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2001 Innovation scoreboard

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2001 INNOVATION SCOREBOARD

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Executive Summary

1. The innovation scoreboard: a request of the European Council

The "European Innovation Scoreboard" responds to an explicit request of the Lisbon European Council. At Lisbon, the Union set itself the combined goal of strengthening social cohesion *and* becoming the most competitive and dynamic knowledge-based economy in the world within the next decade. Establishing a European area of research and innovation (ERA) was agreed to be one of the keys to better combine the efforts of the Union and the Member States. The two Communications on the ERA and "Innovation in a knowledge-driven economy" as well as the Commission proposal for the Next Framework Programme for Community R&D marked important steps in this direction. A preliminary European Innovation Scoreboard was published in September 2000.

2. An overview of Europe's innovation performance

The innovation scoreboard analyses statistical data on 17 indicators in four areas: human resources; knowledge creation; transmission and application of new knowledge; innovation finance, output and markets. The scoreboard depicts achievements and trends, highlights strengths and weaknesses of Member States' performances, and examines European convergence in innovation. The scoreboard is one of the benchmarking exercises of the European Commission that were launched in response to the Lisbon European Council. It builds on the "structural indicators" that the Commission offered in its Communication "Realising the potential of the European Union – Consolidating and extending the Lisbon strategy" [1].

3. Innovation leaders come from Europe

For many innovation indicators, the leading countries of the Union exhibit significant advances over the US and Japan. The UK, Ireland and France for example are world leaders in the supply of science and engineering graduates; Finland, the Netherlands and Sweden in public R&D; Sweden in business R&D; and the Netherlands, Sweden and Denmark in home internet access. This demonstrates the enormous potential for the exchange of good practice and learning within the EU using the "open co-ordination method" defined at Lisbon, as well as for enhanced co-operation between the Member States and the Union which is at the core of the ERA.

4. The Union shows signs of both improvement and weaknesses

For the EU as a whole, an analysis of changes in ten innovation indicators for which data are available over the last four to six years shows improvements in six indicators, no notable difference in one, and a decline in three: public R&D, business R&D, and value added from high technology manufacturing. Comparing current EU and US performances reveals that tertiary education levels, business R&D, home internet access, and high-tech patenting are among the most significant US advances over the EU, while the EU leads the supply of new science and engineering (S&E) graduates, public R&D and ICT (information and communication technology) investments. Compared to Japan, the EU leads only ICT expenditures. In internet access, Japan and the EU are equal, while Japan clearly leads in

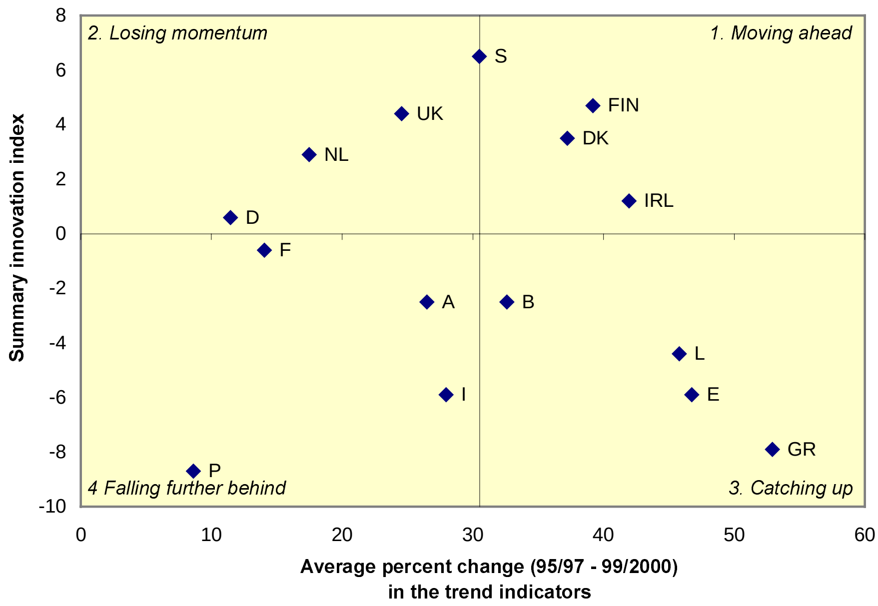
[1] COM(2001) 79.

business R&D (almost double the EU average) and to a lesser extent in science and engineering graduates, public R&D and the share of the working age population with a tertiary education.

5. Positive trends in most countries

The scoreboard provides detailed analysis by countries and by indicators. For an immediate overview, a tentative summary innovation index (SII) and overall country trends were calculated (see figure 1 below). Countries above the horizontal axis have an above average SII, while countries to the right of the vertical axis show an overall trend above the EU average. These two axes divide the Figure into four quadrants. Countries in the upper right quadrant are 'moving ahead' because both their summary innovation index and their past rate of change for the trend indicators are above the EU averages. Conversely, countries in the bottom left quadrant are 'falling further behind' because they are below the EU average for both variables. (see Chapter 3.3 for further details).

Fig. 1 Overall country trends by innovation index



All Member States have improved their innovation performance. Three countries with currently low results show the most positive trends: Greece, Luxembourg and Spain have clearly been "catching up". The three largest EU economies have also improved, but at rates below the EU average. The UK has improved the fastest in this group. Among the most innovative EU countries, Denmark and Finland have been "moving ahead"; Sweden has improved at the EU average and the Netherlands improved at a rate below the EU average.

6. Strong differences between Member States

Although there are substantive national differences in innovation performance, there is no "one best way" of innovation policy. Variations between Member States are particularly high for four indicators: life-long learning, business R&D, high-tech patenting and the share of SMEs involved in co-operative innovation. The differences are greater in areas directly influenced by private decision making. In contrast, there is less variability between Member States for most indicators that are strongly influenced by public policy, such as tertiary education or public R&D investments. For most indicators, the performances of the EU countries have been diverging over the past five to six years.

7. Two major weaknesses: patenting and business R&D

There is some evidence that the decline in public and business R&D expenditure since the early 1990s has ceased, with an increase in business R&D in several EU Member States since 1996. But, rapid increases in business R&D in Japan and the US since 1994 have increased the gap with Europe. Furthermore, US high-tech patenting in Europe is about seven times higher than European patenting in the US and the situation with Japan is almost as unbalanced. The strong position of Japanese high-tech patenting in the US indicates a potential for EU improvement in this area.

8. Action

The results of the 2001 innovation scoreboard support the objectives of the Communication “Innovation in a knowledge-driven economy”. They provide additional evidence for ‘fine tuning’ the recommendations already adopted in this Working Paper. The scoreboard will be updated on an annual basis, paving the way to enhanced European co-operation in innovation policy.

The 2001 innovation scoreboard will be used to further develop innovation policy benchmarking in different ways. The Commission invites the Member States to analyse the scoreboard results, to make comments, and to define, where appropriate, national targets. To facilitate the “open co-ordination method” defined by the European Council, Member States should evaluate their innovation policies systematically and, wherever practical, evaluate similar national policies jointly. The Commission services already support this mutual learning process under the “European Trend Chart on Innovation” (database of national policies, country reports, trend reports, peer reviews). The annual publication “Innovation policy in Europe” will include input from the scoreboard and provide a synthesis of the results from benchmarking innovation policy in Europe. These actions will gradually involve the candidate states.

Innovation has a strong regional dimension and the Commission invites the European regions to participate actively in innovation policy benchmarking. Depending on the contributions from the regions and the availability of data, the regional dimension could be further developed under the next innovation scoreboard.

The quality of the innovation scoreboard relies on statistical data from the Member States. In this context, the Commission recommends paying specific attention to the timely implementation and upgrading of the Community Innovation Survey.

1. Introduction

The Lisbon European Council in March 2000 called for the enhancement of innovation in the Union as a response to globalisation and the challenges of the knowledge-driven economy. At Lisbon the Union set itself the combined goal of strengthening social cohesion *and* becoming the most competitive and dynamic knowledge-based economy in the world within the next decade.

The overall strategy to achieve this was also mapped out at Lisbon. Establishing a European area of research and innovation to better combine the efforts of the Union and the Member States in these two areas was one of the key messages. Building on the economic convergence already achieved, an "open method of co-ordination" was devised in order to help Member States develop more effective policies for creating new skills and capacities. In this context, the European Council explicitly requested the introduction of a European Innovation Scoreboard. At its meeting in Stockholm on 23-24 March 2001 devoted to economic and social questions, the European Council noted the Commission's intention to present the first European Innovation Scoreboard and supported the full integration of candidate countries into the Lisbon process.

The Communication "Innovation in a knowledge-driven economy", adopted in September 2000 [2], marked an important step in the Commission's innovation and enterprise policies. The Communication reviewed progress in the Union following the "First Action Plan for Innovation" [3]; defined five objectives for the next four years, and set out a plan of concerted action by the Commission and the Member States. The Communication included the first outline of the European Innovation Scoreboard, based on data available at the time.

The 2001 scoreboard in the present Working Paper follows the general scheme of the 2000 outline. It analyses the current data in depth, depicts achievements and trends, highlights strengths and weaknesses in Member State performances, examines the level of European convergence, and leads to proposals for action. The scoreboard shows that the world's leading countries for many innovation policy areas are to be found among EU Member States. This demonstrates the enormous potential for the exchange of good practice and learning within the EU.

The scoreboard is one of the benchmarking exercises of the European Commission launched subsequent to the Lisbon European Council. In its Communication "Realising the potential of the European Union – Consolidating and extending the Lisbon strategy" [4] the Commission provided a series of "structural" or "flagship" indicators, on which the more specialised scoreboards such as the European Innovation Scoreboard, the Enterprise Scoreboard [5], and the ongoing benchmarking of national research policies [6] should draw.

The innovation scoreboard complements the "structural indicators". Some scoreboard indicators are identical to the "structural indicators", while several scoreboard indicators either complement the corresponding "structural indicator" or apply more restricted definitions to fulfil the purpose of the scoreboard to "zoom" into the area of innovation

2 COM(2000) 567.
3 COM(1996) 589.
4 COM(2001) 79.
5 Benchmarking Enterprise Policy. First results from the scoreboard, SEC(2000) 1841.
6 Progress report on benchmarking national research policies, SEC(2001) 1002.

policy. To minimise additional statistical burden, the innovation scoreboard mainly uses official Eurostat data, or private data of sufficient reliability if official data is not available.

2. THE EUROPEAN INNOVATION SCOREBOARD

The European Innovation Scoreboard provides an overview of Europe's innovation performance by presenting data on 17 indicators relevant to the innovation process [7]. The scoreboard uses 'traditional' indicators based on R&D and patent statistics and indicators derived from recent surveys. Table A in Annex 1 shows the definition, the data source and the most recent year available. Annex 2 provides further background information on each indicator: its advantages and disadvantages, precautions for its interpretation, comparability or complementary with indicators used elsewhere by the Commission, a graph showing Member State performance, and a trend diagram (for those indicators for which time series are available).

As a policy instrument derived from recent statistics, the scoreboard offers new insights. However, there is still a shortage of internationally comparable statistics in several vital areas such as knowledge diffusion, learning and networking. Therefore, the scoreboard is complemented by more qualitative policy benchmarking tools and analysis, such as the comprehensive database of innovation policy measures and the peer reviews under the "European Trend Chart on Innovation" (see section 4.2).

The 2001 innovation scoreboard builds on the outline scoreboard published in 2000. There are several major improvements: updated data, improved definitions of several indicators in order to focus on innovative activities [8], better coverage of the US and Japan (now for 10 indicators), availability of trend data for 10 indicators, integration of a new indicator on life-long learning, improvement of the patent indicator by inclusion of US patent data, a detailed analysis of trends, variations, and correlations, and recommendations on how the scoreboard could be used as one instrument of the "open co-ordination method".

The indicators of the scoreboard are grouped into four categories:

2.1. Human resources

The scale and quality of human resources are major determinants of both the creation of new knowledge and its diffusion throughout the economy. The indicators are divided into two groups: three indicators for education and learning and two indicators for employment. The former include the supply of new scientists and engineers, the skill-level of the working age population, and a measure of life-long learning (one of the five "structural indicators"). For the first two indicators, data from US and Japan are now available, but their comparability with European data may be limited due to differences between their education systems and those of Europe.

The two employment indicators are the share of the workforce in medium-high and high technology manufacturing and in high technology services. These indicators reflect the

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7 The two measures of patenting at the EPO and at the USPTO are counted as a single patent indicator.

8 The definitions of indicators 1.1, 1.2, 4.1, 4.2, 4.4, and 4.6 in the 2001 innovation scoreboard differ from the definitions in the 2000 outline. These changes produce different results compared to the earlier version. Readers who wish to compare the two scoreboards are advised to carefully check the full definition of each indicator in the Annex.

structural focus (or pattern of specialisation) of each economy on sectors that are likely to have a high innovation content.

2.2. Creation of new knowledge

The three indicators for the creation of knowledge measure inventive activity: public R&D expenditures, business R&D (equivalent to the comparable structural indicator), and patenting. The latter has two sub-categories: high technology patents at the European Patent Office (EPO) and high technology patents at the US Patent Office (USPTO) .

2.3. Transmission and application of new knowledge

This area covers innovation activities outside formal invention, such as the adaptation of new equipment to a firm's production and service systems, adopting innovations developed by other firms or organisations, and adapting new knowledge to the firm's specific needs. Collecting data in this area is relatively new to the national and international statistical systems. The section therefore relies entirely on the second Community Innovation Survey (CIS-2) which is the only source of comparable European data for innovation diffusion [9]. The indicators on in-house innovation and co-operative innovation are limited to small and medium-sized enterprises (SMEs). They provide a better picture of the innovative status of SMEs than business R&D, which is more prevalent among large firms. Separate data for SMEs is worthwhile because they form the majority of firms in most countries and can play a vital role in innovation: as intermediaries between the public research infrastructure and large firms, as developers of new ideas, and as adopters of new technology.

2.4. Innovation finance, output and markets

This group includes six indicators that cover a range of issues: the supply of high-tech venture capital, capital raised on stock markets (new markets or newly admitted firms on main markets), sales from innovations, home internet access (structural indicator), ICT investment (structural indicator), and value-added in advanced manufacturing sectors. Three of these indicators are based on private sources, due to a lack of equivalent public data, but they are included because of their high policy interest. The main drawback to using private data is that there is less information available on how the data are obtained. This makes it difficult to assess their reliability.

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9 The CIS is implemented by all Member States and has become the main innovation statistics instrument of the European Union. A number of OECD countries outside the EU have adopted the CIS methodology for their own national innovation surveys. No innovation statistics comparable to the CIS are available from the US and Japan, but the latter seems to be considering the possibility of carrying out a national innovation survey using the CIS approach. The data from the most recent CIS is for 1996, but 1998 data are available for a few countries (e.g. Germany, the Netherlands and Spain). The third CIS has been launched recently. At present, the CIS is carried out every four years. Increasing this frequency is currently under discussion between Eurostat and the national statistical offices. More frequent data gathering is a precondition for keeping the innovation scoreboard up-to-date.

3. MAIN FINDINGS FROM THE 2001 INNOVATION SCOREBOARD

No	Indicator	EU Mean	EU leaders			US	JP
1.1	S&E graduates / 20 - 29 years	10,4 ‰	17,8 (UK)	15,8 (F)	15,6 (IRL)	8,1	11,2
1.2	Population with tertiary education	21,2 %	32,4 (FIN)	29,7 (S)	28,1 (UK)	34,9	30,4
1.3	Participation in life-long learning	8,4 %	21,6 (S)	21,0 (UK)	20,8 (DK)		
1.4	Employed in med/high-tech manuf.	7,8 %	10,9 (D)	8,3 (S)	7,6(I/UK)		
1.5	Employed in high-tech services	3,2 %	4,8 (S)	4,5 (DK)	4,3 (FIN)		
2.1	Public R&D / GDP	0,66 %	0,95(FIN)	0,87(NL)	0,86 (S)	0,56	0,70
2.2	Business R&D / GDP	1,19 %	2,85 (S)	2,14(FIN)	1,63 (D)	1,98	2,18
2.3a	High-tech EPO patents / population	17,9	80,4 (FIN)	35,8 (NL)	29,3 (D)	29,5	27,4
2.3b	High-tech USPTO patents / pop.	11,1	35,9 (FIN)	29,5 (S)	19,6 (NL)	84,3	80,2
3.1	SMEs innovating in-house	44,0 %	62,2 (IRL)	59,1 (A)	59,0 (DK)		
3.2	SMEs innovation co-operation	11,2 %	37,4 (DK)	27,5 (S)	23,2 (IRL)		
3.3	Innovation expenditure/total sales	3,7 %	7,0 (S)	4,8 (DK)	4,3 (FIN)		
4.1	High-tech venture capital / GDP	0,11 %	0,26(UK)	0,20 (S)	0,17 (B)		
4.2	New capital raised / GDP	1,1 %	5,6 (NL)	4,5 (DK)	4,4 (E)	1,9	
4.3	Sales of new-to-market products	6,5 %	13,5 (I)	9,5 (E)	8,4 (IRL)		
4.4	Home internet access	28,0 %	55 (NL)	54 (S)	52 (DK)	47	28
4.5	ICT markets / GDP	6,0 %	7,4 (S)	6,6 (NL)	6,6 (P)	5,9	4,3
4.6	High tech value added in manuf.	8,2 %	20,5 (IRL)	18,8 (S)	12,5 (FIN)	25,8	13,8

Table 1: Indicator results based on the most recent data available

Table 1 presents, for every indicator, the overall EU mean [10], the three leading Member States with the best results for each indicator, and the results for the US and Japan where available. Full details on each indicator for all Member States, the US and Japan are provided in Table B of Annex 1 [11].

Looking at the EU average, the EU leads for only three of the 10 indicators for which US data are available (S&E graduates, Public R&D expenditure and ICT investment). The most significant US lead over the EU is in business R&D (74 % higher that the overall EU mean), new capital raised (73 %), home internet access (68 %) and high/tech patenting (659 % for US patents; 64 % for EPO patents). The latter demonstrates the strong high-tech US patenting activity in Europe. Including national patents in addition to EPO patents might slightly improve this picture, but it is clear that the US applies for more high technology patents in Europe than Europe in the US.

[10] The overall EU mean treats the EU as a single statistical unit and sums the numerator and denominator across all EU countries. In contrast, the trend analyses use a country-level mean that sums the indicator for each country and then divides by the number of countries.

[11] See Table A in annex 1 and annex 2 for exact indicator definitions.

The position of the EU compared to Japan also shows a quite unfavourable situation: the EU is leading only in ICT expenditure. In home internet access Japan and the EU are equal, while Japan clearly leads in business R&D (almost double the EU average) and to a lesser extent in S&E graduates, public R&D and the share of the working age population with a tertiary education. EU/Japan high-tech patenting is almost as unbalanced as with the US. Japanese high-tech patenting in the US is almost as strong as domestic US patenting, a situation which is radically different from the EU weakness in this indicator.

Shifting the focus from the EU average to the leading Member States shows a different picture. For many innovation indicators, the EU leaders are also world class leaders, sometimes exhibiting very significant advances over the US and Japan: the UK, Ireland and France for example lead in S&E graduates; Finland, the Netherlands and Sweden in public R&D; Sweden in business R&D; the Netherlands, Sweden and Denmark in home internet access. However, the patenting imbalance compared to the US remains valid even for the EU leaders [12].

Looking closer at these strong disparities in innovation performance in Europe, it is particularly striking that the leading slots are dominated by the smaller European countries: Sweden appears 13 times among the leading three; Finland 8 times; Denmark 7 times; the Netherlands 6 times and Ireland 5 times. In comparison, Germany and the UK appear 3 times each, Italy twice, and France once.

The fact that many of the smaller EU economies do either better or worse than the larger EU economies is partly due to larger EU economies contributing more to the overall EU mean than smaller economies, which means that they are less able to diverge from the mean. A second explanation is due to structural conditions [13]. The industrial distribution of small economies is often concentrated in a few sectors, while larger economies are more diverse, spanning all sectors from low to high technology. This can shift the scores towards the mean for many innovation indicators in large economies, while small economies can exhibit either a high or low innovative capacity, depending on the sectors that dominate the economy. This is apparent in the high innovative capacity of the Nordic countries and the relatively low innovation performance of Greece and Portugal. Of course, this shift towards high or low technology sectors is not accidental, but reflects both public and private institutions seeking out areas of comparative advantage and high profitability. This indicates the need for different “paths” of innovation policy in Europe that can build on current strengths and solve country-specific weaknesses.

3.1. Current trends

Table 2 shows trend data for those indicators with available time series [14]. The trends refer to the percentage change in each indicator between the last year for which data are available and

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12 A note of caution is required: this comparison is between the EU leading countries with the entire United States. A comparison of EU Member States with highly innovative American states, such as California or Massachusetts, could be instructive.

13 There are exceptions to the tendency for large economies to revert to the mean. Germany has the best performance for the share of medium-high and high technology manufacturing, while the UK and France have the first and second highest scores for the share of new Science and Engineering graduates. In the future, it might be possible to compare regions with similar sized economies. This would reduce the “mean-reverting” properties of the overall mean.

14 Time series are either unavailable for some indicators (new capital raised and the four CIS-based indicators) or the definition of the indicator was changed in recent years, preventing comparisons over time (S&E graduates and internet use). The time series for tertiary education needs to be interpreted

the average over the preceding three years, after a one year lag [15]. The trend analysis for the entire EU is favourable, showing an improvement in seven indicators, a minimal increase in one, and a decline in three: public R&D, business R&D, and the share of manufacturing value-added from high technology sectors.

No	Indicator	EU Mean	EU leaders			US	JA
1.2	Population with tertiary education	15 %	73 (A)	56 (FIN)	24 (UK)		
1.3	Lifelong learning	29 %	134 (B)	81 (UK)	67 (LUX)		
1.4	Employment in medium/high-tech manufacturing	1 %	8 (GR)	4 (IRL)	4 (I)		
1.5	Employment in high-tech services	12 %	70 (IRL)	65 (L)	22 (UK)		
2.1	Public R&D	-6 %	13 (FIN)	12 (GR)	11 (P)	-10	2
2.2	Business R&D	-1 %	48 (FIN)	21 (E)	20 (DK)	11	12
2.3a	High-tech EPO patents	59 %	350 (IRL)	157 (L)	120 (E)	65	23
2.3b	High-tech USPTO patents	76 %	234 (E)	181 (DK)	143 (FIN)	-10	200
4.1	High-tech venture capital	74 %	350 (GR)	230 (DK)	168 (I)		
4.5	ICT markets / GDP	18 %	41 (GR)	36 (E)	33 (I)	-18	-10
4.6	High tech value added in manufacturing	-12 %	87 (IRL)	73 (FIN)	70 (S)	21	-21

Table 2: Trends of innovation performances (% change)

Trend data for the US and Japan are only available for five indicators (the two patenting indicators count as one indicator). The US trend results lag the overall EU average for public R&D, USPTO patents, and the share of investment in ICT, but the US is ahead in business R&D and in high technology value added. The lag in ICT investment is probably due to much higher past levels of investment in the US, which means that less is currently required to stay ahead. Japan leads the EU on three of the four trend indicators.

About half (17 out of 33) of the leading slots for the trend results are occupied by countries that are below the EU average for many innovation indicators (see section 3.4 below) Greece and Spain appear four times and Spain and Italy three times. Ireland, with a slightly above average innovation index, appears four times. Among the most innovative countries, Finland appears five times and Denmark and the UK three times.

[15] cautiously, due to a change in the definition that increased the number of tertiary graduates. Trend results for specific countries are missing for some indicators, particularly for the smaller EU economies. For example, when the most recent data are for 2000, the trend is based on the percentage change between 2000 and the average for 1996 to 1998 inclusive. The results for 1999 are excluded in order to provide a one year lag. There are several exceptions to this rule due to a lack of adequate data. Annex 2 provides the specific years used to calculate the trends for each indicator.

3.2. Country results

Country	Major relative strengths	Major relative weaknesses
Belgium	Population with tertiary degree; High-tech venture capital	Innovative SMEs; Public R&D expenditure
Denmark	High-tech services; Patenting; Innovative SMEs	S&E graduates supply; New-to-market products;
Germany	Medium-high/high-tech manufacturing; Patenting; Innovative SMEs	Life-long learning; High-tech services
Greece	Innovation finance	Public and business R&D; High-tech patenting; Innovative SMEs; Internet
Spain	Innovation finance; New to market products	Public and business R&D; High-tech patenting; Internet access
France	Supply of S&E graduates; Public R&D; Product innovation	Internet; Innovation finance
Ireland	Supply of S&E graduates; Innovative SMEs; High-tech services	Public R&D; High-tech patenting; Life-long learning
Italy	Product innovation; Innovative SMEs	Public R&D; Education; High-tech patenting; Innovation finance;
Luxembourg	Internet access	High-tech patenting; Innovative SMEs; Life-long learning;
Netherlands	Public R&D; High-tech patenting; Internet; Innovation finance	S&E graduate supply
Austria	Innovative SMEs	S&E graduate supply; High-tech patenting; Innovation finance
Portugal	ICT expenditure; Product innovation	Public and business R&D; Education; Innovative SMEs; High-tech patenting
Finland	Workforce with tertiary degree; R&D, High-tech patenting; Internet	Innovative SMEs
Sweden	R&D; Life-long learning; High-tech services; SMEs; High-tech venture capital; Internet	New capital raised
United Kingdom	Education; High-tech venture capital; Internet	Public R&D

Table 3: Major relative strengths and weaknesses of Member States

Tables 3 and 4 summarise the results for each EU country. Both tables are based exclusively on the scoreboard findings and therefore miss certain strengths and weaknesses that are not reflected in statistics, due to lags in data availability or to a lack of indicators for some innovative activities. Table 3 summarises some of the major relative strengths and weaknesses of each EU Member State, as far as the scoreboard provides indicators to measure them. The table reflects the current situation, while Table 4 summarises the major trends per country for individual indicators (limited to large differences from the baseline trends for the EU as a whole). It should be underlined that the scoreboard is an additional input for a more comprehensive benchmarking process involving information on innovation policies gathered under the "European Trend Chart on Innovation" which will gradually produce a more complete picture.

Country	Average change[1]	Major trends
Greece	52.9 %	Increasing public R&D and ICT investment; declining business R&D
Spain	46.8 %	Increasing business R&D and USPTO patenting
Luxembourg	45.8 %	Rapid increase of employment in high tech services.
Ireland	41.9 %	Increased high-tech service employment, EPO patenting, high-tech value-added, declining public R&D
Finland	39.2 %	Surging ahead on many indicators: tertiary education share, public and business R&D, USPTO patenting, high-tech value added
Denmark	37.2 %	Increase in USPTO patents; decline of educated workforce
Belgium	32.6 %	Increase in USPTO patents
Sweden	30.5 %	Leading Member State; increased high-tech value added in manufacturing; otherwise no major changes
EU mean[2]	30.5 %	-
Italy	28.0 %	Lowest increase in EPO high-tech patents; increase in ICT investment.
Austria	26.5 %	Catching up on tertiary education share, but few other signs of a major improvement.
United Kingdom	24.6 %	Declining public and business R&D
Netherlands	17.5 %	Declining share of high-tech value-added in manufacturing
France	14.0 %	Declining business R&D
Germany	11.5 %	Declining share of high-tech value-added in manufacturing
Portugal	8.6 %	Increase in R&D, limited improvement of trend indicators

1: Average percentage change in the indicators for which trend data are available.

2: The EU country-level mean *(see footnote 9)* is used for all trend analyses.

Table 4: Significant Member State trends

3.3. A tentative European innovation index

A ranking of countries by their innovation performance is not the primary purpose of the scoreboard. However, to improve the readability of the Trend Chart results and to enable comparisons of the overall innovation performance with other national performance indicators, a tentative summary innovation index (SII) was designed.

The SII is equal to the number of indicators that are more than 20 % above the EU overall mean, minus the number that are more than 20 % below. The SII is adjusted for differences in the number of available indicators for each country. The index can vary between + 10 (all indicators are above average) to -10 (all indicators are below average) [16]. The two patent variables count as 0.5 each, giving a maximum of 17 possible indicators [17].

Several cautions are necessary in order to interpret the SII. First, the SII is a *relative* rather than an absolute index. An index of zero means that there is no meaningful difference from the EU average. Second, the SII is not fully comparable between countries because of missing indicators for seven countries. The SII is based on only 8 indicators for Japan, 9 for the US and Luxembourg, 14 for Greece, 15 for Portugal, and 16 for Austria and Belgium. Third, minor differences in the SII between countries are unlikely to be meaningful due to limitations with some of the indicators.

Fig. 1 Overall country trends by innovation index

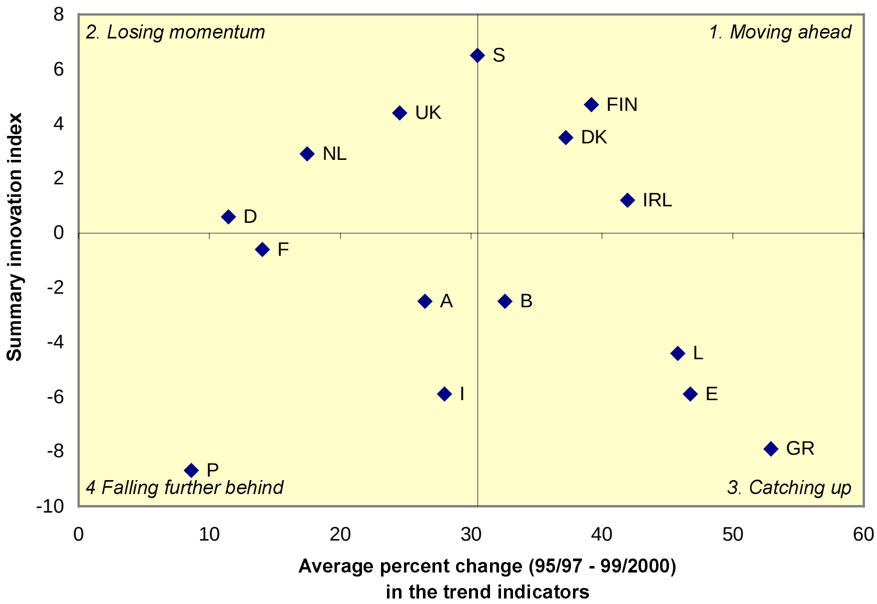

Figure 1 summarises conditions in each country by giving the SII and the average percentage change in the indicators for which relevant data are available. For some countries, the latter is based only on a limited number of indicators, depending on the availability of trend data.

Countries above the horizontal axis have an above average SII, while countries to the right of the vertical axis show an overall trend above the EU average. These two axes divide the chart into four quadrants. Countries in quadrant 1 are "*moving ahead*" (both the SII and the trend are above the EU average). Those in quadrant 2 are "*losing momentum*" (SII above the EU

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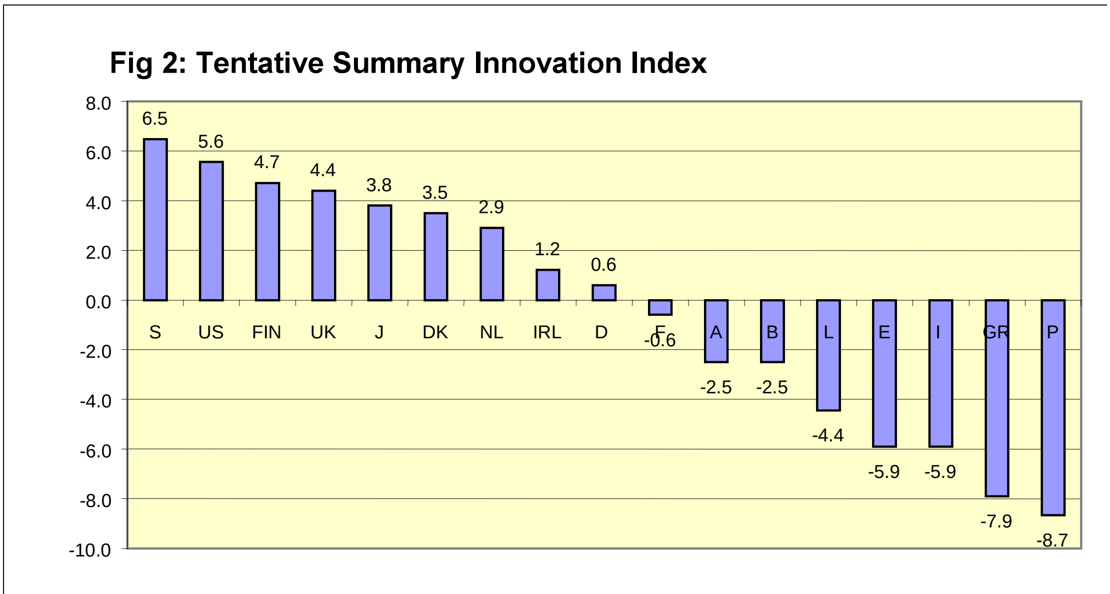
16 A generally applicable model for how each indicator influences innovation is not available, which is why all indicators are given equal value in calculating the SII Due to sampling, definitional, and other errors for many of the indicators, we assume that indicators within +20 % and – 20 % of the overall EU mean do not differ in any meaningful way from the average. The choice of a 20 % boundary is largely arbitrary. Sensitivity analysis found a high correlation (R^2 of 0.98) between the summary index using a 20 % boundary and those for a 15 % and 25 % boundary. The range in the SII from +10 to -10 is also arbitrary - it could have equally varied from -1 to 1 or -100 to +100.

17 A different calculation approach for a summary index was tested based on the average percentage by which each indicator varied from the overall EU average. This indicator is strongly correlated with the retained SII (R^2 of 0.89). The retained SII is preferred over the percentage index because it ignores minor differences from the EU average which may not be meaningful. It is correlated (R^2 of 0.64) with the Economic Creativity Index from the "*Global Competitiveness Report 2000*" of the "World Economic Forum" (WEF).

average, but with a trend below average). Quadrant 3 countries are *"catching up" (*SII below the EU average, but with an above average trend). Countries in quadrant 4 are "*falling further behind"* (SII and trend below EU average) [18]; The picture for countries with innovation performances that are already high is mixed. Denmark and Finland have been rushing further ahead. Sweden is the best performer but with a slightly below average improvement rate. The improvement rate of the Netherlands is below the EU country mean.

For the three largest EU economies, the trend results are below the EU country mean. The best conditions are for the UK, while the trend position for both France and Germany *is well below average*. The strongest overall trends towards improved innovation performances are for three countries with currently low results: Greece, Luxembourg and Spain. Ireland has also improved very quickly. Italy is one of the weak performers on the scoreboard but has been catching up on all trend indicators, except for a relatively poor performance for high technology patenting at the EPO. The very low rate of change for Portugal indicates that its innovation performance has been falling further behind.

Figure 2 shows the SII for all countries providing a "snapshot" of present country performances.



3.4. Are national innovation performances in the EU converging?

The evaluation of trends raises two questions: by how much do the current innovation performances of the Member States vary, and have these performances converged over recent years?

Table 5 provides a measure of the level of variation for each indicator and a measure of convergence for ten indicators for which trend data are available. The convergence measure is equal to the percentage change in the standard deviation. Convergence *decreases* as the change in the standard deviation increases, while a decline in the standard deviation shows

18 Annex 2 provides similar diagrams specific to all trend indicators.

increasing convergence. The table shows which indicators vary widely between Member States and which indicators are subject to only minor differences [19].

No	Indicator	Member States variation [1]	Convergence [2]
1.1	S&E graduates	Medium (48.5)	
1.2	Population with tertiary education	Low (32.8)	Diverging (15 %)
1.3	Lifelong learning	High (79.0)	Diverging (59 %)
1.4	Employment in medium/high-tech manufacturing	Low (37.5)	**Converging** (- 8 %)
1.5	Employment in high-tech services	Low (33.2)	Diverging (18 %)
2.1	Public R&D	Low (32.6)	**Converging** (- 6 %)
2.2	Business R&D	High (65.2)	Diverging (52 %)
2.3a	High-tech EPO patents	High (104.1)	Diverging (53 %)
2.3b	High-tech USPTO patents	High (92.7)	Diverging (156 %)
3.1	SMEs innovating in-house	Low (38.9)	-
3.2	SMEs innovation co-operation	High (62.1)	-
3.3	Innovation expenditure	Medium (39.4)	-
4.1	High-tech venture capital	Medium (56.9)	Diverging (100 %)
4.2	New capital raised	High (161.3)	-
4.3	New-to-market products	Low (33.7)	-
4.4	Home internet access	Medium (42.3)	-
4.5	ICT markets / GDP	Low (10.5)	**Converging** (-24 %)
4.6	High-tech manufacturing value added	Medium (54.5)	-

1: Coefficient of variation among the EU Member States is given in parentheses.

2: The percentage change in the standard deviation across EU countries over the time period (usually 1995 or 1996 compared to 1999 or 2000).

Table 5: Variation and convergence of indicators between Member States

The *variation analysis* sorts the 17 indicators (plus the second indicator for patenting) into three groups: high, medium, and low variation. The least variation between EU countries is for ICT investment, followed by public R&D. The indicators with the greatest variation among the EU Member States are more directly influenced by private decision making than by policy intervention. They include business R&D, patenting in high technology fields, the percent of SMEs involved in co-operation, and new capital raised. The indicator for life-long learning also varies substantially between countries, and is influenced by both public policies and firms' strategies for retraining. In contrast, there is less variability between countries for

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[19] Each indicator is measured using different units, which means that the comparison must be based on a standardised statistic that is unaffected by differences in the unit of measurement. The coefficient of variation (standard deviation/mean*100) is used here and given in Table 5.

most of the indicators that are strongly influenced by public policy, such as education or public R&D investments.

The analyses of *variation over time* determine if there is convergence between EU Member States for the particular indicator. For seven indicators, the performance of the EU countries has been *diverging*, rather than converging. The cause of this divergence is the above average improvement of the indicators in several small countries and the below average improvement of the three largest countries. Only three indicators show convergence: the percentage of employment in medium and high-technology manufacturing, ICT investment as a share of GDP, and the share of GDP for public R&D.

3.5. Understanding the variety of innovation policy "paths" in Europe

In the European Union, the conditions and the need for innovation policy learning are exceptional: some of the world's innovation leaders are Member States, but strong differences in national innovation performances still exist. However, copying policies of the leaders would be a misuse of the scoreboard; there is no "one best way" in innovation policy. A better understanding of the existing "paths", their priorities and internal logic is necessary. To compare innovation performances and, even more, to assess the transferability of "good practices", it is essential to understand the specific environments behind these performances and policy practices.

All Member States give high priority to innovation but they set different priorities. Each country pursues competitiveness, employment, sustainability, regional balance, and reducing social exclusion by its own original policy mix. A whole range of parameters and techniques could be used to identify different "paths" of innovation policy or clusters of countries applying similar innovation policy strategies. For some available parameters, exploratory correlation analyses with the summary innovation index (SII) were conducted.

A note of caution is needed concerning the interpretation of correlation results. Correlations do not provide information about cause and effect. A statistically significant correlation can only be interpreted as either 1) there might be a cause and effect relationship, although the direction is not known without other information, or 2) at the minimum, the two factors do not interfere with each other [20].

No statistically significant ($p < 0.05$) correlations were found between the SII and several employment and GDP based indicators. One reason for this result is that countries such as Luxembourg, Italy and Belgium have relatively high per capita GDP and a low ranking on the SII. This illustrates how there are different ways for a country to achieve a high living standard.

On the other hand, statistically significant negative correlations were found between the SII and two indicators of social exclusion: the percentage of the population living below the poverty line for three consecutive years ($R^2 = 0.52$ with $p = 0.013$) and the skewness of the income distribution ($R^2 = 0.43$ with $p = 0.014$). A third indicator of social exclusion, the

[20] For example, a strong correlation between innovation performance and GDP per person employed (a measure of productivity) would *not* indicate that a high innovative capability increases productivity. Such an interpretation can not be drawn as long as the data cover the same period. For instance, a strong positive correlation between the SII and a productivity measure would suggest, at best, that there might be a relationship or, alternatively, that the factors increasing SII do not interfere with improved productivity.

poverty rate before social transfers, is negative and close to statistical significance ($R^2 = 0.27$ with $p = 0.07$). The Nordic countries and the Netherlands score high on the SII and low on the three social exclusion indicators – in other words: the European innovation leaders manage to increase innovation performance and reduce poverty.

Both poverty and innovation are actively influenced by government policies. The negative correlation between them supports the hypothesis of a policy pattern that encourages innovation *and* reduces poverty. This is the policy pattern put forward at Lisbon as a European model. Although we do not know if the two results are causally related, they suggest that the outstanding innovation performances of the small welfare economies in Europe could partly be due to giving their citizens more economic security. A more conservative interpretation would be that policies preventing social exclusion need not interfere with innovation.

A similar, but less significant pattern could be assumed on the basis of a statistically significant ($p = 0.007$) positive correlation between the SII and an index for environmental sustainability [21]: highly innovative countries tend to give high priority to sustainability.

Another obvious clustering criteria could be country size, since small economies face different problems than large economies. For instance, large economies can maintain a full range of publicly funded research, but small economies tend to specialise and devote most of their resources to a narrow range of public research. Smaller economies could benefit from sharing their experiences on this and related issues.

As an example, cohesion countries, such as Portugal, and Greece to a lesser extent, have made progress on introducing structural reforms and show the highest rates of structural change in Europe [22]. The problem for cohesion countries is how to establish policies and framework conditions that will permit them to rapidly improve their innovation performance, an objective which ranks among the top priorities for regional programmes under the Structural Funds. Strengthening the critical mass of existing high-tech regions and developing the innovation performances of the other regions have to go hand in hand. In this respect, cohesion countries probably have more to learn from Ireland, which has improved rapidly from a low level, than they could learn from the Nordic countries, which are the current innovation leaders.

The level of decentralisation could be another relevant factor. Countries like Belgium, Spain, and to some extent Germany, give more decision making power over innovation policies to regions or provinces than other countries. The regional dimension will be further developed in future versions of the innovation scoreboard [23].

To conclude, the scoreboard results suggest that it is possible to distinguish broadly defined clusters of countries, such as the leading "small modernised welfare economies" (Nordic countries and the Netherlands). However, the assumed underlying similarities do not allow

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21 The "sustainability indicator" from the "World Economic Forum" (WEF) was used for this analysis. The R^2 for the correlation is 0.47. The results of the WEF survey presented in the Global Competitiveness Report 2000 equally indicate a positive correlation between performances in innovation and sustainability (the 'double dividend' hypothesis).

22 European competitiveness report – 2000; p 48.

23 This development work will build upon the "Regional Innovation Observatory" (RINNO; www.rinno.com) and the "Network of innovating regions in Europe" (www.innovating-regions.org) supported by the European Commission.

"country classes", "best of class" countries and other quantitative "benchmarking" methods to be applied, and even less the "top-down" definition of individual national "targets". The scoreboard results should be used as a starting point to develop a deeper understanding of the different national policy environments and strategies in Europe. Enhancing innovation policy learning in Europe will be a major part of the common European effort for more innovation.

4. BENCHMARKING INNOVATION POLICY

Benchmarking innovation policy requires an original approach. The methods are bound to be different from policies, which use binding quantitative targets and strict co-ordination methods. Innovation policy concentrates on creating new skills and capacities. It involves the need to develop original policy measures and to learn quickly. Here, European "diversity" can be an asset provided Member States communicate closely and build on each other's experiences.

4.1. The "open method of co-ordination"

The "open method of co-ordination" adopted by the Lisbon European Council emphasises European diversity. The European Innovation Scoreboard serves the implementation of this method in the area of innovation policy. To better define the practical use of the scoreboard, it is useful to recall the rationale and the principles of the "open method of co-ordination":

At Lisbon, the Council adopted this method as a new concept:

"Implementation of the strategic goal will be facilitated by applying a new open method of co-ordination as the means of spreading best practices and achieving greater convergence towards the main EU goals. This method, ... is designed to help Member States to progressively develop their own policies [24]*."*

A subsequent note of the Council presidency emphasised that it is the purpose of the method "to organise a learning process at the European level in order to stimulate exchange and the emulation of best practices and in order to help Member States improve their own national policies." [25] Best practices should be assessed and adapted in their national context and a clear distinction should be made between reference indicators to be used at the European level and concrete targets to be set by each Member State for each indicator. The process should involve not only public administrations, but also the stakeholders of innovation.

The European Commission plays a crucial role as a catalyst in the different stages of the open method of co-ordination by presenting proposals on European guidelines, organising the exchange of best practices, presenting proposals on indicators, and supporting monitoring and peer review.

4.2. A common reference framework for innovation policy

In the area of innovation policy, the so-called "European Trend Chart on Innovation" is one of the pillars of the open co-ordination method and provides the framework for analysis and co-ordination. The project is run under the Fifth Framework Programme for Community R&D and relies on a network of national correspondents in all Member and Candidate States. In

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[24] Council document SN 100/00.
[25] Presidency note from the Council 9088/00.

addition to developing and updating the innovation scoreboard it offers the following services:

- A database with more than 400 innovation policy schemes and a "who's who" of agencies and government departments involved in such schemes

- Six-monthly "country reports" and "trend reports";

- Annual synthesis reports: "Innovation policy in Europe" [26];

- Peer reviews by policy makers to identify "good practices" and assess the efficiencies of approaches and tools [27].

These products are available via CORDIS [28]. A Group of Senior Officials (GSO) from the Member States advises the Commission on the "Trend Chart". Its role in the co-operation and exchange of views on innovation policy will be strengthened.

4.3. Practical application of the 2001 innovation scoreboard

The scoreboard results provide further support for the objectives of the Communication "Innovation in a knowledge-driven economy" [29] and evidence for 'fine tuning' of the actions proposed in this Working Paper. The scoreboard will be used to further develop innovation policy benchmarking in different ways.

4.3.1. Exchange of good practices and monitoring progress

By means of its 17 indicators, the 2001 innovation scoreboard brings to light differences in the innovation performance of Member States. The scoreboard provides many examples where countries have made substantial and rapid progress in specific areas, but it also reveals cases of underperformance. Most importantly, the scoreboard shows that the leading countries in innovation performance can be found among EU Member States. This demonstrates the high potential for the exchange of good practice and learning in Europe.

The analysis of strong and weak innovation *performances* derived from the scoreboard complements the qualitative analysis of policy *schemes and measures* already carried out under the "European Trend Chart on Innovation". This is an important step towards closing the "causality gap" between measuring aggregate performances and designing adequate policies. The scoreboard identifies strengths and weaknesses in many policy areas and offers new entry points for policy makers in the Member States to find other Member States for "learning partnerships".

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[26] "Innovation policy in Europe 2000" was published in September 2000.

[27] Workshops on "innovation policy co-ordination mechanisms", "Learning networks", and IPR policies" have already taken place.

[28] www.cordis.lu/trendchart.

[29] COM(2000) 567.

Action foreseen:

The Commission invites the Member States to analyse the scoreboard results; to make comments; and to define, where appropriate, national targets. Member States should evaluate their innovation policies systematically and, wherever practical, evaluate similar national policies jointly. The Commission services support this mutual learning process under the "European Trend Chart on Innovation" (database of national policies, country reports, trend reports, peer reviews). The annual reports "Innovation policy in Europe" will include input from the scoreboard and provide a synthesis view of the results from benchmarking innovation policy in Europe. These actions will gradually involve the candidate states.

4.3.2. Stimulating the innovation policy debate

Benchmarking informs policy but it cannot substitute the democratic process of decision making. The challenge for Member States is not to copy the best performers, but to define their own original innovation policy, taking into account specific strengths, weaknesses, priorities and cultural and institutional traditions. This supposes a broad political debate among stakeholders (business, professional associations, unions, academia) to explore the acceptability of the policy options available.

Launching these debates is primarily the responsibility of the Member States, but it also includes an important European dimension: similarly to policy makers, stakeholders need to be informed about policies in other countries, how these perform and what a successful transfer might require. The Commission will support Member States in providing such a European outlook.

Collecting "informed opinions" from stakeholders is another reason why this debate is important. The Commission will investigate whether systematic Europe-wide hearings and polls among stakeholders are an appropriate means to produce representative and comparable data complementary to statistics.

Action foreseen:

The Commission offers Member States its support to introduce a European dimension into the national stakeholder debates on innovation policy. It will launch a Europe-wide pilot survey to collect "informed opinions" on innovation policy issues from stakeholders across Member and Candidate States.

4.3.3. Tackling common EU weaknesses

The scoreboard identifies two key areas where the European Union as a whole does poorly: business R&D [30] and high-tech patenting in the US. Both seem to reveal structural weaknesses of the European innovation system and justify action at European level. Both themes are included in the Commission's proposals for the Sixth Framework Programme and for the European Research Area.

30 This confirms the analysis drawn from the "structural indicators" in COM(2001) 79. However, innovation policy in this area will be constrained by the distribution of industrial firms in Europe - high business R&D spending and patenting levels is dependent upon a large high technology sector. Neither will increase without an expansion of European high technology sectors, which cannot be expected to happen rapidly.

Action foreseen:

There is an urgent need for action to strengthen business R&D. Member States are encouraged to initiate or increase incentives in accordance with articles 87 and 88 of the Treaty.

The reasons for the apparent weaknesses of European high-tech patenting in the US need to be better understood. Do European companies apply defensive patenting strategies in the US? Is this part of their overall business strategies or does it reveal weaknesses? Is it a consequence of a different propensity to patent in Europe and the US? A panel of experts in enterprise policy who might also propose appropriate action will further explore these issues. Ongoing Community action to strengthen the patenting and technology transfer capacities of European universities and research institutes will be reinforced with a particular view to extending these capacities to the world-wide level.

4.4. Next steps towards improving the innovation scoreboard

In the area of "transmission and application of new knowledge" the Second Community Innovation Survey (CIS 2) is the only source for comparable data. However, CIS data date back to 1996 (except for countries with more frequent national surveys). New and improved data from the Third Community Innovation Survey are a precondition to update the scoreboard in this area and high priority should be given to the efforts to increase the CIS frequency.

Europe-wide statistical data is not yet available for important aspects of innovation such as creation of high-tech start-up companies, private public partnerships, knowledge diffusion, the influence of environmental policy and standardisation on innovation, and the quality and intensity of networking. In the short and medium term, the official statistical system will not be able to fill these gaps. To cover these emerging areas adequately, new proxy indicators need to be developed, complementary private data will need to be used, and new types of data collected through surveys.

Innovation has a strong regional dimension and the Commission invites the European regions to participate actively in innovation policy benchmarking. Depending on the contributions from the regions and the availability of data, the regional dimension could be further developed in the next innovation scoreboard.

The following activities are foreseen to update and improve the innovation scoreboard (in close co-operation with Eurostat):

Action foreseen:

Member States should give high priority to the timely implementation of the Third Community Innovation Survey and to the more frequent production of innovation statistics.

The Commission will develop new innovation indicators and carry out surveys as a complement to official statistics.

Following the request of the Stockholm Council, the scoreboard will be extended to Candidate States. The aim is to include these countries in the 2002 innovation scoreboard, subject to the availability of statistical data.

A series of regional indicators complementary to the innovation scoreboard will be developed within the limits of the available statistical data.

5. ACTION ARISING FROM THE 2001 INNOVATION SCOREBOARD

5.1. Road map of activities to be implemented by the Commission

Activity	Date
The innovation scoreboard	
• Annual updates	2002 onwards
• Extension to candidate countries	2002
• Including the regional dimension	2002 (draft)
• Improvements	
• Push forward with CIS 3	2002
• Develop new proxy indicators	2002 (draft)
• Complementary surveys	2003
• More frequent innovation statistics	2004
Common framework of innovation policies	
• Further develop the "European Innovation Trend Chart" (country reports, innovation policy database, peer reviews, annual reports)	Ongoing
• Launch a special activity to better integrate Candidate Countries	2001/2002
• Stimulate the innovation policy debate among the main innovation stakeholders and collect their views through surveys	2002
Further innovation policy actions	
• Investigate the reasons for the weakness of European high-tech patenting in the US and, if relevant, make proposals for Community action.	2001/2002
• Strengthen the patenting and technology transfer capacities of European universities and public research institutes	2001/2002
• Under the Next Research Framework Programme: Encourage research on innovation policy "paths" and the relationship of innovation with socio-economic parameters	From 2003
• Under the Next Research Framework Programme: support Member States to open up existing innovation schemes for participants from other countries and to develop adequate methodologies to transfer policy schemes trans-nationally	From 2003

5.2. Main recommendations to Member States

The Communication "Innovation in a knowledge-driven economy", adopted in September 2000 [31] and the "Broad Economic Policy Guidelines" of April 2001 [32] offer recommendations to Member States how to foster innovation in the knowledge based economy. For the specific purpose of using and further improving the innovation scoreboard for policy benchmarking the recommendations below provide further detail:

- Improve national innovation statistics. Implement the ongoing CIS 3 in time and carry out innovation statistics more frequently.

- Promote policy benchmarking and set quantitative "targets" at the national, regional and local levels where appropriate, co-ordinate national and regional policies properly.

- Participate in the co-ordination of innovation policies in Europe and contribute to the diffusion of good practices. Apply a European outlook when fixing priorities and designing innovation policies. Evaluate innovation policies systematically and, wherever practical, evaluate similar national policies jointly.

- Support Commission action addressing the common European weakness of high-tech patenting and business R&D.

- Develop the dialogue on innovation policy options among stakeholders. Address the European dimension in such debates (with Commission support).

- Under the next Framework Programme: Co-operate with the Commission and other Member States to launch common innovation policy initiatives. Open up national and regional innovation support schemes for participants from other countries and develop adequate methodologies to transfer policy schemes trans-nationally.

6. ANNEXES

Annex 1: Overview tables

Overview Table A: Definitions of all indicators, sources, years

Overview Table B: Current performances (EU mean, Member States, US, Japan)

Annex 2: Technical explanations and descriptions of each indicator

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[31] COM(2000) 567.

[32] COM(2001) 224.

ANNEX 1 - OVERVIEW TABLES

Table A: European Innovation Scoreboard (indicators, sources and years)[1]

N°	Short definition of indicator	Source	Year[2]
1.	**Human resources**		
1.1	New S&E graduates (‰ of 20 - 29 years age class)	EUROSTAT, Education statistics	1999
1.2	Population with tertiary education (% of 25 – 64 years age classes)	EUROSTAT, Labour Force Survey; *OECD Education at a Glance*	2000
1.3	Participation in life-long learning (% of 25 – 64 years age classes)	EUROSTAT, Labour Force Survey (Structural indicator 1.7)	2000
1.4	Employment in medium-high and hi-tech[3] manufacturing (% of total workforce)	EUROSTAT, Labour Force Survey	1999
1.5	Employment in high-tech[4] services (% of total workforce)	EUROSTAT, Labour Force Survey	1999
2.	**Knowledge creation**		
2.1	Public R&D expenditures (GOVERD + HERD) (% of GDP)	EUROSTAT, R&D statistics, OECD	1999
2.2	Business expenditures on R&D (BERD) (% of GDP)	EUROSTAT, R&D statistics (Structural indicator 2.2.1), OECD	1999
2.3a	EPO high tech patent applications (per million population)	EUROSTAT, EPO	1999
2.3b	USPTO high tech patent applications (per million population)	EUROSTAT, USPTO	1998
3.	**Transmission and application of knowledge**		
3.1	SMEs innovating in-house (% of manufacturing SMEs)	EUROSTAT, Community Innovation Survey	1996
3.2	SMEs involved in innovation co-operation	EUROSTAT, Community Innovation Survey	1996
3.3	Innovation expenditures (% of all turnover in manufacturing)	EUROSTAT, Community Innovation Survey	1996
4.	**Innovation finance, output and markets**		
4.1	High technology venture capital investment (% of GDP)	European Technology Investment Report 1999, based on EVCA data	2000
4.2	Capital raised on parallel markets plus by new firms on main markets as a % of GDP	International Federation of Stock Exchanges	1999
4.3	'New to market' products (% of sales by manufacturing firms)	EUROSTAT, Community Innovation Survey	1996
4.4	Home internet access (% of all households)	EUROSTAT, Eurobarometer (Structural indicator 2.4b),US NTIA	2000
4.5	Share of ICT markets as a percent of GDP	EUROSTAT (Structural indicator 2.3), EITO	2000
4.6	Share of manufacturing value-added in high-tech sectors	EUROSTAT	1997

1. For more information on sources, definitions, interpretations, advantages and disadvantages of the indicators refer to annex 2.
2. Most recent year for at least four countries.
3. Includes chemicals (NACE 24), machinery (29), office equipment (30), electrical equipment (31), telecom equipment (32), precision instruments (33), automobiles (34) and other transport (35). The total workforce includes all manufacturing and service sectors.
4. Includes communications (NACE 64), software and computer services (72) and R&D services (73)

Table B: Scoreboard 2001

No	Indicator	Yr[1]	So.[2]	EU	S	FIN	UK	DK	NL	IRL	D	F	A	B	L	E	I	GR	P	US	JP
1.1	‰ S&E grads/20-29 pop	99	1	10,4	9,7	10,4	**17,8**	*4,7*	*5,8*	**15,6**	8,6	**15,8**	*7,8*	*5,1*		9,6	*4,7*		*5,5*	*8,1*	11,2
1.2	% pop with 3rd education	00	1,2	21,2	**29,7**	**32,4**	**28,1**	**25,8**	25,0	22,2	23,8	21,6	*14,2*	**27,1**	18,3	21,8	*9,6*	*16,9*	*9,8*	**34,9**	**30,4**
1.3	Life-long learning	00	1	8,4	**21,6**	**19,6**	**21,0**	**20,8**	**15,6**	*5,2*	*5,2*	*2,8*	7,8	6,8	*4,8*	*4,9*	*5,2*	1,1	*3,3*		
1.4	% empl. h-tech manuf	99	1	7,8	8,3	7,2	7,6	6,4	*4,7*	7,3	**10,9**	7,2	6,6	7,2	*1,8*	*5,5*	7,6	*2,4*	*3,6*		
1.5	% empl. h-tech services	99	1	3,2	**4,8**	**4,3**	**4,2**	**4,5**	3,6	**4,0**	2,8	3,8	2,7	3,2	3,6	*2,1*	2,7	*1,5*	*1,2*		
2.1	Public exp. R&D / GDP	99	1	0,66	**0,86**	**0,95**	0,59	0,71	**0,87**	*0,35*	0,75	**0,80**	0,65	*0,50*		*0,43*	*0,48*	*0,38*	*0,40*	0,56	0,70
2.2	BERD / GDP	99	1	1,19	**2,85**	**2,14**	1,20	1,26	1,05	1,03	**1,63**	1,36	*0,84*	1,28		*0,47*	*0,56*	*0,13*	*0,14*	**1,98**	**2,18**
2.3a	EPO h-tech pats /pop	99	1,3	17,9	**22,9**	**80,4**	18,9	**21,5**	**35,8**	*13,3*	**29,3**	20,2	*9,8*	17,6	*9,2*	*2,5*	*4,8*	*0,5*	*0,4*	**29,5**	**27,4**
2.3b	USPTO h-tech pats /pop	98	1,4	11,1	**29,5**	**35,9**	**14,4**	**17,3**	**19,6**	*3,8*	**14,4**	13,3	*5,6*	12,8	*2,3*	*1,0*	*4,2*	*0,5*	*0,1*	**84,3**	**80,2**
3.1	% SMEs innov in-house	96	10	44,0	44,8	*27,4*	35,8	**59,0**	51,0	**62,2**	58,7	36,0	**59,1**	*29,4*	*24,5*	*21,6*	44,4	*20,1*	*21,8*		
3.2	% SMEs innov co-op	96	10	11,2	**27,5**	**19,9**	**15,7**	**37,4**	**13,8**	**23,2**	**14,7**	12,0	12,9	*8,9*	9,6	*7,0*	*4,7*	*6,5*	*4,5*		
3.3	% innov exp /total sales	96	10	3,7	**7,0**	4,3	3,2	**4,8**	3,8	3,3	3,9	3,9	3,5	*2,1*		*2,4*	*2,6*	*1,6*	*1,7*		
4.1	‰ vent capital / GDP	00	1,5	1,08	**2,04**	**1,38**	**2,56**	*0,64*	**1,62**	*0,65*	*0,68*	*0,74*	*0,11*	**1,65**		*0,36*	*0,41*	*0,04*	*0,01*		
4.2	% new capital / GDP	99	1,6	1,1	*0,5*	*0,3*	*0,6*	**4,5**	**5,6**	0,9	*0,6*	*0,6*	*0,3*	0,9	*0,6*	**4,4**	*0,1*	**1,5**		**1,9**	
4.3	% new-to-markt products	96	10	6,5	6,9	7,3	6,7	*5,1*	6,9	**8,4**	7,1	**7,9**	5,6	*2,6*		**9,8**	**13,5**		7,2		
4.4	% home internet access	00	7, 8	28	**54**	**44**	**41**	**52**	**55**	**36**	27	*19*	**38**	29	**36**	*16*	24	*12*	*18*	**47**	28
4.5	% ICT markets / GDP	00	9	6,0	**7,4**	6,0	6,5	6,1	6,6	*4,8*	5,7	6,1	5,8	5,6		6,3	5,3	6,0	6,6	5,9	*4,3*
4.6	% h-tech value added	97	1	8,2	**18,8**	**12,5**	**11,8**	7,9	7,5	**20,5**	*5,7*	9,7				*5,0*	*5,9*			**25,8**	**13,8**
	Summary Index				*6,5*	*4,7*	*4,4*	*3,5*	*2,9*	*1,2*	*0,6*	*-0,6*	*-2,5*	*-2,5*	*-4,4*	*-5,9*	*-5,9*	*-7,9*	*-8,7*	*5,6*	*3,8*

1: Most recent data available.

2: Data sources: 1= Eurostat, 2 = OECD *Education at a Glance*, 3 = EPO, 4 = USPTO, 5 = EVCA, 6 = FIBV, 7 = Eurobarometer, 8 = US National Telecoms and Information Administration, 9 = EITO, 10 = Community Innovation Survey.

Indicators (except for the summary index) that are more than 20 % above or below the EU average are highlighted in **bold** or *italics* respectively.

ANNEX 2 - TECHNICAL EXPLANATIONS AND DESCRIPTIONS OF EACH INDICATOR

The innovation scoreboard is one of the benchmarking exercises of the European Commission launched subsequently to the Lisbon Council. In its Communication "Realising the potential of the European Union – Consolidating and extending the Lisbon strategy" [33] the Commission provided a battery of "structural" or "flagship" indicators, on which the more specialised scoreboards such as the European Innovation Scoreboard, the Enterprise Scoreboard [34], and the ongoing benchmarking of national research policies [35] should draw.

The selection and definition of the innovation indicators reflect the specific perspective of innovation policy. However, to make progress towards the Commission's goal to offer a modular set of scoreboards, some of the indicators introduced under the outline innovation scoreboard have been adapted. Four indicators are now equivalent to "structural indicators". To further enhance overall coherence the indicator descriptions in this annex refer, where applicable, to the definitions of similar indicators used under the other benchmarking exercises.

The graphs of the trend results show the percentage by which the indicator for each country is above or below the current EU mean (vertical axis) against the trend for the given indicator (horizontal axis). The trends refer to the percentage change between 1995-1997 and 1999 or 2000 (depending on data availability). The horizontal or X axis is the trend, or the percentage change over time, while the vertical or Y axis is the current difference from the EU mean. All countries to the **right** of the vertical axis have shown growth in the indicator, while all countries **above** the horizontal axis are above the EU average. The two axes create four cells:

2 *Losing momentum*	**1** *Moving ahead*
4 *Falling further behind*	**3** *Catching up*

Countries that fall in quadrant 1 are both above the EU average and their trend is positive, indicating that these countries are '*moving ahead*'. A country in quadrant 2 is currently above the EU average for the indicator, but the trend is declining, indicating that the country is "*losing momentum*". Countries in quadrant 3 are below the average, but the trend is positive and so they have a good chance of "*catching up*". Finally, quadrant 4 is the worst possible place to be. Countries in this quadrant are both below the current EU mean and the trend is negative - they are "*falling further behind*".

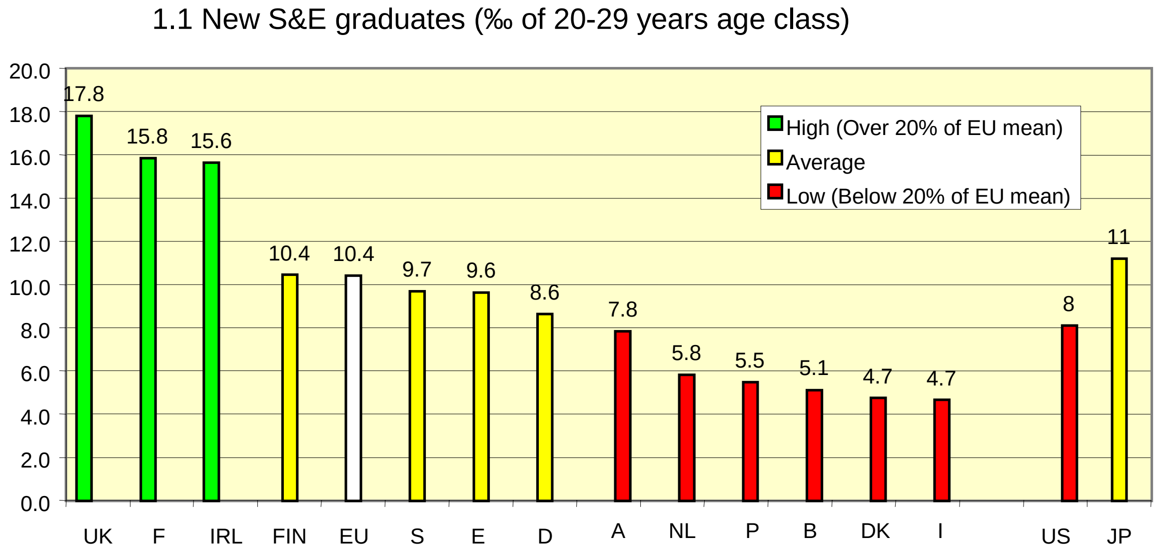
33 COM(2001) 79.

34 Benchmarking Enterprise Policy. First results from the scoreboard, SEC(2000) 1841.

35 Benchmarking national research policies, SEC(2001) 1002.

1. HUMAN RESOURCES

1.1. New S&E graduates (‰ of 20-29 years age class)



All data are from Eurostat, except for the population data for the US and Japan which are from the US Census web site. Results for all countries are for 1999, except for 1998 data for Denmark, France, Ireland, Austria and the UK, and 1997 data for Italy. No data for Luxembourg and Greece.

Definition

The definition of this indicator has been changed as compared to the outline scoreboard. It now uses the entire population of 20 - 29 years olds as a reference. The new definition is in line with the equivalent indicator of the enterprise scoreboard and better reflects the actual number of new S&E graduates available in each country. S&E graduates are defined as all post-secondary education graduates (ISCED classes 5a and above) in life sciences (ISC42), physical sciences (ISC44), mathematics and statistics (ISC46), computing (ISC48), engineering and engineering trades (ISC52), manufacturing and processing (ISC54) and architecture and building (ISC58).

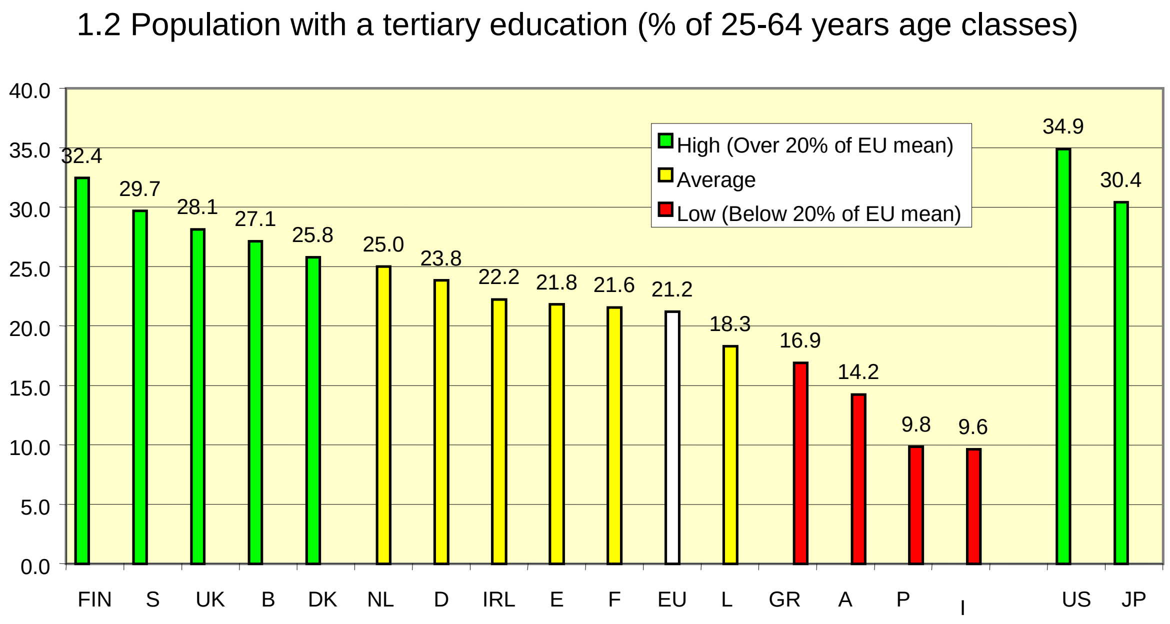
Interpretation

The indicator is a measure of the supply of new graduates with training in S&E. The UK, France and Ireland have the highest supply of S&E graduates, while the lowest percentage in Europe is for Denmark and Italy. Many European countries compare favourably to the US.

Trend results, disadvantages and advantages

Due to problems of comparability across countries, this indicator uses broad educational categories. This means that it covers everything from graduates of one-year diploma programmes to PhDs. Some of the graduates will be younger or older than the population of 20-29 year olds, introducing a small degree of error into the results. Another source of error in the ability of this indicator to measure the supply of new S&E graduates is due to migration - new graduates who leave the country or in-migration from new graduates trained outside of the country. The latter is particularly common in the US. Trend data are not available, due to a 1997 change in the definitions of ISCED classes.

1.2. Population with a tertiary education (% of 25-64 years age classes)



Data from the Eurostat Labour Force Survey for the EU countries and from the OECD *Education at a Glance* for the United States and Japan. The data are for 2000 except for Ireland (1997), the US (1998) and Japan (1998). The results for the latter will be underestimated, due to an average increase of 3.7 percent per year.

Definition

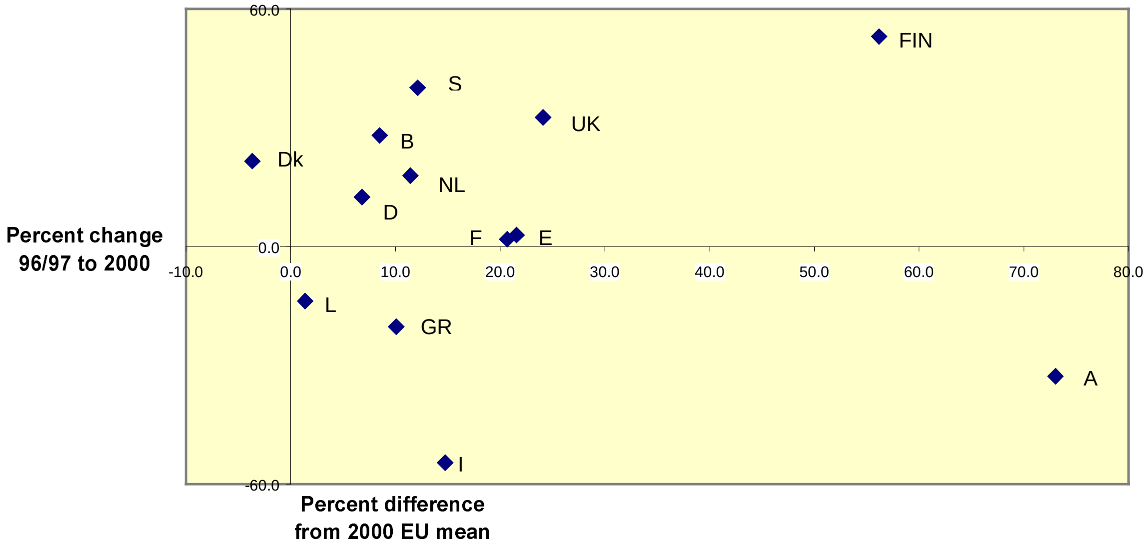
The percentage of the total working age population (25-64 years age classes) with some form of post-secondary education (ISCED 5 and 6).

Interpretation

This is a general indicator of the supply of advanced skills. It is not limited to science and technical fields because the adoption of innovations in many areas, particularly in the service sectors, depends on a wide range of skills. Furthermore, it includes the entire working age population, because future economic growth could require drawing on the non-active fraction of the population.

There is a high level of variability within the EU in terms of the available pool of high-level skills, ranging from 9.6 % of the working age population in Italy to 32.4 % in Finland. Given comparatively high per capita GDP, Italy and Austria have surprisingly low rates of tertiary education among the working age population. The rate in all EU countries lags behind the United States.

1.2 Population with tertiary education (Trend)



Trend results for 1996/1997 versus 2000. (Due to a break in the data series, it was not possible to include 1998 in the average). No reliable trend data for Ireland and Portugal.

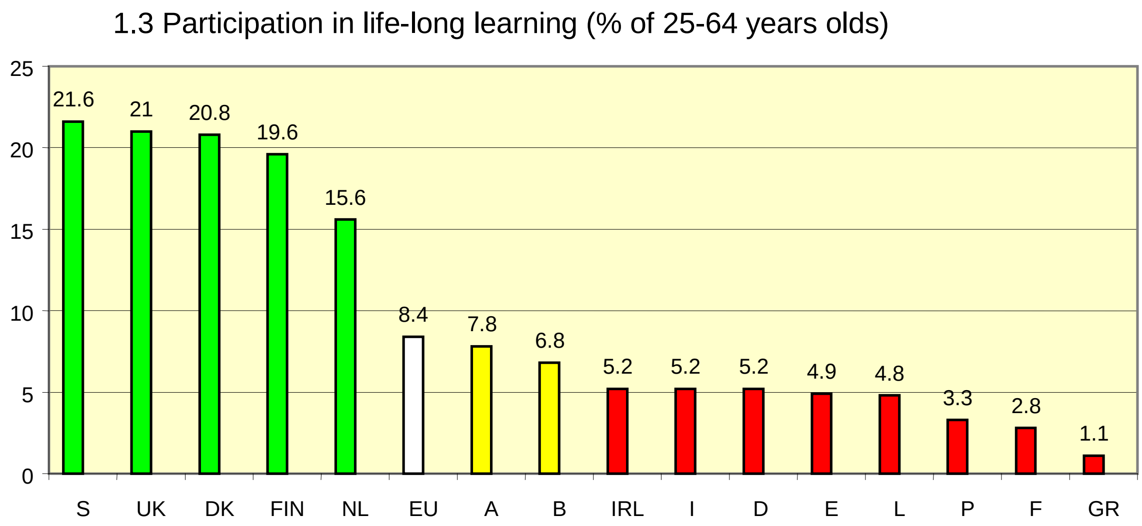
Trends

With the peculiar exception of Denmark, the indicator is growing or stable in all countries. The highest rates of increase have been in Austria and Finland, although these results could be affected by changes over time in the definition of a tertiary education. Otherwise, the tertiary education share has been increasing in Europe by between 0.5 and 1 percentage points per year, due to higher educational levels among younger age cohorts.

Disadvantages and advantages

International comparisons of educational levels are notoriously difficult due to large discrepancies in educational systems, access, and the level of attainment that is required to receive a tertiary degree. Therefore, the results should be interpreted cautiously.

1.3. Participation in life-long learning (% of 25-64 years olds)



The data are from the Eurostat Labour Force Survey. Data for Spring 2000, except for 1997 data for Austria and Ireland. No data for the US and Japan.

Definition

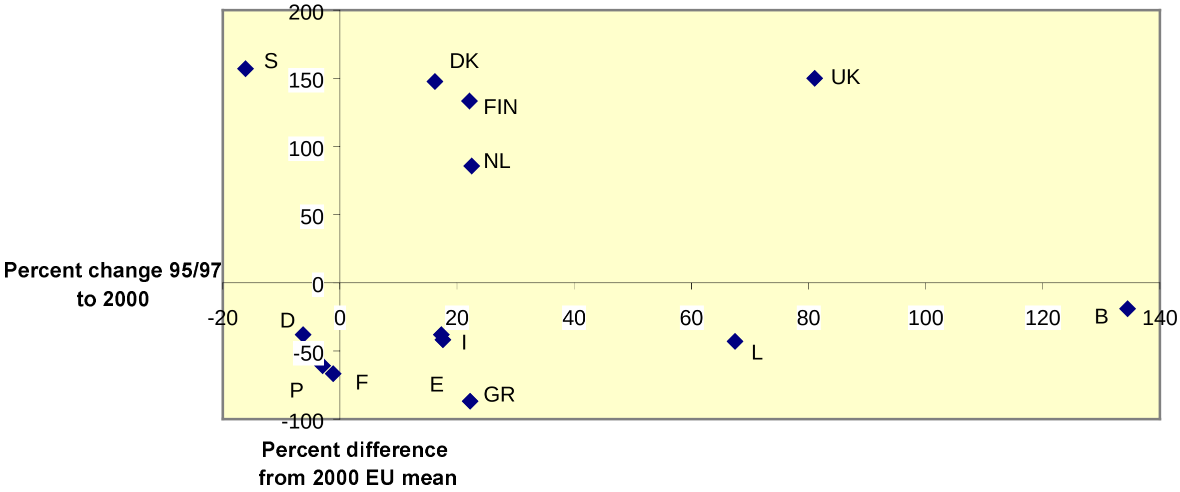
This indicator is equivalent to the European Commission's structural indicator 1.7. The reference population is all age classes between 25 and 64 years inclusive. Life-long learning is defined as participation in any type of education or training course during the four weeks prior to the survey, except in the Netherlands, France and Portugal where the respondent had to be involved in an education or training programme at the time of the survey. Education includes both courses of relevance to the respondent's employment and general interest courses, such as in languages or arts. It includes initial education, further education, continuing or further training, training within the company, apprenticeship, on-the-job training, seminars, distance learning, and evening classes.

Interpretation

A central characteristic of a knowledge economy is continual technical development and innovation. Under these conditions, individuals need to continually learn new ideas and skills - or to participate in life-long learning. All types of learning are valuable, since it prepares people for "learning to learn". The ability to learn can then be applied to new tasks with social or economic benefits.

The Scandinavian countries and the UK have the highest rates of life-long learning, followed by the Netherlands. Conversely, three of the largest EU economies, Italy, Germany, and France, have below average rates of adult participation in education and training, which pulls the EU average down. The low rates for France could be due to the French data being limited to education at the time of the survey, although the same limitation applies to the Netherlands, which has an above average rate of life-long learning.

1.3 Participation in life-long learning (Trend)



Trend results for 95/97 versus 2000, except for the UK, which compares 92/94 results to 2000. No trend results for Ireland and Austria.

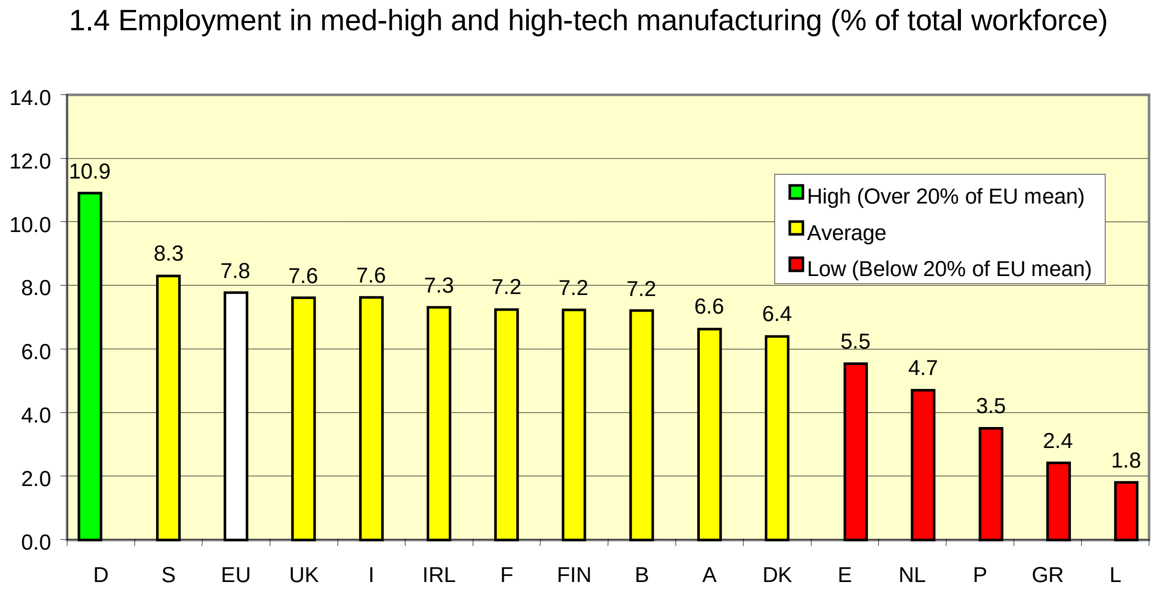
Trends

The trend data covers a definitional change. Before 1998, the indicator was limited to education and training of possible value to employment, while the data for 2000 includes all types of education. This change should magnify the percentage change between 1995/1997 and 2000. However, even with this change, the life-long learning rate in France and Germany has declined, possibly due to educational systems that limit opportunities for adults to pursue further education. All three of the Scandinavian countries, plus the Netherlands and the UK, are staying ahead, while Luxembourg and Belgium, in particular, should catch up to the EU average, due to rapid rates of increase.

Disadvantages and advantages

The limitation of the indicator to a brief window of four weeks in the Spring could reduce comparability between countries due to differences in adult education systems. Little is known at this time about such differences, but differences in the timing of national holidays, preferred times for adult education courses, the average length of adult courses, and other unknown factors could influence the results and reduce comparability.

1.4. Employment in med/high and high-tech manufacturing (% of total workforce)



The data are from the Eurostat Labour Force Survey. The results are for 1999 for all countries, except for 1998 results for Greece. No data for the US and Japan.

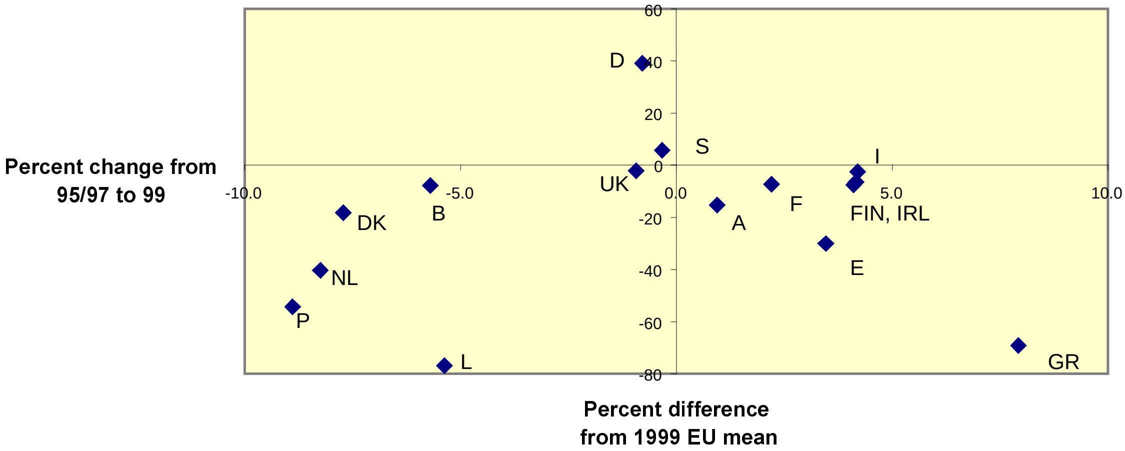
Definition

The medium-high and high technology sectors include chemicals NACE (24), machinery (NACE 29) office equipment (NACE 30), electrical equipment (NACE 31), telecom equipment (NACE 32), precision instruments (NACE 33), automobiles (NACE 34), and aerospace and other transport (NACE 35). The total workforce includes all manufacturing and service sectors. This indicator is equivalent to the indicator used to benchmark national R&D policies.

Interpretation

The percentage of total employment in medium-high and high technology manufacturing sectors is an indicator of the fraction of economic activity in manufacturing sectors characterised by high levels of innovative activity. Germany leads the EU in the share of employment in medium-high and high-technology manufacturing, while the shares are well below the EU average in Greece, Luxembourg and Portugal. Nine EU countries fall into the average category.

1.4 Employment in med-high and high tech manufacturing (Trend)



Trend results for Greece based on 95/97 versus 1998.

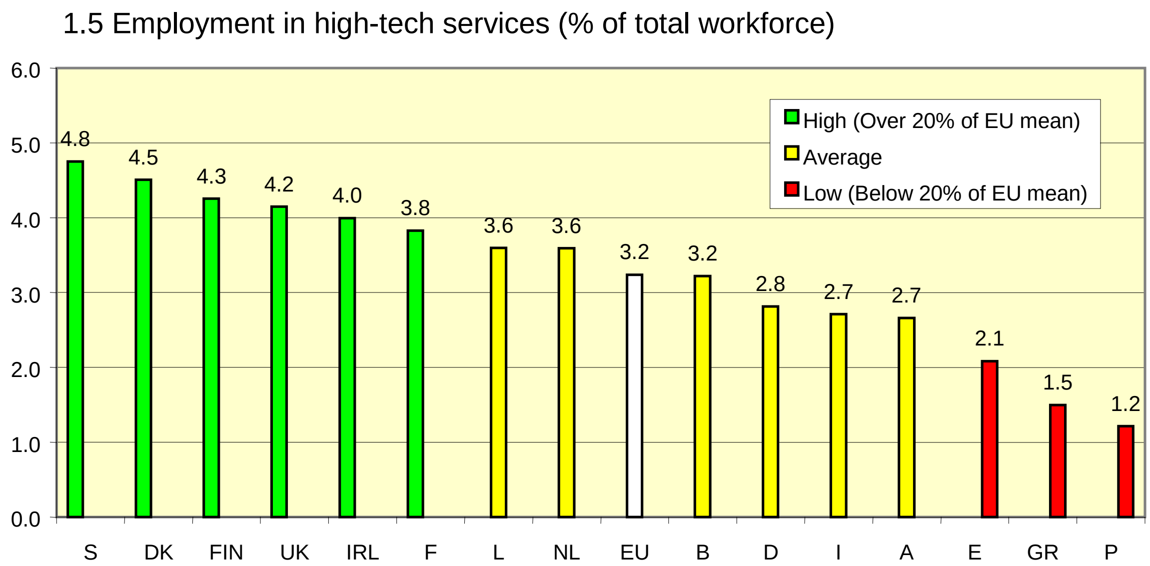
Trends

The trend results show that employment in medium-high and high technology manufacturing is declining in many EU countries, including several large economies such as Germany and the UK. The declines in several advanced economies such as Denmark and the Netherlands could be partly due to a shift out of manufacturing and towards services. Of interest, there are no countries with above average current rates of this type of employment and with a trend increase - quadrant 2 is empty. Greece has the highest rate of increase, although from a very low initial level. This type of employment is also increasing in Spain, Finland, and Ireland and to a lesser extent in France and Austria.

Disadvantages and advantages

The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.

1.5. Employment in high-tech services (% of total workforce)



The data are from the Eurostat Labour Force Survey. The results are for 1999 for all countries, except for 1998 results for Greece. No data for the US and Japan.

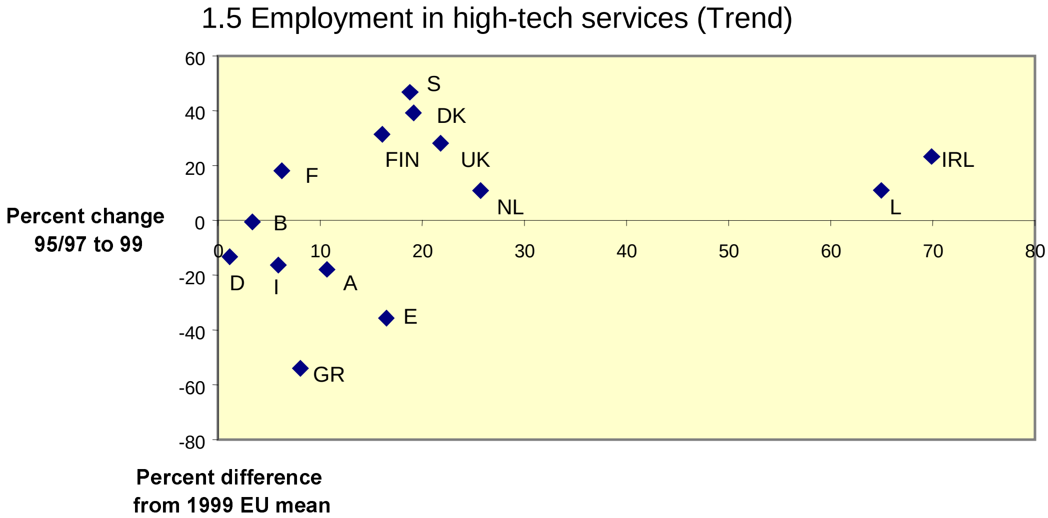
Definition, data source and year

This indicator focuses on three leading edge sectors that produce high technology services: post and telecommunications (NACE 64); information technology including software development (NACE 72); and R&D services (NACE 73). The total workforce includes all manufacturing and service sectors.

Interpretation

The high technology services both provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. High tech services, when properly used, can increase productivity in many economic sectors and support the diffusion of a range of innovations, particularly those based on ICT. Overall, only a very small percentage of total employment is in high tech services. The highest rates in the EU are in Sweden, Denmark and Finland.

In general, there is a moderate level of variability across the EU, with all countries falling within plus or minus 65 % of the mean. The highest scores are in countries that specialise in IT, such as Finland, Sweden and Denmark or in software, as in the UK.



Trend results for Greece based on 95/97 versus 1998. No data for Portugal.

Trends

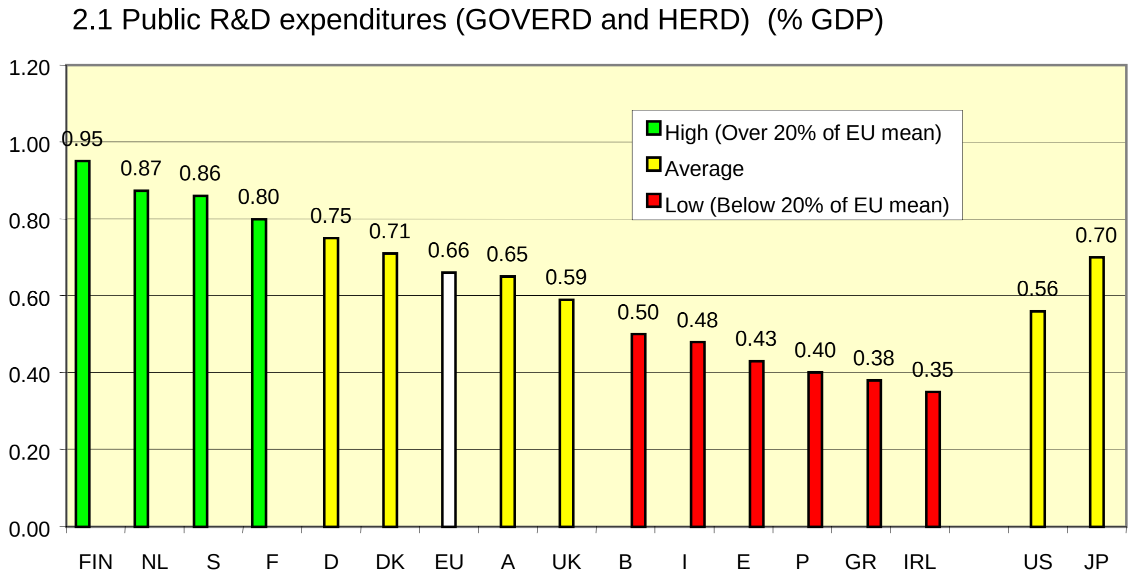
In contrast to employment in medium-high and high technology manufacturing, employment in high-tech services in growing in all countries. The fastest growth is in Luxembourg and Ireland. In general, the countries in quadrant 3 have lower growth rates than the leaders in quadrant 1, suggesting that they will have difficulty catching up with the leaders. This could result in areas of relative specialisation in high technology services, particularly in Scandinavia and the UK.

Disadvantages and advantages

The results depend on the importance of IT in manufacturing and to the degree of out-sourcing of R&D. The former partly explains the comparatively high shares for the Scandinavian countries. The comparable indicator on "knowledge intensive services" used to benchmark R&D policies produces much higher figures because it applies a broader definition including many other sectors, such as finance, health and social work.

2. CREATION OF NEW KNOWLEDGE

2.1. Public R&D expenditures (GOVERD and HERD) (% GDP)



Data from Eurostat. The data is for 1999 for nine countries: Denmark, Germany, Spain, Ireland, Italy, Finland, Sweden, UK, and Japan; for 1998 for three countries: France, the Netherlands, and the US; for 1997 for three countries: Belgium, Greece, and Portugal, and for 1993 for Austria. No data for Luxembourg.

Definition

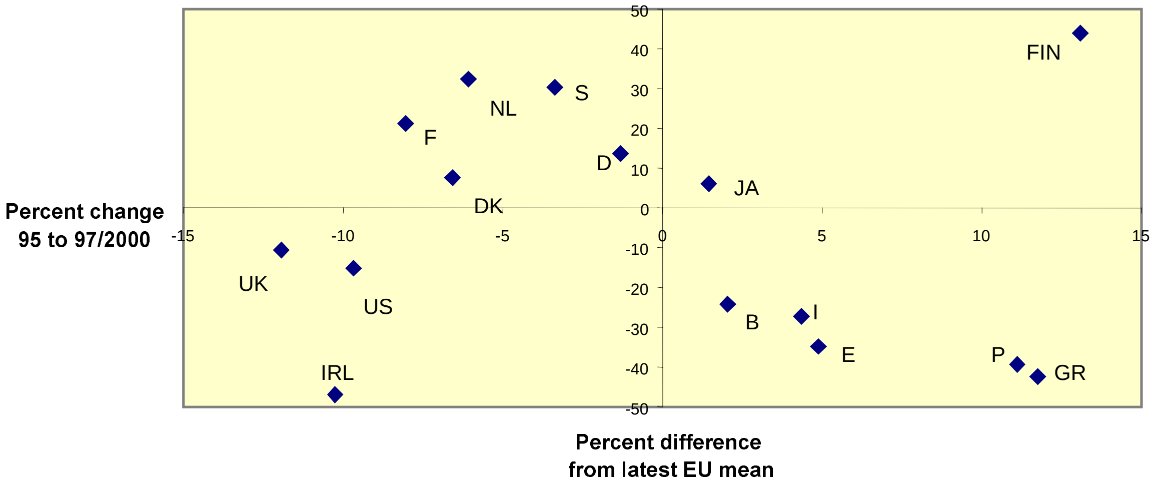
The indicator measures public R&D expenditures (from all sources of funding) by government organisations (GOVERD) and higher-education institutions (HERD). The "structural indicators" do not offer an indicator on public R&D expenditure. However, subtracting structural indicator 2.2.2 (total R&D expenditures) and 2.2.1 (business R&D expenditures) produces a figure that is very similar to this indicator. The only difference is due to "private non-profit" R&D expenditures, which account for less than 1% of all R&D spending in most EU countries.

Interpretation

In addition to the production of basic and applied knowledge in universities and higher-education institutions, publicly funded research offers several other outputs of direct importance to private innovation: trained research staff and new instrumentation and prototypes.

The highest rates of public R&D are in Finland, the Netherlands, Sweden, and France, all of which compare favourably with the US. Within the EU, Greece and Ireland fall well below the average. The poor results for Ireland, in particular, contrast with relatively good results for many other indicators.

2.1 Public R&D expenditures (GOVERD and HERD) (Trend)



No data for Luxembourg or Austria. The EU mean is based on the most recent data available, which varies by country from 1997 to 2000. The trend is based on a comparison with 1995, for which there is consistent data for most EU countries.

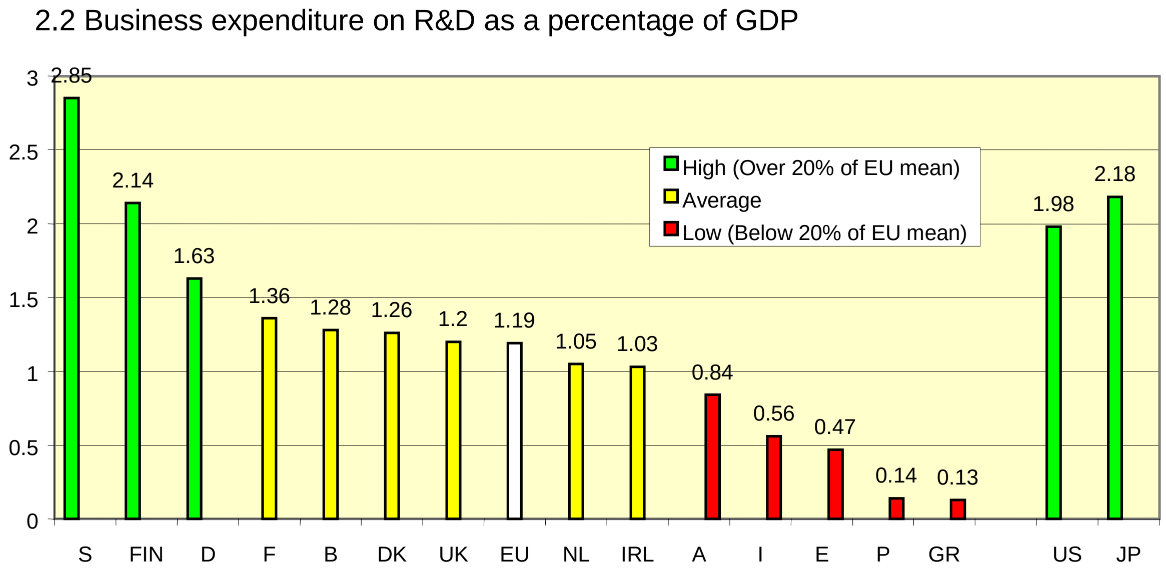
Trend

Finland has surged ahead of other countries in terms of public R&D spending. It currently has the highest rate of this type of R&D among the EU, the US and Japan, and it has the highest rate of increase in spending. All other EU countries with above average public R&D spending have experienced a decline in public spending (quadrant 1), while many of the lagging economies, including Italy, Spain, Portugal and Greece, have increased public spending. In contrast, both the UK and Ireland fall in quadrant 3 and are falling further behind. This will be less serious for Ireland since business R&D spending is increasing (see below), but in the UK business R&D has also been falling and the current level is below the EU average.

Advantages and disadvantages

The main disadvantage is that not all of public R&D is relevant to technical innovation, at least in the short and medium term.

2.2. Business expenditure on R&D (BERD) (% GDP)



Data from Eurostat. The data is for 1999 for seven countries: Denmark, Germany, Spain, Italy, Finland, Sweden, and US; for 1998 for five countries: Belgium, France, the Netherlands, the UK, and Japan; for 1997 for three countries: Greece, Ireland and Portugal, and for 1993 for Austria. No data for Luxembourg.

Definition

This indicator measures the R&D expenditure (from all sources of funding) of the business sector (manufacturing and services) as a percentage of GDP. The indicator is equivalent to the Commission's structural indicator 2.2.1 but different to the indicator used for benchmarking national research policies. The latter measures R&D *financed* by industry.

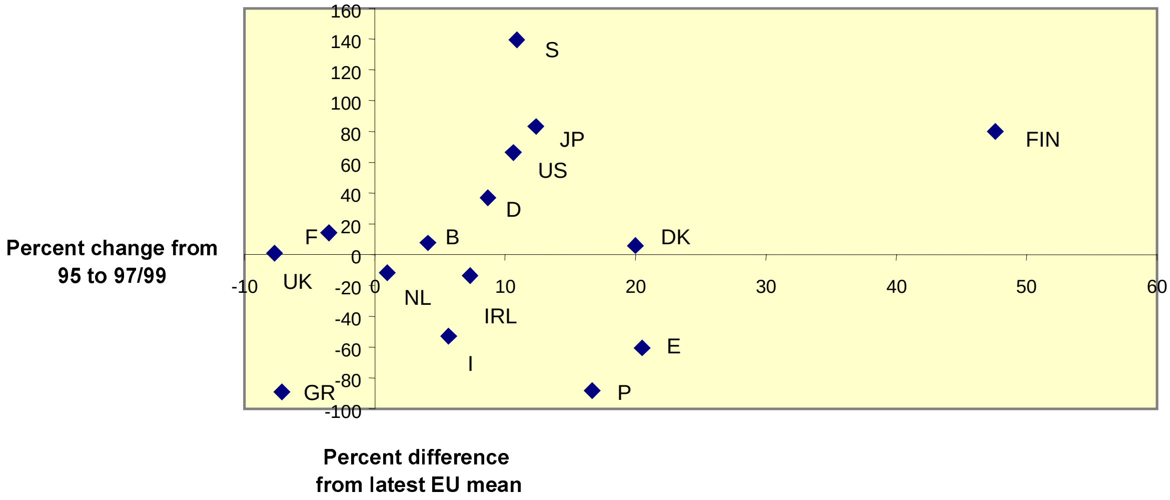
Interpretation

The indicator captures the formal creation of new technical knowledge by firms. It is particularly important in the science-based sectors (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.

All EU countries except Sweden and Finland have lower rates of business R&D than the US and Japan. Five EU countries spend less than 1 % of their GDP on business R&D.

Business R&D is not combined with public R&D because of large differences in their function, with the former primarily focused on applied research and development. Combining the results of the two R&D indicators shows that the EU as a whole compares very favourably with the US and Japan in terms of public R&D but much less so in terms of business R&D. The same EU countries, especially Finland and Sweden, are at the forefront for both indicators. These differences are partly due to the specialisation of Sweden and Finland in high technology sectors, which pulls up their average R&D intensity.

2.2 Business expenditure on R&D (BERD) (Trend)



No data for Luxembourg and Austria. The EU mean is based on the most recent data available, which varies from 1997 to 1999. The trend is based on a comparison with 1995, for which there is consistent data for most EU countries.

Trend

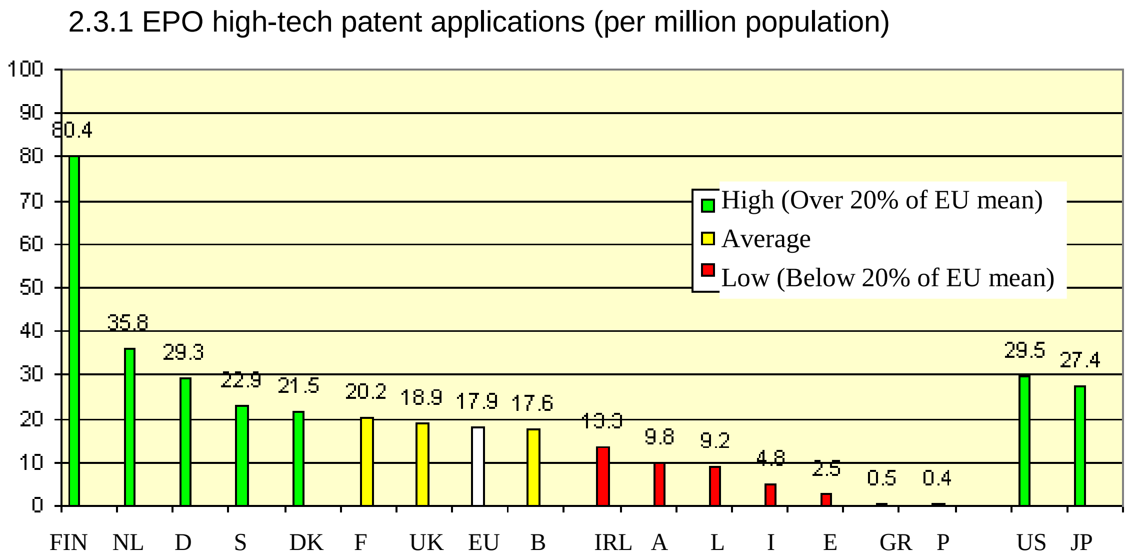
In contrast to public R&D spending as a share of GDP, which has declined in slightly over half of the countries, the business R&D share has increased in all but three countries: Greece, France, and the UK. The fastest rate of increase has been in Finland, which also has the fastest increase in public R&D spending. With the exception of Greece, all EU economies with below average business R&D have experienced an increase in business R&D, with Spain in the lead.

Advantages and disadvantages

There are two main disadvantages for this indicator. First, R&D is a poor measure of the innovative activities of small firms and in those industries where important sources of innovation are outside the R&D laboratory: e.g. in production engineering departments and design offices. Second, differences in aggregate R&D intensity across countries is partly due to differences in the structural mix of industries within each countries. A low average R&D intensity does not necessarily mean that firms in the country are below-average innovators in their industry. For example, countries with a concentration of production in low technology sectors will obtain a lower rank for this indicator than countries with a concentration in high technology sectors, even if firms in the former countries are highly innovative while firms in the latter countries are poor innovators in their respective industrial specialities. A preferable method is to use a standardised industrial distribution, but this creates an additional lag of one or two years in data availability.

2.3. High-tech patent applications

2.3.1. EPO high-tech patent applications (per million population)



Provisional data for all countries for 1999 from Eurostat and EPO.

Definition

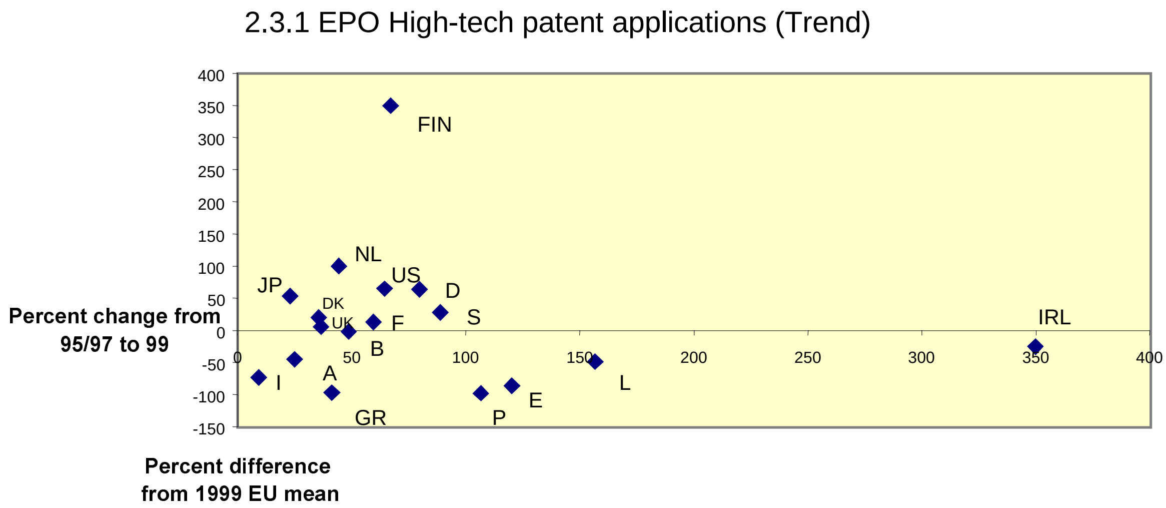
The indicator is the number of 1999 patent applications at the EPO in high-technology patent classes, per million population. The high technology patent classes include pharmaceuticals, biotechnology, information technology, and aerospace.

Interpretation

This indicator complements indicator 2.2 on business R&D in that patenting captures new knowledge created anywhere within a firm and not just within a formal R&D laboratory. The indicator also measures specialisation of knowledge creation in fast-growing technologies.

Of the four largest EU economies, only Germany is over 20 % above the average. Most of the smaller economies divide into two groups: either notably above or below the average, depending on their industrial specialisations.

The propensity to patent at the EPO as reflected by this indicator will be higher among inventors within EU countries than for those from outside the EU. This depresses the results for the United States and Japan. Indicator 2.3.2 is the equivalent indicator based upon US patent data. Both indicators in combination enable comparisons of the results for the US and Japan with the results for the EU countries.



Trend from the average for 1995 - 1997 versus 1999.

Trend

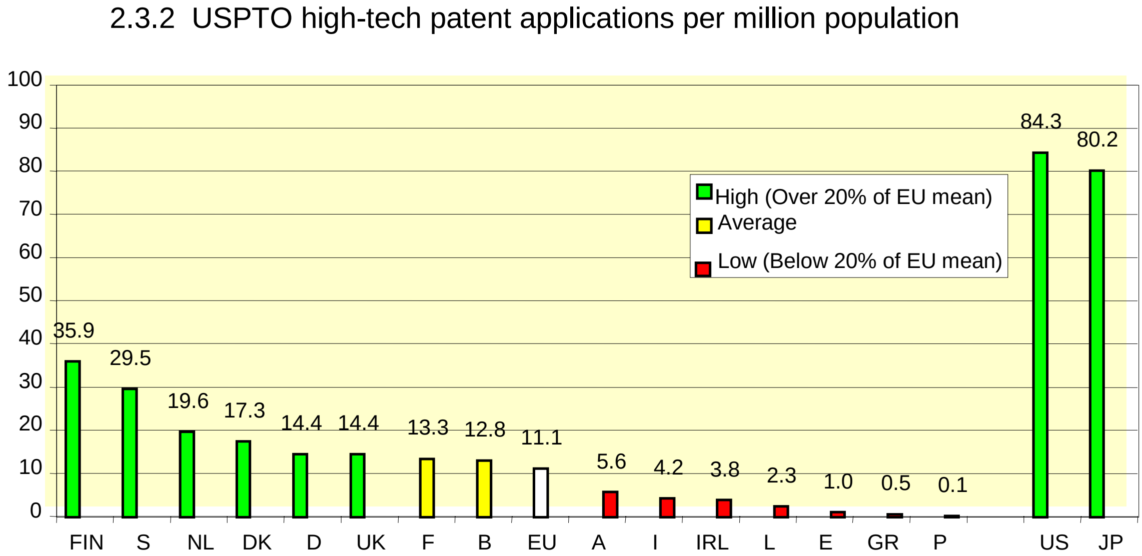
The most notable aspect of the EPO patent trends is that high-tech patenting has increased in all countries, with the fastest rate of increase in Ireland at 350 %. In most EU countries the rate of increase lies between 25 % and 100 %. The lowest rate is in Italy, at 9.2 %. At this rate, Italy will fall further behind, given much more rapid increases in other EU countries. The results for Greece and Portugal, although included in the graph, are not reliable, since they are based on a very small number of patents.

Advantages and disadvantages

The present indicator is limited to rapidly growing patent classes where innovation is science-driven and where a high percentage of all innovations are probably patented. This limitation acts to both measure inventive activity in the most promising new fields and prevents possible distortions due to low patent propensity rates. When only a relatively small percentage of inventions are patented, patents can reflect differences in the appropriation strategies of firms rather than differences in the underlying inventive activity. The indicator used to benchmark national R&D policies relies upon a different set of definitions.

The use of patents to measure innovation suffer from several well known drawbacks : patents vary enormously in quality, many patents are never commercially exploited, and national differences in the use of strategic patenting can distort international comparisons.

2.3.2. USPTO high-tech patent applications per million population



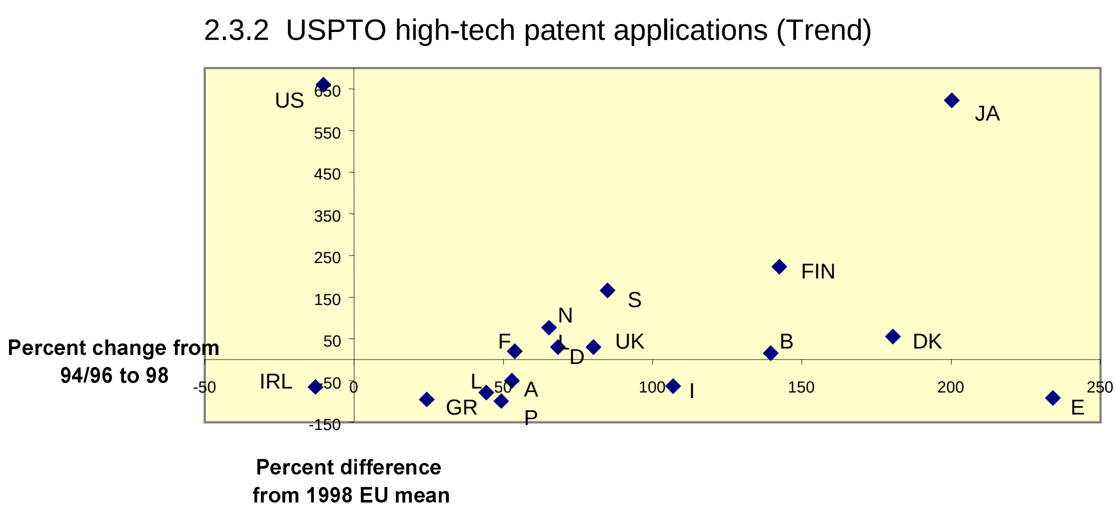
Provisional data for all countries for 1998 from Eurostat and USPTO.

Definition

The indicator is the number of 1998 patent applications at the US Patent and Trade Mark Office (USPTO) in high-technology patent classes, per million population. The high technology patent classes are the same as for the EPO based indicator 2.3.1 and include pharmaceuticals, biotechnology, information technology, and aerospace.

Interpretation

Indicator 2.3.1 above on EPO patent applications favours European versus American and Japanese firms. The present indicator provides the equivalent for American firms and measures US patenting activity by European inventors. Both Finland and Sweden do as well or better in US patenting as the US does in European patenting, as shown by the ratio of US to Finnish patents in Europe (2.7) and the reverse in the US (2.3). Generally, the rank order of European countries is very similar between EPO and USPTO patenting.



Trend

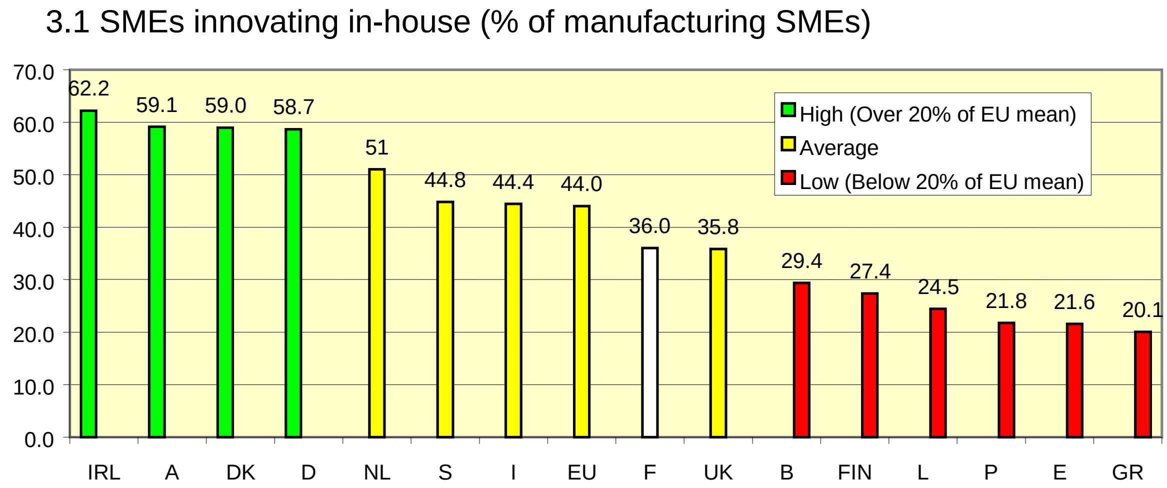
With the exception of the US and Ireland, patent rates at the USPTO have increased for all countries. The decline in Ireland contrasts sharply with the increase in Irish patents at the EPO. This raises questions regarding the source of the invention - is the EPO increase due to foreign firms applying for EPO patents through their Irish subsidiaries? The high rate of increase for Denmark and Finland is probably due to IT patents, while the strong increase for Belgium, otherwise an anomaly given Belgium's average standing for many other indicators, could be due to biotechnology patents. Due to low numbers, the reliability of trend results for Spain, Greece and Portugal is poor.

Advantages and disadvantages

This indicator is limited to rapidly growing patent classes where innovation is science-driven and where a high percentage of all innovations are probably patented. This limitation acts to both measure inventive activity in the most promising new fields and prevents possible distortions due to low patent propensity rates. When only a relatively small percentage of inventions are patented, patents can reflect differences in the appropriation strategies of firms rather than differences in the underlying inventive activity. The indicator used to benchmark national R&D policies relies upon a different set of definitions.

3. TRANSMISSION AND APPLICATION OF NEW KNOWLEDGE

3.1. SMEs innovating in-house (% of manufacturing SMEs)



No data for the US, and Japan. Results from the 1996 Community Innovation Survey (CIS), except for 1998 national results for the Netherlands, Greece and Spain. The EU mean is based on the 1996 CIS.

Definition

The CIS defines innovative manufacturing firms quite broadly as those who introduced new products or processes developed by 1) other firms, 2) in house, or 3) in combination with other firms. The present indicator is more focused in two respects. It is limited to SMEs because almost all large firms innovate and because countries with an industrial structure weighted to larger firms would tend to do better. And, it is limited to firms with in-house innovative activities that either develop product or process innovations themselves or in combination with other firms. The comparable indicator used to benchmark national R&D policies applies the broad CIS definition that includes innovations developed by other firms.

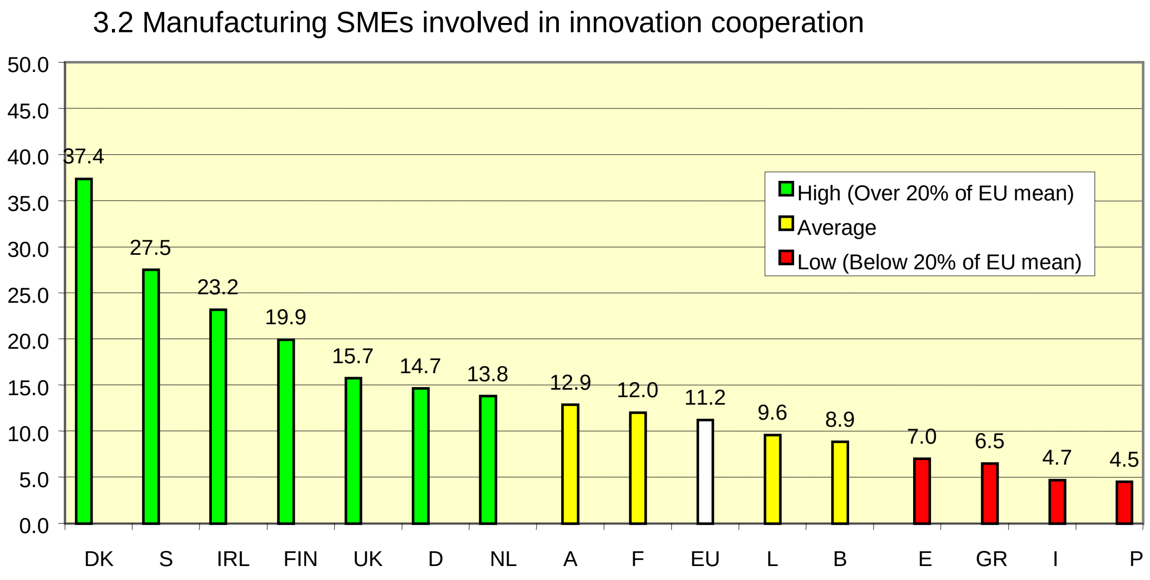
Interpretation

The results provide some surprises. Finland has a below average percentage of innovative SMEs, which contrasts with very high results for the indicators on human resources and knowledge creation. One explanation is that much of Finland's innovative activity is concentrated in large firms. Conversely, Austria has an above average percentage of innovative SMEs, which contrasts with its low scores on other innovation indicators.

Advantages and disadvantages

The major disadvantage is that the definition of an 'innovation' is open to subjective interpretation, although the survey does give several examples and tries to limit innovation to 'significant' technical improvements or advances.

3.2 Manufacturing SMEs involved in innovation co-operation



Results from the 1996 Community Innovation Survey (CIS), except for 1998 national results for the Netherlands, Greece and Spain. The EU mean is based on the 1996 CIS. No data for the US and Japan.

Definition

The indicator is the percentage of all manufacturing SMEs (including non-innovators) that had any co-operation agreements on innovation activities with other independent enterprises or institutions in the three years before the survey.

Interpretation

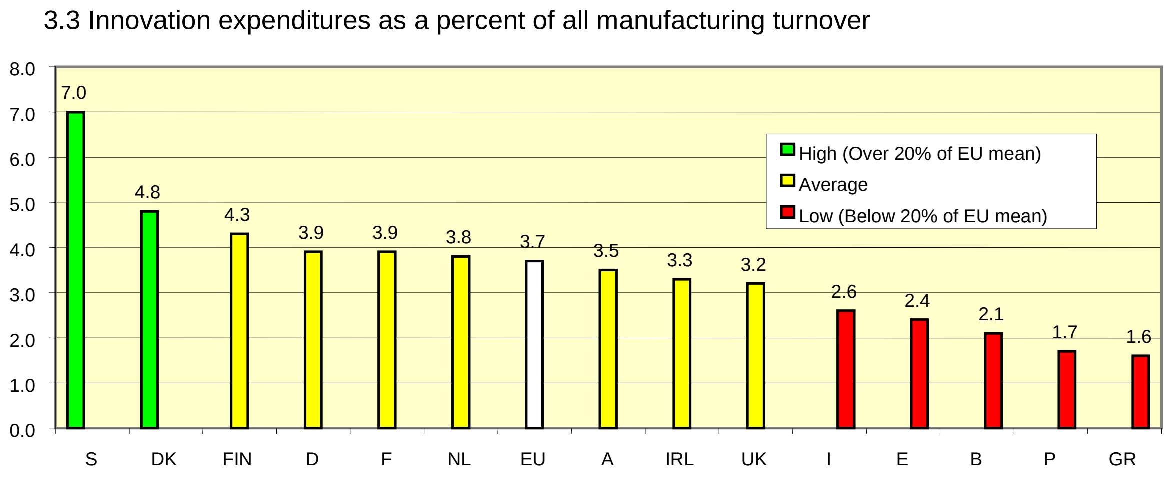
Complex innovations, particularly in ICT, often depend on the ability to draw on diverse sources of information and knowledge, or to collaborate on the development of an innovation. This indicator is a proxy for the existence of some knowledge transfer between public research institutions and firms and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation co-operation. This indicator also captures technology-based small firms, since most are involved in co-operative projects.

The Scandinavian countries plus Ireland have the highest percentage of SMEs that co-operate on innovation. This could be due to sectoral effects (all four of these countries are leaders in IT) or due to other factors that have built up close networks of innovative firms. Three of the four largest economies are above the average – Germany, France and the UK – while Italy has a very low rate of co-operation, similar to that of Spain and Portugal. The low rate for Italy is unexpected, given the large literature on the close-knit networks of innovative SMEs in Northern Italy.

Advantages and disadvantages

The main advantage of this indicator is that it is based on a simple yes or no question and the definition of innovation co-operation is relatively straightforward. However, the indicator does not measure the amount of knowledge transfers to SMEs. It only indicates that some transfer could be occurring through cooperation.

3.3. Innovation expenditures (% of all turnover in manufacturing)



Results from the 1996 Community Innovation Survey (CIS), except for 1998 national results for Germany, Greece and Spain. The EU mean is based on the 1996 CIS. No data for Luxembourg, the US and Japan.

Definition

This indicator includes all manufacturing firms with more than 19 employees. Innovation expenditures includes the full range of innovation activities: in-house R&D, extramural R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licenses, industrial design, training, and the marketing of innovations. Total innovation expenditure by all firms in each country is divided by total turnover. This includes firms that do not innovate, whose innovation expenditures are zero by definition.

Interpretation

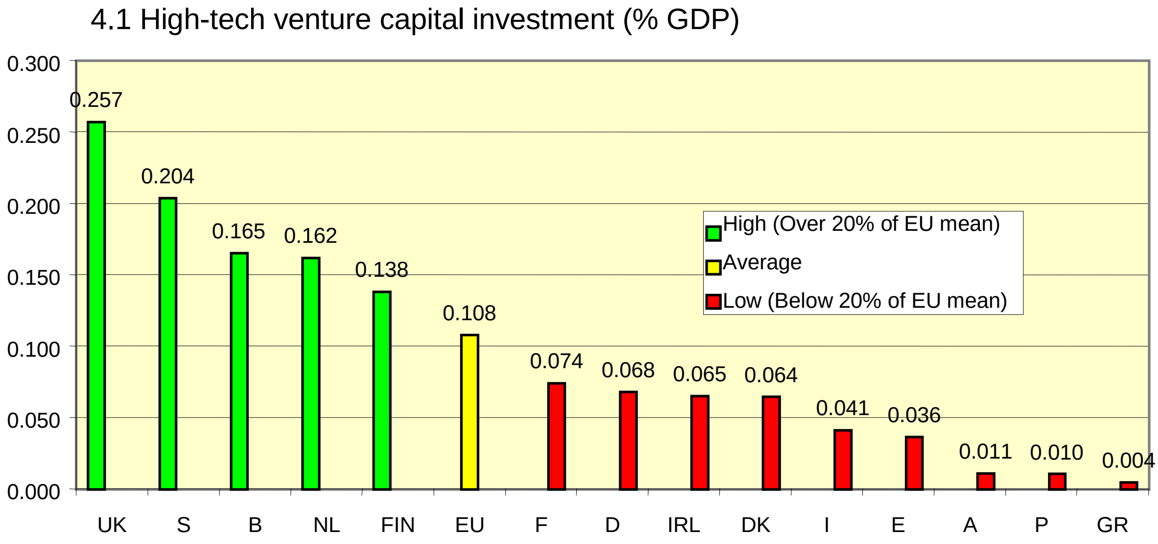
Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measures the diffusion of new production technology and ideas. Overall, the indicator measures total expenditures on many different activities of relevance to innovation. The majority of EU countries have average innovation expenditures, while Sweden is notably higher and Portugal and Spain are well below the average. The clustering near the average is partly because firms that spend little on R&D tend to spend proportionately more on new equipment and machinery (essentially buying in innovations). The result is that the variation in total innovation expenditures is much less than that for business expenditures on R&D (see 2.2) or patenting (see 2.3).

Advantages and disadvantages

The indicator partly overlaps with indicator 2.2 on R&D expenditures. A better version would exclude R&D, but concerns over data reliability have prevented this option. The question also suffers from relatively high item non-response, indicating that many respondents found it difficult to answer these questions. The advantage of this indicator is precisely that it includes all innovative activities. It shows how some firms, countries or sectors that are weak R&D performers can shift towards the mean, in comparison with other indicators such as patents or R&D intensity, by investing proportionately more in innovative equipment and machinery.

4. INNOVATION FINANCE, OUTPUT AND MARKETS

4.1. High-tech venture capital investment (% GDP)



Venture capital data from the EVCA mid-year 2000 survey, GDP data from the OECD. The results are for the first half of 2000 except for 1999 data for Germany. Since venture capital grew across the EU by 23 % between 1999 and 2000, this is likely to depress the result for Germany compared to other EU countries. No data for Luxembourg, the United States, and Japan.

Definition

This indicator measures venture capital by GDP in high technology firms active in the following sectors: computer related fields, electronics, biotechnology, medical/health, industrial automation, financial services. Venture capital is the sum of early stage capital (seed and start-up) plus expansion capital [36]. The indicator is limited to venture capital in high technology sectors for two reasons: these areas are the drivers of current and future innovation across many different sectors and venture capital investments in retail services, tourism or transport are considerably less likely to involve technical innovation. In contrast, structural indicators 2.7.1 and 2.7.2 include investment in all sectors. Data for early stage venture capital only *and* in high-tech sectors are not available.

Interpretation

One of the main barriers to innovation is the ability of new technology-based firms to raise adequate funding. This indicator measures the supply of private venture capital to these firms. The total supply of capital will be higher because of bank and private-placement financing.

Venture capital investment rates are highest in the UK (partly due to investment in the medical/health and biotechnology sectors), in two innovative Scandinavian countries, Finland

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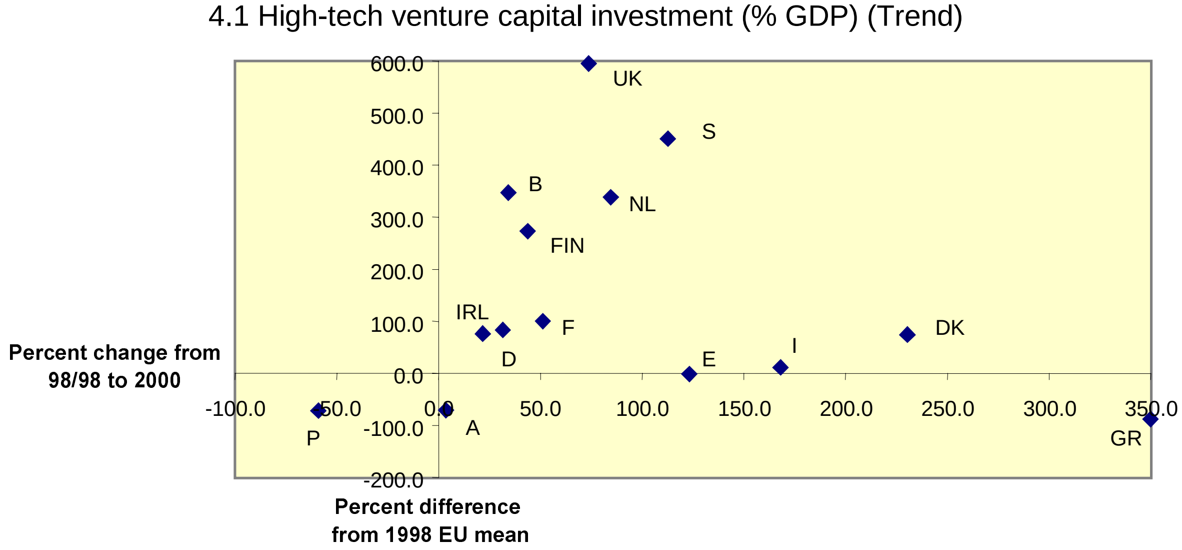
[36] Across Europe, 43.9 % of venture capital in high technology firms was for seed or start-up capital, while another 41.7 % was for expansion.

and Sweden, and in Belgium and the Netherlands. High-tech venture capital rates are very low in Austria, Greece and Portugal.



Result for Germany is the percentage change between 1998 and 1999. No data for Luxembourg.

Trend

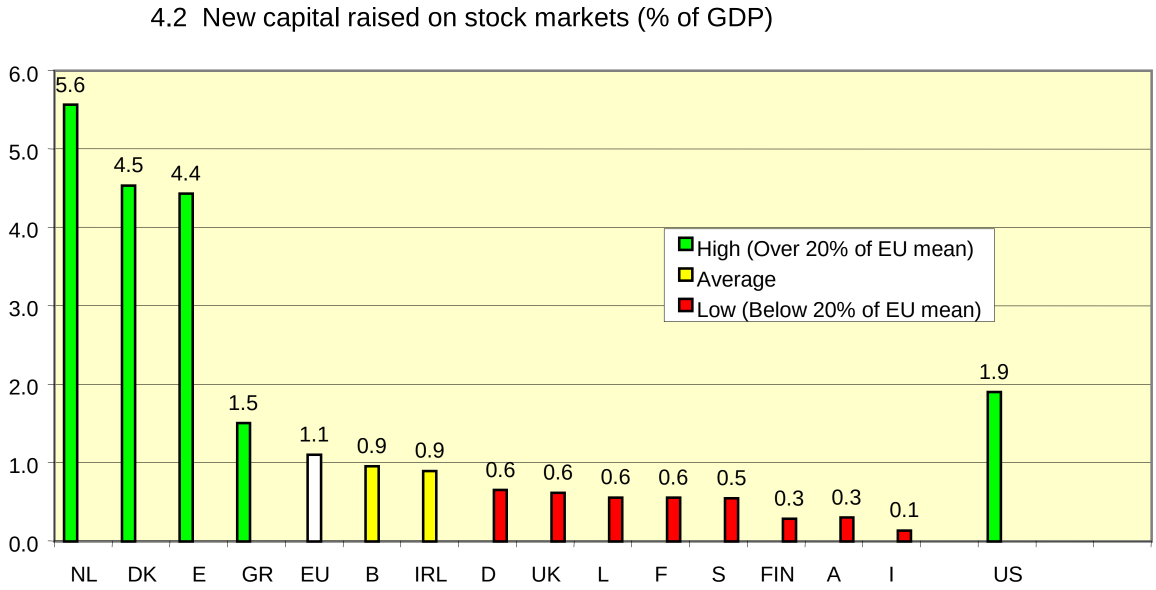
Due a change in the definition of high technology sectors at EVCA, the trend data is only based on the percentage difference between the first half of 2000 and the average for 1998-1999. The trend for high-tech venture capital is positive in all countries except for Portugal, although the result could be an anomaly, due to large year to year fluctuations because of low levels of venture capital in Portugal. The fastest growth rates in high technology venture capital are in Denmark and Greece.

Advantages and disadvantages

The main disadvantage is that there are many alternative methods of financing new technology-based start-up firms that are not covered by this indicator. Firms can also go abroad to raise venture capital. An additional concern is the lack of information on the accuracy of the venture capital data.

Venture capital supply rates could also have peaked in the first half of 2000 and declined thereafter, given a decline in the value of equity investment following the collapse in the dot.com market.

4.2. New capital raised on stock markets (% of GDP)



Data from the International Federation of Stock Exchanges (FIBV) for 1999 for all countries. No data for Portugal or Japan.

Definition

This indicator is the amount of new capital raised by domestic firms on domestic stock markets as a percentage of GDP. It excludes investment funds and unit trusts. And, in order to focus the indicator on new innovative firms, the indicator excludes capital raised by existing firms on the main stock exchanges. Three types of new capital are included: 1) capital raised by newly admitted firms to the main stock exchanges, 2) capital raised on parallel markets by already listed firms, and 3) capital raised on parallel markets by newly admitted firms. The focus on new capital that is probably raised by innovative firms in high technology sectors differentiates this indicator from Eurostat's structural indicator 3.7, which includes all capital raised on stock markets, including capital raised on the main markets. Parallel stock exchanges are focused on high technology sectors, and include Nasdaq in the US and Neuer Markt in Germany. The data for the US is based on only two stock exchanges: NYSE and Nasdaq.

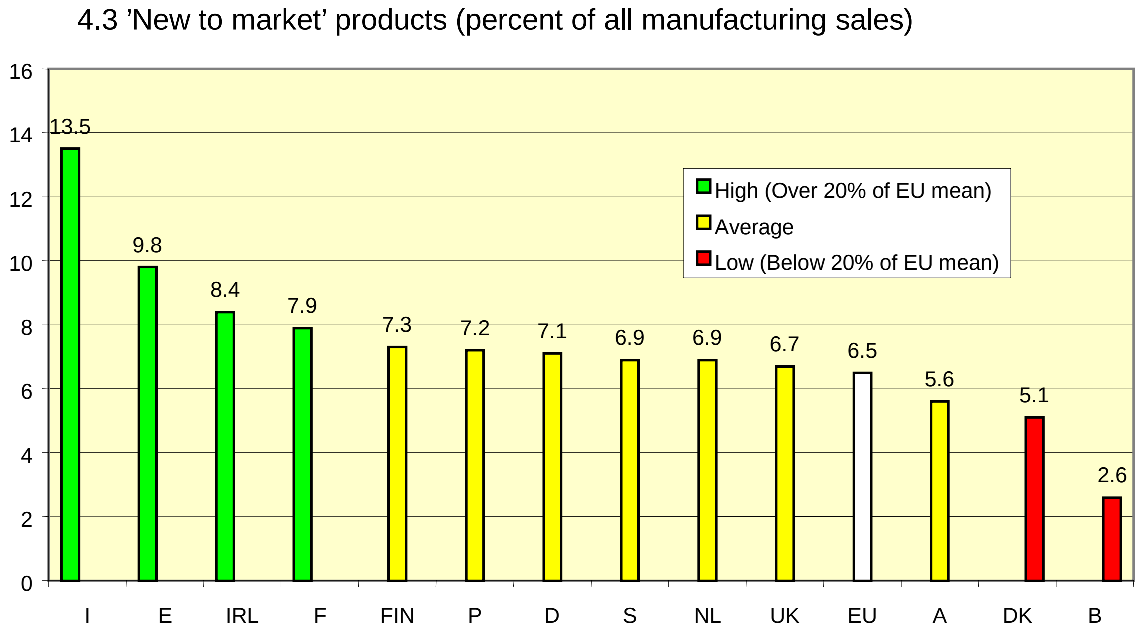
Interpretation

New capital is a major source of investment for many firms, but particularly for fast growing firms in high technology sectors. In contrast to many other innovation indicators, countries such as Spain and Greece have above average results, while the rates are very low in Sweden and Finland. This could partly be due to the ability of Swedish and Finnish firms to raise capital in foreign markets.

Advantages and disadvantages

This indicator has several disadvantages. The indicator is strongly influenced by volatility in capital markets, it includes stocks that have little to do with technology, and the results will be distorted by firms raising capital in foreign markets. No trend data is available.

4.3. 'New to market' products (% of sales by manufacturing firms)



Results from the 1996 CIS, except for 1998 data for Germany and Spain. The EU mean is based on the 1996 CIS. No data for Luxembourg, Greece, the US and Japan. Data

Definition, data source and year

This CIS-2 indicator provides the percentage of all 1996 (or 1998, where relevant) product sales, by manufacturing firms with more than 20 employees, from innovations that are new to the firm's market. These are limited to products that are both new to the firm itself and new to the firm's market.

Interpretation

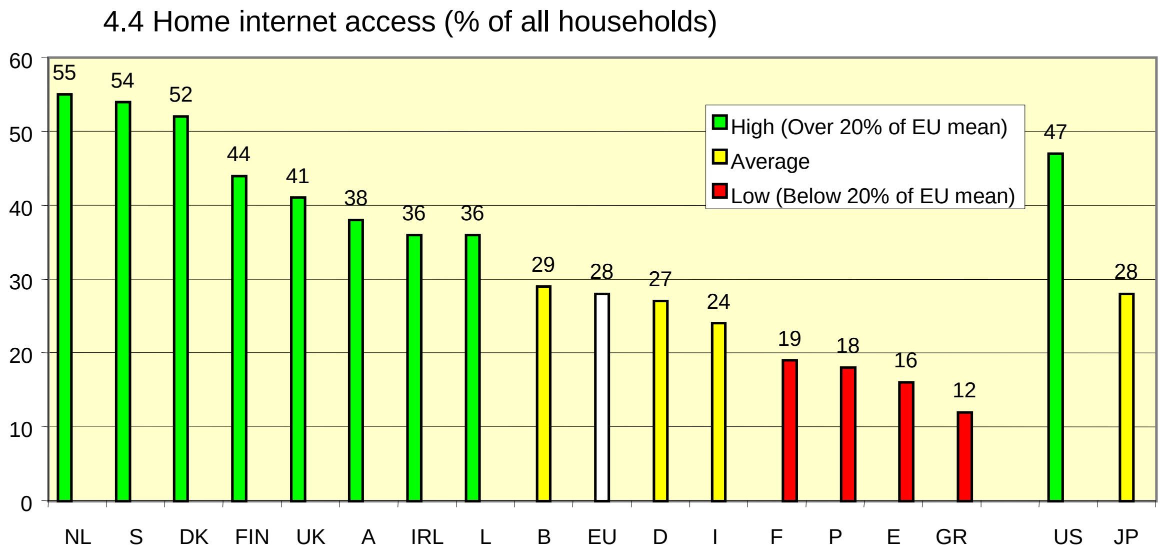
With the exception of Italy, the sales share for new to market products lies within a narrow range of between 2.6 % for Belgium and 9.8 % for Spain. Of interest, the results are above average for less innovative economies such as Spain and Italy. This could be due to differences in how the indicator is interpreted by respondents. A 'new-to-market' product includes both products that are sold for the first time in a geographical market and world-first innovations. It is possible that the Spanish and Italian respondents are referring to the first option.

The above average results for Ireland could be due to rapid change in the IT sector, with Irish foreign subsidiaries introducing new product improvements onto the European market. The results for Italy are an anomaly, since Italy falls near or below the average for most innovation indicators. This intensifies concerns that the high score for Italy is due to a different interpretation over what is 'technologically new'.

Advantages and disadvantages

This is a direct output measure of innovation that is not distorted by market speculation (as would the market value of a firm). The product must be new to the firm, which in many cases will also include innovations that are world-firsts. The main disadvantage is that there is some ambiguity in what constitutes a 'new to market' innovation. Smaller firms or firms from less developed countries could be more likely to include innovations that have already been introduced onto the market elsewhere.

4.4. Home internet access (% of all households)



Data for Europe from Eurobarometer and for the US from the US National Telecoms and Information Administration, Economics and Statistics. The results for Japan are estimated from data from private sources (Media Metrix) and the Japanese Posts and Telecommunications Ministry All results are for October 2000.

Definition

Percentage of citizens who have internet access at home. All forms of use are included. Population considered is equal to or over 15 years old. This indicator is equivalent to the "structural indicator" 2.4b.

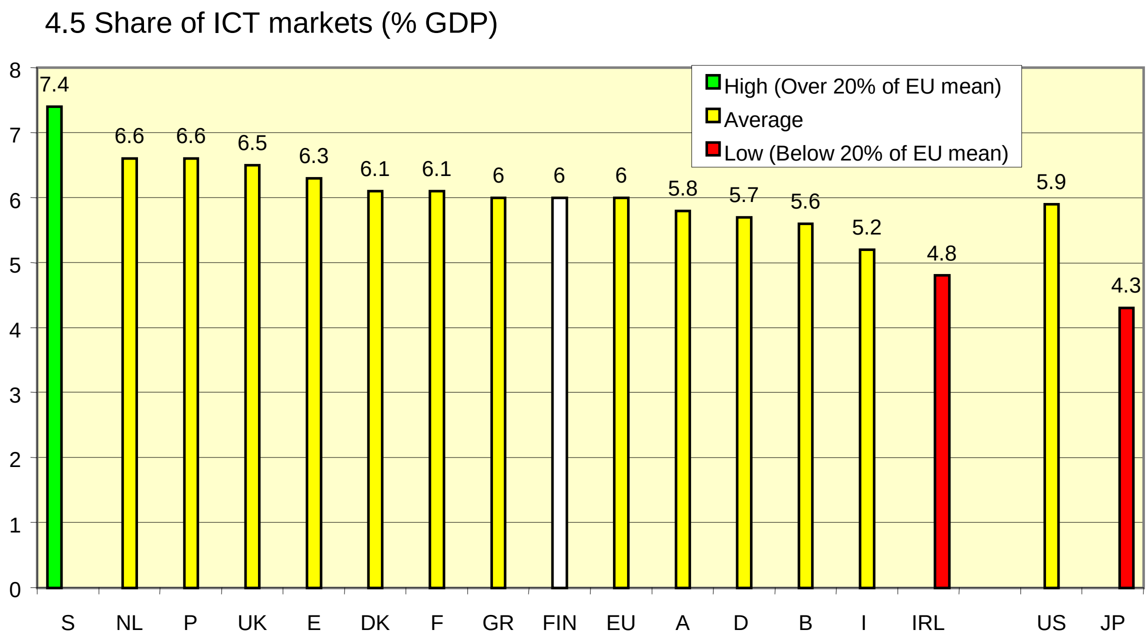
Interpretation

Internet use by the domestic population is a measure of the ability to access an enormous wealth of data on-line, including business-to-consumer e-commerce and government-to-citizen online services. Domestic access in Europe is highest in the Netherlands and in Scandinavia, followed by the UK, while the lowest rates are in the Mediterranean countries. Domestic access in the United States lags behind the Netherlands, Sweden, and Denmark. The low use rate for France could also be due to the widespread diffusion of Minitel in France, which provides some of the same services.

Advantages, disadvantages and trends

In the future, much more sophisticated measures of internet use will be needed. Better data is needed on what the internet is used for and if the population is aware of several efficiency enhancing uses. For this reason, this indicator is only temporary and unlikely to last, in its current form, for more than one or two years. Trend data for this indicator is not particularly relevant nor reliable, due to rapid growth rates in internet use accompanied by changes in how individuals access the Net.

4.5. Share of ICT markets (% GDP)



Data from EITO and available in Eurostat's structural indicators. All results for 2000. Data for Luxembourg included in Belgium.

Definition

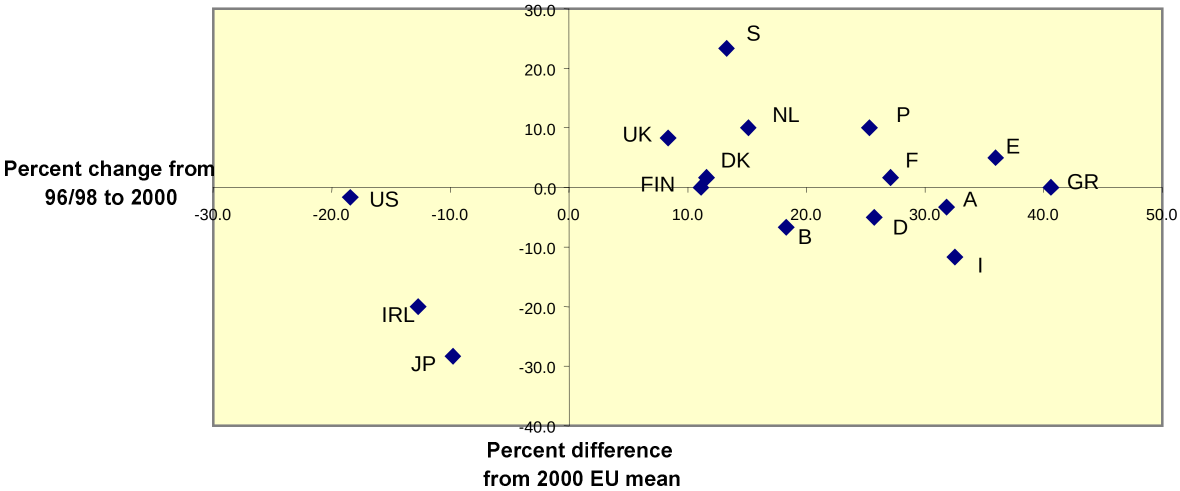
This indicator is equivalent to the Commission's structural indicator 2.3. It measures total expenditures on Information and Communication Technology (ICT) as a percentage of GDP. ICT includes office machines, data processing equipment, data communication equipment, and telecommunications equipment, plus related software and telecom services.

Interpretation

ICT is a fundamental feature of knowledge based economies and the driver of current and future productivity improvements. There is very little variation in the EU, with all countries falling within plus or minus 25 % of the EU mean. This is a much narrower range than for all other indicators in this report. The EU mean is slightly higher than the investment rate in the US, while Japan lags behind Europe.

Investment in Finland is close to the mean, although Finland's industrial structure is concentrated in ICT, and Finland is one of the world leaders in many ICT related indicators.

4.5 ICT expenditures / GDP (Trend)



No trend data for Luxembourg.

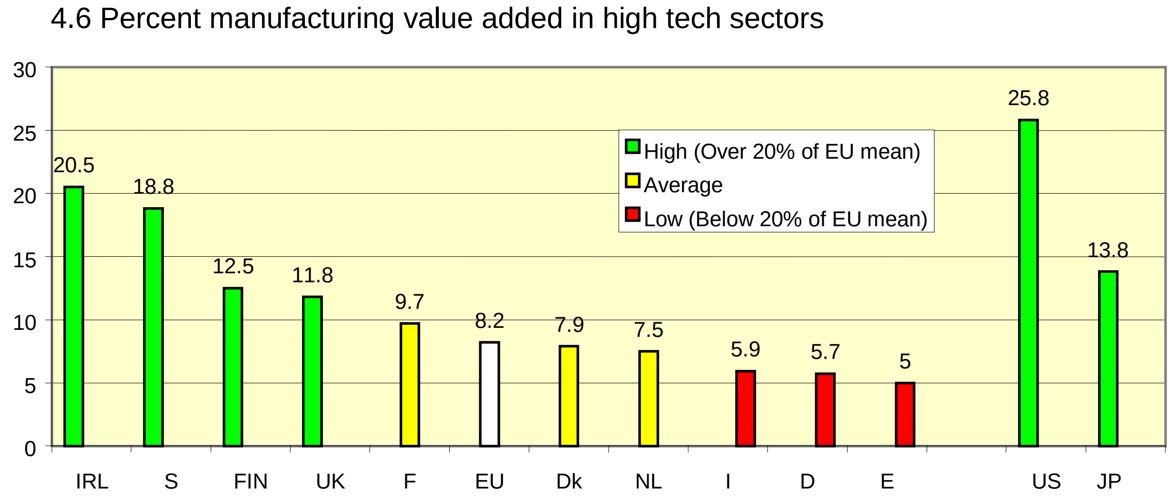
Trends

There is a surprising decline in the ICT indicator for Ireland and the US, both of which have current ICT investment rates below the EU average. However, past ICT investment could explain these results. For example, the highest trend rates are in a cluster of lagging economies: Greece, Italy, Austria and Spain, while much lower ICT trend rates are found in Europe's ICT leaders: Sweden, Finland, Denmark, and the Netherlands. The results suggest that there could be an inverse correlation between the installed base in ICT (highest in the US and lowest in Greece) and both current ICT investment rates and the recent trend.

Advantages and disadvantages

An indicator for ICT investment is crucial for capturing innovation in knowledge-based economies, particularly due to the diffusion of new IT equipment, services, and software. One disadvantage of this indicator is that it is obtained from private sources, with a lack of good information on the reliability of the data. A second disadvantage, as noted in the discussion of trends, is that investment could vary depending on the installed base.

4.6. Percent of manufacturing value-added in high tech sectors



Data from Eurostat (Structural Business Statistics). No data for Austria, Belgium, Greece, Luxembourg, and Portugal.

Definition

This indicator is the percentage of total value added in manufacturing in four high technology industries: pharmaceuticals (NACE 2421), office equipment (NACE 30), telecommunications and related equipment (NACE 32), and aerospace (NACE 35.3). The EU mean is limited to results in the 10 EU countries for which data are available.

Interpretation

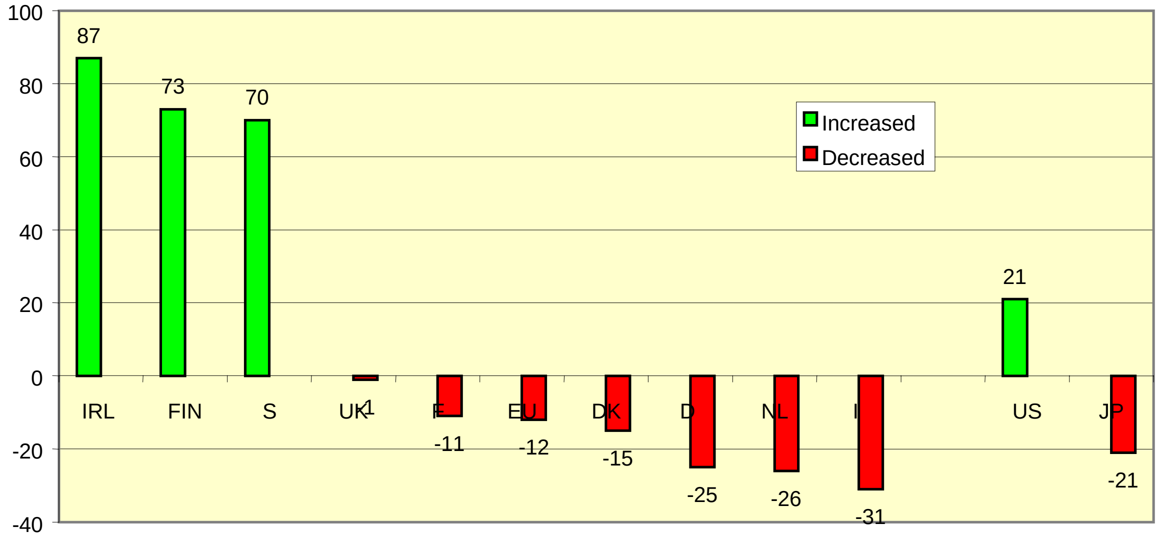
Value-added is the best measure of manufacturing output, whereas other indicators such as total production can be biased by 'screwdriver' plants with little value-added.

Within Europe, Ireland, Sweden, Finland, and the UK have the highest share of high technology value-added. The results for Finland, and Sweden are due to the explosion of the ICT sector in these two countries, while the UK benefits from aerospace and pharmaceuticals. The results for Germany and Italy are below average, partly because German manufacturing is concentrated in medium-high technologies such as automobiles and chemicals. The United States has the highest manufacturing value-added share from high technology, at 25.8 %.

Trends

Trend data are not available for this indicator, due to missing data for several countries at the four digit NACE level for several sectors. However, a close alternative is the percentage change, between 1993 and 1997, in the national share of the total value-added from high technology sectors in the EU, US and Japan (the Triad). The EU data is limited to ten countries (the remaining five account for less than 10 % of EU value added in high technology). In addition, it is not possible to separately identify aerospace (NACE 35.3) from other sub-sectors in NACE 35. The trend data have one advantage over the related indicator given above: they are unaffected by a change in the relative share of manufacturing in each national economy.

4.6 Share of TRIAD high-tech value-added (Trend 1993 -1997)



Within Europe, Ireland, Finland, and Sweden have been remarkably successful in increasing their share of high technology value-added, due to the growth of the ICT sectors in these countries. The UK is barely holding its position, with a one percent decline in its share of high technology value-added. This shows that the relatively good standing of the UK for this indicator is partly due to a hollowing out of manufacturing, in which the value added of low and medium technology manufacturing has declined. The other three large EU economies, Germany, France, and Italy, have all experienced a decline in their share of high technology value added within the Triad. Outside of Europe, the United States has increased its share by a respectable 21 %, while Japan's share has fallen by more than the EU average.

Advantages and disadvantages

The requirement for good data on value added creates a lag of two or more years longer than for GDP and other economic data. The main disadvantage of the main indicator is that a hollowing-out of manufacturing, as in the UK, can lead to relatively good results, if low and medium technology industries no longer survive. This problem does not affect the Trend indicator.