Benchmarking National R&D Policies
Consequences for Austria

tip-Workshop „Benchmarking Science and Technology Policy II“

Vienna, 25-26 November 2002

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Overview

- **Relevance and validity** of RTD benchmarking for national policy making
- **Austria‘s position** in the benchmarking exercise: Selected evidence from the benchmarking reports
- **Conclusions**
  - for Austrian policy
  - for EU policy
  - for future benchmarking activities

Relevance and validity

- **The role of benchmarking in the policy-making process**
  - „Food for thought“ - What can we learn from the figures about the operation of the innovation system?
  - Clear limitations of transfering „best practices“: There is no single model?

- **How to interpret the findings appropriately?**
  - Do the figures confirm or contradict „established wisdom“?
  - Are the interpretations unequivocal?
  - Do the findings point to problems in the innovation system?

Positioning Austria and the EU: The Aggregate Picture

Focus:

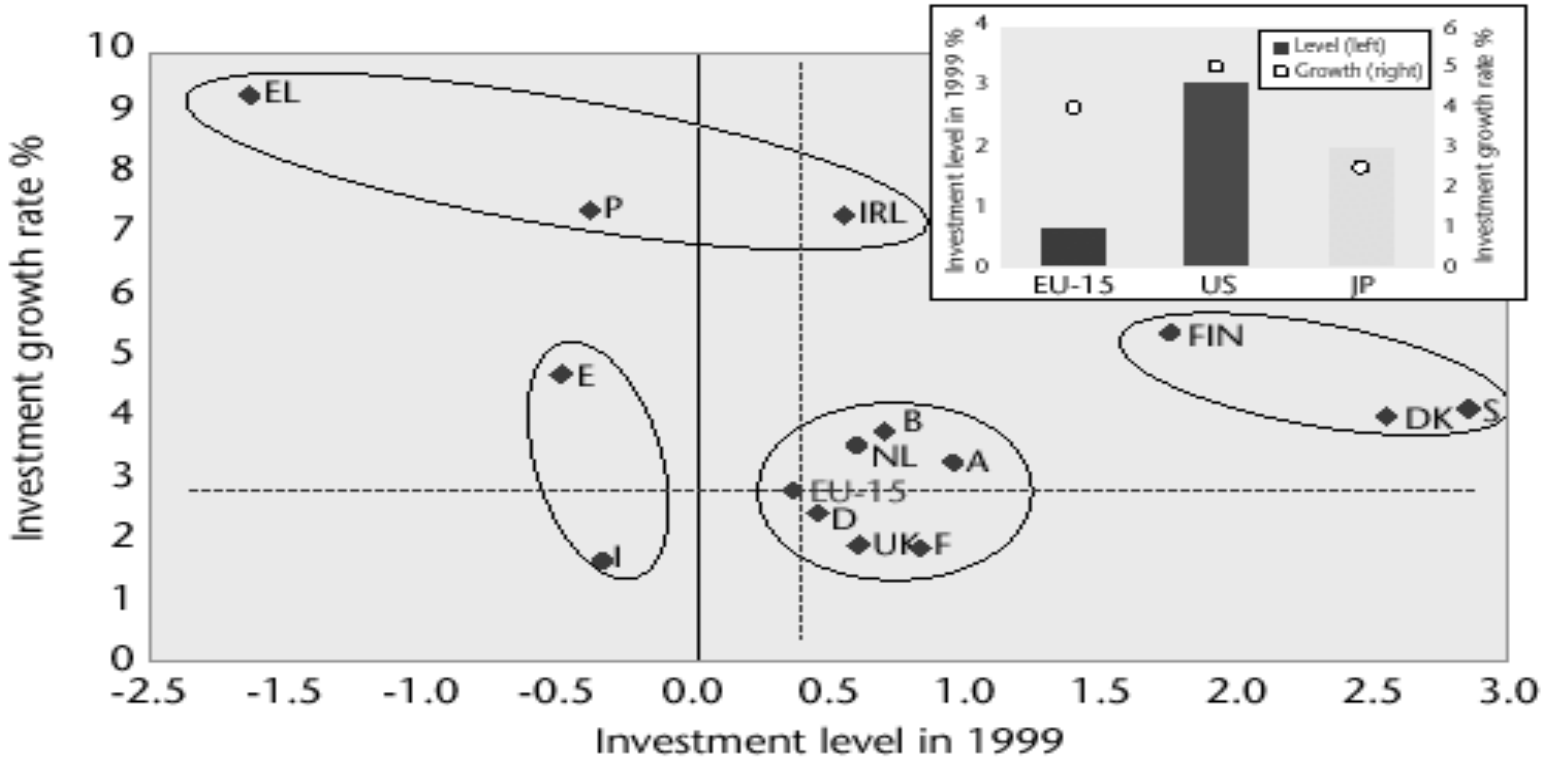
Comparison of whole ‚National Innovation Systems' using composite indicators for

- *INVESTMENT (R&D expenditure, new S&T PhDs, spending on education, GFCF, e-Government, life-long learning)*

and

- *PERFORMANCE (productivity, publications, patents, e-commerce, schooling success rates)*

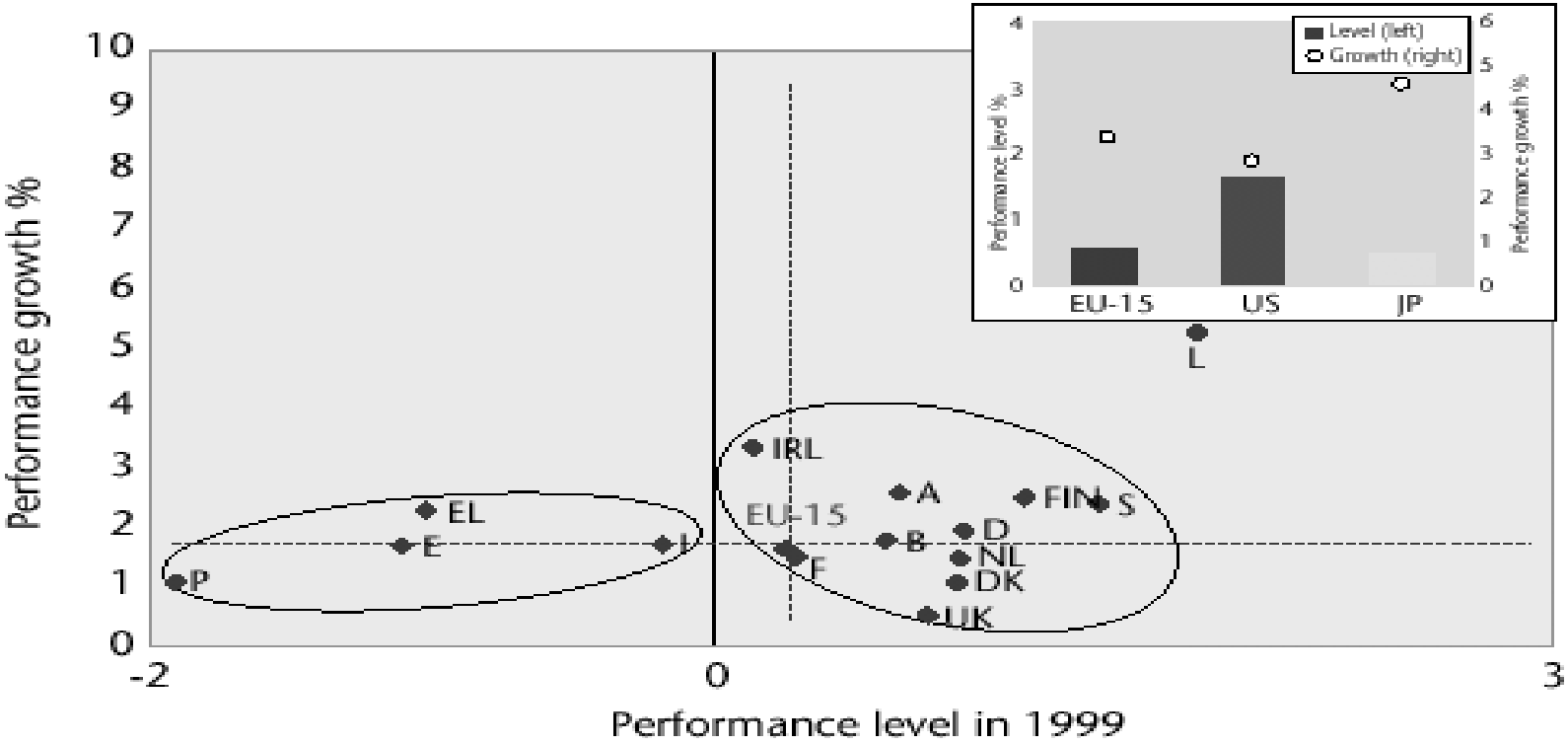
Figure A. Composite indicator of investment in the knowledge-based economy. Relative country positions in 1999 and annual growth rate 1995-1999[1]



Source: DG Research
Data: Eurostat, DG Information Society
Note: For details about the calculations and methodology, see Annex IV

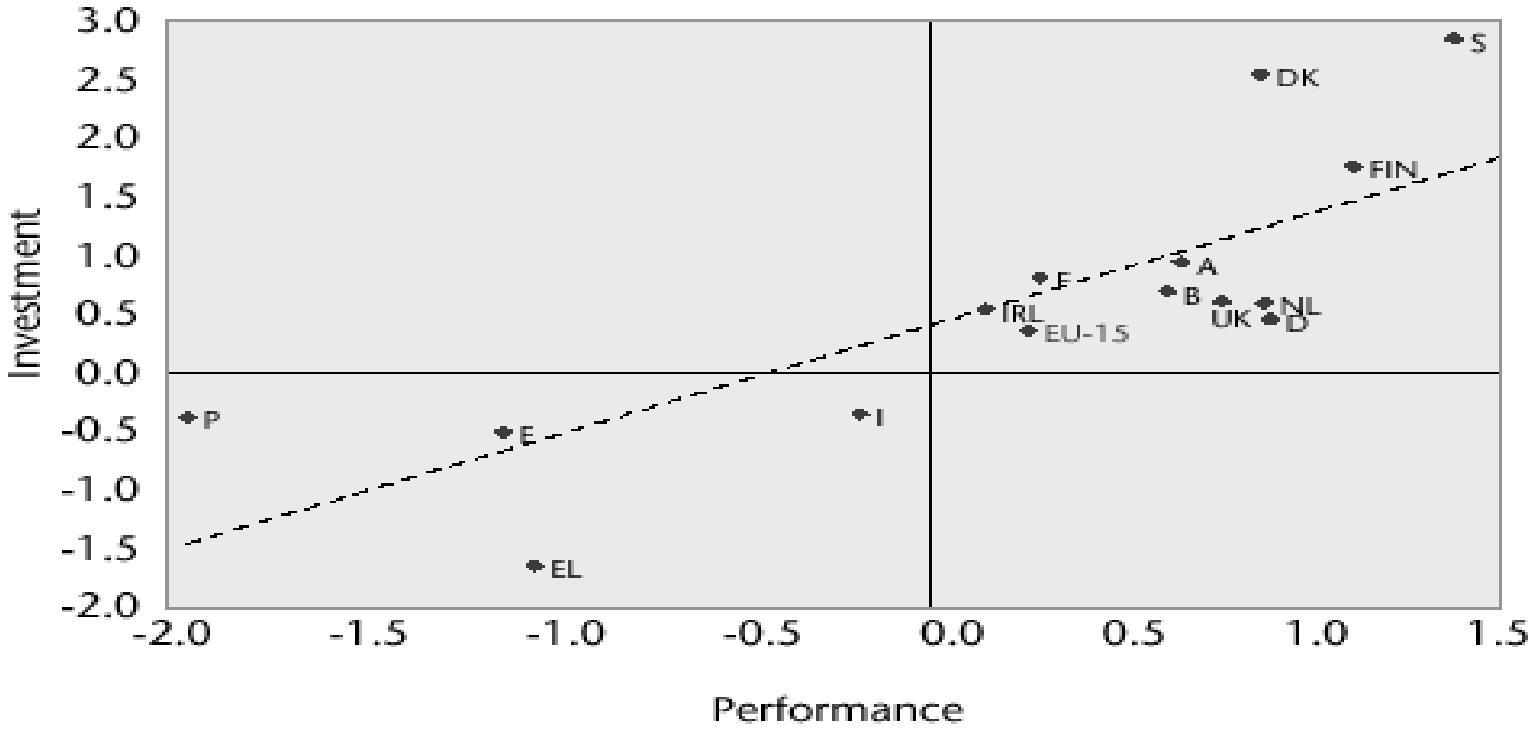
Key Figures 2002

Figure B. Composite indicator of performance in the knowledge-based economy. Relative country positions in 1999 and annual growth rate 1995-1999[2]



Source: DG Research — Key Figures 2002
Data: Eurostat, EPO, USPTO, ISI/CWTS, DG Information Society
Notes: For details about the calculations and methodology, cf. Annex IV

Figure C. Performance vs. Investment of the Member States in 1999



Source: DG Research
Data: Cf. Figures A and B
Note: For details about the calculations and assumptions, cf. Annex IV

Key Figures 2002

Positioning Austria and the EU: The Aggregate Picture (2)

...another picture, derived from the Innovation Scoreboard 2001..

Fig. 1 Overall country trends by innovation index

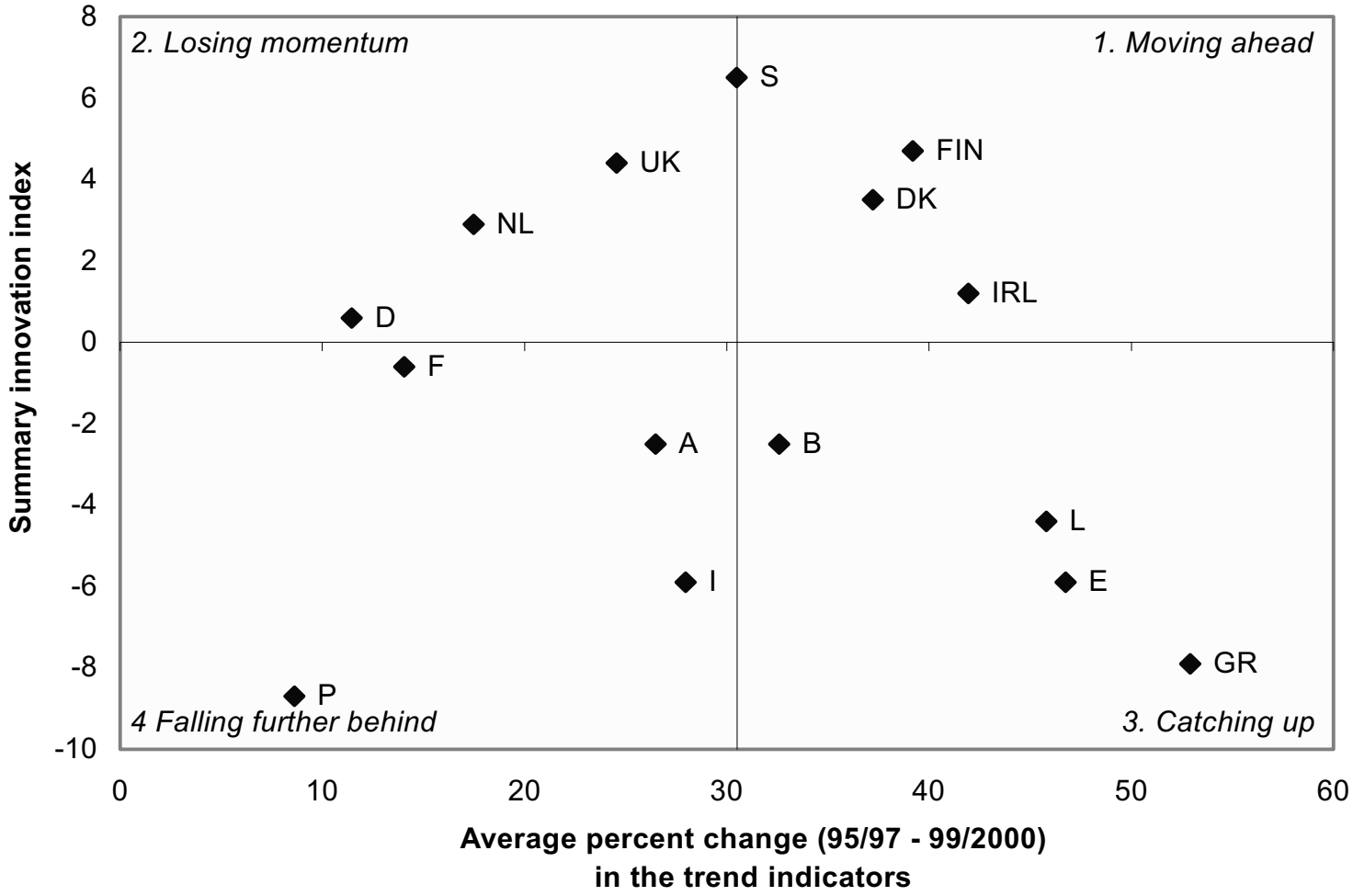
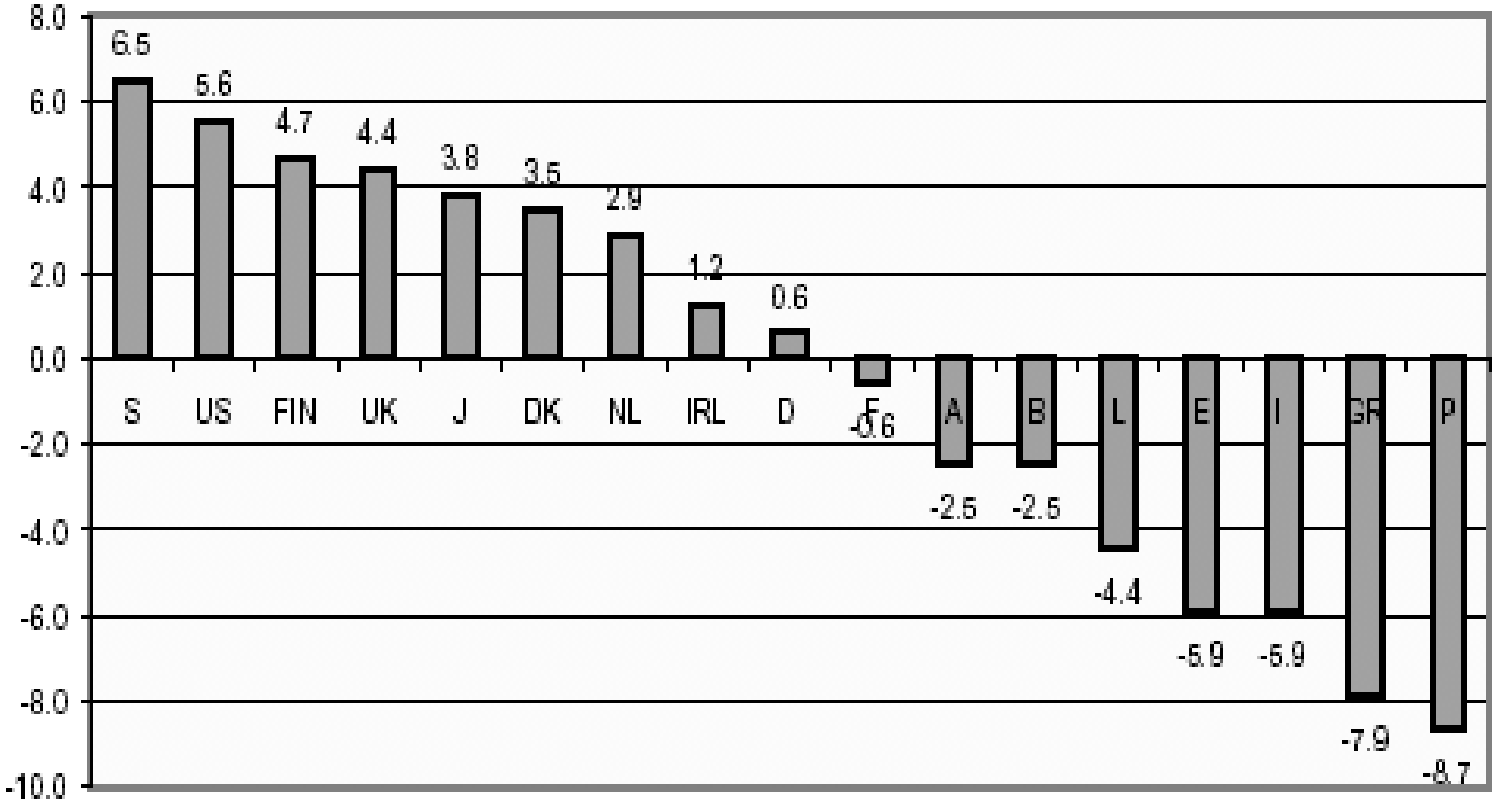


Fig 2: Tentative Summary Innovation Index



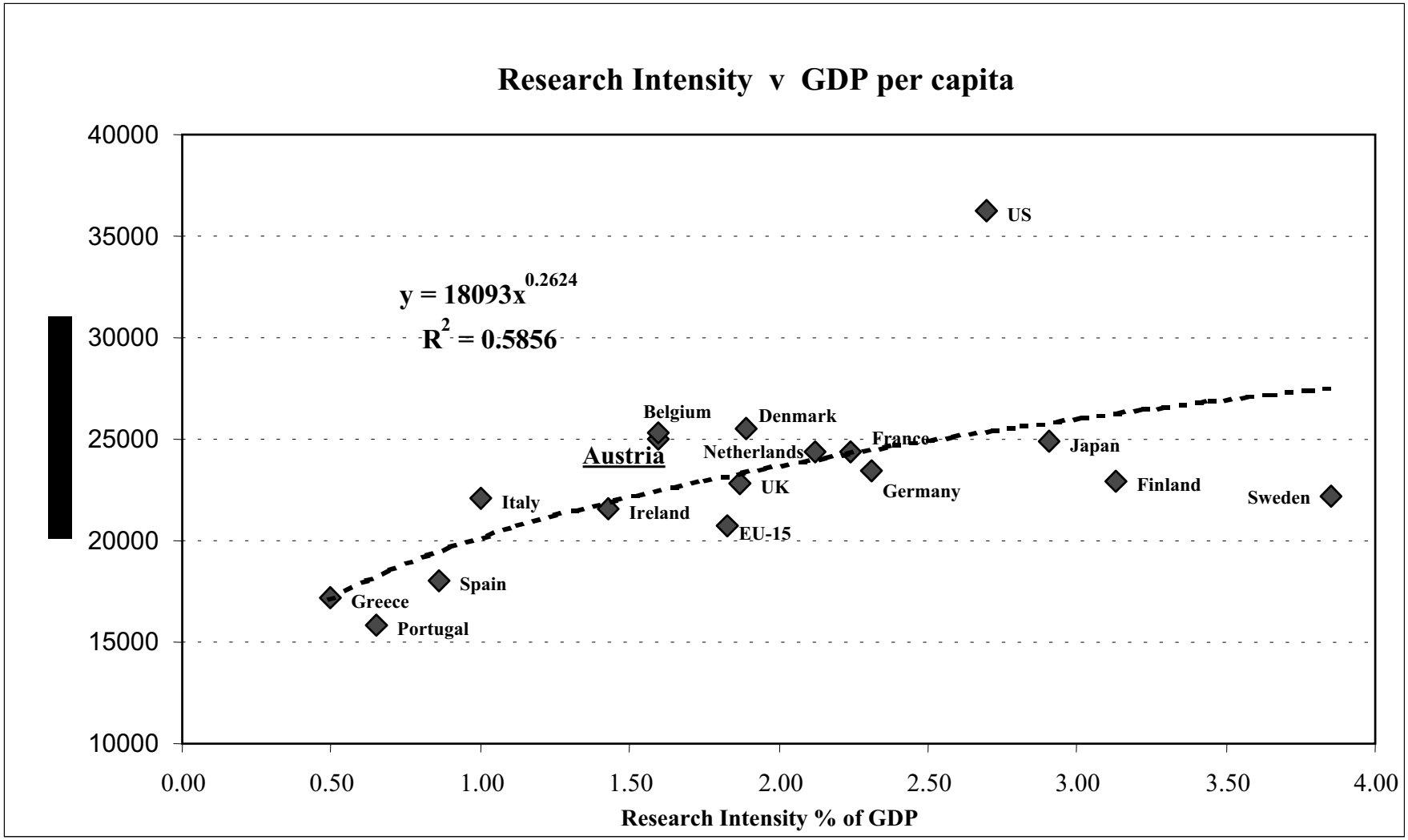
Positioning Austria: Public and Private Investment in R&D

Focus:

Investment dedicated to R&D, as a key input to the national innovation system, complemented by information on financial and regulatory schemes

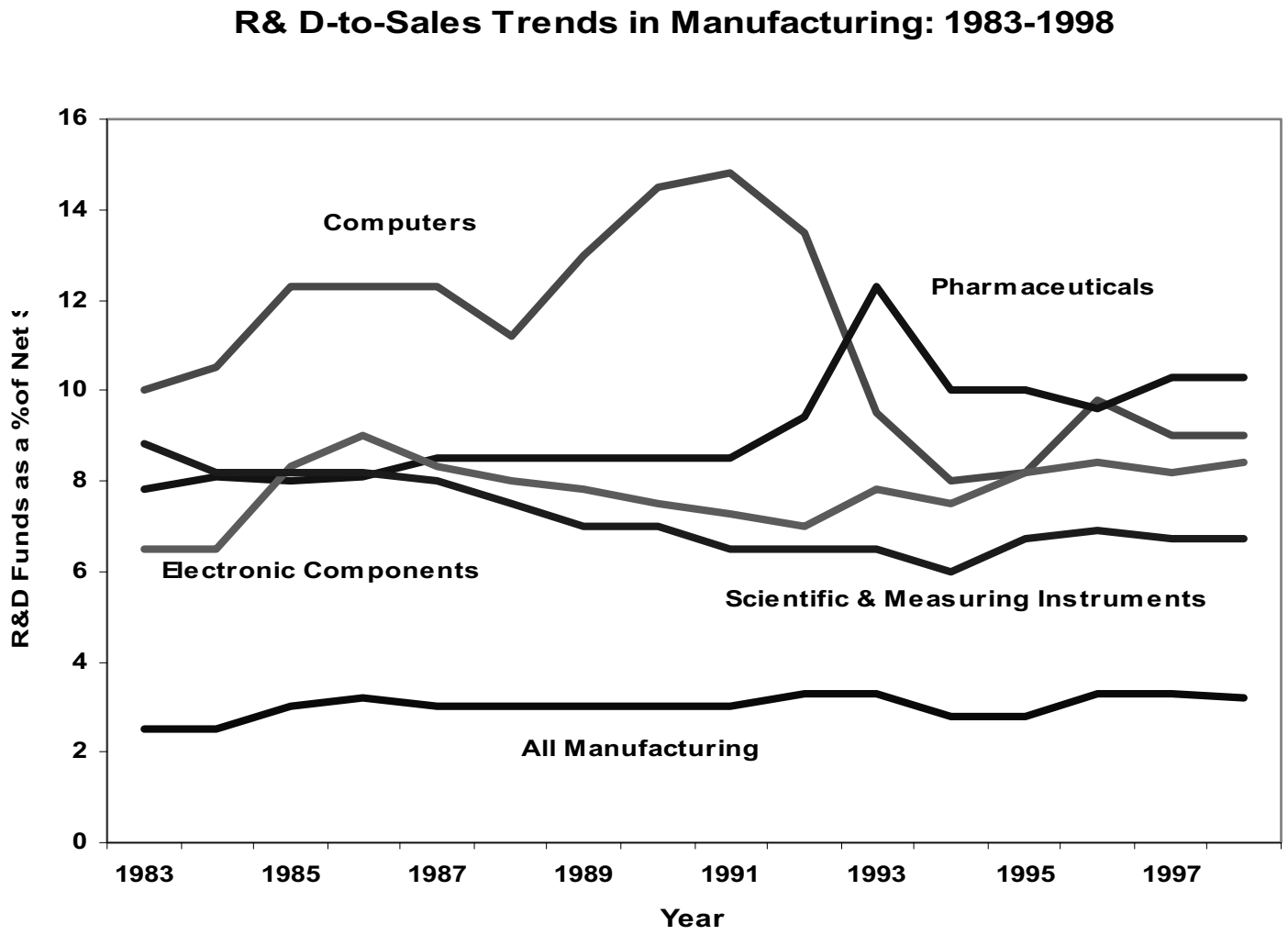
- R&D expenditures by industrial sectors, research sectors
- R&D expenditures per researcher
- Project funding
- Venture Capital
- R&D expenditure and GDP per capita

Research intensity vs. GDP per capita (2000)



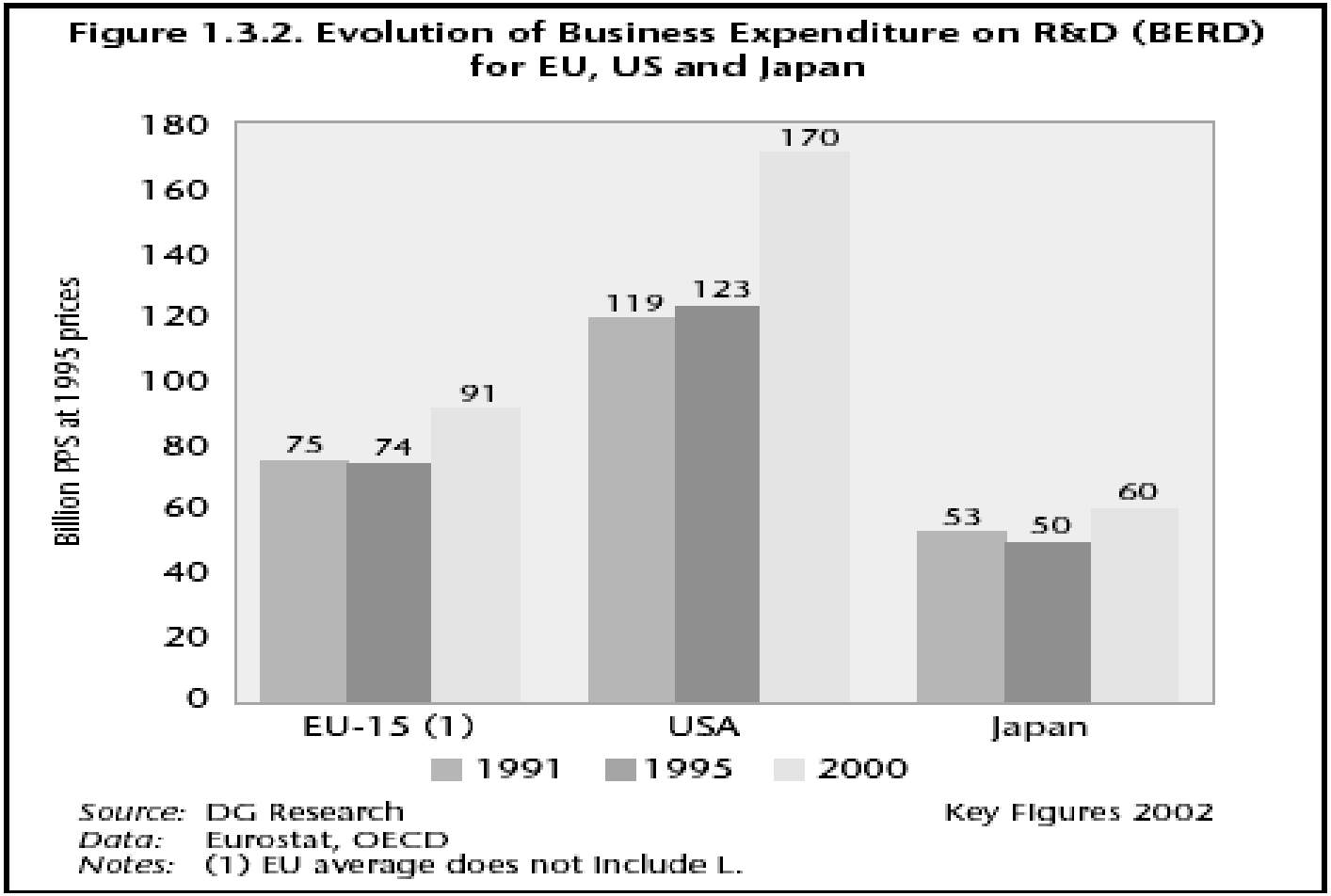
Source: Benchmarking Reports 2002, OECD data

Levels of R&D expenditures in different sectors

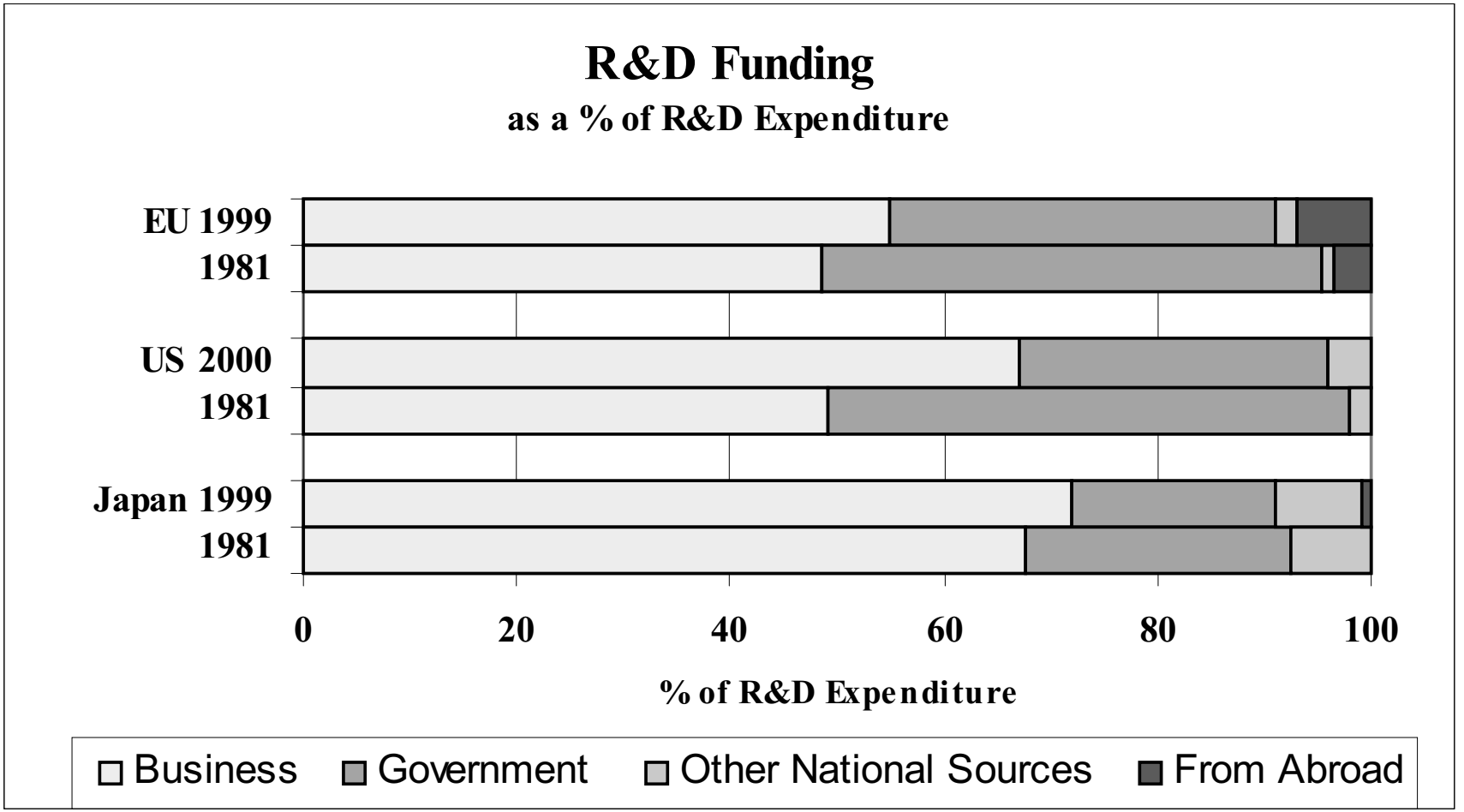


Source: National Science Foundation, *National Patterns of R&D Resources, Early release 2000 Papers*

Growth of business sector R&D: The global picture

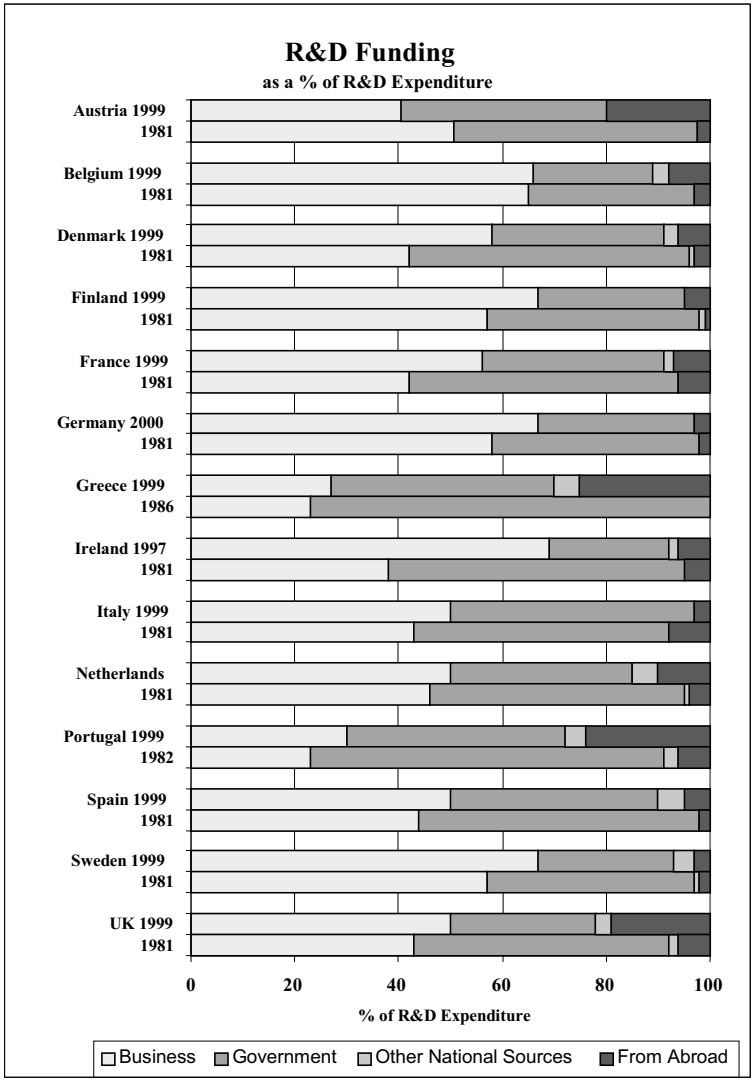


Growth of business sector R&D: Funding by source

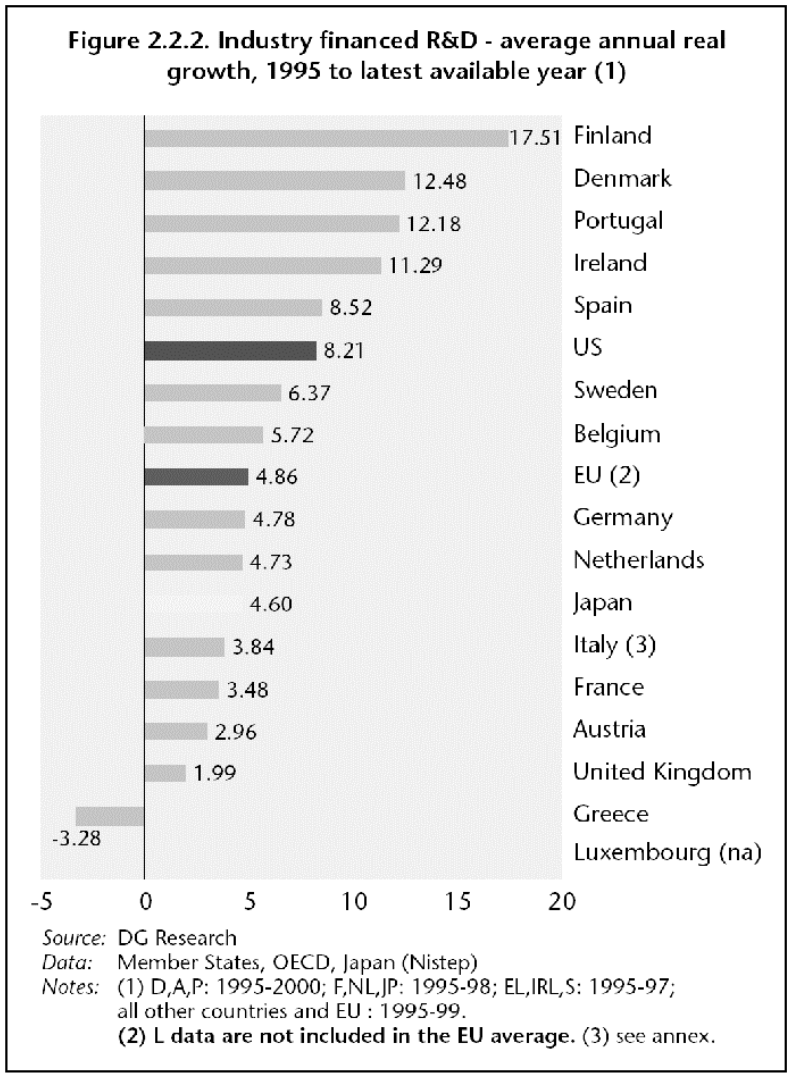


Source: Benchmarking Reports 2002, Data from OECD

R&D financed by business

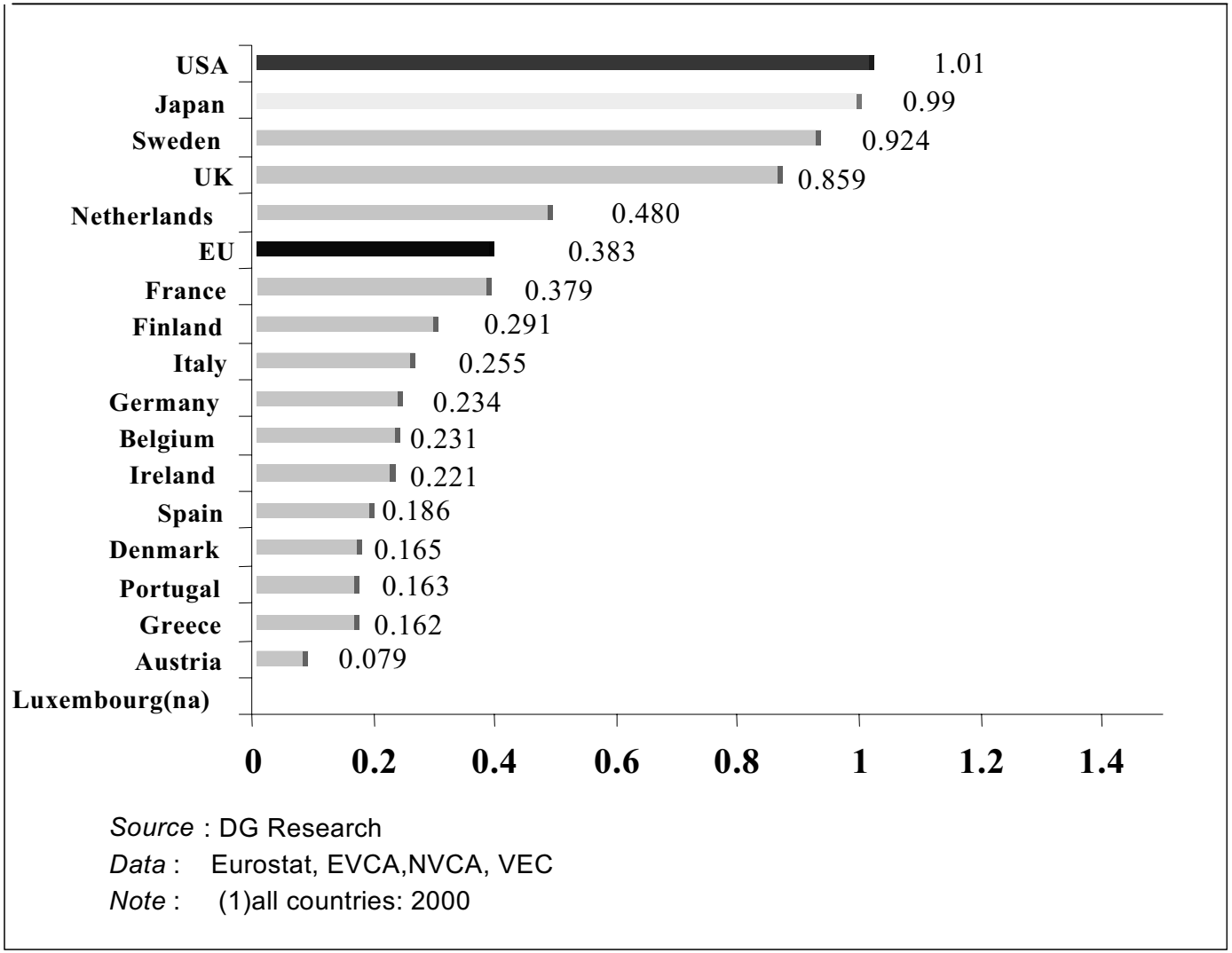


Source: Benchmarking Reports 2002, Data from OECD



Source: Key figures 2001

Seed and start-up venture capital [% of GDP]

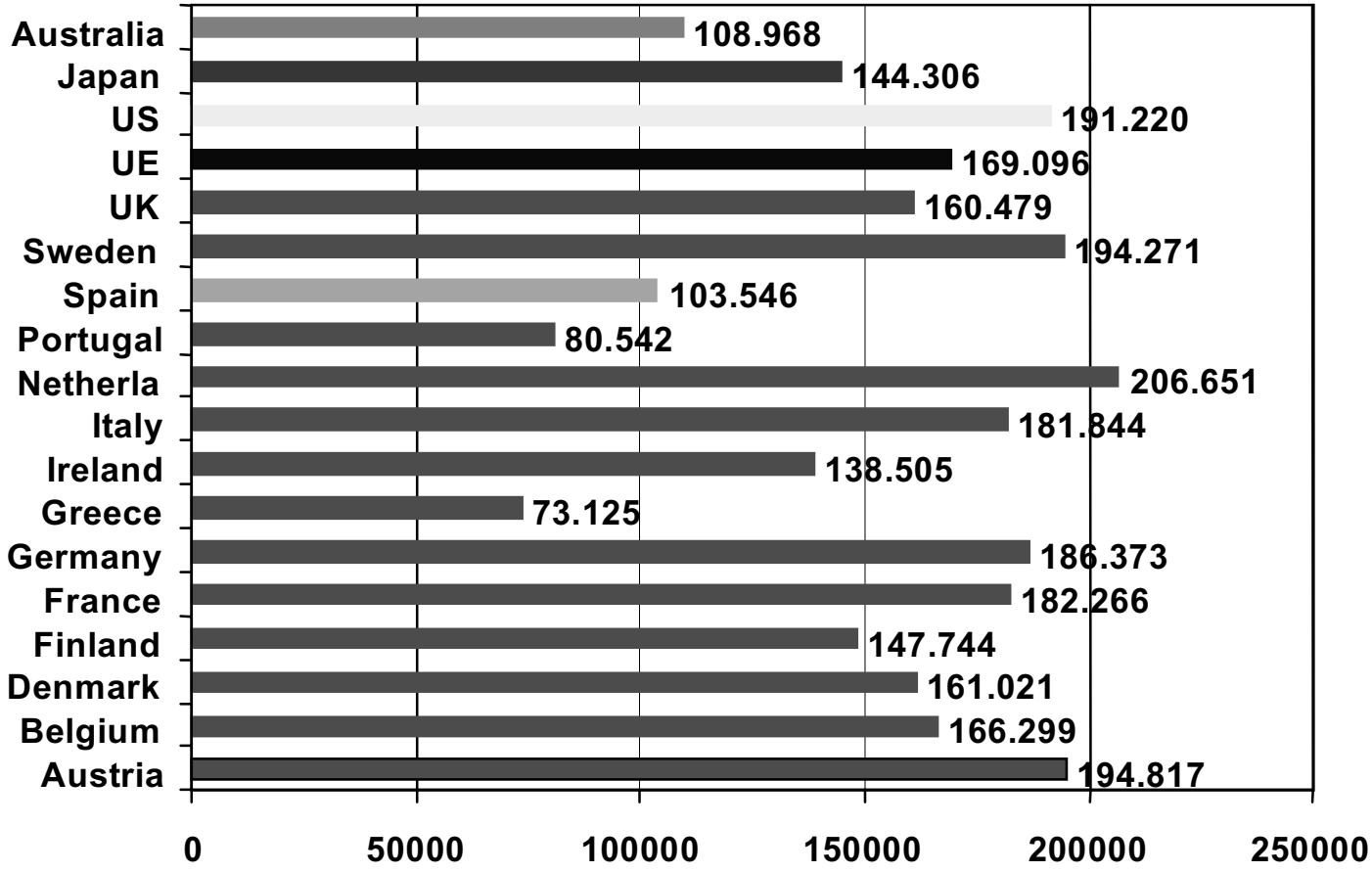


Source : DG Research
Data : Eurostat, EVCA,NVCA, VEC
Note : (1)all countries: 2000

Regional imbalances in R&D investment

- Major problems of data availability at regional level
- Austrian data at NUTS 2 level are from 1993, for many other countries from 1997 or 1998
- Comparatibility of data almost impossible!

GERD per researcher (ppp$)



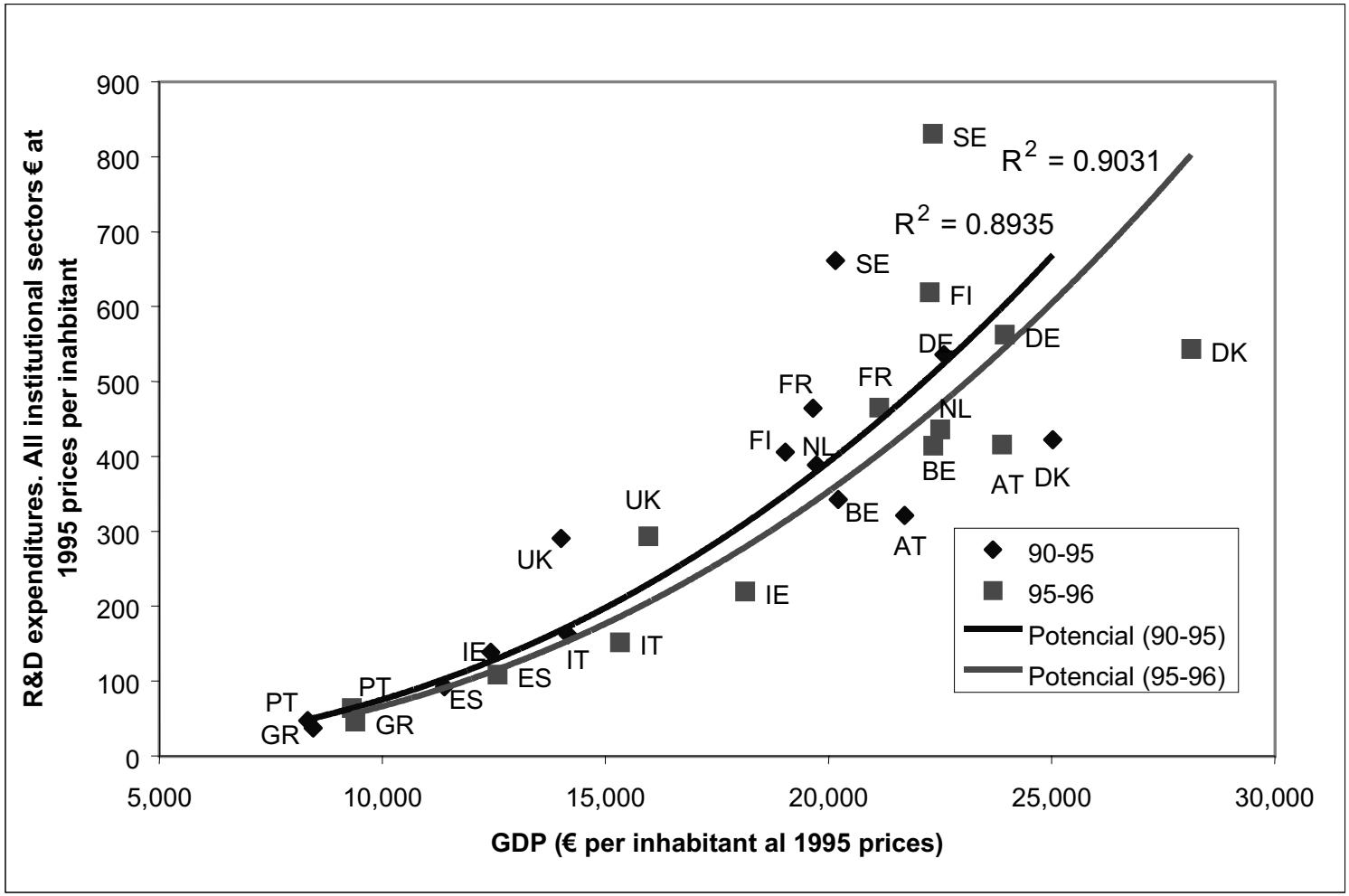
Data 1999; US 1997; Source: OECD, Main Science and Technology Indicators, November 2001

Relative importance of project funding

Member States	Total government financed civil R&D expenditures in 2000 (in M€)	Government financed civil R&D project funding in 2000 (in M€)	Percentage of project funding
Austria	1445	141	10
Belgium	1418	373	26
Denmark	1182	467	40
Finland	1262	523	41
France	10132	689	7
Germany	15000	4579	31
Italy	6697	1203	18
Netherlands	2875	628	22
Spain	2932	339	12
Sweden	1739	581	33
UK	6307	1649	26
TOTAL	**50989**	**11172**	**22**

Source: KOWI

R&D expenditures and GDP per capita : a virtuous circle?



R&D expenditure per capita versus GDP per capita

Source: Benchmarking Reports, data from Eurostat 2002

Key findings for the EU: R&D investment

- Europe continues to lag behind the US and Japan in terms of R&D expenditures, especially for business funded R&D
- EU contributes 24% of project funding, with a significant leverage effect
- Regionalised data on R&D investment are extremely poor and do not allow up-to-date analysis
- A recognised shortcoming: no indicators for intangible goods and capabilities

Key findings for Austria: investment in R&D

- The industrial structure in Austria is one of the main reasons for the comparatively low level of R&D expenditure
- Business R&D is slightly lower and grows slower in Austria than the EU-average, which in turns lags behind the US and Japan in terms of absolute levels
- Expenditures per researcher are not the bottleneck, but their absolute number
- Regional imbalances can hardly be analysed due to the poor data quality; Austrian data are from 1993
- Austria shows the second lowest share of project funding, reflecting its specific institutional set-up

Key findings for Austria: Investment in R&D (contd.)

- Data confirms the very low share of seed and start-up VC in Austria, but this does not necessarily imply a financing problem
- Austria is close to a position of being able to exploit the „virtuous circle“

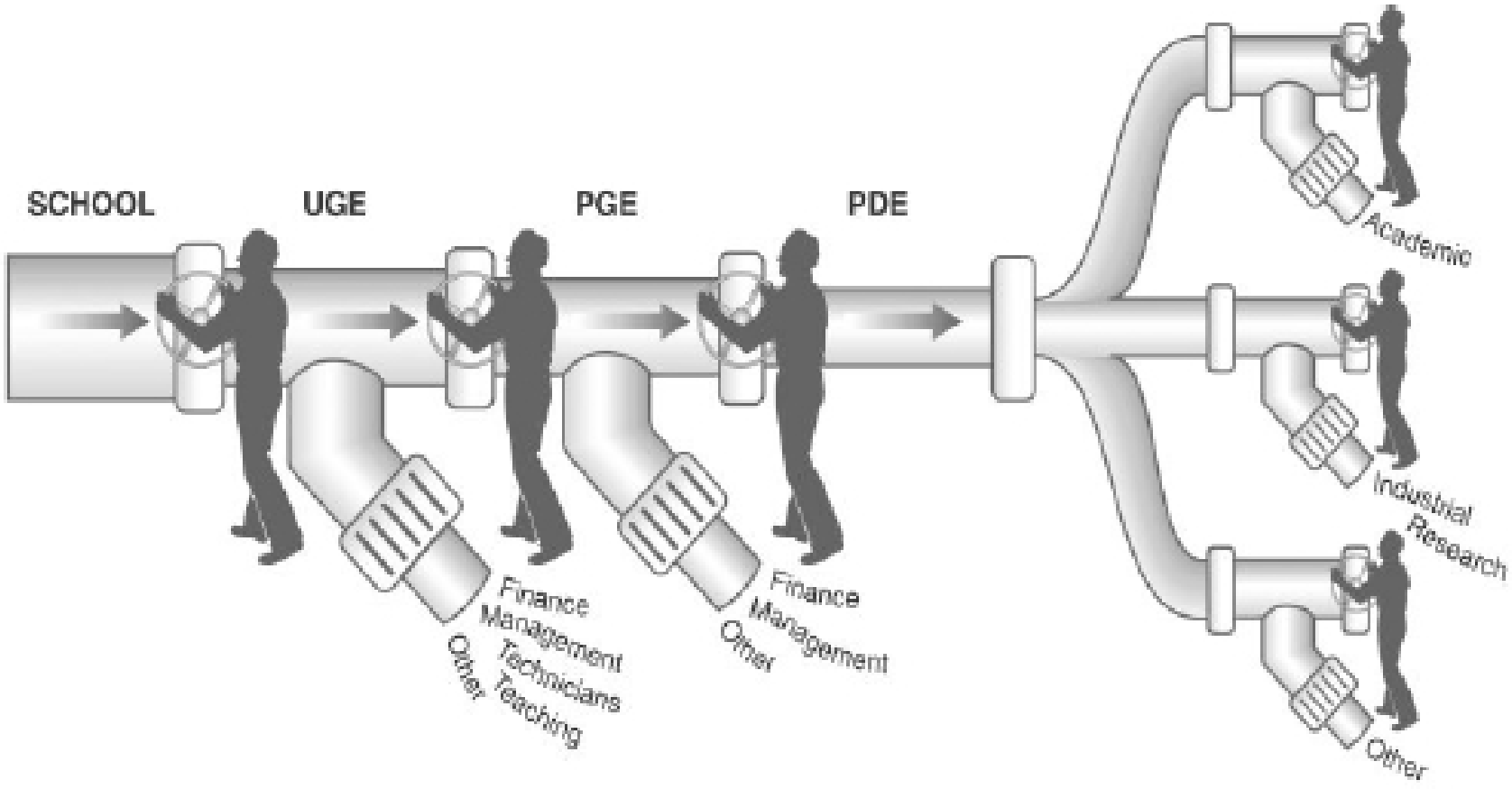
Positioning Austria: Human Resources in RTD

Focus:

Availability of qualified human resources for RTD, especially in the scientific and technical field in order to meet the needs of the knowledge-based economy

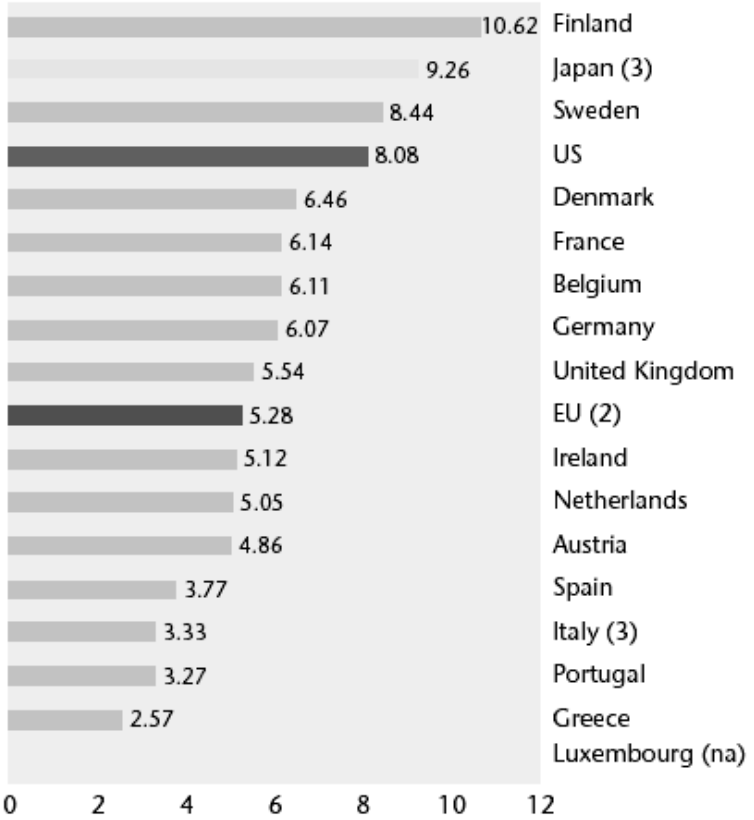
- Researchers in the workforce
- Graduate and postgraduate enrolment/graduation
- Higher education investment
- Complementary qualitative information

The Pipeline Model



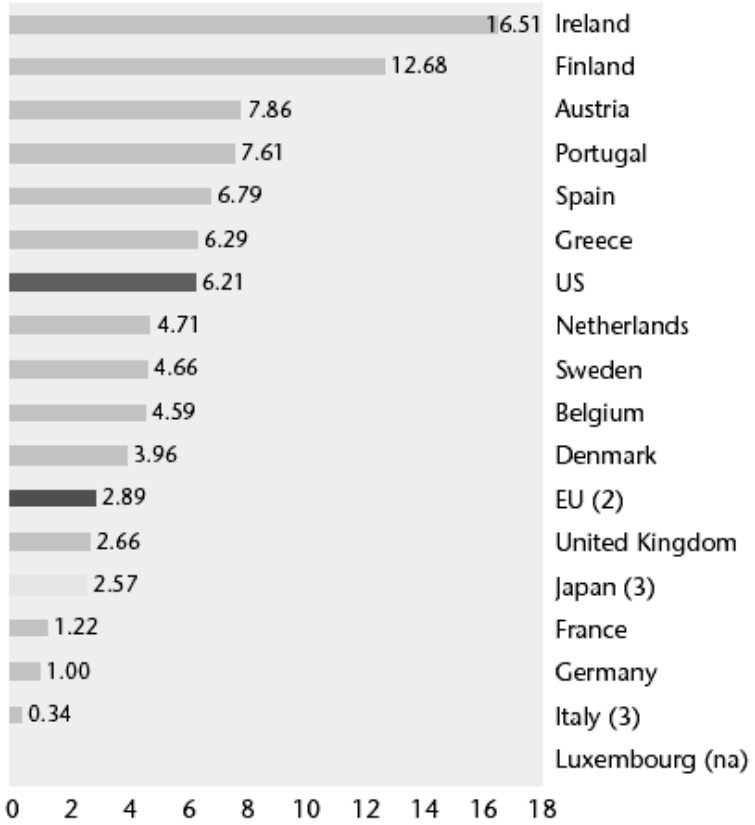
Researchers in the workforce

Total researchers (FTE) per 1000 workforce, latest available year (1)



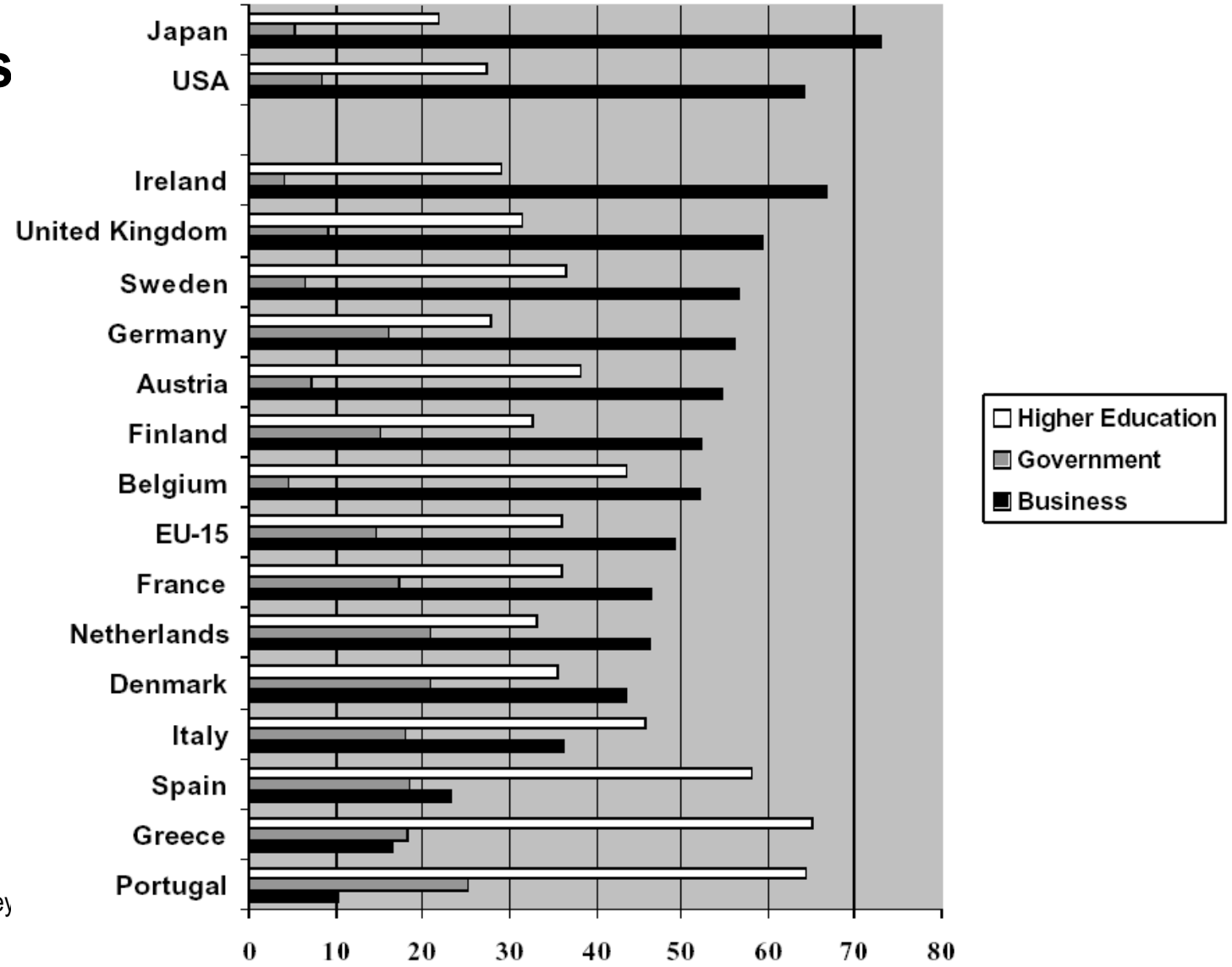
Source: DG Research
Data: Eurostat, Member States, OECD, USA (NSF), Japan (Nistep)
Notes: (1) P,JP: 2000; D,E: 1999; B,EL,IRL,I,FIN,S:,US: 1997; all other countries and EU: 1998. **(2) L data are not included in the EU average.** (3) see annex.

Total researchers (FTE) - average annual growth [%], 1995 to latest available year (1)



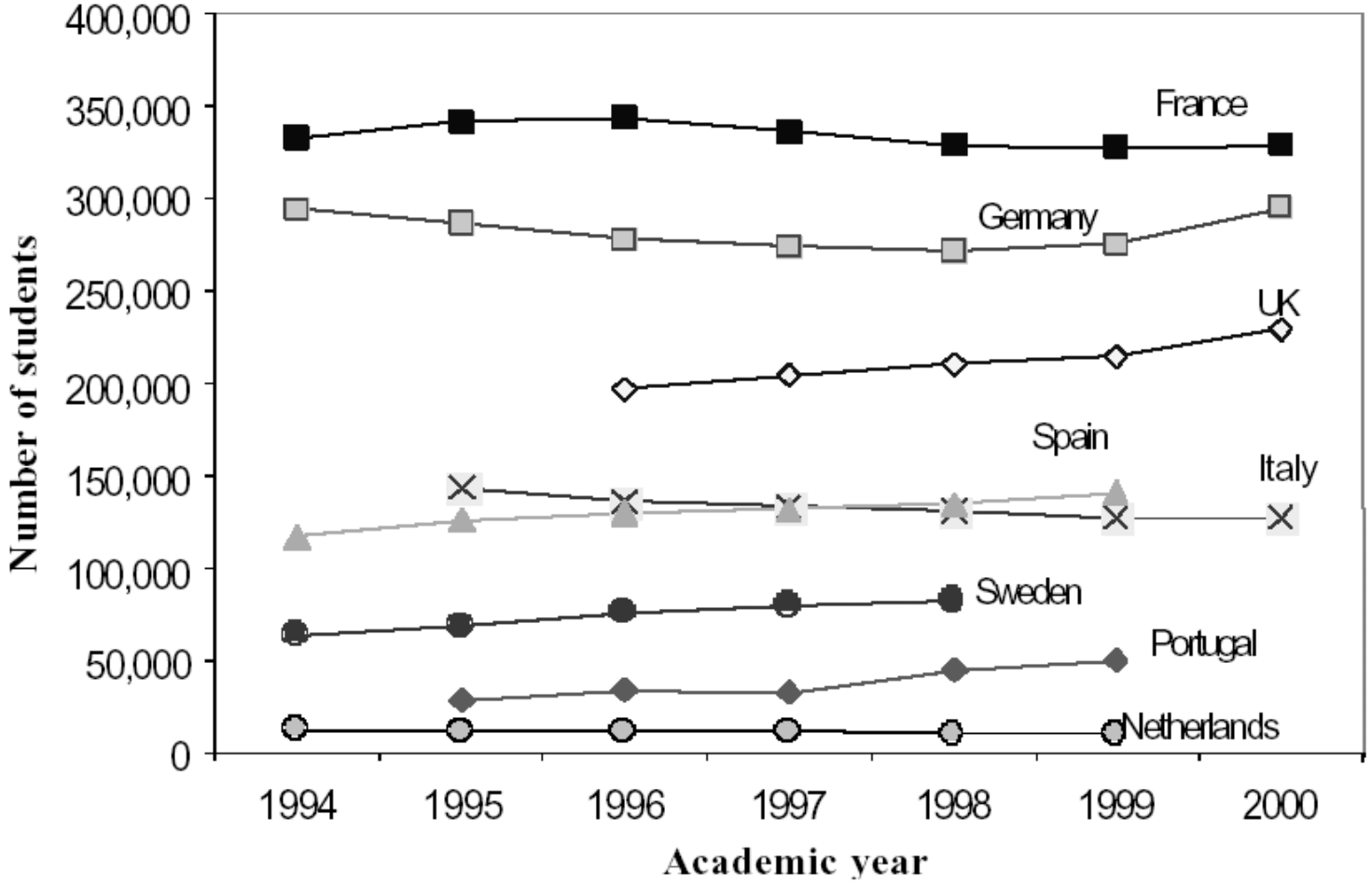
Source: DG Research
Data: Member States, OECD, USA (NSF), Japan (Nistep)
Notes: (1) P,JP: 1995-2000; D,E: 1995-99; B,EL,IRL,I,FIN,S,US: 1995-97; A: 1993-98; all other countries and EU: 1995-98. **(2) L data are not included in the EU average.** (3) see annex.

Researchers per sector [%]



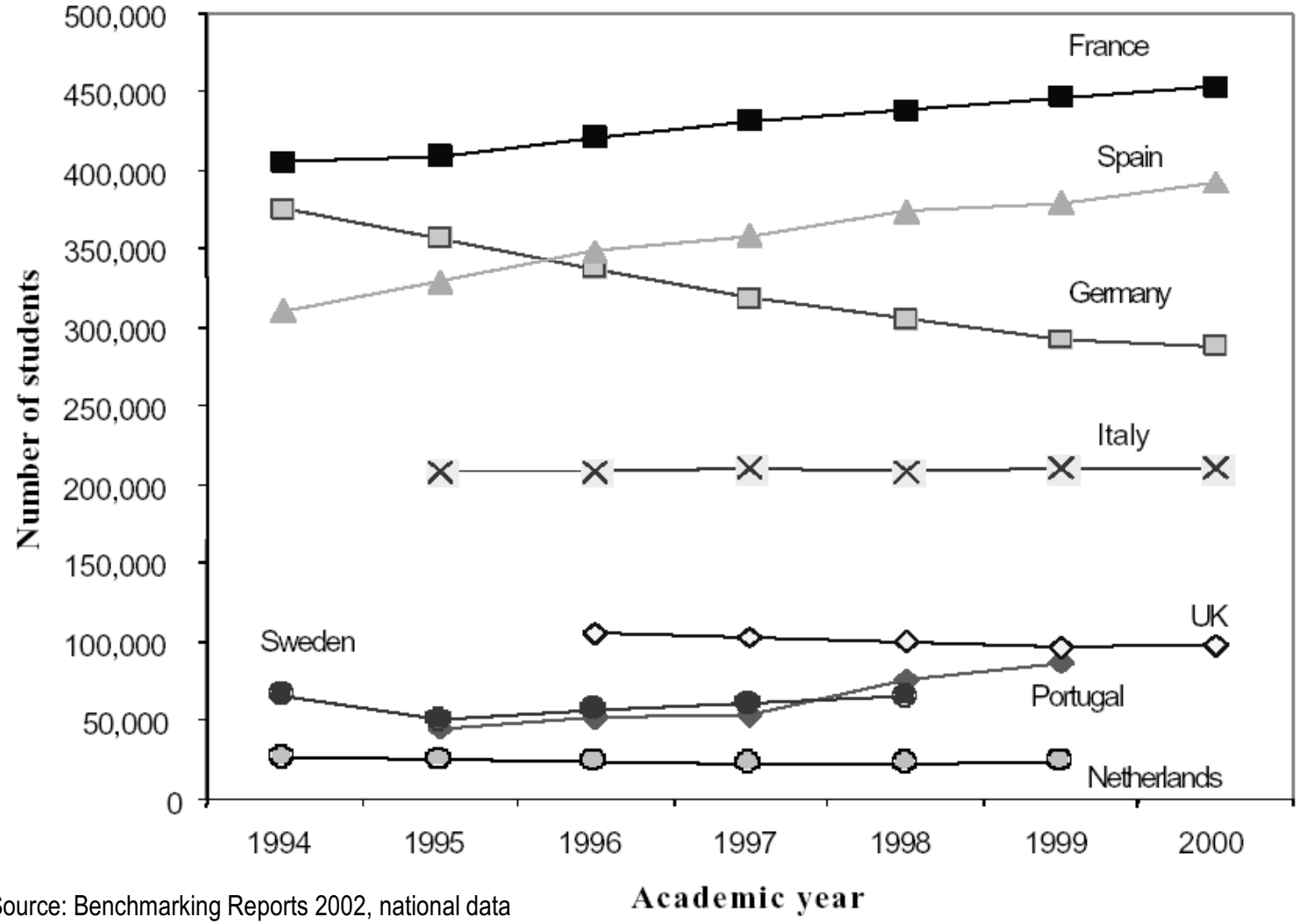
Source: Benchmarking Reports 2002, data from Key figures 2000

Undergraduate enrolment in natural sciences



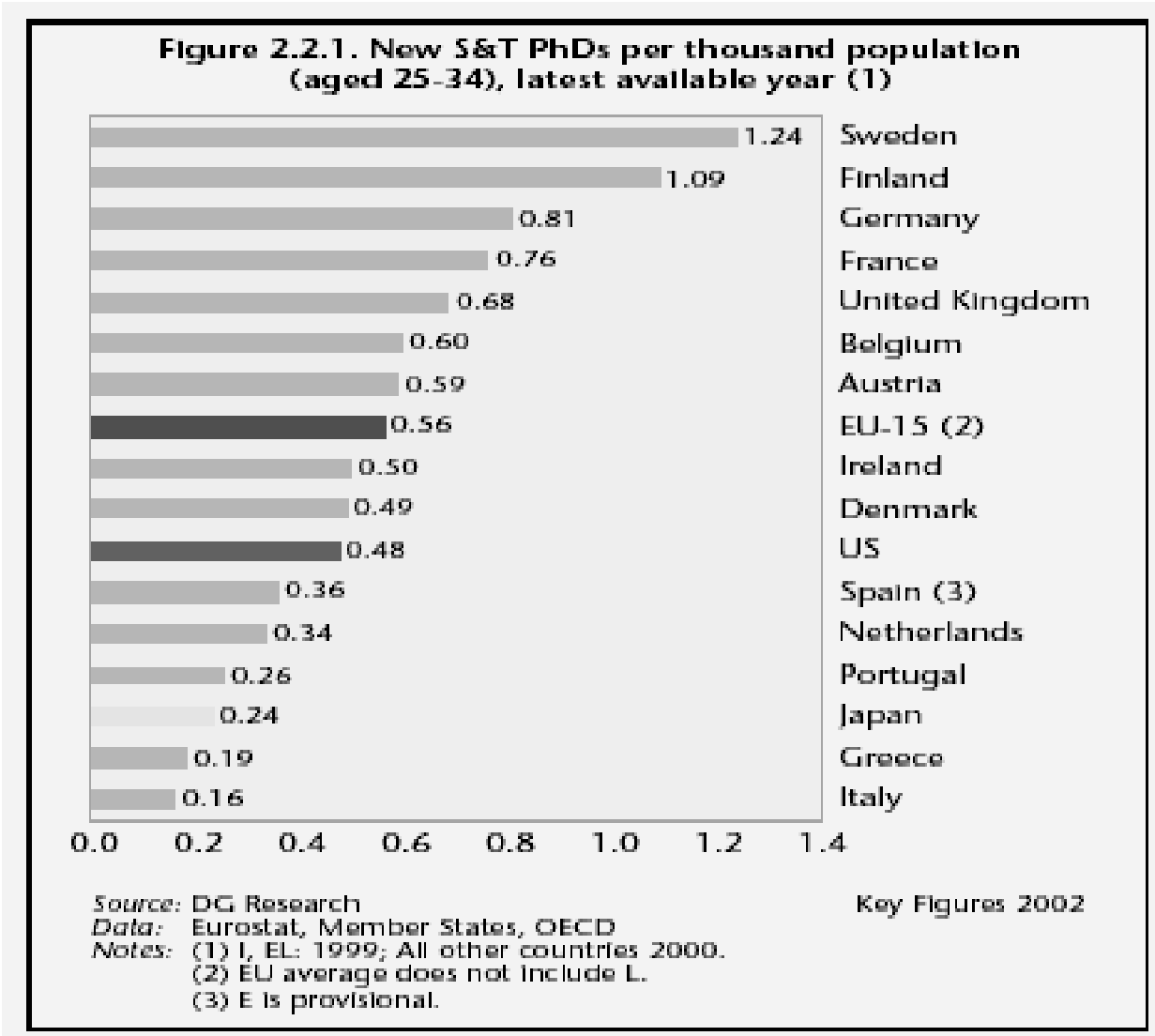
Source: Benchmarking Reports 2002, national data

Undergraduate enrolment in engineering and technology

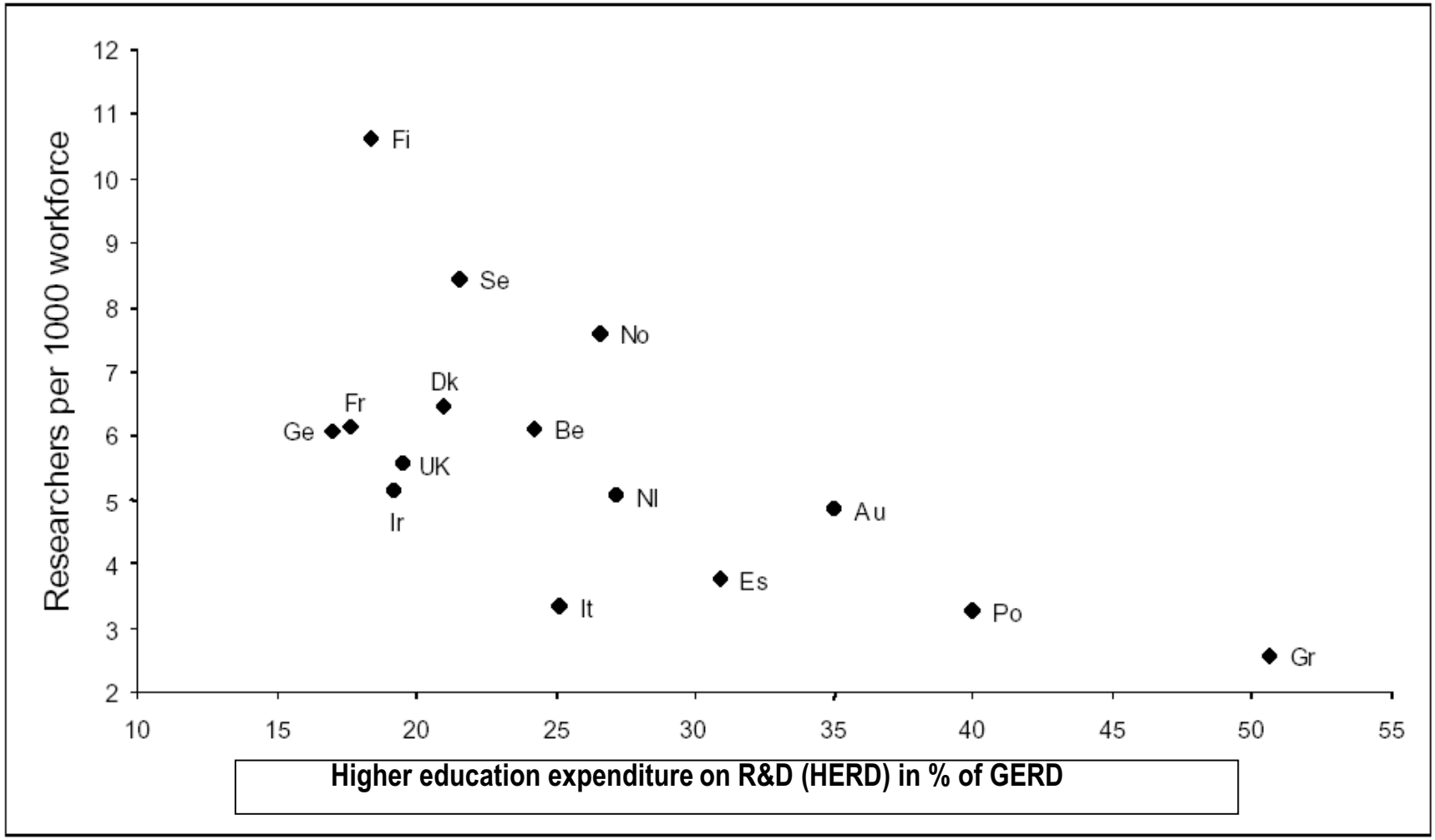


Source: Benchmarking Reports 2002, national data

Growth in S&T PhD graduations



Researchers in the workforce and investment in HE



Source: Benchmarking Reports 2002, data from MSTI database, March 2001

Key findings for Austria and the EU: human resources

- Not so much productivity, but the share and the right type of researchers in the workforce is the problem
  - Reluctance to engage with S&T matters at school level
  - No increase university enrolment for core S&T subjects
  - Underrepresentation of women in research
  - Insufficient mobility of researchers across sectors and disciplines
  - Loss of talent due to insufficient return mobility
  - Too small number of postgraduate students in S&T
  - Many graduates and PhDs take up first jobs outside R&D
  - Too little attention to mid- and late-career development of research scientists
- Findings are highly dependent on national institutional context

Positioning Austria: S&T Productivity

Focus:

The relation between inputs and outputs in scientific and technological activities

- Publications (Number, Citations)
- Patents (EPO, USPTO)
- Other (e.g. scientific infrastructure)....

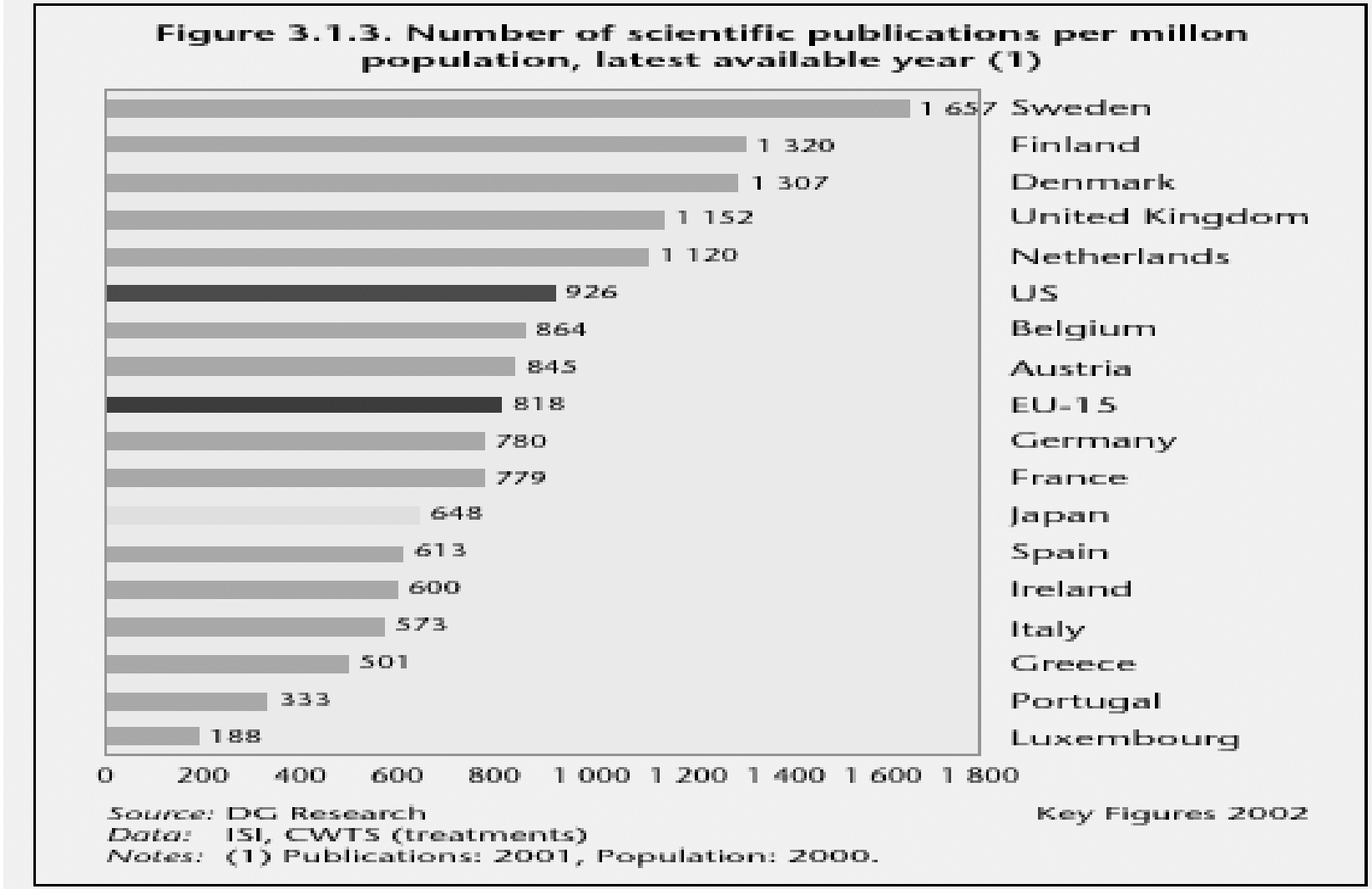
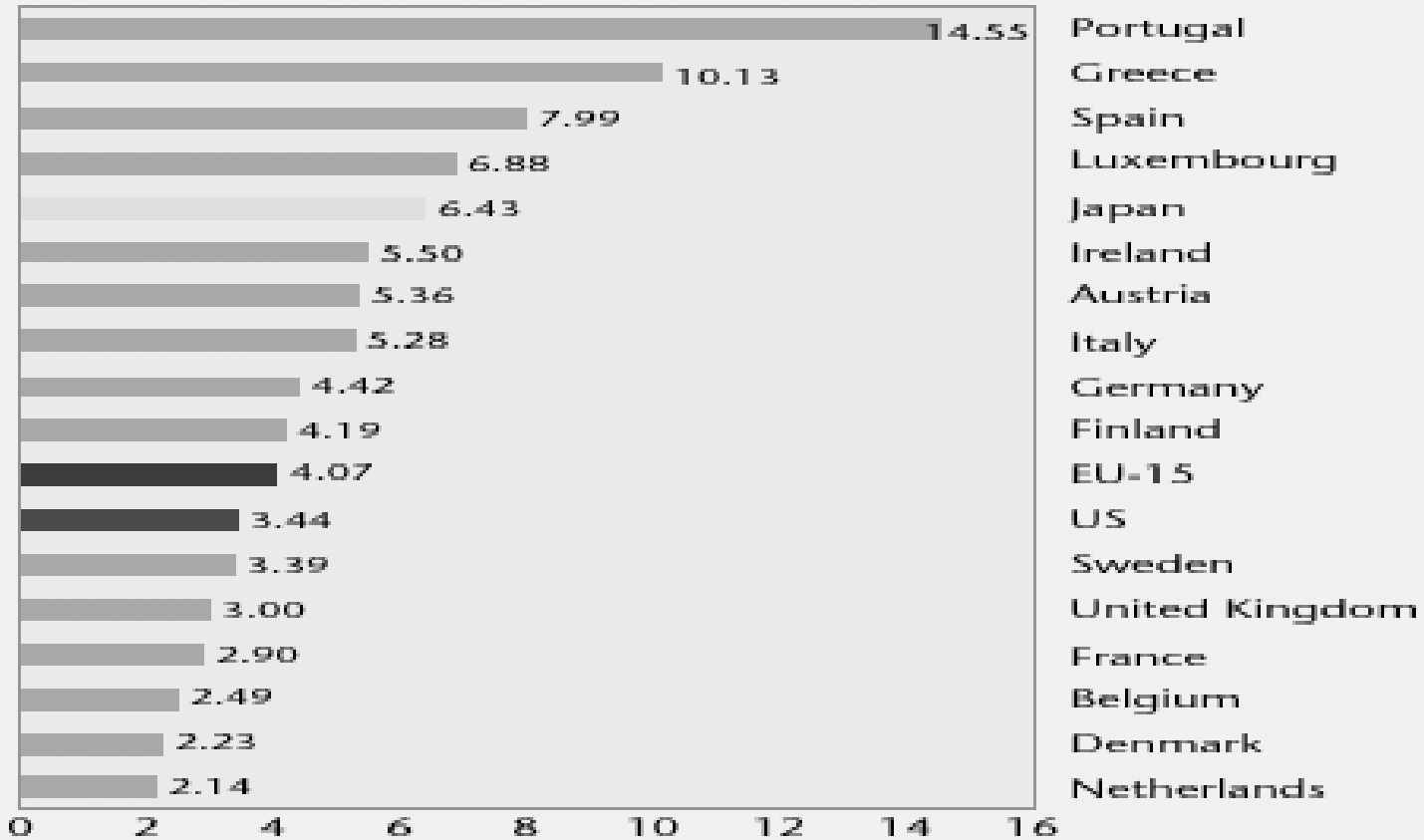


Figure 3.1.3. Number of scientific publications per millon population, latest available year (1)
1 657 Sweden
1 320 Finland
1 307 Denmark
1 152 United Kingdom
1 120 Netherlands
926 US
864 Belgium
845 Austria
818 EU-15
780 Germany
779 France
648 Japan
613 Spain
600 Ireland
573 Italy
501 Greece
333 Portugal
188 Luxembourg
0 200 400 600 800 1 000 1 200 1 400 1 600 1 800
Source: DG Research
Data: ISI, CWTS (treatments)
Notes: (1) Publications: 2001, Population: 2000.
Key Figures 2002

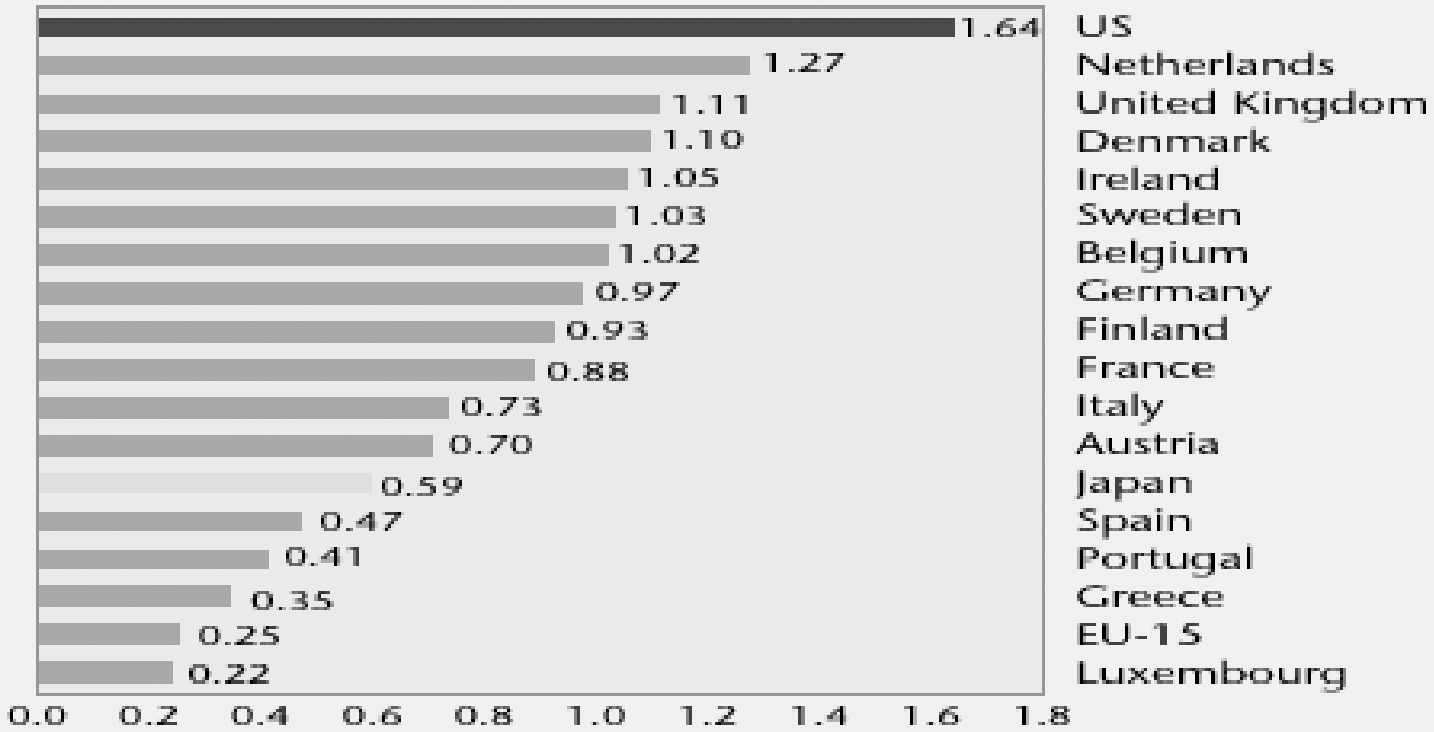
Figure 3.1.4. Average annual growth (%) of number of scientific publications, 1995 to latest available year (1)



Source: DG Research
Data: ISI, CWTS (treatments)
Notes: (1) 2001

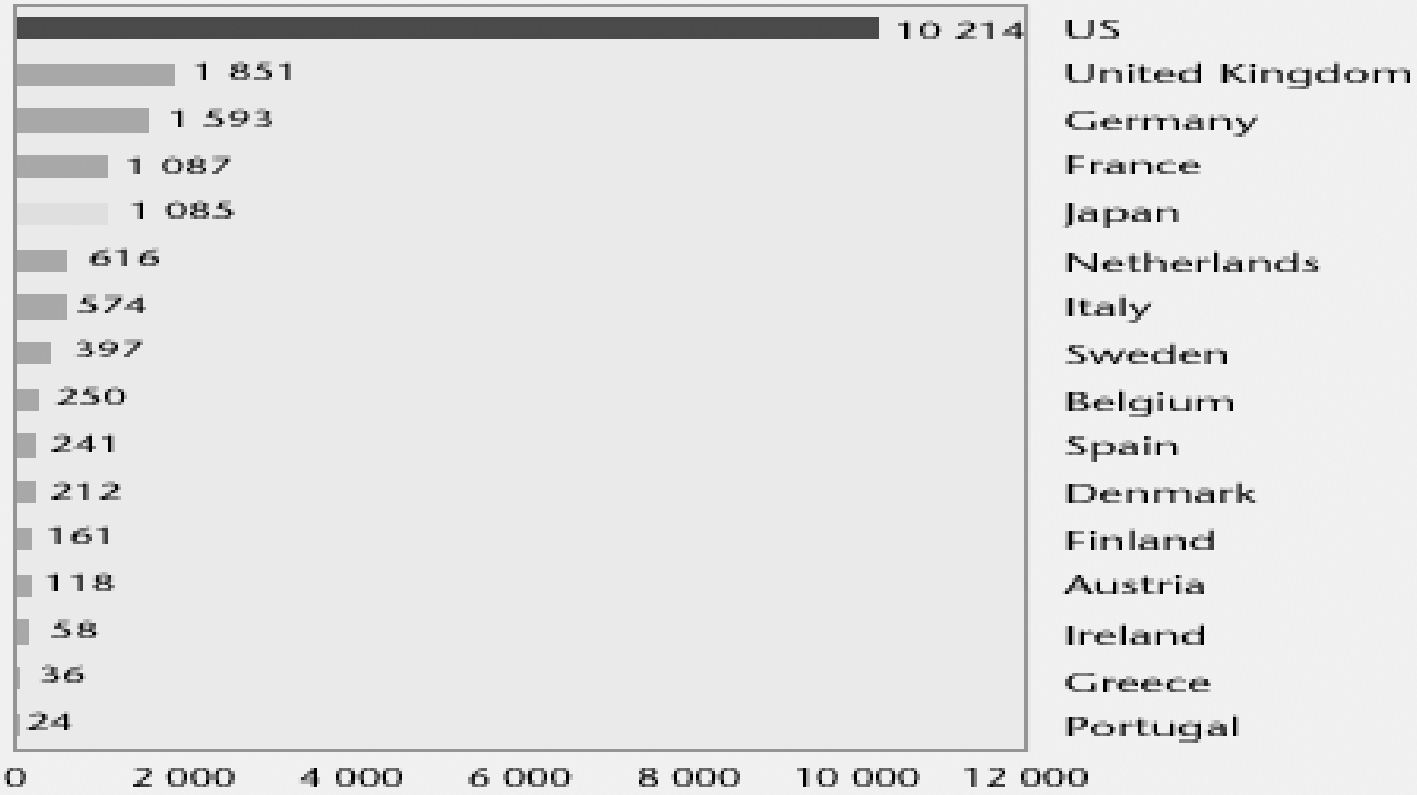
Key Figures 2002

Figure 3.1.5. Highly cited papers as percentage of total number of scientific publications, latest available year (1)



Source: DG Research — Key Figures 2002
Data: ISI, CWTS (treatments)
Notes: (1) Publication period is 1996, 1997, 1998. Citation window is a four year fixed period: publication year plus three years, i.e. 1996-99, 1997-2000, 1998-2001.

Figure 3.1.6. Number of highly cited papers, latest available year (1)



Source: DG Research
Data: ISI, CWTS (treatments)
Notes: (1) cf. Figure 3.1.5

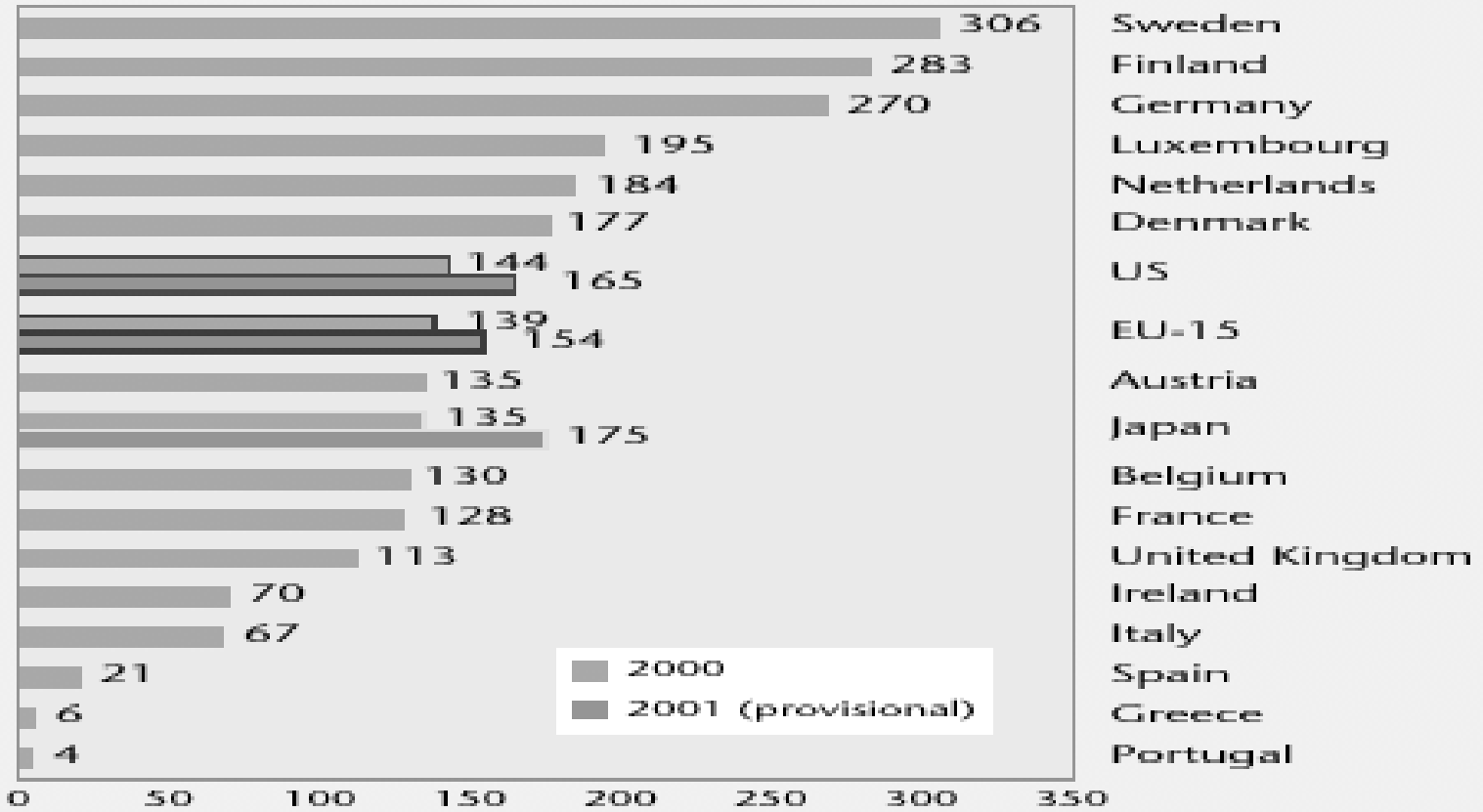
Key Figures 2002

Table 3.2.1. Patents: Shares 1999 and average annual growth 1992-1999 (%)

	Shares EPO	Growth EPO	Share USPTO	Growth USPTO
Germany	17.6	-1	6.3	-3.3
France	6.3	-3.3	2.7	-2.6
UK	5.6	-1.5	2.6	-1.8
Italy	3	-2.3	1.1	-2.9
Sweden	2.6	6.1	0.9	2
Netherlands	2.5	0.1	0.9	-2.3
Finland	1.2	7.8	0.4	2.7
Belgium	1.1	2.9	0.5	3.9
Austria	0.9	-2.2	0.3	-2.7
Denmark	0.8	5.2	0.3	6.8
Spain	0.6	5.6	0.2	2.9
Ireland	0.2	7.6	0.1	2.5
Greece	0.1	6	0	4.6
Luxembourg	0.1	1.2	0	-6.1
Portugal	0	10.8	0	1.4
EU-15	42.6	-0.7	16.4	-2.1
US	33.7	2.6	53.7	0.3
Japan	14.6	-4.3	20.1	-1.1

Source: DG Research Key Figures 2002
Data: EPO, USPTO; OST and Fraunhofer-ISI (treatments & calculations)

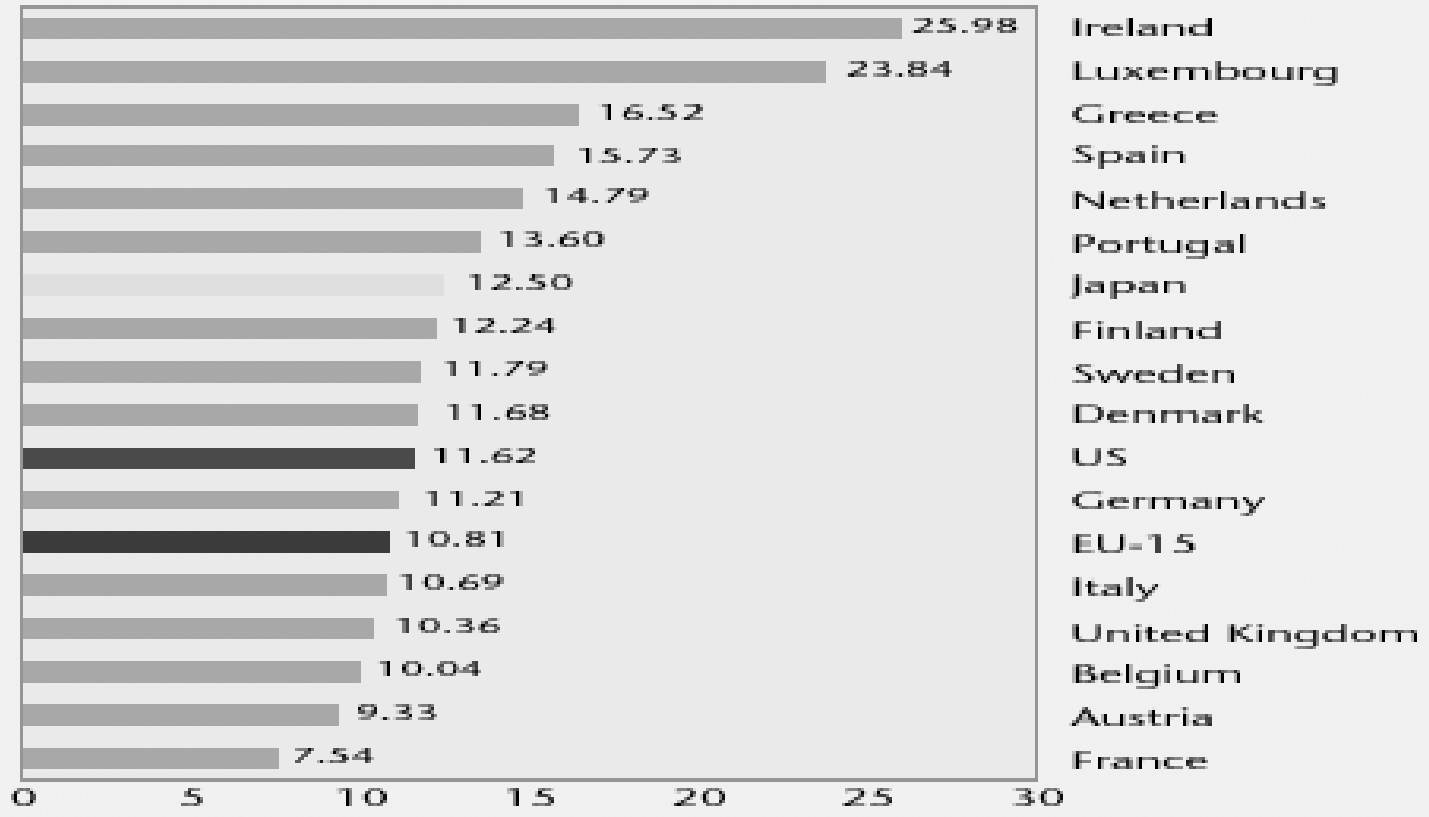
Figure 3.2.1. Number of patents at the European patent office per million population; latest available year (1)



Source: DG Research
Data: EPO, OST (treatments & calculations)
Notes: (1) EU, JP, US: 2000 and 2001 (provisional). All other countries: 2000.

Key Figures 2002

Figure 3.2.2. European patents per million population: Average annual growth, 1995 to latest available year (1), %



Source: DG Research — Key Figures 2002
Data: EPO, OST (treatments & calculations)
Note: (1) EU, JP, US: 1995-2001 (provisional). All other countries: 1995-2000.

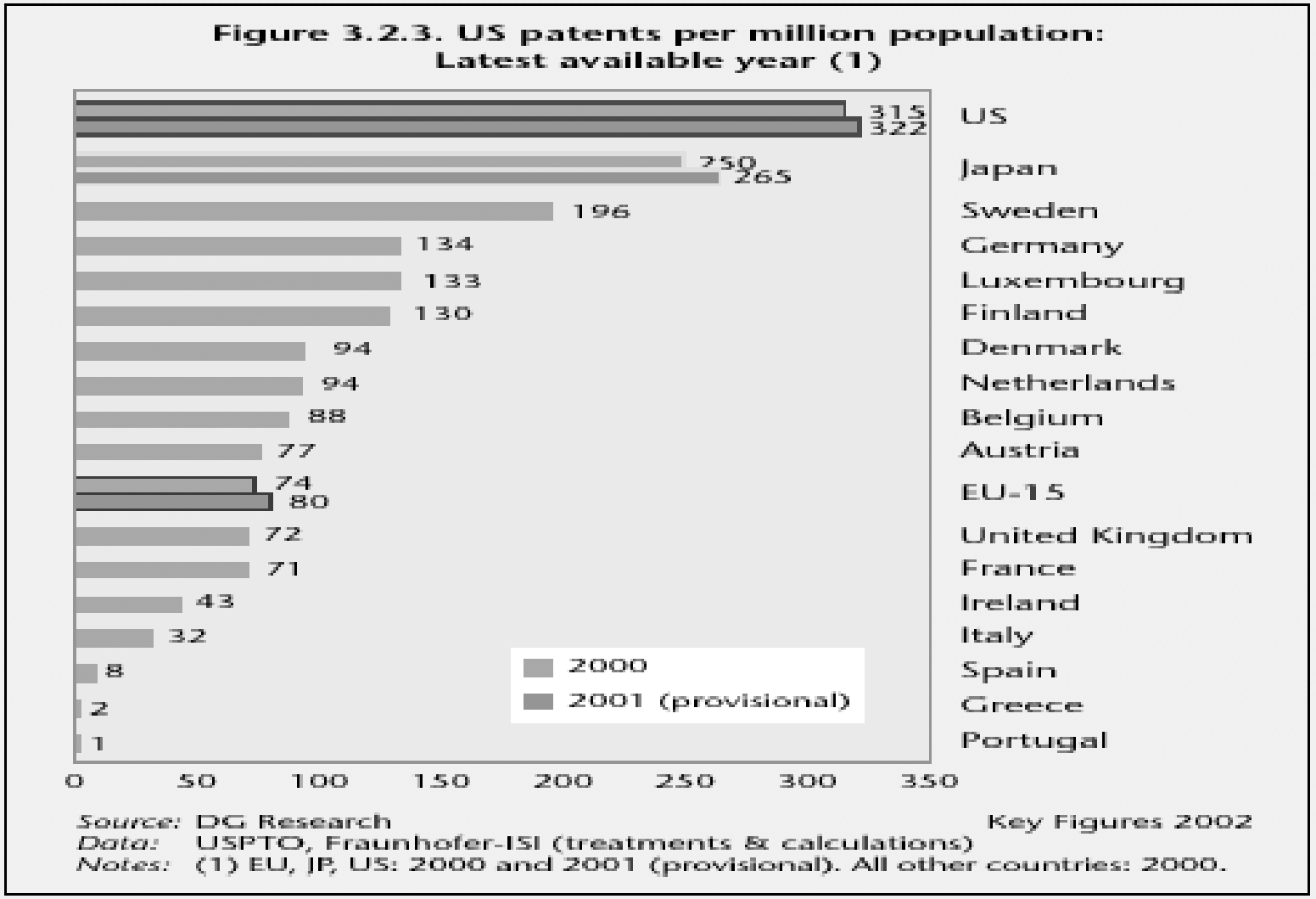
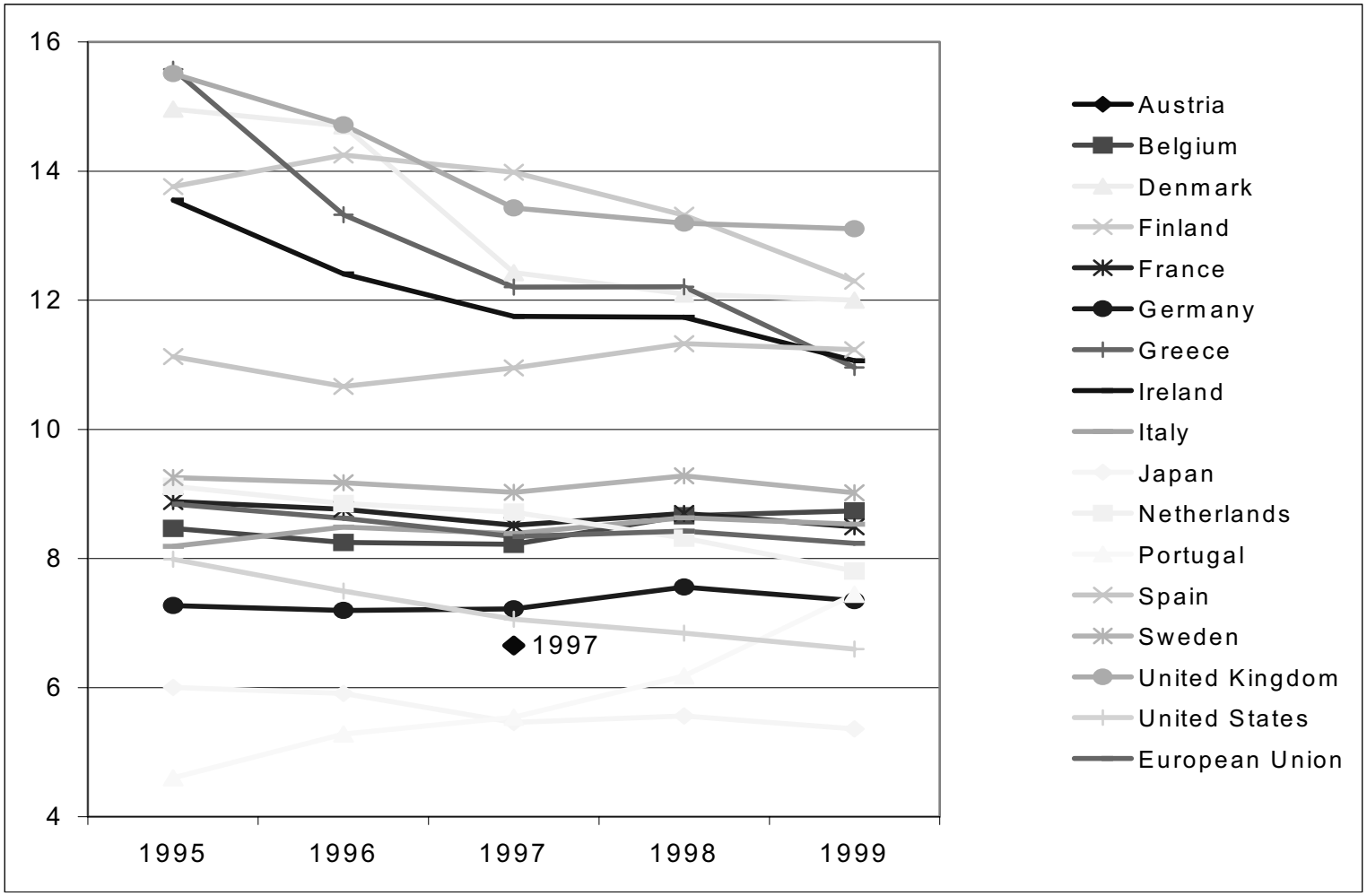
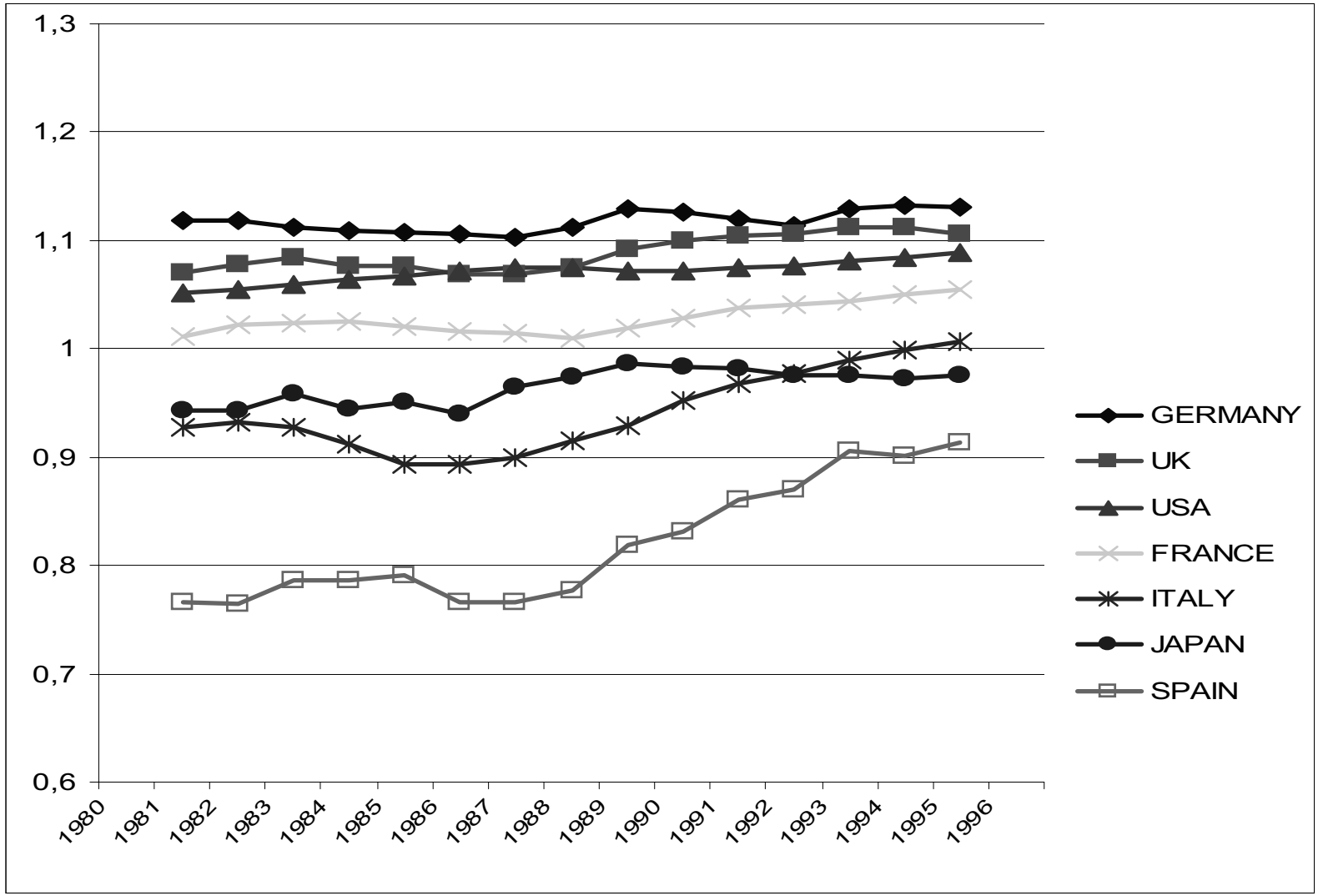


Figure 3.2.3. US patents per million population:
Latest available year (1)
315
322
250
265
196
134
133
130
94
94
88
77
74
80
72
71
43
32
8
2
1
US
Japan
Sweden
Germany
Luxembourg
Finland
Denmark
Netherlands
Belgium
Austria
EU-15
United Kingdom
France
Ireland
Italy
Spain
Greece
Portugal
2000
2001 (provisional)
0
50
100
150
200
250
300
350
Source: DG Research
Data: USPTO, Fraunhofer-ISI (treatments & calculations)
Notes: (1) EU, JP, US: 2000 and 2001 (provisional). All other countries: 2000.
Key Figures 2002

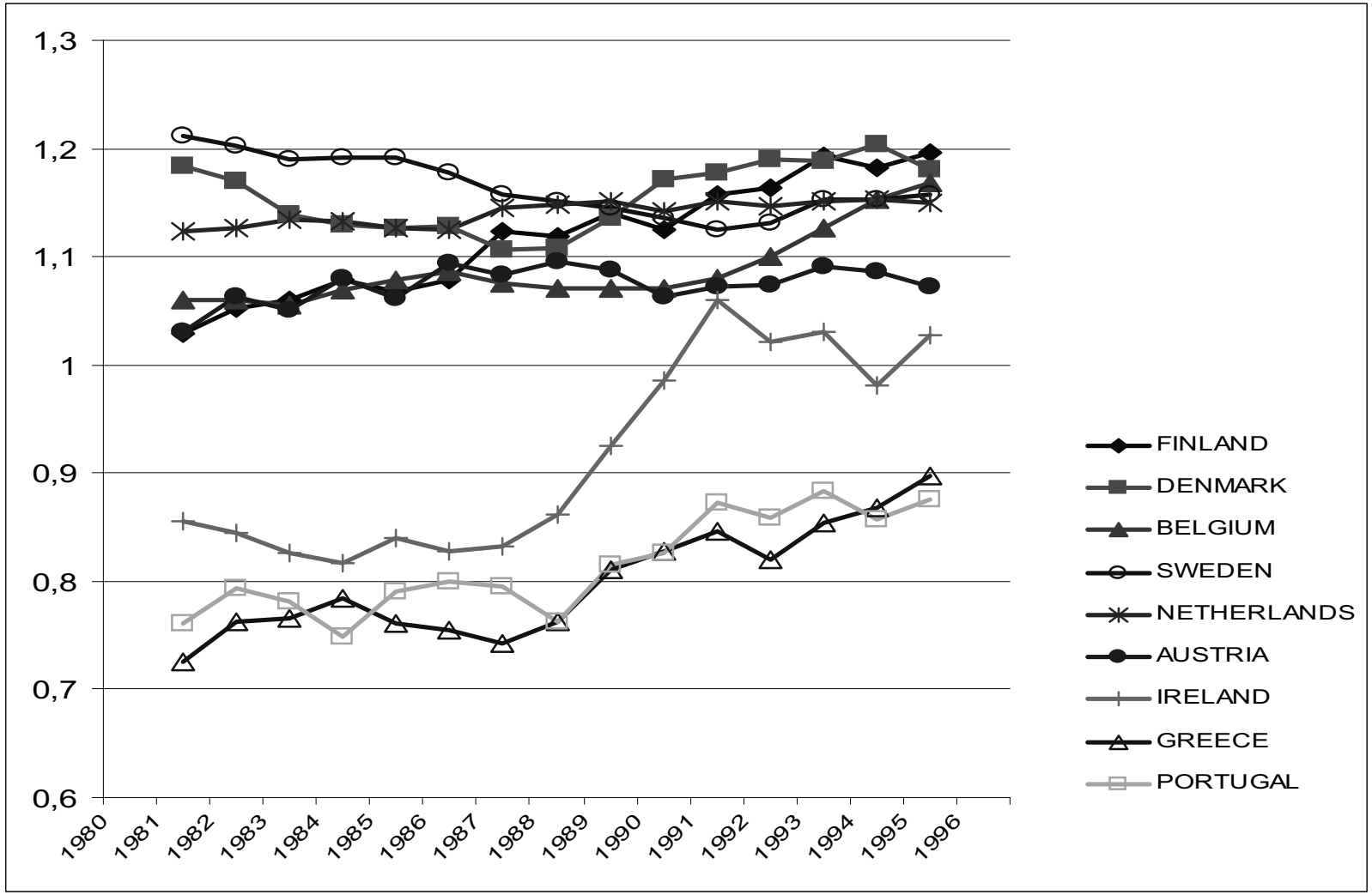
Total scientific publications per million HERD (current PPP $)



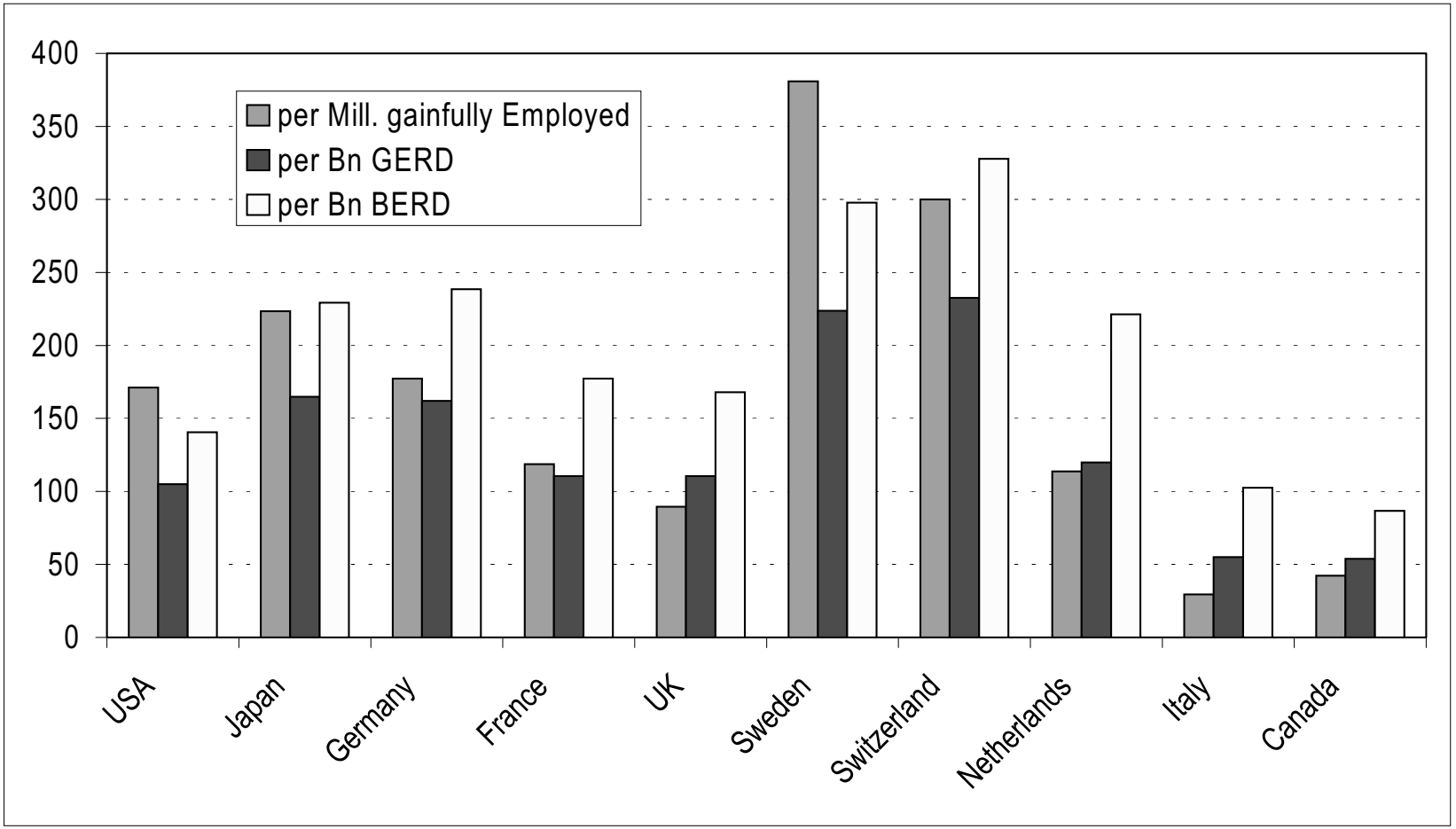
Relative Citation Rates for larger Countries



Relative Citation Rates for small & medium-sized countries



Patent activities measured by Triad patents (1998)



Key findings for the EU: S&T Productivity

- *„Regarding the performance of the European Union vis à vis the US and Japan in scientific publishing and patenting, the data show no clear evidence that Europe is lagging in S&T productivity. They rather point to an input gap, particularly in terms of private, but also public, R&D spending."*

  (Report of the Experts group)

Key findings for the EU: S&T Productivity

- The EU is the largest source of scientific publications slightly ahead of the US, and a great deal ahead of Japan, in absolute numbers.
- In publications per inhabitant, the EU is ahead of Japan but lags behind the US. Gap with the US almost halved between 1995-99.
- In publications per money spent in university research the EU leads the US and Japan, and its lead doubled between 1995 and 1999.
- In citations per scientific publication, a measure of the quality of publications, the US leads the EU, which is ahead of Japan.
- In US patents per money spent in business R&D, Europe lags behind the US and Japan.
- In “triad patents” (patents held in the US, EU and Japan) per money spent in business R&D, a number of European countries outperform Japan and the US..

Key findings for Austria: S&T Productivity

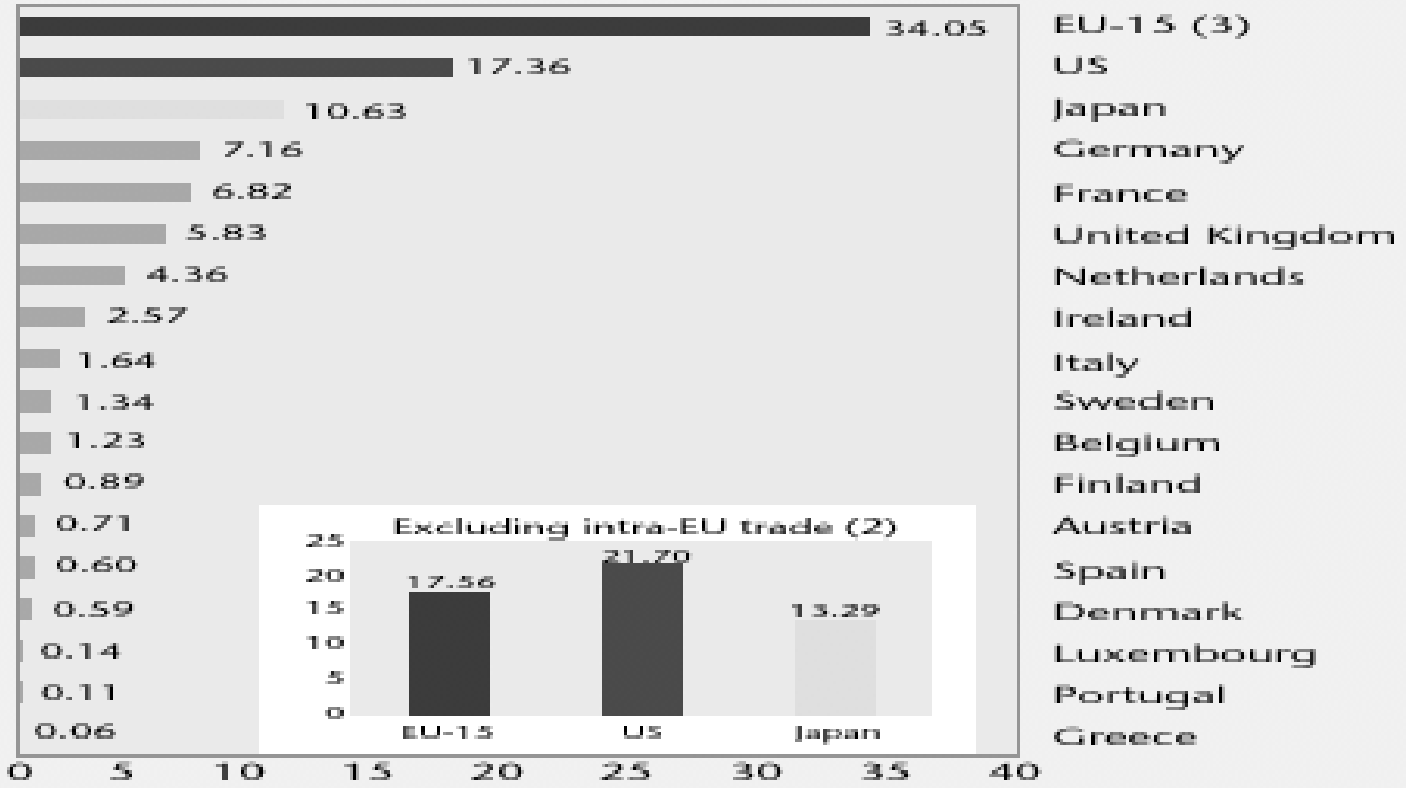
- Austria: good performance in scientific output (slightly above EU average, rapid growth in 2nd half of the 90s).
- ..but less highly cited papers
- Slightly below average in patenting at EPO, laggard in growth
- Around EU average in USPTO, growth above average
- Overall: input and structure problem, rather than quality problem

Positioning Austria: Impact of RTD on Competitiveness and Employment

Focus:

Translation of RTD and Innovaton activities into economic growth and employment.

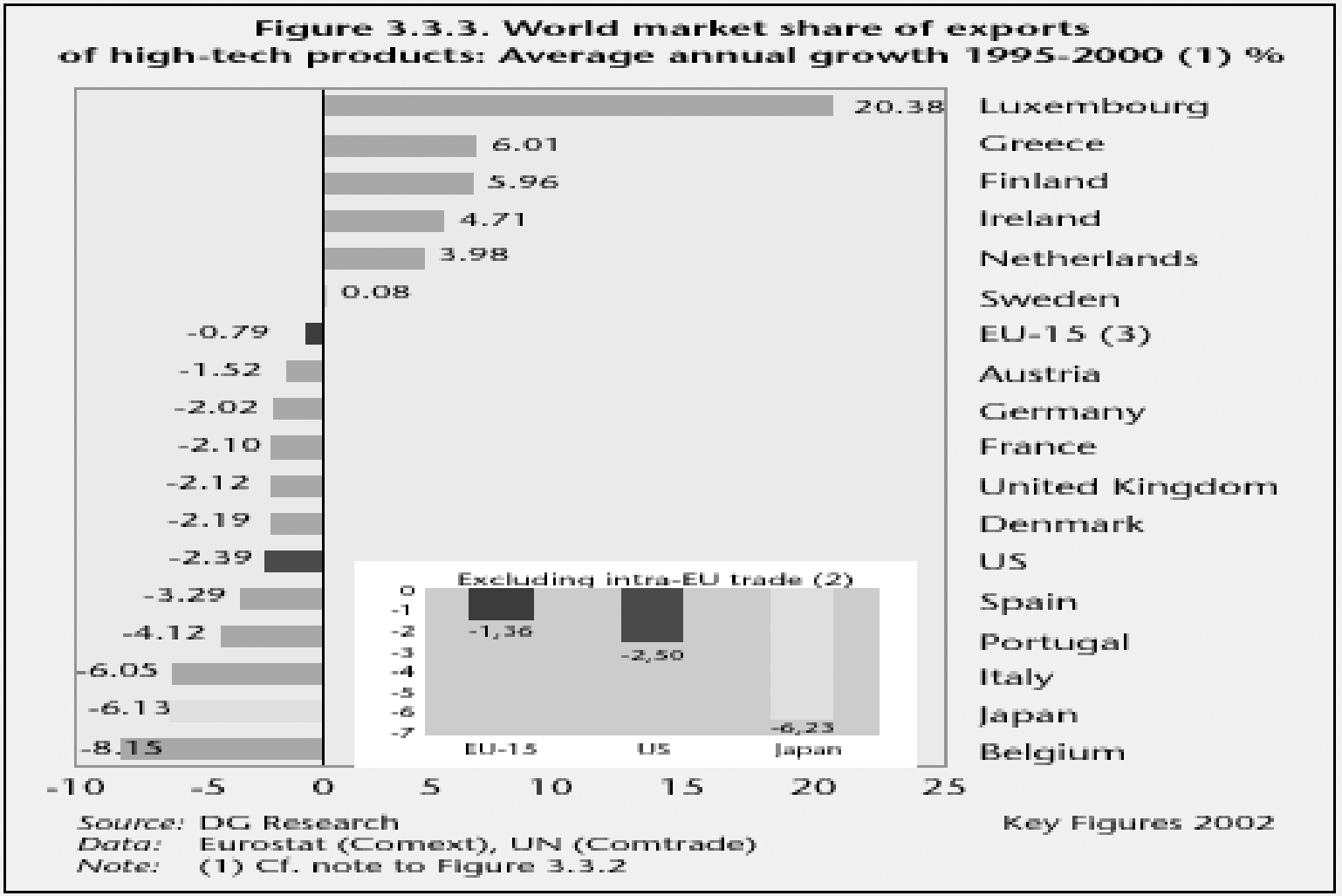
Figure 3.3.2. World market share of exports of high-tech products: 2000 (1) %



Source: DG Research
Data: Eurostat (Comext), UN (Comtrade)
Notes: (1) In the larger figure all data include intra-EU exports, and the world market refers to total world high-tech exports including intra-EU exports.
(2) In the smaller figure, EU-15 excludes intra-EU exports. World market share refers to total high-tech exports excluding intra-EU exports.
(3) Includes intra-EU exports.

Key Figures 2002

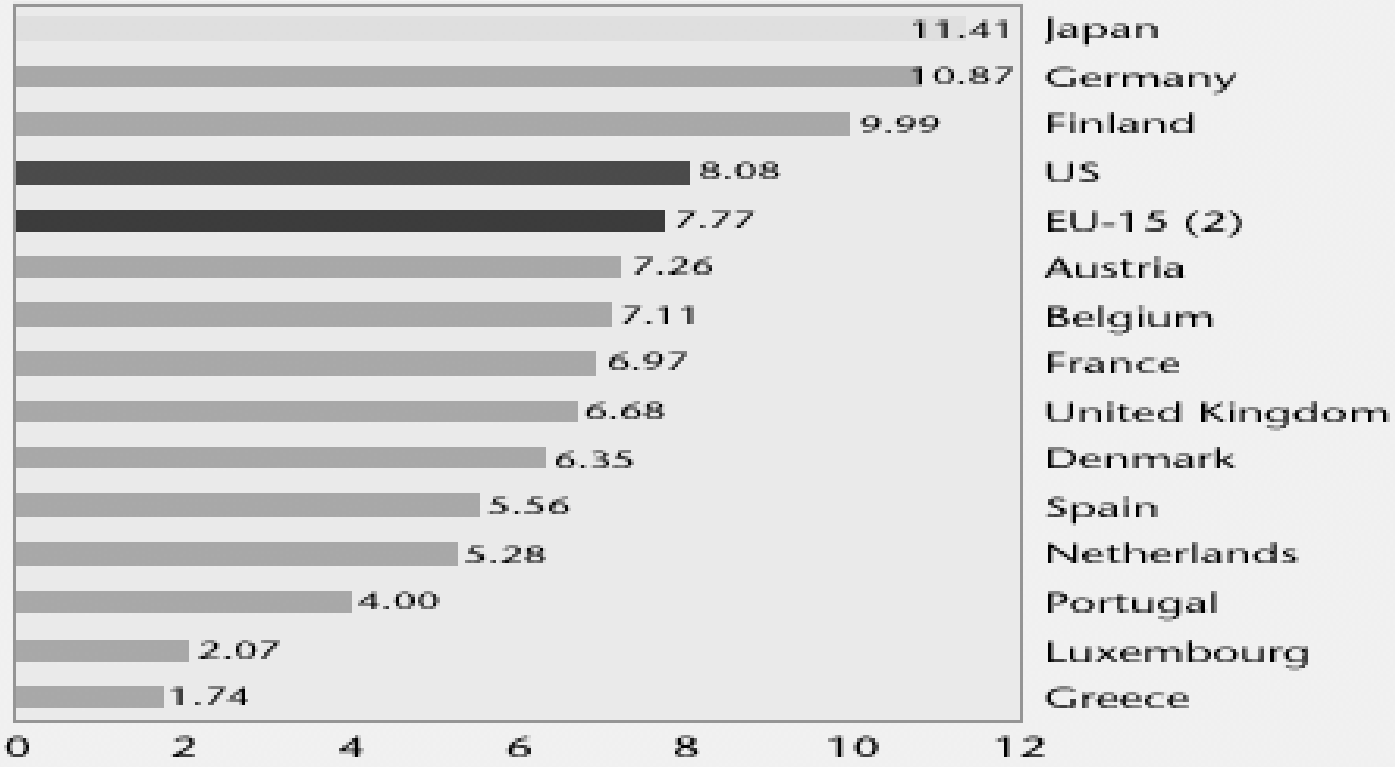
Figure 3.3.3. World market share of exports of high-tech products: Average annual growth 1995-2000 (1) %



Source: DG Research
Data: Eurostat (Comext), UN (Comtrade)
Note: (1) Cf. note to Figure 3.3.2

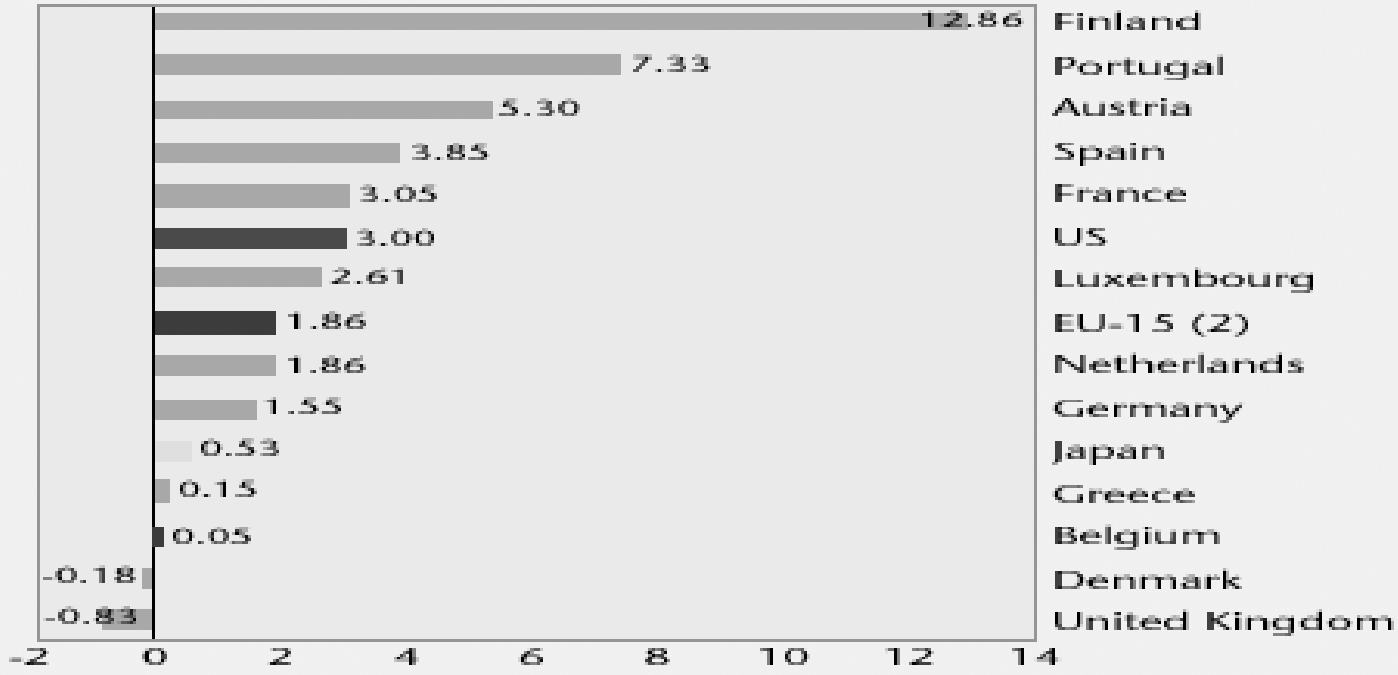
Key Figures 2002

Figure 4.2.1. Share of value added of high-tech and medium high-tech industries as % of total output latest available year (1)



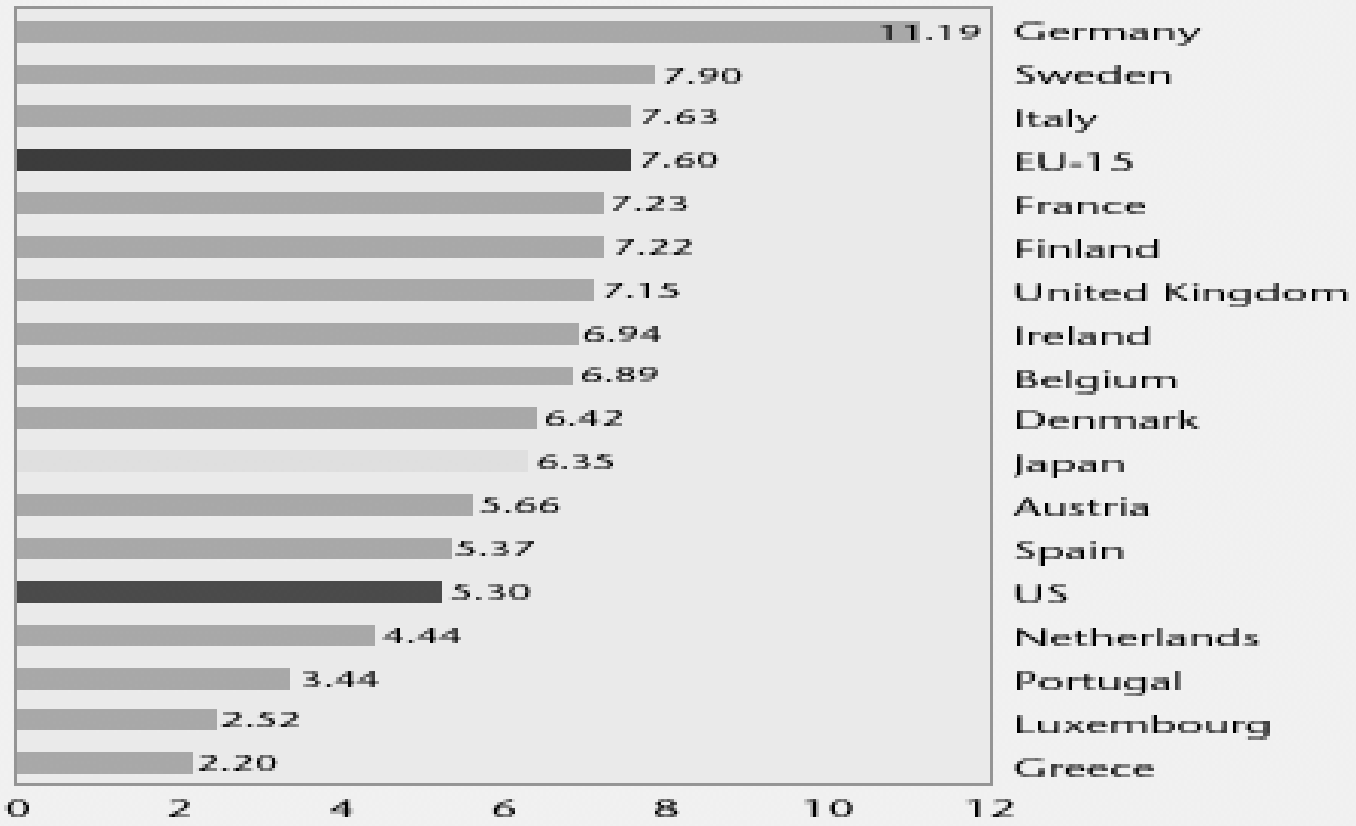
Source: DG Research — Key Figures 2002
Data: Eurostat, Member States
Notes: (1) D,US: 1998; B,DK,P,EU-15: 1999. All other countries 2000.
(2) EU average does not include IRL,I,S.

Figure 4.2.2. Share of value added of high-tech and medium high-tech industries as % of total output: average annual growth, 1995 to latest available year (1)



Source: DG Research — Key Figures 2002
Data: Eurostat, Member States
Notes: (1) B,D,P: 1995-1999. DK,US,EU-15: 1995-1998.
(2) No data available for IRL,I,S, so they are not included in the EU average

Figure 4.2.3. Employment in high-tech and medium high-tech industries as % of total employment; latest available year (1)



Source: DG Research
Data: Eurostat, Member States
Notes: (1) US: 1998; A,EU-15: 1999. All other countries: 2000

Key Figures 2002

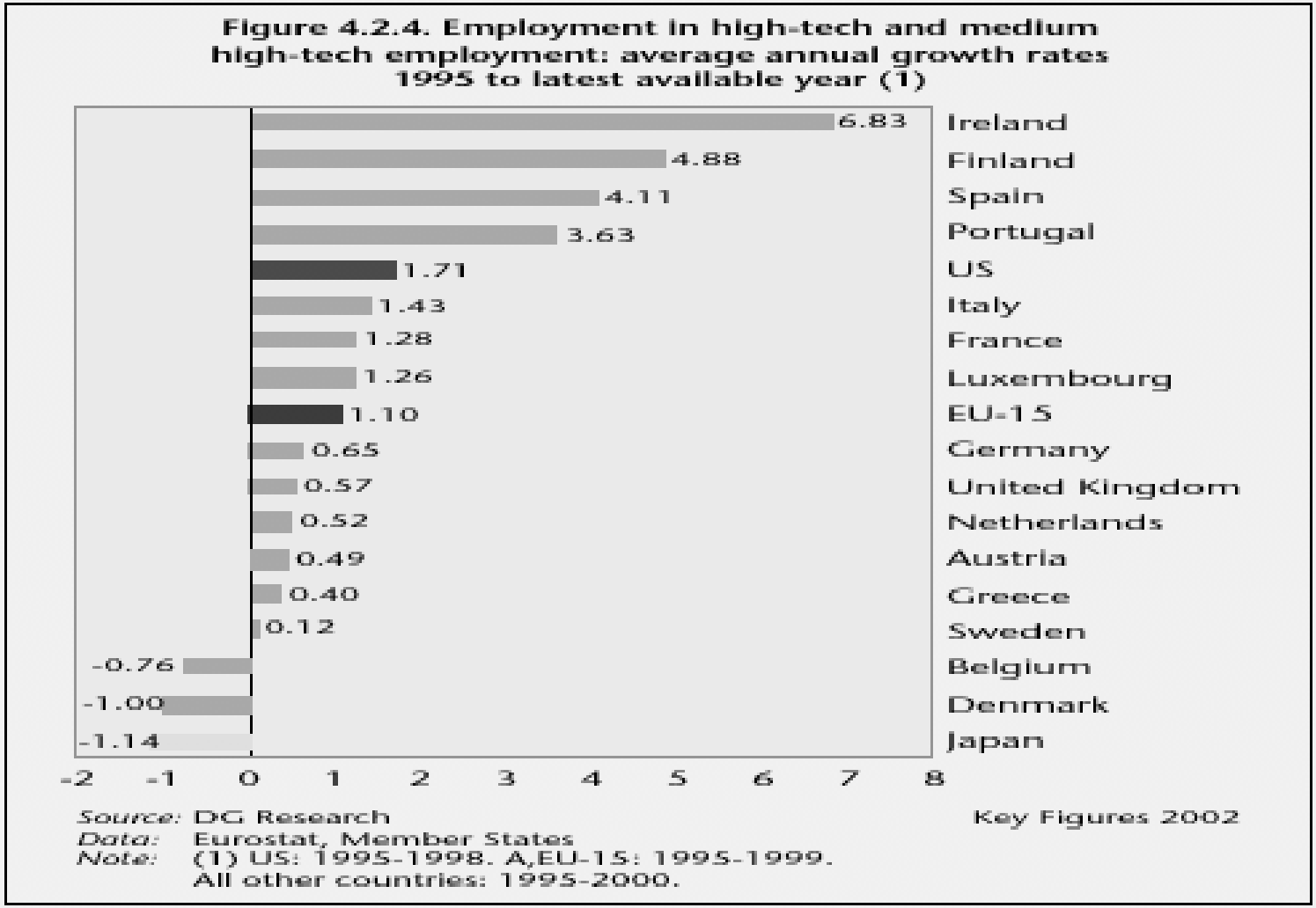


Figure 4.2.4. Employment in high-tech and medium high-tech employment: average annual growth rates 1995 to latest available year (1)
6.83
4.88
4.11
3.63
1.71
1.43
1.28
1.26
1.10
0.65
0.57
0.52
0.49
0.40
0.12
-0.76
-1.00
-1.14
Ireland
Finland
Spain
Portugal
US
Italy
France
Luxembourg
EU-15
Germany
United Kingdom
Netherlands
Austria
Greece
Sweden
Belgium
Denmark
Japan
-2 -1 0 1 2 3 4 5 6 7 8
Source: DG Research
Data: Eurostat, Member States
Note: (1) US: 1995-1998. A,EU-15: 1995-1999. All other countries: 1995-2000.
Key Figures 2002

Key findings for Austria: Economic Performance

- Complex relations, difficult to synthesize, difficult to compare
- Especially problematic: systems characterisation by composite indicators
- Austria:
  - lower share of high-tech trade and value-added from high/medium-high tech-industries than EU average
  - Shrinking world market share of exports of high-tech products
  - But: growing receipts in TBP
  - Good performance in labor producitvity
  - Growing share of value added in high/medium-high tech industries, but employment still considerably below EU average

Positioning Austria: Promoting RTD Culture and Public Understanding of Science

Focus:

The level of public understanding, awareness of, and involvement in, issues concerning science and technology are key to the full democratic implication of citizens in the knowledge society.

- Mainly qualitative data
- A lot of detailed information about individual initiatives

Main trends in the European Union

- Policy makers are taking an increasing interest in promoting a culture for research and technological development
- Numerous mechanisms are available to promote an RTD culture and PUS
  - science centres and museums
  - media
  - S&T education
  - etc.
- These activities depend on the type of actor involved:
  - short term initiatives initiated by group 1: governments, the scientific community and industry
  - ongoing and long-term activities are initiated by science museums, the media and education systems

Changes in the promotion of PUS

- Most European countries are moving from the previously dominant „deficit model“ towards a two-way dialogue between the public and science and technological development
  - deficit model: based on the assumption that the promotion of PUS is simply a matter of providing information to a supposedly uninformed public
  - two-way dialogue: the recognition of the importance of different types of knowledge and citizens involvement

How does Austria compare to other EU-countries?

- No ranking or comparison of countries undertaken in the report
- Individual initiatives and activities highlighted
- Austria is nearer the “deficit model” but, with initiatives to move towards a more integrative approach
- Two Austrian initiatives were especially highlighted in the report:
  - Leadership: the establishment of a national PUS team and strategy
  - Evaluating PUS activities: evaluating the effectiveness of such activities through the evaluation of the Science Week @ Austria 2001

Eurobarometer results: Knowledge indicators

Country	Knowledge	Interest	K/I
Denmark	1,11	1,34	0,83
Germany	0,98	0,66	1,48
Greece	0,85	1,34	0,64
Spain	0,91	0,94	0,97
France	1,02	1,2	0,84
Ireland	0,84	0,7	1,2
Italy	1,05	1,13	0,93
Netherlands	1,16	1,3	0,89
Austria	**1**	**0,83**	**1,2**
Finland	1,12	1,17	0,95
Sweden	1,25	1,42	0,88
U.K.	1,01	1,04	0,97

Is there enough public science in Austria or is there a climate of disenchantment?

Conclusions (1)

- **The role of benchmarking in the policy-making process**
  - Benchmarking as one - among other (e.g. technology assessment, foresight, policy evaluation) – tool for policy learning
  - ...as a starting point for an informed discussion which puts the aggregate results into context
  - ..rather a process of exchange of ‚good practice' than for definition of targets

Conclusions (2)

- **For the next phase of the EU Benchmarking cycle**
  - Refine indicators and improve data quality and comparability (e.g. education, regions)
  - Carry out policy benchmarking only at the more disaggregate level !
  - Explicitly address the policy (governance) structures and mechanisms in Research, Technology and Innovation policies !
  - Create new incentives for and commitment from Member Countries to participate in the BM exercise

Conclusions (3)

- **For EU policy**
  - EU‘s position vis a vis JAP and USA: a problem of inputs rather than of quality !
- **for Austrian policy**
  - Austria‘s position:
    - average, but lagging behind comparable countries
    - both a problem of level and of structure of inputs (especially in RTD&Innovation activities !)
    - there is a possibility to move onto a „virtuous circle“, but this requires additional efforts