditors is more important, and more than 70% of bankruptcies are initiated involuntarily. The other countries lie somewhere between these two extremes.

Different views on trade-offs are also reflected in bankruptcy procedures. In the United States, firms can choose between Chapter 7 or Chapter 11 of the US Bankruptcy Code. Chapter 7 concerns liquidation and Chapter 11 pertains to reorganisation. It is the responsibility of the firm to decide on the procedures and to write the plan for reorganisation. In the United Kingdom and Finland, this is done by a bankruptcy official. Korea has a mixed system, but creditors initiate most bankruptcies.

In general, bankruptcy procedures reflect a country's institutional structure and legal tradition, and there is a class of procedures that satisfies the main efficiency criteria (Hart, 1999). However, two aspects of the procedures could perhaps be more common across countries: *i)* the time creditors have claims on assets and *ii)* the restrictions on bankrupt persons. The length of time creditors have claims on assets can have a direct effect on entrepreneurs as studies at state level in the United States have

shown (Box 3.16). In the United Kingdom, household surveys show that fear of debt is the most important barrier for new entrepreneurs (SBS, 2001).

Box 3.16. Impact of creditor claims periods

In the United States, the entrepreneur must surrender assets above a fixed bankruptcy exemption level for repayment to creditors, but future earnings are exempt. Each state sets its exemption levels and these vary widely from state to state. An econometric study showed that the probability of a typical non-corporate firm being turned down for credit was 40% higher in states with unlimited exemptions than states with low exemptions. For corporate firms, the rejection rate was 30% higher (Berkowitz and White, 2000). Another study shows that the predicted probability of owning a business is 35% higher for homeowners in states with unlimited exemptions than in states with low exemptions. Renter households in states with unlimited exemptions were 29% more likely to own a business than renters in low-exemption states (Fan and White, 2001).

The period of creditor claims varies from one year in the United States to a lifetime in Finland. Korea, the United Kingdom and Finland have recently reduced or are discussing a reduction of claims time. Reducing the time too much, however, can also create problems. Bankruptcy filings in the United States rose from fewer than 300 000 in 1984 to 1.5 million in 2001, partly because the bankruptcy system makes defaulting on consumer debt an attractive option for many borrowers (US Bankruptcy Institute, 2002). About 5% of consumer loans are never repaid. This can lead to higher interest rates for other borrowers, which in some respects can be seen as a tax on borrowers who repay their debts. The average borrower pays about USD 500 a year in extra charges to cover lenders' losses (White, 2000).

The United Kingdom plans to reduce the length of time that creditors have claims on assets to one year for persons and firms whose bankruptcy was due to adverse events. However, a tougher regime of restrictions will still be in place for bankrupt parties whose conduct has been irresponsible, reckless or otherwise culpable. While remaining entrepreneur-friendly, this approach might reduce the relative level of bankruptcies in the American system. In the Canadian system, the length of creditors' claim time is less than one year for first-time bankruptcies but longer for repeat cases.

Some restrictions on bankrupt persons, *e.g.* limiting their ability to have public posts or act as board members, can attach additional stigmas and dampen entrepreneurship. Many restrictions have become obsolete or are informal. In Finland, for example, no official restrictions are attached to a manager of a bankrupt firm, but in practice he or she will encounter difficulties in dealing with financial and other institutions (EVCA, 2002). The upcoming changes in the United Kingdom will help reduce this kind of stigma by abolishing the Crown's preferential rights to recover unpaid taxes ahead of other creditors. This will reduce the number of people that lose money directly in a bankruptcy and may reduce some of the informal restrictions. On the other hand, tax authorities may initiate more involuntary bankruptcies. However, reduction of the number of people who lose money directly can reduce the stigma attached to bankrupt persons.

Effective policies used in these countries regarding bankruptcy include:

- Giving entrepreneurs a second chance by reducing the time that creditors have claims on assets.
- Introducing tougher regimes for bankrupt parties whose conduct has been irresponsible.
- Reviewing and removing unnecessary restrictions on bankrupt persons.
- Abolishing the state's preferential rights to recover unpaid taxes ahead of other creditors.

Policy benchmarks for increasing access to venture capital

Venture capital or risk finance is essential for the creation and early phases of small technology-based enterprises, owing to the generally risk-averse lending practices of banks and other financial

institutions. There are certain similarities in the venture capital policies of the benchmark countries for this driver. Venture capital investment started as a publicly financed activity, with government equity funds used to pump-prime private capital and reduce imbalances in the allocation of funds across different financing stages, sectors and regions. Substantial amounts of risk capital were channelled to younger and smaller firms that had difficulty in obtaining funds from other sources.

Box 3.17. Venture capital policy recommendations based on peer reviews

***Equity programmes**:*

Use public equity funds to leverage private financing.

Target public schemes to financing gaps, *e.g.* start-up firms.

Employ private managers for public and hybrid equity funds.

Consolidate regional and local equity funds or use alternative support schemes.

Focus venture funding on knowledge-based clusters of enterprises, universities, support services, etc.

Evaluate public equity funds and phase out when private venture market matures.

***Investment regulations**:*

Ease quantitative restrictions on institutional investors to diversify sources of venture funds.

Support the development of a private equity culture among institutional investment managers.

Facilitate creation of alternative investment pooling vehicles, such as funds-of-funds.

Improve accounting standards and performance benchmarks to reduce opacity of venture capital funds and protect investors.

Remove barriers to inflows of foreign venture capital finance.

Taxation:

Reduce complexity in tax treatment of capital from different sources and types of investments.

Decrease high capital gains tax rates and wealth taxes which can deter venture capital investments and entrepreneurs.

Evaluate targeted tax incentives for venture capital investment and consider phasing out those failing to meet a cost-benefit test.

***Business angel networks**:*

Link local and regional business angel networks to each other and to national initiatives.

Ensure linkages between business angel networks and technology incubators, public research spin-offs, etc.

Provide complementary support services to enhance investment-readiness of small firms and increase tier demand.

Second-stock markets:

Encourage less fragmentation in secondary-stock markets through mergers, Nordic or European level.

Enhance alternative exit routes such as mergers and acquisitions (M&As).

Note: Policy examples are available in the individual country reviews. All available at www.oecd.org/sti/micro-policies.

Source: OECD (2004g).

In addition, regulations were eased for institutional investors, such as pension funds and insurance companies that were generally blocked from making risky equity investments in many OECD countries. In the United States, for example, legislative changes to the Employee Retirement Income Security Act (ERISA) freed a wave of pension funds that invigorated the venture capital

market. However, the quality of venture investments is also important. Given the need for competent investors and advisors, government schemes should help to train managers in venture investing and support the development of a private equity culture among institutions. These approaches have been confirmed through peer reviews of ten countries, which resulted in a set of agreed policy recommendations also aimed at second-tier stock markets (Box 3.17).

Policy benchmarks for providing entrepreneurial education

The United States and the United Kingdom have maintained entrepreneurship training in primary and secondary schools since the late 1970s. Along with Canada, they teach young people about self-employment as an alternative career and about the positive effects of entrepreneurship. In the four Atlantic Provinces of Canada, for example, students create ideas, write business plans and run their own mini-firms (Stevenson and Lundström, 2001). In the United States, the Kauffman Centre for Entrepreneurship produces educational materials on the importance of entrepreneurs for the economy and practical tools for creating a business plan (Charney and Libecap, 2000).

Finland, on the other hand, aims to develop broader "entrepreneurship attitudes" involving flexibility, initiative, creativeness, ability to take risks and self-initiative. Introducing entrepreneurship in schools is a way to encourage the entrepreneurial spirit beyond just practical tools. In 2004, the Entrepreneurship Project in Finland will provide a new curriculum that requires primary schools to incorporate entrepreneurship in their programmes and provides guidelines on its implementation.

Introduction of entrepreneurship training has to be done in close co-operation with the private sector. School teachers may not be equipped to teach how to start and run a business unless they participate in new training programmes (EU, 2004). Co-operation also introduces a way to introduce students to role models, which has proven to be very important for people desiring to start a business (Lee *et al*., 2004).

Canada has successfully integrated entrepreneurial education in vocational and pre-college education. In the four Atlantic provinces, for example, over 60% of all students at this level are exposed to entrepreneurship training. All of the programmes have been evaluated and improved (Lundström and Stevenson, 2002).

Entrepreneurship education at the university level is especially advanced in the United States, where the first course dates back to the 1940s at Harvard University (Katz, 2003). Stanford University is very active and is viewed by many as the main driver of the Silicon Valley model, since firms with Stanford alumni or faculty founders now generate more than 60% of Silicon Valley revenues (Box 3.18). In the United States, studies show that, compared to other business school alumni, graduates taught entrepreneurship are three times more likely to start new businesses, have annual incomes that are 27% higher, own 62% more assets and are more satisfied with their jobs (Charney and Libecap, 2000).

Effective policies used in these countries for integrating entrepreneurship in education include:

- Teaching practical entrepreneurial skills and attitudes in early and vocational education.
- Integrating entrepreneurial skills in the university curriculum.

Box 3.18. The Stanford model of entrepreneurship education

Stanford University has had a very close relationship with business dating back to the 1930s, when Professor Frederick E. Terman started fostering entrepreneurship and technical excellence. He encouraged two students, William Hewlett and David Packard, to turn their idea for an audio oscillator into a company. They later donated more than USD 300 million to the university. The close relationship with industry continues today. The engineering school is endowed with a Yahoo! Professorship and a William Gates Computer Science Building. In addition to these formal relationships, informal ties are extensive. Staff and students go back and forth from academia to industry. Flexible employment contracts make it possible for faculty members to have part-time jobs in industry and business people to have part-time faculty appointments. Stanford also emphasises entrepreneurship skills in its courses. For example, in the course on high-tech entrepreneurship, students discuss case studies of high-technology start-ups with the founders and managers of the firms. In the industrial engineering class, students have three months of classes followed by three months of practical internship in the private sector, and then three more months of classes. Stanford also has several entrepreneurship networks on campus that organise regular meetings with venture capitalists and former students. The continuing production of Stanford start-ups and spin-offs is largely due to the ingrained entrepreneurial attitudes of faculty and students and the entrepreneurship embedded in the university culture.

Source: http://corporate.stanford.edu/innovations/index.html.

Policy benchmarks for other important but less significant areas

The three policy areas discussed above were confirmed as important by both the benchmarking approach and the regression analysis. Four additional areas were shown to be important for entrepreneurship but not confirmed by both methods of analysis.

Loans and loan guarantees

Studies on the benchmark countries show financing gaps for both loans and equity – lots of ideas but no money (*e.g.* Industry Canada, 2001a; KPMG, 2001). Other studies demonstrate an entrepreneurial gap – lots of money but no ideas (Industry Canada, 2001b; Mason and Harrison, 2001). Despite uncertainty regarding the need for different types of financing, most countries maintain government loan schemes for small firms.

The US Small Business Administration has, for example, a total value of outstanding loans of over USD 7 billion with an average loss rate of 20% (SBA, 2002). The government has started to make the scheme more market-based. Until 2002, loans were subsidised but now it is necessary to break even except for micro-loans (less than USD 35 000). Furthermore, older loans have been bundled and sold to private investors. In Finland, the state-owned FINNVERA provides loans to cover the financing needs of firms from entrepreneurs to large companies. While these are competitively priced, the government also provides interest rate subsidies (up to 3%) for some clients. The value of new loans in 2001 was EUR 331 million compared to a subsidy element of EUR 98.2 million in 2002.

The SME Promotion Fund in Korea provides government loans for business start-ups and SMEs. To be eligible for start-up loans, firms should be less than three years old. Loans are available for a maximum of eight years with an annual maximum amount of KRW 1 billion for facility investment and KRW 0.5 billion for operating expenses. The government increased the amount spent on these loans from EUR 120 million (KRW 260 billion) in 2001 to EUR 500 million in 2002. Canada also provides low-interest loans to small firms through the Business Development Bank, which has evolved from a lender of last resort to a complementary lender.

There are questions about the cost-effectiveness of these loan schemes as well as loan guarantee programmes, whereby the government covers a given share of a private bank's loss on approved loans to SMEs. The policy challenge is to reduce the dead-weight loss of guaranteeing loans for non-viable firms and to ensure that the loans are as cost-efficient as possible. Analysis suggests that the focus

should be on micro-firms that do not tend to have loans approved at the same rate as other companies. In Canada, for example, firms with fewer than five employees had a loan approval rate of 79% compared with an approval rate of 94% for firms with more than 100 employees (Industry Canada, 2002).

The UK loan guarantee scheme is the most targeted, with a low maximum value for loans and strict eligibility requirements. Consequently, the UK schemes only cover a small fraction of the loans to SMEs, whereas the United States and Korean schemes cover a much larger share. Canada now has a very targeted scheme, but retains a number of outstanding loans from previous programmes. Canada and Finland have the most cost-efficient programmes based on the cost as a percentage of the total value of loans guaranteed. The cost of the Finnish scheme is low owing to the low share of loss cover and the high premium paid by the firms. The Canadian scheme also has high premiums, a low average size loan and a low rate of demands against the guarantee.

Effective policies used in these countries for government loans and loan guarantees include:

- Removing the subsidy element in government loans.
- Increasing the cost-effectiveness and focus of loan guarantees.
- Evaluating loan/loan guarantee programmes and phasing-out as market failures are addressed.

Administrative simplification for start-ups

Administrative burdens discourage entry of new firms, and most OECD countries are actively trying to reduce these burdens through simplification of the legal framework. According to the OECD Regulatory Database, in 1998 the United States and the United Kingdom had the lowest administrative burdens on start-ups, followed by Canada. The United Kingdom and Canada had the lowest compliance costs among OECD countries. Adding the two indicators shows that in 1998 the United Kingdom had the lowest barriers to entrepreneurship of all OECD countries.

The United Kingdom's success is due to continuing government efforts to increase efficiency in the public sector. For example, the Companies House in the United Kingdom introduced staff bonuses that depend on meeting performance targets such as processing 99% of public documents within a maximum of five working days and ensuring that 96% of forms are error-free (EU, 2002). These bonuses created an incentive for employees to reduce registration time and improve quality. Improved quality did not come at a higher cost. The real cost of handling registration and dissolution fell by 18% from 1997 to 2001. The Companies House also has a very high use of ICT. It aims to deliver 100% Companies House capability for electronic service by 2005. The UK approach can reduce both the cost and the time of registration.

Korea has also effectively reduced the number of administrative agencies involved in setting up a new facility and the complexity of the licensing process. Before 1997, a start-up firm needed to receive 53 approvals and licences from various administrations. The government introduced a unified factory establishment scheme, which allows start-ups to receive all necessary approvals/licences with one application. If approval procedures are not completed within 45 days, the application is approved automatically.

The United Kingdom has also suggested an interesting simplification of the tax system that will significantly reduce compliance costs. First, it would simplify the VAT for small businesses by introducing a simpler and lower flat rate. Under a VAT flat rate scheme, traders would avoid having to account internally for VAT on all their purchases and supplies, and instead simply calculate their net VAT liability as a percentage of their total turnover, including all their reduced, zero rate and exempt income. This figure would also include the value of supplies to other EU member states. Second, it

would exempt small businesses from the obligation of submitting audited accounts. Third, it has proposed to make the annual company accounts the basis for calculating tax.

Efforts in the United States and Canada are also interesting. The SBA in the United States is very active in reducing compliance costs by lobbying for the removal or redrafting of different regulations. It estimates that it reduced them by USD 4.4 billion in 2001 by working with regulatory agencies. The United States has also changed accounting standards for SMEs to allow them to use the cash method of accounting to reduce compliance costs. Canada offers businesses the option to report and pay their business taxes electronically. The Canadian government has also been working with small businesses to improve services and reduce compliance costs. For example, Canada Customs and Revenue Agency recently introduced a simplified form for claiming expenses, which small businesses may use instead of the longer form. Finally, Canada has a Business Panel, which evaluates the administrative burdens of all new legislation. This provides regulators with detailed information on how compliance costs can be reduced.

Several countries have used the Internet to allow firms to file taxes or pay VAT. This is a step in the right direction but the Web pages of the various ministries are typically not integrated so the user still has to visit several Web pages to deal with day-to-day business. A piecemeal approach does not work if countries want to focus fully on firms' needs.

Finally, it is important to stress that reducing barriers is a no-regrets policy and is important, but there may be a decreasing return to further reductions for the most advanced countries in this policy area. Barriers may have a threshold effect: if, for example, barriers are below a given level, further reduction will have no effect on start-up activities. Reducing the time it takes to register a new company from three days to one day will likely have very little effect on incentives to start a new firm.

Effective policies used in these countries to simplify procedures for start-ups include:

- Introducing incentives for providing good services in government agencies dealing with small firms.
- Merging application forms from different public agencies and automatic approval of applications after a given time.
- Working with firms to reduce compliance costs in the tax system and simplifying the VAT system.
- Using interactive Web pages organised around the needs of firms.

Income and business taxation

The regression analysis points to high average and marginal income taxes as the main barrier in the tax system to entrepreneurship. The analysis of the four benchmark countries highlights capital gains taxes and taxation of stock options as two very important areas for entrepreneurship.

The United States, Canada and Korea have all introduced large cuts in personal income taxes and capital taxation in recent years. In Korea, for example, income tax and corporate tax is reduced by 50% for venture businesses and new start-up firms for the first six years, beginning from the year they generate business income. The US Congress enacted the largest tax reduction package in a generation, totalling USD 1.35 trillion in 2002. The package included two provisions of importance for small businesses, reduction in the marginal income tax rates and phased-in elimination of the inheritance tax. In Canada the federal government announced the largest tax reductions in Canadian history in 2000, and many provinces have done likewise. These large tax cuts require either cuts in public services or transfers or increases in other taxes. These tax reforms should consequently be seen in a larger context than entrepreneurship, which alone cannot justify such tax cuts.

Investment in the United States has been stimulated by reductions in capital gains tax rates. The capital gains tax rate was reduced from a high of 49% in 1978 to its current low level of 20% between 1981 and 1986. The potential impact of further increases or decreases in capital gains taxes on venture investing in the United States is not clear. The increase in the capital gains tax rates embodied in the 1986 Tax Reform Act, for example, did not have a negative effect on new capital commitments to venture capital funds. On the other hand, the prospect of higher capital gains taxes in 1996 led to fewer companies being traded on the secondary stock exchanges.

Korea has also actively used capital gains tax reductions to stimulate investment in new firms. In the late 1990s, Korea introduced a number of tax incentives aimed at increasing investments in both venture capital and late-phase expansions, including income tax reductions and exemptions from securities transaction taxes and capital gains taxes. Corporate and individual investors can deduct up to 15% of the amount invested from their consolidated income tax base, provided that shares are held for at least five years. In addition, dividend income received from these investments is not included in the consolidated income tax base, but is subject to separate withholding taxes. Capital gains taxes are not levied on gains realised by individuals from the disposal of venture capital investments. Corporations and institutional investors are also entitled to exemptions from capital gains taxes on disposal of investments in firms backed by venture capital.

In many countries, such as Finland, the debate regarding capital taxation relates to people who retire and sell or transfer ownership of their business to families or employees. Measures might be needed, but it is important that these are aimed at getting the money reinvested in new firms. Too often the gains are used to secure the life of the retiring person and are not reinvested in new ventures. It is therefore questionable whether tax reductions are needed for these types of business transfers.

Stock options are one way of rewarding risk. Stock incentives can be a large part of the compensation of founders and managers of young companies. A critical factor in determining the value of options is the accounting for such options (whether or not they are treated as expenses) and the treatment of gains as employment or capital income (if employment income, firms may be liable for social charges). While it is preferable that all options are taxed as employment income if these are given free of charge to employees, some timing issues may be important for small growth firms. Some preferential schemes that already exist in some countries – whereby the gains from options are taxed at the time the shares are sold – could be targeted to fast-growing firms. These firms can use the options to attract key employees without putting a strain on their liquidity. Moreover, such firms often have problems for attracting capital for their investments, so compensating employees with stock options frees up resources. Several case studies show that the success of Silicon Valley firms has in some instances been significantly enhanced through use of stock options. The use of options is also often a requirement of venture investors who want to share risks with the employees of the firm. Introducing tailored schemes for employees of small high-growth firms as in the United Kingdom may be a good way of stimulating firm growth without changing the structure of the tax system.

Effective policies for taxation used in these countries include:

- Focusing on capital gains taxes if tax incentives are used to stimulate entrepreneurship.
- Maintaining regulatory frameworks that do not unduly discourage the development and implementation of stock option plans in small growth firms.

Business services for small firms

All the examined countries offer some kind of government-sponsored business services to entrepreneurs mainly through their policy for SMEs. However, the policy focus has shifted from small firms to entrepreneurship in a number of countries, with a great impact on which services the government supports.

Finland is the country where this shift is most noteworthy. The central objective of the Finnish Ministry of Trade and Industry is to "further entrepreneurship that is independent of state aid". Officially, Finland no longer has an SME policy, but an entrepreneurship policy. Most Finnish SME programmes focus on "innovative/technology enterprises" (almost twice as many as the EU average), giving Finland one of the lowest shares of generic SME programmes in the European Union, even though Finland still has several regionally supported SME-focused programmes.

Several OECD countries have implemented schemes to assist new firms with business plans, organising local networks and establishing single access points to ease their entry into the market. For example, Canada's Web pages for new firms are among the best in OECD countries. They provide, for example, an Interactive Business Planner and a Business Start-up Assistant. The Interactive Business Planner guides potential entrepreneurs through a series of questions to be answered on line. After answering all the questions the potential entrepreneur can use this business plan to obtain external finance. Canada also has some other interesting pages, *e.g.* those aimed at exporting firms. Other countries have regional networks of advisors, but again they often reflect the structure of government rather than the needs of firms: one regional office for training, one central organisation for advice on access to capital, one agency for filing annual accounts, etc. Firms need one simple and logical entry to the public sector. Private firms have used the so-called customer relationship management (CRM) or other management systems to deal with such problems. They reorganise services around customer behaviour and needs. The economic benefits of reorganising public support around such a CRM approach could be substantial.

Finland has taken the most interesting step in the direction of the CRM approach in their advice and support system. The Finnish Ministry of Trade and Industry, the Ministry of Agriculture and Forestry, and the Ministry of Labour have combined their regional forces in 15 Employment and Economic Development Centres (one in each region). Each of the three ministries had one or more agencies in each region, for a total of 77 units. The recent simplification benefits firms by reducing administrative burdens and by creating a true one-stop shop for public support in the regions. Furthermore, it is easier to co-ordinate and tailor support to each region's needs when information ranging from labour policies to technology advice is located in one centre instead of four or five units. The more tailored support can help increase productivity and employment.

Evaluations can have two different purposes: to examine the justification for a programme through its impact on the incentives of firms and individuals; and to improve the conduct, quality, responsiveness and effectiveness of a programme. The United Kingdom and the United States perform evaluations comparing the costs and benefits of programmes, as does Canada to a lesser extent. Other countries, including Finland and Korea, tend to use evaluations to enact smaller adjustments in programmes. The United States and the United Kingdom are somewhat better at changing or phasing out programmes on the basis of evaluations. For example, the United States Small Business Innovation Research programme (SBIR) has been evaluated seven times since its introduction in 1981 and has undergone extensive changes (OECD, 2000a).

Programmes sometimes need to be introduced in new markets or areas for which there are no evaluations to provide guidance. A perceived problem in Finland, for example, is that SMEs do not want to pay for the managerial consulting services they need, even though this could increase their profitability. Other countries have government agencies or subsidised private firms supply the needed services. Finland instead pays most of the costs for small firms that want to buy consulting services for a limited period of time as authorised by the Finnish Employment and Economic Development Centres. This technique of time-restricted subsidies or "pump-priming" is one way of testing programmes in new markets. The public intervention is limited in time, evaluations can be made as the subsidy period ends, and the goal of the subsidy is to foster the development of private consulting services. The United Kingdom has also used this method to create the National Business Angel

Network and the Business Angels Network Association in partnership with a number of clearing banks and other sponsoring organisations.

Use of private consulting firms also solves a major problem – lack of flexibility – in most business service/advice programmes. Such programmes are often managed by government agencies and the advice comes from employees at these agencies, who must be retrained in response to changes in the demand for advice. Using a market-based solution removes this problem, as government agencies can shift suppliers of services when advice is needed in new fields. The SBA in the United States has taken a market-based approach for its training and advice programmes so as to make them flexible and cost-efficient.

Effective policies used in these countries for business services for small firms include:

- Focusing on entrepreneurs that create growing firms.
- Evaluating, modifying and phasing out programmes on a regular basis.
- Using private firms to supply advice and training services.

Chapter 4

SEIZING THE BENEFITS OF ICT

Country performance for this driver relates to the ability to realise benefits from investment in and use of information and communications technologies (ICT). Based on the available indicators of performance, Australia, Canada, Finland, Sweden and the United States are the benchmark countries.

The most important areas of the business environment are identified using both benchmarking and regression analysis. The analysis suggest that the following four policy areas may be the most important: *i)* ICT in schools; *ii)* competition in communication markets; *iii)* e-government; and *iv)* private digital content. The analysis also highlights other areas (ICT-related managerial and organisational change, ensuring a supply of IT workers and online security and trust) that are important for seizing the benefits of ICT. These conclusions may change as the methodology and data improve but are the most robust possible given the available data. Effective micro-policies that have been implemented in the five benchmark countries represent practical solutions to common policy problems and could be adapted by other countries to fit their own context and national situation. The most important micro-policies appear to be the following:

- *Developing ICT skills* by: *i)* defining a national strategy for integrating ICT in schools; *ii)* helping schools buy computers and go on line; *iii)* providing ICT training for teachers; and *iv)* developing educational software and online content.
- *Stimulating competition in communication markets* by: *i)* accelerating the process of unbundling local loops; and *ii)* increasing competition across different communications platforms.
- *Implementing e-government* by: *i)* increasing online government services; *ii)* creating common government portals and standardised Web pages; and *iii)* ensuring online security and privacy.
- *Developing digital content* by: *i)* fostering an adequate technological infrastructure; *ii)* creating an environment that allows for changing business models and entry of new market players; *iii)* clarifying regulatory frameworks; and *iv)* facilitating the exploitation of public-sector information.

The timing of these policies is important. ICT in schools and competitive communications markets are part of a policy package for increased connectivity and ICT readiness, as are many e-government solutions. Policies aimed at developing private digital content and e-government solutions based on reorganisation of government services move beyond basic connectivity to facilitate more widespread uptake and use of complex ICT applications and e-business. These more advanced policies, including stimulating ICT-related managerial and organisational changes in enterprises, are increasingly important as more OECD countries go beyond the stage of ensuring ICT readiness. Finally, two important areas, ICT skills in schools and e-government, signal a very high commitment to invest in and use ICT in the public sector. Neither of these areas affects productivity in the private sector directly, but the high commitment and demonstration effect can affect private firms' willingness to invest in and use ICT.

Selection of benchmark countries

It used to be a puzzle why one saw computers everywhere except in productivity statistics but this is no longer the case. ICTs have boosted productivity growth in three ways. First, enterprises have equipped their personnel with much more computing power. These investments have boosted labour productivity. Second, greater use of ICT has made it possible to reorganise production, consumption and trade to economise on both labour and capital, thereby boosting multi-factor productivity (MFP). Third, production of ICT equipment has seen massive productivity growth. Between them, these three channels have boosted growth. For example, they may have increased US labour productivity growth by around 1 percentage point a year between the early and the late 1990s. Furthermore, recent OECD analysis based on both macro- and firm-level data shows that, despite the recent slowdown and the burst of the bubble in the ICT sector, ICT will persist as a driver of productivity growth (OECD, 2003c).

The present analysis focuses on investment and use rather than on production of ICT (Table 4.1). Not all countries are large producers of ICT. However, they can still enjoy the full benefits of investment in and use of ICT. Furthermore, owing to the rapidly falling relative prices of ICT, the welfare benefits accrue mainly to consumers of ICT, not producers. Good performance in seizing the benefits of ICT consequently results from investment in and use of ICT.

Table 4.1. Performance indicators for ICT

Investment in ICT	ICT use
The contribution of investment in ICT capital to GDP growth	Share of business using the Internet
investment in ICT as a percentage of fixed capital formation	Share of business ordering over the Internet
	Number of PC per 100 white collar workers
	Number of workers using the computers for work per 100 workers
	Pick-up in productivity growth in the ICT-using services in the late 1990s compared to the early 1990s

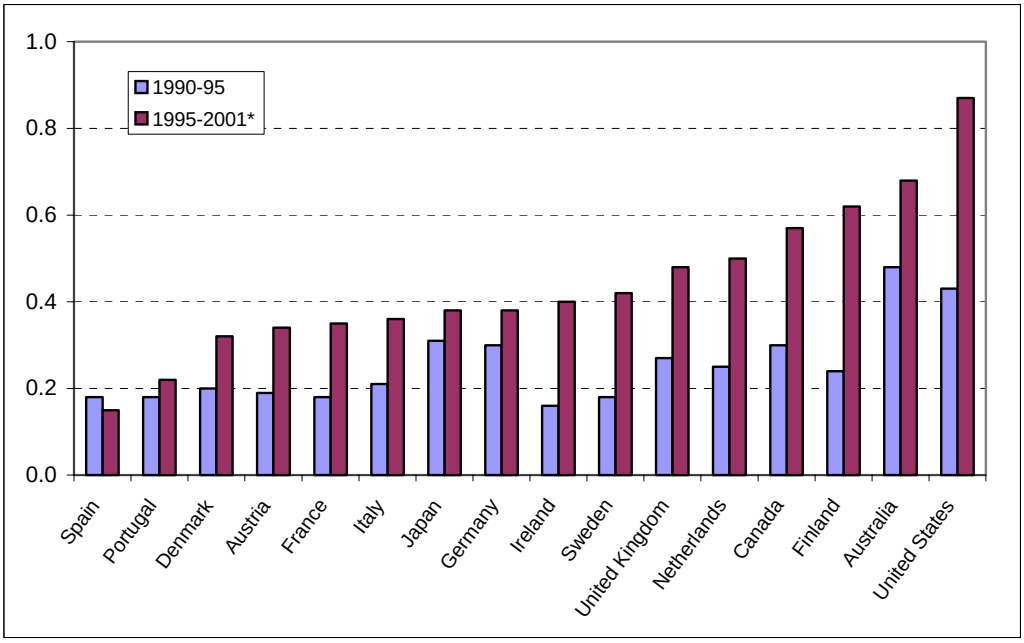
Measuring investment in ICT

Like an investment in any other capital good, investment in ICT contributes to capital deepening and raises labour productivity and thereby GDP growth. It can to some extent be claimed to be an input factor. It is only the productive use of ICT that leads to higher productivity. However, the data on usage is limited, although studies show a significant link between investment in ICT and MFP growth at the firm level. Consequently, investment data are used as performance indicators (OECD, 2004a, Brynjolfsson and Hitt, 2003).

Growth accounting studies indicate that the contribution of investment in ICT to economic growth in the first half of the 1990s was between 0.2 and 0.5 percentage point a year, depending on the country (Figure 4.1). During the second half of the 1990s, this contribution rose from 0.3 to 0.9 percentage points a year. The effects were largest in the United States, followed by Australia, Finland, Canada and the Netherlands, and led to postulations of a “new economy”. Of the 16 countries shown, Spain, Portugal, Denmark and Austria registered the lowest contribution of ICT to economic growth (Colecchia and Schreyer, 2002; Van Ark *et al*. 2002). The calculations have weaknesses that are mainly due to problems with price deflators, but the overall picture is confirmed by several national studies (OECD, 2003d).

Figure 4.1. The contribution of investment in ICT capital to GDP growth

Percentage point contribution to annual average GDP growth

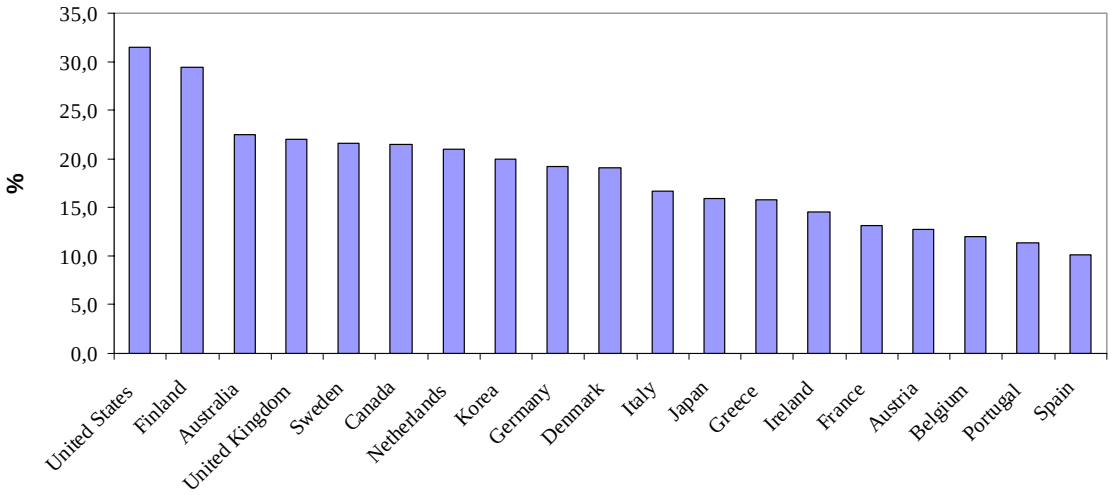


* Or latest available year. National Korean data shows that Korea had an average contribution of 0.5 percentage point in the period 1995-2001.

Source: Colecchia and Schreyer (2002); Van Ark *et al.* (2002).

Another way of judging the benefits of investment in ICT is to examine the share of investment in ICT in total investments. A high share suggests a high return on investment in ICT compared to other investment possibilities, *i.e.* higher benefits from the use of ICT. Investment in ICT as a share of total non-residential investment in the business sector rose from less than 15% in the early 1980s to 30% in 2000. In 2000, it was highest by far in the United States and Finland, followed by Australia, the United Kingdom, Sweden, Canada and the Netherlands (Figure 4.2). Alternatively, the share of investment in ICT in GDP could be used, but the data tend to depend more on the business cycle than on the relative share of investment in ICT.

Figure 4.2. Investment in ICT as a percentage of fixed capital formation



Source: OECD (2003d) and national source for Korea.

The United States, Finland and Australia are candidates for further analysis if investments are judged on the two shown indicators. The United Kingdom, Sweden, Canada and the Netherlands also perform well on both indicators.

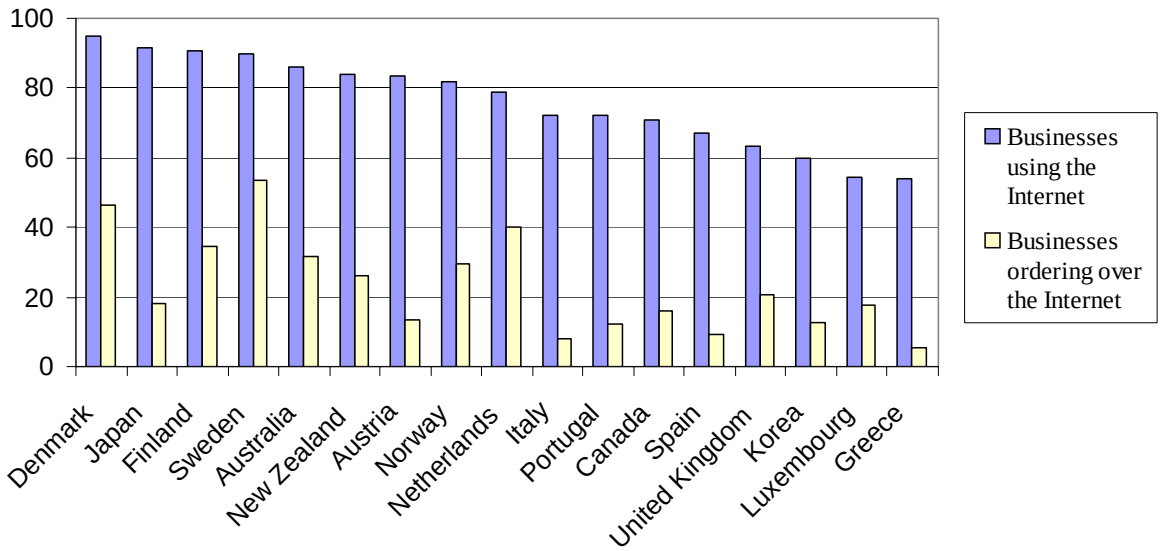
Measuring ICT use

Use of ICT can raise MFP by allowing firms to produce more efficiently. It can also contribute to broader network effects, such as lower transaction costs, higher productivity of knowledge workers and more rapid innovation, which also raise MFP. No direct way of measuring the effective use of ICT exists, as it would require data on the degree of integration of ICT in business processes in individual firms. A comparative analysis of performance in this driver has to rely on indicators that tell part of the story.

The general conclusion from the OECD's firm-level analytical work is that – under certain conditions – ICT use improves firm performance in all countries studied (OECD, 2003d). Different ICT technologies have different impacts on productivity. The greatest effects are found to relate to the use of communications network technologies but also to the use of computers in general. However, most of these effects depend critically on skills upgrading and organisational change, which are difficult to quantify.

The use of communications networks can be captured by an indicator of business use of the Internet and other computer-mediated networks. The more firms use these networks, the higher the productivity gains for the economy. The indicator is available for 15 OECD countries and is based on a survey of firms with more than ten employees. Denmark, Japan and Finland have the highest share of firms using the Internet, while Greece and Luxembourg lag behind (Figure 4.3). Firm-level analysis also shows significant positive effects from buying over the Internet (Clayton and Waldron, 2003). Here the picture is similar for most countries except Japan, Sweden and Netherlands. In Japan only a few firms using the Internet actually place orders over the Internet, whereas in Sweden and the Netherlands, a relatively high share of firms using the Internet place orders on line. Alternative indicators exist and show similar results (Box 4.1)

Figure 4.3. Share of businesses using and ordering of the Internet



Source: OECD (2002b) and national source for Korea.

Box 4.1. Alternative indicators of Internet and PC usage

The two indicators for Internet usage directly measure whether firms actually use the Internet, while the two other available indicators measure whether firms are present on the Internet (number of firms with own Web site; Internet hosts per 1 000 inhabitants). No link between Internet presence and productivity is shown. The number of firms with a Web site has a correlation of 0.64 with the use of the Internet, whereas the correlation between number of hosts in the country and firms using the Internet is lower (0.51) though still significantly different from zero.

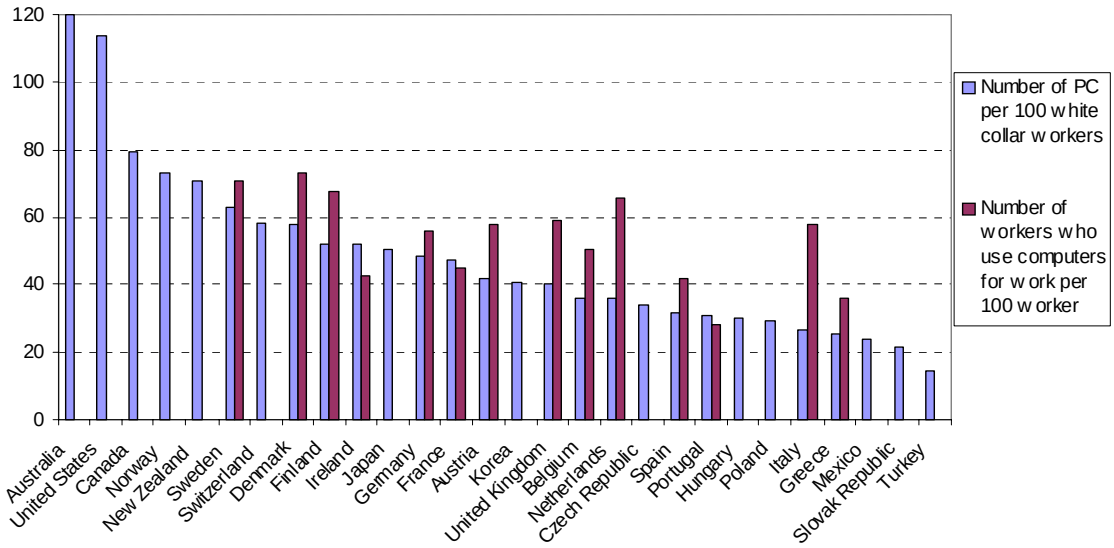
The two indicators applied for the use of PCs by firms are the only two available. Other indicators are presented in various studies but are based on the same basic data (*e.g.* number of PCs per inhabitant) and are consequently highly correlated with the two selected indicators.

An alternative approach is to include measures of household use and access to ICT. However, no studies have shown clear links between personal use of ICT and productivity growth. The indicators for household/individual use of ICT are consequently not seen as performance indicators but rather as input indicators.

The use of computers in firms has also been shown to have a positive effect on productivity in firm-level studies but in most cases only if combined with skilled employees and organisational change. The percentage of employees that use computers in their daily work captures most of these aspects, although the indicator is only available for the EU countries. Alternatively, the total number of computers in the economy (outside of households) normalised with the number of white collar workers can be used. The two measures are highly correlated (0.85), so total number of PCs can be used as a proxy to determine the relative performance of non-EU countries even though it is not directly a performance indicator.

Denmark, Sweden and Finland have the highest share of employees working with computers (Figure 4.4). The three countries also have the highest share of PCs per white-collar workers in the EU. However, Australia and the United States have over 50% more PCs per white-collar worker than the three Nordic countries. Canada and Norway also have a much higher share of PCs per white-collar worker than any EU country. Only two countries (Italy and Netherlands) rank very differently on the two indicators.

Figure 4.4. Employees using computers



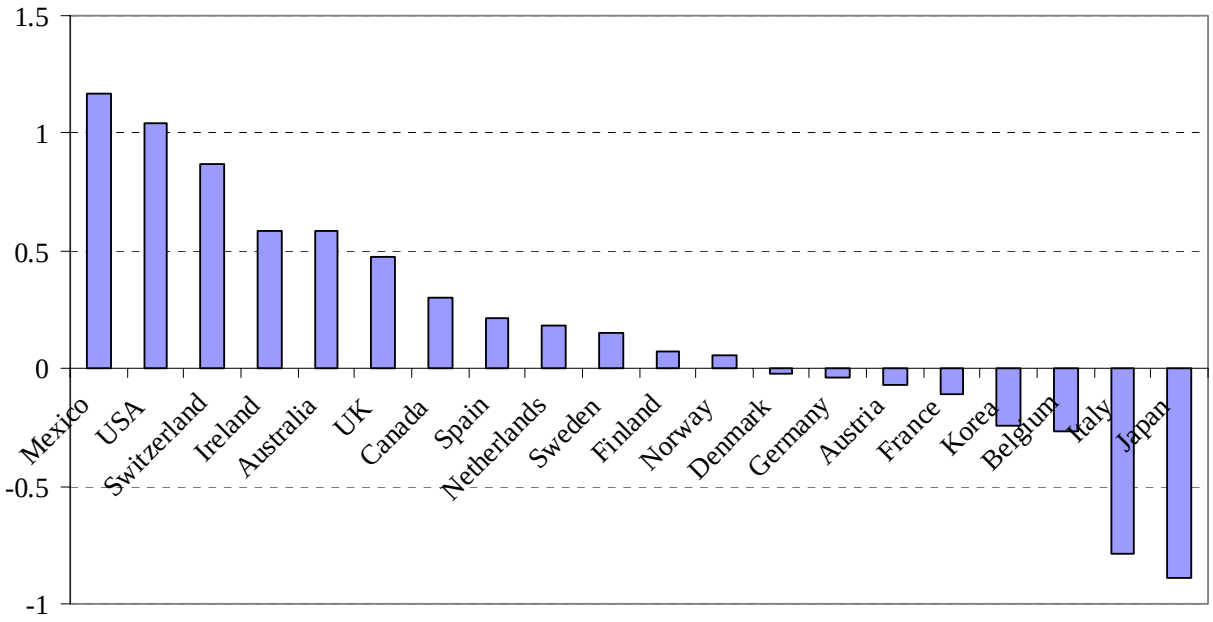
Source: OECD (2002c) and *Eurobarometer (*2001a).

A possible way to measure the impact of ICT usage at the macro level is to examine acceleration of growth from 1990-95 to 1996-2001 in service sectors that used ICT intensively. These sectors comprise wholesale and retail trade, finance, insurance and business services, which all use ICT intensively (Pilat *et al.*, 2002). Firm-level studies confirm ICT usage's strong impact on productivity in these sectors. Thus, countries with the greatest acceleration in these sectors have, other things being equal, benefited most from the use of ICT (McKinsey, 2001; 2002a). McKinsey found that investments in ICT by financial services related to increased automation (*e.g.* lending systems, voice response units); creation of and support for alternate channels (*e.g.* call centres); and scale enablement (*e.g.* realising merger synergies enabled by ICT) had greater impacts on productivity (McKinsey, 2002b). In retail trade, McKinsey also found that ICT played a critical enabling role in the strong labour productivity growth of the 1990s. Across each business process, from merchandise planning and management to store operations, ICT systems enabled better operations (McKinsey, 2002b).

In Mexico, the United States and Ireland, the ICT-using service sectors contributed about five times more to overall productivity growth in the late 1990s than in the early 1990s (Figure 4.5). Mexico's good performance, like that of Ireland, however, is not due to superior ICT usage alone but to a general pick-up in productivity growth in all sectors of the economy. Other countries' rankings are more or less independent of correction in overall pick-up productivity growth.

Several other countries experienced accelerating productivity growth in ICT-using services in the late 1990s. Switzerland, Ireland, the United Kingdom and Canada had a more than 0.25 percentage point higher yearly growth rate in the late 1990s than in the early 1990s. Furthermore, Spain, the Netherlands, Finland, Sweden and Norway also had higher productivity growth.

Figure 4.5. Pick-up in labour productivity in ICT-using service sectors from 1990-95 to 1996-2001



Note: The vertical axis measures productivity growth in ICT-using service sectors in 1996-2001 minus productivity growth in the same sectors in 1990-95.

Source: Based on OECD (2003d).

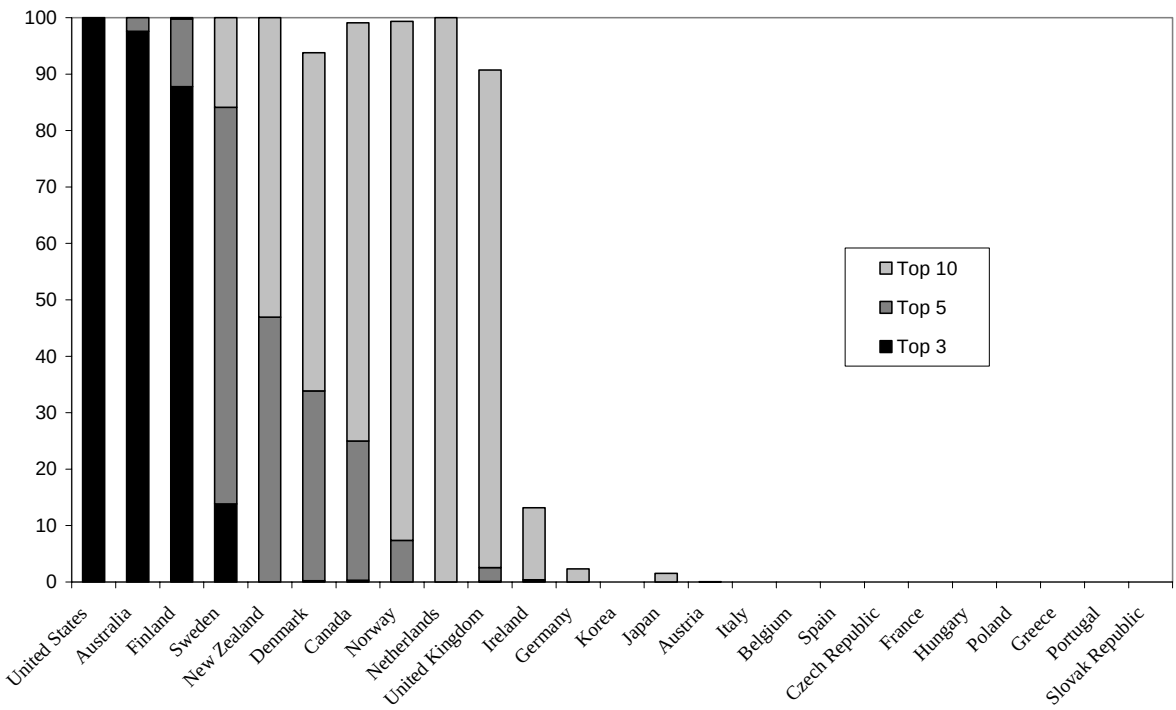
All in all, the five indicators of the benefits of ICT use are a combination of true performance indicators (like pick-up in productivity growth) and indicators that firm-level studies have shown to relate to productivity. The United States is always among the top five countries. Finland, Sweden, Denmark and Japan also do well. Canada does well on two out of three indicators but lags on Internet use.

Selection of benchmark countries

In all, seven indicators were selected to measure countries' performance in seizing the benefits of ICT. There is no information on the relative importance of these indicators, so a distribution of possible composite indicators has been calculated based on random weights. The distribution does not suggest individual rankings of countries but rather a robust division into four groups.

The United States, Australia and Finland are the only clear candidates for a top three ranking. The United States is always among the top three regardless of the weights (Figure 4.6). Australia is among the top three in 97% of the outcomes and among the top five on all indicators. Finland is among the top three in 88% of the outcomes but has a weak point in productivity growth pick-up in the service sector (ranking 11) and ranks sixth in computer usage. All three countries are among the top five in more than 99% of the outcomes of the randomly assigned weights. The only other possible candidate for the top three is Sweden with a top three ranking on 15% of the outcomes. Sweden's weakness is in the contribution of investment in ICTs to growth (ranking seventh) and growth pick-up in the service sector (ranking tenth); otherwise it has top five rankings.

Figure 4.6. Probability of having a given rank with random assigned weights



Note: Mexico and Switzerland have been excluded from the calculation owing to outlier performance in growth catch-up and lack of data on the other indicators. Including Mexico does not change the overall ranking but slightly reduces the top five countries' probability of a top five ranking. All probabilities of top ten rankings are unchanged. Switzerland does well on the two available indicators and could be among the top five, but the available indicators are too scarce for a reliable ranking. New Zealand's probability of top five ranking may be overrated owing to the limited number of available indicators.

The four top countries are followed by a group of three countries (Denmark, Canada and Norway), with Canada the best candidate. Canada does very well on the investment indicators and pick-up of growth, but is weak on the indicator for business use of the Internet (ranking 12). For its part, Denmark does very well on Internet and computer usage, but its investment and pick-up of growth are weak. Norway has missing data for the share of investment in ICT and investment's contribution to growth, for which the other Nordic countries had relatively low values. Its ranking is consequently based on computer and Internet use, where its performance is average. The Norwegian ranking is higher owing to missing values for the investment indicators and should consequently be treated with more care than that of Canada and Denmark for which all indicators are available. The high ranking of New Zealand is, like that of Norway, based on good performance on Internet and computer usage, but all investment and pick-up indicators are lacking.

All in all, the analysis suggests that further analysis should be based on the experience of Australia, Canada, Finland, Sweden and the United States. These five countries are the benchmark countries.

Quantifying the business environment

Previous OECD analysis has identified four factors that affect the ability of households, enterprises and governments to seize the benefits of ICT (OECD, 2002c). In its simplest form, it depends on access to ICT, on skills and on organisation (OECD, 2003c). Growth of the Internet can create additional benefits by creating access to high-quality digital content developed both by private firms and government agencies (OECD, 2003e). Finally, firms with access to ICT, skills and content may not use ICT to its full potential if they do not trust the technology or security on line (OECD, 2003c).

Ten policy areas affect the four factors (Table 4.2). Access to ICT is affected by expenditure on ICT and competition in ICT markets. Government policy mainly affects competition in the communications market, while other ICT markets have more or less free competition. ICT skills can be categorised as basic, applied and professional. Basic and applied skills are learned either in schools or labour training programmes and professional skills are primarily learned in tertiary education (OECD, 2002c). Furthermore, management needs access to the right skills in order to integrate ICT in the organisation. Digital content can either be produced by the private sector or by the government as e-government. Finally, security and trust depend mainly on ICT-related regulations and institutions, but also on relative awareness of these. Several countries have also included applied and basic research programmes in of their ICT policies. These programmes are addressed in the chapter on exploitation of science and technology

Table 4.2. Business environment for seizing the benefits of ICT

Access to ICT	Access to ICT skills and organisational change	Access to digital content	ICT security and trust
Competition in communication markets	Basic and applied ICT skills in schools	E-government	Awareness of security
Expenditure on ICT	Basic and applied ICT skills in the workforce	Private digital content	Regulations and institutions
	Professional ICT skills		
	ICT-related managerial and organisational change		

Most of the areas in Table 4.2 cover factors that can be compared and benchmarked across countries by indicators quantifying the business environment. In all, 32 indicators are used to

benchmark the business environment for seizing the benefits of ICT. Comparable indicators do not yet exist for ICT-related managerial and organisational change and online security and trust. Qualitative data are used for these two areas.

The following sections use spider diagrams in an attempt to identify similarities in the business environment across the five benchmark countries (Australia, Canada, Finland, Sweden and the United States).

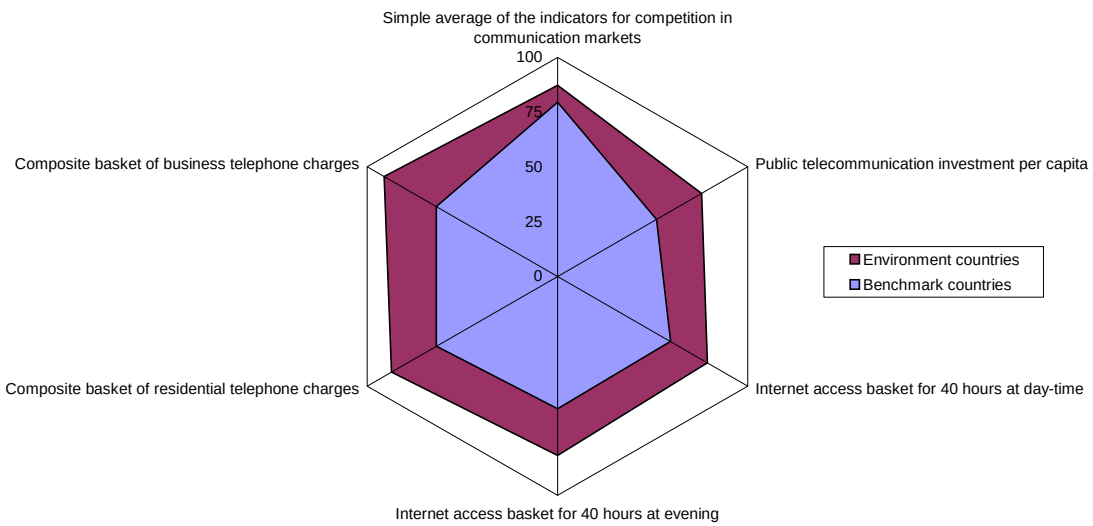
Access to ICT

Access to ICT is the outcome of supply of and demand for ICT. The supply of computers and software is more or less unaffected by government policies in most OECD countries as the markets are quite competitive. This part of supply is consequently not discussed. The supply of communications connections is however highly affected by government policies (OECD, 2001d). Firms' and households' expenditures on ICT determine demand for ICT. These expenditures are affected by national income but also by government subsidies and tax incentives.

Competition in communication markets

Effective competition in communication markets lowers prices for both telephone and Internet access, and four of the five selected indicators are price indicators for telephone charges and Internet access costs. However, effective competition should not only lower prices but also expand the network. The last indicator therefore measures investment in communication networks mainly by private firms (Figure 4.7 and Box 4.2).

Figure 4.7. Benchmarking competition in communication markets in selected countries



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 4.2. Indicators of competition in communication markets

Investment in public telecommunications measures all investments in the basic telecommunication infrastructure primarily made by private firms in 2001 relative to GDP per capita. These investments are a proxy for the development of a country's communications infrastructure. The highest investments are in the United States with USD 335 per capita.

Unfortunately Internet prices only exist for limited use of the Internet (daytime and evening prices for access), so it is not possible to benchmark the access price for firms with greater use of the Internet. The lowest Internet prices for both day and evening access in the OECD are in Canada with USD 15.7 for an Internet access basket of 40 hours at daytime or night-time discounted PSTN rates including VAT.

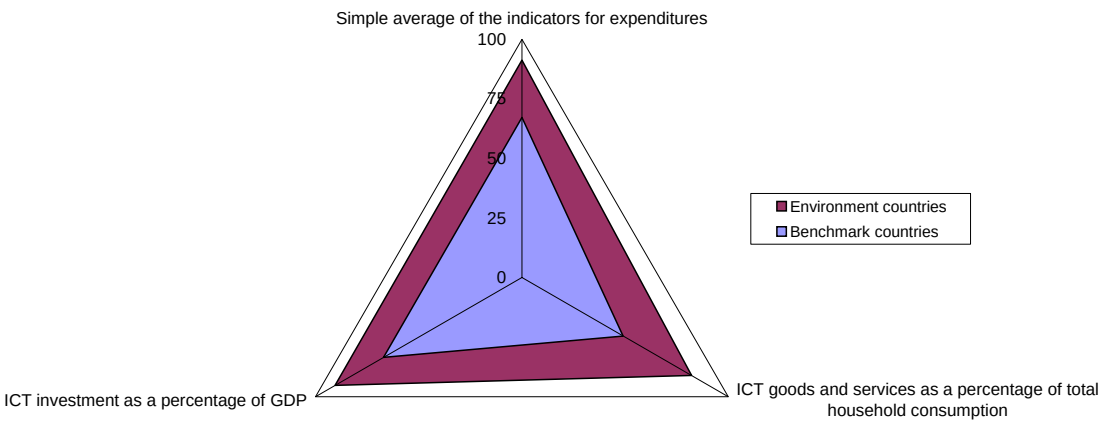
The composite basket of telephone charges is a cost measure of well-defined use of residential and business telephone, based on the OECD Communications database. Ireland has the lowest prices for the residential basket and Iceland has the lowest business prices. The baskets cover average household use of the telephone and the business basket covers an average small business.

The benchmark countries perform well in this area on average, which suggests that it may be among the most important for seizing the benefits of ICT. Canada is the benchmark country that does best, with the highest average for the selected indicators among all OECD countries. The United States also does very well in this area, with the highest communication investments and very low Internet prices. Sweden also performs well, especially on indicators relating to telephony. Australia and Finland have some weaknesses in competition. Telephone charges are above the OECD average in Australia. Finland has below-average investment in telecommunication. The good average performance of the benchmark countries is due to the very good performance of Canada and the United States, but some other OECD countries might perform better than the benchmark countries in terms of telecommunications investment per capita, for example, but have very high Internet prices. The benchmark countries have fewer major weaknesses than the other countries.

Expenditure on ICT

Expenditures can be measured directly by two indicators. Business expenditures on ICT can be measured as investment in ICT as share of GDP. Household expenditures on ICT can be measured as ICT goods and services as a percentage of total household consumption (Figure 4.8 and Box 4.3).

Figure 4.8. Benchmarking ICT demand in selected countries



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 4.3. Indicators of expenditure on ICT

Expenditures can be measured directly. Business demand for ICT can be measured as total investment in ICT as a share of GDP per capita. The main categories of investment in ICT are office and data processing machines; precision instruments; optical instruments and photographic equipment; telecommunication equipment and measuring equipment; electronic equipment; radio and television; gramophone records; and software. Software investment is not as yet available for all OECD countries. The United States has the highest investment in ICT, with 5.3%.

Household demand for ICT can be measured as ICT goods and services as a percentage of total household consumption. The main categories included in household expenditure are: telephone and telefax equipment; telephone and telefax services; equipment for the reception, recording and reproduction of sound and pictures; photographic and cinematographic equipment and optical instruments; information processing equipment; pre-recorded recording media; unrecorded recording media; and repair of audio-visual, photographic and information processing equipment. Expenditure on videogame software is excluded, since it cannot be separated from the household expenditure category "games, toys and hobbies". Korea spends the highest percentage of consumption on ICT with 6.3%.

Both indicators are based on the OECD database on purchasing power parities.

The benchmark countries on average do not spend much on ICT and this may not be among the most important areas for seizing the benefits of ICT. Firms' investment in ICT is high in Sweden and the United States, but it is low in Canada and Finland. Households in the top-performing countries spend around the OECD average of their income on ICT goods even though they are top performers on most indicators of household access to ICT (OECD, 2003e). Low ICT prices and high incomes in the benchmark countries explain part of this apparent inconsistency.

Access to ICT skills and organisational change

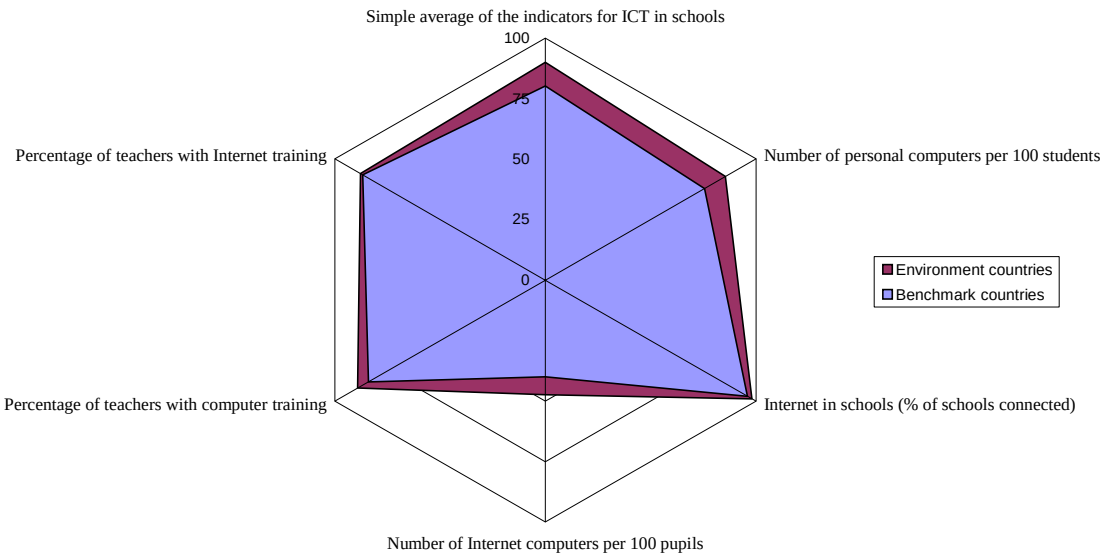
Government plays a large role in providing citizens with ICT skills. Its role is most prominent in schools, but public training programmes for people already in the workforce are also available in most countries. Many countries also play a large role in stimulating the supply of professional ICT skills, which are primarily gained in tertiary education (OECD, 2002c). Finally, some countries have programmes aimed at ICT management training and organisational change.

Basic and applied ICT skills in schools

The government mainly plays a role in ensuring that children have access to ICT in schools and that their teachers receive the proper training. The chosen indicators reflect this and measure access to ICT. Three measures of access are used, number of computers per 100 pupils, number of schools connected, and number of Internet computers per 100 pupils. The number of schools connected gives an idea of the distribution of connectivity across the country, and the number of Internet-connected PCs illustrates how many students have Internet access. The training of teachers is measured simply as the share of teachers who have received training in the use of PCs and training in use of the Internet (Figure 4.9 and Box 4.4).

Access to ICT in schools and teacher training are very high in the benchmark countries, which suggests that this area may be among the most important for seizing the benefits of ICT. The United States and Finland have the highest shares of computers per student. In Sweden and Finland, all schools have Internet access. The benchmark countries score lower on the relative number of Internet-connected PCs. The five top performing countries also perform well on teacher training. Finland has the world's largest share of teachers with ICT training.

Figure 4.9. Benchmarking basic and applied ICT skills in schools in selected countries



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 4.4. Indicators of ICT in schools

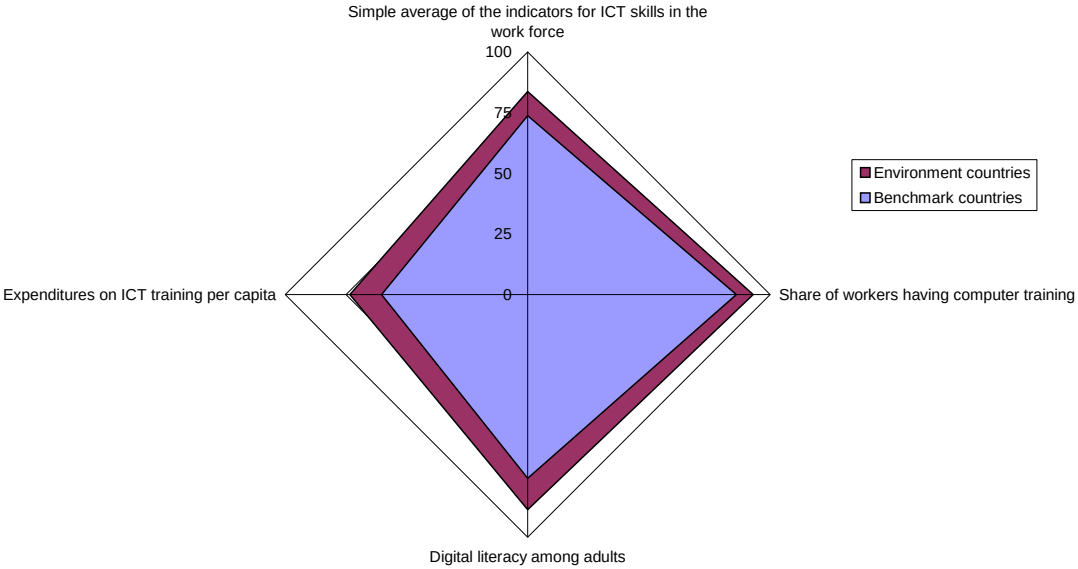
To provide ICT in schools students need access to ICT and teachers need training. Both conditions can be quantified and measured. Number of personal computers per 100 students is simply the total number of computers in primary schools divided by the number of students, and is highest in Sweden with 27 computers per 100 students. The number of schools connected measures the share of schools with Internet access, which is 99% in both Sweden and Finland. The number of Internet-connected computers per 100 pupils measures how many computers in schools have Internet access and is highest in Denmark with 25 computers per 100 students. The training of teachers is measured simply as the share of teachers who have received training in the use of PCs and of the Internet. Finland has the highest share of teachers with computer training (76% of all teachers) and Denmark has the highest number of teachers with Internet training (56% of all teachers).

Basic and applied ICT skills in the workforce

Two indicators measure directly the share of the workforce with basic and applied ICT skills, the share of workers with computer training and workers' digital literacy. Digital literacy among workers is the most useful measure as it indicates whether workers can actually apply ICT skills in day-to-day work. However, digital literacy is only available for some EU countries and is based on a rather small sample. The indicator of computer training consequently supplements the indicators. Another way of measuring ICT skills is to look at expenditures on training. This measure is available for a few non-EU countries and can be used as a proxy for ICT skills in these countries (Figure 4.10 and Box 4.5). The three indicators are as expected highly correlated.

The benchmark countries do not on average perform well in this area, which suggests it is less important for performance. There is a large variation among the benchmark countries. The United States and Sweden do well on all indicators, and Australia lags behind.

Figure 4.10. Benchmarking ICT skills in the workforce



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 4.5. Indicators of ICT skills in the workforce

Three indicators are used to assess the availability of basic and applied ICT skills in the workforce. Two of them (digital literacy among adults and share of workers with ICT training) directly measure skills and the amount of training workers have received. Workers with training reflect more formal ICT training whereas literacy among adults measures the result of both informal and formal training; they are in many respects the best indicators for this area, but are only available for EU countries, and are consequently supplemented by others. Denmark has the highest values for both indicators in the EU (55% of all workers with computer training). The last indicator measures firms' expenditure on ICT training per capita. Sweden spent most on ICT training per capita (USD 53).

Supply of workers with specialised ICT skills

The benchmark countries have a high share of specialised ICT workers – defined as those with the ability to use advanced ICT tools and/or develop, repair and create ICT tools – in the labour force compared to other OECD countries (Box 4.6). Sweden is an outlier with a very high share of specialised ICT workers. The average of the five benchmark countries is consequently about 75% of the Swedish number but quite close to the average of the five environment countries on this indicator. This area consequently appears to be important for performance but the lack of indicators makes it difficult to make robust conclusions. The optimal number of specialised ICT workers also depends on the country's industrial structure.

Box 4.6. Indicators of specialised ICT skills in the workforce

Only one indicator is available to measure number of workers with specialised ICT skills – the share of computer workers in total labour force. Computer workers are defined as people working in IT-related occupation (OECD, 2002c).

ICT-related managerial and organisational change

Comparable indicators do not yet exist for ICT-related managerial and organisational change. The relative importance of this area is judged by the results of a peer-review process of several OECD countries' policies for stimulating diffusion of ICT to business, which was performed in the Working Party on the Information Economy, along with a qualitative analysis of the emphasis on this area in the top-performing countries.

ICT-related managerial and organisational change is seen as important in all benchmark countries, although they differ on the extent of the government's role (OECD, 2004a). However, countries do agree on the importance of ensuring that labour market regulations do not hamper new work practices and on the need for providing hard evidence on the benefits of implementing ICT in combination with organisational change to support overall business strategies. Peer reviews of policies for stimulating diffusion of ICT to business show a need for such policies, as the real benefits of ICT occur when ICT is an integral part of organisational and business processes (OECD, 2004b). This area should consequently be considered as important although not of the highest priority.

Access to digital content

Online content can be created by both the public and the private sector. Public provision of digital content is often labelled e-government and covers issues ranging from reporting of VAT on line to information on air pollution in cities. The market drives the provision of private digital content, but governments have a role in ensuring that regulations do not impede development.

E-government

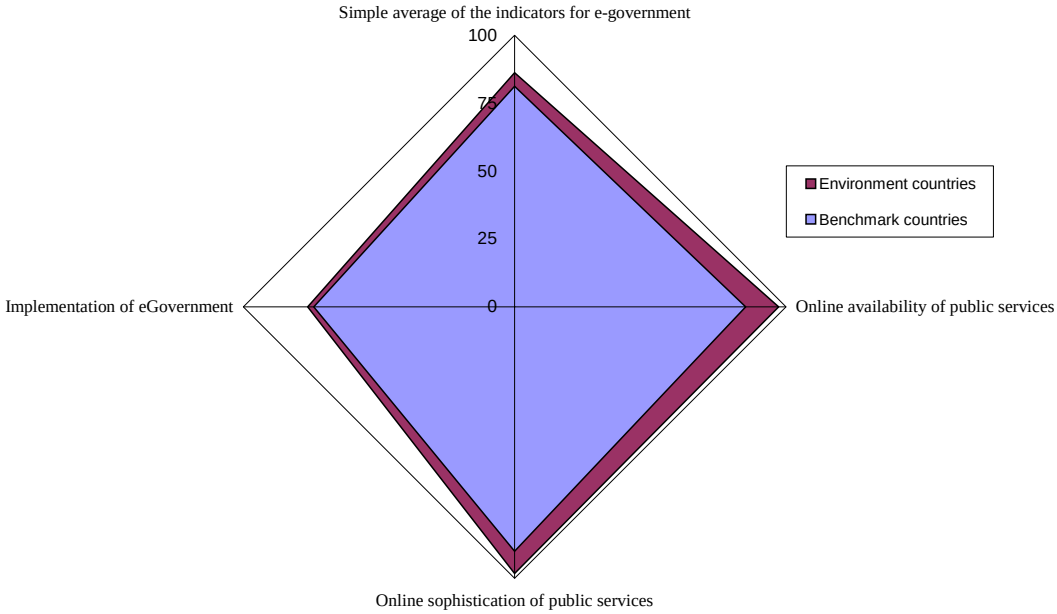
E-government is a question of both online availability of government services and their sophistication. No indicators measuring these two aspects are available for all OECD countries but three different indicators cover all of the OECD and measure these two aspects of e-government. The first indicator is a simple count of the number of services available and the second ranks these services on their sophistication. The two indicators measure the area well but are only available for EU countries. The third indicator is similar to the first two and available for several non-EU countries. The five benchmark countries are among the best in the OECD in this area, which suggest that this is an important area for overall performance. All of the benchmark countries have a high availability of government services on line and the services are sophisticated relative to other OECD countries (Figure 4.11 and Box 4.7).

Box 4.7. Indicators of e-government

Three indicators are applied to assess the availability and sophistication of government services on line. The online availability of public services measures the share of a given set of predefined e-government services available in 2002. Ireland ranks highest. The sophistication of online public services ranks the 20 most common online services. Each service is ranked from one to four: a score of one indicates that the information necessary to start the procedure to obtain the service is available on line, and a score of four indicate full electronic handling. Sweden has the most sophisticated solutions. These two indicators cover most of the aspects needed to measure and compare e-government but are only available for EU countries. They are therefore supplemented with the e-government indicator, which is a subjective ranking of countries' e-government solutions based on predefined services and a five-stage scale of sophistication. This indicator is similar to the first two indicators and the correlations are high (0.7). Canada leads in this indicator.

Two alternative indicators exist, but are composite indicators. They are not used but they confirm the ranking of the countries based on the selected indicators. The government readiness and government usage indicators are based on the World Economic Forum's questionnaires, which ask business executives in each country to evaluate the country's performance on a scale of 1 to 7. Government usage measures aspects close to the indicator of availability of public services and the correlation for EU countries is high (0.64). Government readiness is more like online sophistication and correlation is also high for EU countries (0.5).

Figure 4.11. Benchmarking e-government in selected countries



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Private digital content

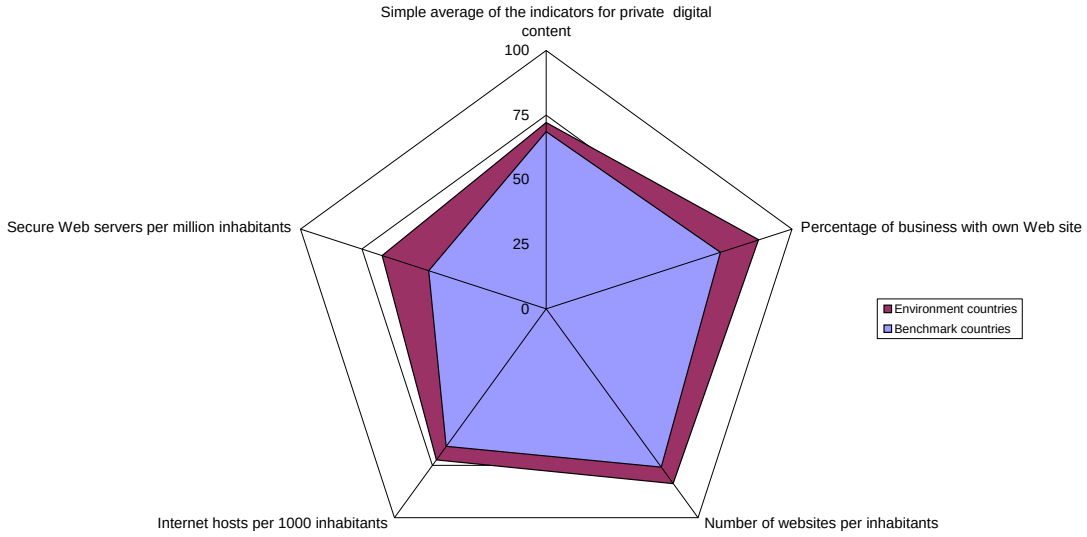
In most countries, reading and downloading online newspapers and magazines are most popular, while video on demand and home networking services – where several devices in a home or office tap one broadband line – are growing in popularity. Four indicators are applied to measure private digital content (Box 4.8).

The benchmark countries are at the forefront, when comparing the available indicators for national content (Figure 4.12). They perform well on Web sites and Internet hosts per 1 000 inhabitants. However, they vary for secure servers. The United States, Australia and Canada are among the top five countries, whereas Sweden and Finland are around average (banks secure most e-trade in Finland and Sweden, so there is no need for secure servers). In businesses with Web sites, Australia performs around the OECD average, whereas Sweden and Finland are top performers.

Box 4.8. Indicators of private digital content

Four indicators measure the availability and quality of privately developed digital content. Percentage of businesses with their own Web site is only available for 16 countries, so the number of Web sites per inhabitant, which is available for all countries, is also included. The number of Web sites per inhabitant directly measures the volume of national content, as it measures the number of servers in each country hosting Internet pages. Some of these Web sites may be personal, so to get a measure of business-created content, the number of Internet hosts per 1 000 inhabitants is also included. An Internet host is a computer that is connected to a TCP/IP network, including the Internet. Each host has a unique IP address. However, these pages may be simple presentation pages, so the number of secure servers is included to judge the degree to which advanced features are available. Secure servers are a good proxy for accessibility to national e-trade in most countries, as secure servers are needed to deal with online payment. All of the indicators are highly correlated (0.6-0.9).

Figure 4.12. Benchmarking digital content availability in selected countries



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

ICT security and trust

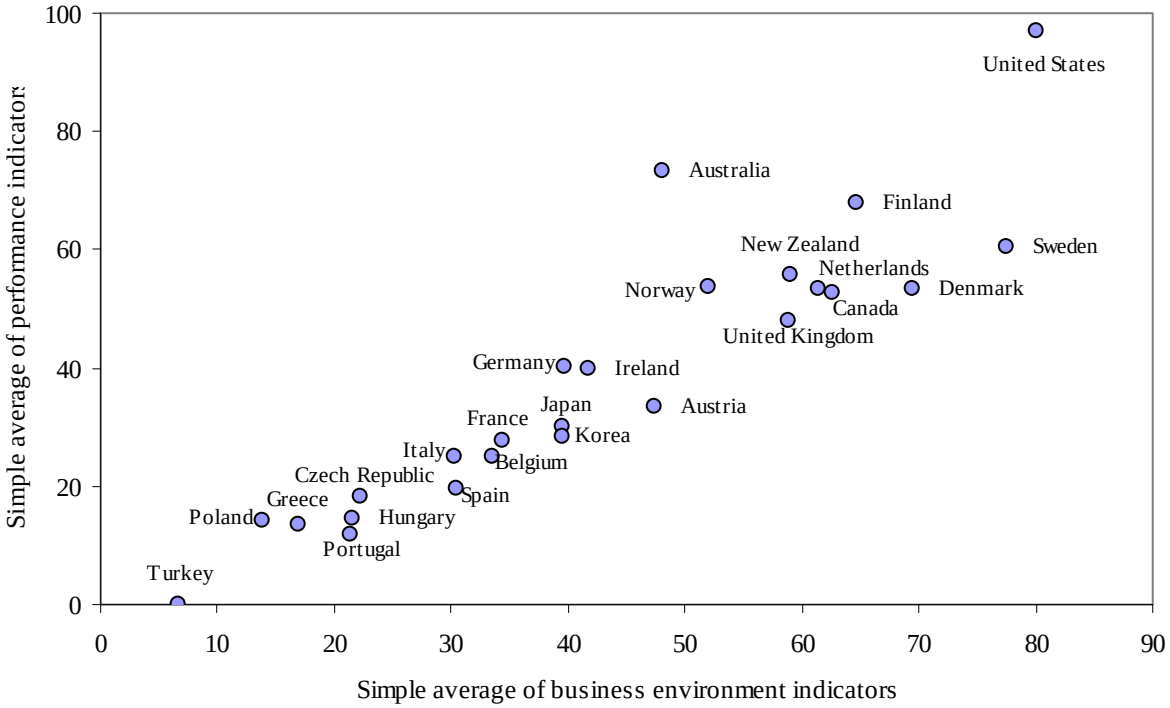
No indicators exist for this area, but all the benchmark countries emphasise enhancing online security and trust. Getting people on line, ensuring ICT skills and providing digital content have limited effects on business performance if people do not feel secure about electronic transactions or do not trust the online environment. The unregulated atmosphere of the Internet has, for example, prompted many to question the privacy and security of government Web sites. Public opinion surveys place these areas near the top of the list of citizen concerns about e-government. Similar security concerns exist for firms engaged in e-business.

Many of the solutions to security problems are found in the private sector. The public sector does however play an important role as a model user of the Internet through e-government. This area might consequently be part of the e-government strategy and less important in its own right.

The link from the business environment to performance

The 35 business environment indicators described above can explain large parts of the variation in performance in seizing the benefits of ICT. A simple average of the indicators of the business environment shows a good correlation (0.83) with a simple average of the indicators of performance (Figure 4.13). The only outlier is Mexico, owing to very high growth in the service sector. Sensitivity tests show that the choice of weights for individual indicators plays a limited role in the analytical findings. In the sensitivity analysis, weights between 0 and 1 were assigned randomly to each of the indicators both for business environment and performance. The correlation between environment and performance varied between 0.78 and 0.95 in 10 000 random indices. The correlation was significantly different from zero and the 0.1% level in all cases (Annex B). The high correlation between environment and performance suggests that the relevant areas of the business environment are captured.

Figure 4.13. The correlation between indicators of the business environment and indicators of performance in seizing the benefit of ICT



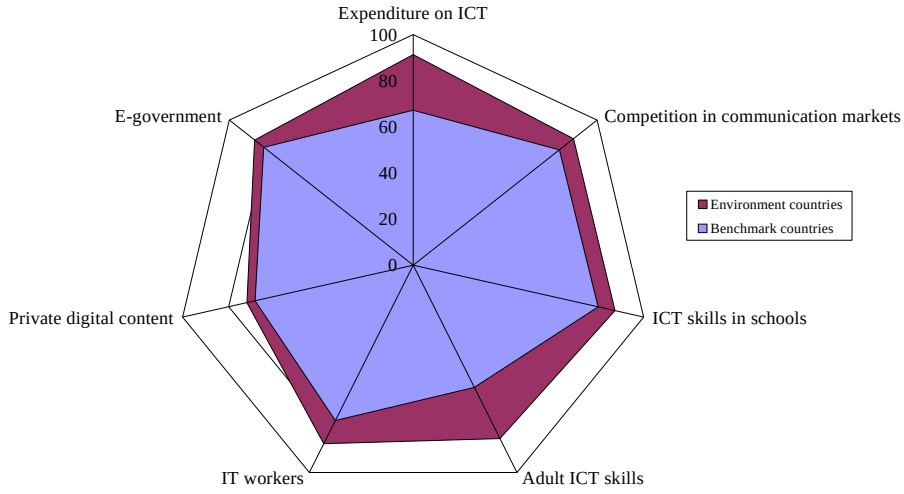
Note: Iceland, Luxembourg, Mexico, the Slovak Republic and Switzerland are not included owing to missing values. Including these countries based on the limited information available will reduce r^2 to 0.53 but the slope will still be significantly different from zero at the 1% level.

Critical policy areas

Not all of the ten policy areas that affect countries' ability to seize the benefits of ICT are equally important. The objective of this section is to identify the areas that may be most important for performance. Two approaches are used. First, the spider diagrams showed some similarities across the benchmark countries (Australian, Canada, Finland, Sweden and United States), and can be seen as a first attempt to prioritise relevant policy actions. The assumption is that the parts of the business environment for which the five benchmark countries have values close to the best performers in individual areas are potentially more important for overall performance. Second, regression analysis can be used to determine which policy areas have the highest correlation with overall performance in this driver. The interaction among policy areas can also be examined.

The benchmarking results can be summarised by looking at the main areas of the business environment (Figure 4.14), which show that the business environment can be discussed in terms of: *i)* areas where the average in the five benchmark countries is close to that of the five countries with the best business environment (competition in communication markets, ICT in schools, IT workers, private digital content and e-government); and *ii)* other quantifiable but less important areas (adult ICT skills and expenditure on ICT); and *iii)* areas that cannot be quantified (ICT-related managerial and organisational change, e-procurement and security and trust).

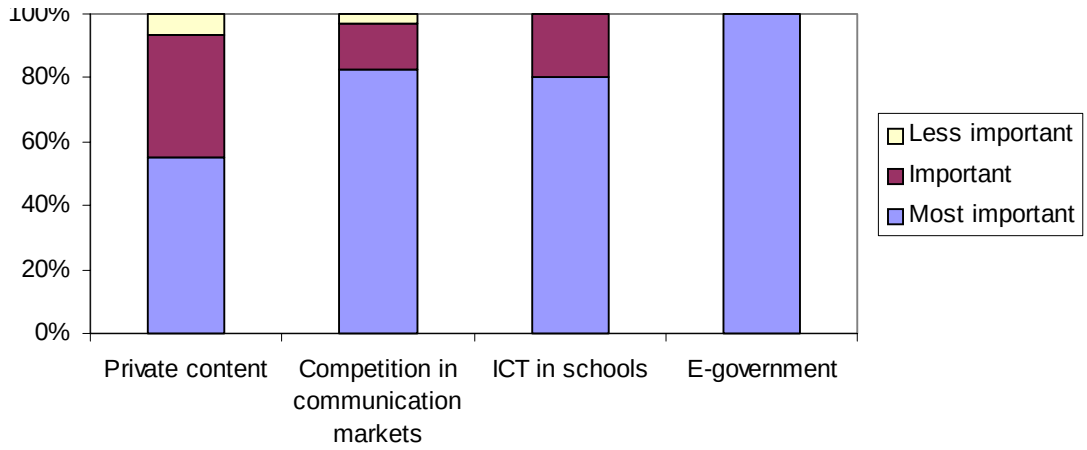
Figure 4.14. Benchmarking the overall ICT business environment



Note: The spider diagram compares the average ranking of the five benchmark countries (Australia, Canada, Finland, Sweden, United States) with the five countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries). The headlines cover the simple average of the indicators used to measure that particular area of the business environment

The analysis is based on an implicit assumption of equal weights for all underlying indicators. Sensitivity tests show that for most areas of the business environment this assumption plays a limited role (Figure 4.15). Regardless of the weights, e-government is among the most important. ICT in schools and competition in communication markets are also robust and are among the most important in over 80% of outcomes. For private digital content, there are large variation among the benchmark countries, which might suggest that policies for private digital content on line are less important than the other three areas. No sensitivity analysis is made for IT workers as this is based on one indicator.

Figure 4.15. Sensitivity of the results when weights are assigned randomly



Note: The distance between the benchmark countries and the environment countries determines whether an area is less important, important or most important. The figure shows the share of 10 000 randomly calculated composite indicators for each area in these three groups. The weights to the underlying indicators are drawn randomly from a uniform distribution (0 to 1).

Correlation analysis confirms the benchmarking results. All areas except for expenditure on ICT are significantly correlated with all types of performance measures (Table 4.3). The highest

correlations are found in ICT skills in schools and private digital content. Regression analysis performed at the indicator level also shows high correlation for most indicators.

Table 4.3. Summary results of the correlation analysis

	Correlation with		
	All performance indicators	Indicators of investment in ICT	Indicators of ICT use
Simple average of indicators	***0.74***	*0.36*	***0.91***
ICT skills in schools	***0.83***	***0.72***	***0.76***
Private digital content	***0.78***	***0.49***	***0.90***
IT workers	***0.71***	***0.58***	***0.80***
Competition in communication markets	***0.65***	***0.46***	***0.70***
Adult ICT skills	***0.61***	*0.51*	***0.70***
E-government	***0.61***	0.26	***0.68***
Expenditure on ICT	0.36	0.08	*0.38*

Note: All t-values bolded in italics are significantly different from zero at the 1% level, all t-values in italics are significantly different from zero at the 5% level.

Attempts to perform more advanced multi-variant regression analysis did not provide much insight, as the high correlation among the indicators and the high individual explanatory power, for example, of ICT skills in schools and private digital content make it possible to reduce all multi-variant regressions to single correlations by eliminating insignificant indicators. The elimination process did however show that private digital content was highly correlated with all measures of performance in all regressions. This area should therefore be included as one of the most important, despite some variation in performance among the benchmark countries.

Qualitative analysis of the two areas that cannot be quantified shows that the benchmark countries emphasise security and trust, although policies are difficult to isolate, as security and trust depend significantly on international actions. The great importance of managerial and organisational change is shown in peer reviews of policies to stimulate diffusion of ICT to business although the possibilities for policy action in this area are limited (OECD, 2004c).

All in all, the benchmarking and the regression analysis identified five areas as most significant for seizing the benefits of ICT (competition in communication markets, e-government, ICT in schools, private digital content and IT workers). The importance of these areas is supported by the sensitivity analysis. Qualitative analysis finds one additional area to be important: ICT-related managerial and organisational change.

Two of these areas, ICT skills in schools and e-government, signal a very high commitment to investment in and use of ICT in the public sector. Neither of these two areas affects productivity in the private sector directly, but high commitment and the demonstration effect may have affected the willingness of private firms to invest in and use ICT. Nonetheless, causality is hard to determine. High public commitment can also mirror high private commitment. Analysis highlights the need for high commitment and belief in the benefits of investment in and use of ICT in both the public and private sectors to fully seize the benefits of ICT (OECD, 2004b).

The last four important areas, competition in communication markets, private digital content, IT workers and ICT-related managerial and organisation change, directly affect productivity. Competition lowers prices and increases ICT uptake but also ensures entry of new business models that allow for more productive exchanges (OECD, 2003f). The same is true for ICT-related managerial and organisation change, which directly affects firms' ability to seize the benefits of ICT (OECD, 2003d).

IT workers also directly affect productivity, as they are needed in all parts of the economy to implement and seize the benefits of new IT systems (McKinsey, 2002a). Finally, private digital content determines to a high degree the possible productivity gain from use of the Internet.

The timing of these policies is important. ICT in schools and competitive communications markets are part of a policy package for increased connectivity and ICT readiness, as are many e-government solutions. Policies aimed at developing private digital content and e-government solutions based on reorganisation of government services move beyond basic connectivity to facilitate more widespread uptake and use of complex ICT applications and e-business. These more advanced policies, including those that stimulate ICT-related managerial and organisational change in enterprises, are increasingly important as more OECD countries progress beyond ensuring ICT readiness.

The following sections review micro-policies implemented in the benchmark countries in each of the important areas in order to identify effective micro-policies that might inspire other OECD countries in their policy making. A policy implemented in one of the benchmark countries is not necessarily an effective policy in other countries. The micro-policies identified are not necessarily first-best solutions but practical approaches to common policy problems.

The effectiveness of ICT policies will depend on how well they are integrated with other areas such as regional and industrial policies. Central governments may emphasise, for example, technology neutrality in their policies, while certain regions may focus on getting all firms on line with specific technical solutions and portals. Industrial and regional policies also tend to include supports and subsidies to get small firms or areas on line as well as policies to diffuse information about the benefits of ICT. The benchmark countries do not have a common solution to co-ordination problems, but address them in different institutional set-ups and on a case-by-case basis.

Policy benchmarks for ICT skills in schools

Enhancing the provision of ICT in schools can give young citizens and future employees basic ICT skills and may affect their future productivity. All the benchmark countries implemented at an early stage national strategies for integrating IT in primary education. All emphasise the importance of these national strategies which provide a clear vision and specific goals. The strategic objective is to provide all students with basic ICT skills: the ability to use a computer for basic tasks and as a tool for learning. The national strategies are quite similar and are to a large extent based on the first strategy formulated in the United States in 1996, which consisted of three steps: *i)* establishing an ICT infrastructure with financial support from the central government (computers and access to the Internet); *ii)* training teachers; and *iii)* using ICT to improve existing models of teaching and learning.

All the benchmark countries have used targeted federal/central government money to help schools buy computers and go on line, although there are major differences in how the programmes are implemented owing to large differences in the autonomy of regions and schools in the various countries. The E-Rate Scheme in the United States, for example, provided almost USD 8 billion to facilitate access to the Internet for schools and libraries in underprivileged areas, even though these schools are largely autonomous. The scheme helped one million classrooms to go on line between 1996 and 2000. Although the programme is still operational, there is a USD 2.25 billion annual cap on the public subsidy element. Similarly, the National Action Programme for ICT in Schools in Sweden has invested USD 150 million in ICT and online access for schools.

All benchmark countries have integrated ICT into initial and continuing teacher training. Finland has the world's largest share of teachers with ICT training based on the OPE.FI programme which specifies ICT proficiency skills and includes explicit and measured targets for each level of proficiency. Each school selects a few teachers to receive government-funded ICT training, after

which they train their colleagues using the school's equipment and specially designed teaching materials. The Swedish government has a unique scheme whereby it offers all teachers a multimedia personal computer if they complete the required ICT training. Although this programme is costly, about 50% of all Swedish teachers have accepted the offer and passed the required ICT tests.

The lack of software and suitable online content is another challenge. Canada has chosen an innovative response with the GrassRoots project which supports the creation of Internet-based educational content by teachers and students. It is a joint venture by federal and provincial governments and private sponsors which aims at creating 22 000 projects over a four-year period to help students and teachers become skilled users of ICT as well as to create pedagogically relevant Canadian content. The evaluation of the programme showed that GrassRoots has had a major impact on teachers' professional learning and development of technology skills, on students' technology skills and employability skills development, and on access to teaching resources, leadership opportunities, and school growth and development. Other countries (*e.g.* the Netherlands) have developed a variation of the Canadian scheme for their own use.

Another approach to creating online content is to construct school-nets for exchanging experience and providing teachers with online content. School-nets are closed secure networks among students and teachers. The Swedish School-net, which was founded in 1994 and formed the basis for the European School-net, has four main features: Link Library, which is a search engine that searches Web pages with appropriate content for children; On-Line Dictionaries, which includes online dictionaries and encyclopaedias; Classroom Activities, which lists links to various Internet-based activities and projects suitable for schools; and the Multimedia Bureau, which is a resource centre to help teachers and students to create their own multimedia products, *i.e.* to use images, sound and music in their educational work. The Multimedia Bureau has a large sound, music and picture archive, a project hotel where one can book a room for publishing material, and an ideas bank offering hints and ideas for various age groups. The Canadian School-net is very similar and also includes comprehensive links to teaching resources.

Effective policies for providing basic ICT skills in schools include:

- Defining a national strategy for integrating ICT in schools.
- Helping schools to buy computers and go on line using central funds.
- Providing ICT training for teachers.
- Developing educational software and online content.

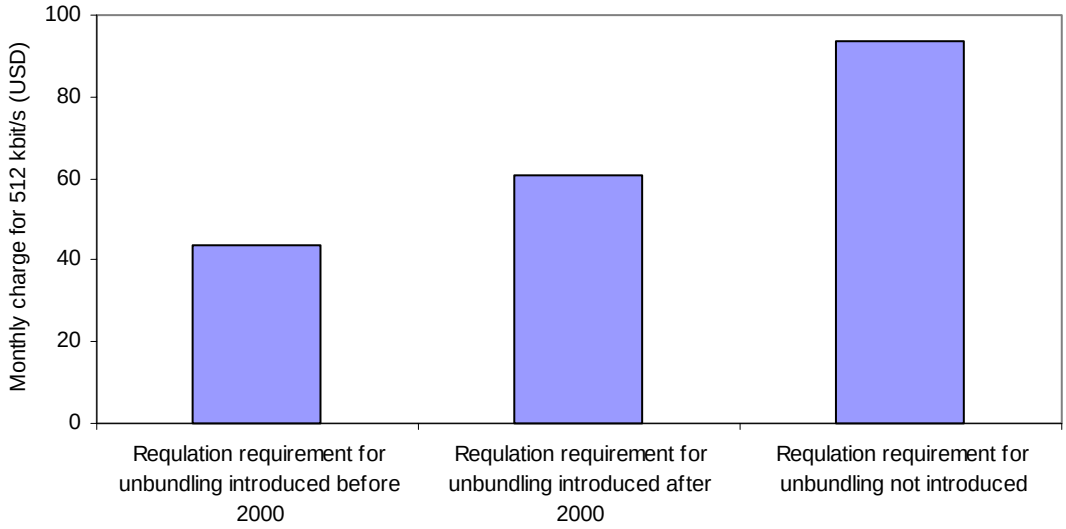
Policy benchmarks for competition in communication markets

Increasing competition in local communication markets can be problematic, since incumbent telecommunication operators have frequently built their networks in a monopoly framework and have little incentive to cede these networks to competitors. Countries have two main options: *i)* strengthen competition in telecommunications markets by unbundling local loops; and/or *ii)* increase competition across different technologies or markets by stimulating entry and allowing for competition across platforms. Most countries are taking the first approach but this analysis and related OECD work show promising results for cross-platform competition; for example, wireless technologies provide interesting alternatives for fixed networks and put competitive pressure on broadband prices (OECD, 2004d).

Local loop unbundling occurs when new entrants lease lines from the incumbent and provide subscribers with new services. Countries that introduced legislation early have benefited most in terms of lower prices and higher uptake of broadband (Figure 4.16). About 5% of local loops are unbundled in the United States and 4% in Canada; these are the highest ratios in OECD countries (OECD, 2003f).

Finland has unbundled around 2.2% of the local loops, while Sweden and Australia have unbundled less than 0.05%; this is reflected in their lower broadband uptake.

Figure 4.16. Unbundling lowers price of broadband



Note: Several countries did not offer 512 kbit/s, but the calculation corrects the price in these countries for the highest speed they offer.

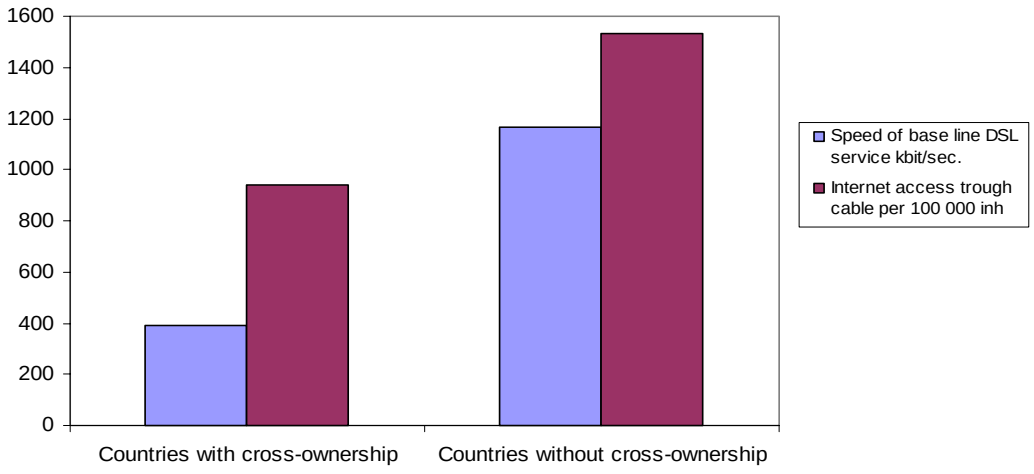
Source: Own calculations based on OECD (2003f).

The process of unbundling can be slow and complicated but can be enhanced by an active regulator. In Australia, for example, incumbents were not allowed to launch ADSL services before competitors could do the same using the incumbent's network (OECD, 2002d). Australia has also addressed the problem of space allocation in the existing network. All new entrants can "force" the incumbent to expand the space available for sharing by jointly constructing more space. The new entrant bears all construction costs but gets full access to the network. Canada is forcing incumbents to give competitors access to exchange platforms so that the equipment of the competitors can be placed together with the incumbent's equipments (called co-mingling), which reduces cost of entry.

Competition across platforms can also be an important driver for broadband uptake and ICT supply. In several countries, cable networks are an important competitor to telecommunication firms for providing broadband connections, and platforms such as wireless are also becoming a viable alternative. The number of broadband connections per 100 inhabitants and speed of service are three times higher in countries where telecommunications carriers do not own shares in cable networks (Figure 4.17).

Canada and the United States have benefited from competition across platforms (primarily cable and telecommunications networks). Canada has the highest uptake of broadband among the benchmark countries, with about 60% of subscriptions through cable. Cable providers in the United States have been active in providing telephone services since all barriers were removed by the 1996 Telecommunications Act. Australia, Finland and Sweden, on the other hand, still have a high degree of cross-ownership in these networks, although Sweden has announced that the incumbent telecommunications operator will sell its cable division. In Finland and Sweden, only 20% of those with broadband access use cable networks.

Figure 4.17. Cross-ownership and broadband speed and access



Source: Own calculations based on OECD (2003f).

Australia subsidises satellite-based Internet connections for people living in remote areas where the cost of constructing the needed infrastructure is much higher than the relatively low cost of subsidising a satellite connection. The policy advantage is that it is very easy to shift technology if new technical developments make other means of access possible at lower cost (NOIE, 2002). Australia has also been using public pre-registration schemes to indicate the level of demand for broadband for both incumbent and potential entrants. Canada has been successful in supporting wireless connection in remote areas to increase competition and provide access. To further develop wireless applications, the Canadian government announced spectrum auction in 2004.

Effective policies for stimulating competition in communication markets include:

- Speeding up the process of unbundling local loops, for example by having a very active regulator.
- Increasing competition across different communication platforms and networks, *e.g.* by separating ownership of telecommunications and cable, and stimulating new entrants.

Policy benchmarks for e-government

The benchmark countries recognise that the government, by introducing e-government, plays an important leadership role in enhancing the extent to which business and communities take full advantage of the opportunities provided by ICT. Using ICT to deliver government services can reduce administrative burdens and have a significant "demonstrator" and "pull-through" effect on ICT users.

A high-profile and clear strategy for putting services on line has contributed to good performance in the benchmark countries. The strategy develops in stages – put services on line, create unified access and transform services (OECD, 2003g). Several countries have combined their strategies with soft targets for putting services on line to increase visibility and accountability. Australia aimed at (and succeeded in) having all relevant government services on line by 2001. Canada's target is to have the most frequently used public services on line by 2005. Government information and transactions that can be done electronically should all be possible by 2005 in the United States. Finland has defined key areas for e-government services with relevant targets.

The United States – which in some ways is a front runner in e-government – has focused on putting services of different agencies on the Internet but has not worked towards the integration of the various Web pages or introduced "look and feel" standards. "Look and feel" standards ensure that all government Web pages have the same visual and technical design. To compensate for the lack of a common portal, the United States introduced www.firstgov.gov, which is a search engine and a collection of topical and customer-focused links that connect to other online services. The search engine examines more than 186 million Web pages from federal and state governments. Most of these pages are not available on commercial Web sites. The advantage of the approach is that services reach the Internet faster as no time is spent agreeing on common formats.

However, the United States may have difficulty pushing the development of e-government without some co-ordination. The 2002 E-government Act concluded: "Most Internet-based services of the Federal Government are developed and presented separately, according to the jurisdictional boundaries of an individual department or agency, rather than being integrated cooperatively according to function or topic." A new Office of Electronic Government within the Office of Management and Budget was established to provide the needed leadership and co-ordination. The new office was also given a budget to support innovative e-government projects across government agencies. Furthermore, a draft white paper was issued in late 2002, which described the recommended technology standards. These recommendations aim to ensure that new agency systems are compatible and interchangeable with others across government. The draft guide intends to serve as a technical framework for agencies developing new systems rather than requirements or rules. It explains the technologies and approaches that, if applied across the entire government, would make it easier for agencies to share investments and information.

Canada has created a unified and standardised access to public services through one government portal launched in 1995. The portal was developed and updated in several stages and is today viewed in Accenture's survey of e-government solutions to be the world's best-developed. The biggest challenge for common government portals is to provide a logical structure for government services based on needs or events seen from the user's viewpoint. In the Canadian portal, for example, all events and information relating to human resource management in enterprises are grouped under one heading, although information originates in different government agencies. Canada Benefits – a general portal for citizens – groups all information according to life situations (parent, student, senior, person with a disability, veteran, artist or athlete, newcomer to Canada, in need of social assistance) and major events (unemployment, retirement, learning, home ownership, divorce or separation, health concerns, tax concerns and dealing with death).

In addition, all Canadian government Web pages "look and feel" the same because they follow the Treasury Board Common Look and Feel (CLF) Standards, which at an early stage required all government Web pages be similar. The standards enable Canadians to distinguish federal programmes and services from others and to navigate successfully from one federal site to another. Government agencies were given two years to move their Web pages to the new environment when the standards were introduced in 2000. Canadian consumer surveys confirm the success of the approach and show that over 40% of all citizens and 75% of Canadian businesses use the services. About 75% of users are satisfied with overall quality (Booz, Allen & Hamilton, 2002).

Another challenge is to transform these portals from a collection of valuable public information sources into real online services. Canada has implemented a strategy to transform government services and to improve quality and horizontal linkages across government agencies. Canada also established an Internet user panel to begin collecting information on online service preferences and expectations that will enable Canada to modify online services to match users' needs.

Finland has also increased its focus on quality rather than number of services. A work group set up by the Finnish Ministry of Finance has proposed common quality and valuation criteria for the

network services maintained by municipalities and federal authorities. The criteria are viewed as necessary to improve the quality of network services, in particular from the point of view of users.

To move public services to an online format, governments need to bridge the gap between their front-office portals and their back-office applications, processes and data storage. This involves defining standards for making information systems interoperable and assuring security and privacy for users. Canada has created the Secure Channel, which is available to all departments and agencies, to receive, store and exchange electronic information securely and to identify clients electronically. Australia is developing a similar system, Fedlink. Finland has established citizen identification cards to ensure security and privacy and combine information from different government agencies.

Finally, a major challenge facing all e-government projects is achieving positive returns. Australia has met this challenge by preparing "business cases for e-government". Similar attempts have been made in the United States and Canada. A business case is systematic identification, analysis and documentation of the relative attractiveness of multiple investment alternatives. For specific e-government projects, the business case outlines tangible benefits from the project and tracks the results against these measurable goals. It calculate real return on investment and net present value of e-government project to determine direct positive returns.

Effective policies for implementing e-government include:

- Creating a common vision for the goal of e-government.
- Increasing online government services, focusing on the most used.
- Creating common government portals and standardised Web pages that reflect the needs of users rather than government structures.
- Ensuring online security and privacy.
- Ensuring interoperability of government portals and systems.
- Documenting positive returns of e-government solutions.

Policy benchmarks for private digital content

The private sector plays a vital role in developing and providing digital content (OECD, 2003e). Current OECD work addresses some of the analytical shortcomings in this area in an attempt to provide more information for policy makers. The policy conclusions in this section should be seen as a first step, which should be supplemented by further initiatives. A good starting point for policies for digital content is to secure digital content no less favourable treatment than other content, such as printed matter. Many countries have special tax rules for printed materials, such as exemption of newspapers from VAT or public support for the printing of books.

The main regulatory problems associated with digital content relate to copyright issues. The benchmark countries have introduced sections in their copyright legislation to clarify the rules on digital content. For example, Australia introduced the Digital Agenda amendments to the 1964 Copyright Act and published a Digital Rights Management Guide to help firms understand and use the regulations. Canada introduced amendments in 2002 specifying that transmitters using the Internet have to negotiate copyright with all rights holders in order to obtain authorisation to broadcast their works. Canada has also made it easier for people who want permission to copy materials to locate copyright owners. People can purchase a licence online by searching the Canadian Copyright Licensing Agency's extensive database of over 750 000 Canadian works.

Australia conducted a study of the "industrial cluster" of digital content industries to identify key enterprises, their location and productivity drivers and barriers. Local content rules and datacasting

restrictions were found to be important obstructions. In Europe, similar analyses have been conducted as part of the e-Europe strategy and have found data protection legislation and cross-country billing to be major obstacles to e-trade and development of digital content.

Unintended side effects of regulation can also emerge as a result of the convergence of industries in the communications area that were previously viewed as separate, in both a commercial and technological sense, such as television and the Internet. These areas have quite distinct regulatory traditions and arrangements (OECD, 2003h). Uncertainty and unnecessarily restrictive policies can inhibit the development of these content services. The approach taken to clarify regulations varies substantially among the benchmark countries. The main issue is the choice of regulatory regime.

In Sweden, for example, audio-visual content offered via the Internet is treated as cable broadcasting, but in the United States it is not regulated. The goals of telecommunication regulation have been free competition, liberalisation and a move towards greater reliance on general competition law. The goals underlying the regulation of broadcasting, on the other hand, have been directed to its social and cultural impact (OECD, 2003h). Broadcasting can require a given share of national content and restrict the amount of advertising that may be broadcast, in terms either of quality or quantity.

In the United States and Canada, telecommunications and broadcasting are regulated by the same authority; this offers possibilities for co-ordination. Australia has integrated the regulation of content on the Internet in the Broadcasting Services Act. So as not to restrict the e-content industry, the regulation is flexible; the minister can at any time exempt a given type of transmission from the regulations without changing the regulation. The minister has exempted transmission of television and radio over the Internet from the broadcasting regulations, as the local content requirement was perceived as a barrier for the online content industry. Finally, the new EU regulatory framework adopts a horizontal approach, according to which regulations will be structured around activities, such as content or carriage, and not around delivery platforms.

Finland and Sweden are part of the e-Europe Digital Content Towards 2005 programme, which has commercial exploitation of public-sector information as a key objective. Public-sector information (*e.g.* geographical, business, traffic) is an important asset which the private sector can access and use to develop digital content. A first step was a directive aimed at harmonising the legislation for commercial exploitation of public information across EU member states; the next is supporting commercial transborder projects using public information.

European countries and Australia provide support for the development of digital content by firms, but no cost-benefit studies of such support have been made. The e-Europe strategy co-finances digital content projects that are high-risk, high-reward, cross-sectoral and transnational, user-oriented and capable of a multiplier effect. The EC contribution represents up to 50% of the project costs (not to exceed EUR 2.5 million), and the total project budget is EUR 100 million for a five-year period. In Australia, the Broadband Content Fund administered by the Australian Film Commission provides AUD 2.1 million in seed funding for Australian digital content producers to pursue opportunities in new broadband applications. Australia's telecommunication provider Telstra has also established the Telstra Broadband Fund to stimulate and fast-track the development of new and innovative digital content applications, tools or technologies for broadband delivery.

Effective policies for stimulating development of digital content include:

- Securing "no less favourable treatment" for digital content as compared to other content such as printed content.
- Clarifying intellectual property regimes for online content.
- Clarifying ownership and pricing rules for digital content based on public sector information.

Policy benchmarks for facilitating ICT-related managerial and organisational change

Productivity growth is highest in firms that combine new work practices with investment in ICT (OECD, 2003d). Unfortunately, there are as yet no comparable cross-country indicators for this area of the business environment, as organisational structures and related changes are difficult to measure and vary widely across countries and sectors. The role of government in stimulating firm-level organisational change is different from that of raising e-readiness and e-awareness. Policies tend to fall into three categories: *i)* providing hard evidence of the positive effects of ICT-related organisational change; *ii)* providing advisory services for enterprises; and *iii)* implementing programmes aimed directly at organisational change. Finally, ensuring labour market flexibility is important for facilitating organisational change in all countries.

The benchmark countries have all developed programmes to raise managerial awareness of the benefits of ICT-related organisational change by providing hard evidence of the positive effects. Case studies of successful organisational change or other hard evidence of the positive effects of ICT implementation in conjunction with new management practices are part of national campaigns. Australia, for example, has produced over 100 case studies highlighting the utility of a variety of e-business technologies for small firms. These case studies include concrete examples of e-business at work and illustrate the use of broadband technologies and ways to deal with e-security. The case studies also show the need for new and flatter work organisation, more teamwork and secure value chains to realise the benefits of investment in ICT. Countries such as Canada have combined such information campaigns with self-evaluation tools or guides for enterprises.

The benchmark countries also have advisory schemes that combine ICT-based technical solutions with information on needed organisational and managerial changes. All of these programmes foster generic tools that benefit firms independently of their size or sector. In the United States, the Manufacturing Extension Partnership (MEP) groups 400 centres that help firms implement lean production approaches based on better use of ICT. In Canada, the Canadian Technology Network acts as a pathfinder to connect small firms with e-business problems to experts who advise on needed organisational changes. In Australia, the eBusiness Pathways Guide outlines how firms should change their business processes to go on line.

Finland has integrated its ICT-related support programmes through 15 regional Employment and Economic Development Centres. These centres – a joint venture of the Finnish Ministry of Trade and Industry, the Ministry of Agriculture and Forestry and the Ministry of Labour – offer Branded Expert Services, including two related to ICT implementation. The eAskel scheme aims to increase management competence in strategic e-business development, operationalise e-business opportunities, identify core development needs for e-business, and produce a development programme for participating companies. Private consultants take between two and five days to analyse each of the participant companies and develop action plans, with 85% of consultant fees paid by the government. This unified approach creates a one-stop shop for public support at regional level and ensures that ICT programmes are co-ordinated with other policies.

It is essential to evaluate these ICT advisory services for their effectiveness in altering firm behaviour. Sweden and the United States use customer surveys, but these tend to overestimate benefits. The United States introduced a control group based on census data to show that MEP clients had 5.2% higher productivity growth on average than non-clients between 1996 and 1997 (US Bureau of the Census, 1999; Jarmin, 2001).

Among the benchmark countries, only Sweden provides direct support to promote ICT-based organisational change in firms as part of its Flexible Organisation scheme. Sweden has expanded the Objective 4 programme of the EU support system to incorporate a broad interpretation of organisational change. Consultants are funded to evaluate individual firms and to describe

organisational shortcomings and prepare a plan for competence development. Evaluations that used well-defined control groups and controlled for selection bias found large positive effects on firm performance. However, the government's role in this area remains controversial. Implementing organisational change is a core management decision and is closely linked to overall business strategies, which are usually firm-specific and non-generic. Subsidies for the adoption of a given organisational structure, for example, could distort firms' decision-making process.

Finally, the benchmark countries try to ensure that labour market regulations do not hamper organisational change at firm level. Countries need to have policies favouring labour market flexibility to benefit from ICT. Appropriate rules are needed regarding flexible job types, working hours, compensation, portable pensions, restructuring, etc., which safeguard the interests of both firms and workers. Measures to ease restrictions on labour mobility, both geographically and occupationally, can contribute to redressing skills imbalances and reduce the costs associated with organisational change.

Effective policies for facilitating ICT-related managerial and organisational change include:

- Providing hard evidence (good business cases) on the benefits of implementing ICT in combination with managerial and organisational changes.
- Stimulating the availability of ICT-management advisory services and training.
- Ensuring that labour market regulations do not hamper new work practices.

Policy benchmarks for IT workers skills

Studies show that ICT applications that are tailored to sector-specific business processes, deployed in a sequence that build skills over time, and introduced in combination with managerial and technical innovations have positive productivity effects (McKinsey, 2002a; OECD, 2003d). In the United States in the 1990s, two-thirds of ICT workers worked outside the ICT-producing sector and contributed greatly to American productivity performance (OECD, 2002c). This has led to concern in many countries about potential shortages of ICT workers. Countries can take two steps to avoid such shortages: *i)* ensure that the supply of ICT workers keeps up with changing demand in terms of the number of people and composition of skills; and *ii)* ensure a transparent ICT labour market.

The benchmark countries, except Finland, set up task forces with government and industry representatives to examine future ICT skills demand and suggest actions for stimulating the supply of ICT workers. For example, the Australian Industry IT&T Taskforce played an important role in defining an ICT education strategy and in creating the IT Skills Hub. The goal of this non-profit company is to bring business together with education and training providers to improve information on ICT skills and promote uptake of ICT-related training and careers. The Hub regularly surveys Australian business to identify changing needs for ICT workers and has developed an ICT Skills Tracking and Monitoring System to determine changes in demand for skills. This is partly based on surveys of advertisements for new employees, business surveys and expert workshops. The success of these task forces has not been evaluated in any of the countries.

Countries face the challenge of increasing the supply of ICT workers either through the educational system or through immigration. OECD countries generally need to boost technical courses and give greater emphasis to the development of skills linked to ICT (Stern *et al*., 2000). In countries where universities are publicly financed, the number of places at higher education institutions in technical fields has expanded, and campaigns have been mounted to make ICT-related careers more attractive, in particular for women. In the United States, companies such as Microsoft, Sun Microsystems and Cisco are involved in provision of ICT-related education. In Sweden, the Knowledge Foundation was established by the Swedish Parliament to promote broad use of ICT in

society, partly by setting up consortia of universities and businesses to provide technology-based education and training.

In Finland, European structural funds were used to modernise the local business structure by investing in university research and ICT-based education. A special two-year Master's degree was created for students who had completed 50% of their university studies or who had vocational training in engineering-related fields, particularly ICT. The programme allocated over half of its EUR 17 million budget to the ICT sector. In the Netherlands, initiatives were launched by the Ministries of Economic Affairs and of Education, Culture and Science to boost participation in ICT and other technical education. The AXIS Programme brought together the business, government and education sectors to make careers in technology more appealing by financing a series of projects aimed at bringing students into the problem-solving process. From 1998 to 2002, the programme co-financed over 70 projects and greatly increased the supply of ICT workers.

Australia, Canada and the United States have drawn on the international supply of ICT workers. In the United States, the H-1B programme provides a six-year permit for ICT workers (to be renewed after the first three years). Foreigners admitted under this programme now account for around 17% of the US ICT workforce. Australia uses an ICT exam for foreigners who seek working permits, while Canada has relaxed the immigration requirement for highly skilled personnel.

Information programmes to increase the transparency of ICT labour markets are also essential. Australia's IT Skills Hub provides information and resources on ICT education, training, development and services as well as business demand through an education portal. Users can browse case studies and news clippings intended to inspire people to obtain ICT skills; they can be linked to course providers and government support programmes; and they can learn about specific careers and average earnings for a range of ICT-related jobs. In Canada, the Self-Managing Learner Toolkit provides information about employable skills and examples of ways to develop and demonstrate these skills. Employability Skills 2000+, the result of the Canadian ICT worker taskforce, is available on the Internet.

Effective policies for ensuring the supply of specialised ICT workers include:

- Surveying labour markets to assess future ICT needs and integrating results in education planning.
- Working with the private sector to develop long-term strategies for increasing the ICT workforce.
- Increasing transparency in the market for ICT skills by creating educational portals.

Chapter 5

FOSTERING EXPLOITATION AND DIFFUSION OF SCIENCE AND TECHNOLOGY

Country performance for this driver relates to: *i)* the ability to exploit science and technology in developing new products processes, services and systems; and *ii)* the ability to diffuse technologies (both domestic and foreign) throughout the economy. Based on quantitative and qualitative (survey responses) indicators, Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and the United States are of interest for further analysis. When countries are grouped according to the characteristics of their national innovation systems, those whose policy approaches may prove the most interesting are Finland, the Netherlands, Japan and the United States.

Within a national innovation system framework, eight broad factors are examined: demand, access to human capital, access to finance (venture capital and R&D support), effectiveness of market processes, public research (level, quality and relevance), science-industry links, access to good business practices, and collaborative networks and clusters. Based on benchmarking, regression and qualitative analysis, the following three policy areas are identified as potentially most important for this driver:

Enhancing the quality of public research by: *i)* creating centres of excellence for research; *ii)* involving industry in the design and financing of the centres; and *iii)* developing competitive mechanisms to identify research areas.

Promoting industry-science links by: *i)* fostering spin-offs and licensing agreements from public research with flexible IPR infrastructure; and *ii)* promoting public-private partnerships with well-defined objectives and clear funding arrangements.

Stimulating demand for new products, processes and services by: *i)* public procurement of new products and services; *ii)* creating awareness and public acceptance of new technologies; and *iii)* fostering acceptance among the social partners of the long-term benefits of new technologies.

These conclusions may change over time as the method and data improve but the conclusions are the most robust possible given currently available data. The micro-policies represent practical solutions to common policy problems implemented in the four benchmark countries and might be adapted by other countries to fit their own context and national situation. Six detailed country notes prepared by national experts from Austria, Finland, Japan, the Netherlands, Sweden and the United Kingdom supplement this analysis. These country notes provide an important historic and national context to the policies discussed in this paper (OECD, 2005a).

Selection of benchmark countries

In advanced industrial countries, exploitation of scientific discoveries and new technology has been the principal source of economic growth and increasing social well-being. In the future, this is likely to be even more crucial to economic and social progress (OECD, 2001a). Countries whose firms fail to exploit new science and technology will find themselves in direct competition with newly industrialising economies with lower labour costs as the latter increasingly master existing technologies and business methods. The development and exploitation of novel products, processes,

services and systems and their constant upgrading is the only way for OECD countries to maintain and increase their relatively high levels of economic and social well being.

At the same time, investments in technology, and to some extent funding of scientific research, are intended to advance economic performance and living standards generally. A key test of successful performance on this driver of growth is how well a country performs on such economic and social indicators as GDP and productivity growth. Macroeconomic growth does not depend primarily on the introduction of new products, processes, services and systems, but on their diffusion throughout the economy. Experience suggests that while industrialising countries may achieve rapid growth rates by exploiting products and ideas developed abroad, this will not sustain and increase the high standards of economic well-being currently enjoyed by many OECD countries (OECD, 2003i).

Assessment of performance must therefore cover a country's ability not only to develop new products, processes, services and systems, but also to diffuse technologies throughout the economy, both those originating in the country and those developed abroad (Table 5.1). For all but the largest OECD countries, the great majority of novel products and ideas will come from abroad. However, all OECD countries must exploit new science and technology effectively to meet their needs. Performance on this driver is thus measured in absolute terms, without taking into account resources spent on investment in new knowledge and diffusion.

This definition tends to overestimate the importance of technical innovations. Firms' competitive advances are more and more due to better understanding of markets' and customers' needs combined with superior design. More work is needed on this new form of innovation.

Table 5.1. Performance indicators for development and exploitation of science and technology

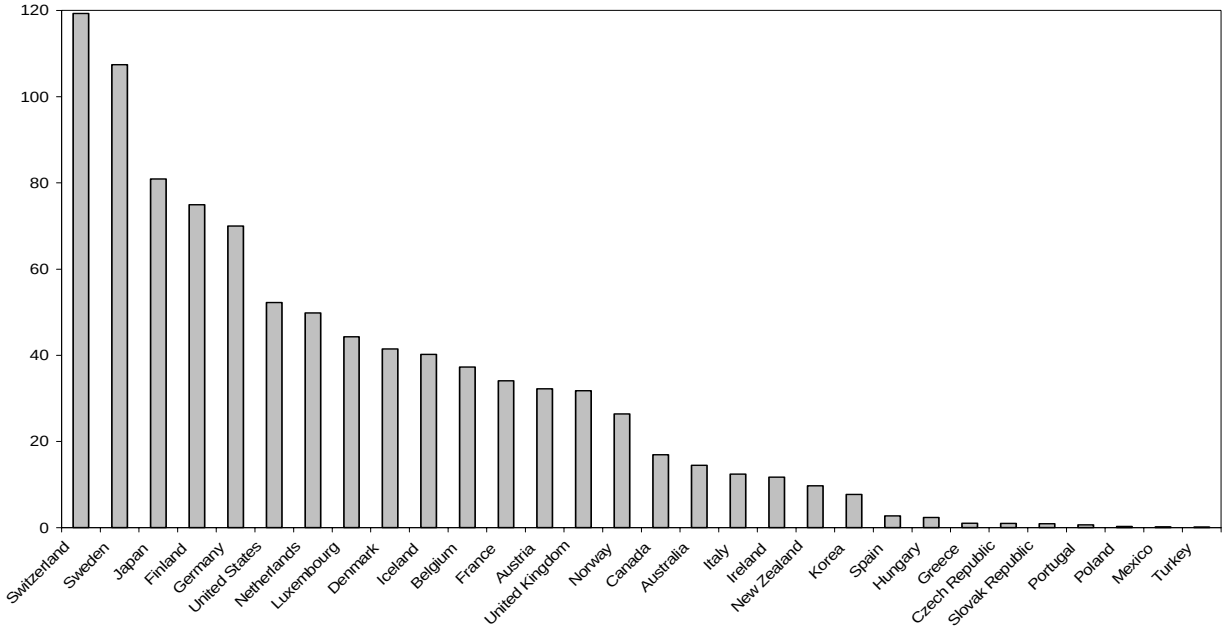
New products, processes, services and systems	Technology diffusion
Number of patents in "triadic" patent families per million population, 1998	Qualitative evaluation of firm-level technology absorption
Share of firms introducing new products or processes	Qualitative evaluation of production process sophistication
Qualitative evaluation of capacity for obtaining new technologies	Technology payments to foreign countries
Qualitative evaluation of revenue generation by firm-level innovation	
Qualitative evaluation of quality of branding	
Qualitative evaluation of quality of design	

Measuring the development of new products, processes, services and systems

Six indicators are used to measure new products, processes, services and systems. These are: patents; share of firms introducing new products or processes; capacity for obtaining new technologies; judgement of revenue generation by firm-level innovation; quality of branding; and quality of design. They include one quantitative indicator, patents, and five qualitative indicators based on survey responses.

Patents are often used to assess exploitation of science and technology, but they mainly measure inventions and are therefore an intermediate rather than a final indicator of performance. Switzerland and Sweden are clear top performers with respect to patents, partly owing to their industrial structure (Figure 5.1). Both countries have significant production in biotechnology, one of the most patent-intensive industries. Japan, Finland and Germany also have a very high level of patenting.

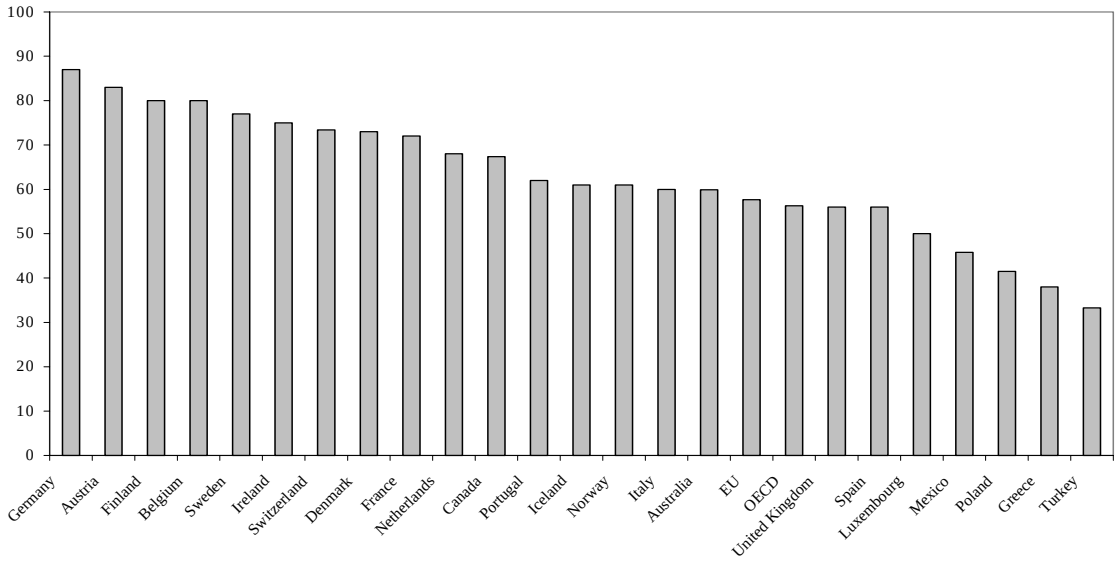
Figure 5.1. Number of patents in "triadic" patent families per million population, 1999



Source: OECD (2004f).

The best survey-based indicator is obtained from the Community Innovation Survey (CIS), which covers 21 OECD countries and shows the share of firms introducing new or technologically improved products or processes in manufacturing. Germany has the highest share with almost 80% of all firms introducing new or technologically improved products or processes on the market (Figure 5.2). In Luxembourg, the Netherlands, Ireland, Switzerland and Denmark, more than 70% of firms introduce new or technologically improved products or processes each year.

Figure 5.2. Share of firms introducing new products or processes on the market, 1998-2001

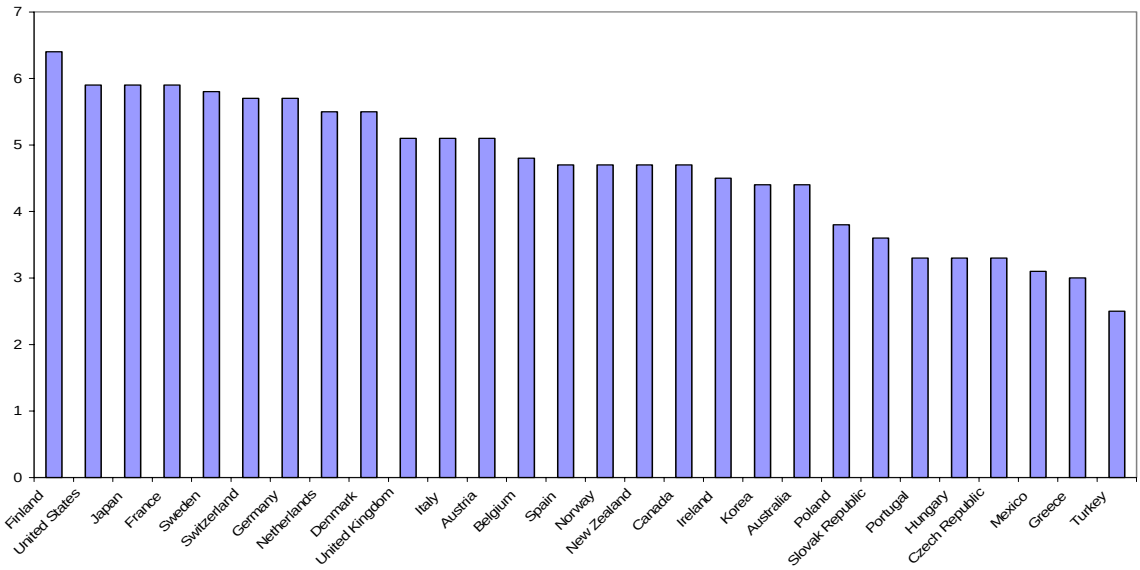


Note: The data for Australia, Canada, Mexico, Poland and Switzerland are from 1995-97. Data for all other countries are based on the third Community Survey on Innovation.

Source: OECD (2001e) and Eurostat (2004).

A more qualitative judgement of a country's ability to introduce new products and processes shows that Finland is the best-performing country, followed by five countries with more or less identical values (France, Japan, United States, Sweden, Germany and Switzerland) (Figure 5.3). The judgement is based on the World Economic Forum's executive survey (Box 5.1). For most countries the two data sources show similar results (correlation 0.6).

Figure 5.3. A qualitative evaluation of capacity for obtaining new technology



Source: WEF, 2003. The executives were asked "Companies obtain technology (1=exclusively from foreign companies, 7=by pioneering their own new products or processes)".

A qualitative evaluation of whether the exploitation of science and technology actually affects profitability shows very little variation among countries but does suggest that the United States has more firms for which it plays a major role in generating revenue (Figure 5.4). Switzerland, Sweden, Japan and Finland also do well on this indicator. The correlation between profitability and the number of patents is high (0.65) and significantly different from zero, with France the marked exception.

Indicators for patents and for the introduction of new products and processes focus on technical developments, whereas many developments take the form of a design or a brand. No quantitative data exist on these aspects of exploitation of science and technology but the WEF survey can be used for a qualitative judgement. The top-performing countries in design and branding tend to be the same as those for more technical developments. The correlations among various indicators are high (varies from 0.55 to 0.75). Italy is the only exception, as it scores well on branding and design but not on the more technical developments.

Box 5.1. Problems with using subjective surveys

The lack of good performance data in this driver has led to the use of a few answers from the World Economic Forum's Executive Survey (WEF, 2003). This is problematic, as these answers are based on the respondent's subjective judgement of the country as a whole and not as, for example, in the CIS, on the respondent's own firm's performance. Because of the subjective nature of the responses, the results are less reliable and should be interpreted with caution. Ideally, the questionnaires capture the perceptions of leading investment and business decision makers worldwide. The survey was carried out in collaboration with national partner institutes, typically national research or academic institutes. The partner institutes should ensure that the sample of respondents is representative of the economies in question and that the method used is consistent across countries. However, the total number of responses (7 741 from the 74 participating countries) is quite a small sample and it is difficult to control who actually responded to the questionnaires.

The quality of the data can be illustrated by comparing responses to some WEF questions to hard data. Three questions are directly comparable with hard data:

i) Question: "Companies' spending on research and development in your country (1=is non-existent, 7=is heavy relative to international peers)?" compares to BERD as a percentage of GDP (from OECD, 2003j). The correlation is very high (0.88).

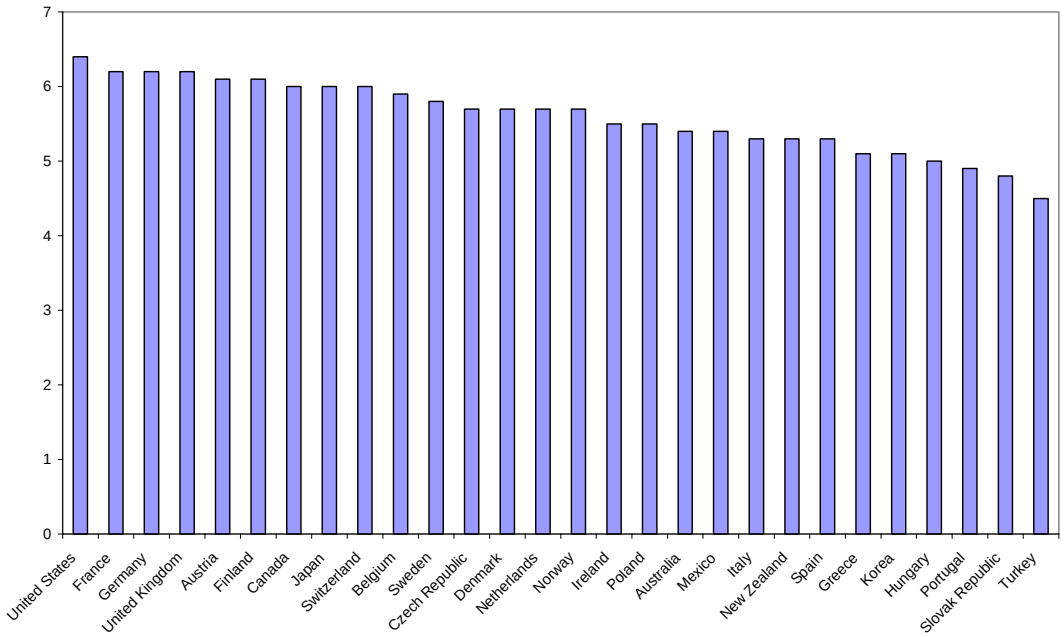
ii) Question: "Government tax credits for firms conducting research and development in your country (1=never occur, 7=are widespread and large)?" compares to relative generosity of tax treatment of R&D (from OECD, 2003j). The correlation is significantly different from 0 at the 5% level but the correlation is only 0.4.

iii) Question: "Direct government subsidies for firms conducting research and development in your country (1=never occur, 7=are widespread and large)?" compares to percentage of BERD financed by government (OECD, 2001e). The correlation is not significantly different from 0.

These correlation coefficients highlight that hard data should be used whenever possible but that the survey data can sometimes give an accurate picture of the situation in a country but are sometimes misleading. The relatively low correlation between the tax question and calculated tax rates are mainly created by Portugal and Spain which view their tax system as less favourable than it is. R&D investment will be affected by this perception so the survey question does reveal important information. The subsidy question is not affected by outliers.

In spite of the limitations of the WEF survey, it is used as it is the only survey that covers these areas. However, countries whose performance differs significantly in the survey data and in hard data should be analysed further using qualitative approaches.

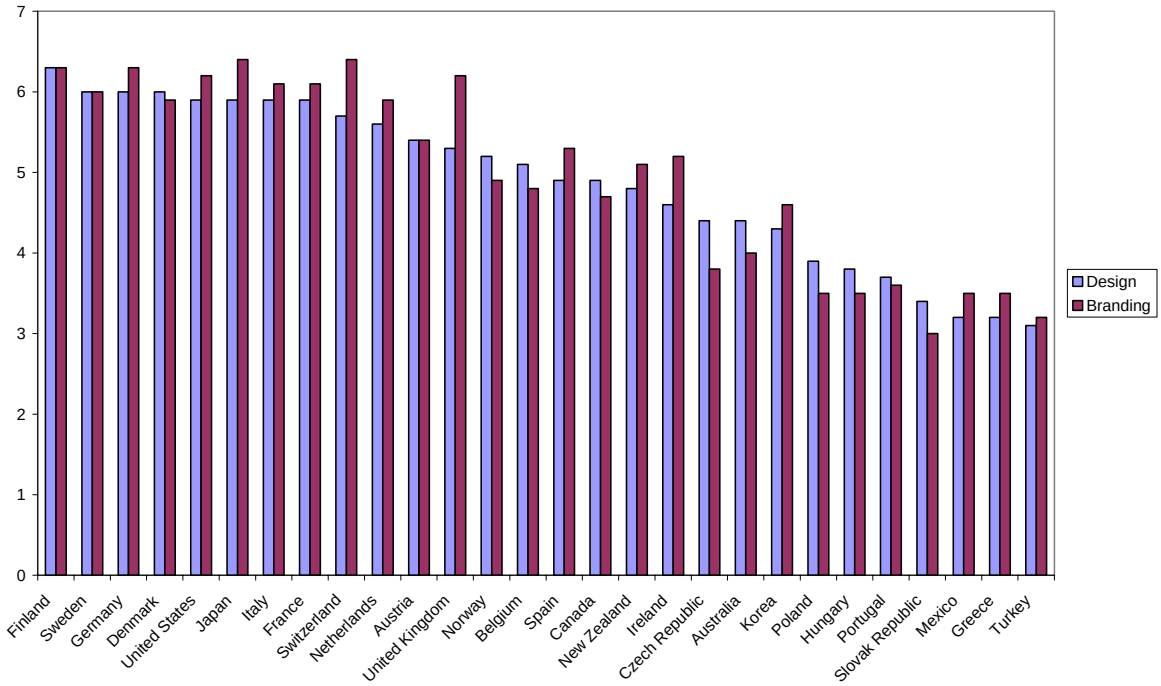
Figure 5.4. Qualitative evaluation of revenue generation due to firm-level innovation



Source: WEF, 2003. The executives were asked "In your business, does continuous innovation play a major role in generating revenue (1=not true, 7=true)"

Finland, Denmark, Germany and Sweden are strong in design (Figure 5.5), whereas Japan, Switzerland, Finland and Germany lead in branding. Generally, countries tend to perform the same on the two measures (correlation 0.95).

Figure 5.5. Qualitative evaluation of quality of branding and design



Source: WEF, 2003. The executives were asked "Product designs are (1=copied or licensed from abroad, 7=developed locally)", "Companies that sell internationally (1=sell commodities or market under foreign brands, 7=have developed their own international brands)".

All in all, the six indicators of development of new products, processes, services and systems tell a coherent story for most OECD countries. Finland, Germany, Japan and the United States consistently show good performance in both "hard" and "soft" indicators. Finland has one weak point (share of firms introducing new products) but is among the top five on the five other indicators. Germany, Japan and the United States have no real weaknesses and are among the top five for most indicators. Sweden also performs well on most indicators.

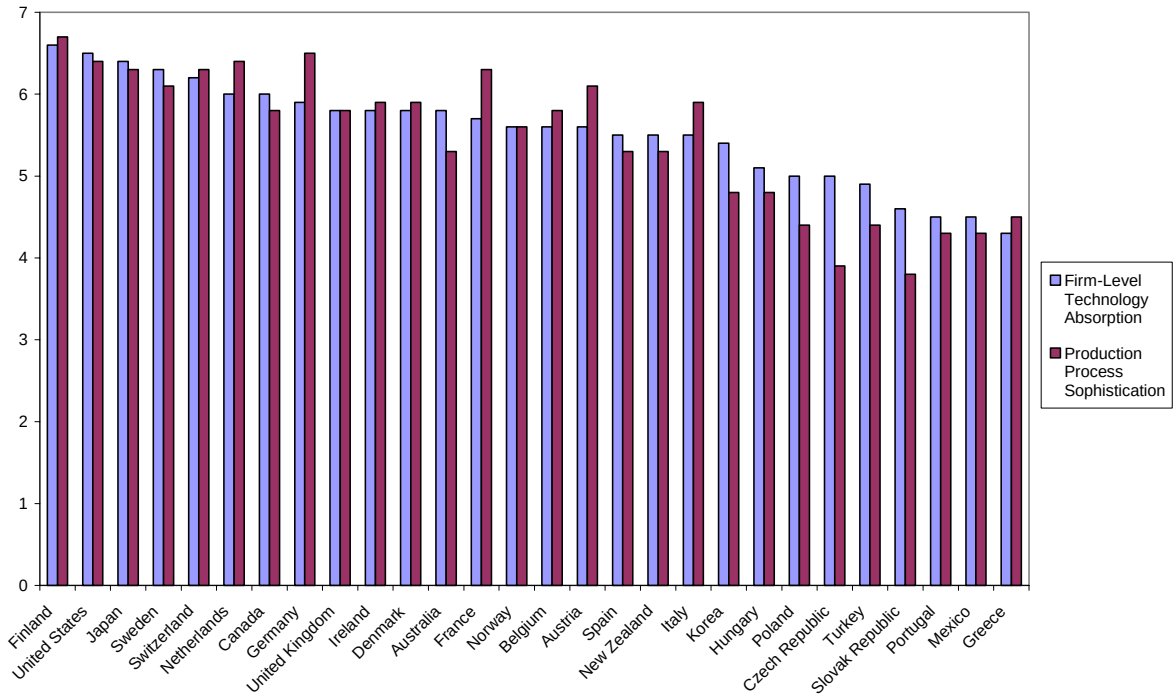
A few countries' performance is difficult to judge as the indicators tell different stories (France, Ireland and Italy). France's performance varies from ranking second in two indicators to around average in two others; more qualitative analysis is needed to determine France's relative performance. The other two countries are easier to explain. Ireland has one outlier ranking (share of firms introducing new or technologically improved products or processes) but ranks more or less around the OECD average on the other indicators. The high ranking may be a measurement problem in the CIS, as Ireland does not perform well on patents. Italy ranks high in one type of development of new products, processes, services and systems but not in others, which causes large variation in its rankings.

Measuring technology diffusion

Two qualitative indicators based on survey responses are used to measure technology diffusion at the national level and one quantitative indicator based on technology balance of payments is used to measure diffusion at the international level. Ideally, technology diffusion should be measured by surveys of the diffusion of new technologies, processes and business methods (OECD, 2003i). However, cross-country surveys asking firms about how they absorb and use new technologies in general are only available at the aggregate level.

According to the WEF survey, firms in Finland, the United States and Japan are most aggressive in absorbing new technologies (Figure 5.6). Absorption of new technologies measures the diffusion of science and technology throughout the economy, which is not captured in the previous indicators. However, the high-ranking countries tend to be the same for the two measurements.

Figure 5.6. Qualitative evaluation of firm-level technology absorption and production process sophistication



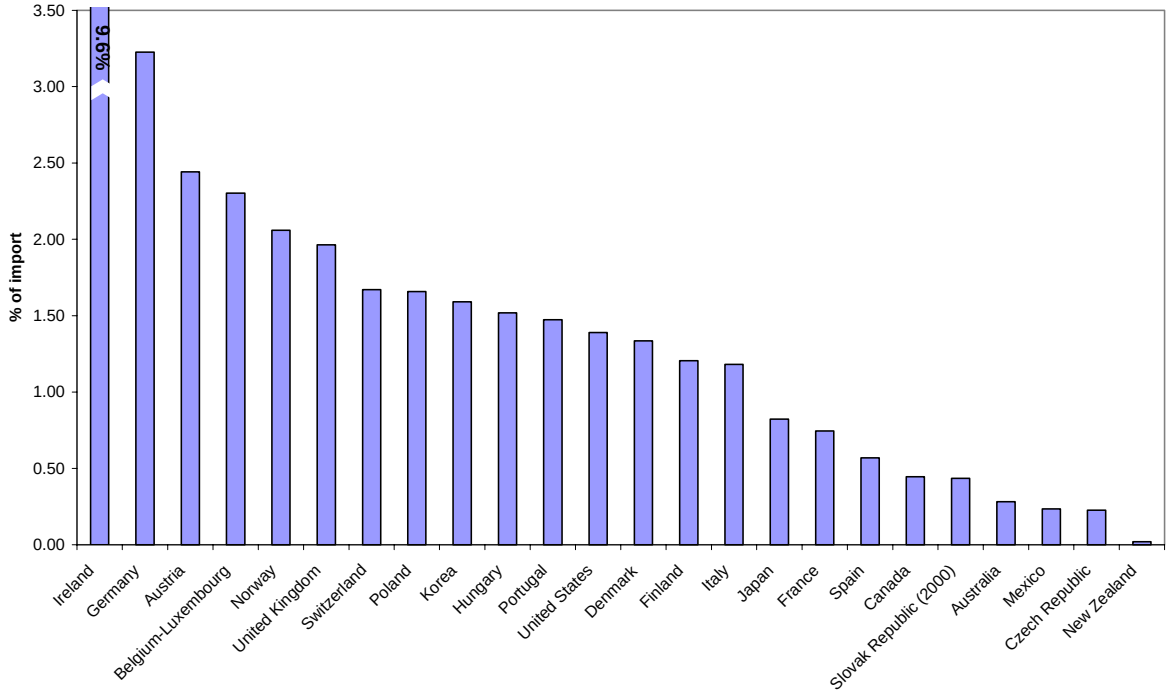
Source: WEF, 2003. Executives were asked "Companies in your country are (1=not interested in absorbing new technology, 7=aggressive in absorbing new technology)?" and "Production processes generally (1=use obsolete technology, 7=employ the world's best and most efficient technology)?".

A related question regarding the use of efficient process technologies shows very similar results. Finland again ranks highest and the United States and Japan also do well. Germany and the Netherlands have a higher ranking in sophistication of production processes than in absorption. Otherwise the rankings among the top performing countries are more or less the same on the two indicators. The correlation between the two indicators is very high (0.9).

The only quantitative indicator of technology diffusion measures the international aspect of technology diffusion and shows Ireland as the largest importer of technology. The indicator measures payments for foreign technology normalised by the country's trade to make it comparable among

countries. Ireland is by far the largest importer of technology owing to its high share of multinational firms (Figure 5.7). Germany and Austria also perform well on this indicator.

Figure 5.7. Technology payments to foreign countries as a percentage of trade



Note: Technology payments comprise four main categories: *i)* transfer of techniques (through patents and licences and disclosure of know-how); *ii)* transfer (sale, licensing, franchising) of designs, trademarks and patterns; *iii)* services with a technical content, including technical and engineering studies, as well as technical assistance; and *iv)* industrial R&D.

Source: OECD (2003j).

A simple average of the standardised value of the three indicators used to measure diffusion shows that Sweden, the Netherlands and Ireland can be placed in the first group. They are followed by Finland, the United States and Germany, which all have very similar performance. The results are not as robust as the previous indicators. The high ranking of Ireland is due to its high imports of technology; for Sweden and the Netherlands data on these indicators are lacking. The weaker performance of Finland and the United States is mainly due to their average performance on imports of technology.

Selection of benchmark countries

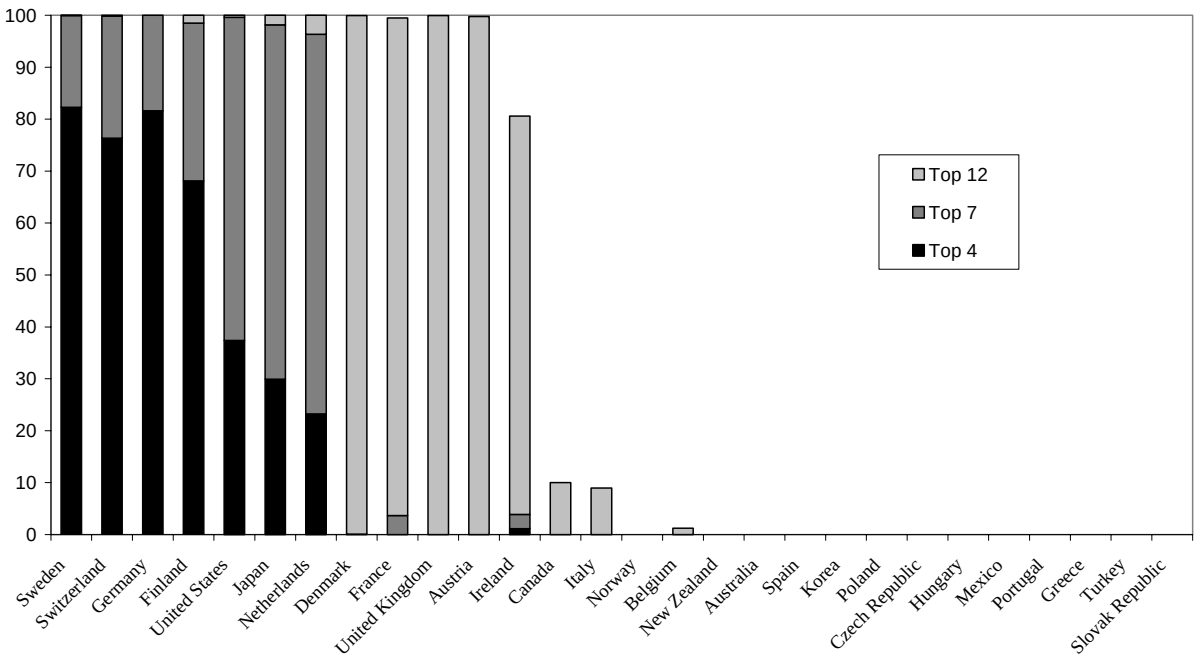
Measuring performance in this driver is difficult as only a few quantitative indicators are available. In all, nine indicators are used to illustrate various aspects of performance. In spite of the weaknesses of the indicators, several countries perform well on all. Finland, Germany, Japan and the United States consistently show good performance on all indicators relating to development of new products, processes, services and systems. Finland, Germany and the United States also do well on the indicators for technology diffusion as do Sweden and the Netherlands.

Owing to a lack of information on the relative importance of the nine indicators, a distribution of possible composite indicators was calculated based on random weights (Figure 5.8). The distribution does not suggest a specific ranking of countries but rather a robust division. The best split is a top-four and a top-seven group. The former is not very clear but the latter (Sweden, Switzerland, Germany,

Finland, United States, Japan and the Netherlands) is very stable. In more than 95% of cases these countries are among the top seven. The random calculation also shows that all countries in this group might be the best-performing country even though it is in less than 0.1% of the outcomes that Japan, for example, is the best performing country.

There is also a possible top-12 group including five more countries (Denmark, France, United Kingdom, Austria and Ireland). These five countries are rarely among the top performers, except for Ireland, if most weight is given to imports of foreign technology. The performance of the top seven and the top 12 groups is consequently very different. The same is true for the rest of the OECD countries, none of which, except for Canada and Italy, is among the top 12 for any of the 10 000 randomly assigned weights. However, Canada and Italy never rank higher than tenth.

Figure 5.8. Probability of having a given rank with randomly assigned weights



Note: Based on 10 000 randomly assigned weights for the indicators shown above. The weights are drawn from a uniform distribution from 0 to 1 and assigned to the standardised indicators.

All in all, the analysis suggests basing further analysis on Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and the United States. These are very different countries and represent a broad range of national innovation systems.

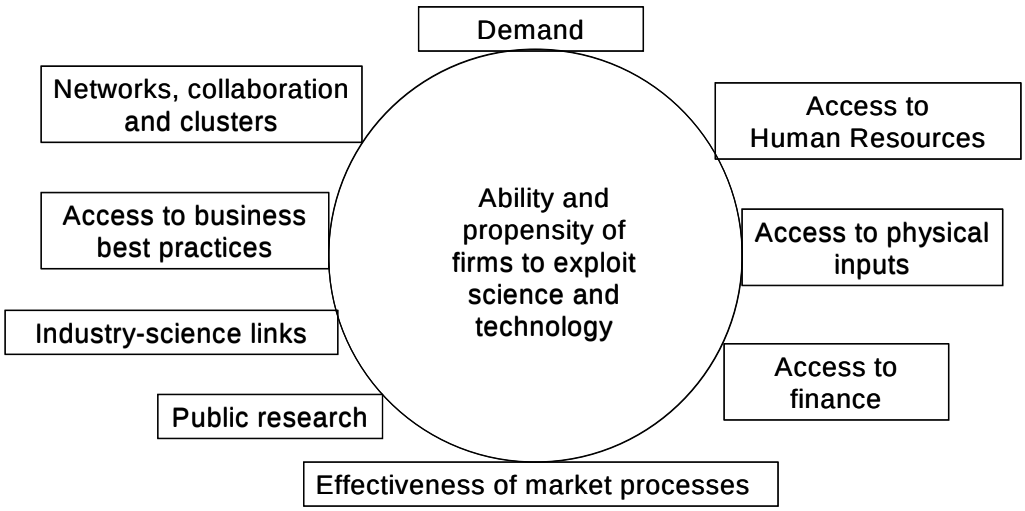
Quantifying the business environment

There is much academic and business literature on factors affecting exploitation of science and technology and technology diffusion, but for policy purposes the topic is best considered within the framework of a national innovation system (NIS). For the purposes of assessing the factors that determine national performance in development and exploitation of science and technology, the NIS can be assumed to include ten factors, nine of them external and one internal to the firm.

The first external factor is the demand for new goods and services, the following three are the inputs to the process (access to physical inputs, human capital and finance), the fifth is the competitive environment of the firm (effectiveness of the market process) and the last four the firm's access to both public and private knowledge (public research; industry-sciences links; network, collaboration

and clusters; and access to best business practices) (Figure 5.9). The internal factor is the firm's ability and propensity to exploit science and technology, which depends on quality of management and organisation. Each of the factors can to various degrees be affected by government policies. Only the external factors are discussed here.

Figure 5.9. Important factors in the national innovation system for exploitation of science and technology and technology diffusion



A country's performance depends not only on its performance on individual elements of the NIS but also on their interaction. Previous OECD work indicates several different configurations, which can result in successful overall performance for the exploitation of science and technology and technology diffusion. It is the cohesiveness of the NIS that matters for successful performance, as well as how well the country does on each of the main elements (OECD, 2003i).

The following sections use spider diagrams to identify similarities in the business environment across the seven countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) selected as benchmark countries for further analysis owing to their performance in this driver.

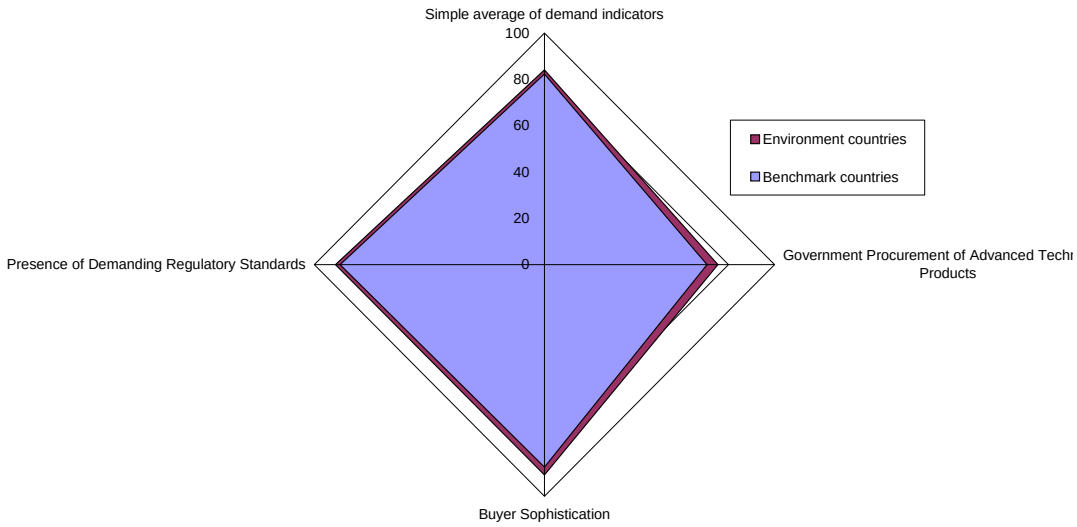
Demand

Demand in this area reflects the willingness and ability of consumers, firms and public sector organisations to be intelligent and demanding customers and to purchase novel products and services. The propensity of consumers to buy novel products and services is a function of national culture, per capita income, etc., while that of firms is much more endogenous to the NIS; the more innovative the firms, the more they buy innovative inputs. Demand is measured by three qualitative indicators based on the World Economic Forum's survey (Box 5.2). The first measures public procurement; here governments have a direct influence on markets and can create demand for innovative products and services. The second measures the sophistication of other buyers' demand, and the last relates to regulatory requirements.

The benchmark countries do well in this area, which suggests that it could be among the most important for exploiting science and technology. The average of indicators for the benchmark countries for both private and public demand is very close to those of the best country (Figure 5.10). Regulatory standards are also high in all benchmark countries and push firms to develop new products and processes. The benchmark countries' high income per capita creates conducive demand

conditions, as rich countries tend to have more "advanced" demand. However, regression analysis shows that the demand conditions are better in the benchmark countries than expected from their income levels, which suggests that demand works as a driver for exploiting science and technology.

Figure 5.10. Benchmarking demand in selected countries



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 5.2. Indicators of demand and links to GDP

The three indicators of demand are taken from the World Economic Forum's Executive survey (WEF, 2003). The first two directly address the "quality" of local demand and the last examines government's indirect effects on demand through regulatory standards. The first question measures businesses' assessment of buyers' sophistication: "Buyers in your country are (1=unsophisticated and choose based on the lowest price, 7=knowledgeable and demanding and buy innovative products)." Finland has the highest value among the OECD countries for this indicator. The second question measures businesses' assessment of the extent to which government procurement of advanced technology products is based on price alone or encourages innovation: "Government decisions on the procurement of advanced technology products are based on (1=price alone, 7=technology and encouraging innovation)." Finland has the highest value among the OECD countries for this indicator. The third question measures business assessment of the presence of demanding regulatory standards, which is another way for government to affect demand conditions, *e.g.* by introducing energy, safety, environment standards: "In your country are regulatory standards (1=lax or non-existent, 7=among the world's most stringent)." Germany has the highest value among the OECD countries for this indicator.

It is well known that richer countries also have more advanced demand for innovative products. This makes it difficult to determine the importance of demand for exploitation of science and technology as all the benchmark countries are high-income countries. To correct for income effects a regression was performed with the simple average of the demand indicators as the dependent variable and GDP per capita (PPP) as the independent variable. The r^2 equals 0.7, and the slope is significantly different from zero at the 0.01% level. An analysis of the residuals shows that the residuals are positive for six out of the seven benchmark countries, which means that almost all have better demand conditions than expected from their income. Only the United States has slightly lower demand conditions than income would suggest. The sum of the residuals for all benchmark countries is highly positive.

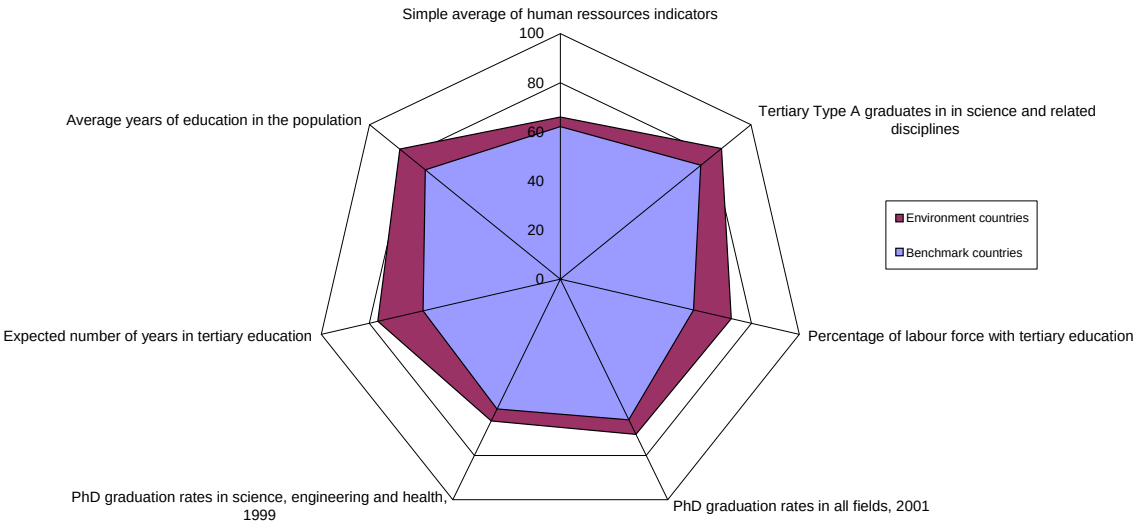
	Summary statistics				Residual output	
	Coefficients	t Stat	P-value	Observation	Predicted Y	Residuals
Intercept	-1.82	-0.22	0.83	Finland	65.65	31.97
GDP per cap.	0.00	7.62	0.00	Germany	67.73	12.64
R^2	0.69			Japan	67.36	8.23
				Netherlands	70.86	4.61
				Sweden	67.79	12.34
				Switzerland	76.98	10.19
				United States	90.24	10.63

Access to human resources

Six quantitative indicators are used to measure access to human capital (Box 5.3). All relate to formal tertiary education and include both the supply of new graduates and stocks of people with tertiary education. This area has a high degree of overlap with enhancing human capital and realising its potential. Many aspects of the driver of human capital are inputs to development and exploitation of science and technology, especially the availability of highly educated people.

The benchmark countries perform well in this area although the average of the seven countries is far from the best in this area. Benchmark countries perform well on most of these indicators and have no major weaknesses, except for Japan, which scores below the OECD average on all indicators except for the share of the population with tertiary education. The Netherlands also has some weak points. Finland is the best performer in this area among the OECD countries.

Figure 5.11. Benchmarking access to human resources



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 5.3. Indicators of human resources

The indicators for human resources measure the relative share of highly skilled people in different countries to give an idea of countries' educational attainments at this level. Tertiary type A graduates in science and related disciplines reflect the share of graduates in engineering, manufacturing and construction, health and welfare, life sciences, physical sciences, mathematics and statistics and computing, relative to all students who complete studies at this level. A type A graduate education requires more than three years of full-time graduate courses. Switzerland has the highest share (53%). The percent of the labour force with tertiary education is also a stock variable and a broader measure of the overall educational level of the population. The United States has the highest share (31%). PhD graduation rates in all fields and PhD graduation rates in science, engineering and health refer to net graduation rates by single year of age in public and private institutions. This is an indicator of the current rate of production of advanced knowledge by a country's education system. Countries with high PhD graduation rates are generally characterised by a highly skilled labour force. Sweden has both the highest graduation rate (2.7% of a cohort) and the highest graduation rate in science, engineering and health (1.8%). Average years of education in the population and expected number of years in tertiary education are measures of the population's overall skills level that may not be captured in tertiary-level graduation rates, as they measure the amount of tertiary education undertaken by an age cohort. Australia has the highest expected years of education (20.6 years). Finland has the highest expected years in tertiary education (4.2 years)

Access to physical inputs

Access to physical inputs has become less relevant over time as trade barriers and transport costs have declined significantly. Indicators of local production are consequently less important than they were 20 years ago. The importance of local links is now based on access to knowledge (discussed in the section on network, collaboration and clusters). No indicators will be used to evaluate the importance of this area.

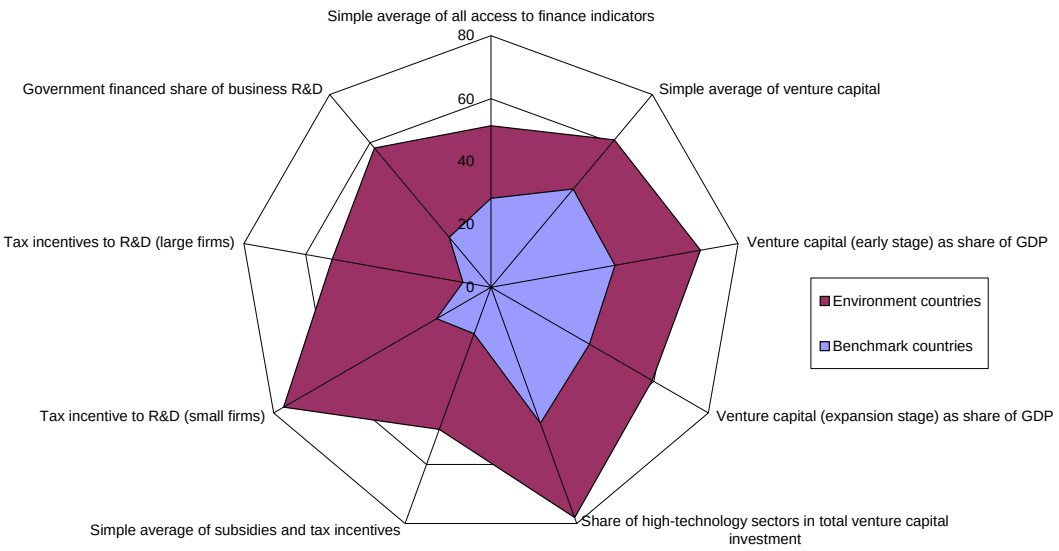
Access to finance

Access to finance covers a very broad set of issues, from direct public support to access to risk capital. The assessment is divided into two main areas, which are analysed separately: access to venture capital and government subsidies and tax incentives for R&D.

Venture capital is a special type of equity finance, typically for young, high-risk and often high-technology firms. These firms need capital to fund start-up, product development or growth and must, by the nature of their business, obtain this capital largely in the form of equity. Three indicators are used to measure access to venture capital as a share of GDP (Box 5.4).

The benchmark countries do not on average perform very well in this area and there are large differences among them, suggesting that this is not a key area for exploitation of science and technology (Figure 5.12). The United States and Sweden have some of the largest venture markets in the OECD area, while Germany and Japan lag behind. However, the low average performance of the benchmark countries is not driven by the lagging countries. Venture capital does not appear to be important even when the analysis focuses on the five countries with the highest indicators for venture capital.

Figure 5.12. Benchmarking access to finance



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (Environment countries).

Government subsidies and tax incentives for R&D can to some extent be measured directly by three indicators (Box 5.4). The first two indicators measure the generosity of existing tax credits with

respect to R&D investment and other tax incentives. The third measures government subsidies by examining the share of business R&D that is directly financed by the government.

The indicators show that the benchmark countries use subsidies and tax incentives to a lesser extent than other OECD countries, which suggests that these instruments are not the reason for their success. Their weakest area is tax incentives. It seems that this is not a very favourable instrument in these countries, except in the Netherlands which has quite generous tax treatment of R&D, especially for small firms.

Box 5.4. Indicators of access to finance

The selected venture capital indicators measure its availability (venture capital investment as a share of GDP) and its specialisation (high-technology sectors as a share of total investment). Venture capital investment as a share of GDP is divided into early- and expansion-stage investment and covers an average over 1999-2002. Canada has the highest share of early-stage investment (0.2% of GDP), and the United States has the highest share of expansion investment (0.3% of GDP). Investments in high-technology sectors as a percentage of GDP cover both the early and expansion stages in health, biotechnology, information technology and communication. This indicator is a proxy for how mature the venture market is. The high-technology sectors are the most difficult to invest in, and high investment in these markets therefore signals a mature market. Ireland has the highest share of investment in these sectors (90% of all investments).

Government subsidies and tax incentives can to some extent be measured directly. Four indicators were chosen. The first two directly measure the tax incentives for R&D (for small and large firms) in OECD countries, several of which have special R&D taxes for small firms so the index is calculated for both large and small firms. The indicator is based on the so-called B-index, which is defined as the present value of before-tax income necessary to cover the initial cost of R&D investment and payment of corporate income tax that makes it profitable to perform research activities. Algebraically, the B-index is equal to the after-tax cost of an expenditure of USD 1 on R&D divided by one minus the corporate income tax rate. The after-tax cost is the net cost of investing in R&D, taking into account all the available tax incentives (the index is rescaled so higher values equal higher incentives). Italy has the most generous tax treatment of R&D for small firms, and Spain has the highest share for large firms.

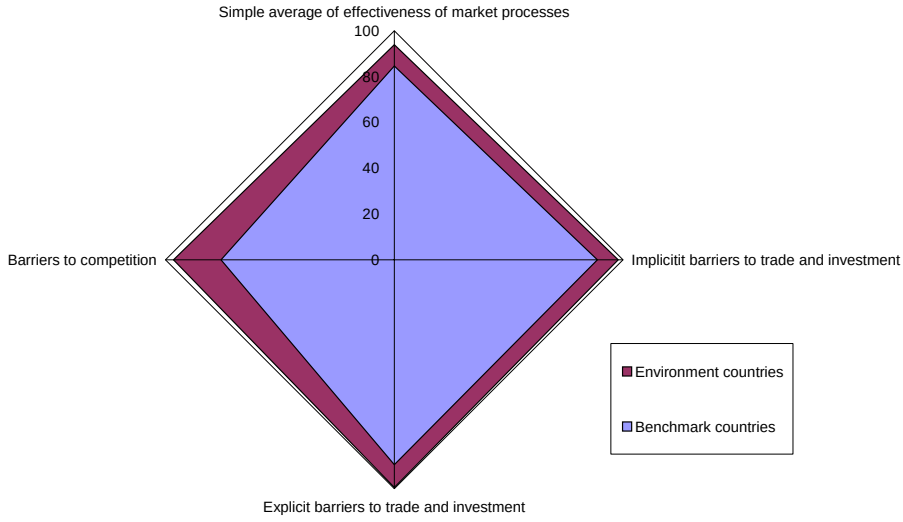
The OECD also maintains data on the government-financed share of business R&D. This indicator directly measures the relative importance of public direct support for private R&D. Poland has the highest share with 27% of private R&D financed by government.

Effectiveness of market processes

An effective market process should produce inter-firm rivalry and competition, which is conducive to exploitation of science and technology. The optimal degree of competition in a market is still being debated in the theoretical literature, but OECD analysis shows that tougher competition leads to higher investments in R&D (OECD, 2003k). Competition cannot be measured directly. The three chosen indicators therefore relate to regulation of competition, trade and investment, as this is the main instrument for government to affect competition (Box 5.5). Other regulations such as intellectual property right are also important for the functioning of the market processes but are difficult to measure.

The benchmark countries do well on average in this area although some of the countries have some weaknesses (Figure 5.13). They have fewer barriers to trade and investment than most other OECD countries. They also tend to have fewer barriers to competition. Among the benchmark countries, Switzerland has the least effective market process and the Netherlands the most effective.

Figure 5.13. Benchmarking the effectiveness of market processes



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 5.5. Indicators of the effectiveness of market processes

The three indicators measuring the effectiveness of market processes are from the OECD regulatory database. They measure regulatory barriers to effective competition and not the effectiveness of the processes. The first two measure implicit and explicit barriers to trade and investment, as competition from abroad is an important driver for exploitation of science and technology and technology diffusion. Explicit barriers measure regulations to prevent foreign ownership. Ireland has the fewest explicit barriers and Australia has the fewest implicit barriers.

The third indicator measures barriers to competition and focuses mainly on the permit and licensing system and on exceptions in competition regulation. Spain has the fewest barriers to competition.

Public research

There is significant evidence of the positive effects of public-sector R&D on growth and productivity and of the leverage effects of public research expenditures on those of the business sector (OECD, 2001b). Furthermore, the role of public research in the exploitation of science and technology is expected to be enhanced in knowledge-based economies. Indeed, as new products become more science-intensive and firms increasingly acquire scientific and technical knowledge from external sources, businesses make more intensive use of public research (OECD, 2004e). The indicators used to measure public research can be divided into three areas: level, relevance and quality.

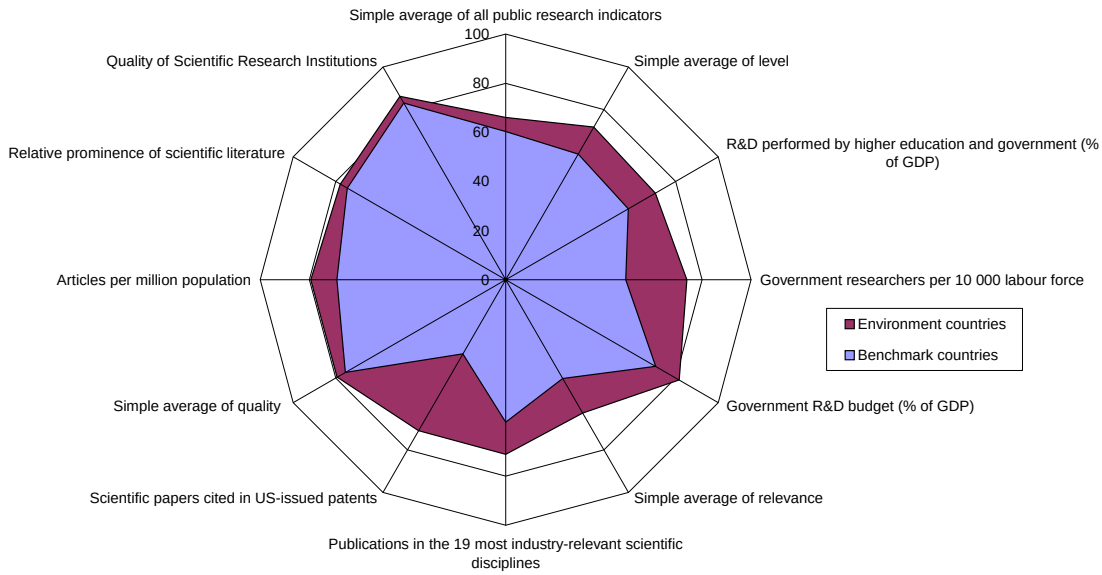
The level of public research is measured by three indicators. The first directly measures the cost of R&D performed by higher education and government, the second is a head count of public researchers, and the third is the total budget for government-financed R&D (Box 5.6). The benchmark countries are well above the OECD average but still more than 15% below the seven countries with the highest level of public research (Figure 5.14). The average covers large differences. Sweden, Finland and Switzerland spend more on R&D in higher education and government relative to GDP then other OECD countries. Finland and Sweden also have the highest number of public researchers compared to their total labour force. Finland's performance is unique among OECD countries in having a very high number of public researchers outside the higher education sector. The largest

public budgets for R&D are found in Iceland, France, Finland and the United States. In the United States about 50% of that budget goes for defence research, whereas it is around 25% of the French budget. The data for public budgets for R&D are less comparable across countries than the two previous measures as the data are based on budgetary sources, whereas the other two follow international standards. The advantage is that this indicator covers all public expenditures independent of where the R&D is performed.

Relevance is difficult to measure and two simplistic indicators are used here. The first measures publications in industry-relevant disciplines and the second measures papers cited in US patents. The benchmark countries have relatively low values for both indicators, particularly scientific papers cited in US patents. None of the benchmark countries performs well on both indicators. Based on these indicators, relevance of public research seems less important than its level and quality.

Quality is measured by three indicators. The first is a simple measure of production of scientific articles. The second measures quality more directly by examining whether papers are cited by other papers. The third is a qualitative evaluation of quality taken from World Economic Forum survey. The benchmark countries have a high average value for these indicators. They give great prominence to research, and the survey result shows that senior management in the benchmark countries feel that the country performs high-quality research. The high values of the indicators in the benchmark countries suggest that quality may be the most important aspect of public research.

Figure 5.14. Benchmarking public research (level, relevance and quality)



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 5.6. Indicators of public research

The level of public research can be measured by three different indicators: R&D performed by the higher education and government sector as a percentage of GDP; government researchers per 10 000 labour force; and government R&D budgets as a percentage of GDP. The indicators are highly correlated. The main cost of public research is wages for researchers. However, there are large differences for some countries; for example, the United States and France have large budgets for procurement of R&D related to defence, which is included in the last indicator but not in the other two. Finland has the highest value for the first two indicators. Finland spends 1% of GDP on R&D performed by the higher education and government sectors. Finland has 58 public-sector researchers per 10 000 persons in the labour force. France has the highest public budget for R&D (1% of GDP).

Available data fail to accurately measure the relevance of public research, but two available indicators measure some aspects. The number of scientific papers cited in US patents and publications in industry-related journals measure the degree of specialisation in areas of high industry relevance. Sweden has the highest number of scientific papers cited and Denmark has the highest number of publications in industry-related journals.

The quality of public research is measured by the ability of scientists and researchers to carry out research that is beneficial to overall economic and social progress. Traditionally, the quality of research is measured by the number of scientific publications per million population. In 1999 Switzerland had the highest number among OECD countries with 973 publications per million population. However, it is also possible to examine the relative prominence of scientific literature by country by examining citations of published papers. Article counts and citations are based on science and engineering articles published in a stable set of about 5 000 of the world's most influential scientific and technical journals, tracked since 1985 by the Institute of Scientific Information's (ISI's) Science Citation Index (SCI) and Social Science Citation Index (SSCI). Switzerland also has the highest citation index. In addition, WEF's survey of business assessment of the quality of scientific research institutions asks whether scientific research institutions in the country, such as university and government laboratories, are (1=non-existent, 7=the best in their fields). This survey question puts the United States, closely followed by Switzerland, as the OECD countries with the highest-quality research institutions.

Industry-science links

Science-industry links cover a broad array of interactions, from business funding of public research to start-up companies by universities and research institutions (OECD, 2001f). Three indicators are used to measure this complex area (Box 5.7). All relate to co-operation between private firms and public research institutions. The first measures the share of firms that co-operate, the second the relative importance of privately financed R&D in public research, and the third is a qualitative evaluation of the co-operation. No indicators are available on spin-offs from public research or the degree of licensing, but the number of incubators per SME is used as a proxy. Incubators often house science- and technology-based firms which could be spin-offs or based on licensed technology.

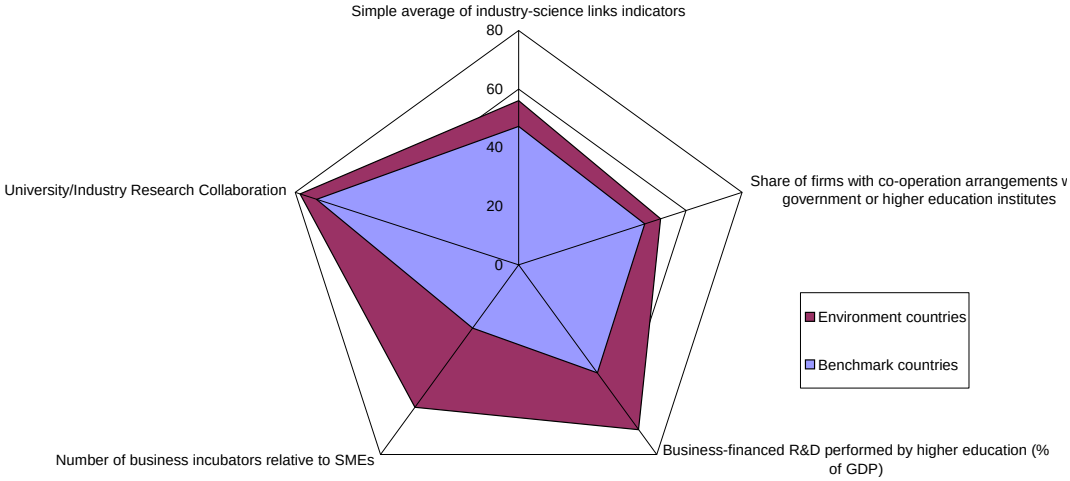
The indicators show that the benchmark countries do well on average in this area (Figure 5.15). However, average performance is forced down by Japan's low performance on all aspects of science-industry links. The total number of incubators per SME is also quite low in the benchmark countries. Finland and Sweden are among the best in terms of the links, while the Netherlands stands near the OECD average.

Box 5.7. Indicators of industry-science links

Among the four indicators, the first two deal with the formal links between firms and research institutions either through co-operation or direct financing (share of firms with co-operation agreements with government or higher education (1994-96) and business funding of public research as a share of GDP. The third indicator is business assessment of university-industry collaboration from the WEF survey: "In its R&D activity, business collaboration with local universities is (1=minimal or non-existent) 7=intensive and ongoing)."

The final indicator measures the number of business incubators relative to small firms. These incubators are often closely linked to universities and are often spin-off firms from universities.

Figure 5.15. Benchmarking industry-science links



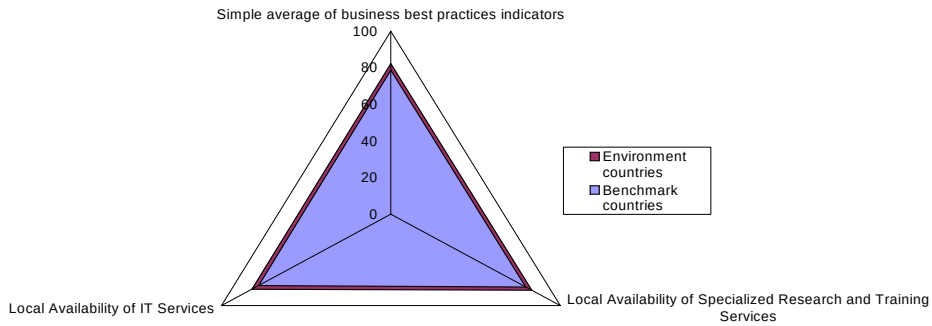
Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Access to business best practices

Firms need to adapt constantly to changes in technology and in consumer demand. Access to private and public business advice services can help firms to adopt good business practices. The availability and quality of business services are difficult to measure. Only two indicators based on qualitative data from the World Economic Forum are available (Box 5.8), making it difficult to draw robust conclusions about this area. The first indicator measures availability of local training services, and the second measures availability of local IT services. These are only a subgroup of the required services but no other indicators are available.

The indicators show that all benchmark countries are doing well in this area (Figure 5.16). In all, local training is readily available and they have good local access to specialised IT services. This may suggest that this area is important for overall performance. The United States has the highest values for both indicators, closely followed by Finland.

Figure 5.16. Benchmarking access to business best practices



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Box 5.8. Indicators of good business practices

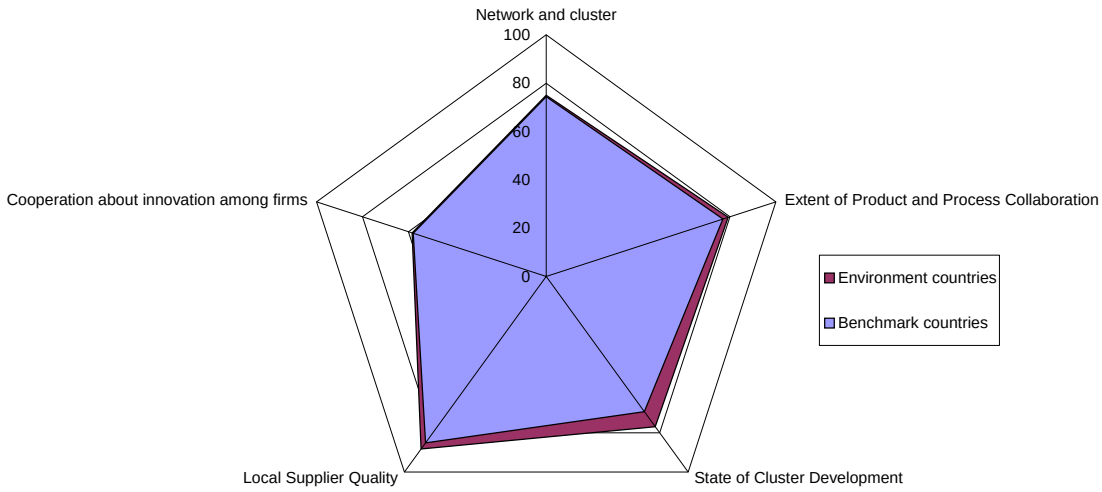
Only qualitative indicators are available for this area. The two indicators are based on WEF's questionnaire. The first question is examines the availability of general training: "In your industry, specialised research and training services are (1=not available in the country, 7=available from world-class local institutions)." The second focuses more on local availability of IT services: "In your industry, specialised IT services are (1=not available in the country, 7=available from world-class local institutions)."

Networks, collaboration and clusters

Exploitation of science and technology and technology diffusion are interactive and iterative processes among firms, the capital market and public institutions. Several governments consequently support networking, collaboration and cluster activities among firms to increase their capacity to exploit science and technology. Four indicators are used to measure this area, and they show a coherent story for the benchmark countries (Box 5.9). The first indicator measures the share of firms that co-operate directly with other firms in innovation. The others are based on survey data from WEF. The first WEF indicator addresses the quality of supplies which is important in cluster formation. The second deals directly with cluster formation. The third deals with the local development process through networks.

The benchmark countries are top performers and have high values for all of the indicators, which suggests that this is an important area for exploitation of science and technology (Figure 5.17). The simple average of the indicators in the benchmark countries is close to the best in the area. The United States and Finland have some of the highest values on all indicators. The low value of the average benchmark countries for co-operation in innovation is due to a very high share of co-operating firms in Finland.

Figure 5.17. Benchmarking network, collaboration and clusters



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

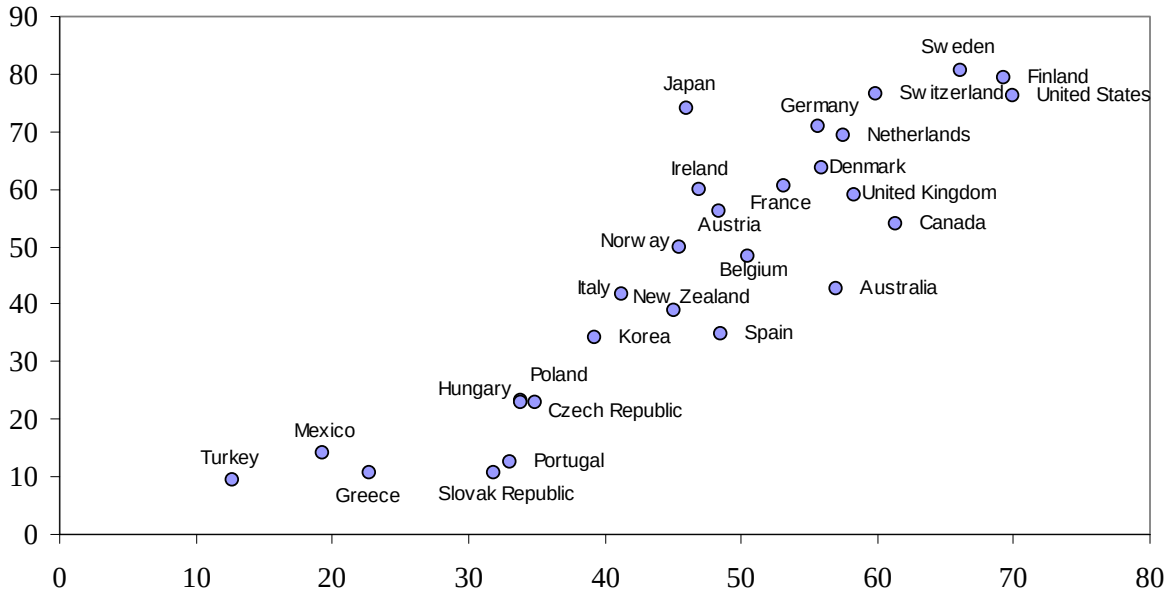
Box 5.9. Indicators of network, collaboration and clusters

Four indicators are used to measure network, collaboration and clusters. The first deals directly with collaboration as it measures the share of firms with co-operation arrangements on innovation activities with other enterprises or institutions. Finland has the highest share with 71%. The other three are based on the WEF survey. The first examines the quality of suppliers: "Local suppliers in your country are (1=inefficient and have little technical capability, 7= international competitive and assist in new product and process development)." Germany has the highest value in the OECD for this question. The second indicator deals directly with cluster formation: "How common are clusters in your country? (1=clusters are limited and shallow, 7=clusters are common and deep)." The third indicator deals with the local development process through networks: "Product and process development in your country is conducted (1=within companies or with foreign suppliers, 7=in collaboration with local suppliers, customers & research institutions)." Finland has the highest value for the last two questions.

The link from the business environment to performance

The differences in business environments described previously can explain a large part of the variation in country performance as measured on the available indicators. A simple average of the indicators of the business environment shows a high correlation (0.9) with a simple average of the indicators of performance (Figure 5.18). Sensitivity tests show that the choice of weights for individual indicators plays a limited role in the analytical findings. The correlations remain significantly different from zero even with large variations in the weights. In the sensitivity analysis, weights between 0 and 1 were assigned randomly 10 000 times to each of the indicators for both business environment and performance. The correlation between the business environment and performance indicators varied between 0.75 and 0.91. The correlations were significantly different from zero at least at the 0.1% level in all cases (Annex B).

Figure 5.18. The link between indicators of the business environment and indicators of performance



Note: All indicators are described in Annex 1. R^2 equals 0.73 and the slope is significantly different from zero at the 0.001% level.

Critical policy areas

Not all of the policy areas examined are equally important. This section aims to identify areas that may be most important for performance, using three approaches. First, the benchmarking methodology and spider diagrams found some similarities across the seven benchmark countries, which can be summarised by looking at the 11 areas in the business environment that can be quantified. This can be viewed as a first attempt to prioritise the policy actions that may be useful for the development and exploitation of science and technology. The assumption is that the parts of the business environment where the seven benchmark countries have values close to the best performers on individual sub-areas might more important for overall performance. Second, regression analysis can be used to identify the policy areas with the highest correlation with performance in this driver; the interaction of policy areas can also be examined. Third, qualitative analysis based on six detailed country notes written by national experts shows that the identified policies play an important role in policy making (Box 5.10).

The benchmarking analysis shows that in five areas, the distance is short between the average of the seven benchmark countries and the seven countries with the highest values for that part of the environment (demand; human resources; network and clusters; business best practices; and quality of public research) (Figure 5.19). They are followed by market processes, relevance of public research and industry-science links, where the distance is also quite small. The last four areas have much larger differences between the benchmark countries and the best environment countries.

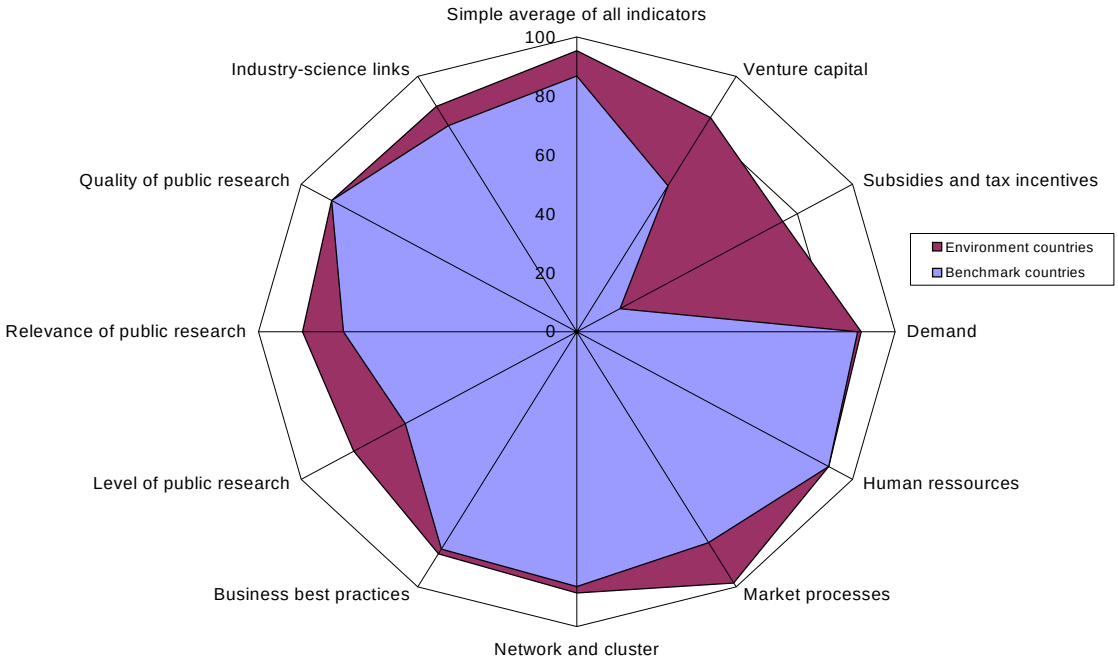
Box 5.10. Dealing with the complexity of national innovation systems

This driver was discussed at two workshops organised jointly with member countries and builds on six country notes. The country notes followed a common framework and were prepared by national experts from Austria, Finland, Japan, the Netherlands, Sweden and the United Kingdom. The framework was constructed by the OECD Secretariat, in collaboration with Mr. Barber, former chairman of the OECD's Committee for Science and Technological Policy (CSTP), and based on conclusions from a workshop on evaluating innovation performance, held on 25 March 2003 in London, and previous CSTP work on innovation policy. The country notes allow for qualitative analysis, which can supplement the quantitative analysis. Some factors may not show up as important in the indicator approach simply because of lack of data, but country reports may show that these factors receive a lot of attention in all benchmark countries. Based on the combination of indicators and qualitative analysis, it is possible to identify important areas for development and exploitation of science and technology.

The work on this driver was also discussed at a workshop held on 9-10 February 2004 in Oslo, which helped to define performance for the driver and resulted in renaming the driver (as the original "fostering innovation and technology diffusion" was too broad). The workshop also gave input into the determining factors to be examined in this area.

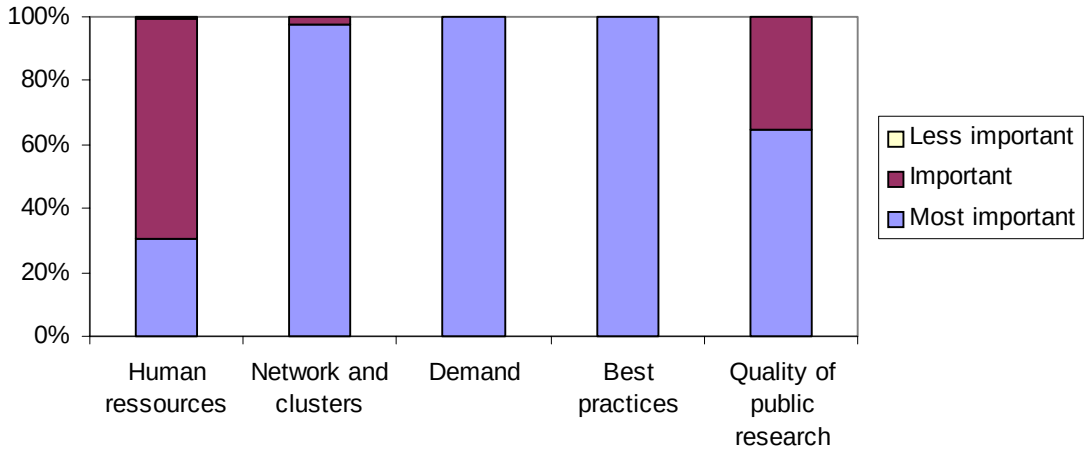
The analysis of relative importance can depend on the choice of weights for the underlying indicators in each policy area. However, the sensitivity tests show that the areas are robust to changes in weights. The areas of networks and clusters, demand, and access to business best practices are, regardless of the weights assigned to the individual indicators, always among the most important areas (Figure 5.20). Quality of research is also relatively robust to changes in weights. Human capital is less robust to changes in weights and may be less important than the other four areas. Further sensitivity analysis also shows that the selection of the most important area is robust to changes in the benchmark countries (see Annex B).

Figure 5.19. Benchmarking the business environment for development and exploitation of science and technology



Note: The spider diagram compares the average ranking of the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and United States) with the seven countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

Figure 5.20. Sensitivity of the results when weights are assigned randomly



Note: The distance between the benchmark countries and the environment countries determines whether an area is less important, important or most important. The figure shows the share of 10 000 randomly calculated composite indicators for each area that falls in these three groups. The weights to the underlying indicators are drawn randomly from a uniform distribution (0 to 1).

Correlation analysis of each of the policy areas shows that ten of the 11 areas have a correlation that is statistically different from zero, with the simple average of the performance indicators at least at the 5% level (Table 5.2). Only subsidies and tax incentives are insignificant. This confirms the standard results of the NIS literature that all areas are important for exploitation of science and

technology and technology diffusion. The most important areas, based on simple correlations, are networks and clusters, demand, and quality of public research. Further regression analysis performed at the indicator level confirms the high correlation, as only seven indicators have a correlation with performance that is not significantly different from zero.

Table 5.2. Summary of the correlation results

	Correlation with simple average of:		
	All performance indicators	Performance indicators for new products, processes	Performance indicators of technology diffusion
Business environment	***0.90***	***0.87***	***0.89***
Network and cluster	***0.94***	***0.93***	***0.91***
Demand	***0.91***	***0.90***	***0.88***
Quality of public research	***0.90***	***0.89***	***0.87***
Business best practices	***0.84***	***0.84***	***0.81***
Human resources	***0.79***	***0.74***	***0.80***
Level of public research	***0.73***	***0.72***	***0.72***
Industry-science links	***0.56***	***0.49***	***0.61***
Market processes	***0.51***	***0.49***	***0.50***
Venture capital	***0.50***	*0.43*	***0.55***
Relevance of public research	*0.45*	0.37	*0.50*
Subsidies and tax incentives	-0.30	-0.32	-0.27

Note: all values in bold and italics are significantly different from zero at the 1% level, all values in italics are significantly different from zero at the 5% level.

More advanced multi-variant regression techniques based on stepwise elimination of insignificant factors show that 92% of the variation in performance among countries can be explained by two factors: quality of public research and networks and clusters among firms. This analysis suggests that these two areas are perhaps the most important for policy makers. All other areas become insignificant when entered in a multiple regression.

The qualitative analysis based on the country notes confirms that stimulating co-operation among firms and clusters and ensuring high-quality public research are among the most important policies (Box 5.11). The country notes also highlight enhancing industry-science linkages as very important. Finally, they show that fostering knowledge-based SMEs in services and the coherency of innovation policy should be included as very important areas. The service sector will not be discussed further, but small firms will be considered when worthy of note.

All types of analysis highlighted two areas as most important (network and cluster policies; and quality of public research). Industry-science links and demand were also shown to be very important in the case studies; this was partly confirmed by the regression and benchmarking analysis. Human capital was also found to be important, but will be discussed in the chapter on human capital. The analysis also highlights business best practices as an important factor. The role for government is limited in this area and is therefore not discussed further. Finally, a crosscutting area (co-ordinating and rationalising policies) is included, as the qualitative analysis highlighted this area as a key challenge.

Box 5.11. Conclusions from the national case studies

The following six points emerged from the qualitative analysis:

Enhancing industry-science linkages. There is a much greater need than in the past for strong links between firms and universities and public research organisations. Research suggests that such links depend much more on the in-house capabilities and orientation of these two groups of organisations than on the creation of the linkages themselves. Technologically sophisticated firms will usually know how to access knowledge from the public sector research base, but firms in more traditional sectors that may have had little need for interaction with the science base in the past will find it much more difficult. Because SMEs are less likely to be closely integrated with customers and suppliers in established supply chains, technological support for SMEs is a much bigger policy issue.

Strengthening public sector engagement with industry. Encouraging universities and public sector research entities to engage with business by removing legal impediments with a view to increasing their in-house interface with firms is a key objective of policy. Encouraging mobility of researchers is a concern of all six countries as this is seen as the most effective means of knowledge transfer.

Promoting collaboration among firms. While firms tend to focus on fewer products, the number of technologies incorporated in any one product is increasing. Science-based technologies are increasingly relevant to more traditional sectors in which technology has hitherto been largely engineering-based. Firms therefore need to have an in-house capability or access to an increasing range of technologies. Outsourcing of technologies has increased, but even if a firm acquires a technology from elsewhere it will still require some degree of understanding of the nature of that technology and what it can do. One consequence is that government support for collaborative research and similar public-private partnerships becomes ever more important.

Fostering SMEs and new technology-based firms. Outsourcing, the modulisation of technology, and the difficulties that large established firms have in adapting to the different business models/innovation modes required by new sectors creates a much greater role for SMEs with advanced capabilities in science-based technologies. However, the framework conditions, financial institutions, institutions and management needed to foster the creation, development and growth of such SMEs are very different from those required by the previous technology paradigm. This is perhaps particularly difficult for countries such as Japan whose NIS was particularly well-adapted for success in the period up to about 1990.

Globalisation of R&D. Large firms seek appropriate technology from the best source, and central corporate research laboratories are being replaced by a distributed applied research base which includes universities, public research organisations and high-technology SMEs. Together with increasing globalisation, this means that large national companies tend to undertake more of their R&D abroad. This was particularly of concern to Sweden and the Netherlands whose business enterprise R&D is dominated by a few large MNEs of national origin. However this phenomenon is by no means confined to those two countries. All OECD countries should try to create domestic conditions that allow them to gain as much as they lose from international mobility of R&D and innovative activities.

Innovation in services. An increasing proportion of GDP is accounted for by service sectors, and technology- and knowledge-based services have been growing rapidly. Encouraging innovation within services is therefore of increasing importance to policy makers.

Co-ordinating and rationalising policy. Several countries, *e.g.* the United Kingdom and the Netherlands, are concerned about the proliferation of support measures over time and the need for rationalisation and simplification.

Source: OECD, 2005a.

The following sections review micro-policies implemented in the benchmark countries in each of the important areas. The analysis of countries' relative performance in this driver identified seven countries as doing well on the available indicators. To focus the analysis and reflect different national innovation systems, the policy examples are drawn from four of the countries (Finland, Japan, the Netherlands and the United States), which are considered the benchmark countries.

A policy implemented in one of the benchmark countries is not necessarily an effective policy in other countries, as effectiveness often depends on interaction with other policies and institutions in the

national innovation system. The micro-policies identified may therefore not be first-best solutions for all countries. The intent is to identify effective micro-policies that may inspire other OECD countries' policy making in this area. What follows is largely based on the country notes for Finland, Japan and the Netherlands prepared for the Working Party on Technology and Innovation Policy (OECD, 2005a). Information on the United States is drawn from national sources and previous OECD work.

The need for more effective co-ordination and rationalising of policies for the exploitation of science and technology is a cross-cutting theme in all countries. Finland's system for co-ordinating science, technology and innovation policies provides an interesting example. It demonstrates the importance of close policy co-ordination, of a clear national consensus, of a central role for policy, of a long-term policy perspective that fits the country's current state of development and of flexibility in the face of changing circumstances.

The Finnish NIS is based on an elaborate public support system that works with networks of clustered research-oriented firms. The public system is streamlined, with clearly defined tasks for every component. A characteristic feature is easy and informal communication over all horizontal and vertical levels. This means, first, good public-private co-operation on all levels. Second, it indicates effortless co-operation among administrative areas. Third, it suggests non-hierarchical governance of policy areas. For example, the management performance system gives the National Technology Agency of Finland (TEKES) broad freedom of operation at the level of policy strategy.

The key institution of the Finnish system is the Science and Technology Policy Council. Headed by the Prime Minister, it has high status. The members represent all the stakeholders: cabinet ministers for science, technology, finance, environment, labour and culture, representatives from universities, research institutions, the enterprise sector and trade unions. Tasks of the Council are comprehensive: setting the national strategy, co-ordinating policy makers' activities and assessing the measures taken as well as analysing future policy needs.

The Council is essential to maintaining a high level of political and social consensus. For example, public expenditure for R&D continued to rise through the deep recession of the early 1990s, with no political or public opposition. Second, it plays a central role in regulating inter-ministerial disputes over authority and division of tasks. Third, it gives the private partners a direct communication link to the highest level of governmental decision making. Fourth, as a flexible and open institution, it sets an example to other actors in the innovation system. Similar councils have recently been established in both Germany and the Netherlands.

In Japan, as part of the overall restructuring of the central government, a Council for Science and Technology Policy, chaired by the prime minister, was established in 2001. Consisting of relevant ministers as well as experts from academia and industry, the Council has responsibility for co-ordinating policies across ministries and evaluating them. Based on its evaluations, the Council makes recommendations about science and technology policy priorities and budget allocations.

Policy benchmarks for enhancing the quality of public research

The science systems in many OECD countries have undergone significant changes in their governance over the last two decades. The main challenges have been to : respond to a more diverse set of stakeholders including business and civil society; exploit emerging opportunities presented by new technologies such as ICT, biotechnology and nanotechnology; and ensure the long-term sustainability of the research enterprise, including adequate funding for basic research and a continued stream of highly qualified human resources. OECD governments have undertaken a number of reforms in response. They include changes in governance structures, in research priority-setting procedures, in the public research funding allocation mechanisms, and in measures aiming at matching the supply of and demand for highly qualified human resources in science and technology.

Centres of excellence are a means of creating a critical mass in specific research areas, promoting interdisciplinary research and encouraging public-private collaboration. However, in many countries, including Japan and Finland, they aim above all to improve the quality of scientific output at a world-class level and to fill gaps in fundamental research capabilities.

Finland's current strategy for national centres of excellence dates back to 1997 (Academy of Finland, 1997). Its aim is to provide the framework for the development of high-quality, creative and efficient research environments in which research of international quality can be carried out. A Finnish centre of excellence is defined as "a research unit or researcher training unit which comprises one or several high-standard research teams with shared, clearly defined research goals, and which is at, or has good potential for reaching, the international forefront in its field. Research teams working outside the universities may also be awarded centre of excellence status" (Academy of Finland's Web pages). Centres of excellence are selected for a term of six years on a competitive basis, with evaluations provided by international experts. For 2000-07, 26 centres were selected for funding with a total of 42 centres being funded. Many of their programmes and projects are co-funded from several sources, including industry.

Japan launched a new university resource allocation prioritisation scheme called the 21st Century COE Programme in 2002. The creation of centres of excellence is seen as a solution to many of the current problems in the country's public research sector. The programme's aim is to promote world-class research units in selected fields. The fields supported in 2002 were life sciences, chemistry and material sciences, information science, electrical science and electronics, humanities and interdisciplinary subjects. Each research unit selected as a centre of excellence is allocated resources of JPY 100-500 million for five years. In November 2002, 113 research units at 50 institutions were selected out of 464 applications from 163 institutions.

The Netherlands is using a series of programmes to create centres of excellence. The first, the Innovation Oriented Research Programme, was shown as very effective in evaluation studies. The programme's basic idea is to support research at universities in areas which industry regards as new and important but difficult to finance within the existing budget of the research institution. Industry partly finances the research and is involved in user groups and in administering possible patents resulting from the projects. Some of these research areas have developed into formal "centres of excellence", which are supported as part of the programme for leading technology institutes. The leading technology institutes have been very successful in generating high-quality research and produce valuable knowledge for Dutch industry. The institutes concentrate existing knowledge and people in a particular field of technology. Industry is closely involved in defining the long-term strategies of the institutes, which conduct strategic and fundamental research. The cost of this programme is around EUR 25 million a year.

Effective policies for enhancing the quality of public research in the benchmark countries include:

- Creating centres of excellence to prioritise public support and conduct world-class research.
- Involving industry in the design and financing of centres of excellence.
- Developing competitive mechanisms to determine research areas.

Policy benchmarks for promoting industry-science links

Private investment in R&D is the most important means of exploiting science and technology, but commercialisation of publicly funded research also provides an important contribution to a country's performance. Improving the ability of business to exploit the output of universities and public research organisations is at or near the top of policy makers' agendas in most OECD countries.

Spin-offs and licensing agreements are key instruments in governments' attempts to speed up the transfer of knowledge and technologies developed through publicly financed research. The faster transfer of knowledge creates new innovative firms and can increase the innovative capacity of existing firms. The objective for government is not to make basic research more commercially relevant but to improve information on existing commercially relevant research results (OECD, 2002e).

University spin-offs are few in number but can play an important role in some sectors. In the Netherlands, for example, about 30% of all life-science-based start-ups in the 1990s were spin-offs from public research (Bekkers and Van der Steen, 2002). Among the benchmark countries, the United States clearly produces more spin-offs per researcher than other OECD countries. American universities generate three to four times more spin-offs per research dollar than most other countries (Table 5.3). In the United States, universities generate the most spin-offs. The focus on knowledge transfer from American public labs is – despite a relatively low number of spin-offs – also very high. The US government started in 2002 to survey the status of such transfers for every public lab and report it to Congress (US Department of Commerce, 2002).

The United States is also the most advanced in generating income from licensing agreements. It is worth mentioning that, even in the best-performing country, licensing income covers less than 2.5% of the research budget and that the University of California, which earns the most, has an income from licence agreements that equals about 6% of its total budget (OECD, 2002e). The number of public-sector patents also varies widely among countries, although it is difficult, on the basis of the available data, to determine absolute differences. The available data suggest that Japan has the fewest among the benchmark countries and the United States the most, but data collection methods vary, so caution should be used when interpreting the data.

Table 5.3. Number of spin-offs and licensing agreements

	Number of spin-offs (per 1 000 researchers)	Number of licensing agreements (income as share of total R&D)	Number of patent applications (per 1 000 researchers)
The Netherlands (both)	26 (0.9)	368 (<0.01%)	212 (7.7)
Finland (public labs)	(2-3)	(0.3)	(12)
Japan: (universities)	1 (0.0)	89 (<0.01%)	448 (5)
United States			
Universities	281 (2.4)	4 049 (2.3%)	4 140 (35)
Public labs	Not available	4 396 (0.3%)	2 172 (15)

Source: Own calculations based on OECD(2002e); OECD(2002f); US Department of Commerce (2002); EU (2001).

Many have attributed the United States' success with spin-offs, licensing agreements and patents from universities to the introduction of the Bayh-Dole Act which permits universities and small businesses to elect ownership of inventions made under federal funding and to become directly involved in the commercialisation process. A look at the numbers tells the story. In the ten years before Bayh-Dole, the number of university patents increased by approximately 40% and in the ten years afterwards by about 360% (US Congress, 1999). A large part of the increase was in biomedical technologies, which boomed independently of the Bayh-Dole Act in the mid-1980s. Biomedical technologies are also the core contributor to licence income in the United States. The Bayh-Dole Act requires royalties from licensing to be shared with the inventor, with the remaining income to be used to support research at the university. At Stanford, for example, the royalties are shared equally among the inventor, the department and the university.

Japan has followed the United States' example and introduced what they call the Japanese Bayh-Dole provision in 1999 by which intellectual property rights emerging from all government-contracted research belong to the contractors. At Japanese universities, the inventor has ownership unless the government decides that the invention has general public importance and demands joint ownership (the Netherlands has a similar system).

A cross-country view shows that assigning ownership to the research institution tends to generate more spin-offs than other ways of assigning ownership. This may explain the relatively low number of spin-offs and licensing agreements in the Netherlands, despite good potential. Assigning ownership to the institution creates an incentive to construct an efficient infrastructure for handling spin-offs and patents. Partly due to the lack of infrastructure, Japanese professors, for example, forward their inventions to companies directly. Estimates based on the mention of professors as main inventors in patent applications from private firms show that Japan could double its current number of university patents if professors did not forward their inventions to industry (EU, 2001; OECD, 2002f). Japan intends to change this situation and has recently introduced a target of 1 000 university-born start-ups in three years and of a ten-fold increase in university-held patents over the next five years.

Public-private partnerships for innovation promote co-operation between the public sector (*e.g.* government agencies or laboratories, universities) and the private sector in undertaking joint projects, which broadly include research, development of science and technology infrastructure, and human resource development. These partnerships tend to be in areas where the actors have mutual or complementary interests but judge that they lack the capability and the incentive to act efficiently alone.

All four countries are quite active in using public-private partnerships, but especially the United States and the Netherlands. The most well-known US public-private partnership is the Advanced Technology Program (ATP) which aims to accelerate the development of high-risk technologies that promise significant commercial payoffs and benefits for the economy. ATP is aimed at R&D projects "that create *i)* technologies with benefits that extend well beyond the companies involved in the project; *ii)* technologies with broad potential applications, particularly across different industrial sectors; and *iii)* path-breaking technologies that open up new potential markets or make possible wholly new products or industrial processes". The cost is around USD 270 million.

The Netherlands spends a large share of its budget for innovation policy on PPP-type programmes. The largest concerns the leading technology institutes, which have been very successful in generating high-quality research and knowledge for Dutch industry. These institutes are centres of excellence that concentrate existing knowledge and people in a particular field of technology. Industry is closely involved in defining the long-term strategies of the institutes, which conduct strategic-fundamental research. The cost is around EUR 25 million. The Netherlands will also introduce a set of "third generation" instruments for supporting public–private partnerships on breakthrough technologies like genomics. The Netherlands Genomics Initiative has established national centres focused on social research, bio/IT linkages and proteomics. A number of new demand-driven research consortia consisting of companies, research institutes and social interest groups were expected to start work in 2004 in fields such as infectious diseases, soil detection systems and nutrigenomics (OECD, 2003l).

In Japan, the National Institute of Advanced Industrial Science and Technology has several co-operation projects with industry, but these have not been formalised in a specific programme. However, the Japanese government has actively promoted collaborative projects since the 1960s. The well-known large-scale projects of the former MITI were in some cases powerful instruments for improving the competitiveness of an industry sub-sector. These projects typically created research consortia with participants from business, public research institutes and universities. Competing firms were often found to belong to the same consortium, sharing knowledge and facilities to the extent that

they could. Probably the most successful and the most publicised of these projects was the Very Large Scale Integrated Circuit (VLSI) project of the late 1970s. The highly competitive Japanese semiconductor manufacturing sector of the 1980s was in large part due to the success of this project, and the large-scale projects scheme itself has served as the model for collaborative partnership projects in other countries.

Effective policies for promoting industry-science links in the benchmark countries include:

- Fostering spin-offs and licensing agreements from public research with flexible IPR infrastructure.
- Promoting public-private partnerships with well-defined objectives, roles and expectations of parties and clear funding arrangements.

Policy benchmarks for fostering collaborative networks and clusters

Because exploitation of science and technology and technology diffusion is an interactive and iterative process among firms, the capital market and public institutions, several governments support networking activities among firms. The main rationale for these programmes is to address systemic failures. For example, if links among firms are lacking, their capacity to exploit science and technology is hampered. Public intervention can help establish these links with limited resources and thus increase firms' capacity to exploit science and technology.

The Netherlands has been very active in supporting network and cluster-based programmes and sees these programmes as one of the cornerstones of Dutch innovation policies. Several of these programmes have been evaluated but the results are mixed. The main problem for many programmes is that they subsidise ongoing activities so that no additional results are achieved. Furthermore, there has been a high degree of overlap among the programmes and other policy instruments. As a result, many Dutch programmes have been merged. The Technology Co-operation programme, for example, is a merger of two old schemes for which evaluations showed overlap and lack of additional results. A further reduction in the number of programmes is expected in the next streamlining process.

The cluster approach is mainly used to stimulate the creation of knowledge-intensive new firms. The Dutch Biopartner is, for example, a combination of a network instrument, subsidy scheme, equity financing and virtual incubator. The starting point of Biopartner is the notion that financial support or fiscal measures alone cannot create new companies. To achieve structural improvement in the climate for new entrepreneurship in the life sciences, a cluster approach is needed. A policy approach has to be designed for the sector; the goal is not to create a lot of incubators but a few focused networks. The budget is about EUR 9 million a year. An evaluation of Biopartner showed a clear increase in the number of start-ups and increased interest in setting up high-technology companies. The evaluation also showed that a sectoral approach was less important and that the cluster approach gave good results. The Netherlands has consequently expanded the scheme to cover more fields of research, and it is now called Techno-starter.

Finland has been very active in supporting network and cluster activities, but most involve public research institutions and are discussed below. The Finnish Cluster Programmes (Forest, Welfare, Transport, Telecommunication and Environment) involved public research institutions but were mainly aimed at promoting co-operation among various actors in the private sector, including producers and users of knowledge. The programmes involved six ministries and showed a clear commitment to the cluster approach. They aimed at creating new permanent networks of industry and science. EUR 100 million were shared among over 3 000 projects in 400 participating organisations. The Environmental Cluster Programme has continued after the end of the initial programme. The evaluation showed positive results but the development of new forms of co-operation has taken longer than expected owing to increasing bureaucracy and the need for negotiation among funding

organisations. Collaboration between public organisations and private companies has been more problematic than anticipated. Finland also directly stimulates networking among large and small firms. For large parts of public support to private R&D, the networking of large firms with smaller ones is a key criterion.

The experimental US Program to Stimulate Competitive Technology has an interesting co-finance element, in that regional authorities have to furnish proposals and most of the money. The goal is to stimulate R&D in regions that normally do not get government funding. The evaluation showed that getting money and commitment both from national and local governments "made things happen" so the results were much greater than the relatively small amount spent on the programme would suggest (OTP, 2002). "Making things happen" is an often cited result of these networks. Getting the right people from a region or an industry in a room to discuss the challenges can have a greater effect than subsidies or other incentives.

Many Japanese regional programmes focus on incremental improvements especially for SMEs. For instance, in Ohta-ku of Tokyo and Higashi-Osaka, where many SMEs are located, there are frequent technological information exchange sessions among SMEs through regional clusters. They also receive orders from large companies, and specialised SMEs in the cluster organise project teams in co-operation and input their own specialities into a joint project. As a policy measure to support regional clusters, the Japanese government launched the Industrial Cluster Initiative in April 2001 with participation by 19 regional projects across the nation. One year after the launch, participants of the projects included 3 800 SMEs and 200 universities (including 80% of all national universities with science and/or engineering departments).

Effective policies for fostering collaborative networks and clusters in the benchmark countries include:

- Evaluating and streamlining networking programmes.
- Integrating a cluster approach when designing support programmes, *e.g.* at the regional level.
- Focusing more on getting the right people together than on providing subsidies.

Policy benchmarks for stimulating demand

Aside from the United States, most countries have not been very active in stimulating demand for new products, processes and services as part of their policies for enhancing exploitation of science and technology. The United States has a long tradition of procuring new products, services and processes from private firms, *e.g.* for space or military purposes. The United States also has several support programmes that more or less work to stimulate demand, such as the already mentioned ATP.

An often-mentioned drawback of public procurement and direct support is that small firms tend to get a disproportionately small share of the funding. The United States Small Business Innovation Research (SBIR) programme tries to correct the problem by requesting each government agency with an extramural R&D budget in excess of USD 100 million to spend 2.5% of its budget on the SBIR programme. The programme finances research aimed at solving specific problems of public interest but it also involves a high degree of networking that can benefit small firms. SBIR brings small firms into direct contact with federal agency and R&D programme managers, and this gives them access to extensive networks. For example, some applications are sent to large companies and venture capitalists that have shown interest in funding these types of projects. In spite of a budget of USD 1.5 billion, the total costs and benefits of the programme have not been estimated, but several evaluations of the benefits have been made and show that the programme facilitates higher growth among small firms, in terms both of turnover and employees, although several government institutes see the SBIR as a tax on their research budget (NRC, 2001).

Japan also considers public procurement as a catalyser for accelerating innovative activities. However, most government procurement in Japan is spent on “public construction”. Therefore, public procurement cannot be expected to stimulate demand for high-technology products at present. As one type of targeting, Japan introduced a procurement system called “green procurement” a few years ago. Under this system, fuel cell cars were procured for the use of executive officials; however, this it is a rare example of government procurement of technologically innovative products.

The Netherlands has approached demand side stimulation from another angle. Science awareness and public acceptance of new technologies with an impact on society and its conventions is more and more considered in the process of policy formulation in the Netherlands. An example is the public debate on genomics preceding legislation. Public opinion on the impact of genomics has been studied and addressed during the legislative process as consumers will not use and buy new products if they do not “feel safe”. Governments can help consumers to feel safe quicker than the market.

An interesting feature of the Finnish labour market which has had a great impact on demand for new technology is that Finnish trade unions have not only accepted new technologies but have been active in introducing and applying them in the workplace. This is partly an achievement of the development of the labour market system in the 1970s and partly due to developments in the workplace, especially in the 1980s, when emphasis was put on ways of launching technological renewal and introducing more flexibility in production processes. This positive attitude towards new technologies has created demand for new products and processes by Finnish firms. The public sector has also been quite innovative in this respect. All in all, the role of competent users has been critical in developing innovations in Finland, but no special schemes or initiatives are in place.

Effective policies used in the benchmark countries for stimulating demand include:

- Increasing public procurement of new products and services.
- Creating awareness and public acceptance of new technologies.
- Creating acceptance among the social partners of the long-term benefits of new technologies.

Chapter 6

ENHANCING HUMAN CAPITAL AND REALISING ITS POTENTIAL

Country performance for enhancing human capital, specifically for making productive use of highly skilled workers in the private sector, relates to the number and quality of knowledge workers and to the management and organisational structures in private firms. Based on quantitative and qualitative indicators, the following countries are identified as benchmark countries for further analysis: Finland, the Netherlands, Sweden and the United States.

An attempt is made to benchmark the business environment across countries in terms of making productive use of highly skilled workers in the private sector. Based on benchmarking, regression and qualitative analysis, three policy areas were identified as potentially most important for this driver. Effective micro-policies that have been implemented in the four benchmark countries represent practical solutions to common policy problems and could be adapted by other countries to fit their own context and national situation. The most important micro-policy areas appear to be the following:

- *Increasing educational attainment* by: *i)* providing cost-effective support to tertiary education; *ii)* stimulating competition among educational institutions; and *iii)* linking higher education to the conduct of government-financed R&D.
- *Providing incentives for continuous training* by: *i)* negotiating tripartite agreements to share costs and responsibility for enterprise training; *ii)* offsetting costs and time constraints of individual investments in training; and *iii)* developing schemes to help small firms provide more worker training.
- *Fostering knowledge-based management and organisation in firms* by: *i)* promoting flexible work approaches through labour market policies; *ii)* adopting knowledge-based management approaches in the public sector; and *iii)* upgrading managerial skills in small firms.

Some questions remain unanswered and require further work. For example, evidence suggests that management and organisational structures in firms are not always optimal and that changes can boost productivity. Some countries believe direct measures are needed to stimulate change, whereas others believe that few government actions beyond labour market policies are needed. More analysis is warranted on the balance between active measures and laissez-faire policies in the area of organisational change.

Selection of benchmark countries

Human capital has long been recognised as a key engine of growth. Human capital is the knowledge, skills and competencies of workers which are relevant to economic activity. Early empirical studies suggest for example that human capital has a positive impact on productivity, and there seems to be a strong complementarity between physical capital and the skills and education level of workers (Bartel and Lichtenberg, 1987). Studies on the link between human capital and economic performance also generally find a strong positive association between education/training and growth (Temple, 2000; Barro, 2000; Ahn and Hemmings, 2000). Furthermore, recent studies show that OECD countries can achieve growth in GDP per capita by improving the average quality of their workforce. Improvements in human capital (as measured by average years of schooling) accounted for an increase of over half a percentage point in growth in labour productivity in the 1990s. Moreover, the analysis

indicates that one additional year of education on average for the labour force could lead to higher GDP in several OECD countries (Bassanini and Scarpetta, 2001).

The optimal level of human capital in an economy depends on its stage of development and industrial structure. Low-income countries will, according to classic growth theory, catch up with high-income countries by having higher growth rates over time. The low-income OECD countries had a higher contribution to growth from human capital in the 1990s mainly owing to a higher growth rate in the stock of human capital (Bassanini and Scarpetta, 2001). For example, Spain increased its average years of schooling by 50% from 1970 to 1998 as compared to a 10% increase in the United States.

The effects of human capital accumulation on growth can be measured in a growth accounting framework. For example, studies from the United States show that increased labour quality due to higher education contributed 0.17 percentage points to labour productivity growth in the late 1990s (Jorgenson, 2004). Furthermore, estimated returns on investment in human capital are generally well above the real interest rate, an indication of clear benefits from further investment (OECD, 2002h). The returns to tertiary education vary from around 6-7% in Canada, Denmark, Germany, Italy and Japan to 13%-15% in France, the United States and United Kingdom. The differences are mainly due to shorter length of studies in some countries as well as lower marginal taxes on high income. While these are averages, they suggest that further investment in human capital would be beneficial.

Finally, in recent years, policy makers have shown renewed interest in upgrading human resources (OECD, 2003i). Investments in human capital are seen as necessary complements to investments in new technology in order to reap the full benefits. For information and communications technologies (ICT) to be developed and used effectively, and for the network externalities of new technologies to materialise, the right skills and competencies must be in place. Technological innovation alters demand in favour of better educated workers at the high end of the human capital spectrum (*i.e.* knowledge workers) because they have a comparative advantage for implementing new technologies.

All in all, most analyses show that human capital is a key driver of productivity growth. However, the transmission mechanism from human capital to productivity is very complex. This study focuses on one of the main mechanisms, the productive use of highly skilled employees in the private sector, using as a proxy a combination of two components that encourage productive use of the highly skilled (Table 6.1). One is the stock of human capital in private firms measured as the number and quality of knowledge workers. Increases in multi-factor productivity (MFP) can be realised if the number of knowledge workers increases and/or if the quality of existing knowledge workers increases. The second involves the management and organisational structures that determine how the productive use of the stock of knowledge workers. In other words, a large stock of knowledge workers is a necessary but not sufficient condition for higher productivity growth.

Table 6.1. Performance indicators for enhancing human capital and realising its potential

Stock of knowledge workers	Organisational and managerial structures
Share of employees in high-skill jobs	Qualitative judgment of willingness to delegate authority to subordinates
Private sector researchers per 10 000 labour force	Qualitative judgment of share of employees managed by objectives
Share of population aged 16-65 at literacy level 4/5	Qualitative judgment of adaptability to market changes
	Qualitative judgment of quality of domestic managers

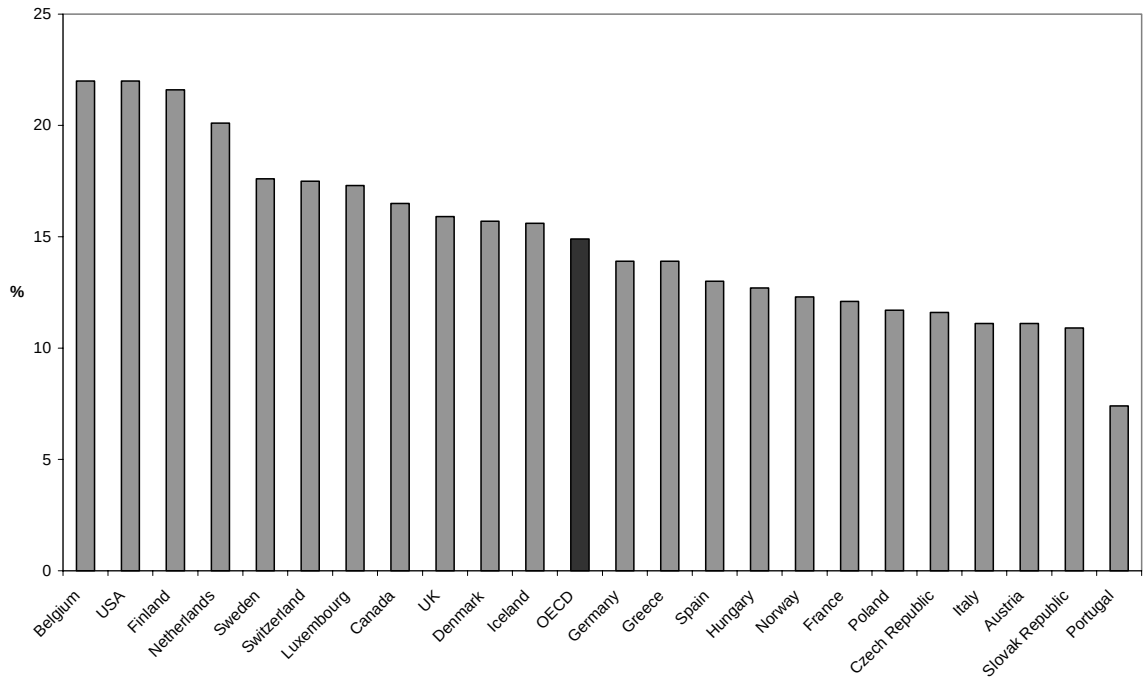
Measuring the stock of knowledge workers

The stock of knowledge workers should ideally be measured by the availability of knowledge, skills and competencies that enhance productivity. Such a heterogeneous concept cannot be measured by a single indicator, but needs to rely on a combination of various types of indicators that combine measures of numbers of workers and of the quality of individual workers. The most direct way to measure number of workers is to compare the number of high-skill jobs relative to other types of occupations in the economy or to measure the number of researchers in the labour force.

The percentage of the labour force in high-skill jobs measures job requirements rather than individual qualifications and is based on the International Standard Classification of Occupations. Roughly speaking, this measure classifies jobs by skill according to the current normal entry-level educational qualifications for a particular occupation. The indicator shows less variation across countries than that measuring overall educational attainment. Four OECD countries – the United States, Belgium, Finland and the Netherlands – clearly stand out, with a 20-22% share of employees in high-skill jobs (Figure 6.1). They are followed by Sweden, Switzerland and Luxembourg, with 17-18% of the labour force in high-skill jobs.

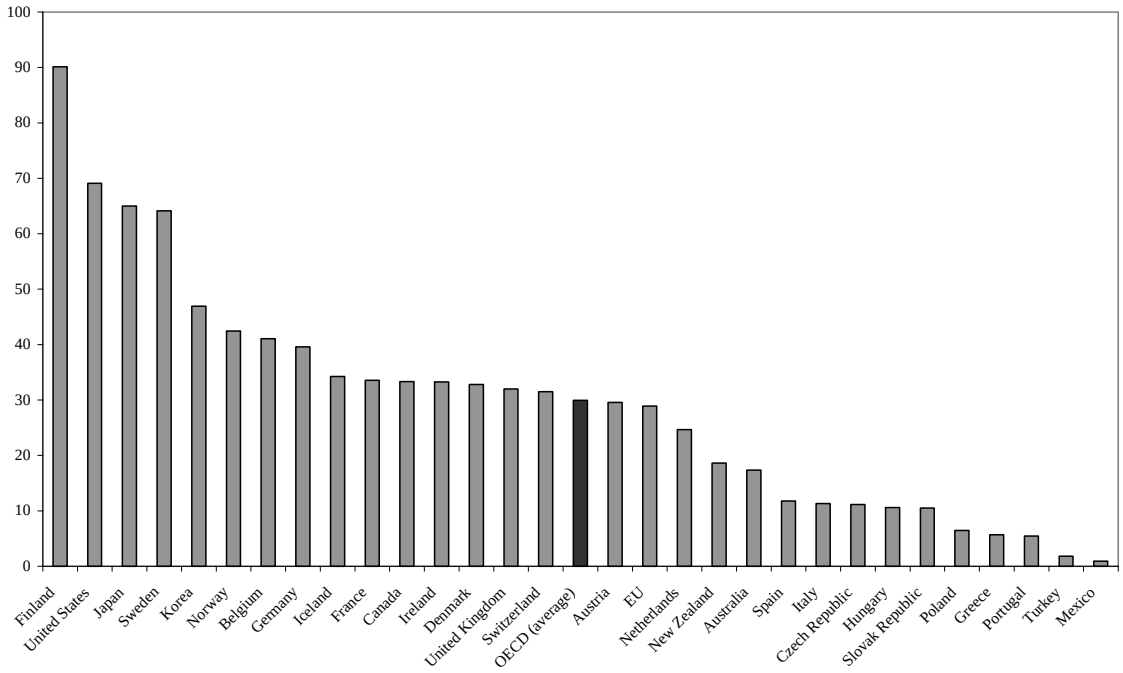
An alternative indicator is the number of researchers per 10 000 labour force in the private sector, which is a sub-group of high-skill jobs. Researchers are directly involved in turning knowledge into productive use and are consequently very important for productivity growth. Researchers are defined as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems and are directly involved in the management of projects. Data compiled on the basis of the methodology of the *OECD Frascati Manual* show that Finland has the highest share of researchers, with 90 per 10 000 employees in the private sector (Figure 6.2). It is followed by the United States, Japan and Sweden with an almost identical share of around 65 researchers per 10 000 employees Overall, approximately 3.2 million researchers are engaged in research and development (R&D) activities in the OECD area.

Figure 6.1. Share of employees in high-skill jobs



Source: OECD, 2002h.

Figure 6.2. Private sector researchers per 10 000 labour force



Source: OECD (2003j).

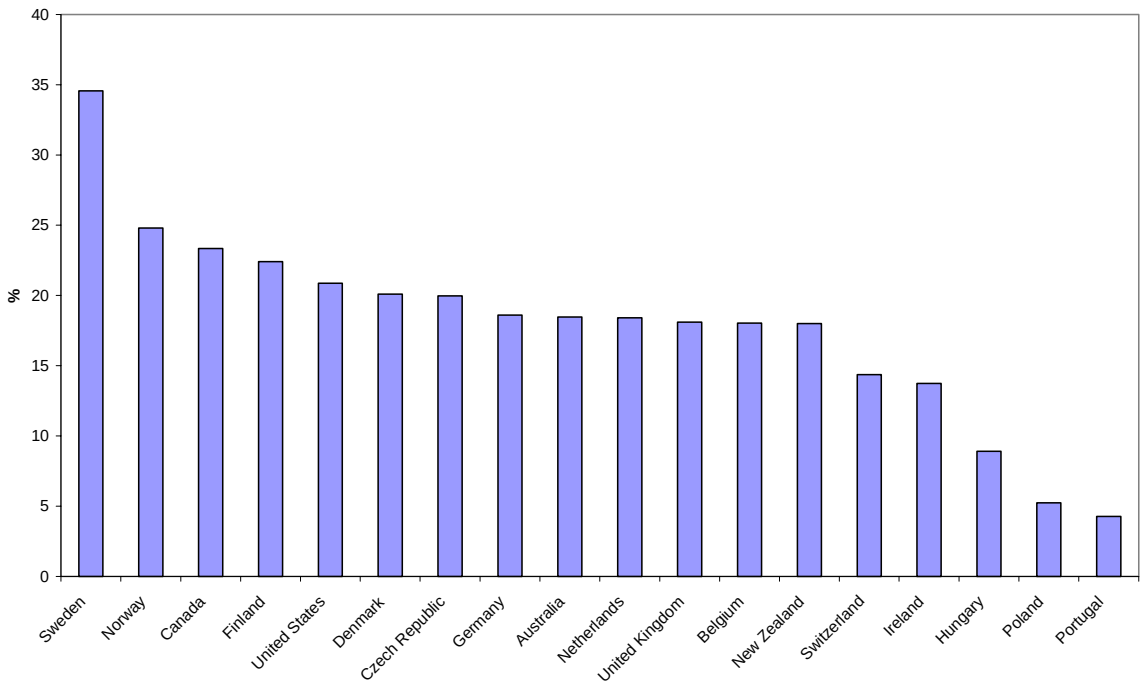
The quality of knowledge workers can be measured by formal tests of adult skills, such as the International Adult Literacy Survey. Here, the overall skill level of economies is assessed by examining the share of the population with the highest level of literacy (level 4/5), *i.e.* those who demonstrate command of higher-order information and processing skills. It is above the level necessary for entry to higher education and demonstrates the ability to integrate several sources of information and solve more complex problems. The literacy skills examined include three domains: *i)* prose literacy, or the knowledge and skills needed to understand texts and similar sources of information; *ii)* document literacy, or the skills necessary to locate and use information contained in different formats; and *iii)* quantitative literacy, or the knowledge and skills required to apply arithmetic-type operations (OECD, 2000b). By this measure, Sweden clearly has the highest share of people with skill level 4/5 followed by Norway, Canada, Finland and the United States (Figure 6.3). The share of a country's population at level 4/5 is almost comparable to the number of high-skill jobs.

Several alternative indicators exist for measuring the stock of knowledge workers, but these are more indirect or are not available across countries. An often used alternative is educational attainment, measured either as average years of schooling or as the percentage of the population aged 25-64 that has completed upper secondary or higher education, for example. However, these indicators do not measure human capital attributes but rather completed educational levels, which are only broadly associated with some form of economically relevant knowledge (OECD, 1998). Another alternative is to estimate the value of human capital in a given area or industry by using wage data. So far, such studies are only available at the national or regional level in a few countries (Jorgenson and Freumeni, 1993; Ahlroth *et al.* 1997).

The three indicators discussed above – share of employees in high-skill jobs, private sector researchers in the labour force, and share of population with superior literacy levels – cover a broad range of the relevant aspects of the high end of the human capital spectrum. Countries that consistently

perform well on all three indicators can be seen as top performers compared to other OECD countries with respect to having a high stock of knowledge workers.

Figure 6.3. Percentage of the population aged 16-65 at literacy level 4/5



Note: Level 4/5 describes respondents who demonstrate command of higher-order information and processing skills. It is above the level necessary for entry to higher education and demonstrates the ability to integrate several sources of information and solve more complex problems.

Source: OECD (2000b).

Measuring organisational and managerial practices

Competitive markets should ensure optimal utilisation of the available knowledge workers in an economy, but only over time. Firms with the right organisation and management structures can gain market shares from other firms and thereby increase the number of their employees. Yet, several studies have shown that the rate of adoption of flexible organisational approaches is lower – and slower – than would be predicted on the basis of their potential contributions to productivity and profitability (OECD, 1999). Among the possible explanations are the reluctance of managers to give control to lower-level workers and the unwillingness of stock markets to value intangible investments such as those required to implement flexible organisations (Applebaum and Batt, 1994). Furthermore, regulatory barriers and small markets can reduce competition and incentives for new organisational structures. OECD analysis shows that the probability of a workplace flattening its management structure is 10 percentage points higher for those that are subject to foreign competition for products (OECD, 1999).

Measuring organisational and managerial practices is even more difficult than measuring the stock of knowledge workers. Ideally, indicators should measure how well organisational and managerial structures make the most productive use of the available stock of human capital. Data on firm-level knowledge or on the use and effectiveness of knowledge management practices would be a valuable input. As these indicators are not available, judgments as to relative performance must rely

on survey-based qualitative information. The line between performance and input measures is thus blurred (Box 6.1). In this analysis, performance is measured by all indicators relating to organisational structures that are known to benefit from knowledge workers and by the quality of the current management. With regard to the business environment, inputs to management and organisation are defined as the availability of managers, quality of management schools, and the general motivation of employees and their willingness to change.

Box 6.1. Performance vs. inputs to management and organisation

Organisational and management practices are in some respect both a performance and an input factor. This analysis uses 12 indicators relating to management and organisation. Four of these are labelled performance indicators, and the rest are used to describe the business environment. Performance is measured by: i) willingness to delegate authority to subordinates; ii) share of employees managed by objectives; iii) adaptability to market changes; and iv) quality of domestic managers. The first two indicators measure directly the spread of organisational structures that are known to increase the productivity of knowledge workers (OECD, 1999). The third addresses a firm's overall ability to change and thereby use employees to their fullest potential. A lack of adaptability reduces productivity. The final indicator measures the quality of current management. A better manager can, for example, increase productivity directly within the firm. A higher value on all of these indicators should increase productivity in firms.

Input indicators relating to management measure the availability of senior management, availability of managers with international experience, quality of management schools, and hours spend on management training. A higher value may not directly affect productivity in firms, but only improve access to qualified management. For example, better management schools will allow firms to attract better employees and managers with international experience and give firms a broader selection of managers, but these factors do not directly affect productivity.

Input indicators relating to organisational change measure worker motivation, co-operation in labour-employer relations, employees' participation in decision making, and percentage of workers who have the possibility to discuss organisational change. These measure aspects of work organisation which are important for productivity, but may not increase it directly. For example, good labour-employer relations are important for allowing necessary organisational change, but are not a sufficient condition for higher productivity growth. It is important for employees to be able to discuss organisational change, but this does not ensure that necessary changes are made.

Available qualitative data on performance of management and organisational structures are based on four questions from a survey conducted by the International Institute for Management Development (IMD) *World Competitiveness Yearbook*, the World Economic Forum, and the European Commission (Table 6.2). The first two questions measure aspects of a knowledge-based organisation: delegation of authority and management by objectives. Delegation of authority is often viewed as one of the most important ways to get more benefit from knowledge workers. In management by objectives, workers are made responsible for reaching pre-defined targets without being overly controlled in the process. This type of management, which emphasises self-assessment and problem-solving, gives workers greater flexibility in terms of their method and rate of work and should increase productivity of knowledge workers. The third question measures the ability of firms to adapt quickly to market changes. Shifts in consumer demand and new technologies may offer better ways to organise production, and companies therefore need to adapt their organisational structure to maximise employees' performance. The fourth question compares the quality of current management to international competitors, and again reflects the ability to maximise employees' performance.

Based on the survey responses concerning these four aspects of management and organisational performance, the top-performing countries appear quite similar regardless of the differences in source. Netherlands, Sweden and Finland are among the top five in three out of the four questions/indicators, while the United States and Denmark are among the top five in two out of four. Iceland, Australia, Austria, Belgium and Switzerland are only among the top five for one question.

Table 6.2. Qualitative evaluation of management and organisational performance

Question/indicator	Highest ranking countries	Source
Willingness to delegate authority to subordinates	Sweden, Denmark, Finland, Netherlands, United States	WEF, 2003
Share of employees managed by objectives	Netherlands, Denmark, Sweden, United Kingdom, Belgium	EUROFOND, 2000
Adaptability to market changes	United States, Finland, Australia, Denmark, Iceland	IMD, 2002
Quality of domestic managers	Netherlands, Austria, Finland, Sweden, Switzerland	IMD, 2002

Selection of benchmark countries

It is proposed to examine those countries with the highest relative number and quality of highly skilled employees in the private sector and also the most adaptive organisational and management structures in order to identify potentially helpful micro-policies to support the productive use of highly skilled workers. Seven indicators were selected to measure performance in this area, but no information is available as to their relative importance. However, the stock of human capital is viewed as the most important, and managerial and organisational structures are considered a necessary but not sufficient condition for increasing productivity.

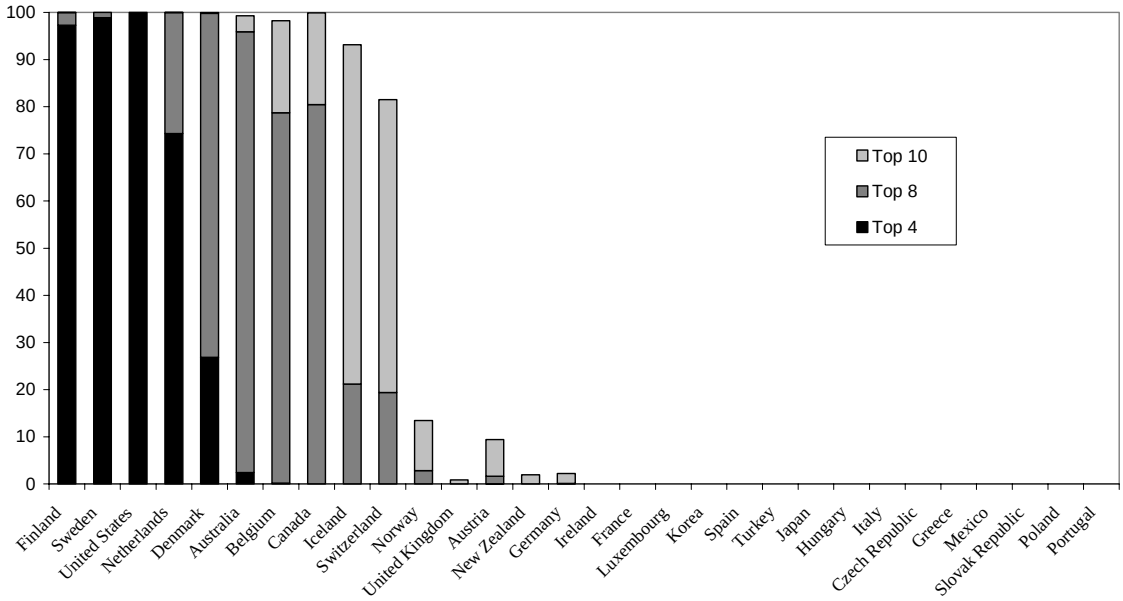
The three indicators for the stock of human capital show a very coherent picture of performance for Sweden, Finland and the United States, which are consistently among the top five countries. A simple average of the standardised indicators also shows a much higher value for these countries compared to other OECD countries. Belgium, Canada and the Netherlands are in the next group of top performers. Belgium has a very high share of high-skill jobs, but performs around the OECD average on the other two indicators. Canada has a high share of the population with skill level 4/5, an above average number of high-skill jobs, but a below average number of private researchers. The Netherlands has very high share of high-skill jobs, an average share of people with skill level 4/5, and a below average number of researchers. It is consequently not possible to determine a relative ranking of these three countries based on the available indicators of the stock of human capital.

The indicators on measuring management practices and the predominance of new forms of work organisation confirm the high ranking of Sweden and Finland. The United States and the Netherlands also rank highly, although their rankings are more sensitive to the relative weights assigned to the indicators. The indicators also show that the high ranking of Canada can be confirmed, whereas that of Belgium depends on the selected weights.

No prior information on the relative importance of these indicators exists so a distribution of possible composite indicators was calculated based on random weights. The distribution does not suggest a specific country ranking, but rather a robust division of countries into groups: a possible top four (United States, Finland, Sweden and Netherlands), top eight (including Denmark, Australia, Belgium and Canada) and top ten (including Iceland and Switzerland) followed by the other OECD countries (Figure 6.4). Denmark might be among the top four, and Norway and Austria might be among the top ten, but otherwise the groupings are very robust.

The indicators of organisational and managerial practices are the least reliable. Removing these indicators from the calculation has no impact on the top three countries (United States, Finland and Sweden) but suggests that Belgium should be included instead of the Netherlands (Annex B). The sensitivity analysis will consequently test the results for including Belgium instead of the Netherlands. A final alternative approach based on factor analysis also confirms the grouping of countries (Annex B).

Figure 6.4. Probability of a given rank with randomly assigned weights



Source: OECD.

The analysis suggests that further examination of policy benchmarks for enhancing human capital, and specifically for making the most productive use of highly skilled workers in the private sector, should be based on the experience of Finland, the Netherlands, Sweden and the United States. Possible alternative countries include Denmark, Australia, Belgium and Canada.

Quantifying the business environment

The business environment affecting the effective use of human capital in the private sector is broadly comprised of several areas, most of which are influenced by public policies, either directly (*e.g.* public expenditures on education) or indirectly (*e.g.* use of flexible work arrangements). OECD analysis has identified four main areas of the business environment that affect the ability of firms to enhance human capital and realise its potential (Table 6.3). First, the highly educated from the formal education system are an important source for expanding the number of people capable of doing highly skilled work. Second, access to on-the-job training/lifelong learning is the second most important way of investing in human capital. Third, investment in human capital is complementary to investing in managerial and organisational changes at the firm level. Fourth, the possibility of creating new jobs for the highly skilled depends on the flexibility of the labour market.

Each of these four areas has several aspects, most of which can be compared and benchmarked across countries by available indicators. However, comparable indicators do not yet exist for certain aspects of the business environment such as organisational change. A total of 39 indicators are used here to benchmark the business environment with respect to enhancing human capital and realising its potential. All indicators with reasonable country coverage (at least ten OECD countries of which at least three are benchmark countries) are included.

The following sections use spider diagrams in the attempt to identify similarities in the business environment across the four countries (Finland, the Netherlands, Sweden and the United States) selected for further analysis based on their performance in this driver. These four countries are the benchmark countries.

Table 6.3. Human capital policy domains

Business environment for human capital			
Access to the highly educated	Access to training/lifelong learning in the workplace	Access to knowledge-based management and organisation	Knowledge-based labour markets
Educational attainment	Incentives to firms to finance training for their employees	Availability of trained managers	International worker mobility
Support to education	Incentives to individual to invest in training	Preconditions for organisational change	Workforce participation of underrepresented groups
The learning environment			Flexible work practices through flexible labour markets
Links between education and labour markets.			

Access to the highly educated

Firms' access to highly educated employees is mainly determined by the educational attainment of the population, which depends on support for education. However, policy can also affect the educational quality either by improving the learning environment or by encouraging better links between education and the labour market.

Educational attainment

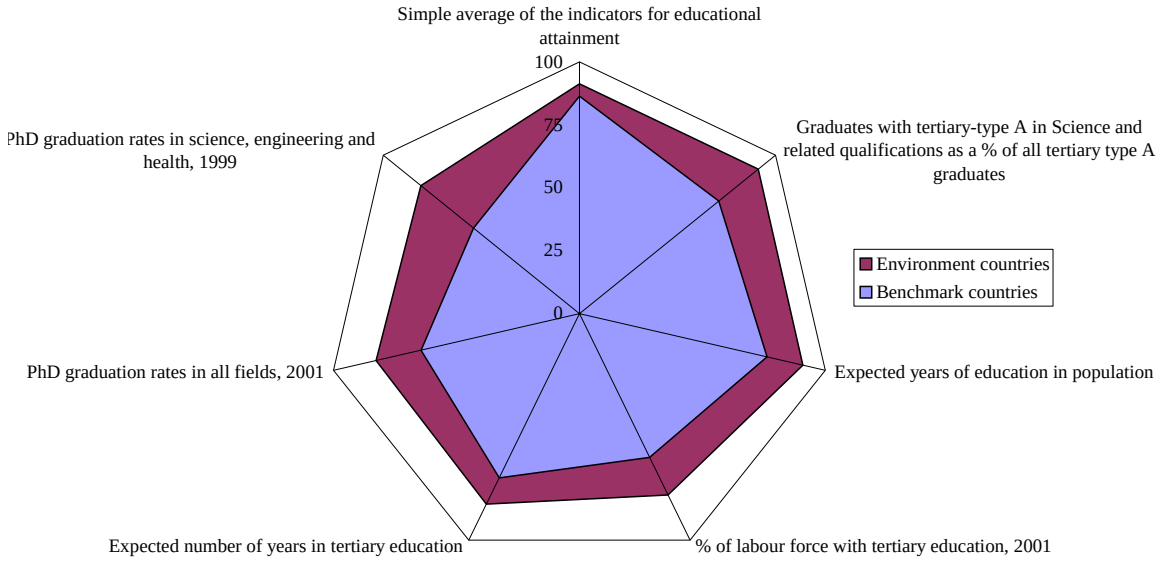
Policies that prepare students for tertiary-level studies are, of course, a requisite for boosting the population of the highly skilled. The effectiveness of such policies may be seen in completion rates of tertiary studies as well as in the educational achievement of the overall population (Box 6.2). Several indicators exist for educational attainment. The selected indicators comprise both stock indicators, *e.g.* share of the labour force with tertiary education, and flow indicators, *e.g.* PhD graduates in all fields.

Finland, Sweden and the United States are all top performers in this regard (Figure 6.5). The Nordic countries benefit from particularly high PhD graduation rates, a characteristic they share with Switzerland. Finland, however, falls near the mean in terms of the share of the labour force with tertiary education. The Netherlands, while still in the upper third, is held back by a lower rate of expected years of tertiary education. All in all, this area seems important, as the benchmark countries all perform well and are close to the best countries on each of the indicators, except for PhD graduation rates in science, engineering and health.

Box 6.2. Indicators of educational attainment

Six indicators measure countries' educational attainments at the higher level. Tertiary type A graduates in science and related disciplines are the share of graduates in engineering, manufacturing and construction, health and welfare, life sciences, physical sciences, mathematics and statistics and computing, relative to all students who complete studies at this level. A type A graduate education is more than three years of full-time graduate courses with a theoretical content. Expected years of education and expected number of years in tertiary education are both measures of the overall skill level of the population that may not be captured in tertiary-level graduation rates, as it measure the amount of tertiary education undertaken by an age cohort. The percentage of the labour force with tertiary education is also a stock variable and a broader measure of the overall educational level of the population. PhD graduation rates in all fields and PhD graduation rates in science, engineering and health refer to net graduation rates by single year of age in public and private institutions. This is an indicator of the current rate of production of advanced knowledge by each country's education system. Countries with high PhD graduation rates are generally characterised by a highly skilled labour force.

Figure 6.5. Benchmarking education attainment



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Support to education

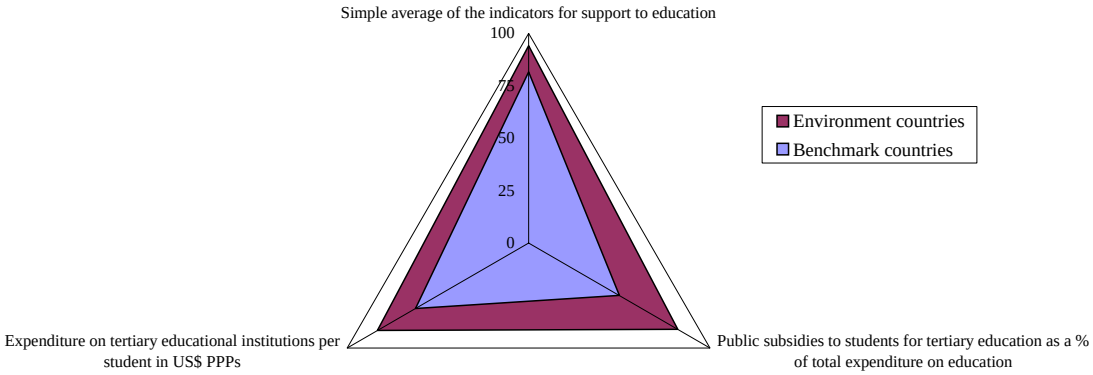
Public funds are used to increase the overall level and quality of human capital in an economy by channelling funds either to educational institutions or to individual recipients. The four benchmark countries rank highly on the indicators selected to measure the area of financing public education (Box 6.3 and Figure 6.6). The United States has the highest average score in this category. While in the middle of OECD countries in terms of subsidies paid directly to students, it has by far the highest share of education expenditure per student dedicated to institutions at the tertiary level. The Netherlands and Sweden also have policies that place them among the OECD countries with the highest levels of subsidies to tertiary education. Interestingly, while performance in Finland is especially high, public expenditure per student in Finland falls near the median.

Box 6.3. Indicators of support to education

Two indicators measure expenditure on higher education directed to institutions as well as to individual students. These measures vary in importance depending on the country's structure for financing of education. Public subsidies to students for tertiary education are measured as a percentage of total public expenditure on education. This indicator shows the proportion of spending on education that is transferred to students, families and other private entities in the form of loans, scholarships, grants and other transfers and payments to households or private entities. Subsidies are particularly important in countries where students are expected to pay for at least part of their education or in countries with high marginal taxes that raise the costs of education.

Expenditure on tertiary educational institutions refers to funds, per student, directed to universities and other bodies of higher education as a share of total educational expenditure. The indicator shows direct expenditure in educational institutions in relation to the number of full-time equivalent students in order to control for the relative size of each economy's educational requirements as measured by its student population. This indicator, which is measured in US dollars converted using purchasing power parities (PPPs), can give a relative idea of access to trained personnel and up-to-date facilities and equipment. Because it is measured on a per-student basis, the variations in expenditure per student capture not only the variation in the material resources provided to students, but also the variation in relative salary levels. However, this indicator cannot be considered in isolation as it masks a high proportion of expenditure on R&D in some countries (including the Netherlands and Sweden) as well as the fact that some countries with moderate expenditure rank highest in level of performance (*e.g.* Finland).

Figure 6.6. Benchmarking support to education



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

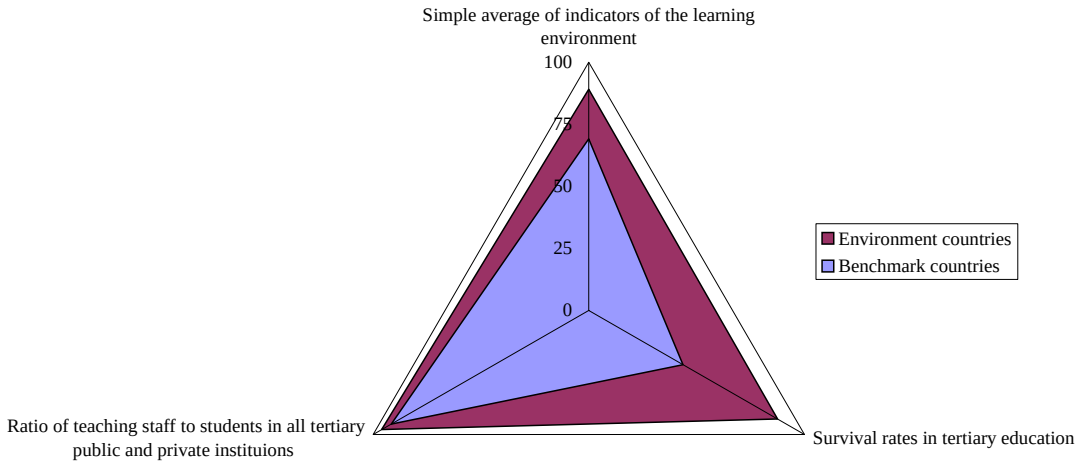
The learning environment

The ability to create an education system with a suitable learning environment is essential for attracting and maintaining students in classes at all levels. The learning environment is measured here by survival rates and student-to-teacher ratios in tertiary education (Box 6.4). All benchmark countries have a low share of students relative to teachers in tertiary education compared to other OECD countries, as well as high expenditure per student (Figure 6.7). However, the survival rate is below the OECD average in three of the benchmark countries. Only Finland is a good performer in this respect. The Netherlands, Sweden and the United States all hover around the median in terms of survival rates. The low values for the benchmark countries could suggest that survival rates are not very important for overall performance, whereas the student-teacher ratio is very important.

Box 6.4. Indicators of the learning environment

Two indicators indicate the ability of a country to retain students in the higher education system and give an idea of the quality of the learning environment. Survival rates in tertiary education measure the number of graduates divided by the number of new entrants in a typical year. This is an important measure of an education system's ability to retain students and thereby efficiently develop human capital. Rates may be affected by a number of factors, including the ability to finance studies and the higher education system's standards of achievement or policy of access. They may also reflect student choices such as changing subjects or leaving early for employment. Low survival rates may also point to educational programmes that do not meet student expectations or are too long to justify a prolonged absence from the labour market. Ratios of students to teaching staff in tertiary education provide an indication of average class size in an economy and therefore an idea of the quality of direct attention to students. The indicator is rescaled so a higher score indicates more teaching staff per student.

Figure 6.7. Benchmarking the learning environment



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

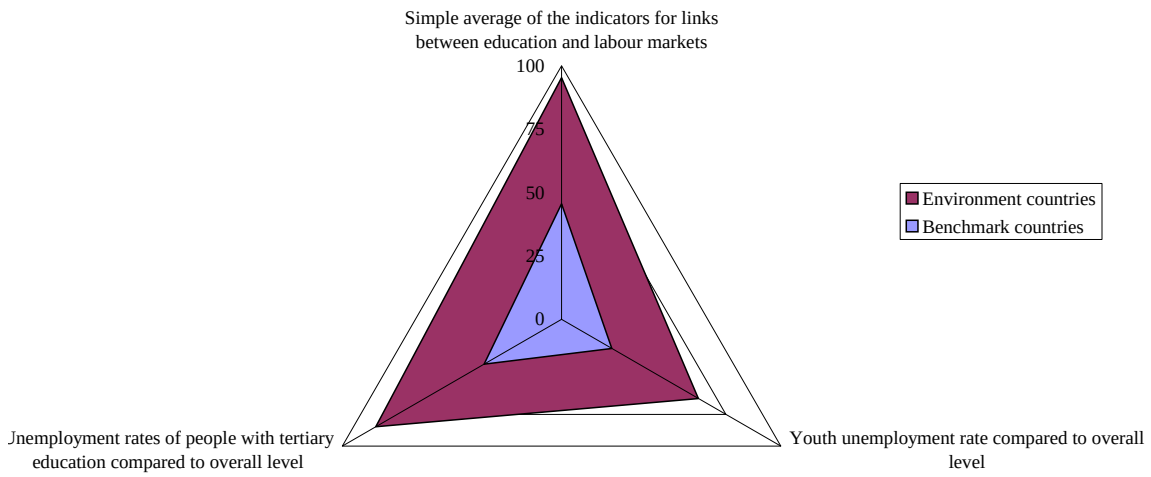
Links between education and labour markets

This aspect concerns school-to-work and other policies aimed at facilitating the entry of school-leavers into employment. Such policies are aimed at reducing unemployment rates for youth and the highly educated (Box 6.5). All four countries, with the exception of the Netherlands, have high unemployment rates for 15-24 year-olds compared to the overall level of unemployment (Figure 6.8). The unemployment rates of people with tertiary education is half of the overall unemployment rate in most countries, although the benchmark countries, with the exception of the United States, do not perform very well on this measure. This area may therefore not be among the most important for performance.

Box 6.5. Indicators of links between education and labour markets

The links between education and the labour market can be measured indirectly by looking at measures of unemployment. First, the overall unemployment rate divided by the unemployment rate of 15-24 year-olds directly measures labour market demand for the skills of young people. However, such rates are affected by a variety of factors and can only be used as a rough guide since many of the young unemployed lack jobs owing to insufficient education. Second, the overall unemployment rate divided by the unemployment rate of people with tertiary education directly measures labour market demand for the skills people attain during their studies and are consequently a good proxy for the links between universities and labour markets. Statistics on the duration of job vacancies in high-skill areas or indicators of skill mismatches in different economies might be useful in describing the dynamics of demand and supply of highly skilled human capital. However, comparable statistics of this nature are not available for many OECD countries.

Figure 6.8. Benchmarking the links between education and labour markets



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Access to training/lifelong learning in the workplace

The relative policy area can be considered as a block, under the heading of incentives for lifelong learning.

Incentives for lifelong learning

Policies that promote lifelong learning include incentives to employers as well as to workers. Incentives for employers are particularly important given that employers often hesitate to invest in training that they may be unable to recoup if the employee leaves the firm. Lifelong learning in OECD countries is compared here on the basis of both policy incentives and participation rates, which indicate the effects of the policies (Box 6.6). All four benchmark countries, together with Denmark, rank among the top performers in this category, although there seems to be wide overall variance (Figure 6.9). Sweden ranks highest among the countries considered. Sweden benefits from a high level of participation of employed adults in job-related training as well as a high rate of public expenditure on labour-market training as a percent of GDP. The United States lags behind most OECD countries in the latter area. The tax treatment of training is not very favourable in the benchmark countries. The Netherlands has, for example, the least favourable tax system for providing incentives for training.

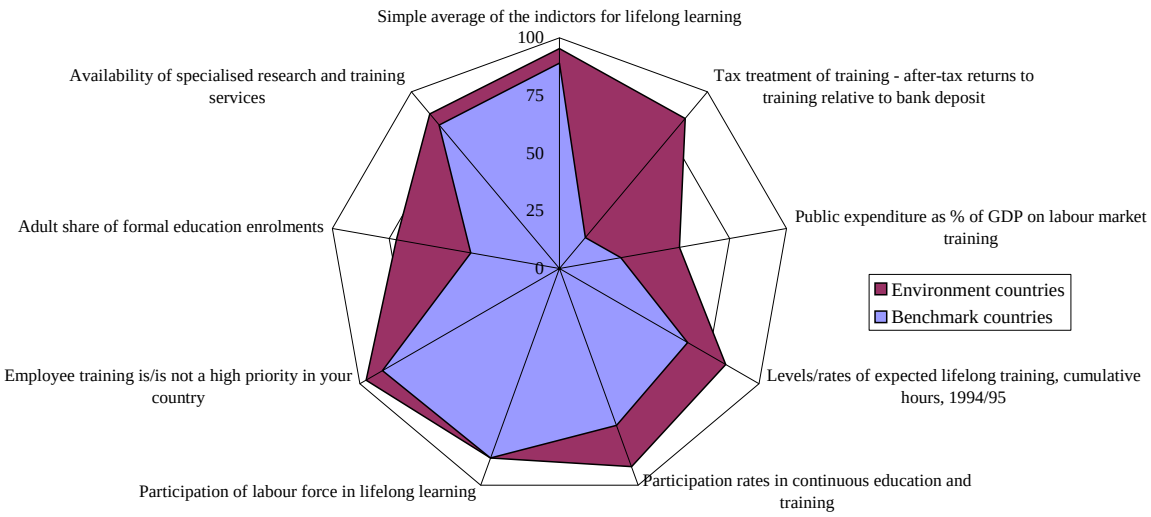
The benchmark countries score high on the average of these indicators, suggesting that the area is important for good overall performance. However, they score low on three indicators (tax incentives, public expenditures on labour-market training, and formal adult enrolments), which suggests that tax incentives and public labour-market training may not be needed to stimulate lifelong learning.

Box 6.6. Indicators of lifelong learning

Eight indicators measure the availability of and the incentive to undertake lifelong learning. The availability of lifelong learning opportunities for workers depends on a variety of factors, including tax treatment and public subsidies and programmes. The extent of government incentives is measured in terms both of incentives and results. Tax treatment of training is an indicator of incentive. It is measured as the before-tax amount an investment in training by a top-bracket earner must yield to pay the personal investor the same after-tax return as a bank deposit (rescaled so that a higher score indicates a more favourable tax treatment of investment in training). Public expenditure on labour-market training as a percentage of GDP gives an indication of direct government participation in continuous training.

The next four indicators point to actual levels and rates of lifelong learning and training. Levels/rates of expected lifelong learning are measured as the cumulative number of hours of career-related training of persons between the ages of 25 and 64. Participation rates in continuous education and training measure participation of 25 to 64-year-olds within a 12-month period. This indicator gives a broad picture of the incidence of adult participation in continuing job-related education and training. It does not include informal training activities such as "on the job" or other self-organised learning. Participation of the labour force in lifelong learning is obtained from a Statistical Indicators Benchmarking the Information Society (SIBIS) survey based on a questionnaire which asks whether respondents have participated in training in the preceding four weeks. This is a more restrictive indicator than the previous. The module focuses on work-related training only and was put to contract workers as well as to the self-employed and the unemployed. The adult share of formal education enrolments demonstrates whether formal education encourages or facilitates participation by prime-age and older adults. The IMD survey measure of employee training as a country priority asks the question "Employee training is/is not a high priority in companies?" and gives an idea of the effectiveness of policies supporting lifelong learning. Finally, the WEF indicator on the availability of specialised research and training services reflects answers to the survey question: "In your industry, specialised research and training services are not available in the country/available from world-class local institutions?" This indicator is used to measure the demand-side perception of the supply of such services in the different economies.

Figure 6.9. Benchmarking lifelong learning



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Access to knowledge-based management and organisation

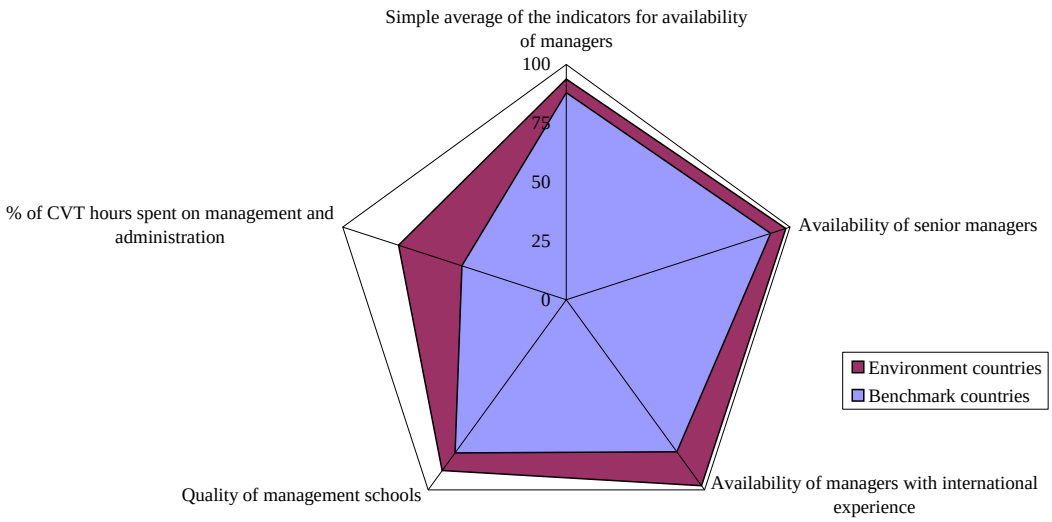
This area concerns the inputs to management and organisation structures that are known to benefit knowledge workers. It is defined as the availability of trained managers and the preconditions for organisational change.

Availability of trained managers

An available pool of trained managers is central to worker motivation and efficient allocation of labour. The indicators attempt to measure the availability of managers and the amount and quality of their training as well as the potential sources of management skills (Box 6.7). Management skills may be learned on the job or in management schools. Management practices may also be imported via international mobility of highly skilled labour.

The selected indicators suggest that the benchmark countries benefit from the availability of competent senior management, with the United States, Finland and Sweden faring particularly well (Figure 6.10). The high scores in the area suggest that it is among the most important for overall performance. The European countries for which data are available demonstrate a relatively high share of continuous vocational training (CVT) hours dedicated to management and administration. All countries, and in particular the United States, benefit from a high perceived quality of management schools. The European benchmark countries appear to benefit from managers with international experience relative to other OECD countries. The United States, on the other hand, is below the median in this respect. The lack of managers with international experience in the United States is to some extent a result of the size of the country. Large countries have by definition less need for trade.

Figure 6.10. Benchmarking availability of trained managers



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 6.7. Indicators of the availability of managers

Four indicators assess the degree to which the different countries are endowed with management experience and resources for obtaining it (*e.g.* management schools, managers with international experience). Three of the four indicators used here are based on IMD and WEF surveys. Availability of senior managers and of managers with international experience are taken from the 2002 IMD survey and questions regarding the scarcity or abundance of management in the respondent country. The questions are, respectively: "Competent senior managers are/are not available in your country's labour market?" and "Management usually has no/significant experience in international business and postings abroad?"

Quality of management schools, from the WEF survey, refers to the perceived quality of such schools in the different economies. The relevant question is: "Management schools in your country are limited and of poor quality/among the world's best?" The percentage of continuous vocational training hours spent on management and training comes from European Social Statistics and is therefore available only for EU countries.

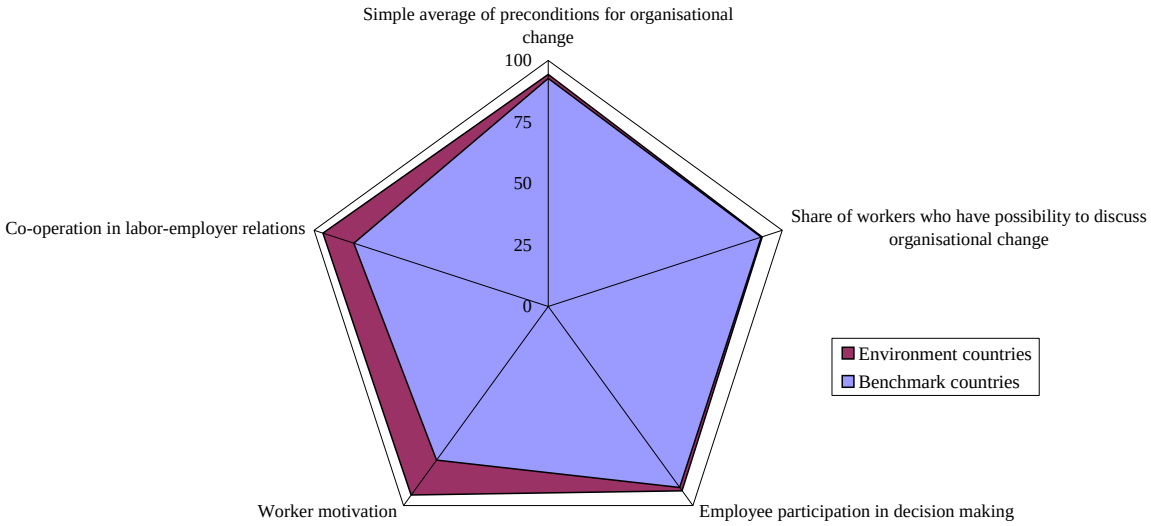
Preconditions for organisational change

This area measures the general factors affecting the ability of firms to change organisational approaches and the attitudes to change among workers. Indicators demonstrating the effectiveness of policies designed to stimulate organisational change are scarce. However, some indicators are available on human resource management practices, such as involving workers in the decision-making process (Box 6.8). The benchmark countries are all top performers with regard to the indicators considered (Figure 6.11). However, they appear to lag behind several OECD countries, namely Switzerland, Austria, Denmark and Iceland, with regard to overall worker motivation. The high scores suggest that this area is very important for overall performance.

Box 6.8. Indicators of preconditions for organisational change

Four indicators measure preconditions for organisational change. The indicators for employee participation in decision-making and share of workers who have the possibility to discuss organisational change may be regarded as inputs to the third indicator, worker motivation. The first two indicators come from the EC Information Society Programme SIBIS and are only available for EU countries. Employee participation in decision-making is a SIBIS indicator derived from the European Survey on Working Conditions. Worker motivation is measured by the WEF survey, which asks the question "worker motivation is high/low in your country?" This indicator suggests the effectiveness of human resource management in an economy. Finally, the general spirit of co-operation between employer and employees is measured by a question from the World Economic Forum: "Are labour-employer relations in your country generally confrontational or co-operative?" Co-operation is important for experimenting with new organisational structures.

Figure 6.11. Benchmarking preconditions for organisational change



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Knowledge-based labour markets

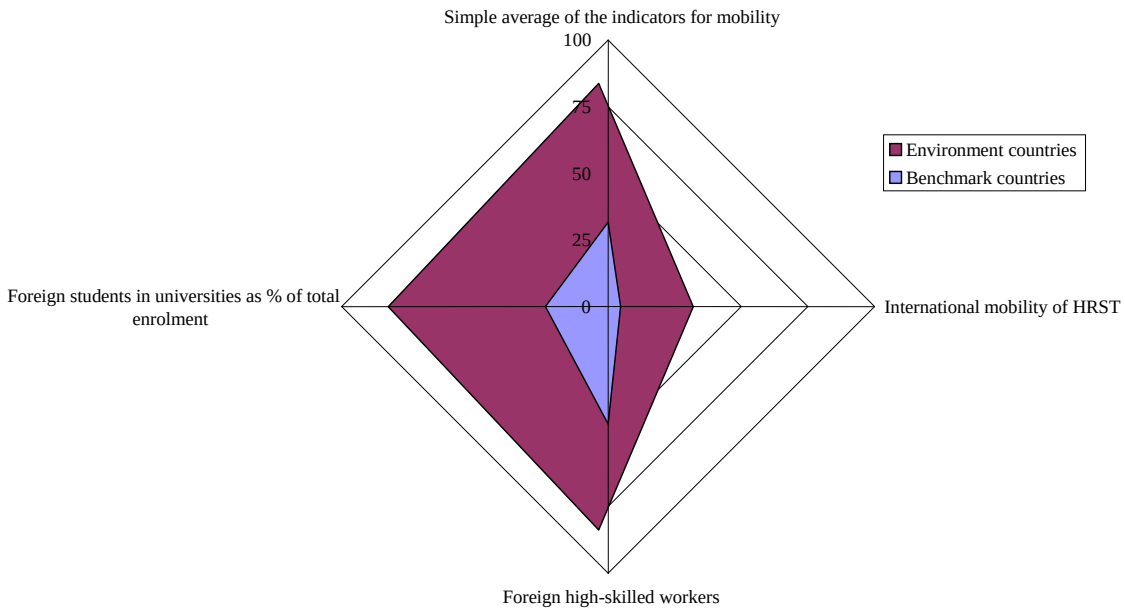
The final factor determining the productive use of highly skilled people is the functioning of the labour market. Three different aspects are considered. International worker mobility plays an increasingly important role for the highly skilled and is greatly affected by regulation and policy. Workforce participation of underrepresented groups is another area where public policies play an important role for increasing the number of highly skilled on the market. Finally, many new organisational forms require flexible labour markets.

International worker mobility

International mobility is crucial to alleviating skill gaps and the transfer of know-how across countries. On the basis of the indicators presented here, none of the benchmark countries appears to perform at the top of the environment (Box 6.9 and Figure 6.12). While a lack of data may be partly responsible for this outcome, it is also due to high rates of international mobility and large shares of foreign highly skilled workers in OECD countries with smaller labour markets, such as Austria, Belgium and Luxembourg. The sizeable presence of international institutions in Belgium and an important banking sector in Luxembourg, relative to the size of their labour markets and the weight of other industries in the economy, explain the high shares of foreign workers in these economies. The United States, which has the highest presence of foreign highly skilled workers, deviates from this pattern. Shares of foreign students in Australia, Austria, Belgium and Switzerland are also considerably higher than in the benchmark countries.

The low score for the benchmark countries on all the indicators suggests that the area is not very important for overall performance, despite the fears of brain drain in national debate in many OECD countries. This subject is not addressed here as the indicators only examine whether the countries are good at attracting foreign highly skilled labour rather than whether highly skilled nationals emigrate, an area for which data are lacking.

Figure 6.12. Benchmarking international worker mobility



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Box 6.9. Indicators of international mobility of workers

A dearth of harmonised cross-country indicators on the international mobility of labour makes it difficult to examine policies promoting such flows. Three indicators are selected. International mobility of human resources for science and technology (HRST) refers only to EU countries. The data portray the relative share of non-national resources in science and technology for professionals, technicians and associate personnel in activities such as science and engineering, computing, architecture, health, education and business and legal activities. The indicator gives an idea of the attractiveness of an economy to foreign highly skilled labour. The appeal of an economy to foreign highly skilled labour is also measured by an IMD survey question: "Foreign highly skilled people are/are not attracted by the business environment of your economy?" The presence of foreign students as a percentage of total enrolment also measures the openness and attractiveness of a country to potential foreign skilled labour.

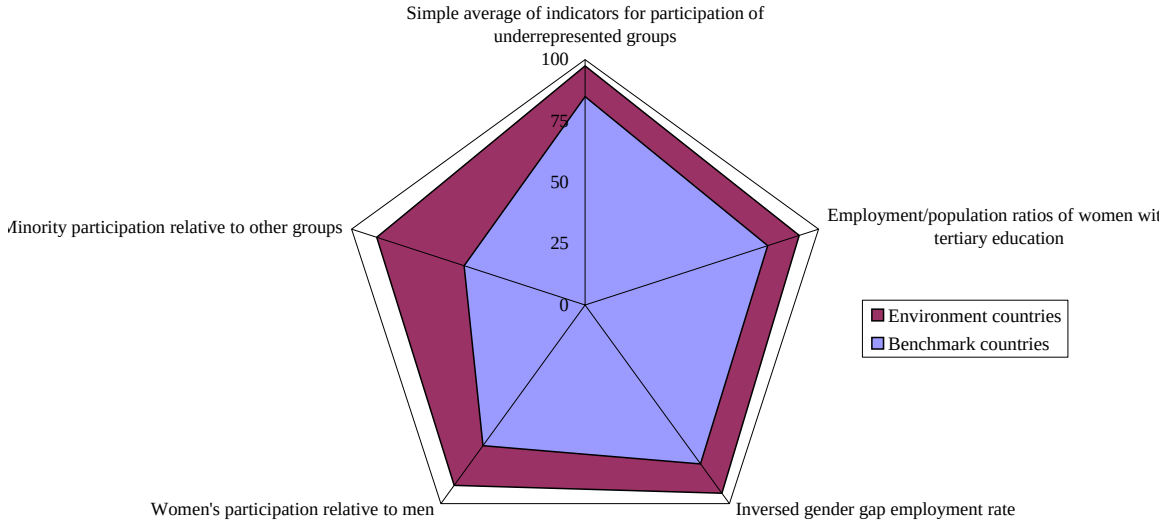
Workforce participation of underrepresented groups

Efficient use of skilled labour involves reaching all sections of the potential labour pool by including underrepresented groups such as women and minorities (Box 6.10). The benchmark countries have been better than the OECD average at more equal participation of women in their labour forces, with Sweden and Finland most highly ranked (Figure 6.13). Participation of minority groups is not high, however, in the benchmark countries. Finland and the United States have values above the OECD average in this area, whereas Sweden and the Netherlands have values below the OECD average. The Netherlands is also the weakest country with respect to female participation in the workforce. The mixed overall score reflects high performance with regard to female participation, but weak performance with regard to workforce participation by minority groups.

Box 6.10. Indicators of labour force participation by underrepresented groups

The indicators in this section give a general idea of a country's ability to draw women and minorities into the workforce. Employment population ratios of women with tertiary education indicate how well an economy brings highly skilled women into the active labour force. High rates show efficient use of their skills on the labour market and may be the result of various factors, such as family-friendly policies, attractive wage rates relative to their male peers, or policies that remove "glass ceilings". The gender gap employment rate is defined as the percentage point difference in employment rates for women and men with university-tertiary education (rescaled so that a higher score indicates more equality). This indicator gives a further idea of an economy's ability to draw highly skilled women into the economy. Women's participation relative to men and minority participation relative to other groups are indicators based on WEF survey questions: "Women's participation in your economy is limited and usually takes places in less important jobs/is equal to that of men?" An identical question asks the same about minority groups (rescaled so that a higher score indicates more equality). These indicators give an idea of the perception of equality of opportunity in the labour market.

Figure 6.13. Benchmarking participation by under-represented groups



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

Flexible work practices through flexible labour markets

Flexible work practices are positively correlated with productivity growth and are an increasing area of analysis and policy focus. Working hours, flexitime, working arrangements, etc., can serve as indicators and as proxies for policy (Box 6.11). The benchmark countries all show a good degree of worker-centred flexibility (Figure 6.14). The four benchmark countries show a relatively high degree of flexibility in terms of working hours and arrangements. However, the European benchmark countries demonstrate a relatively high degree of rigidity with regard to policy. The United States leads the OECD in many of the indicators, including the extent of incentive-based compensation. With regard to flexibility relating to university/industry co-operation, Finland and Sweden have the highest shares of firms with co-operation arrangements with government or institutions of higher education, respectively. The relatively high scores of the benchmark countries suggest that this is an important area for overall performance. In particular, the extent of incentive compensation and of university and research collaboration appear significant.

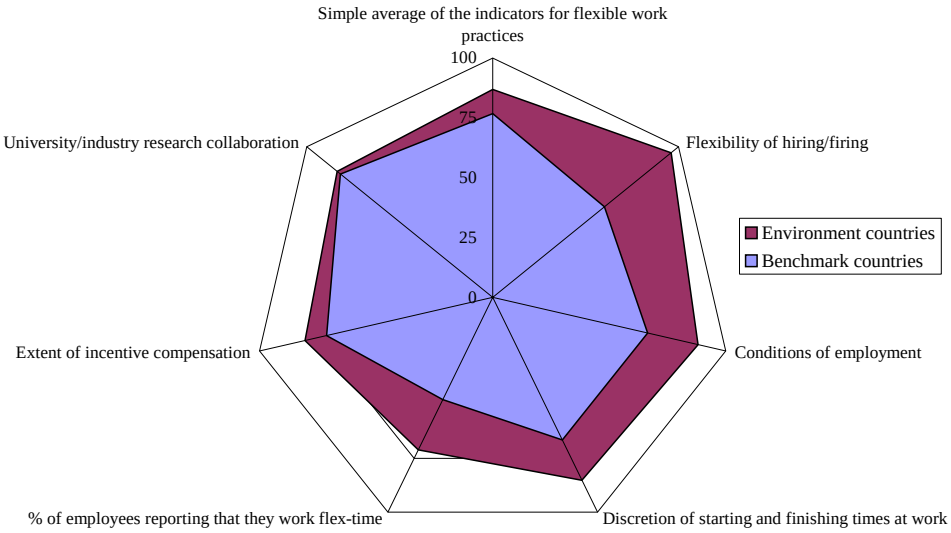
Box 6.11. Indicators of flexible work practices through flexible labour markets

Six indicators attempt to assess flexibility in working time, location and contracts for both workers and firms. They are divided between those that reflect policy (flexibility of hiring and firing, conditions of employment and adaptability of work arrangements) and those that reflect a more flexible work culture.

Flexibility in hiring and firing and conditions of employment are components of the World Bank's Employment Law Index, which compares legal restrictions on employment practices. Both indices are calculated using the same assumptions for workers and employers across all countries. The hiring and firing indices cover the availability of part-time and fixed-term contracts, legal protections against dismissal, notice periods and severance payments. The conditions of employment index covers working time requirements, including mandatory minimum daily rest, maximum number of hours in a normal work week, premium for overtime work, restrictions on weekly holiday, mandatory payment for non-working days and minimum wage legislation. The SIBIS indicator for discretion of starting times at work asks workers whether they can, in their current work arrangement, adapt their daily starting and finishing times to their personal preferences. This, together with the OECD indicator for the percentage of employees reporting that they work flexitime, demonstrates flexibility both in firm work culture and the labour market.

The incentive compensation indicator comes from the WEF questionnaire and the question: "Compensation of management in your country is based exclusively on salary/includes substantial incentives in the form of bonuses and stock options?" Also from the WEF, the indicator for university/industry research collaboration answers the question: "In its R&D activity, business collaboration with local universities is minimal or non-existent/intensive and ongoing?" This indicator demonstrates flexibility in public sector research and university contracts.

Figure 6.14. Benchmarking flexible work practices through flexible labour markets



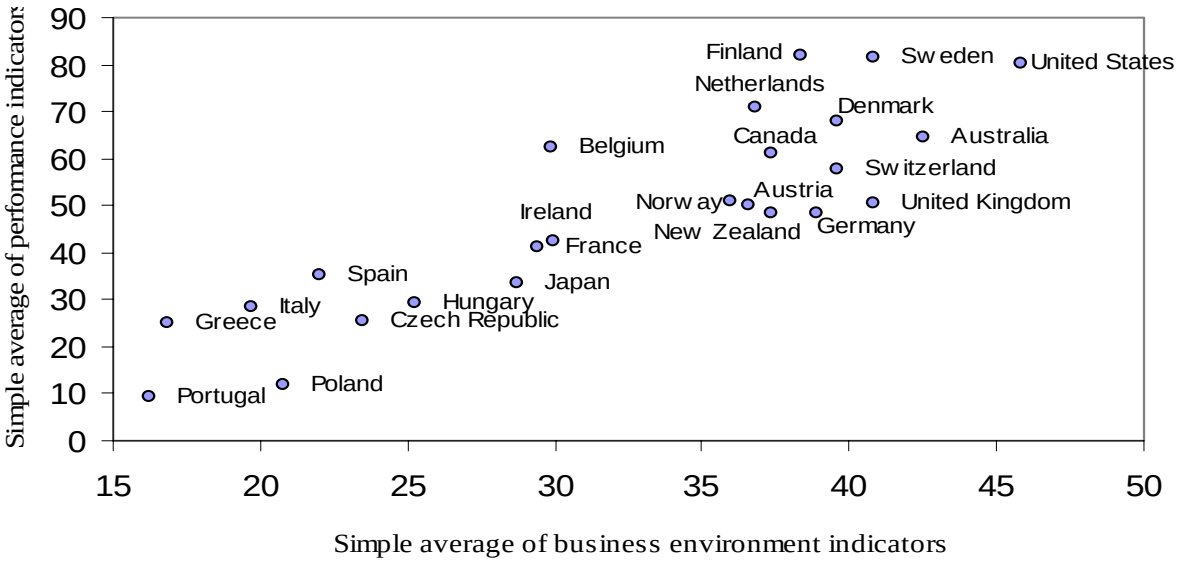
Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment).

The link from the business environment to performance

The business environment indicators described previously can explain a large part of the variation in country performance. A simple average of the business environment indicators shows a high correlation with the simple average of indicators used for country performance with regard to the productive use of highly skilled workers in the private sector (Figure 6.15). The high correlation between environment and performance suggests that many important aspects are captured by the analysis. However, the selected countries perform better than would be expected from their business

environment, indicating that they are also doing better than the OECD average on the areas that could not be quantified.

Figure 6.15. Business environment and performance for enhancing human capital



Note: R^2 equals 0.76 and the coefficient is significantly different from zero at the 1% level.

Source: OECD.

Sensitivity tests show that the choice of weights for the individual indicators plays a very limited role in the analytical findings. In the sensitivity analysis, weights between 0 and 1 were assigned randomly 10 000 times to each of the indicators for the business environment and for performance regarding highly skilled workers. The correlation between the business environment and this area of performance varies between 0.81 and 0.89 (or $0.67 < r^2 < 0.80$). The full variation of the composite indicators is taken into account. The correlation is significantly different from zero and the 1% level in all cases.

Indicators of management and organisational structures are used both as performance and input measures. In order to avoid double counting, none of the indicators of management and organisational structures is included in the average of the environment indicators. Including these indicators would increase r^2 to 0.84. Another possible area of double counting is educational attainment, which is highly correlated with the indicator of number of high-skill jobs that is used to measure performance. Excluding educational attainment only reduces r^2 slightly (from 0.76 to 0.70) and the slope coefficient is still significantly different from zero at the 1% level.

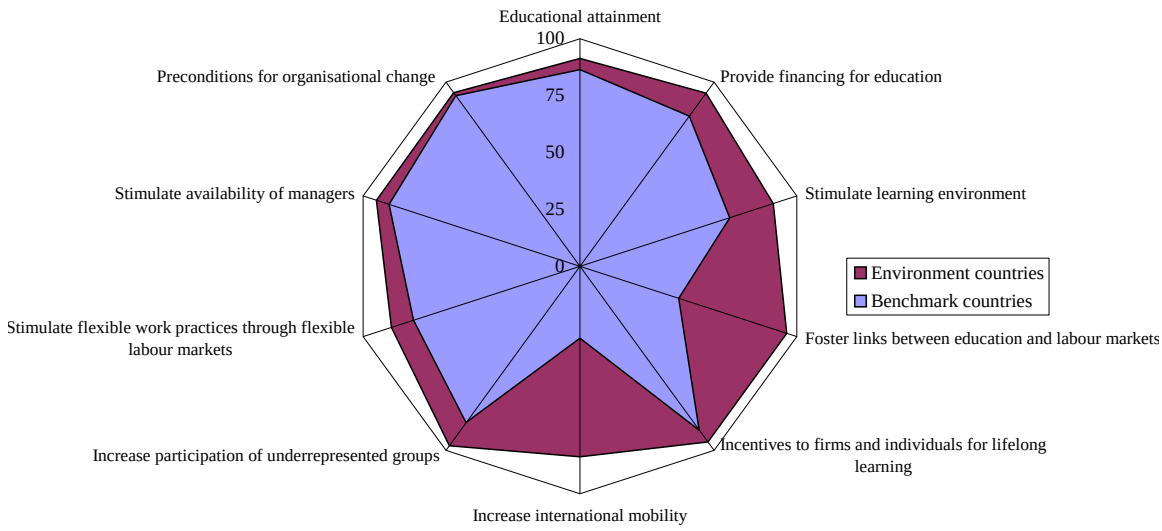
Critical policy areas

Not all of the policy areas examined in the business environment are equally important. The objective of this section is to identify areas that may be most important for performance. Two approaches are used. First, the benchmarking approach with the spider diagrams in the previous section found some similarities in the business environment across the four benchmark countries. This is a first attempt to prioritise policy actions that may be useful for enhancing human capital and realising its potential. The assumption is that the parts of the business environment where the four benchmark countries have values close to the best performers on individual areas may be more

important for overall performance. Second, regression analysis can be used to determine which policy areas have the highest correlation with performance in this driver; the interaction of policy areas can also be examined.

The benchmarking methodology shows that the four benchmark countries are close to the best performers in five areas of the business environment: *i)* educational attainment; *ii)* incentives for lifelong learning; *iii)* stimulating flexible work practices through flexible labour markets; *iv)* availability of managers; and *v)* preconditions for organisational change (Figure 6.16). These five areas are closely followed by providing finance for education and increased participation of under-represented groups.

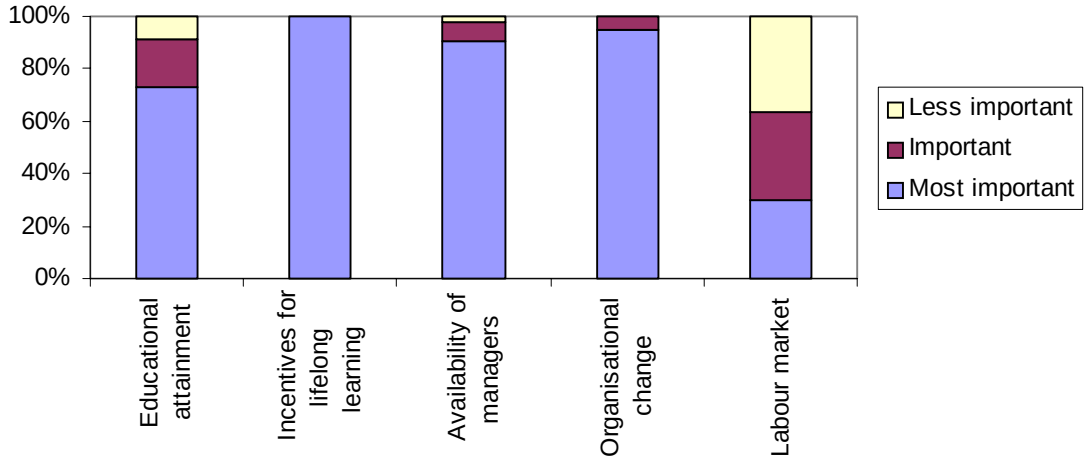
Figure 6.16. Benchmarking the overall business environment for enhancing human resources



Note: The spider diagram compares the average ranking of the four benchmark countries (Finland, the Netherlands, Sweden and the United States) with the four countries with the highest ranking on the particular indicator or aspect of the business environment (environment countries).

The average of all indicators in a given area can cover large variations in some parts of the business environment. Indices have been calculated for each of the most important areas of the business environment with random weights. This sensitivity analysis shows incentives for lifelong learning to be the most stable and always an important area regardless of weights. Availability of managers and preconditions for organisational change are also stable and are almost always, regardless of weights, important areas. The conclusions for labour market and educational attainment are the least stable to changes in weights for these five areas. The sensitivity analysis shows that the results are robust for including Belgium as a benchmark country instead of the Netherlands, as noted in the section on selecting countries.

Figure 6.17. Sensitivity of the results when weights are assigned randomly



Note: The distance between the benchmark countries and the environment countries determines whether an area is less important, important or most important. The figure shows the share of 10 000 randomly calculated composite indicators for each area in these three groups. The weights to the underlying indicators are drawn randomly from a uniform distribution (0 to 1).

The correlation analysis confirms the benchmarking results. The five areas identified above as important are significantly correlated with all the measures of performance (Table 6.4). The correlation analysis also shows that international mobility is significantly correlated with performance but at a lower level. Sensitivity analysis with the weights based on factor analysis also confirms these results (Annex B).

Table 6.4. Summary of the regression results

Business environment for human capital			
Access to highly educated	**Access to training/lifelong learning in the workplace**	**Access to knowledge-based management and organisation**	**Knowledge-based labour markets**
Educational attainment	Incentives to firms to finance training for their employees	Availability of trained managers	*International worker mobility*
Public support to education	**Incentives to individuals to invest in training**	**Preconditions for organisational change**	Workforce participation of underrepresented groups
The learning environment			**Flexible work practices through flexible labour markets**
Links between education and labour markets.			

Note: All areas in bold are significantly correlated with performance at the 1% level. All areas in italics are significantly correlated with performance at the 5% level.

More advanced multi-variant regression techniques based on stepwise elimination of insignificant areas show that three areas (educational attainment, incentives for firms and individuals for lifelong learning, stimulation of organisational change and focus on human resource management) can explain 90% of the variation in performance. All three indicators are significant at the 1% level and have quite similar coefficients (Table 6.5).

Table 6.5. Summary of the final step in the stepwise elimination regressions

Adjusted r^2	0.89		
	Coefficient	t-value	p-value
Intercept	-12.92	-2.89	0.01
Educational attainment	0.48	3.90	0.00
Incentives to firms and individuals for lifelong learning	0.43	2.77	0.01
Stimulate organisational change and focus on human resource management	0.36	3.46	0.00

The robust message emerging from these different types of analysis is that governments have four main roles in ensuring the productive use of highly skilled labour. First, they should ensure high educational attainment through public finance for education and other actions. Second, they should create incentives for both firms and individuals to invest in lifelong learning. Third, they should stimulate knowledge-based management and organisation in firms. Fourth, they should ensure that regulatory frameworks and inflexible labour markets do not hinder the use of flexible work practices in private firms. The first three roles are confirmed by all methods of analysis and are significant in the multi-variant regression analysis. The fourth is significant in the benchmarking analysis and in the simple correlation analysis but is eliminated in the stepwise regression as it is highly correlated with stimulating organisational change. The following section reviews micro-policies used by the benchmark countries in these four areas.

Policy benchmarks for increasing educational attainment

Education systems in OECD countries vary in their ability to produce highly qualified personnel for the high end of the labour market. In view of the role of skilled labour in economies heavily reliant on knowledge, improved quality and efficiency of higher education systems are a priority. Tertiary education attainment rates in the four benchmark countries are among the highest in the OECD: over 30% of the population aged 25-64 in the United States, Finland and Sweden and over 24% in the Netherlands (OECD, 2003n).

Evidence suggests that public financing has an important positive impact on enrolment rates in higher education. In developed countries, a 1% increase in public funding of tertiary education can have a similarly positive effect on enrolments (Lanot *et al*., 2001). The United States, Sweden and the Netherlands have among the highest expenditures per student for tertiary-level education, while Finland spends somewhat less. These countries judge public intervention in the funding of higher education – through grants and loans to students and direct funding of educational institutions – necessary to realise social returns as well as to make access to tertiary education more equitable. This is especially important in countries where private returns to education are lowered by high marginal tax rates. For example, the Swedish government has decided to restore the attractiveness of student loans by reducing the part repaid by students to 70%.

Providing more public money does not solve all problems, however, as this does not ensure the quality and relevance of the education for firms. Some OECD countries provide a larger share of their government subsidies to tertiary education than the top-performing countries but score lower on the performance indicators. Several approaches to increase relevance have been tried. The high relevance and quality in the United States are due to very beneficial competition among private and public universities. This may be difficult to do in countries where all or most universities are public.

Sweden and Finland have tried to create incentives for relevance and quality in their public education institutions through their manner of financing and evaluation. In Finland, for example, the higher education evaluation council regularly evaluates the quality of each polytechnic and has the

power to remove funding from an institution if the quality is insufficient. Links to working life and regional educational and service functions are among the criteria for evaluation (OECD, 2003q). The financing of polytechnics also provides incentives to provide relevant courses. Each region pays according to the number of inhabitants to a central fund, which then finances the polytechnic according to the number of students. Finally, the Finnish Ministry of Education allocates performance-based funding according to general performance criteria, one of which is employment of students after graduation.

Educational quality as well as innovative performance can be enhanced by linking tertiary education to the conduct of R&D (Stern *et al.*, 2000). The share of research performed by the academic sector is an important determinant of, and has a direct impact on, an economy's level of innovation. Sweden, Finland, the Netherlands and the United States are among the countries with the highest shares of GDP for R&D conducted by the higher education sector (OECD, 2003j). The United States has the highest expenditures dedicated to tertiary-level institutions, mostly through R&D support, and is renowned for the quality of graduate education linked to such research. Swedish government research funds are allocated both through direct grants to universities, where the vast majority of the country's government-funded research is carried out, and through grants to research councils to which researchers apply on a competitive basis. In 1997, Swedish investment in R&D amounted to 3.85% of GDP, the highest in the OECD.

Finland has established a series of "graduate schools" that cover the main research areas and form a nationwide network. The network ensures that a school in the network has access to high-quality research and teaching capacity in all fields. There are now 114 such schools accommodating more than 4 000 doctoral students and providing about 1 300 full-time research positions financed by the Ministry of Education. Finland also encourages enrolments by allowing researchers to retain the intellectual property rights to their research and exploit the commercial applications of their work (along the lines of the Bayh-Dole Act in the United States). R&D performed by tertiary institutions is also substantial in the Netherlands, where many universities receive research funds from the government-funded Netherlands Organisation for Scientific Research (WNO).

Enhancing rates of return to tertiary education is a primary means of increasing demand for university education and the share of students who stay in school and graduate. The two main determinants of private internal rates of return to education are earnings differentials and length of studies. Comparing the costs of tertiary education (*e.g.* tuition fees) to the gains thereafter (*e.g.* earnings) shows that rewards appear to be higher in the United States than in most other OECD countries. High rates of return are generally due to shorter university periods and high pre-tax earnings. In the United States, for example, rates of return to education exceeding 15% are largely due to relatively short university studies. With this in mind, Finland has undertaken reforms to shorten the time required to complete a degree to four years and to encourage students to graduate and gain employment at an earlier age. Evaluations show that tertiary enrolment and graduate levels increase when the rates of return are higher. This depends as much on lower fees and shorter study periods as on expected wages and tax rates (Blondal *et al.*, 2002). The shortening of study should be based on a balanced approach which maintains high quality by intensifying studies rather than the requirements. For students who will enter basic research after their studies, quality is more an issue than length of study.

Effective policies for increasing educational attainment include:

- Providing public subsidies to tertiary education.
- Stimulating competition among education institution either directly or through financing and evaluation.

- Increasing quality by linking tertiary education to the conduct of government-financed research and development.

Policy benchmarks for providing incentives for continuous training

Firm-level or worker-related training is an area with significant market failures. Because employers cannot internalise the benefits of training that will accrue to future employers, they tend to under-invest in upgrading of employees' skills despite the fact that technological change necessitates continuous upgrading. Firms as well as governments have a stake in ensuring that workers, including the highly skilled, receive training to increase their ability to adapt to new technologies and tasks. The four countries examined here have among the highest rates of adult participation in continuous education and training in the OECD (OECD, 2003m). They have adopted a variety of initiatives to increase both firms' and workers' investments in lifelong learning.

These countries have tended to use tripartite agreements and levy-based schemes to raise the level of enterprise training above that set by the market. The analysis clearly shows that general tax incentives were not used. No clear picture emerges on the split of costs in the tripartite agreements, as these vary across sectors and countries.

In the Netherlands and Sweden, collective bargaining has resulted in provisions that generalise the right to training. The Netherlands has a system of training levies at the sectoral level, set mostly during the 1980s and 1990s by collective agreement, which are supplemented by government grants. Employer contributions vary by industrial sector and average 1.7% of the wage bill. The agreements are voluntary rather than statutory and cover about half of the Dutch workforce. There is a similar approach in Finland, where a system of levies provides for the subsidisation of wages while on training leave, which is paid for by the government, enterprises and workers' councils. In addition, Finnish law requires that all companies with more than 30 workers submit annual training plans to joint enterprise committees and negotiate these with employee representatives. Investment in training by Finnish companies is estimated at 3% of the total wage bill.

In the United States, some sectors with high union participation, including the aerospace, automotive and telecommunications industries, also raise training funds through levies. In Sweden, most training is financed through government subsidies and a system of paid training leave. Between 38% and 40% of workers receive some sort of employer-sponsored training each year. Sectoral agreements between unions and employers are used to establish company-level assessment of qualification needs and the design of training plans. For example, an agreement between the Graphic Workers Union and the Swedish Graphic Companies' Federation guarantees each worker in this sector at least four days training for a four-year trial period. In the four benchmark countries, cost-sharing arrangements and partnerships between firms, governments and other stakeholders have been successful in helping address the issue of the risks and costs of training for enterprises.

Individuals as well as enterprises need incentives to overcome barriers to invest in lifelong learning, and these four countries have taken steps to offset the costs and time constraints of lifelong learning for workers. Individual learning accounts (ILAs) are self-managed savings accounts earmarked for training, with the contributions from the account holder supplemented by the employer and/or the government. The governing principles behind ILAs are cost-sharing and freedom of choice, with decisions as to the time and type of training made by the account holder. In the Netherlands, a series of ILA pilot projects have been under way since 2001 and are aimed at different types of workplace-related skills. The government makes an initial contribution of between EUR 150 and EUR 450. Two projects require a contribution from the workers themselves and seven schemes receive contributions from employers or sectoral training funds. In the United States, ILAs are becoming increasingly common, particularly at state level, where they have proven effective in

increasing individuals' motivation to invest in continuous training and in leveraging public and private sources of funds (OECD, 2003g).

Other interesting programmes are based on apprenticeship or payback clauses. Finland has an apprenticeship programme covering both new entrants to the workforce and further vocational training for entrepreneurs. The programme is based on countrywide organisation of apprenticeship centres, which take care of preparations related to the training arrangements. Payback clauses have been used in the United States, where workers sign an agreement before receiving training that they will pay back the cost of the training if they leave the firms before a given date. These contracts require significant involvement from the social partners in order to work.

The four countries have also taken steps to increase the share of workers receiving training in small firms. Knowledge-intensive start-ups are closely tied to rapid growth sectors such as biotechnology, telecommunications and software and, as such, small businesses are important employers of skilled staff. However, there is significantly less training by small firms than by larger ones and it varies widely across countries. Employees in small firms in Sweden, Finland and the Netherlands are far more likely to be trained than in other OECD countries (OECD, 2003q). Similar training rates for small firms are likely in the United States, although comparable data is not available.

These governments have adopted innovative schemes to help small enterprises expand their capacity to develop skilled human resources. Despite the lack of general tax incentives, the Netherlands provides extra tax deductions to small and medium-sized enterprises (SMEs) for training costs, of which up to 140% may be deducted from turnover. Training must be relevant to the current functions of the employee and provided internally to receive the full deduction. In the United States, the Small Business Administration (SBA) offers a series of training schemes for SMEs with the aim of upgrading managerial and worker skills. The United States also encourages networking among large firms, smaller enterprises and worker representatives to disseminate training best practices.

NUTEK, the Swedish Business Development Agency, launched IT.SME in 2000 to enhance the ICT skills training of workers in smaller firms. It is financed by the Swedish government and run in collaboration with the Federation of Private Enterprises and other business organisations. The Swedish government reports that demonstrated demand for the programme confirms the need for such support in SMEs. The Finnish government has used European regional and structural funds to create the Adaptation of the Workforce to Structural Change (ADAPT) programme, which is aimed at SMEs and works to develop professional skills as well as flexibility and mobility among workers in small firms.

Effective policies for increasing training and lifelong learning include:

- Negotiating tripartite agreements to share the costs and responsibility for enterprise training.
- Offsetting costs and time constraints of individual investments in training.
- Developing schemes to assist small firms to provide more worker training.

Policy benchmarks for stimulating knowledge-based management and organisation in firms

It is now recognised that enterprises need to adopt different and more innovative approaches to management and organisation in order to maximise returns from new technology and skilled labour. These place a premium on flexibility, adaptability, continuous learning and the ability to transfer experience and skills between activities. The four top-performing countries score high on indicators relating to the availability of a qualified pool of managers, the use of new organisational approaches, and the implementation of flexible work practices, and this allows them to make the most productive use of the highly skilled in the workplace. This section focuses on policies aimed at individual firms, whereas the next section deals with labour market policies, which also affect firms' ability to organise work flexibly.

In most OECD countries, small firms play a central role in the economy. Good management skills are particularly important in smaller enterprises, which must be quick to adapt to changing markets and circumstances. However, they often lack the resources necessary to pay for management training. Preliminary evidence suggests that formal management training can reduce failure rates of small firms, particularly in the early years (OECD, 2002i). To aid small-firm survival rates and increase management capabilities in SMEs, the four benchmark countries have developed manager-training programmes specifically targeted to SMEs.

In Finland, where almost 98% of firms are SMEs, the 15 regional Employment and Economic Development Centres provide formal management courses that can last up to two years, with instruction taking place from one to three days a month. These programmes focus specifically on current managers of SMEs, or those about to assume such responsibilities. The centres also offer a management training programme aimed at women who hold management positions in small firms and seek to develop their ability to analyse, plan and develop business activities, adopt up-to-date management systems and methods, and develop effective leadership skills. Sweden has the Starting Line scheme (*Startlinjen*), a NUTEK-managed programme for SMEs that trains managers in areas such as setting up a business, administrative frameworks, financing and accounting and also provides information and databases for obtaining government financing and permits.

The Netherlands provides management training for small firms through programmes run by the Chambers of Commerce and the government-financed Institutes for Small and Medium-sized Enterprises (IMKs). These aim to enhance the quality of management through courses on product innovation, teamwork, quality control and external partnerships.

The United States has also been very active in creating management programmes for small firms. The SBA supports several management training programmes. The SBA and other US federal agencies support, for example, Small Business Development Centers (SBDCs), the Service Corps of Retired Executives, Business Information Centers, Women Business Centers, and US Export Assistance Centers.

SBDCs are located across the United States. Through co-sponsorships with the private sector, they are able to provide entrepreneurs training and counselling at little cost to the participant. The US government provides USD 88 million to support the SBDCs. Started in 1979, the SBDCs assist over 500 000 businesses annually. In addition to counselling and training, the SBDCs provide written materials, videos and electronic media as resources to clients. Training courses last anywhere from two hours to several weeks and are meant to address specific aspects of managing a business. Sample SBDC course topics include: advertising and marketing, bookkeeping, competitor analysis, selling, business plans and loan packaging strategies. Certified business counsellors who have owned or managed successful businesses teach these courses. They are able to provide added insight on operating and managing businesses from their own experience. One evaluation of these centres found that management training for both start-ups and established businesses contributed significantly to job creation and the leveraging of external finance from the private sector (Chrisman, 1997).

The United States also offers a large range of resources on line. The Small Business Training Network is a virtual campus housing free training courses, workshops and knowledge resources designed to assist entrepreneurs and business students. Anyone can access this information on the SBA Web site. The Service Corps of Retired Executives (SCORE) is a resource for entrepreneurs who can obtain advice and ask questions. This body of seasoned professionals includes 1 200 counsellors who provide help through the Internet. About 900 of them have foreign trade experience. SCORE matches counsellor experience with client needs and provides one-on-one counselling. Over half a million clients have participated in this service, one-fifth of them on line. SCORE offers a basic management techniques workshop.

Based on studies showing that "flexible organisations emerge strongly as being more productive" (NUTEK, 1999a), Sweden has been active in facilitating organisational change through government support schemes. The government promotes human resource development and organisational change through programmes such as *Växtkraft Mål 3*, one of the objectives of which is to stimulate organisational change in small firms (fewer than 50 employees). The programme supports an analysis of the company's current situation and its future position, which is used to write an action plan for needed changes in organisation and structure and competence-building plans for all employees. The company can also receive support of 50% of the costs of implementing the suggested changes, with an upper limit that varies according to the size of the company and the region. The support is around EUR 450 per employee with a maximum per firm of around EUR 20 000. The evaluation of a similar programme (*Mål 4*) showed very positive effects on productivity and revenue in the firms involved (NUTEK, 1999b).

Effective policies for enhancing knowledge-based management and organisation in firms include:

- Upgrading managerial skills in small firms through market-based solutions.
- Creating networks to support management in small firms.
- Stimulating firms to reorganise through advice schemes.

Policy benchmarks for stimulating flexible work practices through flexible labour markets

Flexible work practices, including telecommuting and part-time work, can help firms make the best use of new technologies by easing the need for workers to choose between career and family. The labour force participation of women, many of whom work part-time, has been successfully increased in the four countries, which have made part-time employment an important focal point of their labour policies, largely by improving employment conditions for part-time workers. In the Netherlands, a series of "flexicurity" agreements have greatly reduced the wage disparity between part-time and full-time workers. Dutch labour law includes greater flexibility for full-time employment while increasing security for part-time workers. In Sweden, the principle of "non-discrimination" between full-time and part-time workers has contributed significantly to worker flexibility and high female labour-force participation rates. Swedish legislation stipulates that part-time workers must not be treated less favourably than their full-time counterparts in respect of any employment conditions, including pay, benefits and training. Similarly, in Finland, legislation on employment contracts, period of notice, redundancy pay, etc., apply equally to full-time and part-time workers.

Taxation policies can also play a role in increasing the number of individuals engaged in part-time work. Over the past two decades, the relative tax rates of second earners has declined in Finland, Sweden and the United States relative to other OECD countries. This increases the neutrality of taxation of individuals, thus allowing more family members to work in part-time employment (OECD, 2003p). In Finland and Sweden, the tax assessment formulas ensure that the same tax rate applies irrespective of the marital situation and the employment status or income of any partner. This gives incentives for second earners to participate in the labour force and is reflected in high female participation rates and employment population ratios in these countries. In the Netherlands, the system provides for separate taxation, but does not treat single and dual income households equally, with tax rates for the latter slightly higher. Although participation rates and employment population ratios for women are high in the Netherlands, they do not equal those of Sweden or Finland. In the United States, households may choose their tax status and whether spouses wish to be taxed separately or together.

Knowledge workers at all levels need more flexible contracts. OECD studies show, for example, a clear link between flexible labour markets and investment in ICT (OECD, 2003d). Finnish unions have recognised the positive long-term benefits from investment in new technologies and reorganising

the workplace. The unions actively support such changes even though this may displace employees. The unions are also actively involved in retraining displaced workers. Recognising the need for flexible contracts and frequent changes in the workplace are a prerequisite for realising the full potential of highly skilled workers.

Skill standards can also increase flexibility on the labour market by increasing transparency. Workers can better document their skills and thus increase their mobility. In order to provide formal recognition of skills and learning, Finland has introduced a system of competence-based qualifications or "free exams" to credit adult skills independently of how the skills are acquired. Credits are not conditioned on course attendance in a vocational training or educational institution. The social partners are heavily involved in the elaboration of the certification schemes through expert groups. This system has led to significant expansion of vocational adult education, which now accounts for two-thirds of all adult education. Courses are provided through the Open University and the Open Polytechnic, and credits earned are transferable to higher education degree programmes. The number of students enrolled in the Open University increased from 39 000 in 1990 to 78 000 in 1999 (OECD, 2003m).

The four countries have also provided practical examples of flexible work approaches by rethinking hiring practices and using more flexible work approaches in the public education and research sectors. Previously characterised by low staff turnover, such institutions are reforming themselves to interact more closely with the private sector. In the Netherlands, decentralisation has meant that academics are no longer civil servants, and hiring decisions and human resource management are dealt with by universities in conjunction with trade unions. Similarly, in Sweden, the government has devolved much of its power over human resource issues in universities so as to introduce more flexible work practices and contracts in light of increased linkages with industry. The National Technology Agency of Finland (TEKES) has encouraged less contractual and workplace rigidity in universities and the research sector through funding for technology-based partnerships and cluster activities. The United States has long had a system of private for-profit universities, where work arrangements and human resource practices evolve alongside those in the private sector in terms both of conditions and pay. In most cases, the introduction of more flexible contracts is accompanied by flexible wage-setting mechanisms so that higher wages can offset less secure positions and maintain incentives to joint the public research sector.

Effective policies for stimulating flexible work practices through flexible labour markets include:

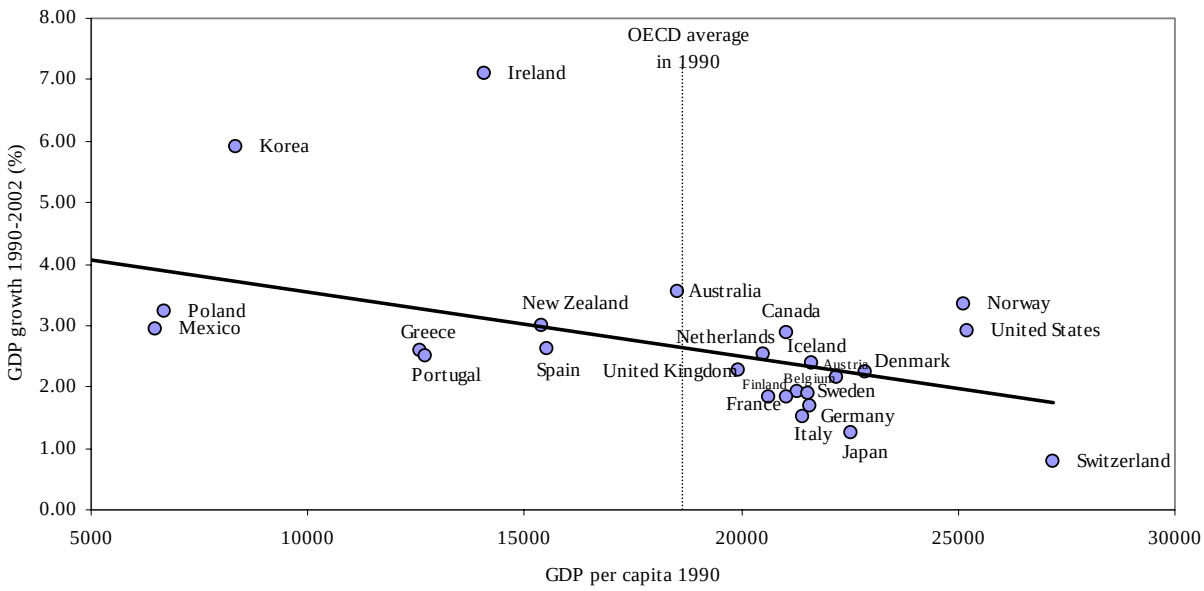
- Enhancing flexible work arrangements, *e.g.* by removing restrictions on part-time work.
- Promoting understanding of frequent changes in the workplace.
- Promoting skills recognition/standard programmes.
- Promoting flexible work practices in the university and research sectors.

Chapter 7

INTERACTION AMONG THE MICRO-DRIVERS AND PRODUCTIVITY GROWTH

Growth in the 1990s broke the well-known catching-up patterns of the 1960s and 1970s, in which countries that lag in terms of labour productivity and GDP per capita gradually close the gap *vis-à-vis* the leader (the United States). After stalling during the 1980s, the convergence process appears to have reversed during the 1990s among the largest OECD economies. GDP per capita grew faster in the United States than in Japan and the large EU member countries (Figure 7.1). However, Ireland, Korea, Australia, Norway, New Zealand and Canada have seen GDP per capita rising faster than in the United States, allowing them to narrow the income gap.

Figure 7.1. The historical caching-up pattern in GDP broke down in the 1990s



Note: The correlation between growth rates in the 1990s and GDP per capita in 1990 is 0.5 compared to 0.7 for the similar measure for the 1960s.

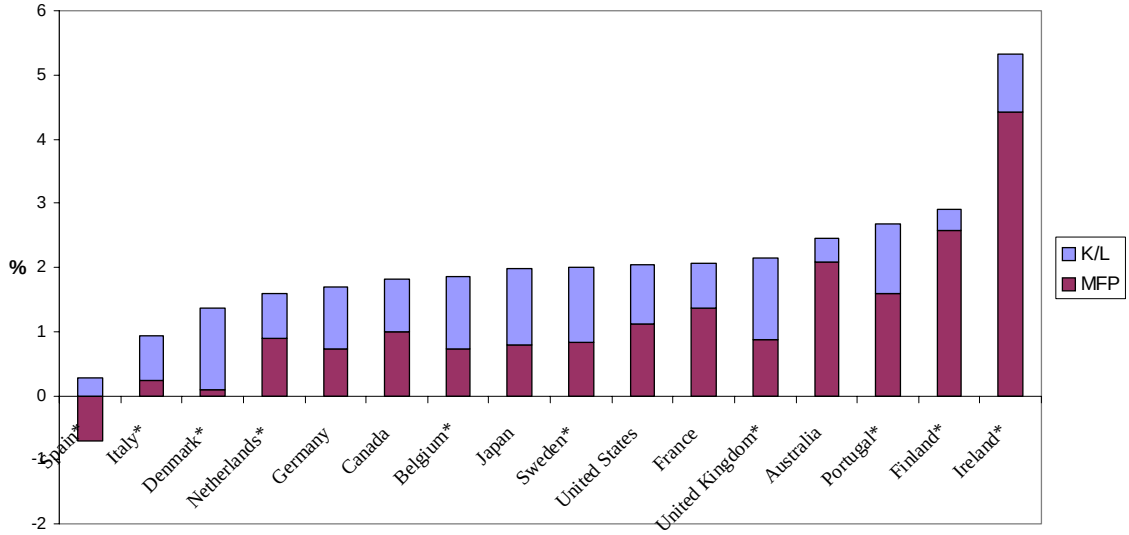
Source: OECD.

This new growth pattern was created by large increases in multi-factor productivity (MFP) in some countries. MFP growth can explain more than 50% of GDP growth in the last part of the 1990s in eight of the 14 countries with comparable data. Higher MFP played a major role in Australia, Finland, Ireland and Portugal, where more than 75% of their increase in labour productivity growth can be attributed to increased MFP (Figure 7.2). The large increase in MFP in Australia, Ireland and Portugal was combined with a relatively large increase in labour utilisation so that more people were working more productively. Many ways of measuring MFP growth exist, but most studies focus on

changes in MFP growth from one period to another. This is due to the methodological problems relating to measurement of capital goods and prices especially relating to ICT (Annex C).

Figure 7.2. Growth of labour productivity reflects capital deepening and multi-factor productivity

Yearly changes in labour productivity split into capital deepening and MFP (1995-2002)



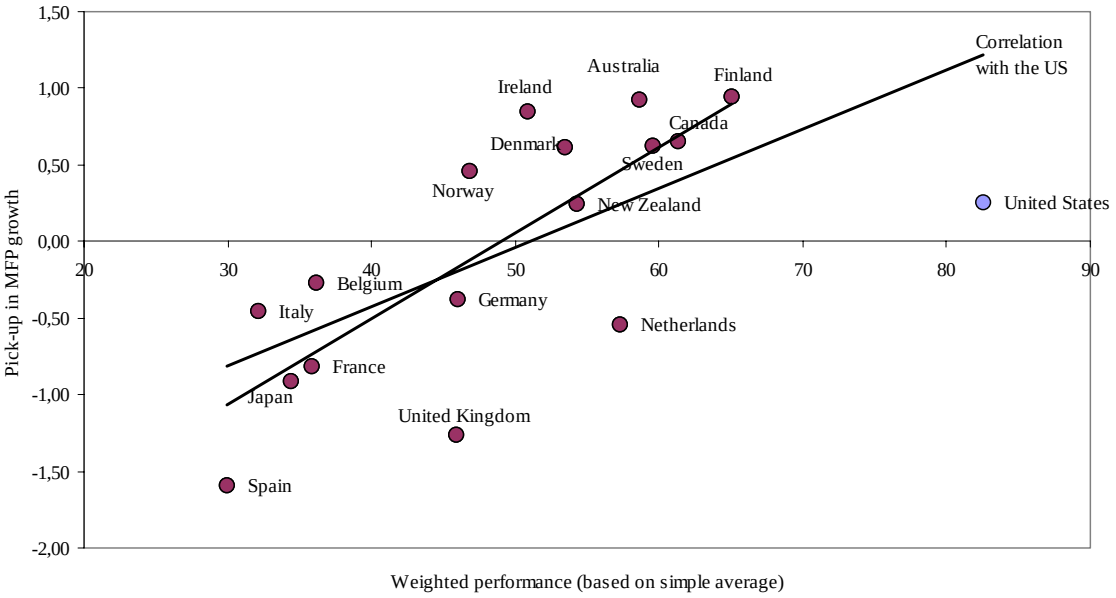
Note: MFP covers the total economy and is based on hedonic prices calculated by the OECD. Data for countries with * are based on 1995-2001.

Source: OECD Productivity Database, 2004.

MFP used to be called "a measure of our ignorance". However, the four micro-drivers described in this report are highly correlated with MFP. According to the available indicators, they explain almost 60% of the variation in the pick-up in MFP growth from the 1980s to the 1990s in OECD countries (excluding the United States). If the United States is included the percentage of explanation drops to 44% (Figure 7.3). The pick-up in growth is used to reduce the problems relating to measurement of the capital stock and especially the price indices used for ICT (Ahmad *et al.*, 2003).

Sensitivity tests show that using factor analysis to determine the weights or assigning weights randomly to individual indicators have limited effect on the results (Annex C). The correlation between the performance indicators and the pick-up in MFP growth is always significantly different from zero. Other tests show that the correlation is also robust when other measures of MFP are used. Multi-variant analysis with all drivers included separately is difficult owing to the limited number of countries with MFP data. Finally, the sensitivity tests also involve maximisation of the correlation between the drivers and pick-up in MFP by allowing the weights to vary. These tests show that r^2 can be increased even further when the drivers are allowed to interact. All in all, the analyses suggest that while a stable macroeconomic environment provides the overall basis for growth, the combined effects of the four micro-drivers are needed for growth today.

Figure 7.3. The correlation between overall performance and pick-up in MFP growth in the business sector



Note: R^2 for the full sample is 0.44 and 0.59 for the sample without the United States. More restricted tests, *e.g.* keeping the weights between the drivers constant, increase the lower bound of this r^2 interval. Pick-up in MFP growth measures the change in MFP growth from the 1980s to the 1990s in the business sector.

Three countries (Australia, Ireland and Norway) had higher pick-up in MFP than expected from their performance in the micro-drivers. Australia's high pick-up is mainly a result of structural reforms that increased competitive pressures in the economy. These structural reforms reflect policy recommendations in the 2001 OECD Growth Study (OECD, 2001a). The higher Irish pick-up in MFP growth has to a large extent been driven by multinational firms locating production (especially ICT) in Ireland. This aspect of globalisation is not captured by the current analysis. The high pick-up in growth in Norway is due to exploitation of their oil resources, which is not included in the analysis.

Three other countries (Netherlands, the United Kingdom and the United States) had a lower pick-up in MFP growth than expected from their performance in the drivers. The Netherlands did reasonably well in the 1990s but the indicators suggest they should have done even better. One reason might be the Dutch focus on labour utilisation. The Netherlands is among the OECD countries that increased employment the most in the late 1990s. Higher labour utilisation can affect productivity negatively as new employees typically have lower productivity than existing employees. The United Kingdom's low pick-up is more problematic, as the United Kingdom did not increase employment more than an average OECD country. One explanation might be a time lag between policy and performance. Knowledge-based policy making in the United Kingdom has expanded substantially since the UK government published its Competitiveness White Paper in 1998 (DTI, 1999). Another explanation is the choice of period. In the United Kingdom, the pick-up in MFP growth in the late 1990s compared to the early 1990s is among the highest in the OECD. The UK results are very sensitive to choice of period. The lower than expected pick-up in MFP growth in the United States may be due to the country's already higher productivity in the early 1990s.

The micro-drivers interact

The high overall correlation between the micro-drivers and pick-up in MFP growth covers some differences among the drivers. Human capital and ICT are both highly correlated with pick-up in MFP growth, whereas entrepreneurship is only weakly correlated and exploitation of science and technology is not correlated. These separate correlations should not be seen as a test of relative importance as the drivers are highly correlated.

More advanced techniques based on factor analysis confirm the strong interaction among the drivers. Factor analysis involves a set of techniques designed to identify order and structure in data sets with high internal correlation by providing a parsimonious and meaningful explanation for the observed variation and co-variation in the indicators. The factor analysis of the four drivers identified two underlying factors. The first factor consists of entrepreneurship with a weight of 2/3 and science and technology with a weight of 1/3. The second factor consists of science and technology with a weight of 1/5, human capital and ICT both with a weight of 2/5 (Table 7.1). Tests of fitness show that the estimation is not very robust and that the full set of data should be used if all variation is to be exploited. This suggests the need for coherent growth strategy including all four micro-drivers.

Table 7.1. Results of the factor analysis of the four drivers of growth

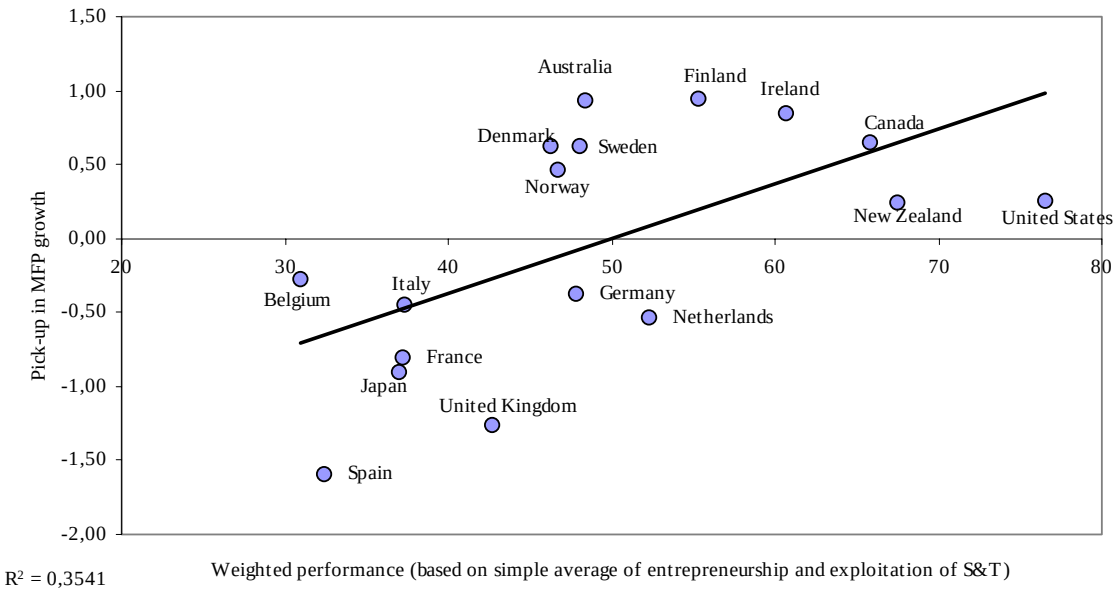
	Factor 1	Factor 2
	Weight in factor	Weight in factor
Entrepreneurship	0.03	0.64
Exploitation of science and technology	0.20	0.32
Human capital	0.38	0.00
ICT	0.39	0.04
Factor weights	0.62	0.38

Note: It is not common for one indicator to fall in two factors with almost equal weight, which is also the main reason for rejecting the estimation as a good fit of the data.

The interaction is also explored directly by correlating pick-up in MFP with various combinations of the micro-drivers. These correlation tests show that several different combinations of the drivers can increase the correlation. Human capital seems to interact with both ICT and science and technology. Science and technology seems to interact with entrepreneurship (Annex C).

The interaction between entrepreneurship and exploitation of science and technology is complex. Factor analysis groups science and technology and entrepreneurship, which suggests that the two policy areas interact. For example, countries like Japan, Germany and the Netherlands might not get the full benefits of science and technology as they lack entrepreneurs to turn ideas into profit. Other countries like New Zealand and Korea may lack the science and technology base needed to benefit fully from their many entrepreneurs. A simple average of the indicators for entrepreneurship and science and technology has a higher correlation with MFP than either of the two micro-drivers alone (Figure 7.4). The interaction between science and technology and entrepreneurship is also shown in the academic literature (Acs and Audretsch, 2001). An integrated policy approach in which science and technology is promoted together with entrepreneurship is therefore needed to enhance overall performance. An alternative hypothesis is that inflexible labour markets impinge on the ability to exploit science and technology and to create entrepreneurs. The analysis cannot confirm this hypothesis. Various measures of labour market inflexibility were combined with the indicators for science and technology and correlated with pick-up in MFP growth. The correlations are insignificant most cases.

Figure 7.4. The correlation between pick-up in MFP growth and the average of the performance indicators for science and technology and entrepreneurship



Note: R^2 = 0,35 and the t-value for the correlation equals 2.87.

The factor analysis shows a very high correlation between performance in ICT and human capital. The high correlation could be driven by the fact that training and education are an important prerequisite for successful implementation of ICT. Research suggests that only 10% of an ICT investment in firms should be spent on hardware, 15% should be spent on technology complements and 75% on work practices, human capital and organisational restructuring (Brynjolfsson, 2003). This is also confirmed in the peer reviews of policies for ICT diffusion to business. The Finnish review shows, for example, that the very high level of skills in the Finnish population is a big explanatory factor of the very high uptake of ICT in small Finnish firms relative to other countries (OECD, 2004c). Good performance in human capital consequently seems to be a prerequisite for seizing the benefits of ICT. Another possible explanation of the high correlation is that a country's income level influences both ICT uptake and human capital. However, two-step regression analysis shows that the two are highly correlated even when controlling for the income level (Annex C).

Finally, the analysis shows a high correlation between human capital and the exploitation of science and technology. This is not surprising. Human resources in science and technology are known to be essential for advancing science and innovation and in generating productivity growth (OECD, 2004e). This relates both to new graduates in science and technology but also to the organisation of the existing work force. Globalisation and ICT increasingly play a role in all sectors of the economy. The development and the effective use of human capital has become essential for firms' ability to improve their competitiveness by developing new products, processes and services. Human capital can in this respect be seen as the fundamental building block for growth strategies in the knowledge-based economy.

Annex A

DATA SOURCES

Performance indicators for fostering firm creation and entrepreneurship			
Creative destruction		New high-growth firms	
Firm entry rates, average 1998-2000 Own calculations based on Eurostat (2003), Baldwin *et al.*, 2002.		Change in employment from 1998 to 1999 in new firms Own calculations based on Eurostat (2003)	
Entrepreneurial activity, 2002 Global Entrepreneurship Monitor, 2003		Share of young firms with more than 60% growth rates in a two year period, 1999 – 2002 Own calculations based on Junge and Kaiser (2004)	
Access to skills			
Entrepreneurial education		Labour market regulation	
Quality of entrepreneurship education at primary education. From GEM Expert Survey questions: GEM (2003)		Conditions of employment index: World Bank (2003)	
Quality of entrepreneurship education at higher education From GEM Expert Survey questions: GEM (2003)		Flexibility of firing: World Bank (2003)	
		Flexibility of hiring: World Bank (2003)	
		Recruitment procedures, first employee EU(2002, p. 32)	
		Recruitment procedures, additional employee: EU(2002, p. 32)	
Access to capital			
Loans and loan guarantees	Venture capital	Stock markets	Wealth and bequest taxes
Extent of guarantees European Commission (2003b, p. 38) Stevenson and Lundström, (2001); SMBA (2002); SBA (2002; p. 187) and OECD (2002, p. 218)	Venture capital (early stage) as share of GDP OECD (2004, p.8)	Capitalisation of secondary stock market (5-year average) OECD (2004, p.25)	Top marginal bequest tax rates Chen, Lee and Mintz (2002, p. 22)
Main constraint on business performance is NOT access to finance EIM (2002)	Venture capital (expansion stage) as share of GDP OECD (2004, p.8)	Newly listed companies in secondary stock market per 1 million inhabitants (5-year average) OECD (2004, p.25)	Revenue from net wealth tax on individuals (%GDP) (OECD 2003b, p.116-195) and Economic Outlook database for GDP
Private credit (% of GDP) World Bank (2003)	Share of high-technology sectors in total venture capital investment OECD (2004, p.10)		Revenue from estate and bequest taxes (% GDP) (OECD 2003b, p.116-195) and Economic Outlook database for GDP
Five bank concentration World Bank (2003)			
Interest spread (%) World Bank (2003)			

Access to opportunities		
Administrative simplifications	Deregulation of protected sectors and competition	Incubators, spin-offs and licensing from public research
Starting a business cost World Bank (2003)	Barriers to competition Nicoletti *et al.* (1999, p. 75)	Incubators per SME DG Enterprise (2002, p. 2)
Starting a business number of procedures World Bank (2003)	Public ownership Nicoletti *et al.* (1999, p. 23)	
Starting a business time World Bank (2003)	Public involvement in business operation Nicoletti *et al.* (1999, p. 23)	
Enforcing contracts number of procedures World Bank (2003)		
Enforcing contracts procedure complexity World Bank (2003)		
Enforcing contracts time World Bank (2003)		
Regulatory and administrative opacity Nicoletti G., S. Scarpetta and O. Boylaud (1999, p. 75)		
Influencing the risk-reward trade-off		
Bankruptcy	Business taxation	Income and capital taxes
Length of time that creditors still have claims on a bankrupt's assets OECD (2001b, p. 107)	SME tax rates Chen, Lee and Mintz (2002, p. 16)	Average income tax plus social contribution OECD (2003b, p. 13)
Actual cost (% of estate) World Bank (2003)	Taxation of corporate income revenue as % of GDP (OECD, 2003a, p.116-195) and Economic Outlook database for GDP	Highest marginal income tax plus social contribution OECD (2003b, p. 86)
Actual time (in years) World Bank (2003)		Taxation of stock options EU (2002, p. 30)
Goals-of-Insolvency Index World Bank (2003)		Taxation of capital gains on shares – long term Chen, Lee and Mintz (2002, p. 24)
		Taxation of capital gains on shares – short term Chen *et al.* (2002, p. 24)
		Taxation of dividends – Top marginal rates of dividend income Chen *et al.* (2002, p. 17)
		Taxation of dividends – Top tax rate for the self-employed Chen *et al.* (2002, p. 17)

Data sources and Internet links for indicators

Baldwin (2002), "The Importance of Entry to Canadian Manufacturing with an Appendix on Measurement Issues", OECD Working Paper 2002/3.

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World Bank (2002), Financial Structure and Economic Development Database, at www.worldbank.org/research/projects/finstructure/database.htm.

World Bank (2003), Doing Business, at http://rru.worldbank.org/DoingBusiness.

Performance indicators for ICT	
ICT investments	ICT use
The contribution of investment in ICT capital to GDP growth: Colecchia and Schreyer (2001) and Van Ark *et al.* (2002a).	Business using the Internet: OECD (2002a, p.51)
ICT investment as a percentage of fixed capital formation: OECD (2004, p. 10)	Business ordering over the Internet: OECD (2002a, p.50)
	Number of PC per 100 white collar workers: OECD, based on data from IDC, Eurostat, US Bureau of Labor Statistics, and ILO
	Number of workers using computers for work per 100 workers: Eurobarometer, November 2001
	Pick-up in productivity growth in the ICT-using services: Own calculation based on Pilat *et al*. (2002)
Access to ICT	
Expenditures on ICT	Competition in communication markets
ICT goods and services as a percentage of total household consumption: OECD (2002a, p. 13)	Public telecommunication investment per capita: OECD (2003a, p 94-95)
ICT investment as a percentage of GDP: OECD (2002a, p. 11)	Internet access basket for 40 hours at daytime: OECD (2003a, p 170)
	Internet access basket for 40 hours at evening OECD (2003a, p 171)
	Composite basket of residential telephone charges: OECD (2003a, p 158-160)
	Composite basket of business telephone charges: OECD (2003a, p 158-160)

Access to ICT skills and organisational change[1]		
Basic and applied ICT in schools	Basic and applied ICT skills in the workforce	Professional ICT skills
Number of personal computers per 100 students: OECD(2002b, p. 194)	Share of workers having computer training: eEurope (2002c)	Share of computer workers in total workforce: OECD (2002b, p. 161)
Internet in schools (% of schools connected): eEurope (2002b)	Digital literacy among adults: SIBIS (2003, p. 132)	
Number of Internet computers per 100 pupils: eEurope (2002a)	Expenditures on ICT training per capita: MEA (2002, p. 39)	
Percentage of teachers with computer training: Eurobarometer, (2001a, p. 6)		
Percentage of teachers with Internet training: Eurobarometer, (2001b, p. 6)		

Access to digital content	
E-government	Private digital content
Online availability of public services: European Commission (2003)	Percentage of business with own Website: OECD (2002a, p. 49
Online sophistication of public services: Cap Gemini Ernst & Young (2003)	Number of Web sites in July 2000: OECD (2001b, p. 73)
Implementation of eGovernment: Accenture (2003)	Internet hosts per 1000 inh., 2002: OECD (2002b, p. 189)
	Secure Web servers per million inh. 2001: OECD(2003b, p.83)

1. No indicators exist for ICT-related managerial and organisational change.

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Performance indicators for development and exploitation of S&T	
New products, processes, services and systems	Technology diffusion
Number of patents in "triadic" patent families per million population, 1998: OECD (2004a, p. 38)	Qualitative evaluation of firm-level technology absorption : WEF (2002 variable 10.04)
Share of firms introducing new or technologically improved products or processes on the market, 1998-2001: OECD (2001, p. 57), Eurostat (2004, part 2)	Qualitative evaluation of firm-level production process sophistication WEF (2002 variable 3.01)
Qualitative evaluation of capacity for obtaining new technology: WEF (2002 variable 3.03)	Technology payments to foreign countries as % of trade: OECD, (2003a, p.128)
Qualitative evaluation of revenue generation by firm-level innovation: WEF (2002 variable 3.02)	
Qualitative evaluation of non-technical introduction of new products and processes – Branding; : WEF (2002 variable 10.03)	
Qualitative evaluation of non-technical introduction of new products and processes – Design: WEF (2002 variable 10.05)	

Demand
Government procurement of advanced technology products: WEF (2003, variable 3.10): Buyers sophistication: WEF (2003, variable 9.01) : Presence of demanding regulatory standards: WEF(2003, variable 9.04)

Access to human resources		
	Tertiary type A graduates in science and related disciplines: OECD (2003b, p. 60) % of labour force with tertiary education, 2001: (OECD 2002h, p. 54) PhD graduation rates in all fields, 2001 (OECD 2003b, p. 51) PhD graduation rates in science, engineering and health, 1999: (OECD databases) Expected number of years in tertiary education: (OECD 2003b, p. 268) Expected years of education in the population: OECD (2003b, p.257)	

Access to finance	
Subsidies and tax incentives	Venture capital
Tax incentives to R&D (small firms): OECD (2003a, p.43)	Venture capital (early stage) as share of GDP: OECD (2004a, p.8)
Tax incentives to R&D (large firms): OECD (2003a, p.43)	Venture capital (expansion stage) as share of GDP: OECD (2004a, p.8)
Government financed share of business R&D: OECD Database – Main Science and Technology Indicators	Share of high-technology sectors in total venture capital investment: OECD (2004a, p.10)

Effectiveness of market process		
	Implicit barriers to trade and investment: Nicoletti et al. (1999, p.76) Explicit barriers to trade and investment: Nicoletti et al. (1999, p.76) Barriers to competition: Nicoletti et al. (1999, p. 75)	

Public research		
Level	Relevance	Quality
R&D performed by the higher education and government sector as a percentage of GDP:(OECD, 2003a, p. 31)	Scientific papers cited in US patents: (OECD, 2004a, p.17)	Number of scientific publications per million population, 1999 : (National Science Board 2002, pp.39 and appendix table 5-50)
Government researchers pr. 10 000 labour force: (OECD, 2003a, p. 31)	Number of scientific and technical articles published in industry-related periodicals: (OECD, 2000, p. 173).	Relative prominence of scientific literature : (National Science Board 2002, Appendix table 5-52)
Government R&D budgets as a percentage of GDP : (OECD, 2004a, p. 14)		Quality of Science Research Institutions: WEF(2003, variable 3.05)
Science industry links	Access to best business practices	Network, collaboration and cluster
Share of firms with co-operation agreements with government or higher education (1994-1996). CIS-II survey: (OECD, 2001, p. 29)	Local availability of specialized research and training services: WEF (2003, indicator 9.10)	Extent of Product and Process Collaboration : WEF (2003, 9.07)
Business funding of public research as a share of GDP. : OECD (2004b, p. 17)).	Local availability of specialized IT services: WEF (2003, indicator 9.11)	State of cluster development : WEF (2003, 9.06)
Incubators per million populations: DG Enterprise (2002, p. 2)		Local supplier quality : WEF (2003, 9.03)
University/industry research collaboration: WEF (2003, indicator 3.09)		Cooperation about innovation among firms : Eurostat (2001, p. 74)

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Performance indicators for enhancing human capital and realising its potential	
Stock of knowledge workers	Organisational and managerial practices
Share of employees in high-skill jobs: OECD (2002b, p. 19)	Willingness to delegate authority to subordinates: WEF (2003 indicator 10.13)
Private sector researchers per 10 000 labour force: OECD (2003c, p.57).	Share of employees managed by objectives: Eurofond (2000, p. 26)
Per cent of population aged 16-65 at literacy level 4/5: Own calculation based on OECD (2000c. p.37).	Adaptability to market changes: IMD (2002, indicator 3.4.01)
	Quality of domestic managers: IMD (2002, indicator 3.2.19)

Access to highly educated			
Educational attainment	Support to education	The learning environment	Links between education and labour markets
Graduates with tertiary-type A in Science and related qualifications as a % of all tertiary type A graduates: OECD (2003c, p. 60)	Public subsidies to students for tertiary education as a % of total expenditure on education: OECD, (2003c, p. 237)	Survival rates in tertiary education: OECD (2003c, p.52)	Youth unemployment rate compared to overall level: (OECD, 2003b, p.304) normalised with overall unemployment from same publication
Expected years of education in the population: OECD (2003c, p.257)	Expenditure on tertiary educational institutions per student in USD PPPs: OECD, (2003c, p.197)	Ratio of students to teaching staff in all tertiary public and private institutions: OECD, 2003c, p.330	Unemployment rates of people with tertiary education compared to overall level: (OECD, 2003b, p.316) normalised with overall unemployment from same publication
% of labour force with tertiary education, 2001: (OECD 2002a, p.54)			
Expected number of years in tertiary education: (OECD 2003c, p. 268)			
PhD graduation rates in science, engineering and health, 1999: (OECD databases)			
PhD graduation rates in all fields,2001: (OECD 2003c, p. 51)			
Access to training/life long learning in the workplace			
	Tax treatment of training – after-tax returns to training relative to bank deposit: OECD, 2001a Public expenditure as % of GDP on labour market training: OECD Database on Labour Market Policies Levels/rates of expected lifelong training, cumulative hours, 1994/95: OECD, 1999b, p. 157 Participation rates in continuous education and training: OECD, 2002a, 251 Participation of labour force in lifelong learning: SIBIS Indicator 144 Employee training is/is not a high priority in your country: IMD 2002, 3.2.09 Adult share of formal education enrolments: OECD, 2001b, p. 146 Availability of specialized research and training services: WEF 2002, indicator 9.1		

Access to knowledge-based management and organisation	
Availability of skilled managers	Precondition for organisational change
Quality of management schools: WEF 2003, indicator 10.16	Share of workers who have possibility to discuss organisational change: Eurofond (2000, p. 26)
Availability of senior managers: IMD 2002, indicator 3.2.20	Employee participation in decision making: SIBIS, indicator No. 30
Availability of managers with international experience: IMD 2002, indicator 3.2.19	Worker motivation: IMD 2002, indicator 3.2.07
% of CVT hours spent on management and administration: EU (2002, p 88-89)	Co-operation in labour-employer relation: WEF 2003, indicator 10.21

Knowledge-based labour markets		
International worker mobility	Workforce participation of underrepresented groups	Flexible work arrangements through flexible labour markets
International mobility of HRST: OECD, 2003c, p. 59	Employment/population ratios of women with tertiary education: OECD, 2003b, p. 316	Flexibility of hiring/firing: World Bank 2003
Foreign highly skilled workers: IMD, 2002 indicator 3.2.18	Gender gap employment rate: OECD, 2002a, p. 74	Conditions of employment: World Bank 2003
Foreign students in university-level education as % of total enrolment: OECD, 2003c, p. 281	Women's participation relative to men: WEF 2003, indicators 3.13	Discretion of starting and finishing times at work: SIBIS, indicator No. 32
	Minority participation relative to other groups: WEF 2003, indicator 3.14	% of employees reporting that they work flex-time: OECD, 2001c, p. 149
		Extent of incentive compensation: WEF 2002, indicator 10.14
		University/industry research collaboration: WEF 2002, indicator 3.09

Data sources and Internet links for indicators

EU (2002), European Social Statistics Continuing vocational training survey, Theme 3, Eurostat, European Commission.

Eurofond (2000), Third European survey on working conditions 2000, European Foundation for the Improvement of Living and Working Conditions, www.eurofound.eu.int/publications/files/EF0121EN.pdf.

IMD (2002), *World Competitiveness Yearbook 2002*, at www01.imd.ch/wcy/.

OECD (1999a), *Education at a Glance*, OECD, Paris.

OECD (1999b), *Employment Outlook*, OECD, Paris.

OECD (2000), *Literacy in the Information Age*, OECD and Statistics Canada

OECD (2001a), "Intangible Investment, Growth and Policy," DSTI Working Paper.

OECD (2001b) *Education Policy Analysis*, OECD, Paris.

OECD (2001c), Employment Outlook, Paris

OECD (2002a), *Education at a Glance*, OECD, Paris.

OECD (2002b), "Measures of Skill From Labour Force Surveys – An Assessment", DSTI/EAS/IND/SWP(2002)13.

OECD (2003a), *Education at a Glance*, OECD, Paris.

OECD (2003b), *Employment Outlook*, OECD, Paris.

OECD (2003c), *Science, Technology and Industry Scoreboard of Indicators*, Paris.

SIBIS, Statistical Indicators Benchmarking the Information Society, at www.empirica.biz/sibis/statistics/stat_ind.htm.

World Economic Forum (2003), *Global Competitiveness Report 2003*.

Annex B

SENSITIVITY ANALYSIS

Entrepreneurship

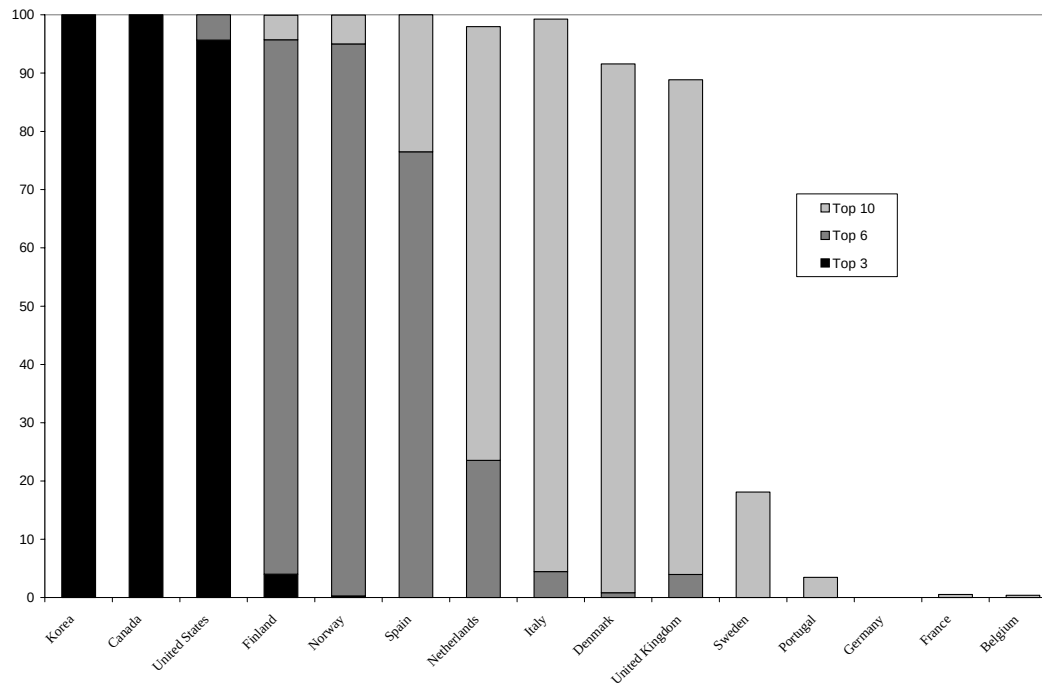
The results in the driver "fostering firm creation and entrepreneurship" are robust to changes in weights, included variable and analytical method. The two main conclusions can be summarised as:

- The link between the weighted average of performance indicators and the business environment indicators are always significant regardless of weights.
- The important policy areas for this driver fall in two groups. All types of analysis confirmed the importance of venture capital, bankruptcy and entrepreneurship education. An additional five policy areas (income and capital taxes, stock markets, simplification for start-ups, business service and loan and loan guarantees) were also identified as important by one of the method of analysis.

Selection of benchmark countries

The section on selection of benchmark countries questioned whether the data from the Global Entrepreneurship Monitor were true performance indicators and did not include them. Including the data only has a limited effect on the selection of countries (Figure B1). The two distributions are almost identical and the correlation between the median values in each distribution is 0.98.

Figure B1. Probability of having a given rank with random assigned weights

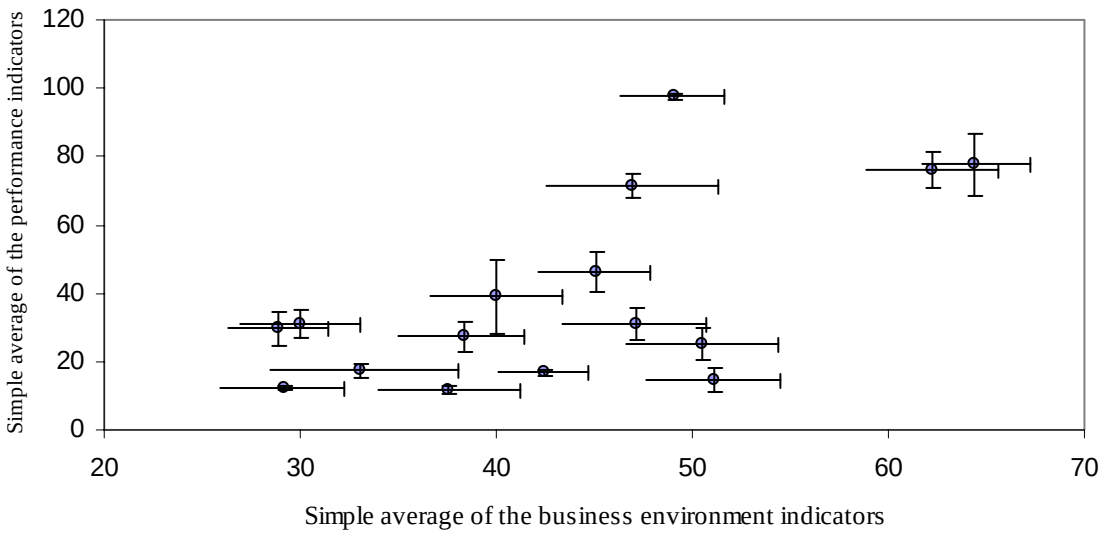


Note: The distribution is based on the following indicators: *i)* Firm entry rates, average 1998-2000; *ii)* entrepreneurial activity from GEM (2003); *iii)* share of young firms with more than 60% growth rates in a two-year period, 1999-2002; and *iv)* change in employment from 1998 to 1999 in new firms.

Link from business environment to performance

The correlation between the simple average of the business environment indicators and the simple average of the performance indicators is confirmed even when the variation in the randomly calculated indexes is taken into account. Regression analysis was performed on 10 000 combinations of the random business environment index and the 10 000 combinations of the random performance index. The error bars show 95% of the possible values of the composite indicator based on 10 000 randomly generated indexes for both of the indexes (Figure B2).

Figure B2. Correlation between business environment and performance with randomly assigned weights



Note: The bars show the 95% confidence interval for the index based on 10 000 random weights between 0 and 1 for each indicator.

The correlation between the business environment and performance indicators varied between 0.43 and 0.74 in the 10 000 different indexes (Table B1). The correlations are significantly different from zero at least at the 10% level in all cases, which suggest very robust results.

Table B1. Test for correlation between environment and performance with 10 000 randomly assigned weights

	Correlation	R^2	Corresponding t-value	Corresponding p-value for a two - sided t-test	Corresponding p-value for a one-sided t-test
Lowest possible	0.430	0.185	1.782	0.095	0.048
Lowest 5%	0.550	0.302	2.463	0.026	0.013
Median	0.616	0.380	2.929	0.010	0.005
Highest 95%	0.679	0.461	3.460	0.003	0.002
Highest possible	0.738	0.545	4.097	0.001	0.001

Selection of the most important areas of the business environment

Correlation analysis confirms the relative importance of three of the areas identified in the benchmark analysis (entrepreneurial education, venture capital, bankruptcy). The area of loan and loan guarantees is not significantly correlated with performance even though the benchmarking analysis showed this area as important (Table B2). This is mainly due to very low spread in the capital market indicators, combined with a relative large spread in the performance indicators and two extreme outliers in the data. The Netherlands has a much better capital market than their entrepreneurship performance suggests and the contrary is true for Korea. Finally, the correlation analysis also shows a strong correlation between stock markets and performance, which was not found in the benchmarking analysis.

Table B2. Correlations between the policy areas and performance

	R^2	t-value	0.01	0.05
Business environment for entrepreneurship	0.37	3.04	Yes	Yes
Entrepreneurial education	0.61	4.98	Yes	Yes
Venture capital	0.59	4.82	Yes	Yes
Stock markets	0.56	4.52	Yes	Yes
Bankruptcy	0.36	3.03	Yes	Yes
General legal framework	0.19	1.96		
Incubators, spin-offs and licensing	0.18	-1.86		
Wealth and bequest tax	0.08	1.22		
Deregulating protected sectors	0.07	1.12		
Business taxes	0.05	-0.91		
Labour market regulation	0.04	0.87		
Income and capital taxes	0.04	0.79		
Legal framework for start-ups	0.01	0.42		
Loans and guarantees	0.00	0.03		

Note: The t-test is a two-sided test for whether the slope of the regression is significantly different from zero.

Again, including the data from the Global Entrepreneurship Monitor (GEM) has a limited impact on the results. Four of the five significant areas are still significant. Bankruptcy becomes insignificant, as the only available data on Japan are from the GEM, where Japan is the worst performer. Japan consequently gets a zero value for performance. Bankruptcy becomes significant again if Japan is removed or if only countries with data from two sources are included in the analysis. Income and capital taxes become significantly correlated with performance if the GEM data are included.

The next step in the correlation analysis is to move to the indicators level. This analysis shows that ten of the 41 indicators are statistically significantly correlated with performance (Table B3). The significant indicators cover capital markets, bankruptcy, simplification for start-ups and taxes.

Table B3. Correlation analysis of indicators of business environment and performance

			Statistically significantly different from 0 in a two-sided t-test	
	R^2	t-value	1% level	5% level
Newly listed companies in secondary stock market per 1 million Inhabitants (5-year average)	0.60	4.90	Yes	Yes
Early stage venture capital (% of GDP)	0.55	4.41	Yes	Yes
Interest rate spread (%)	0.43	3.50	Yes	Yes
% high-technology sectors in total venture capital investment	0.37	3.08	Yes	Yes
Expansion-stage venture capital (% of GDP)	0.35	2.91	Yes	Yes
Share of SMEs with subsidiaries/branches/joint ventures located abroad	0.33	2.80		Yes
Length of time that creditors still have claims on a bankrupt's assets	0.32	2.77		Yes
Starting a business cost	0.31	-2.70		
Average income tax plus social contribution	0.31	2.65		Yes
Goals-of-Insolvency Index	0.28	2.49		Yes

Note: Only significant indicators are shown. The performance measure is the simple average of the following indicators: start-up rates (Eurostat data and national data), number of persons employed in new and surviving enterprises (Eurostat), employment growth in a enterprise born in 1998 surviving to 1999 (Eurostat), number of persons employed in newly born and surviving enterprises (OECD data), growth among young firms based on turnover (Amadeus data) and growth among young firms based on employment (Amadeus data).

An alternative approach is to explore the sectoral aspect of the Eurostat start-up rate data (Brandt, 2004b). This approach confirms the importance of two indicators (regulatory and administrative opacity; length of time that creditors have claims on a bankrupt's assets). The analysis uses a two-step estimation method. In the first step, firm entry rates are regressed on industry and time dummies and on country-specific ICT industry dummies to account for the cross-industry variation in entry rates and for specifics of the ICT sector. The coefficients of the industry dummies – often referred to as fixed effects – express how much, in terms of percentage points, the average entry rate in an industry differs from that in a reference sector. Correspondingly, the country-specific ICT industry effects express how much the average entry rate across ICT industries differs for each country from that in a reference country. Because of the inclusion of these country-specific ICT industry effects, the residuals of the first-step estimation should mainly capture the cross-country variation of entry rates in non-ICT related sectors. Country dummies are not included in the first-step estimation because the idea is that the regulatory variables should explain the observed cross-country variation in entry rates in the second step. In the second step, residuals from the first step are regressed on the various indicators.

Expanding the analysis to a multi-variant regression analysis is difficult owing to the low number of countries with performance data. The degrees of freedom consequently become too low when adding explanatory variables. Only 16 countries have performance data so adding the four main areas in the business environment will reduce the degrees of freedom to 12. This makes the regression results questionable. A regression that includes all 12 policy areas would be impossible owing to lack of degrees of freedom.

A regression with the four main areas (providing skills, providing capital, providing opportunities and influencing the risk-reward trade-off) explains 66% of the variation in the performance. However, only providing capital is significantly different from zero (Table B4). The coefficient for capital is very stable in the sequential removal of the least significant areas. It remains in the 1.87-1.88 range as long as one of the other areas is included. This confirms the importance of providing capital, but,

given the low degrees of freedom, the relative importance of the four areas should not be overemphasised.

Table B4. Summary output

Multiple R	0.81			
R^2	0.66			
Adjusted R^2	0.53			
	Coefficients	Standard error	t stat	p-value
Intercept	-89.63	34.90	-2.57	0.03
Providing skills	0.00	0.37	-0.01	0.99
Providing capital	1.89	0.71	2.67	0.02
Providing opportunities	0.00	0.72	0.00	1.00
Influencing the risk-reward trade-off	0.54	0.64	0.85	0.42

ICT

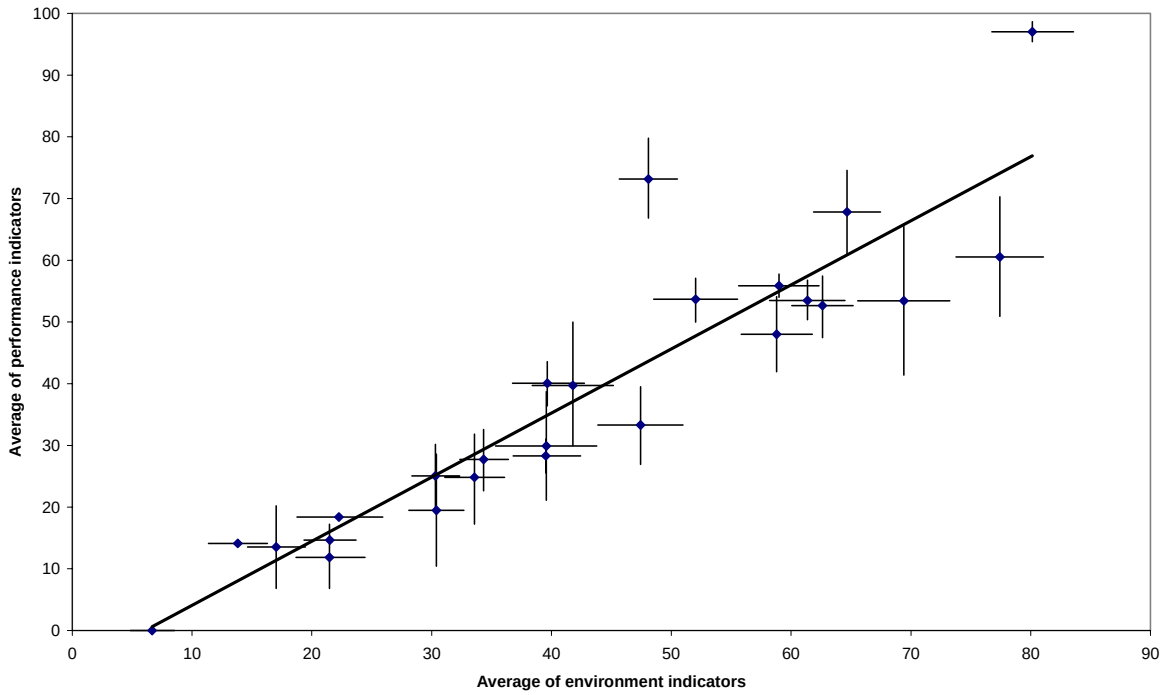
This section examines the links from the business environment to performance and the selection of the most important policy areas. The two main conclusions of the sensitivity analysis can be summarised as:

- The link between the weighted average of performance indicators and the business environment indicators is always significant regardless of the weights used to construct the weighted average of performance and environment indicators.
- Four policy areas (supply conditions, ICT in schools. private content and e-government) are identified as most important. Three of these areas (supply conditions, ICT in schools and e-government) are very robust to changes in weights, countries included and method of analysis. The fourth identified policy area (private content) is more sensitive to changes in weights in the benchmarking method but is strongly correlated with performance in the regression analysis and is consequently viewed as one of the four most important areas.

Link from business environment to performance

The correlation between the simple average of the business environment indicators and the simple average of the performance indicators is confirmed even when the variation in the randomly calculated indexes is taken into account. Regression analyses have been performed on 10 000 combinations of the random business environment index and the 10 000 combinations of random performance index. The error bars show 95% of the possible values of the composite indicator based on 10 000 randomly generated indexes for both of the indexes (Figure B3).

Figure B3. Correlation between business environment and performance with randomly assigned weights



Note: The bars show the 95% confidence interval for the index based on 10 000 random weights between 0 and 1 for each indicator.

The correlation between the business environment and performance indicators varies between 0.78 and 0.95 in the 10 000 different indexes. The correlations are significantly different from zero at the 0.1% level in all cases, which suggest very robust results (Table B5).

Table B5. Test for correlation between environment and performance with 10 000 randomly assigned weights

	Correlation	R^2	Corresponding t-value	Corresponding p-value for a two sided t-test	Corresponding p-value for a one sided t-test
Lowest possible	0.782	0.611	5.603	0.000	0.000
Lowest 5%	0.858	0.736	7.472	0.000	0.000
Median	0.904	0.816	9.431	0.000	0.000
Highest 95%	0.930	0.865	11.296	0.000	0.000
Highest possible	0.948	0.898	13.294	0.000	0.000

Selection of the most important areas of the business environment

Simple correlation analysis between the areas and the performance indicators shows a high degree of correlation for all areas (Table B6). It is only expenditures on ICT that are not significantly correlated with the performance indicators. All other areas are highly correlated. The highest correlation is found in ICT in schools and private digital content, which is also among the most important in the benchmarking analysis. The only surprise is that the area of IT workers is more highly

correlated with both measures of performance than e-government. The benchmarking analysis showed that e-government was more important.

Table B6. Correlations between the policy areas and performance

	Correlation			Corresponding t-vales		
	All performance indicators	ICT investment	ICT use	All performance indicators	ICT investment	ICT use
Simple average of the business environment indicators	0.74	0.36	0.91	5.74	2.03	11.28
ICT skills in schools	0.83	0.72	0.76	6.03	4.13	4.67
Private digital content	0.78	0.49	0.90	6.36	2.86	10.36
IT workers	0.71	0.58	0.80	3.79	2.69	4.94
Competition in communication markets	0.65	0.46	0.70	4.41	2.69	5.09
Adult ICT skills	0.61	0.51	0.70	3.51	2.75	4.53
E-government	0.61	0.26	0.68	3.96	1.42	4.87
Expenditure on ICT	0.36	0.08	0.38	1.98	0.39	2.14

Multiple-regression analysis does not add much, although it can be used to reduce the number of important areas by excluding the least significant policy areas stepwise. The first regression included all eight areas and the following regressions drop the least significant area one by one (Table B7). After seven regressions only private digital content is significant, mainly because of the very high correlation between ICT use and private digital content. The regression is repeated without private digital content. This leads to a similar elimination and competition in communication markets becomes the only significant policy area. The multi-variant regression analysis therefore does not add much to the prioritisation of the areas, but it does confirm the importance of private digital content and competition in communication markets.

Table B7. Multi-variant regression

	1	2	3	4	5	6	7
Adjusted r^2	0.57	0.54	0.57	0.59	0.60	0.61	0.59
Intercept	-0.22	0.00	-0.08	-0.07	-0.09	0.23	3.14
Private digital content	2.82	2.87	3.03	3.13	3.31	3.60	5.85
Competition in communication markets	0.98	0.52	0.61	0.71	1.33	1.37	
Expenditure on ICT	0.63	0.77	0.73	0.73	0.88		
E-government	0.48	0.65	0.75	0.65			
ICT skills in schools	0.21	-0.11	-0.42				
IT workers	-0.17	-0.31					
Adult ICT skills	-1.21						

Fostering development and exploitation of science and technology

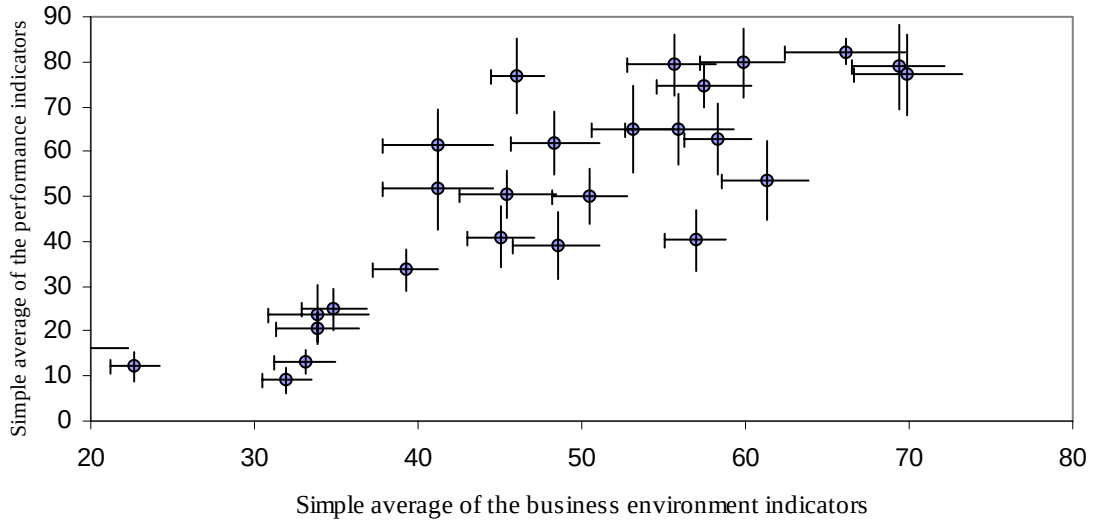
The results in the driver of fostering development and exploitation of science and technology are robust to changes in weights, included variable and analytical method. The two main conclusions can be summarised as:

- The link between the weighted average of performance indicators and the business environment indicators is always significant regardless of weights.
- Four policy areas (enhancing the quality of public research, promoting industry-science links, fostering collaborative networks and clusters, stimulating demand for new products, processes and services) are identified as potentially the most important. Three of these (quality of public research, network and clusters and demand) are very important in all types of analysis, whereas industry-science links are very important in the qualitative approach and the regression analysis.

Link from business environment to performance

The correlation between the simple average of the business environment indicators and the simple average of the performance indicators is very high (0.9). This high correlation is confirmed even when the variation in the randomly calculated indexes is taken into account. Regression analyses were performed on 10 000 combinations of the random business environment index and the 10 000 combinations of random performance index. The error bars show 95% of the possible values of the composite indicator based on 10 000 randomly generated indexes for both of the indexes (Figure B4).

Figure B4. Correlation between business environment and performance with randomly assigned weights



Note: The bars show the 95% confidence interval for the index based on 10 000 random weights between 0 and 1 for each indicator.

The correlation between the business environment and performance indicators varied between 0.75 and 0.91 in the 10 000 different indexes (Table B8). The correlations are significantly different from zero at least at the 1% level in all cases, which suggests very robust results.

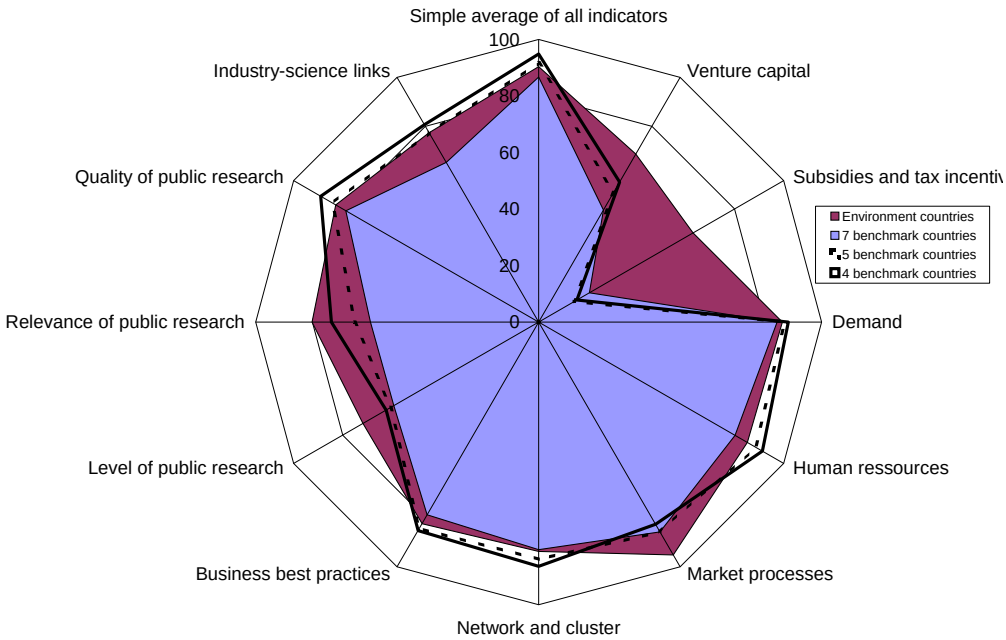
Table B8. Test for correlation between environment and performance with 10 000 randomly assigned weights

	Correlation	R^2	Corresponding t-value	Corresponding p-value for a two-sided t-test	Corresponding p-value for a one-sided t-test
Lowest possible	0.748	0.560	4.221	0.0	0.0
Lowest 5%	0.818	0.669	5.317	0.0	0.0
Median	0.858	0.736	6.247	0.0	0.0
Highest 95%	0.887	0.786	7.169	0.0	0.0
Highest possible	0.914	0.835	8.410	0.0	0.0

Selection of the most important sub-areas of the business environment

The benchmarking analysis shows that for five of the areas the distance is very short between the average of the seven top performing countries and the seven countries with the highest values for that particular part of the environment (demand, human resources, network and clusters, business best practices and quality of public research). These five are followed by market processes and industry-science links, where the distance is also quite small. The last four areas have much larger differences between the top seven performance and the top seven environment.

Figure B5. Selection of the most important areas when the selection of top performing countries is changed



The analysis shows some variation among the seven benchmark countries (Finland, Germany, Japan, the Netherlands, Sweden, Switzerland and the United States). Similar calculations were therefore done for five benchmark countries (Finland, Germany, Sweden, Switzerland and the United States) and four benchmark countries (Finland, Sweden, Switzerland and the United States) (Figure B5). These calculations show that the most important areas (demand, human resources, network and clusters, business best practices and quality of public research) are very robust to changes

in the countries included. The areas have been chosen for all seven, five and four benchmark countries.

Only industry-science links are affected by changing the benchmark countries. Japan has weak formal industry-sciences links, whereas the six other benchmark countries have relatively strong links. Removing Japan from the list of benchmark countries consequently make the area important in the benchmark analysis. This suggests the need for more analysis to determine the relative importance of industry-science links and the benchmarking evaluation of this area should not be overemphasised.

Simple correlation analysis of each of the policy areas and the average of the performance indicators shows that ten of the 11 areas have a correlation that is statistically significantly different from zero with the simple average of the performance indicators at least at the 5% level (Table B9). Only subsidies and tax incentives are insignificant. This confirms the standard results of the national innovation systems literature that all areas are important for exploitation of science and technology and technology diffusion. The most important areas based on the simple correlation are networks and clusters, demand and quality of public research. Further regression analyses performed at the indicator level confirm the high correlation as only seven indicators have a correlation with performance that is not statistically significantly different from zero (Table B10).

Table B9. Summary of the regression results

	Correlation with simple average of			Corresponding t-values		
	All performance indicators	Performance indicators for new products, processes	Performance indicators of technology diffusion			
Business environment	0.90	0.87	0.89	***10.29***	***8.80***	***9.99***
Networks and clusters	0.94	0.93	0.91	***13.79***	***12.48***	***11.26***
Demand	0.91	0.90	0.88	***11.11***	***10.39***	***9.54***
Quality of public research	0.90	0.89	0.87	***10.57***	***10.00***	***9.13***
Business best practices	0.84	0.84	0.81	***7.95***	***7.83***	***7.04***
Human resources	0.79	0.74	0.80	***6.48***	***5.67***	***6.69***
Level of public research	0.73	0.72	0.72	***5.57***	***5.33***	***5.33***
Industry-science links	0.56	0.49	0.61	***2.88***	***2.38***	***3.31***
Market processes	0.51	0.49	0.50	***2.95***	***2.84***	***2.88***
Venture capital	0.50	0.43	0.55	***2.87***	*2.35*	***3.32***
Relevance of public research	0.45	0.37	0.50	*2.31*	1.85	*2.66*
Subsidies and tax incentives	-0.30	-0.32	-0.27	-1.45	-1.54	-1.31

Note: All t-values in bold and italics are significantly different from zero at the 1% level, all t-values in italics are significantly different from zero at the 5% level.

Table B10. Summary of the regression results at the indicator level

	Correlation with			Corresponding t-values for		
	Simple average of all performance indicators	Simple average of indicators for new products, processes	Simple average of indicators for diffusion	All performance indicators	New products	Diffusion
Product designs are developed locally	0.92	0.95	0.86	12.36	15.12	8.59
Extent of branding (WEF 10.03)	0.92	0.95	0.85	11.85	15.60	8.06
Private research and links	0.91	0.87	0.91	11.04	9.18	10.87
Buyer sophistication (WEF)	0.90	0.90	0.87	10.60	10.25	8.95
Relative prominence of scientific literature (relative citation index)	0.89	0.89	0.85	10.03	10.08	8.32
Quality of Scientific Research Institutions (WEF)	0.89	0.85	0.88	9.70	8.33	9.55
Local supplier quality (WEF)	0.88	0.89	0.82	9.24	9.97	7.36
Number of patents in the "triadic" patent families per million population	0.85	0.85	0.81	8.52	8.61	7.33
Presence of demanding regulatory standards (WEF)	0.84	0.84	0.81	8.06	8.05	7.02
Local availability of specialised research and training services (WEF)	0.84	0.84	0.80	7.83	8.03	6.69
Extent of product and process collaboration (WEF)	0.83	0.86	0.76	7.63	8.66	6.03
Local availability of information technology services (WEF)	0.83	0.82	0.81	7.60	7.22	7.03
Continuous innovation plays a major role in generating revenue	0.83	0.87	0.75	7.52	8.96	5.74
University/industry research collaboration (WEF)	0.81	0.74	0.85	7.10	5.64	8.33
Government procurement of advanced technology products (WEF)	0.79	0.76	0.79	6.54	5.96	6.48
PhD graduation rates in all fields, 2001	0.78	0.77	0.76	6.21	5.96	5.80
Share of firms introducing new or technologically improved products or processes	0.77	0.76	0.74	5.29	5.09	4.80
R&D performed by higher education and government as % of GDP	0.74	0.71	0.74	5.70	5.28	5.64
GBAORD as percentage of GDP by civil/defence	0.71	0.74	0.65	5.35	5.89	4.48
Scientific and technical articles per million population	0.70	0.71	0.67	5.22	5.26	4.77
State of cluster development (WEF)	0.68	0.67	0.67	4.73	4.55	4.55
Co-operation about innovation among firms	0.68	0.54	0.75	3.04	2.11	3.78
Co-operation between businesses on R&D	0.68	0.54	0.75	3.04	2.11	3.78
PhD graduation rates in science, engineering and health, 1999	0.68	0.66	0.65	4.30	4.07	4.03
Publications in the 19 most industry-relevant scientific disciplines	0.66	0.60	0.69	4.06	3.44	4.35
Average years of education in the population	0.58	0.54	0.60	3.64	3.26	3.82
Venture capital (early stages) as share of GDP	0.54	0.47	0.58	3.17	2.64	3.60
Explicit barriers to trade and investment	0.53	0.51	0.52	3.09	2.96	3.03

Table B10. Summary of the regression results at the indicator level (cont'd.)

	Correlation with			Corresponding t-values for		
	Simple average of all performance indicators	Simple average of indicators for new products, processes	Simple average of indicators for diffusion	All performance indicators	New products	Diffusion
Tertiary Type A graduates in sciences and technology as a share of total tertiary type A graduates	0.47	0.48	0.44	2.49	2.55	2.28
Share of firms with co-operation arrangements with government or higher education institutes	0.46	0.36	0.53	1.93	1.44	2.36
Venture capital (expansion) as share of GDP	0.43	0.39	0.46	2.39	2.10	2.58
Researchers per 10 000 labour force public	0.43	0.38	0.46	2.46	2.12	2.70
Expected years in total tertiary education (type A and B and advanced research programmes)	0.40	0.33	0.46	2.22	1.78	2.61
Percentage of labour force with tertiary education	0.39	0.33	0.43	2.23	1.85	2.54
Implicit barriers to trade and investment	0.38	0.34	0.40	2.05	1.81	2.21
Share of high-technology sectors in total venture capital investment	0.28	0.21	0.34	1.45	1.07	1.80
Technology payment to foreign countries as % of trade	0.27	0.17	0.37	1.32	0.81	1.86
Number of business incubators relative to SMEs	0.26	0.24	0.26	1.03	0.94	1.05
Business-financed R&D performed by higher education (% of GDP)	0.22	0.17	0.26	1.12	0.88	1.35
Barriers to competition	0.15	0.18	0.12	0.78	0.93	0.59
Scientific papers cited in US-issued patents	0.08	0.02	0.13	0.35	0.10	0.59
Government financed share of business R&D	-0.24	-0.19	-0.28	-1.24	-0.97	-1.47
Tax treatment of R&D (small firms)	-0.25	-0.26	-0.24	-1.20	-1.24	-1.11
Tax treatment of R&D (large firms)	-0.35	-0.39	-0.31	-1.73	-1.92	-1.48

More advanced regression techniques based on stepwise elimination of insignificant factors in multi-variant regressions with all of the policy areas show that 92% of the variation in performance among countries can be explained by two factors: quality of public research and networks and clusters (Table B11). This analysis suggests that these two areas are perhaps the most important for policy makers . All other areas become insignificant when entered in a multi-variant regression.

Table B11. Summary of the final step in the multiple regressions with stepwise elimination

R^2	0.929			
Adjusted r^2	0.924			
	Coefficients	Standard error	t-stat	p-value
Intercept	-5.91	3.18	-1.86	0.07
Quality of public research	0.38	0.09	4.19	0.00
Network and cluster	0.68	0.11	6.45	0.00

Human capital

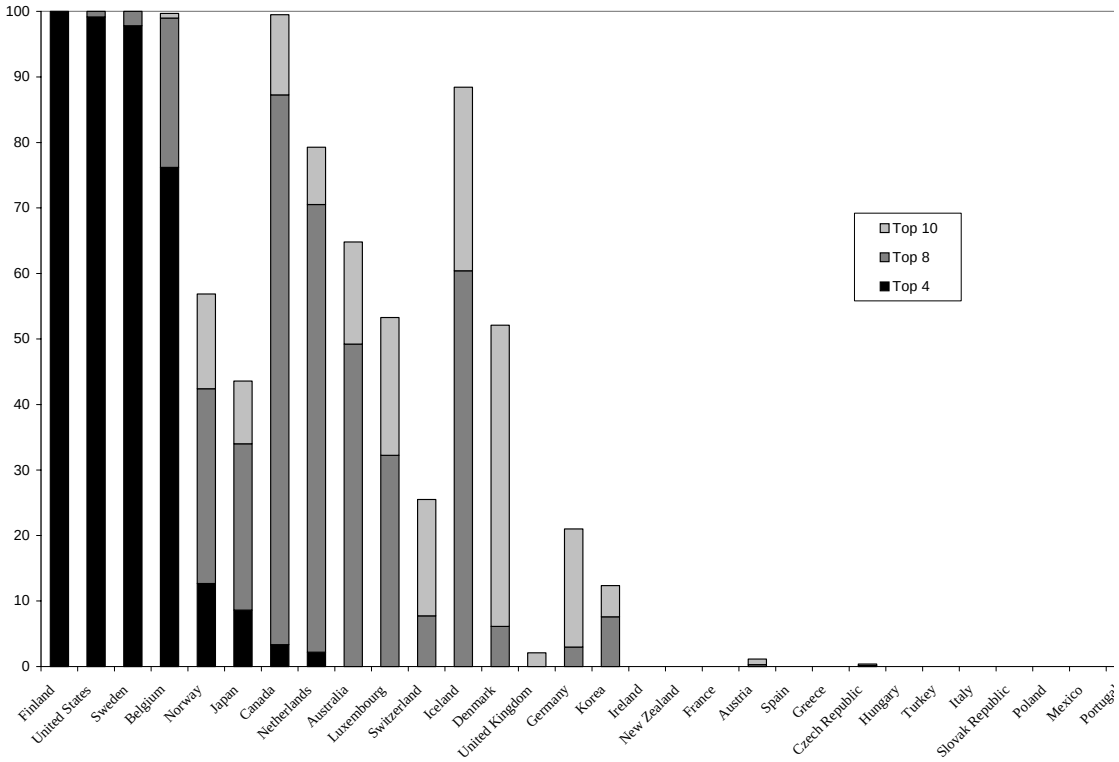
The results in the driver of human capital are robust to changes in weights, included variable and analytical method. The two main conclusions can be summarised as:

- The link between the weighted average of performance indicators and the business environment indicators are always significant regardless of weights.
- The most important policy areas (educational attainment; organisational change and preconditions for organisational change; and incentives to firms and individuals for lifelong learning) are very robust to changes in weights, countries included and method of analysis. The fourth identified policy area (flexible work practices through flexible labour markets), identified as important, is more sensitive to changes in method of analysis.

Selection of countries for further analysis

The selection of benchmark countries is based on random assignment of weights to the various indicators. The section on measuring management practices suggested that these indicators were the least reliable. Removing these indicators from the calculation has no impact on the top three countries (United States, Finland and Sweden) but does suggest that Belgium should be included instead of the Netherlands (Figure B6). Denmark also moves down a bit the ranking and Norway moves up. The other countries have very similar rankings in the two analyses. The correlation between the median in the two distributions based on the random weights with and without the indicators for management and organisation is 0.93. This suggests that the possibly poor quality of the indicators of management and organisation has no effect on the results. However, the sensitivity analysis tests the results for including Belgium instead of the Netherlands as a top-performing country.

Figure B6. Probability of a given rank with randomly assigned weights when only indicators of the stock of human capital are included



Note: Based on *i)* share of employees in high-skill jobs, *ii)* private sector researchers per 10 000 labour force; and *iii)* percentage of the population aged 16-65 at literacy level 4/5.

An alternative to using random weights is to use factor analysis on the seven performance indicators. Factor analysis involves a set of techniques designed to identify order and structure in large data sets with high internal correlation by providing a parsimonious and meaningful explanation for the observed variation and co-variation in the indicators. Factor analysis identifies a set of a few factors or composite indicators that capture the variation of the many underlying indicators. The seven indicators can be explained by one factor, which can explain 64.62% of the total variance among the seven performance indicators (Table B12). Additional factors will not add much explanatory power. The weights vary from 0.10 to 0.19 among the seven indicators, and the final ranking is almost identical to the ranking based on equal weights. None of the benchmark countries has different ranks in the two methods. The correlation between the results from the two methods is 0.99. The selection of countries is consequently very robust to changes in weights.

Table B12. Result of the factor analysis

Factor	Eigen value	Var. explained	Cumulative
1	4.52	64.62%	64.62%
2	0.85	12.20%	76.82%
3	0.58	8.30%	85.12%
4	0.46	6.52%	91.64%
5	0.31	4.44%	96.08%
6	0.17	2.40%	98.48%
7	0.11	1.52%	100.00%

Tests of the robustness of the business environment results

The ranking of countries with respect to their business environments is based on an implicit assumption of equal weights for each of the indicators. To test the robustness of this ranking, a distribution of possible composite indicators was calculated based on random weights and shows robust results for most countries (Figure B7). Switzerland, Denmark, France and Japan have some variation if all 10 000 outcomes are considered. The distribution figure should not be confused with the confidence interval in the statistical sense, as the values of the composite indicators for the individual countries are highly correlated. The Netherlands might have for example high values for the same weights as Switzerland, which would mean that there is no overlap between the two countries even though the figure shows an overlap. The spread in the figure and the overlap is consequently much larger than if one examines relative rankings of countries. Figure B8 clearly show robust ranking of most countries in their business environment.

Figure B7. Possible spread of the index for ICT business environment

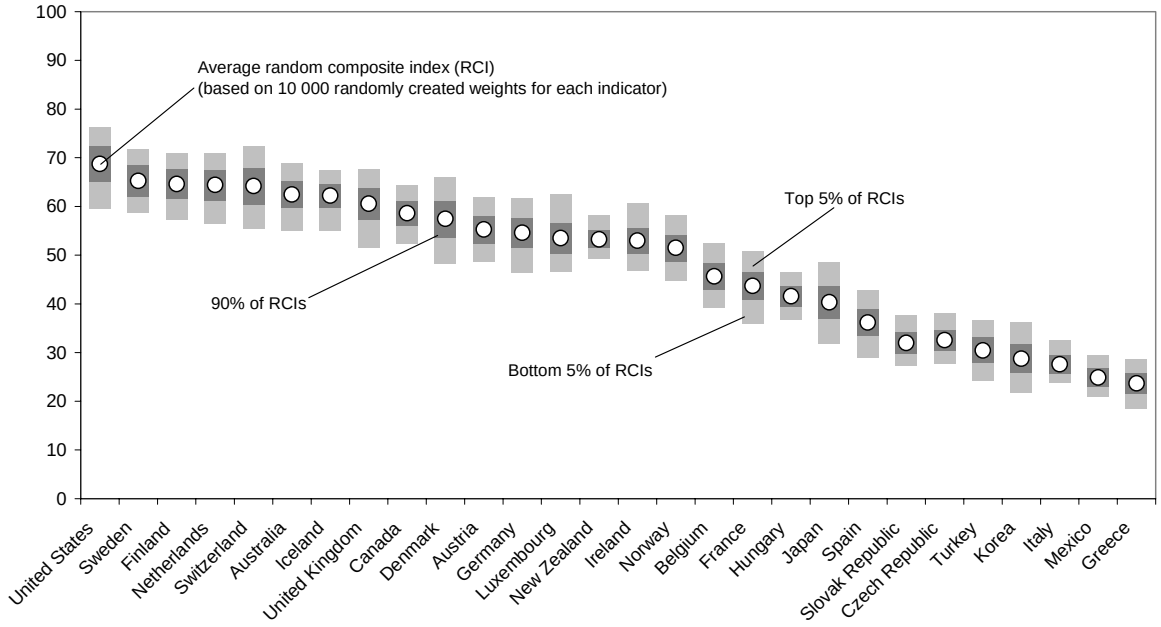
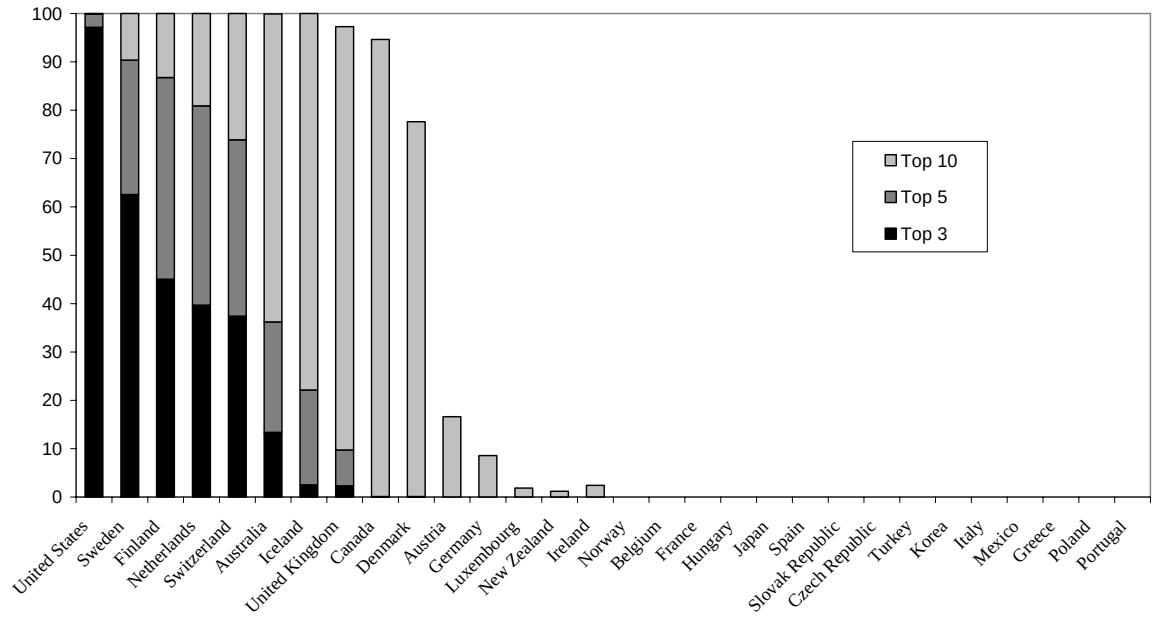


Figure B8. Possible ranking of business environment based on 10 000 randomly generated weights

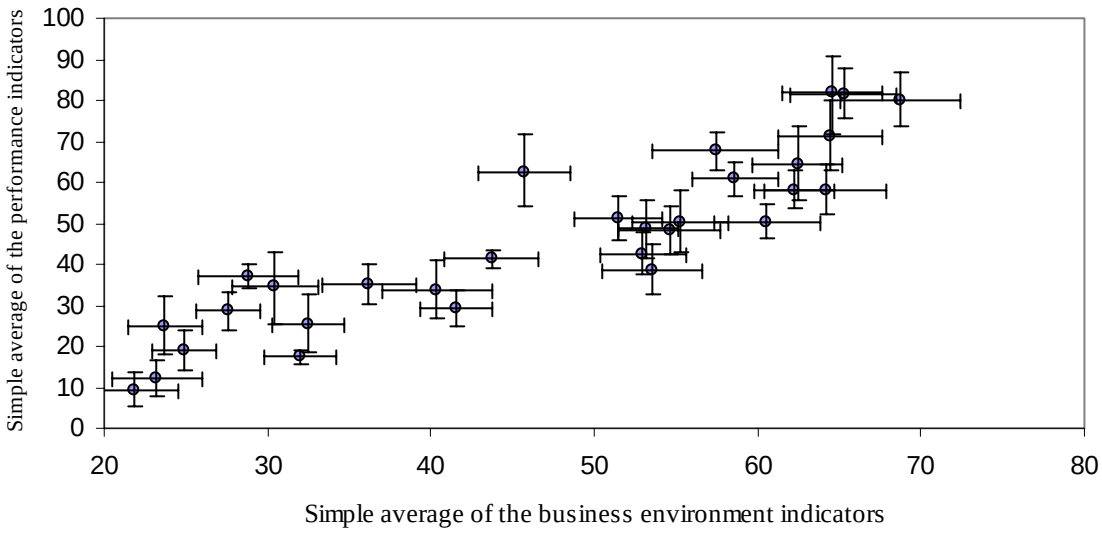


Link between performance and the business environment

The correlation between the simple average of the business environment indicators and the simple average of the performance indicators is confirmed even when the variation in the randomly

calculated indexes is taken into account. Regression analyses were performed on 10 000 combinations of the random business environment index and the 10 000 combinations of random performance index. The error bars show 95% of the possible values of the composite indicator based on 10 000 randomly generated indexes for both of the indexes (Figure B9). The distribution of correlation coefficients between environment and performance has an average of 0.9, and 90% of all coefficients are between 0.85 and 0.91. The average coefficient is significantly different from zero at the 1% level and the 95% lower confidence interval is also significantly different from zero at the 1% level.

Figure B9. Correlation between business environment and performance with randomly-assigned weights

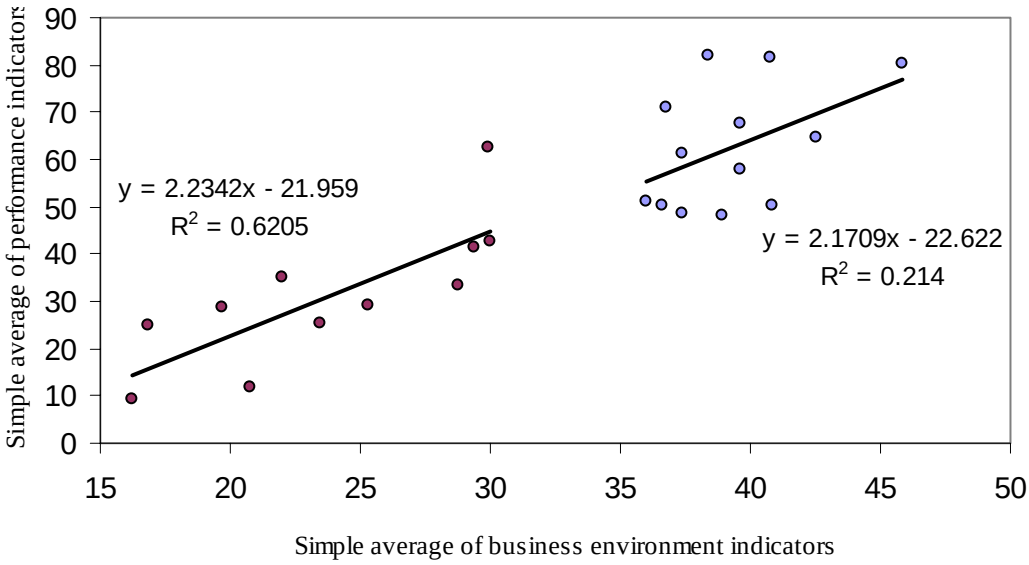


Note: The bars show the 95% confidence interval for the index based on 10 000 random weights between 0 and 1 for each indicator.

The data fall into two groups – countries with an average of the business environment indicators below 30 and countries with an average above 35. Groups like these can make the regression results problematic; however, separate regressions on the two groups shows very similar coefficient results (Figure B10). The two lines have almost identical slope even though they concern the two groups separately. The r^2 is much lower among the top group mainly due to the very good performance of Finland, which is not reflected in an equally good business environment. The United Kingdom, at the other extreme, does not get the full benefit of its business environment.

Very few time series exist for these indicators, so it is not possible to test the correlation for causality. Formal tests like the Granger causality test require time series for all variables in order to test whether changes in the business environment lead to changes in performance, changes in performance cause changes in the business environment, or whether they are determined simultaneously. Consequently, it is not certain, from a statistical point of view, that improvements in the business environment will improve performance, but qualitative arguments support that causality goes from the business environment to performance.

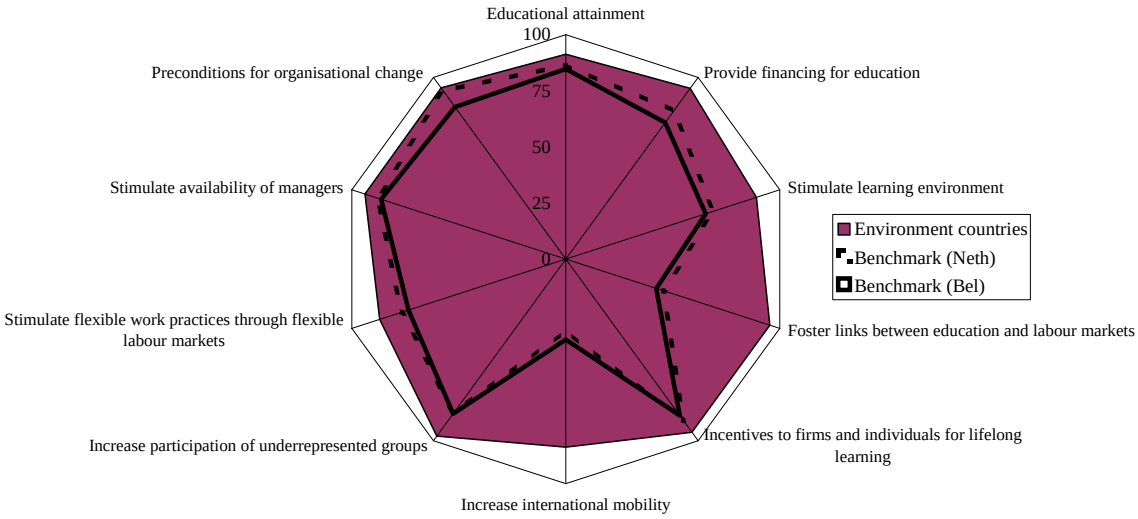
Figure B10. Correlation between business environment and performance



Selection of the most important areas of the business environment

The selection of countries showed that, based on the selection of weights, either the Netherlands or Belgium should be included as a benchmark country. The first sensitivity test is consequently whether the selection of most important policy areas is affected by substituting the Netherlands by Belgium in the calculations. The results are unchanged (Figure B11). The two lines for the benchmark countries when either Belgium or the Netherlands is included are more or less identical.

Figure B11. Benchmarking the business environment for selected countries



Note: The spider diagram compares the average ranking for four countries with the highest ranking on the particular indicator or aspect of the business environment (top four environment) with the average of Finland, the Netherlands, Sweden and the United States (benchmark Neth) and the average of Finland, Belgium, Sweden and the United States (benchmark Bel).

The most important areas can also be determined using regression analysis. The correlations confirm that the four areas selected (educational attainment, incentives to firms and individuals for lifelong learning, stimulating availability of managers, and organisational change) based on the benchmarking approach are highly correlated with performance. They also show that some of the other areas are significantly correlated with performance (Table B13). The policy areas are also highly correlated with the two sub-indexes for stock of human capital and management and organisational change.

Table B13. Simple correlation between the various areas of the business environment and performance

	Correlation with			Corresponding t-values for the correlation		
	Equal weights for all performance indicators	Only indicators of stock of human capital	Only indicators of management and organisation	Equal weights in performance	Stock of human capital	Management and organisation
Stimulate organisational change and focus on human resource management	0.91	0.76	0.96	***7.50***	***4.10***	***11.54***
Incentives to firms and individuals for lifelong learning	0.87	0.78	0.80	***8.38***	***5.89***	***6.17***
Provide public financing for education	0.84	0.70	0.84	***7.67***	***4.74***	***7.46***
Stimulate flexible work practices through flexible labour markets	0.82	0.66	0.81	***7.30***	***4.41***	***6.96***
Stimulate availability of managers	0.81	0.50	0.86	***6.87***	***2.86***	***8.49***
Educational attainment	0.79	0.82	0.64	***6.33***	***6.90***	***4.10***
Increase international mobility	0.43	0.27	0.52	***2.36***	1.36	***3.01***
Increase participation of underrepresented groups	0.42	0.17	0.48	***2.30***	0.86	***2.72***
Stimulate learning environment	0.00	0.02	0.01	0.00	0.10	0.02
Foster links between education and labour markets	-0.01	-0.08	0.06	-0.03	-0.40	0.28

Note: All values in bold and italics are significantly different from zero at least at the 5% level.

Multi-variant regression analysis can be used to reduce the number of important areas by excluding the least significant policy areas stepwise. The first regression included all ten areas, and the following regressions drop the least significant area one by one (Table B14). After eight regressions, all of the included indicators were significant at the 1% level. The regressions confirm that educational attainment, incentives to firms and individuals for lifelong learning, and organisational change are the main areas for determining performance (adjusted r^2 equals 0.9). Availability of managers is removed in the last regression as the two-sided t-test shows it is significantly different from zero at the 11.7% level.

Table B14. Statistics in the series of regressions (t-values)

	1	2	3	4	5	6	7	8
Intercept	-0.66	-0.68	-0.70	-1.27	-1.28	-1.63	-3.10	-2.89
Educational attainment	1.35	1.38	1.38	1.69	1.92	2.70	3.20	3.90
Stimulate organisational change and focus on human resource management	2.18	2.31	2.64	2.64	3.07	3.03	2.56	3.46
Incentives to firms and individuals for lifelong learning	0.87	1.054	1.11	1.24	1.71	2.37	2.73	2.77
Stimulate availability of managers	1.93	2.01	2.05	1.87	1.75	2.10	1.63	---
Foster links between education and labour markets	-1.61	-1.64	-2.09	-2.22	-2.20	-1.70	---	---
Stimulate flexible work practices through flexible labour markets	1.17	1.27	1.87	1.61	1.51	---	---	---
Increase international mobility	-0.96	-1.00	-1.04	-0.77	---	---	---	---
Increase participation of underrepresented groups	-0.63	-0.86	-0.97	---	---	---	---	---
Provide public financing for education	0.40	0.36	---	---	---	---	---	---
Stimulate learning environment	0.22	---	---	---	---	---	---	---
Adjusted r^2	0.90	0.90	0.91	0.91	0.91	0.90	0.90	0.89

Note: In this analysis the indicators with the smallest numeric t-value have been removed. Alternatively, the indicator with the lowest t-value could be removed given that it is assumed that none of the policy areas affects performance negatively. The results are the same for the two methods.

The regression analysis confirms that the important areas are captured and that the three most important areas are educational attainment, incentives to firms and individuals for lifelong learning, and organisational change. Stimulating availability of managers is very close to being included, whereas the other areas are never significantly different from zero.

The coefficients of the three significant indicators show that a one point higher value in one of the three indicators of the business environment gives about a 0.4 higher average performance. The biggest impact is from educational attainment, where the coefficient equals 0.48, and the lowest performance is in stimulating organisational change, where the coefficient is 0.36.

Annex C

THE INTERACTION AMONG THE MICRO-DRIVERS OF GROWTH AND THEIR LINKS TO MULTI-FACTOR PRODUCTIVITY

Good performance in the four micro-drivers of growth should lead to higher multi-factor productivity (MFP) growth at the macro level. The connection between good performance in the micro-drivers and overall macro performance is complex, as the drivers interact and MFP is not a simple measure. This annex has three main sections. First, it examines different ways of measuring MFP in order to identify the countries that, regardless of measurement issues, seem to have experienced high MFP growth in the 1990s. Second, it examines the correlation between MFP and the drivers. Third, it looks at the interaction among the drivers.

Different measures of MFP growth

MFP is based on better use of existing resources. MFP increases, for example, when more efficient firms gain market shares from less efficient firms, when new firms with better organisational structure enter the market or when new technologies allow firms and consumers to exchange goods and services more efficiently in the market place.

Many ways of measuring MFP growth exist, but all the data pinpoint Finland and Ireland as top-performing countries (Table C1). Australia is also a top performer on most measures of MFP. Portugal and Sweden can also be cited as high-growth countries for a few of the MFP measures.

MFP can be measured for the total economy or only for the business sector. Most analyses focus on MFP growth in the business sector, mainly because data are available for more countries (OECD, 2003b). Most countries' rankings are only slightly affected by using business sector data instead of total economy, although Denmark and the Netherlands perform much better in the business sector than they do in the total economy in the early 1990s, whereas the opposite is true for France. The correlation between the MFP growth rate in the business sector and in the total economy is not very high for the 1990s (owing to Denmark, France and Netherlands), whereas it is quite high at the end of the 1990s (Table C1).

MFP growth can be measured as pick-up growth or as average growth in a period. Pick-up growth is growth in one period minus growth in an earlier period. Pick-up growth has the advantage of removing all problems relating to the use of different methods to measure the capital stock in OECD countries. Pick-up growth to some extent also takes normal catching-up growth into account. Countries with low productivity tend to catch up to more productive countries by having higher growth. Pick-up growth measures acceleration in growth, which might be due to a better business environment and not "just" catching up. Pick-up growth measures tend to be highly correlated with the average growth rate in the last of the two periods compared (Table C1). Owing to these problems and to the fact that the results are quite similar across the various measures, the following discussion will only refer to MFP pick-up growth from 1980-90 to 1990-2000 in the business sector.

Table C1. Ranking of OECD countries based on various MFP measures

	Total economy			Business sector			
	1995-2000	1990-2000	Pick-up 90-95 to 95-00	1995-2000	1990-2000	Pick-up 90-95 to 95-00	Pick-up 80-90 to 90-00
Australia	3	3	8	3	5	7	2
Canada	8	12	5	6	7	3	4
Denmark	12	11	11	4	4	10	6
Finland	2	2	1	2	2	1	1
France	4	5	3	9	12	6	11
Germany	9	8	10	10	11	8	8
Ireland	1	1	2	1	1	2	3
Italy	13	6	13	13	10	11	9
Japan	10	10	9	12	8	13	12
Netherlands	11	13	7	5	3	12	10
Sweden	5	7	4	7	6	9	5
United Kingdom	7	4	12	11	13	4	13
United States	6	9	6	8	9	5	7
Correlations							
1995-2000	1.00						
1990-2000	0.74	1.00					
Pick-up 90-95 to 95-00	0.77	0.31	1.00				
1995-2000	0.57	0.25	0.62	1.00			
1990-2000	0.29	0.07	0.49	0.86	1.00		
Pick-up 90-95 to 95-00	0.75	0.57	0.58	0.47	0.13	1.00	
Pick-up 80-90 to 90-00	0.54	0.34	0.54	0.80	0.70	0.51	1.00

Source: OECD Productivity Database, 2004 and OECD, 2003i.

The correlation of the micro-drivers with MFP

A simple plot shows high correlation between the average of all performance indicators and pick-up growth in MFP. All countries except for the United States are very close to the trend line. The drivers examined in the project can explain almost 60% of the variation in MFP growth among OECD countries if the United States is excluded. If it is included, the degree of explanation is reduced to 44%.

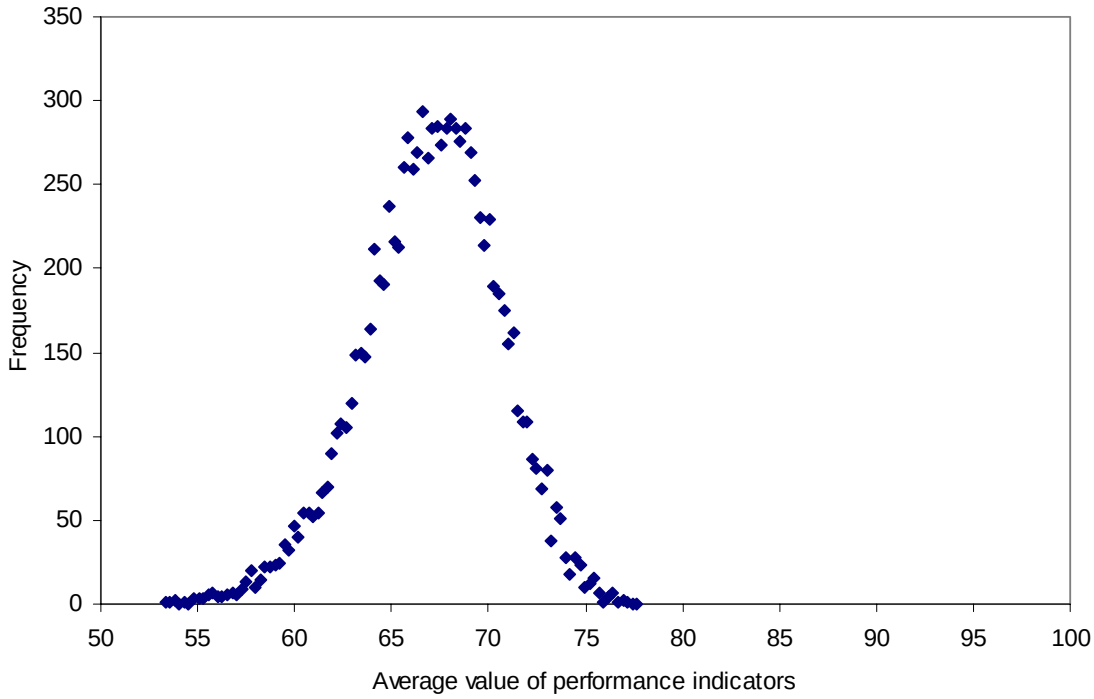
This correlation is affected by the choice of weights for the underlying indicators. The simple average of the performance indicators is calculated in two steps.

- Step 1: Four composite indicators are constructed (one for each of the four micro-drivers) based on simple averages of the underlying indicators.
- Step 2: A single indicator is constructed based on the simple average of the four composite indicators for the micro-drivers.

The first sensitivity analysis allows the weights in step 1 to vary between 0 and 1 and repeats the calculation 10 000 times. This gives a distribution of 10 000 individual composite indicators for each micro-driver. Based on these four distributions is it possible to construct a single distribution by

assigning equal weights to each micro-driver. Finland, for example, has values from around 55 to 78 with an average of 67 in this single indicator (Figure C1). The values follow a normal distribution according to the central limit theorem. Similar figures can be constructed for all other OECD countries. The distribution allows for correlation analysis with pick-up in MFP growth. The correlation with pick-up in MFP growth is calculated for each of the 10 000 composite indices (Table C2). The results show that the correlation is significant even in the extreme case.

Figure C1. Histogram for 10 000 performance indicators for Finland when weights for the individual indicators vary randomly and the weights among the drivers are constant



Note: The histogram is based on 100 steps for the 10 000 indicators.

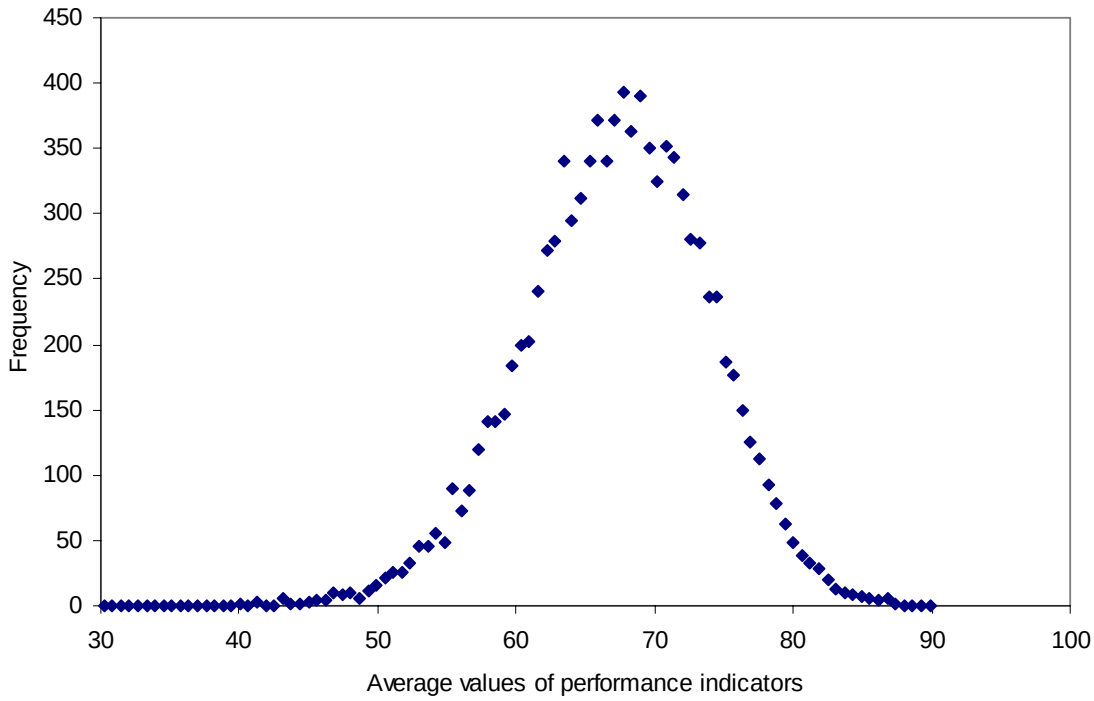
Table C2. Test of correlation between performance and pick-up in

	Correlation	R^2	t-value	p-value two-sided test	p-value one -sided
Lowest possible	0.595	0.355	2.458	0.029	0.014
Lowest 5%	0.642	0.412	2.777	0.016	0.008
Median	0.672	0.451	3.008	0.010	0.005
Highest 95%	0.700	0.489	3.248	0.006	0.003
Highest possible	0.742	0.551	3.676	0.003	0.001

The second sensitivity analysis allows the weights assigned to the individual indicators and the weights assigned to each driver to vary between 0 and 1, *i.e.* random weights in both steps. This naturally increases the spread of the correlations. For example, Finland has now values from around 40 to 90. The average is unchanged (Figure C2). The correlation analysis with pick-up in MFP growth

is repeated. The extreme case is no longer significantly different from zero but about 95% of the outcome is significantly different from zero (Table C3), which suggest a very robust correlation.

Figure C2. Histogram for 10 000 performance indicators for Finland when weights for individual indicators and drivers vary randomly



Note: The histogram is based on 100 steps for the 10 000 indicators.

Table C3. Test of correlation between performance and pick-up in MFP when weights for individual indicators and drivers vary randomly

	Correlation	R^2	t-value	p-value two-sided test	p-value one-sided
Lowest possible	0.101	0.010	0.337	0.742	0.371
Lowest 5%	0.513	0.264	1.984	0.069	0.034
Median	0.650	0.423	2.838	0.014	0.007
Highest 95%	0.704	0.496	3.288	0.006	0.003
Highest possible	0.746	0.557	3.720	0.003	0.001

An alternative to this sensitivity analysis is to maximise r^2 under the condition that none of the drivers can have negative weights. The very high correlation between human capital and ICT makes this maximisation problem difficult to solve. The maximisation problem is therefore solved for only three drivers at a time. The highest r^2 is obtained when human capital has a weight that equals about 2/3, entrepreneurship has a weight of 1/3 and science and technology has a weight around 1/20 (Table C4). All optimal solutions also assign weights to all three drivers when other measures of MFP are used. This suggests the need for a coherent growth strategy that promotes all drivers together.

Table C4. Maximizing r^2

Weight	Entrepreneurship	Science and technology	ICT	Human capital	R^2
	0.37	0.14	0.49	-	0,42
	0.34	0.04	-	0.62	0,50

Note: R^2 is maximised in the correlation between the weighted average of the micro-drivers and pick-up in MFP growth. The constraints are that weights have to be greater than or equal to zero.

Several other attempts have been made to maximise r^2 by allowing the drivers to interact. It is somewhat difficult to include all interaction terms, as pick-up growth in MFP is only available for 17 countries. In order to keep some degrees of freedom, only four variables at a time are included in the multi-variant regression. There can be literally thousands of ways to compose these four indices. Moreover, for each of the many combinations, the relative importance of the original indicators is unknown. An attempt is therefore made, for each of the possible index combinations, to randomise the relative weights by which the original drivers enter the new indices, and to see what weights cause a higher degree of explanation of the variation in the MFP measure. This randomisation method shows that r^2 can be even higher when the drivers are allowed to interact, but it also shows that several combinations of the drivers can lead to a high r^2.

The correlation is also affected by the choice of MFP measure. The previous section identified seven possible ways of measuring MFP. It is only the pick-up growth rates that are significantly correlated with MFP growth (Table C5). The main reason for the lack of correlation is the very high MFP growth rates in Ireland and the relatively low growth in the United States. Ireland had more than 4% yearly growth in MFP in the 1990s, whereas the United States had around 1% yearly growth. Data are only available for 17 countries, so two clear outliers make the correlations insignificant. Removing the United States and Ireland makes all of the correlations significantly different from zero at the 5% level.

Table C5. Correlations between the simple average of performance indicators and different measures of MFP

	Business sector				Total economy	
	1980-90 to 1990-99	1990-95 to 1995-99	1990-99	1995-99	1995-2001	Pick-up 90-95 to 96-2001
Correlation	0.67	0.41	0.24	0.30	0.18	0.48
R^2	0.45	0.17	0.06	0.09	0.03	0.23
t-value	3.47	1.74	0.95	1.21	0.72	2.12
p-value	0.00	0.10	0.36	0.24	0.48	0.05

Interaction among the micro-drivers

The four drivers are correlated. Human capital and ICT are highly correlated. Only entrepreneurship and science and technology are not correlated (Table C6).

Table C6. Correlation among the drivers and MFP

	Entrepreneurship	Science and technology	Human capital	ICT	Pick-up in MFP
Entrepreneurship	1.00	-0.01	0.27	0.61	0.41
Science and technology	-0.01	1.00	0.49	0.45	0.12
Human capital	0.27	0.49	1.00	0.79	0.58
ICT	0.61	0.45	0.79	1.00	0.57
Pick-up in MFP	0.41	0.12	0.58	0.57	1.00

Note: MFP measures the change in MFP growth from the 1980s to the 1990s in the business sector.

Tests based on factor analysis show that the four drivers of growth need to be included to express the full variation of the data. Factor analysis involves a set of techniques designed to identify order and structure in data sets with high internal correlation by providing a parsimonious and meaningful explanation for the observed variation and co-variation in the indicators. Factor analysis identifies a set of underlying trends that capture the variation of the many underlying indicators. The factor analysis of the four drivers showed two underlying factors with entrepreneurship and science and technology in the first and science and technology, human capital and ICT in the second (Table C7). However, tests of the fitness of the estimation show that this is not a very robust estimation and that the full set of data should be used if all variation is to be considered.

Table C7. Results of the factor analysis of the four drivers of growth

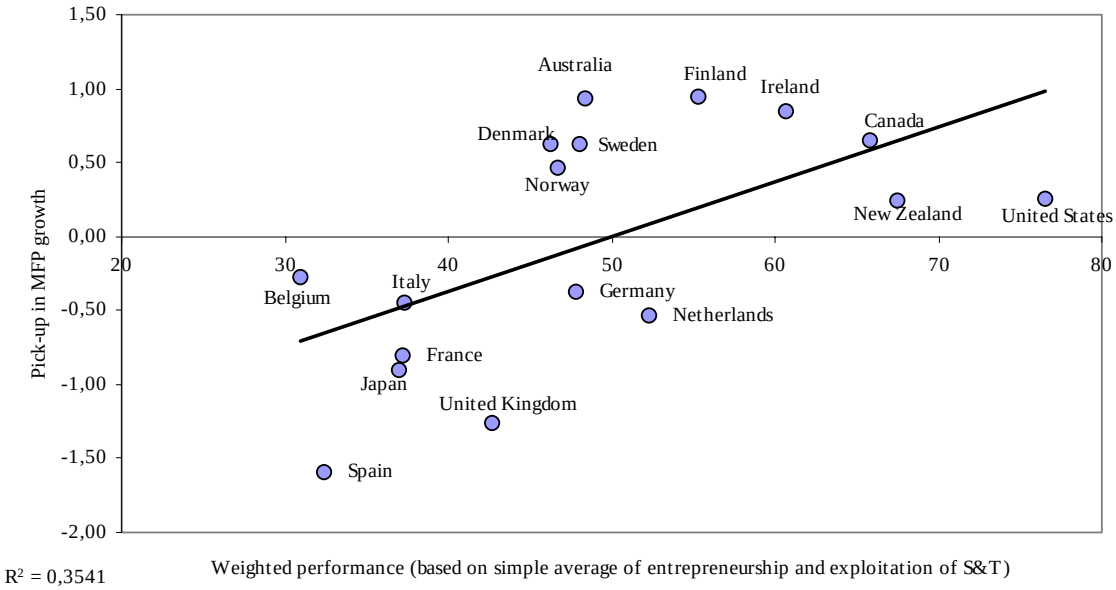
	Factor 1		Factor 2	
	Factor loadings	Weight in factor	Factor loadings	Weight in factor
Entrepreneurship	0.25	0.03	0.93	0.64
Exploitation of science and technology	0.66	0.20	-0.65	0.32
Human Capital	0.92	0.38	0.02	0.00
ICT	0.93	0.39	0.22	0.04
Eigen value	2.21		1.33	
Factor weights	0.62		0.38	

Note: It is not common for one indicator to fall in two factors with almost equal weight, which is the main reason for rejecting the estimation as a good fit of the data.

The main reason for the lack of fit in the factor analysis is the small negative correlation between entrepreneurship and exploitation of science and technology. Countries that are good at exploitation of science and technology need not be good entrepreneurs and *vice versa*. A closer look at the data shows some interesting interactions between entrepreneurship and exploitation of science and technology. The top-performing countries in science and technology that are not good performers in entrepreneurship (for example Japan, Sweden and Germany) do not get the full benefit of their science and technology. The policy conclusion is that an integrated policy approach in which science and technology are promoted together with entrepreneurship is needed to increase MFP.

The interaction between development and exploitation of science and technology and entrepreneurship can be shown by correlating the simple average of the entrepreneurship and the science and technology indicators with pick-up in MFP. A simple average of the indicators for entrepreneurship and sciences and technology has a higher correlation with MFP than either of the two micro-drivers separately (Figure C3).

Figure C3. The correlation between the average of science and technology and entrepreneurship indicators and pick-up growth in MFP



Note: The x-axis is simply the average of the performance indicators for entrepreneurship and the performance indicators for exploitation of science and technology. R^2 = 0.35 and the t-value for the correlation equals 2.83.

An alternative hypothesis is that inflexible labour markets impinge on the ability to exploit science and technology. Inflexible labour might also impinge on entrepreneurship. Entrepreneurship might therefore look like the key to exploitation of science and technology. Various measures of lack of labour market flexibility have been combined with the indicators for science and technology and correlated with pick-up in MFP growth (Table C8). The correlations were in most cases insignificant. This suggests that entrepreneurship is the main explanatory factor for some countries' lack of performance in spite of a good science and technology base.

Table C8. Labour market regulation and science and technology's correlation with pick-up growth in MFP

	Simple average of all labour market regulation indicators	Conditions of employment index interaction	Flexibility of firing interaction	Flexibility of hiring interaction	Recruitment procedures, first employee interaction	Recruitment procedures, additional employee interaction
Correlation with pick-up in MFP	0.42	0.41	0.12	0.28	-0.02	0.22
R^2	0.18	0.17	0.02	0.08	0.00	0.05
t-value	1.80	1.76	0.48	1.14	-0.08	0.87
p-value	0.09	0.10	0.64	0.27		0.40

Note: The correlation is based on an average of the labour indicator and the composite indicator for exploitation of science and technology.

Factor analysis shows very high correlation between the use of ICT and human capital. The high correlation between human capital and ICT may be driven by the fact that training and education are an important prerequisite for successful implementation of ICT. Research suggests that only 10% of an ICT investment in firms should be spent on hardware, 15% on technology complements and 75%

on work practices, human capital and organisational restructuring (Brynjolfsson, 2003). This is also confirmed in the peer reviews of policies for ICT diffusion to business. The Finnish review shows, for example, that the very high level of skills in the Finnish population is a big explanatory factor in the very high uptake of ICT in small Finnish firms relative to other countries (OECD, 2004a). Good performance in human capital thus seems to be a prerequisite for seizing the benefits of ICT, in addition to its direct effect on productivity.

Another possible explanation of the high correlation between human capital and ICT is that a country's income level influences both ICT uptake and human capital. Correlation between two variables can be spurious: both are correlated with a third indicator but there is no connection between the two variables. The income level of a country affects both the level of ICT uptake (OECD, 2004b) and the level of investment in education and human capital (OECD, 2003n). A two-step procedure has been used to test for this correlation. First, the simple average of performance indicators of human capital is regressed on GDP per capita in 2001. The regression shows high correlation between GDP and the human capital indicators. Second, the residuals from the regression are regressed on the simple average of the ICT performance indicators. This correlation is significantly different from zero at the 1% level. This shows that the correlation between ICT and human capital is not driven by their correlation with GDP.

Finally, the analysis shows a high correlation between human capital and the exploitation of science and technology. This is not surprising. Human resources in science and technology are known to be essential to advancing science and innovation and generating productivity growth (OECD, 2004e). This relates both to new graduates in science and technology and also to the organisation of the existing work force. Globalisation and ICT increasingly play a role in all sections of the economy. The development and effective use of human capital consequently become essential for firms' ability to improve their competitiveness by developing new products, process and services. Human capital might in this respect be seen as the fundamental building block for growth strategies in the knowledge-based economy.

Annex D

INTERNET LINKS FOR POLICY BENCHMARKS

Bankruptcy legislation	
World Bank Dataset	http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/LAWANDJUSTICE/GILD/0,,pagePK:181022~theSitePK:215006,00.html
World Bank Guidelines	http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/LAWANDJUSTICE/GILD/0,,language:120701~menuPK:146208~pagePK:181008~piPK:159223~theSitePK:215006,00.html
	www.minez.nl/home.asp?page=/Homepages/english_home.htm
	www.abiworld.org/
EU Conference on "Business Failure and Bankruptcy"	http://europa.eu.int/comm/enterprise/entrepreneurship/support_measures/failure_bankruptcy/why.htm
US Bankruptcy Institute	
EC work on stock options	
Education	
Centre for Entrepreneurship Education and Development in Nova Scotia	www.ceed.ednet.ns.ca/index.html
Teaching resources in Canada	www.ceed.ednet.ns.ca/Leadingedge/welcome.html
Teaching resources in Kauffman Centre	www.emkf.org/pages/129.cfm
Kauffman Centres evaluations of entrepreneurship education	www.entreworld.org/Bookstore/PDFs/RE-024.pdf
Stock options	
Beyster Institute for Entrepreneurial Employee Ownership	www.fed.org/
UK rules for stock options	www.inlandrevenue.gov.uk/shareschemes/emi_employers.htm
EC work on stock options	http://europa.eu.int/comm/enterprise/entrepreneurship/support_measures/taxation/index.htm
Government loans/loan guarantees	
Finnish loan guaranties	www.finnvera.fi/index.cfm?lang=3
Finland's loan	www.tekes.fi/eng/default.asp
UK loan guarantees	www.dti.gov.uk/expenditureplan/expenditure2001/objective_a/chapter3/section10.htm and www.businesslink.org
The US loans	www.sba.gov/starting/finding.html
The US guarantees	www.sba.gov/financing/fr7aloan.html
The Business Development Bank in Canada	www.bdc.ca/bdc/home/Default.asp

Simplifications and business services	
UK Companies House	http://ws4.companieshouse.gov.uk
Targets for Companies House	http://ws4.companieshouse.gov.uk/frame.cgi?OPT=about
US SBA reduction of compliance costs	www.sba.gov/advo/laws/flex/01regflx.pdf
Canadian reduction of compliance costs	www.ccra-adrc.gc.ca/
UK Business Link WebPages	www.businesslink.org
Canadian programme to help exporting firms	http://Exportsource.ca/aboutus_e.cfm
Canada's Business Start-up Assistant	www.cbsc.org/english/
UK differentiated WebPages	www.inlandrevenue.gov.uk/shareschemes/index.htm
TE Centres in Finland	www.te-keskus.fi/web/ktmyht.nsf/TE-mainENG?OpenFrameset
Providing basic and applied ICT skills in schools	
The US E-rate scheme	www.sl.universalservice.org/
Sweden's National Action programme for ICT in Schools	www.itis.gov.se/english/index_about_itis.html
Finland OPE.FI project	www.edu.fi/koulutus/opefi/english.htm
Dutch evaluation questionnaire	www.ict-onderwijspanel.nl/
Canada grassroots project	www.schoolnet.ca/grassroots/
Canada schoolnet	www.schoolnet.ca/home/e/
Sweden schoolnet	www.skolutveckling.se/skolnet/pdf/schoolnetfolder.pdf
Ensuring supply of IT workers	
Australia – ICT Skills Tracking and Monitoring system	www.mmv.vic.gov.au/Web/MMV/MMV.nsf/ImageLookup/publications/$file/ ICT%20Skills%20Snapshot%20-%20November%202002.pdf
Australia – IT careers/skills	www.itskillshub.com.au
Canadian toolkit	www.conferenceboard.ca/education/learning-tools/toolkit.htm
Canadian IT worker task force	www.conferenceboard.ca/education/learning-tools/esp2000.pdf
Internet tool/IT skills	www.schoolnet.ca/EmployabilitySkills/
Facilitating ICT-related organisational change	
Self-evaluation tools	www.noie.gov.au/projects/ebusiness/Advancing/case_studies.htm
Australia – eBusiness pathways guide	www.noie.gov.au/publications/NOIE/ITOL_CS/guide/index.htm
	www.govonline.gov.au/projects/ebusiness/Advancing/index.htm
US Manufacturing Extension Partnership	www.ces.census.gov/paper.php?paper=100254&PHPSESSID=4f2ac4a137451cb8d586b0e48927f985
EU Benchmarking national and regional e businesspolicies for SMEs	http://www.europa.eu.int/comm/enterprise/ict/policy/benchmarking/final-report.pdf
Finland – Branded Expert Services	www.verkkokaveri.fi/web/verkkokaveri/verkkoka.nsf/TE-mainENG?OpenFrameset
Sweden – subsidy programme	www.itps.nu/pdf/svenflex.pdf
Sweden – organisational change	www.vinnova.se/publ/pdf/vr-02-21.pdf
Programmes for organisational change	www.itps.nu/pdf/A2001-001.pdf

Implementing e-government	
The Netherlands position	www.overheid.nl
Targets for Finland	www.infosoc.fi/PublicServices.pdf
Electronic government services The Netherlands	www.europemedia.net/shownews.asp?ArticleID=7954
US 2002 e-government act	www.thomas.loc.gov/cgi-bin/query/z?c107:H.R.2458.ENR
US government technical framework	www.fcw.com/fcw/articles/2002/1028/web-omb-10-29-02.asp
Canada benefits	www.canadabenefits.gc.ca
Developing digital content	
Australia Copyright Act	www.copyright.org.au/PDF/InfoSheets/G071.pdf
Canada amendment to Copyright Act	www.dcita.gov.au/download/_Toc38172319
Canada copyright licence	http://strategis.gc.ca/sc_mrksv/cipo/cp/billc11-e.html www.accesscopyright.ca/licenses.asp?a=5
Australia cluster study	www.govonline.gov.au/projects/environment/ClusterStudy/index.htm
Australia Broadcasting Services Act	www.aba.gov.au/internet/faqs/int_cont.htm#coreg
Canadian regulation	www.crtc.gc.ca/eng/statutes.htm#Acts
E-Europe	www.ftp.cordis.lu/pub/econtent/docs/work_programme_2003_2004_en.pdf
Australia broadband applications	www.noie.gov.au/publications/NOIE/BAG/report/326_BAG_report_setting_2.pdf
Overall	
Finnish Science and Technology Policy Council	www.minedu.fi/tiede_ja_teknologianeuvosto/eng/
Quality of research	
Academy of Finland	www.aka.fi
21st century COE Japan	www.mext.go.jp/english/news/2004/05/04052401.htm
Innovation-oriented research programme	www.polymers.nl/PRO1/general/show_item.asp?itemid=201&link=From+science+to+innovation+03
Dutch Leading Technology Institutes	www.polymers.nl/PRO1/general/show_item.asp?itemid=201&link=From+science+to+innovation+03 www.oecd.org/LongAbstract/0,2546,en_2649_33703_21693396_119663_1_1_1,00.html
Industry-science links:	
US ATP	www.atp.nist.gov and www.oecd.org/dataoecd/6/40/2730171.pdf
Practical solutions to the management and organisation of incubators	www.nbia.org or europa.eu.int/comm/enterprise/entrepreneurship/support_measures/incubators/index.htm
Pop quiz on incubators	www.nbia.org/resource_center/review/01Feb/quiz.php
Japanese law on incubators	www.meti.go.jp/english/report/data/gIP1102e.html
Japan's National Institute of Advanced Science	www.aist.go.jp/index_en.html

Collaborative networks and clusters	
Overview of the Dutch programmes	www.ez.nl/content.jsp?objectid=13374
Dutch Biopartner	www.biopartner.nl/asp/default.asp
Finland's environment cluster programme	www.ymparisto.fi/default.asp?node=11578&lan=en
Experimental Program to Stimulate Competitive Research (EPSCoR)	www.ehr.nsf.gov/epscor/
Demand	
US Small Business Innovation Research (SBIR)	www.sba.gov/sbir/indexsbir-sttr.html

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