RESEARCH & DEVELOPMENT
IN INFORMATION SCIENCE AND TECHNOLOGY
IN THE MAJOR INDUSTRIAL COUNTRIES

STATISTICAL ANALYSIS OF
R & D INVESTMENT

VOLUME 2: INDICATORS PER COUNTRY

Canada, South Korea, the United States, Japan, the European Union
(including Germany, Finland, France, United Kingdom, and Sweden)
and **Non-OECD Countries**

February 2007

Centre de traduction Minéfi – Dossier n° 0901/07 – 12/07/07

Study conducted for the

Ministry for Education, Higher Education and Research

Ministère de l'enseignement supérieure et de la recherche

by the

French Association of Electronic Information Industry

(Groupement Français de l'Industrie et de l'Information, GFII)

in partnership with

M.V. Études et Conseil

Update of the study conducted in 2003[1] and in 2005 for the

Strategic Advisory Board on Information Technologies

(Conseil Stratégique des Technologies de l'Information, CSTI)

with the assistance of the

Ministry Delegate for Research and New Technologies

(Ministère délégué à la Recherche et aux Nouvelles Technologies)

Remarks:

- The report presents the updated data, using estimates up until 2006, compiled from the OECD R&D statistical series, published in July 2006 (latest available data).

- Monetary values are expressed in PPP$ (dollar at parity of purchasing power) as international comparisons should be based on an approach using the parity of purchasing power and not on nominal currency units (dollars or euros). The OECD establishes the conversion tables between local currencies and PPP$ every year.

- Any reference to the European Union means the 25-member Union (EU-25) unlike the earlier studies that referred to the 15-member Union (EU-15).

[1] In 2003, the study was conducted for the **Strategic Advisory Board on Information Technologies** (*Conseil stratégique des technologies de l'information,* CSTI)) and funded by the Ministry of Research

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3. Indicators per OECD Country

3.1. The United States

Note: The following pages present and comment a selection of indicators on the funding of information and communication science and technologies research and development (ICT R&D) in the United States. For access to all the relevant statistical data, go to the appended Excel database and data tables.

3.1.1. The United States' relative share of global ICT R&D funding

Indicator 3.1.1. – The United States: trend of the relative share of ICT R&D funding within the 9 countries in the study

Trend of the United States' relative share of total ICT R&D funding

Share of all investments in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Within the 9 studied countries, the United States relative share of total ICT R&D funding ranges from 44% to 63%, depending on the source of funds and the year. While the relative share of funds from 'business and others' has clearly (see chapter 1) fallen off (-4% from 2000 to 2006), the relative share of US budget appropriations for ICT R&D compared to all budget appropriations is moving in exactly the opposite direction, evidencing strong growth, i.e., jumping to 61% from 58% from 2000 to 2006. Consequently, within the 9 studied countries, the United States' relative share of total ICT R&D funding has been steady at 47% since 2002. The relative share of ICT R&D funding greatly exceeds the United States' relative share of global GDP (the United States accounts for a mere 27% of global GDP). This can probably be found only in two other fields, viz., R&D for military purposes and biosciences R&D.

The United States relative share of global ICT R&D funding is even substantially higher than the country's relative share of global 'ICT equipment' production and export volumes, as depicted in table 3.1.1 below. For both types of equipment (computers and office machinery, and communication equipment), the United States accounts for a 'mere' 34%, or so of global production (and for 16% of 'export' flows). Consequently, in the United States, the ICT R&D effort seems 'oversized' compared to its macroeconomic and trade impact. Of course, the apparent gap can be explained by the close entwinement of ICT R&D and the military (addressed further down).

Table 3.1.1. – The United States: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
United States' relative share of global production	34.0%	34.4%
United States' relative share of global export volume	17.0%	16.4%

Source: NSF from the WEFA database, 2000 data

3.1.2. ICT R&D Indicators in the United States

3.1.2.1. Volume and structure of ICT R&D funding in the United States

Indicator 3.1.2. – The United States: ICT R&D funding

ICT R&D funding (PPP$ billion)

ICT R&D financed by business
ICT R&D financed by Federal funds
ICT R&D financed by other sources

Indicator 3.1.3. – The United States: ICT R&D funding structure

The United States: ICT R&D funding structure (PPP$ billion)

ICT R&D financed by business
ICT R&D financed by Federal funds
ICT R&D financed by other sources

Indicator 3.1.2 (*supra*) highlights the trend of *intramural expenditure on ICT R&D* in absolute values (current dollars, million) in the United States from 1999 to 2005, broken down into three sources of funds: public (federal or local) funds, industry funds (US businesses or businesses with their head office abroad), and (non public) own funds from higher education and Private Non-Profit institutions (PNP).[2] **In the United States, total intramural expenditure on ICT R&D went from 67.3 billion dollars in 2000 to nearly 71.2 billion dollars (projected estimate) in 2006, i.e., a fairly weak 6% overall growth in current values, which - excluding inflation - probably means an erosion**. The moderate growth rate results from a clear slump in business funding (that dropped from 57.7 to 55.6 billion dollars) and a **sharp rise of public funding, which jumped to 13.7 billion dollars from 8.3 billion (i.e., +68%).** Although ICT R&D funded by higher education or PNP (Private Non-Profit institutions) out of their own funds only accounts for 2 to 2.5% of the total, the figure soared to 19 billion dollars from 1.3 billion, i.e., a 46% rise.

The decoupling of the growth rates of public funding from private funding has substantially altered the funding structure of total US gross domestic expenditure on ICT R&D (ICT GERD), with a sharp increase in the public funding share. The United States is the only studied country to experience such a shift.

[2] This source of funding was taken into account only for the United States, as it is negligible in the other countries.

3.1.2.2. ICT R&D Intensity in the United States

Indicator 3.1.4 below illustrates 'ICT R&D intensity' measured by gross domestic expenditure on ICT R&D (ICT GERD) as a percentage of GDP. Notably, the United States has high albeit not unequalled values and, according to this indicator, shares the lead with other countries, as can be seen in table 3.1.2 below.

The ICT GERD/GDP ratio dropped from 0.69% to 0.56% from 2000 to 2006, chiefly because of lower business funding of ICT R&D. According to this indicator, the United States holds fifth world rank behind Finland, South Korea, Sweden, and Japan. In 2004, ICT R&D investment per capita amounted to $244, thus ranking the United States second worldwide, practically on a par with Sweden ($248 per capita). Yet notably, this figure is nearly twice as low as the one reported for Finland ($480 per capita).

Indicator 3.1.4. – The United States: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in the United States

Indicator 3.1.5. – The United States: ratio of total expenditure on ICT R&D per capita population

The United States: intramural expenditure on ICT R&D per capita population (PPP$)

It is also true that, according to the indicators, the United States stands out as having a much higher ICT R&D intensity than the average intensity in the 9 countries (see table below) in the study and specifically higher than the reported density for Europe-25. As we pointed out earlier in Chapter 2**, in the United States, ICT R&D intensity is twice as high as in Europe if one looks at the '% of GDP' ratio and is three times higher if one compares it with the 'per capita' ratio.**

Table 3.1.2. – The United States: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

3.1.2.3. The place of ICT R&D investment within total R&D investment in the United States

Indicator 3.1.6. – The United States: ICT R&D ratio of total (public and private) R&D expenditure

The United States: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by the Federal Government/Total GERD financed by the Federal Government

Indicator 3.1.6 highlights the ratio of ICT R&D financed by business compared to all R&D financed by business, on the one hand, and the ratio of budget appropriations for ICT R&D compared to all Government Budget Appropriations or Outlays for R&D (GBAORD), on the other. In the first parameter, with an ICT R&D ratio dropping from 30.8% to 30% of the overall envelope of R&D business investments, the US figure is not remarkable. It is much lower than the reported values for Finland (62%), South Korea (57%), Japan (35%), and even France, in 2005. However, it is higher than the EU-25 figure (19%). On the other hand, although it has remained steady (despite strong growth in absolute value, a fact we have already underscored), to the order of 10.1%, the relative share of ICT R&D outlays compared to all budget appropriations for R&D is fairly high. For the other countries, only in Finland (11.1%), Japan (10.6%), South Korea (10.7%) and France (11.7%) (2005 data) do we find an indicator value higher than 10%. Notably, while the relative share of the envelope of budget

appropriations for ICT R&D within all US R&D budget appropriations remained steady from 2000 to 2006 despite the soaring absolute value, *this is due to the concomitant and even stronger growth of budget appropriations for R&D in biosciences*. Despite its swift pick-up, the relative share of investments in ICT R&D has not grown within US R&D budgets. This can be clearly seen in indicator 3.1.7 below, which compares the overall GERD index, which went from index 100 to index 120 whereas, during the same time period, the ICT GERD index merely climbed from index 100 to index 106. **Today in the United States, ICT R&D is no longer the main engine driving expenditures on R&D, inclusive of all sectors**.

Indicator 3.1.7. - The United States: index of ICT R&D expenditure and index of total R&D expenditure

The United States: index of ICT R&D and index of total R&D expenditure

GERD
ICT GERD

3.1.2.4. Business investment in ICT R&D

Indicator 3.1.8 below focuses on the changing volume of business ICT R&D funding (already depicted in indicator 3.1.2). Business ICT R&D funding dropped from $57.7 billion in 2000 to an estimated $55.6 billion in 2006, i.e., a 4% decrease in current terms (excluding inflation). The deflated values may highlight even sharper erosion. Although US business's financial effort for ICT R&D grew dramatically from 2000 to 2001, chiefly due to the boom of Internet developments, the growth rate of US business investment in ICT R&D (performed in-house) is now negative (roughly -2% per year) due to a probable relocation of some R&D activities to countries with low-cost labour.

Indicator 3.1.8. – The United States: business-financed ICT R&D

Business-financed ICT R&D in the United States (PPP$ million)

Indicator 3.1.9. – The United States: index of expenditure on ICT R&D and index of expenditure on R&D financed by business

The United States: index of expenditure on ICT R&D and index of expenditure on R&D financed by business

All R&D financed by business
ICT R&D financed by business

For business alone, indicator 3.1.9 confirms the fall-off of business funds for ICT R&D compared to the rise of business funds for R&D, inclusive of all sectors. For the 2000-2006 period, the analysis of the index value (2000 = 100) of the two budget items highlights that expenditure on ICT R&D dropped 4 points whereas all business spending on R&D rose 12 points. The decoupling, which had already started during the earlier studies, is increasing. Further down (see indicator 3.1.14), it appears that the analysis of the indexes shows that the downward trend of business funds for ICT R&D contrasts with the steadily rising level of budget appropriations for business ICT R&D.

Indicator 3.1.10. – The United States: trend of public funding for ICT R&D allocated to business

Trend of public funding for ICT R&D allocated to business in the United States

PPP$ million
Index

Indicator 3.1.10 above highlights another aspect of US business ICT R&D, i.e., the budget appropriations going to business, often as research contracts, thus strengthening business's own ICT R&D potential. From the businesses' standpoint, they are in a 'contract-based' rationale since they themselves are not providing the funds (which, of course, are not included in the volumes of the ICT R&D funded by own capital of said businesses).

The amounts, which soared to $8.5 billion in 2006 from $5.6 billion in 2000, appear to be huge. They grew apace from 2000 to 2006 (+51%). The index of the volume of budget appropriations for ICT R&D allocated to business jumped from index 100 to index 151, i.e., 55 index points more than the index of ICT R&D funded by business own capital. Indeed budget appropriations for ICT R&D allocated to business, which are moving in exactly the opposite direction of dwindling business funds for ICT R&D, more than compensate for the weakness of private self-funding. **It is no exaggeration to say that budget appropriations for ICT R&D allocated to business 'subsidise' a strong ICT R&D potential in US business, despite the fall-off of business-performed R&D financed by business own capital.**

The huge amount of public funds for US business-performed ICT R&D should obviously be seen in light of the sizeable amount of military budget appropriations for ICT R&D, of which a large share goes to business (see *infra*).

Thus unsurprisingly, the relative share of budget appropriations in the volumes of the business-performed ICT R&D has risen, as can be seen in indicators 3.1.11 and 3.1.12 below. Budget

appropriations, which accounted for 8.9% of the volumes of business-performed ICT R&D in 2000, today account for about 13.3%. Further down, we will see that budget appropriations for ICT R&D allocated to business are chiefly linked to very large military appropriations.

Indicator 3.1.11. – The United States: funding of business-performed ICT R&D

Structure of business-performed ICT R&D in the United States (PPP$ million)

ICT R&D financed by public funds
ICT R&D financed by business own-capital

Indicator 3.1.12. – The United States: share of business own capital and of budget appropriations for business-performed ICT R&D

ICT R&D funding structure of US business

ICT R&D financed by public funds
ICT R&D financed by business own-capital

3.1.2.5. – Business ICT R&D and ICT production value

Table 3.1.3. – The United States: compared ratio of ICT R&D financed by business versus total business-enterprise expenditure on R&D (BERD) on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of total business value added	**10.6%**
ICT manufactured goods value added as % of total business value added	**12.75%**
Business ICT R&D as % of total business R&D	**30%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (30%) is about three times higher than the ICT ratio on total value added of business. Several reasons explain this gap. One, ICT services and manufacturing industries are high-tech activities for which R&D investment is

intrinsically high; two, ICT are ‘empowering technologies’ and R&D in this field has outlets in other services or manufacturing industries than the ICT industry.

3.1.2.6. Budget appropriations for ICT R&D in the United States

Indicator 3.1.13. – The United States: trend of ICT R&D financed by public funds

The United States: trend of ICT R&D financed by public funds (million $)

The trend of the volume of ICT R&D financed by public funds (chiefly federal funds as all the funding from the different states, which is included in these figures, accounts for less than 1% of the total) can be seen in indicator 3.1.13. We have already pointed out in Chapter 2 that no other country or group of countries devotes such huge amounts of budget appropriations to the support of ICT R&D.

Indicator 3.1.14. – The United States: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Index of ICT R&D financed by public funds and by private funds

ICT R&D financed by business
ICT R&D financed by federal funds

Indicator 3.1.14 also shows that funds for ICT R&D from budget appropriations are now rising much faster than private budget funds, which dropped from index 100 to index 96 from 2000 to 2006 whereas, on the whole, budget appropriations for ICT R&D rose from index 100 to index 166.
Despite the huge and growing transfers (in absolute value) of budget appropriations for ICT R&D to business, budget appropriations for ICT R&D going to research performers other than business also grew apace from 2000 to 2006. The relative share of government budget appropriations for ICT R&D allocated to business dropped to about 62% at the end of the period, down from 68.1%, of the total envelope.

Indicator 3.1.15. – The United States: public funding of ICT R&D by performance sector

Public funding of ICT R&D by performance sector
(PPP$ million)

ICT R&D budget appropriations for business
ICT R&D budget appropriations for other sectors

Table 3.1.4. – The United States: public funding of ICT R&D by performance sector

	2000	2001	2002	2003	2004	2005	2006
ICT R&D budget appropriations for business	68.1%	66.9%	52.2%	53.4%	53.0%	51.7%	61.9%
ICT R&D budget appropriations for other sectors	31.9%	33.1%	47.8%	46.6%	47.0%	48.3%	38.1%

Indicator 3.1.16. – The United States: index of ICT R&D expenditure and index of all R&D expenditure financed by public funds

The United States: index of ICT R&D expenditure and index of all R&D expenditure financed by public funds

Budget appropriations for ICT R&D
Budget appropriations for R&D (inclusive of all sectors)

Last, it should be pointed out that, although the US public authorities' sustained ICT R&D funding effort has always been spotlighted and has cleared the way for the set-up of special organisations (National Coordination Office for Information Technology R&D), this effort is not remarkable if taken within the overall framework of the changing public expenditure on R&D, as can be clearly seen in indicator 3.1.16 above. Remarkably, the trend of overall budget appropriations for R&D and the trend of budget appropriations for ICT R&D are in line with each other. Government outlays for ICT R&D account for about 10.4% of all US budget appropriations for R&D. Thus, it is not the relative size of ICT R&D that explains the striking parallelism of the two curves, that is even more remarkable as the trend of budget appropriations for ICT R&D was established without any direct reference to NSF data but by a specific examination of budget documents, unlike the overall envelope of budget appropriations for R&D that was compiled based on the NSF series. What the indicator reveals is the overall acceleration of public effort for R&D in the United States (that deserves, however, a finer industry-focussed analysis as all the sectors do not receive equal funding).

US publicly funded ICT R&D also has a very specific feature, viz., the size of the military appropriations out of the budget outlays for the Department of Defence (the DoD and its special agencies, DARPA and NSA), as can be clearly seen in indicator 3.1.17, which analyses the structure of US budget appropriations for ICT R&D. From 2000 to 2006, on average, DoD appropriations account for 85% of US budget outlays for ICT R&D, a ratio that cannot be found in any other country.

Indicator 3.1.17. – Trend of the ICT R&D public budget structure in the United States

USA: Trend of the ICT R&D public budget structure (million $)

Civil budget appropriations for ICT R&D
Defence appropriations for ICT research
Defence appropriations for ICT developments

3.2 Canada

Note: The following pages present and comment a selection of indicators on ICT R&D funding in Canada. For access to all the relevant statistical data, go to the complete Excel database and the data tables in Appendix 1.

3.2.1. Canada's relative share of ICT R&D funding compared the 9 studied countries

Indicator 3.2.1. – Trend of Canada's relative share of ICT R&D funding

Trend of Canada's relative share of all ICT R&D funding

Share of all investment in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Canada's relative share of all ICT R&D investment compared to the 9 studied countries seems small. Canada's relative share of overall ICT R&D funding 'weighed' 4.5% of total funding at the start of the period (2000) and 3.7% in 2006. **However, based on these figures, it should be pointed out that Canada's relative share exceeds the shares of countries such as Sweden and Finland. Thus Canada is hardly a lightweight in terms of ICT R&D in developed countries** and the country's relative share exceeds that of the Canadian economy in the global GDP (2.4%).

Canada's relative weight in global ICT R&D investment also largely exceeds (by a factor of 1 to 2; more if only private investments are considered) Canada's relative share of ICT equipment production and export, as can be seen in table 3.2.1 below (2000 data).

However, in Canada's case, for the two selected indicators (total ICT R&D investment; private investment), Canada's relative share is rapidly dwindling whereas it had risen rapidly up until 2001, at a pace unmatched by any other country. The volatility of ICT R&D funding volumes as well as the 'oversized' private funding of ICT R&D in Canada can be explained by the same factor, i.e., a very bold research tax credit policy that has put the country in the lead of developed countries for its appeal to non-Canadian business investments in R&D.

Consequently, the country has become an R&D 'platform' in North America for numerous non-Canadian (mainly US) companies. Foreign funds account for about 18% of the Canadian GERD (gross domestic expenditure on R&D), inclusive of all sectors. In 2002, according to an expert at Canada's National Statistical Agency (Statscan), the percentage was to the order of 25 to 30% of the ICT GERD. *However, relocated ICT R&D is also fragile because it is strongly affected by cyclical factors and chiefly because, since 2002, large US ICT groups have been exploring other relocation opportunities (India, China, and so on) that are more advantageous than what Canada has to offer.* Canada, which benefited from the ICT R&D relocation move in the early decade, has now become the first 'victim' of relocation and has become subject to decision-making centres on R&D investment relocation, which are outside the country and thus unencumbered by any 'economic patriotism' issues.

On the other hand, Canada's relative share of public funding for ICT R&D, which grew from 4.6% in 1999 to 5.4% (estimate) in 2006, is in line with the country's economic weight. The relative share of budget appropriations in gross domestic expenditure on R&D (GERD) is shifting in the opposite direction of the relative share of business ICT R&D[3] funding, and partially compensating for its fall-off.

Table 3.2.1. – Canada: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
Canada's relative share of global production	1.4%	1.4%
Canada's relative share in volume of global export volume	2.0%	2.0%

Source: NSF from the WEFA database

3.2.2. ICT R&D Indicators in Canada

3.2.2.1 Volume and structure of ICT funding in Canada

Indicator 3.2.2 below illustrates the absolute values of ICT R&D funding in Canada, broken down into 'financed by public funds' and 'financed by business and others'. The overall value of funding dropped from PPP$5.97 to PPP$5.7 billion from 2000 to 2006 (estimate). Canada is the only studied country where overall funds for ICT R&D have decreased in absolute value.

Indicator 3.2.2. – Canada: ICT R&D financed by business and financed by the Federal State

ICT R&D financed by business and financed by the Federal State in Canada

(PPP$ million)

ICT R&D financed by business
ICT R&D financed by public funds

Table 3.2.2. – Canada: trend of the ICT R&D budget structure in Canada

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
ICT R&D financed by business	95.0%	94.9%	94.3%	93.6%	93.5%	93.2%	93.5%
ICT R&D financed by public funds	5.0%	5.1%	5.7%	6.4%	6.5%	6.8%	6.5%

[3] In the earlier edition of the study, an error was made regarding business investment in ICT R&D during the relevant period. A low figure, i.e., slightly more than 1%, was mistakenly given.

The funding structure of ICT R&D performed on Canadian soil can be found in table 3.2.1. From 2000 to 2006, the share of budget appropriations increased in relative value as well in absolute value, going from 5% to 6.5% that is a very substantial increase in terms of relative share. The rise in the share of budget appropriations should be measured against the drop of private funds. In Canada, it is as if budget appropriations were working to offset the strong variations of ICT R&D volumes financed by business (among other objectives). The same development was also observable in the United States.

3.2.2.2. ICT R&D Intensity in Canada

Indicator 3.2.3 – Canada: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in Canada

Indicator 3.2.3 illustrates ICT R&D intensity measured by the GERD/GDP ratio, in Canada. The indicator values put Canada in a median position among the 9 studied countries (see table 3.2.3 *infra*). In Canada, the total ICT R&D investment ratio to GDP dipped from 0.69% to 0.52% during the relevant period.

Table 3.2.3 – Canada: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

Indicator 3.2.4. – Canada: expenditure on ICT R&D per capita population

Expenditure on ICT R&D per capita population in Canada

3.2.2.3. The place of ICT R&D investment within total R&D investment in Canada

Indicator 3.2.5. – Canada: ICT R&D ratio of total (public and private) R&D expenditure

Canada: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.2.5 highlights the ratio of business-financed ICT R&D compared to all R&D financed by business, on the one hand, and the ratio of budget appropriations for ICT R&D compared to all Government Budget Appropriations or Outlays for R&D (GBAORD), on the other. In the first parameter, Canada is among the countries whose private R&D is clearly 'ICT-oriented' even if the drop from the 2000 figure (49%) to the 2006 estimate (35%) mirrors the shrinking ICT R&D volume. According to this criterion, Canada ranks behind Finland (62%) and South Korea (57%), is on a par with Japan (35%), and is ahead of the United States' (30% mean from 2000 to 2006). During this time, Canada's ratio was higher than the ratios in EU-25, France (31%), Germany (21%), and the United Kingdom (18%).

On the other hand, the relative share of budget outlays for ICT R&D compared to all budget appropriations for R&D is much lower (5.7% mean from 2000 to 2006, at a par with the European mean). Thus, Canada ranks behind Finland (11.1%), Japan (10.6%), France (11.7%), South Korea (10.7%), and the United Kingdom (8%). The 'decoupling' of the two indexes is quite typical of the Canadian situation. **Excluding the strong incentive of the tax credit mechanism that explains the relocation of R&D activities in Canada, it is as if the direct action of budget appropriations was not accompanying the strong ICT oriented policy of the private R&D sector.** Of the nine countries, Canada is perhaps one of the best illustrations of a 'free market model' of the drive of ICT R&D funding.

Indicator 3.2.6. – Canada: Index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes

Index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes in Canada

ICT R&D funding
All R&D funding

Indicator 3.2.6 compares GERD index (inclusive of all sectors) with the ICT GERD index. Clearly, total intramural expenditure on R&D has risen surely and steadily, from index 100 (2000) to index 130 (2006 estimate) while the ICT GERD has levelled off, with the index dropping to 95 down from index

100. This again illustrates the fact that, because ICT R&D volumes are strongly impacted by R&D relocation and/or outsourcing by US ICT businesses, they have become very volatile in Canada, something which does not occur in other sectors (Canada is still a major platform for the relocated R&D of the US aerospace, pharmaceutical and automotive industries). Based on the Canadian example, it can be assumed that ICT R&D is particularly sensitive to relocation policies.

3.2.2.4. Business ICT R&D investment in Canada

Indicator 3.2.7. – Canada: business-financed ICT R&D

Business-financed ICT R&D in Canada (PPP$ million)

In Canada, the reaction of business ICT R&D investment to cyclical factors can also be seen in indicator 3.2.7 that compiles the absolute values (PPP$ million) of these funds. Since 2002, the volume of private funding for ICT R&D has shrunk substantially. Despite the turnaround of the 2006 estimate, the indicator is far from reaching the 2000 figure.

Indicator 3.2.8 (see *infra*), which compares the index of business-financed ICT R&D with the index of all R&D (inclusive of all sectors) financed by business, also shows that the fragility is special to ICT R&D since the privately funded R&D index has risen, on the whole. The curves here are exactly the same as the curves found in indicator 3.2.6 that depicted the index for all ICT R&D funding. Thus, in Canada, business investment effectively drives the overall funding impetus.

Indicator 3.2.8. – Canada: index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes financed by private funds

Index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes financed by private funds in Canada

ICT R&D funding
All R&D funding

Indicator 3.2.9. – Canada: trend of public funding for ICT R&D allocated to business

Trend of public funding for ICT R&D allocated to business in Canada

PPP$ million
Index

The Canadian public authorities'[4] weak 'interventionism' in *direct* ICT R&D funding (since most of the incentive is provided by the research tax credit) is also highlighted in indicator 3.2.9. From 2000 to 2006, budget appropriations for ICT R&D going directly to business averaged PPP$130 million, i.e., an average 2.6% of the volume of Canadian business-performed ICT R&D. Furthermore, the index of budget appropriations for ICT R&D going to the private sector, slackened, despite an upswing in 2001-2002, with the 2000 index of 100 climbing to only 114 at the end of the period. However, this apparent increase masks a standstill in deflated values. This is perfectly in line with the Canadian government's stated goals of limiting direct support (in favour of the indirect support provided by the tax credit) to R&D with a 'technological' purpose.

Table 3.2.4. – Canada: relative share of business own capital and public funds in the volumes of Canadian business-performed ICT R&D

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
ICT R&D financed by business own capital	97.8%	97.3%	97.4%	97.4%	97.4%	97.4%	97.4%
Business-performed ICT R&D financed by public funds	2.2%	2.7%	2.6%	2.6%	2.6%	2.6%	2.6%

3.2.2.5. – Business ICT R&D and ICT production value

Table 3.2.5. – Canada: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of total business value added	**10.6%**
ICT manufactured goods value added as % of total business value added	**12.75%**
Business ICT R&D as % of total business R&D	**30%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT

[4] The Federal authorities as well as the authorities of the federal states that, overall, only provide 1% of the public funds for ICT R&D, with 78% of the appropriations coming from only two states, i.e., Ontario for more than 50% and Quebec for about 28%.

manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (30%) is about three times higher than the ICT ratio on total value added of business. Several reasons explain this gap. One, ICT services and manufacturing industries are high-tech activities for which R&D investment is intrinsically high; two, ICT are 'empowering technologies' and R&D in this field has outlets in other services or manufacturing industries than the ICT industry

3.2.2.6. Budget appropriations for ICT R&D in Canada

Indicator 3.2.10. – Canada: direct ICT R&D funding by the Federal State

Trend of budget appropriations for ICT R&D in Canada
(PPP$ million)

Despite the Canadian public authority's relative non-interventionism in the funding of R&D for technological purposes, the budget appropriations for ICT R&D did, however, increase from 2000 to 2006, as ICT R&D was still a public research programme priority. The increase can be seen in indicator 3.2.10 above. During this time, budget appropriations jumped from PPP$300 million to PPP$372 million, i.e., a 24% increase in seven years. The trend of the budget appropriations index (see indicator 3.2.11 below) is positive and 'swings away' from the trend of the private funding index. The latter dropped by 6 index points whereas public spending climbed from index 100 to index 124.
In Canada, the share of military appropriations in budget appropriations for ICT R&D averaged 6.6% from 2000 to 2006 and tended to drop, as the ratio of military appropriations accounted for 7.3% in 2000 and only for 6.5% (estimate) in 2006, after undergoing slow but steady erosion.

Indicator 3.2.11. – Canada: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Trend of the ICT R&D index financed by business and of the ICT R&D index financed by public funds in Canada

ICT R&D financed by business and others
ICT R&D financed by public funds

The breakdown of Canadian ICT R&D budget appropriations between civil and military appropriations is illustrated in indicator 3.2.12 below.

Indicator 3.2.12. – Canada: share of civil and military appropriations in budget outlays for ICT R&D

Share of civil and military appropriations in budget outlays for ICT R&D (PPP$ million)

Civil appropriations
Military appropriations

Table 3.2.6. – Canada: share of civil and 'defence' appropriations in budget outlays for ICT R&D

	2000	2001	2002	2003	2004	2005	2006
Share of ICT civil research in budget appropriations for ICT R&D	92.7%	93.4%	93.4%	93.3%	93.5%	93.6%	93.5%
Share of ICT 'defence' research in budget appropriations for ICT R&D	7.3%	6.6%	6.6%	6.7%	6.5%	6.4%	6.5%

3.3 Japan

Note: The following pages present and comment a selection of indicators on ICT R&D funding in Japan. For access to all the relevant statistical data, go to the complete Excel database and the data tables found in Appendix 1.

3.3.1. Japan's relative share of global ICT R&D funding

Indicator 3.3.1. – Japan: trend of Japan's relative share of global ICT R&D funding

Trend of Japan's relative share of global ICT R&D funding

Share of all investment in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Japan's relative share of global investment in ICT R&D ranks the country as the world's second largest R&D investor, with an average to the order of 21.6% from 2000 to 2006. Its relative share climbed slightly. Japan 'weighed' 20.6% of global funding at the start of 2000 and 22.3% (estimate) in 2006. Other indicators mirror Japan's upswing in global ICT R&D funding, mainly due to business-financed R&D. Japan's relative share of ICT R&D greatly exceeds its relative economic weight as Japan only generates a mere 8.8% of the global GDP. However, Japan's relative weight in global ICT R&D investment is more in line with the country's relative weight in the global production of ICT equipment (see table 3.3.1 below). Japan generated about 28% (2000 data) of global production (in value) of computers and office machinery and about 22% of the global production of communication equipment.
Notably, Japan's performance was chiefly linked to the size of the relative share of business ICT R&D since business's relative share ranged from 21.5% in 2000 to 24% (estimate) in 2006.
On the other hand, Japan's relative share of public ICT R&D funding, albeit higher than the country's economic weight worldwide, has been eroding, dropping from 15.6% in 2000 to 14.7% (estimate) in 2006.

Table 3.3.1. – Japan: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
Japan's relative share of global production	28.6%	22.1%
Japan's relative share of global export volume	10.8%	12.5%

Source: NSF from the WEFA database, 2000 data

3.3.2. ICT R&D Indicators in Japan

3.3.2.1. Volume and structure of ICT funding in Japan

Indicator 3.3.2 below illustrates the absolute values of ICT R&D funding in Japan, broken down into 'financed by public funds' and 'financed by business and others'.

Indicator 3.3.2. – Japan: ICT R&D financed by business and ICT R&D financed by public funds

ICT R&D financed by business and financed by public funds in Japan (PPP$ million)

ICT R&D financed by business and others
ICT R&D financed by public funds

In overall value, funding climbed from PPP$27.2 billion to PPP$34.15 billion, i.e., a 27% rise from 2000 to 2006.

The funding structure of the ICT R&D performed in Japan can be seen in indicator 3.3.3 below.

Indicator 3.3.3. – Japan: trend of the ICT R&D budget structure

Trend of the ICT R&D budget structure in Japan

% of ICT R&D financed by business
% of ICT R&D financed by the State

From 1999 to 2005, the relative share of budget appropriations increased from 8.2% to 9.5%, which in terms of relative share is a substantial increase. Correlatively, the share of business funding decreased in inverse proportions. In Japan, the profile of the ICT R&D funding structure is typical of a country where the State intervenes little in the area of R&D funding for industrial purposes. The funding structure typology is similar to the one found in South Korea, Canada, Finland, and Sweden. However, it is radically different from the structure found throughout EU-25 where public funding accounted for 15.3% of all ICT R&D funding from 2000 to 2006. In Japan, the role of budget appropriations is not as striking as it is in the United States where the ratio of budget appropriations accounts for 17% (federal government and PNP) of all ICT R&D funding. The small relative share of budget appropriations in no way prevents the Japanese public authorities from conducting a pro-active policy in this area, as will be seen further down.

3.3.2.2. ICT R&D intensity in Japan

Indicator 3.3.4. – Japan: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a percentage of GDP in Japan

Indicator 3.3.4 above illustrates ICT R&D intensity measured by the GERD/GDP ratio, in Japan. Japan's figure places the country among the leaders of the 9 studied countries (see table 3.3.2 *infra*).

ICT R&D in the major industrial countries

Japan's mean value of total expenditure on ICT R&D as a percentage of GDP is 0.84%, Europe's is nearly 0.25%, and the United States' is 0.60%. Only Finland (1.55%), South Korea (1.3%), and Sweden (1.04%) have higher ratios than Japan.

Table 3.3.2. – Japan: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

Indicator 3.3.4-A. – Japan: expenditure on ICT R&D per capita population (PPP$)

Expenditure on ICT R&D per capita population in Japan
(PPP$)

3.3.2.3. The place of ICT R&D investment within total R&D investment in Japan

Indicator 3.3.5. – Japan: ICT R&D ratio of total (public and private) R&D expenditure

Japan: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/ Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.3.5 highlights the ratio of ICT R&D financed by business compared to all R&D financed by business, on the one hand, and the ratio of budget appropriations for ICT R&D compared to all

Government Budget Appropriations or Outlays for R&D (GBAORD), on the other. For the first parameter, the ratio of ICT R&D averaged about 35% of the global envelope of business investment in R&D, from 2000 to 2006. Thus, Japan is among the countries whose private R&D is clearly 'ICT-oriented'. Based on this criterion, Japan is only behind Finland (62%) and South Korea (57%), has a ratio higher than the United States (30%) and EU-25 (22.5%). Japan also leaves the major European economic powers behind, i.e., France (32%), Germany (21%), and the United Kingdom (18%).

However, the relative share of ICT R&D financed by public funds within all budget appropriations for R&D is lower (mean 10.6% from 2000 to 2006), ranking Japan fifth among the nine other countries, based on this criterion. Japan is virtually on an equal footing with Finland and France (11.7%) and boasts a slightly higher figure than the one reported for the United States (10.3%).

Indicator 3.3.6. – Japan: index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes

Index of ICT R&D volumes and index of R&D (inclusive of all sectors) volumes in Japan

ICT R&D funding
All R&D funding

Indicator 3.3.6 compares the index of GERD (inclusive of all sectors) with the index of ICT GERD. In Japan, both curves are very similar, rising steadily albeit slightly, from index 100 (2000) to index 128 (2006 estimate index for all gross domestic expenditure on R&D [GERD]), and from index 100 to index 125 for the ICT GERD. If one takes into account the fact (see *infra*) that, because of their relative weight (more than 91% of all outlays for ICT R&D), R&D business funding determines general curve rates, one can assume that Japanese business manages its activity sector of R&D investments in a regular, predictable and fairly autonomous manner. Unlike the United States or Canada, Japanese business investment in the ICT sector, as in other sectors, is apparently not the adjustment variable of business operating accounts.

3.3.2.4. Business investment in ICT R&D in Japan

Indicator 3.3.7. – Japan: direct ICT R&D funding by business

Direct ICT R&D funding by business in Japan (PPP$ million)

The above data illustrates the decoupling between the Japanese business investments in ICT R&D from short-term cyclical factors affecting businesses in the ICT sector. Already high funding volumes are rising, thus making Japanese business the world's second largest investor in ICT R&D financed by private funds.

Indicator 3.3.8 (see *infra*), which compares the index of expenditure on ICT R&D with the index of expenditure on R&D financed by business and performed in Japan, confirms the tight phasing between the volume of ICT R&D financed by business and the total volume of R&D financed by business (inclusive of all sectors). The curves rise at exactly the same rate as the curves found in indicator 3.3.7 that depicts the trend of direct ICT R&D business funding. In Japan, as in all the other countries where state 'interventionism' is weak, business investment drives the overall funding impetus.

Indicator 3.3.8. – Japan: index of ICT R&D expenditure and index of R&D (inclusive of all sectors) expenditure financed by business

Index of ICT R&D expenditure and index of R&D (inclusive of all sectors) expenditure financed by business in Japan

ICT R&D financed by business
All R&D financed by business

Japan is noteworthy for having a watertight barrier - at least in terms of appropriations transfer - between budget appropriations and private funds for R&D. Inclusive of all sectors, budget appropriations account for about 1.3% of business-performed R&D funding (compared to about 13.3% in the United States, 8% in EU-25, and 9.7% in France). This figure is even lower, i.e., of no consequence, in the ICT sector since most Japanese budget appropriations for R&D allocated to business go to the aerospace industry.

3.3.2.5. – Business ICT R&D and ICT production value

Table 3.3.3. – Japan: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**9.16%**
ICT manufactured goods value added as % of business value added	**8.53%**
Business ICT R&D as % of total business R&D	**35%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.
Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (30%) is about three times higher than the ICT ratio on total value added of business. Several reasons explain this gap. One, ICT services and manufacturing industries are high-tech activities for which R&D investment is intrinsically high; two, ICT are 'empowering technologies' and R&D in this field has outlets in other services or manufacturing industries than the ICT industry.

3.3.2.6. Budget appropriations for ICT R&D in Japan

The fact that the relative share of Japanese budget appropriations account for a small fraction of the overall outlay for ICT R&D does not at all mean the absence of a ICT R&D public policy in Japan, as can be seen in indicator 3.3.9 that compares the index of budget appropriations with the index of private funding for ICT R&D. The upsurge of budget appropriations, which climbed to index 158 from index 100, exceeded the rise of business funding that went from index 100 to index 124, from 2000 to 2006. ICT R&D is apparently still on top of the agenda for the Japanese government, a priority that is materialised in the very positive, very steady upward trend of budget appropriations for ICT R&D.

Indicator 3.3.9. – Japan: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Index of ICT R&D financed by business and index of ICT R&D financed by public funds in Japan

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.3.10 below depicts the substantial growth (in absolute value) of budget appropriations for ICT R&D, which rose more than 30% from 2000 to 2006.

Indicator 3.3.10. – Japan: direct budget appropriations for ICT R&D

Direct budget appropriations for ICT R&D in Japan (PPP$ million)

In Japan, the share of military appropriations within budget outlays for ICT R&D accounted for about 5% on average from 2000 to 2006.

However, as it is hard to assess military appropriations for R&D, and specifically the outlays for ICT R&D, caution should be exercised when interpreting the data although it is certain that the amount of appropriations from the defence budget amounts to a very small share of total Japanese funding envelope for ICT R&D.

The breakdown between civil appropriations and military appropriations in Japanese budget appropriations for ICT R&D can be found in indicator 3.3.11 below.

Indicator 3.3.11 – Japan: trend of the ICT R&D public budget structure

Japan: trend of the ICT R&D public budget structure

Civil appropriations
Military appropriations

3.4 South Korea

Note: The following pages present and comment a selection of indicators on ICT R&D funding in South Korea. For access to all the relevant statistical data, go to the appended complete Excel database and data tables.

3.4.1. South Korea's relative share of global ICT R&D funding

Indicator 3.4.1. – South Korea: trend of South Korea's relative share of global ICT R&D funding

Trend of South Korea' relative share in global ICT R&D funding

Share of all ICT R&D investment
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Similar to the report in the two earlier studies, of all the studied countries, South Korea's relative share of global ICT R&D investment had the highest growth from 1999 to 2005. South Korea's relative share of global ICT R&D investment rose from 5.5% to 8.8%, i.e., a more than 3-point increase, a considerable rise in terms of relative share. This increase chiefly mirrors business's ICT R&D effort. Within the reference frame of the study (i.e., the 9 countries), South Korean business's relative share of the total envelope of private funding for ICT R&D climbed from 5.7% to 9.5%. In this area as well, South Korea has the highest reported rise of the studied countries. The relative share of South Korean budget appropriations within global budget appropriations for ICT R&D fell from 2.1% to 1.7%. In absolute value and from the standpoint of total (public and private) ICT R&D investment, South Korea multiplied the volume of its funding by a factor of 1.84 from 2000 to 2006.

South Korea's relative share of ICT R&D investment greatly exceeds its relative economic weight since the country generates a mere 2% of the global GDP (but 8.8% of ICT R&D). South Korea's relative weight in global R&D investment is even 'oversized' compared to the country's relative weight in global ICT equipment production (see table 3.4.1 below). Clearly, the purpose of South Korea's huge private ICT R&D investment is to conquer tomorrow's market shares. The strategy has apparently paid off as South Korea has seen its relative weight in the global ICT equipment trade (mainly for mass consumer markets) grow fast to the detriment of its Japanese neighbour whose relative weight is dwindling. The South Korean example (as well as the Finnish example, see *infra*) clearly highlights the existence of a direct correlation, albeit deferred over time, between increased ICT R&D effort and increased markets shares.

Table 3.4.1. – South Korea: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
South Korea's relative share of global production	2.2%	4.5%
South Korea's relative share of global export volume	1.7%	3.0%

Source: NSF from The WEFA database, 2000 data

3.4.2. ICT R&D Indicators in South Korea

3.4.2.1. Volume and structure of ICT funding in South Korea

Indicator 3.4.2. – South Korea: ICT R&D financed by business and ICT R&D financed by public funds

ICT R&D financed by business and ICT R&D financed by public funds in South Korea (PPP$ million)

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.4.2 above illustrates the absolute values of ICT R&D funding in South Korea, broken down into 'financed by public funds' and 'financed by business and others'.

The overall value of the funds soared to PPP$13.43 billion from PPP$7.28bn and were multiplied by a factor to the order of 2, or so. Because South Korea is planning ahead for tomorrow's market shares, it is the only country that displays a strong rise of business funding over the past two years, regardless of cyclical factors, because it is still at the stage of 'seed-funding' (in already substantial amounts, in absolute value) and of gaining trade positions. The budget structure for ICT R&D performed in South Korea can also be found in indicator 3.4.3 below.

Indicator 3.4.3. – South Korea: trend of the ICT R&D budget structure

South Korea: trend of the ICT R&D budget structure

ICT R&D % financed by the State
ICT R&D % financed by business

From 2000 to 2006, the budget structure remained very steady as the relative share of budget appropriations accounted for a 8.9% mean (i.e., South Korea has a much lower mean than the reported mean ratio of budget appropriations in the 9 studied countries). Business funding regularly accounted for more than 92% of all ICT R&D funding, a figure that is only equalled in Japan and Finland.

3.4.2.2. ICT R&D Intensity in South Korea

Indicator 3.4.4. – South Korea: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in South Korea

Indicator 3.4.4 above illustrates ICT R&D intensity measured by the GERD/GDP ratio, in South Korea. According to this indicator, South Korea made a 'great leap forward' from 2000 to 2006 since the ratio

jumped to 1.3% from 0.95%, thus ranking South Korea second behind Finland (1.55%) among the nine studied countries.

Table 3.4.2. – South Korea: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

Indicator 3.4.5. – South Korea: expenditure on ICT R&D per capita population

Expenditure on ICT R&D per capita population in South Korea(PPP$)

In South Korea, ICT R&D intensity is also very impressive if one looks at the other R&D intensity measure, viz., expenditure on ICT R&D per capita population. From 2000 to 2006 (estimate), expenditure on R&D per capita skyrocketed from PPP$154 to PPP$284. This increase cannot be found in any other country and marks the strong pro-active ICT R&D development policy of business as well as the State.

3.4.2.3. The place of ICT R&D investment within total R&D investment in South Korea

Indicator 3.4.6. – South Korea: ICT R&D ratio of total R&D expenditure

South Korea: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.4.6 highlights the ratio of ICT R&D financed by business compared to all R&D financed by business, on the one hand, and the ratio of budget appropriations for ICT R&D compared to all Government Budget Appropriations or Outlays for R&D (GBAORD), on the other, in South Korea. For the first parameter, with a ratio of ICT R&D going from 35.4% to 53.3% of the total envelope of business R&D investment from 2000 to 2006, South Korea ranks alongside Finland (with a similar ratio) among the top countries whose private R&D is strongly 'ICT-oriented'. Furthermore, the sharp rise of the indicator mirrors South Korean conglomerates' very deliberate choice to redirect their business portfolios, which were marked by 'heavy' activities (iron & steel, shipbuilding, and so on) up until the mid-nineties, toward high-tech activities, and ICT in particular. According to this criterion, South Korea is ahead of Japan (35% mean from 2000 to 2006), the United States (30%), and especially EU-25 (19.2%) and all its major economic powers, i.e., France (31%), Germany (21%), and the United Kingdom (18%).

Based on this criterion, the relative share of ICT R&D financed by public funds within all budget appropriations for R&D is smaller (10% mean from 2000 to 2006), thus ranking South Korea sixth among the nine studied countries.

Indicator 3.4.7. - South Korea: index of ICT R&D expenditure and index of R&D (inclusive of all sectors) expenditure

Index of total R&D expenditure (inclusive of all sectors) and index of total ICT R&D expenditure in South Korea

Total ICT R&D expenditure
Total gross domestic expenditure on R&D (GERD)

Indicator 3.4.7, which compares the index of GERD (inclusive of all sectors) with index of ICT GERD, well illustrates that the exceptional growth of ICT R&D weight reflects the choice to specialise in an economic area, a choice that is assumed nationwide. Whereas total intramural expenditure on R&D rose steadily from index 100 (1999) to index 166 (2006 estimate), the ICT GERD rose much more dramatically (going from index 100 to index 184). In short, South Korea emerges as a country that has been investing heavily in R&D (inclusive of all sectors) but with a clear priority focussed on ICT, for a decade.

3.4.2.4. Business investment in ICT R&D in South Korea

Indicator 3.4.8. – South Korea: business-financed ICT R&D

Business-financed ICT R&D in South Korea

ICT R&D in the major industrial countries

(PPP$ million)

South Korean ICT businesses, like Japanese businesses, seem to have decoupled the trend of ICT R&D investment from cyclical factors. Their ICT R&D investment, illustrated in indicator 3.4.8 (absolute values, PPP$), kept growing from 2000 to 2006. Now, South Korea also ranks third worldwide for the volume of private ICT R&D funding.

Indicator 3.4.9 (see *infra*), which compares the index of business expenditure on ICT R&D with the index of business expenditure on R&D (inclusive of all sectors), also shows that the non-reaction of ICT R&D to cyclical factors is special to this sector as privately funded R&D rose at a steadier pace. The curves rise at exactly the same rate as the curves in indicator 3.3.7, which depicts the ICT R&D total funding index. In South Korea, because of its relative weight, business funding clearly drives the overall funding impetus.

Indicator 3.4.9. – Index of ICT R&D expenditure and index of total R&D expenditure financed by business in South Korea

Index of R&D expenditure (inclusive of all sectors) and of ICT R&D expenditure financed by business in South Korea

ICT R&D financed by business
R&D (inclusive of all sectors) financed by business

Indicator 3.4.9 compares the index of R&D (inclusive of all sectors) financed by business with the index of ICT R&D financed by business. Both curves rise at the same rate overall although R&D (inclusive of all sectors) financed by business rises at a constantly slower pace than the 'volume of ICT R&D financed by business.'

3.4.2.5. – Business ICT R&D and ICT production value

Table 3.4.3. – South Korea: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**7.49%**
ICT manufactured goods value added as % of business value added	**17.4%**
Business ICT R&D as % of total business R&D	**57%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (57%) is much higher than the ICT ratio of total value added of business.

3.4.2.6. Budget appropriations for ICT R&D in South Korea

The fact that South Korean budget appropriations account for a small relative share (10.7%, 2004 figure) of the overall funding envelope for ICT R&D hardly means that South Korea has no public ICT R&D support policy. Actually, the exact opposite is true, as can be seen in indicator 3.4.11 (see below), which compares the budget appropriations index with the private funding index for ICT R&D.

Indicator 3.4.10. – Budget appropriations for ICT R&D in South Korea

Budget appropriations for ICT R&D in South Korea
(PPP$ million)

From 2000 to 2006, budget appropriations went from index 100 to index 184. Their impetus is in line with business funding that went from index 100 to index 185 in the same period. Along with Finland, South Korea is the only country exhibiting a coordinated trend of budget appropriations and private funds for ICT R&D, serving an overall ‘national industrial project’. In both cases, the efficiency of public expenditure is not tied to its absolute volume (fairly small in both countries) but to its perfect ‘synchronisation’ with the priorities of the national industrial fabric and its ICT ‘redeployment’ strategy. Synchronisation involves a sizeable amount of budget appropriations for ICT allocated to business, a parameter found in indicator 3.4.12.

Indicator 3.4.11. – Index of ICT R&D financed by business and index of ICT R&D financed by public funds in South Korea

Index of ICT R&D financed by business and index of ICT R&D financed by public funds in South Korea

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.4.12. – Trend of budget appropriations for ICT R&D allocated to business in South Korea

Trend of budget appropriations for ICT R&D allocated to business in South Korea

PPP$ million
Index

The share of military appropriations in budget outlays for ICT R&D is significant in South Korea. From 2000 to 2006, their mean value accounted for 20%. However, indicator 3.4.13 below[5] shows the clear downward trend of said appropriations.

Clearly, according to the indicator, in South Korea, military budget appropriations for ICT R&D initially played a role of strengthening the public ICT R&D base.

Indicator 3.4.13. – South Korea: trend of the ICT R&D public budget structure

South Korea: trend of the ICT R&D public budget structure

Civil appropriations
Military appropriations

[5] For South Korea, it has already been said that, as it is hard to assess military appropriations for R&D and particularly appropriations for ICT R&D, the data should be interpreted cautiously. However, it is certain that the contribution of defence budget appropriations accounts for a substantial share of the overall envelope of South Korean ICT R&D funding.

3.5 Germany

Note: The following pages present and comment a selection of indicators on ICT R&D funding in Germany. For access to all the relevant statistical data, go to the appended Excel database and data tables.

3.5.1. Germany' relative share of ICT R&D funding compared to the 9 studied countries

Indicator 3.5.1. – Trend of Germany's relative share of ICT R&D funding compared to the 9 studied countries

Trend of Germany's relative share (%)

Share of all investments in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Germany's relative share in global ICT R&D investment increased[6] slightly from 2000 to 2006, going from 6 to 6.4% of all ICT R&D funding, within the study reference frame (9 countries). Germany has confirmed its third place within the 9 studied countries.[7] The increase contrasts sharply with the trend of Germany's weight , which accounted for 7.71% in 2000 and 7.23% in 2005 (OECD data), in the global GDP. The growth of Germany's relative share of total ICT R&D in the 9 countries results from two divergent trends for each of the ICT R&D components. Whereas the relative share of ICT R&D financed by business took an upward turn from 2000 to 2006 (going from 6 to 6.8%), the relative share of publicly funded ICT R&D sharply decreased (dropping to 4.6% from 6.4%, which in relative share is a sizeable decline). The German 'scissor effect' between the relative shares of the two ICT R&D components cannot be found in any other country.

3.5.2. ICT R&D Indicators in Germany

3.5.2.1. Volume and structure of ICT R&D funding in Germany

Indicator 3.5.2 below illustrates the absolute value of ICT R&D funding broken down into 'financed by public funds' and 'financed by business,'[8] in Germany. In overall value, ICT R&D funding increased by 22% from 2000 to 2006, jumping from PPP$9.95 to 9.75 billion, thus ranking Germany first for overall volume of ICT R&D investment within EU-25.

[6] Unlike the 2005 study that reported a slight erosion of Germany's ICT R&D relative shares of all the funding components. This is because, as only estimates were available for 2004 and 2005, we used the low figures. This edition has corrected and increased the figures. Thus, in Germany, ICT R&D is still strong, especially in the field of 'embedded computing'.
[7] This is true only if Germany's relative share is analysed within the 'study reference frame' (9 countries). If one takes a global outlook and includes ICT R&D in emerging countries, the relative share of Germany, as well as the share of most developed countries, is declining within the global frame of reference.
[8] Including R&D financed by foreign businesses but performed on German soil, unlike Canada, France, and the United Kingdom where the R&D funding by foreign companies is not very high. It accounts for about 2% of total BERD (R&D performed by business), i.e., five times less than in France and ten times less than in the United Kingdom and Canada.

Indicator 3.5.2. – Germany: ICT R&D funding structure

Germany: ICT R&D funding structure (PPP$ million)

Business
Public Sector

The trend is marked by a slight downturn from 2002 to 2003 (a crisis period for Internet developments) but took a sharp upward swing as of 2004. In apparent value, budget appropriations rose slightly but steadily from 2000 to 2006 (+11%). However, in real terms (deflated values), budget appropriations probably dropped. At the same time, business ICT R&D investment increased by 24%, i.e., much more than cumulative inflation, from 2000 to 2006.

The funding structure of ICT R&D performed on German soil can be found in indicator 3.5.3 below. From 2000 to 2006, the funding structure remained steady, showing that budget appropriations and private funds followed similar trends during that time.

Indicator 3.5.3. – Trend of the ICT R&D budget structure in Germany

Trend of the ICT R&D budget structure in Germany

ICT R&D % financed by the State
ICT R&D % financed by business

3.5.2.2. ICT R&D Intensity in Germany

Indicator 3.5.4. – Germany: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP

Indicator 3.5.4 above illustrates ICT R&D intensity measured by the ratio of ICT GERD as a percentage of GDP and indicator 3.5.5 below depicts ICT R&D intensity measured by the ratio of intramural expenditure on ICT R&D per capita population.

Indicator 3.3.5. – Germany: expenditure on ICT R&D per capita population

Expenditure on ICT R&D/GDP per capita population in Germany (PPP$)

Table 3.5.1. – Germany: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

From 2000 to 2006 in Germany, for the ratio of total ICT R&D as a percentage of GDP, the figure went from 0.37% to 0.41%, a substantial increase unparalleled elsewhere except in South Korea. The upturn mirrors the upswing of private ICT R&D funding. In both cases, reported values for the indicator rank Germany in eighth position, virtually on equal footing with France, within the studied countries. The values are under the reported mean for the 9 studied countries (0.50%).

3.5.2.3. The place of ICT R&D investment within total R&D investment in Germany

Indicator 3.5.6. – Germany: ICT R&D ratio of total (public and private) R&D expenditure

Germany: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.5.6 shows that ICT R&D is fairly stable in Germany, whether it is from the standpoint of R&D financed by business or R&D financed by public funds. The ICT R&D ratio of R&D (inclusive of all sectors) financed by business own capital went from 20.2% in 1999 to 20.7% (estimate) in 2006 following a 22.3% 'peak' in 2001, just before the Internet bubble burst. The figure was lower than the one reported for EU-25 (27%) at the start of 2000. However, in 2006, it was higher than the EU-25

figure (that dropped to 18.6%, in this indicator). The good performance of the ICT R&D share within all business-financed R&D mirrors the size of embedded computer applications within industrial production, tied to the specialised industries of the German economy, viz., top of the line auto-making, industrial process controls and machines, measuring instruments, and automatic control systems.
For the indicator '*ratio of budget appropriations for ICT R&D of total Government Budget Appropriations or Outlays for R&D (GBAORD)'*, Germany's ratio was steady, to the order of 5.5%, half the reported ratio for France, from 2000 to 2006.

Indicator 3.5.7. - Germany: trend of total expenditure for R&D (public and private) and for ICT R&D

Germany: index of total expenditure for R&D (public and private) and for ICT R&D

Total GERD
ICT GERD

Indicator 3.5.7 compares the index of GERD (inclusive of all sectors) with the index of the ICT GERD in Germany. Total intramural expenditure on R&D rose steadily from index 100 (2000) to index 119 in 2006, in real terms (meaning weak growth in deflated values). From 2000 to 2006, the trend of ICT GERD matched the trend of GERD but took a sharp upward turn from 2001 to 2003, at the height of the economic cycle and the Internet bubble, before shifting back toward the GERD index as of 2004. However, aside from the cyclical variations, both curves are, on the whole, in line. This underscores the fact that in Germany, through embedded applications specifically, ICT production is less an autonomous production compartment than it is 'input' from the other above-mentioned specialised sectors of the German manufacturing industry.

3.5.2.4. Business investment in ICT R&D in Germany

Indicator 3.5.8. – Germany: business-financed ICT R&D

Germany: business-financed ICT R&D in Germany (PPP$ million)

In Germany, the volumes of ICT R&D financed by business own capital are given in indicator 3.5.8 above, that compiles absolute funding values (PPP$ million). From 2000 to 2006, the volumes of ICT R&D business investment rose (+21%). The increase in absolute value of the single 'R&D financed by

business' parameter caused Germany's relative share of all private ICT R&D funding in the 9 studied countries to increase slightly (from 6% to 6.4%).

Indicator 3.5.9 below compares the index of business expenditure on ICT R&D with the index of business expenditure on R&D (inclusive of all sectors) performed on German soil. In the indicator, the curves exhibit the same rate as the curves of indicator 3.5.7, which shows the trend of the overall ICT R&D funding index. Although public funding has increased, as it harmonises with private funds and is moderate (see *infra*), private business funds drive the overall impetus of ICT R&D investment.

Indicator 3.5.9. – Germany: trend of ICT R&D expenditure and of R&D (inclusive of all sectors) expenditure financed by business

Germany: index of ICT R&D expenditure and index of R&D (inclusive of all sectors) expenditure financed by business

Total GERD financed by business
ICT GERD

3.5.2.5. – Budget appropriations for ICT R&D allocated to business in Germany

Indicator 3.5.10 below shows the volumes of budget appropriations for ICT R&D that are allocated to business in Germany. The absolute values and indexes are given. In absolute value, the structure of ICT R&D performed by German business, broken down into 'financed by budget appropriations' and 'financed by business own capital' can be found in indicator 3.5.11. Table 3.5.4 compiles the relative share of business own-capital and budget appropriations in the volumes of business-performed R&D.

The table highlights that budget appropriations for ICT R&D allocated to business account for a 6% mean of business-performed ICT R&D, a figure that is steadily declining. The indicator places Germany right behind the United States (from 10 to 13% from 2000 to 2006), France (10%), and the United Kingdom (7%). Unlike these three countries, the main explanatory factor is not so much the relative weight of the defence industries but the traditionally strong interweaving of public research and business in Germany. The trend of the budget appropriations index for ICT R&D allocated to business is positive despite a downswing from 2004 to 2005. However, these are apparent values; in deflated values, the volumes of budget appropriations for ICT R&D allocated to business have declined.

Indicator 3.5.10. – Trend of public funds for ICT R&D allocated to business in Germany

Trend of public funds for ICT R&D allocated to business in Germany

PPP$ million
Index

Indicator 3.5.11. – Germany: funding structure of business-performed ICT R&D

Germany: funding structure of business-performed ICT R&D in Germany

(PPP$ million)

ICT R&D financed by business own-capital
Business-performed ICT R&D financed by budget appropriations

Table 3.5.2. – Germany: relative share of business own capital and public funds in the volumes of German business-performed ICT R&D

	2000	2001	2002	2003	2004	2005	2006
Business-performed ICT R&D financed by budget appropriations	6.5%	6.3%	5.8%	5.7%	5.7%	5.7%	6.3%
ICT R&D financed by business own capital	93.5%	93.7%	94.2%	94.3%	94.3%	94.3%	93.7%

3.5.2.6. – Business ICT R&D and ICT production value

Table 3.5.3. – Germany: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**6.82%**
ICT manufactured goods value added as % of business value added	**5.63%**
Business ICT R&D as % of total business R&D	**22%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (22%) is about four times higher than the ICT ratio on total value added of business. Several reasons explain this gap. One, ICT services and manufacturing industries are high-tech activities for which R&D investment is

intrinsically high; two, ICT are 'empowering technologies' and R&D in this field has outlets in other services or manufacturing industries than the ICT business.

3.5.2.6. Budget appropriations for ICT R&D in Germany

Indicator 3.5.12. – Germany: budget appropriations for ICT R&D

Germany: budget appropriations for ICT R&D (PPP$ million)

Indicator 3.5.12 above illustrates the absolute values in PPP$ million of German budget appropriations for ICT R&D from 2000 to 2006. During this time, the increase (+ 11%) was positive in current data but, in real terms, it eroded if one looks at the net values in terms of inflation.

Indicator 3.5.13 below, which compares the index of (civil and military) budget appropriations for R&D and the index of ICT R&D financed by business own capital shows that the public authorities' effort for ICT R&D is moderate (+11%) but steady over the period. However, private German ICT R&D investment appears more dynamic than publicly funded investment.

Indicator 3.5.13. – Germany: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Germany: index of ICT R&D financed by business and index of ICT R&D financed by budget appropriations

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.5.14. – Germany: trend of Government Budget Appropriations and Outlays for R&D (GBAORD) and of public funding for ICT R&D

Germany: trend of GBAORD and of public funding for ICT R&D

Total R&D budget appropriations
ICT R&D budget appropriations

Indicator 3.5.14 above compares the index of German government expenditure on ICT R&D with the index of GBAORD (government budget appropriations and outlays for R&D for civil or military purposes). Both curves are strictly in line but, from 2005 to 2006, the two curves seem to separate as budget appropriations for ICT R&D waned. As the data for 2005 and 2006 are only estimates, this fact should not be construed as the beginning of an actual trend.

Indicator 3.5.15. – Germany: structure of budget appropriations for ICT R&D by performance sector

Germany: structure of budget appropriations for ICT R&D by performance sector (PPP$ million)

Public sector performed ICT R&D financed by budget appropriations

Business-performed ICT R&D financed by budget appropriations

If we analyse (as is done by indicator 3.5.15) ICT R&D financed by budget appropriations by performance sector and distinguish business-performed ICT R&D financed by budget appropriations from budget appropriations for ICT R&D performed by public facilities, we can see (in indicator 3.5.16 below) that budget appropriations go mostly to business but that the balance is shifting toward the public sector.

Table 3.5.4. – Germany: budget appropriations for ICT R&D by performance sector

	2000	2001	2002	2003	2004	2005	2006
Business-performed ICT R&D financed by budget appropriations	53.1%	58.8%	51.7%	49.1%	49.9%	51.2%	52.2%
Public sector performed ICT R&D financed by budget appropriations	46.9%	41.2%	48.3%	50.9%	50.1%	48.8%	47.8%

In Germany, the share of military appropriations in the budget outlays for ICT R&D is much lower than the reported share in the United States, France, or the United Kingdom.

The comparatively weak ratio of ‘defence appropriations’ in ICT R&D places Germany well below the mean in Europe where defence appropriations for ICT R&D account for about 26% of all ICT GBAORD.

Indicator 3.5.16. – Germany: breakdown of budget appropriations for ICT R&D between civil appropriations and defence appropriations

Germany: trend of the ICT R&D budget appropriations structure

ICT R&D civil budget appropriations
ICT R&D military budget appropriations

3.6 France

Note: The following pages present and comment a selection of indicators on ICT R&D funding in France. For access to all the relevant statistical data, go to the appended Excel database and the data tables.

3.6.1. France' relative share of global ICT R&D funding

Indicator 3.6.1. – France: trend of the relative share of global ICT R&D funding

Trend of France' relative share of global ICT R&D funding

Share of all investment ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

France's relative share in global ICT R&D investment was apparently very steady from 2000 to 2006. For its relative share of total ICT R&D funding (in the 9 countries), France 'weighed' 5% of global funding at the start of 2000 as well as at the end of 2006. Based on this figure, France ranks fourth worldwide. France's weight in global investment for ICT R&D slightly exceeds the French economy's relative share of global GDP (4.2%).

Within the study reference frame (9 countries), the stability of France's relative share of total ICT R&D investment results from a (-0.1%) drop of France's relative share of privately funded ICT R&D combined with a slight fall-off (after a rise from 1999 to 2002) of its relative share of government budget appropriations for ICT R&D.

Notably, for public as well as private funding, France's relative share of global ICT R&D investment substantially exceeds its relative economic weight in ICT equipment production and export (except for telecommunication equipment exports where Alcatel's specific global weight has a very positive impact on this figure).

The discrepancy between relative ICT R&D shares and relative weight in 'ICT goods' production and sale may indicate that France, like Canada and the United Kingdom, acts as a relocated ICT R&D platform for foreign groups (IBM, Xerox, HP, and so on), due to the excellence of the research scientists with a strong background in outstanding public research. (In support of this hypothesis, France has a high ratio, i.e., more than 10%, of foreign investment in BERD[9], inclusive of all sectors. Among the major economic powers, this ratio can only be found in Canada and the United Kingdom. Also, this ratio is probably even higher in the ICT sector.) However, recent events have shown that relocated R&D in France can be very fragile.

[9] Contract based business-enterprise expenditure on R&D

Table 3.6.1. – France: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
France's relative share of global production	2.3%	2.7%
France's relative share of global trade volume	3.4%	4.2%

Source: NSF from the WEFA database, 2000 data

3.6.2. ICT R&D Indicators in France

3.6.2.1. Volume and structure of ICT funding in France

Indicator 3.6.2 below illustrates the absolute values of ICT R&D funding broken down into 'financed by public funds' and 'financed by business' (including R&D funded by foreign companies and performed on French soil). In overall value, the funding rose from PPP$6.7bn to PPP$7.6 billion, i.e., a 13.4% increase from 2000 to 2006 (estimate), in France. The trend, which was on the upswing until 2002, was later strongly affected by dwindling business-funded expenditures. On the other hand, budget appropriations rose during that time (non-deflated figures).

Indicator 3.6.2. – France: ICT R&D funding structure

ICT R&D funding structure
(absolute value, PPP$ million)

ICT R&D financed by public funds
ICT R&D financed by business and others

Indicator 3.6.3 below shows the funding structure of ICT R&D performed on French soil. From 1999 to 2005, the relative share of budget appropriations steadily rose from 14.7% to 17.8%, which in terms of relative share is a very substantial increase. Correlatively, the share of business funding dropped from 85.3% to 82.2%.

Indicator 3.6.3. – Trend of the ICT R&D budget structure in France

Trend of the ICT R&D budget structure in France

ICT R&D % financed by business
ICT R&D % financed by the State

ICT R&D in the major industrial countries

In France, the trend of the ICT R&D budget structure can be explained partly by the relative drive of ICT public research appropriations, which is more sustained than the R&D of the French ICT industrial fabric.

3.6.2.2. ICT R&D Intensity in France

Indicator 3.6.4. – France: ratio of total expenditure on ICT R&D as a % of GDP

France: ratio of total expenditure on ICT R&D as a % of GDP

Indicator 3.6.4 above illustrates ICT R&D intensity in France measured by ICT GERD as a % of GDP.

Table 3.6.2. – France: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

In this indicator, France's ratio is lower than the reported (arithmetic) mean in the 9 studied countries but is higher than the figure (0.25%) for EU-25. From 2000 to 2006, France's ratio remained stable although it did rise sharply from 1999 to 2002. Based on this indicator, France ranks seventh of the 9 studied countries.

Indicator 3.6.4-A. – France: expenditure on ICT R&D per capita population

France: expenditure on ICT R&D per capita population
(PPP$)

ICT R&D intensity can also be measured by the expenditure on ICT R&D per capita population. Based on this parameter, there has been an ongoing moderate rise even if the most recent figures did not reach the reported high ratios for 2002, before the 'Internet bubble' burst.

3.6.2.3. The place of ICT R&D investment within total R&D investment in France

Indicator 3.6.5. – France: ICT R&D ratio of total (public and private) R&D expenditure

France: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.6.5 highlights the ratio of ICT R&D financed by business compared to all R&D financed by business, on the one hand, and the ratio of budget appropriations for ICT R&D compared to all Government Budget Appropriations or Outlays for R&D (GBAORD), on the other. The first parameter rose very slightly (+1%) during that time (except in 2001) and then levelled off at 32%, i.e., 6 to 7 points higher than the European mean. From 2000 to 2006, the ICT R&D ratio of all R&D financed by public funds increased steadily from 10.2 to 12.1%. This growth rate did not seem to be affected by budgetary cuts, which were undoubtedly more substantial in other sectors that received less political attention.

Indicator 3.6.6. - France: trend of total expenditure on R&D (public and private) and on ICT R&D

France: index of the ICT GERD and index of total GERD

Total GERD
ICT GERD

Indicator 3.6.6 compares the index of GERD (inclusive of all sectors) with the index of ICT GERD in France. Aside from the cyclical factor of the 'Internet bubble', total intramural expenditure on R&D (inclusive of all sectors) and total intramural expenditure on ICT R&D rose at the same pace. At the end

of 2006, ICT GERD reached index 114, after peaking at index 118 in 2002. GERD rose surely and steadily from index 100 to index 119.

3.6.2.4. Business investment in ICT R&D in France

Indicator 3.6.7. – France: business-financed ICT R&D in France

France: business-financed ICT R&D (PPP$ million)

In France, the reaction of business ICT R&D investment to cyclical factors can be seen in indicator 3.6.7 that compiles the absolute values (PPP$ million) of these funds. From 2000 to 2006, business investment in ICT R&D rose 9% (i.e., probably a stagnation in deflated figures) despite rapid growth from 2000 to 2006 (2003 saw a sudden drop in business investment).

Indicator 3.6.8 below compares the index of business expenditure on ICT R&D with the index of business expenditureon R&D performed on French soil (inclusive of all sectors) and financed by business. It shows that the reaction to cyclical factors was not special to ICT R&D since the curve for privately funded R&D, on the whole, is similar to the ICT R&D curve. Both curves have the exactly same pace as the curves in indicator 3.6.6, which shows the index for all ICT R&D funding. In France, clearly business drives the impetus of all funding.

Indicator 3.6.8. – France: trend of ICT R&D expenditure and of R&D (inclusive of all sectors) expenditure financed by business

France: ICT R&D ratio to total (public and private) R&D expenditure

ICT GERD
R&D, inclusive of all sectors

Indicator 3.6.9 below highlights than France shares a common trait with the United States, the United Kingdom and, to a lesser extent, Germany, viz., the relative size of budget appropriations for ICT R&D allocated to business. Indicator 3.6.9 compiles this share by measuring the absolute values of budget appropriations allocated to business, on the one hand, and the index-based trend of these appropriations. Table 3.6.3 compiles the relative share of business own-capital and the relative share of budget appropriations for business-performed R&D.

The table highlights that budget appropriations account for a meaningful share (approx. 10.5% mean from 2000 to 2006). Only in the United Kingdom and the United States do we find a similar mean. The relative weight of the defence industries in the three countries is the main explanatory factor. However, the index-based trend of budget appropriations for ICT R&D allocated to business (fairly steady since it went from index 100 to index 109 (estimate) in 2006) was much lower than the overall index of public expenditure on ICT R&D that went from 100 to 145 during that time, as will be seen further down. In other words, the increased public effort for ICT R&D apparently did not benefit the national ICT industrial fabric much.

Indicator 3.6.9. – Trend of public funding for ICT R&D allocated to business in France

Trend of public funding for ICT R&D allocated to business in France

PPP$ million
Index

Table 3.6.3. – France: relative share of business own capital and public funds in the volumes of French business-performed ICT R&D

	2000	2001	2002	2003	2004	2005	2006
ICT R&D financed by business own capital	90.3%	99.5%	106.7%	97.6%	98.4%	97.6%	98.6%
Business-performed ICT R&D financed by public funds	9.7%	10.7%	11.5%	10.5%	10.6%	10.5%	10.6%

3.6.2.5. – Business ICT R&D and ICT production value

Table 3.6.4. – France: compared ratios of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**9.13%**
ICT manufactured goods value added as % of business value added	**6.27%**
Business ICT R&D as % of total business R&D	**32%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the

one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (32%) is about three times higher than the ICT ratio on total value added of business. Several reasons explain this gap. One, ICT services and manufacturing industries are high-tech activities for which R&D investment is intrinsically high; two, ICT are 'empowering technologies' and R&D in this field has outlets in other services or manufacturing industries than the ICT industry.

3.6.2.6. Budget appropriations for ICT R&D in France

Indicator 3.6.10. – Budget appropriations for ICT R&D

France: ICT R&D financed by public funds (PPP$ million)

Indicator 3.6.10 above provides the absolute values (PPP$ million) of French budget appropriations for ICT R&D. From 2000 to 2006, the rise (+45%) was substantial. Indicator 3.6.11 below clearly highlights that budget appropriations rose much more than private funds during that time.

Indicator 3.6.11. – Index of ICT R&D financed by business and index of ICT R&D financed by public funds in France

France: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Total of ICT R&D financed by private funds
ICT R&D financed by budget appropriations

Indicator 3.6.11, which compares the index of (civil and military) budget appropriations for ICT R&D with the index of business-financed ICT R&D, clearly shows that the public authorities' ICT R&D effort is sustained and regular. However, since 2002, it has no longer been in line with the trend of private funds that have stagnated.

Indicator 3.6.12 shows that while (civil and military) budget appropriations for ICT R&D are in line with the trend of GBAORD (government budget appropriations or outlays for R&D), the budget effort for ICT R&D is markedly higher (keeping in mind, however, that the figures for 2005 and 2006 are only estimates).

Indicator 3.6.12. – France: trend of Government Budget Appropriations and Outlays for R&D (GBAORD) and of public funding of ICT R&D

France: trend of ICT R&D and R&D (inclusive of all sectors) financed by public funds

All budget appropriations for R&D
Budget appropriations for ICT R&D

Indicator 3.6.13. – France: budget appropriations for ICT R&D by performance sector

Budget appropriations for ICT R&D by performance sector (PPP$ million)

Public Sector
Private Sector

The fact that the public authorities' increased effort for ICT R&D did not benefit business as much can also be clearly seen in indicator 3.6.13 above. Incidentally, the indicator shows, however, that France along with the United States and the United Kingdom is one of the countries where business absorbs a very large share of government budget appropriations for ICT R&D.

Last, in France, the share of military appropriations in budget outlays for ICT R&D was substantial, i.e., 44% mean, from 2000 to 2006 and remained steady, on the whole.

The breakdown of French budget appropriations into civil and military appropriations can be seen in indicator 3.6.14 below.

Indicator 3.6.14. – Trend of the ICT R&D budget structure in France

Trend of the ICT R&D public budget structure in France

ICT R&D civil budget appropriations
ICT R&D military budget appropriations

3.7 The United Kingdom

Note: The following pages present and comment a selection of indicators on ICT R&D funding in the United Kingdom. For access to all the relevant statistical data, go to the appended Excel database and the data tables.

3.7.1. The United Kingdom's relative share of global ICT R&D funding

Indicator 3.7.1. – The United Kingdom: trend of the relative share of global ICT R&D funding

UK: trend of the relative share of global ICT R&D funding

Share of all investment in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

The United Kingdom's relative share of ICT R&D funding within the study reference frame (9 countries) was steady from 2000 to 2006, on the whole. Based on this figure, the United Kingdom ranked seventh among the 9 studied countries in 1999 and in 2005. The stability of the United Kingdom's relative position results from the stability of Great Britain's relative weight within budget appropriations for ICT R&D as well as from the country's relative weight within the total private funding envelope. Its relative share of overall ICT R&D funding reflects the country's relative GDP weight, to the order of 4.2%. It also mirrors the weight of the British economy in the production of ICT goods (table 3.7.1).

Table 3.7.1. – The United Kingdom: share of the global production and trade of ICT goods

	Computers and office machinery	Communication equipment
The United Kingdom's relative share of global production	6.0%	3.0%
The United Kingdom's relative share of global export volume	6.9%	5.1%

Source: NSF from the WEFA database, 2000 data

3.7.2. ICT R&D Indicators in The United Kingdom

3.7.2.1. Volume and structure of ICT funding in The United Kingdom

Indicator 3.7.2 below illustrates the absolute values of ICT R&D funding broken down into 'financed by public funds' and 'financed by business',[10] in the UK. In overall value, funding rose 44% from 2000 to 2006, i.e., the highest growth rate among the major European economic powers (whereas EU-25 growth rate rose a mere 10.6% during that time), and jumped to PPP$6.3 billion from PPP$ 4.bn. The rise was steady during the entire time. Budget appropriations also rose steadily and continuously (+83%) from

[10] This includes foreign business funding of the R&D performed on British soil. Foreign funds account for about 22% of ICT R&D business funding as numerous US companies have 'relocated' a share of their R&D effort to the United Kingdom.

2000 to 2006, as did private funding but at a lower rate (+34%), but they did not undergo the sudden cyclical decline starting in 2002, which affected most of the other major economic powers.

Indicator 3.7.2. – The United Kingdom: ICT R&D funding structure

The United Kingdom: ICT R&D funding structure

(PPP$ million)

ICT R&D financed by the State
ICT R&D financed by business

Indicator 3.7.3. – Trend of the ICT R&D budget structure in the United Kingdom

Trend of the ICT R&D budget structure in the United Kingdom

ICT R&D % financed by business
ICT R&D % financed by the State

Indicator 3.7.3 highlights the funding structure of ICT R&D performed on British soil. Notably, the share of public funding rose sharply from 15.1% of the total to 20.8%, marking a very substantial increase of public funding from 2000 to 2006.

3.7.2.2. ICT R&D Intensity in the United Kingdom

Indicator 3.7.4. – Ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in the United Kingdom

Indicator 3.7.4 above illustrates ICT R&D intensity measured by the ICT GERD/GDP ratio, in the United Kingdom. According to this parameter, the figures for the United Kingdom are low, ranking the country last among the 9 studied countries, at a level barely higher than the mean for EU-25. In the field of ICT, the United Kingdom is among the least 'R&D intensive' countries of the major European economic powers. A fact that hardly prevents the UK from being a heavyweight in the field of the world production and trade of ICT goods, as noted above, because of its role as a platform for numerous US or Japanese ICT companies in Europe.

Table 3.7.2. – The United Kingdom: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

3.7.2.3. The place of ICT R&D investment within total R&D investment in the United Kingdom

Indicator 3.7.5. – The United Kingdom: ICT R&D ratio of total (public and private) R&D expenditure

The United Kingdom: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.7.5 confirms that, from the standpoint of business-financed R&D, the United Kingdom ranks last among the 9 studied countries, with a 17.5% ICT R&D ratio of total business-financed R&D. British R&D is not strongly 'ICT-oriented'. ICT R&D financed by public funds is comparatively higher. According to this parameter, Great Britain ranks fifth among the 9 studied countries.

Indicator 3.7.6, which compares the index of GERD (inclusive of all sectors) with the index of ICT GERD, highlights that the expenditure on ICT R&D was higher than the expenditure on all GERD, from 2000 to 2006 in the United Kingdom. However, both curves end up being in line.

Indicator 3.7.6. - The United Kingdom: trend of total expenditure for R&D (public and private) and for ICT R&D

The United Kingdom: trend of public funding and of business funding for ICT R&D

3.7.2.4. Business investment in ICT R&D in the United Kingdom

Indicator 3.7.7. – The United Kingdom: business-financed ICT R&D

The United Kingdom: business-financed ICT R&D (PPP$ million)

In the United Kingdom, the volumes of ICT R&D financed by business own capital are illustrated in indicator 3.7.7, which compiles the absolute value (PPP$ million) of the funding. Notably from 2000 to 2006, the volumes of business investment in ICT R&D rose slightly (+3%) and fell off less dramatically than they did in other countries during the 2003-2004 cyclical slump.

Indicator 3.7.8 below compares the index of business expenditure on ICT R&D with the index of business expenditure on R&D performed on British soil (inclusive of all sectors) and financed by business. The curves parallel, albeit at a more attenuated rate, the curves found in indicator 3.7.6, which depicted the trend of the ICT R&D funding index. The trend of business funding for ICT R&D is higher than all business funding for R&D. The strengthening of private ICT R&D in the United Kingdom diverges from a less sustained R&D effort on the part of British business. One can also assume that the sharp increase of British business's ICT R&D from 2000 to 2006 was tied to the Internet investments made by the service sector, which is quite developed in Britain.

Indicator 3.7.8. – The United Kingdom: trend of ICT R&D expenditure and of R&D (inclusive of all sectors) expenditure financed by business

The United Kingdom: index of ICT R&D expenditure and of R&D (inclusive of all sectors) expenditure financed by business

Total GERD financed by business
ICT GERD financed by business

3.7.2.5. – Budget appropriations for ICT R&D allocated to business in the United Kingdom

Indicator 3.7.9 below shows the relative size of budget appropriations for ICT R&D that are allocated to business in the United Kingdom. The absolute values and the trend of their index are given. Indicator 3.7.10 shows the structure of ICT R&D performed by British business, broken down into financed by 'budget appropriations' and by 'business own capital', in absolute values.

The graph highlights that budget appropriations for British business tended to dwindle, dropping to 8 from 10 of business-performed ICT R&D. However, according to this parameter, the United Kingdom is still well placed, behind the United States (13.2%, 2003 figure) and on a par with France (8.5%). In the three countries, the size of budget appropriations (which, however, is still quite small) in the volumes of ICT R&D performed by business is tied to the existence of strong defence industries whose R&D is partly financed by public contracts. From 1999 to 2005, budget appropriations for ICT R&D allocated to business rose slightly (+9%) and less swiftly than all budget appropriations for ICT R&D (+83%).

Indicator 3.7.9. – Trend of public funding for ICT R&D allocated to business in the United Kingdom

Trend of public funding for ICT R&D allocated to business in the United Kingdom

PPP$ million
Index

Indicator 3.7.10. – The United Kingdom: funding structure of business-performed ICT R&D

The United Kingdom: funding structure of business-performed ICT R&D

(absolute value, PPP$ million)

Financed by business own capital
Financed by budget appropriations

Table 3.7.3. – The United Kingdom: relative share of business own capital and public funds in the volumes of UK business-performed ICT R&D

	2000	2001	2002	2003	2004	2005	2006
ICT R&D financed by business own capital	91%	91%	93%	89%	90%	90%	90%
Business-performed ICT R&D financed by budget appropriations	9%	9%	7%	11%	10%	10%	10%

3.7.2.6. – Business ICT R&D and ICT production value

Table 3.7.4. – The United Kingdom: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**11.9%**
ICT manufactured goods value added as % of business value added	**8.89%**
Business ICT R&D as % of total business R&D	**18%**

ICT R&D in the major industrial countries

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.
Actually, the OECD series on production compiles relative values (%) compared to total value added of business, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ratio of ICT R&D / total business expenditure on R&D (32%) is about three times higher than the ICT ratio on total value added of business.

3.7.2.7. Budget appropriations for ICT R&D in the United Kingdom

Indicator 3.7.11. – The United Kingdom: ICT R&D financed by public funds

The United Kingdom: ICT R&D financed by public funds (PPP$ million)

Indicator 3.7.11 compares the absolute values (PPP$ million) of British budget appropriations for ICT R&D from 2000 to 2006. The increase (+ 52%) was very high but was encompassed within a rise of similar, albeit more sustained proportions of all government budget appropriations or outlays for R&D (GBAORD), as can be seen in indicator 3.7.12 below. It clearly shows that there is not specific support policy to ICT R&D in the United Kingdom, it accompanies a continuous and substantial strengthening of the (civil and military) R&D effort financed by public funding.

Indicator 3.7.12. – The United Kingdom: trend of total Government Budget Appropriations and Outlays for R&D (GBAORD) and of total public funding for ICT R&D

The United Kingdom: trend of budget appropriations for R&D (GBAORD) and for ICT R&D

GBAORD
Budget appropriations for ICT R&D

Indicator 3.7.13. – The United Kingdom: trend of public funding and business funding for ICT R&D

The United Kingdom: trend of public funding and business funding for ICT R&D

ICT GERD financed by business
ICT R&D budget appropriations

Indicator 3.7.13 compares the index of British government expenditure on ICT R&D with the index of the private funding for ICT R&D. Unlike the report for Germany, for example, the trend of public

funding stands out as being much more dynamic that the almost inexistent trend of private funding for ICT R&D.

Indicator 3.7.14. – The United Kingdom: public funding for ICT R&D by performance sector

The United Kingdom: public funding for ICT R&D by performance sector

(absolute value, PPP$ million)

Public Sector
Private Sector

Indicator 3.7.14 analyses British budget appropriations for ICT R&D by performance sector, broken down into budget appropriations going to business-performed ICT R&D and budget appropriations going to public sector performed ICT R&D. The analysis shows that, from 2000 to 2006, the increase of budget appropriations for ICT R&D was much higher for public research organisations. However, the increase was not to the detriment of public funding for R&D allocated to business, which also rose, albeit more moderately (6.7%) from 2000 to 2006.

Table 3.7.5. – The United Kingdom: budget appropriations for ICT R&D by performance sector

	2000	2001	2002	2003	2004	2005	2006
Public sector performed ICT R&D financed by public funds	42.0%	52.6%	36.0%	56.7%	49.6%	42.7%	42.2%
Business-performed ICT R&D financed by public funds	58.0%	48.1%	45.6%	35.7%	37.4%	36.1%	41.5%

In the United Kingdom, military appropriations are high (59%, 2003 figure) in the budget outlays for ICT R&D. The figure places the country clearly behind the United States (85%) but on a comparable level with France (31%). The high ratio of ‘defence appropriations’ in ICT R&D ranks the United Kingdom well above the mean in Europe where military appropriations for ICT R&D is to the order of 26.5% of government budget appropriations or outlays for ICT R&D.

Indicator 3.7.15. – Trend of the ICT R&D budget structure in the United Kingdom

Trend of the ICT R&D public budget structure in the United Kingdom

ICT R&D civil budget appropriations
ICT R&D military budget appropriations

3.8 Finland

Note: The following pages present and comment a selection of indicators on ICT R&D funding in Finland. For access to all the relevant statistical data, go to the complete Excel database and the data tables in Appendix I.

3.8.1. Finland's relative share of global ICT R&D funding

Indicator 3.8.1. – Finland: trend of the relative share of ICT R&D funding

Finland: trend of the relative share of ICT R&D investment

Share of all investment in ICT R&D
DShare of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Finland's relative share in global ICT R&D investment is low, to the order of 2%. Thus, Finland ranks eighth of the 9 studied countries for its relative share in total value of ICT R&D funding. The relative share of global ICT R&D funding was much higher than Finland's relative GDP weight (i.e., 0.4% from 2000 to 2006) within the global economy.

3.8.2. ICT R&D Indicators in Finland

3.8.2.1. Volume and structure of ICT funding in Finland

Indicator 3.8.2 below shows the absolute values of ICT R&D funding broken down into 'financed by public funds' and 'financed by business', in Finland. In overall value, funding climbed 47% from 2000 to 2006. The effort of the Finnish economy for ICT R&D, albeit ongoing, continued at a slower pace than the one reported in the earlier study, which established that Finland had multiplied its overall volume of ICT R&D by a factor of 2.5 (granted, it had started from a very low level). Despite the increase, from 2000 to 2006, Finland remained in ninth place within the 9 studied countries for overall ICT R&D volume and in fifth place within EU-25 (moving ahead of Italy, the Netherlands and Spain). Budget appropriations increased (+ 31%) but not as much as business funding (+ 49 %). Consequently, in Finland, the ICT R&D funding structure saw an increase in the relative share of private investment, as can be seen in indicator 3.8.3.

Indicator 3.8.2. – Finland: ICT R&D funding structure (absolute values)

Finland: ICT R&D funding structure
(PPP$ million)

ICT R&D financed by the public funds
ICT R&D financed by business own capital

Indicator 3.8.3. – Finland: ICT R&D funding structure (%)

Finland: ICT R&D funding structure

ICT R&D % financed by public funds
ICT R&D % financed by business and others

3.8.2.2. ICT R&D Intensity in Finland

Indicator 3.8.4. – Finland: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in Finland

Indicator 3.8.4 illustrates ICT R&D intensity measured by the ICT GERD/GDP ratio, in Finland. According to this parameter, the figures for Finland are very high, putting the country in the lead of the 9 studied countries. The Finnish economy is probably the most 'R&D intensive' in the field of ICT, worldwide.

Table 3.8.1. – Finland: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

Indicator 3.8.4-A. – Finland: expenditure on ICT R&D per capita population

Finland: expenditure on ICT R&D per capita population (PPP$)

Finland's exceptional R&D policy is spotlighted when ICT intensity is measured by 'ICT R&D expenditure per capita population'. Indeed it reaches a level unmatched elsewhere.

3.8.2.3. The place of ICT R&D investment within total R&D investment in Finland

Indicator 3.8.5. – Finland: ICT R&D ratio of total R&D expenditure

Finland: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Indicator 3.8.5 underscores Finland's far-reaching policy focussed on ICT R&D. The ICT R&D ratio of Finnish business R&D is 63%, a figure that is not matched elsewhere. At the same time, publicly funded ICT GERD is also high, to the order of 11%, a figure only matched by France, Japan, and South Korea (at a slightly lower level for the two latter). The figures highlight the 'single ICT specialisation' policy of the local industrial fabric dominated by Nokia, number one for mobile communications worldwide.

Indicator 3.8.6. - Finland: trend of all funding for R&D and for ICT R&D

Trend of all funding for R&D (inclusive of all sectors) and for ICT R&D

ICT GERD
Total funding for R&D (GERD)

Indicator 3.8.6, which compares the index of GERD (inclusive of all sectors) with the index of ICT GERD, shows that the expenditure on ICT R&D is higher than the overall expenditure on GERD, which was already high. From 2000 to 2006, ICT GERD jumped to index 129 from index 100. That both curves are similar is unsurprising as ICT GERD accounts for two-thirds of total Finnish R&D.

3.8.2.4. Business investment in ICT R&D in Finland

Indicator 3.8.7. – Finland: business-financed ICT R&D

Finland: business-financed ICT R&D (PPP$ million)

In Finland, the volumes of ICT R&D financed by business own capital are given in indicator 3.8.7, which compiles absolute funding values (PPP$ million). Notably from 2000 to 2006, an increase

(+ 29%) of business investment in ICT R&D continued, including during the most recent period, and seemed little affected by cyclical factors.

Indicator 3.8.8 below compares the index of business funding for ICT R&D with the index of R&D (inclusive of all sectors), in Finland. The index of business funding for ICT R&D matched the index of business funding for all R&D. ICT R&D, which weighs more than 60% of all business funding for R&D, obviously 'sets the tone' for the overall impetus of private Finnish funding for R&D.

Indicator 3.8.8. – Finland: trend of business funding for R&D (inclusive of all sectors) and for ICT R&D

Finland: trend of business funding for R&D (inclusive of all sectors) and for R&D

ICT R&D financed by business
Total R&D financed by business

3.8.2.5. – Budget appropriations for ICT R&D allocated to business in Finland

Indicator 3.8.9 below shows the relative size of budget appropriations for ICT R&D allocated to business, in Finland. The index trend and absolutes values of the appropriations are given. Indicator 3.8.10 illustrates the structure of ICT R&D performed by Finnish business, in absolute values, broken down into 'budget appropriations' and 'business own capital'. Table 3.8.2 compiles the relative share of business own capital and budget appropriations in the volumes of business-performed R&D in Finland. The table underscores that budget appropriations for ICT R&D allocated to Finnish business are very low, accounting for roughly 3.4% of the ICT R&D they perform.[11]

Indicator 3.8.9. – Trend of public funding for ICT R&D allocated to business in Finland

Trend of public funding for ICT R&D allocated to business in Finland

PPP$ million
Index

Indicator 3.8.10. – Finland: funding sources for business-performed ICT R&D

Finland: funding structure of business-performed ICT R&D
(PPP$ million)

[11] In the 2003 edition of the study, a major error was made when compiling the indicator. The error showed a large share of budget appropriations as a funding source for business-performed R&D. Actually, this is not at all true. Finland's parameter, i.e., a weak share of budget appropriations allocated to business, is closer to the reported parameter for Sweden.

Financed by business own capital
Public funds

Public funding for ICT R&D allocated to business is very low. The outstanding Finnish effort for ICT R&D is virtually exclusively financed by business.

3.8.2.6. – Business ICT R&D and ICT production value

Table 3.8.2. – Finland: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**12.63%**
ICT manufactured goods value added as % of business value added	**22.87%**
Business ICT R&D as % of total business R&D	**63%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.
Actually, the OECD series on production compiles relative values (%) compared to total value added of businesses, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ICT R&D / total business expenditure on R&D ratio is much higher than the ICT ratio on the total value added of businesses.

3.8.2.7. Budget appropriations for ICT R&D in Finland

Indicator 3.8.11. – Finland: trend of budget appropriations for ICT R&D

Finland: budget appropriations for ICT R&D
(PPP$ million)

Indicator 3.8.11 above shows the absolute values (PPP$ million) of Finnish budget appropriations for ICT R&D, from 2000 to 2006. The increase (+ 33%) was high but lower than the relative rise of private funding, as can be seen in indicator 3.8.12. On the other hand, this public backing (see indicator 3.8.13) was closely in line with the positive albeit moderate trend of the publicly funded Finnish effort for R&D (inclusive of all sectors).

Indicator 3.8.12. – Finland: trend of budget appropriations for R&D (inclusive of all sectors) (GBAORD) and of public funding for ICT R&D

Finland: trend of budget appropriations for R&D (inclusive of all sectors) and budget appropriations for ICT R&D

GBAORD
Budget appropriations for ICT R&D

Indicator 3.8.13. – Finland: index of ICT R&D financed by business and index of ICT R&D financed by public funds

Finland: index of ICT R&D financed by business and index of ICT R&D financed by public funds

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.8.13 compares the indexes of public expenditure and of private expenditure on ICT R&D in Finland. The trend of public spending is slightly lower.

If one analyses Finnish budget appropriations for ICT R&D by performance sector, broken down into budget appropriations for business-performed ICT R&D and budget appropriations for public sector performed ICT R&D, from 2000 to 2006 (see table 3.8.4 below), the relative share of public funding for business-performed ICT R&D was stable at 45%.

Table 3.8.3. – Finland: budget appropriations for ICT R&D by performance sector

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Public sector	53.6%	53.7%	55.3%	53.4%	54.2%	56.4%	57.6%
Private sector	46.4%	46.3%	44.7%	46.6%	45.8%	43.6%	42.4%

In Finland, military appropriations in the budget outlays for ICT R&D were quite small, although the share of ‘defence’ appropriations tended to grow and more than doubled from 2000 to 2006 (granted, they started from very low). Based on this parameter, the country ranks last among the 9 studied countries.

Indicator 3.8.14. – Finland: relative share of military appropriations and civil appropriations in budget outlays for ICT R&D

Finland: relative share of military appropriations and civil appropriations in budget outlays for ICT R&D

ICT R&D civil appropriations
ICT R&D military appropriations

3.9 Sweden

Note: The following pages present and comment a selection of indicators on ICT R&D funding in Sweden. For access to all the relevant statistical data, go to the complete Excel database and the data tables in Appendix I.

3.9.1. Sweden's relative share of global ICT R&D funding

Indicator 3.9.1. – Sweden: trend of the relative share of ICT R&D funding

Sweden: trend of the relative share of global investment in ICT R&D

Share of all investment in ICT R&D
Share of government budget appropriations for ICT R&D
Share of private funds for ICT R&D

Sweden's relative share of global investment in ICT R&D was to the order of 1.7% and increased slightly from 2000 to 2006. Based on this figure, Sweden ranked last of the 9 studied countries in 2003. Albeit moderate, the relative share in global ICT R&D funding was much higher than Sweden's relative GDP weight, a mere 0.6%, within the world economy. The performance of Sweden's relative share in the global envelope of budget appropriations for ICT R&D (that increased substantially for a relative share, from 0.8% to 0.9%, from 2000 to 2006) was more moderate and was in line with its relative economic weight.

3.9.2. ICT R&D Indicators in Sweden

3.9.2.1. Volume and structure of ICT funding in Sweden

Indicator 3.9.2 below illustrates the absolute value of ICT R&D funding broken down into 'financed by public funding' and 'financed by business', in Sweden. In overall value, the funding increased by 32% from 2000 to 2006 (whereas EU-25 only rose by 11%), soaring to PPP$3 billion from PPP$2.3bn. As budget appropriations for ICT R&D grew at a faster rate than private funding, the ICT R&D funding structure gradually shifted, with public funding acquiring a larger share (see indicator 3.10.3).

Indicator 3.9.2. – Sweden: ICT R&D financed by business and by public funds

ICT R&D financed by business and ICT R&D financed by public funds in Sweden (PPP$ million)

ICT R&D financed by business and others
ICT R&D financed by public funds

Indicator 3.9.3. – Sweden: trend of the budget structure of ICT R&D financed by business and by public funds

Trend of ICT R&D budget structure in Sweden

ICT R&D financed by business
ICT R&D financed by public funds

3.9.2.2. ICT R&D Intensity in Sweden

Indicator 3.9.4. – Sweden: ratio of total expenditure on ICT R&D as a % of GDP

Ratio of total expenditure on ICT R&D as a % of GDP in Sweden

Indicator 3.9.4 illustrates ICT R&D intensity measured by the ICT GERD/GDP ratio, in Sweden. Based on this parameter, the figure for Sweden is very high, placing it in the lead of the studied countries behind Finland and South Korea and is three times higher than the reported mean for Europe. This confirms the Scandinavian economies' strong affinity for ICT R&D.

Table 3.9.1. – Sweden: total ICT R&D investment ratio to GDP

	2000	2006
Finland	*1.55%*	*1.55%*
South Korea	*0.95%*	*1.30%*
Sweden	*1.23%*	*1.04%*
Japan	*0.83%*	*0.84%*
United States	*0.69%*	*0.56%*
Canada	*0.69%*	*0.52%*
France	*0.43%*	*0.41%*
Germany	*0.37%*	*0.40%*
United Kingdom	*0.33%*	*0.28%*
Europe-25	*0.32%*	*0.25%*

Indicator 3.9.4-A. – Sweden: expenditure on ICT R&D per capita population

Expenditure on ICT R&D per capita population in Sweden

(PPP$)

The very strong bent of Swedish R&D for ICT can be seen in the outstanding level of the 'expenditure on ICT R&D per capita population' indicator.

3.9.2.3. The place of ICT R&D investment within total R&D investment in Sweden

Indicator 3.9.5. – Sweden: ICT R&D ratio of total R&D expenditure

Sweden: ICT R&D ratio of total (public and private) R&D expenditure

Ratio of ICT GERD financed by business/Total GERD financed by business
Ratio of ICT GERD financed by public funds/Total GERD financed by public funds

Nevertheless, indicator 3.9.5 qualifies Sweden's strong bent toward ICT R&D. The ratio of ICT R&D within the R&D of Swedish business accounted for about 30% (2005 figure), a level comparable with France's. The sharp erosion highlighted by the indicator is found in but few countries whereas, at the same time, the ICT GERD financed by public funds increased slightly but continuously in Sweden since the ICT R&D ratio climbed to 7.4% from 6.2% of the total envelope of budget appropriations for R&D.

Indicator 3.9.6. - Sweden: trend of total funding for R&D (GERD) and for ICT R&D

Sweden: trend of all funding for R&D (GERD) and for ICT R&D

ICT GERD
Total funding for R&D (GERD)

Indicator 3.9.6 clearly shows that in Sweden the trend of ICT R&D funding was more erratic than the GERD trend, which was very high. From 2000 to 2006, ICT GERD crept from index 100 to 104 while GERD increased at a more sustained pace (+20% from 2000 to 2006). Apparently in Sweden, the R&D effort is being redeployed so that it becomes less dependent on the single ICT sector.

3.9.2.4. Business investment in ICT R&D in Sweden

Indicator 3.9.7. – Sweden: business-financed ICT R&D

Business-financed ICT R&D in Sweden
(PPP$ million)

Indicator 3.9.7 illustrates the volumes of ICT R&D financed by business own capital in Sweden and compiles the absolute values (PPP$ million) of the funding. From 2000 to 2006, the volumes of business funding for R&D stagnated after peaking at nearly PPP$3.16 billion in 2001 before falling off and then picking up to attain a volume to the order of PPP$2.8 billion.

ICT R&D in the major industrial countries

Indicator 3.9.8 compares the index of the business expenditure on ICT R&D with the index of business expenditure on R&D (inclusive of all sectors) financed by business. This indicator also shows a redeployment of the R&D effort financed by business own capital toward other sectors than the ICT sector. Business-financed ICT R&D fell off sharply as of 2002 whereas all business investment in R&D (inclusive of all sectors) continued to grow steadily. It is as if, from 2002 on, Swedish business was focussing more on other R&D fields (biotechnologies) thus clearly shifting away from a 'single ICT specialisation' unlike its Finnish neighbour.

Indicator 3.9.8. – Sweden: trend of business funding for R&D (inclusive of all sectors) and for ICT R&D

Sweden: trend of business funding for R&D (inclusive of all sectors) and for ICT R&D

ICT R&D financed by business
Total R&D financed by business

3.9.2.5. – Budget appropriations for ICT R&D allocated to business in Sweden

It was not possible to compile the budget appropriations for ICT R&D allocated to business in Sweden because of the very sketchy data provided by Sweden to the OECD.

3.9.2.6. – Business ICT R&D and ICT production value

Table 3.9.2. – Sweden: compared ratio of ICT R&D financed by business versus total BERD on the one hand, and the ratio of ICT manufactured goods and services value added as % of total value added of business activities, on the other

ICT services value added as % of business value added	**12.64%**
ICT manufactured goods value added as % of business value added	**6.96%**
Business ICT R&D as % of total business R&D	**30%**

A comparative ratio of the value of the production of ICT goods and services versus total business investments in ICT R&D cannot be constructed based on OECD data.

Actually, the OECD series on production compiles relative values (%) compared to total value added of businesses, inclusive of all sectors, viz., share of ICT services in the value added of businesses on the one hand; share of ICT manufactured goods, on the other. Notably, for ICT services as well as for ICT manufacturing industries, the ICT R&D / total business expenditure on R&D ratio is much higher than the ICT ratio on the total value added of businesses.

3.9.2.7. ICT R&D Budget appropriations for ICT R&D in Sweden

Indicator 3.9.9. – Sweden: budget appropriations for ICT R&D

Sweden: budget appropriations for ICT R&D
(PPP$ million)

Indicator 3.9.9 above shows the absolute values (PPP$ million) of Swedish budget appropriations for ICT R&D from 2000 to 2006. The increase of the index (indicator 3.9.10) from 2000 to 2006 (+ 144 %) was the highest of EU-25 and much higher than the already high overall trend of budget appropriations for all R&D (which rose 69% during that time).

Clearly in Sweden, the public authorities are rolling out a very pro-active action to strengthen the country's base of ICT skills and expertise. This fact is also interesting because, at this stage, this public policy does seem in line with the private R&D policy that has slowed, although it has remained at high intensity levels, as we have already said. The 'divorce' between the trend of public funding and the trend of private funding for ICT R&D in Sweden is clearly shown in indicator 3.9.11.

Indicator 3.9.10. – Sweden: trend of budget appropriations for R&D (inclusive of all sectors) and of budget appropriations for ICT R&D

Sweden: trend of budget appropriations for R&D (inclusive of all sectors) (GBAORD) and of public funding for ICT R&D

GBAORD
Budget appropriations for ICT R&D

Indicator 3.9.11. – Sweden: trend of budget appropriations for ICT R&D and of private funding for ICT R&D

Trend of budget appropriations for ICT R&D and of private funding for ICT R&D in Sweden

Budget appropriations for ICT R&D
ICT R&D financed by business

Remarkably, for a whole set of parameters, although Sweden and Finland both share a very high level of ICT R&D intensity peculiar to the Scandinavian countries, the countries do not give the same priority to 'ICT specialisation' and deploy different policies in their articulation of public R&D and private R&D.

In Sweden, military appropriations in the budget outlays for ICT R&D were substantial, amounting to about 28%. (The very high figure for 2002 seems to be a ‘statistical artefact’, due to a change in the method used to assess defence R&D, for instance). However, aside from this possible anomaly in the increase of the military appropriations for ICT R&D, it should be noted that these appropriations are at a relatively high level in Sweden.

Indicator 3.9.12. – Sweden: ICT R&D budget appropriations structure

Trend of budget appropriations structure for ICT R&D in Sweden

Military appropriations for ICT R&D
Civil appropriations for ICT R&D

4. ICT R&D in non-OECD Countries

4.1 – Methodological framework and preliminary remarks

Similar to the 2005 update, this study highlights a decline of corporate ICT R&D performed in-house and financed by US business, and to a lesser extent, by European business. This prompts us to hypothesize that business R&D activities are increasingly being relocated in non-OECD countries.

Chapter four (reprinted in full in the appendix) of the OECD Science, Technology and Industry Outlook[12] report published on 4 December 2006, provides an exhaustive analysis of ***the Internationalisation of R&D.***

However, the analysis deals with R&D internationalisation in a general framework and does not provide any specific details about ICT R&D internationalisation. Nevertheless, it does not seem that the trend of ICT R&D internationalisation (see below) is any different from the reported trend for all R&D. A notable fact in the OECD report is that R&D outsourcing to OECD countries (and specifically in Europe, viz., Ireland, the United Kingdom and… France) continues to account for sizeable R&D volumes. ***Based on OECD data and other sources, nothing warrants the affirmation that the build-up of R&D in emerging countries brings about a "loss of substance" of developed countries' R&D potential,*** quite the contrary**.** Therefore, the R&D build-up in emerging countries is but a facet of the internationalisation of R&D activities. The OECD report underscores that:

> *"Current R&D internationalisation has three distinguishing characteristics: it is taking place at a much faster pace, it is spreading to an increasing number of countries, including developing countries, and it involves R&D that extends beyond adapting technology to local conditions. This chapter suggests that the last of these phenomena may represent a distinctive new trend in the internationalisation of R&D. In the past, the evidence suggested that major global firms kept their key technology creation activities – as evidenced by R&D and patenting – close to their home bases. Now, however, they seem not only to seek to exploit knowledge generated at home in other countries, but also to tap into worldwide centres of knowledge. This implies genuinely international sourcing of knowledge."* We shall see that other analyses confirm these facts.

[12] ISBN 92-64-02850-1

Therefore, the term 'relocation' applied to R&D in general (and there is no reason to believe that it is any different for ICT R&D) should be used with caution. A recent Duke University study (see point 4.5) shows that ***R&D activity outsourcing is the only kind of outsourcing that does not cause employment (scientific employment in this case) downsizing in the US firms strengthening their R&D activities in emerging countries***.

This fact is borne out by the reported statistical trend of a -2% per year downsizing of ICT R&D volumes of US firms. Actually, *budget appropriations for business-performed intramural ICT R&D (see chapter 3, United States case study) allocated to US firms are rising dramatically and more than compensate for the fall-off of business own capital funding of the ICT R&D of US firms.*

Therefore, it is not appropriate to use the term "relocation" in the usual meaning of the word: the strong growth of R&D activities in emerging countries marks:

1. The determination of firms to redeploy the 'global breakdown' of their R&D effort (by making inroads into high growth potential markets, among others) rather than a transfer of their resources and activities
2. The determination to harness the high numbers of well-trained low-cost workforce that are available in those countries whereas the human resources available in developed countries are now scarcer and more expensive.

Rather than relocation, we are seeing an internationalisation of R&D activities in general, and of ICT R&D activities in particular, with a view to harnessing the high-level skills, expertise and resources of the scientific personnel in countries such as India or China (but the range of relevant countries is not limited to these two countries, as will be seen further down).

In the latest issue of the *OECD Science, Technology and Industry Outlook* study, the OECD statistical departments have collected data on R&D and innovation in countries such as China, India, Taipei, etc., for the first time. However, the OECD underscores the major methodological stumbling blocks due to the fact that, as most emerging countries are not OECD members, they do not fit in with its statistical production system. *Therefore, it is impossible to approach the issue of ICT R&D in non-OECD countries on the basis of the (OECD) statistical base that is the foundation for our assessments of the 9 countries that were analysed in the preceding chapters of the study.*

All the estimates in this chapter are drawn from another source, i.e., the data published by the Battelle Memorial Institute (www.battelle.com). Aside from its own R&D contracts performed for third parties

(amounting to $3.7 billion in 2005), Battelle has a department that monitors business R&D activity. The reports of Battelle's R&D watch, advisory consulting, and optimisation are published in R&D Magazine (www.rdmag.com; free access). We took the basic data for this chapter from the magazine, and specifically from its special issue, ***2007 Global R&D Report***, published in September 2006.

In Table 4.1, we compare several countries' expenditure on R&D, as measured by the OECD on the one hand, and by the Battelle Institute, on the other, to highlight the problem of compiling a statistical measure of R&D in non-OECD countries,

Table 4.1. Estimate of total GERD in several non-OECD countries
(absolute values, billion current dollars)

	A: Battelle Data	**B: OECD Data**	**A-B gap**	**A-B gap %**
China	109	94	15	13.8%
India	33.3	24	9.3	27.9%
Russia	17.4	17	0.4	2.3%
Taipei	11.9	15	-3.1	-26.1%

The comparison shows that:

- The figures published by the Battelle Institute are higher than the OECD figures, except for Taipei.
- The higher Battelle figures do not change the order of magnitude for gross domestic expenditure (GERD) in China that, according to both sources, holds fourth place worldwide (immediately behind the United States, EU-25, and Japan) among the countries pays ranked according to GERD size.
- On the other hand, the Battelle estimate is nearly 28% higher than the OECD estimate for India.

These, sometimes large, gaps probably reflect differences in the methodologies used to measure R&D. ***We assume*** (*although we do not have any visible methodology to confirm this*) ***that ICT issues may be the reason for the very different estimates***. The fact that the most important gap relates to India is very meaningful. For we know that software development (computer programme compilation) performed in India for western customers is extremely high. The value of the 'development' is probably partly included in the Battelle estimate whereas perhaps the OECD does not take this factor into account, as its definition of R&D is based on the Frascati Manual that only takes into account R&D efforts for the production of technological innovations and not routine software development (that OECD includes in the production, not the R&D, of the computer services sector).

Further down in this chapter, we have opted to use the Battelle figures consistently and not the OECD source that was used for the 9 countries in this update. Several reasons explain this choice:

- The Battelle estimates cover a wider range of non-OECD countries than the OECD's recent report (where the focus is mainly on continental China) does and some of these countries are interesting from the standpoint of measuring total ICT R&D effort.
- We believe that the Battelle estimates are closer to business rationales since the figures have been compiled based on a systematic effort to monitor R&D budgets and performance rationales within a large panel of 'R&D-intensive' firms.
- Intuitively, we feel that OECD estimates for India underestimate this large country's ICT R&D, as they probably do not take account of software development.[13]
- The Battelle figures are supplemented with qualitative indications that shed light on the rationales underlying the reasons why firms in developed economies resort to the R&D potential of emerging countries.

[13] However, it should be pointed out that for the 9 developed economies whose ICT R&D is examined in the first part of the study, software development is included in the estimates only if they are an integral part of an R&D effort in the Frascati Manual meaning of the term. Therefore, the data in this chapter (4) is not, and cannot be, homogenous with the data in the first part of the study. Another major difference is that for the 9 OECD countries in the study, all the data is expressed in dollars at parity of purchasing power (PPP$) whereas the data for emerging countries is given (by Battelle and the OECD) in current dollars, thus preventing any term-to-term comparison.

4.2 - Initial guideline: estimating GERD in non-OECD countries

Gross domestic expenditure on R&D (inclusive of all sectors and not only ICT) for a selection of OECD and non-OECD countries can be found in table 4.2 and indicator 4.1 below.

Table 4.2. Total GERD (inclusive of all sectors) for a selection of OECD and non-OECD countries

	2004 GDP (billion $)	GERD as % of GDP (2004 value)	2004 GERD (billion $)	2005 GERD (billion $)	2006 GERD (billion $) (estimate)	2007 GERD (billion $) (estimate)
China	7,262	1.5%	108.9	124.3	136.3	149.8
India	3,319	1.0%	33.3	36.1	38.8	41.8
Brazil	1,492	1.0%	22.9	24.4	25	25.6
Russia	1,408	1.30%	17.5	20.7	22	23.3
Taiwan	540.2	2.20%	11.9	13.9	14.4	15
Israel	129	3.60%	6	6.9	7.3	7.7
Singapore	120.9	2.80%	2.3	2.73	2.91	3.1

Indicator 4.1. GERD of OECD and non-OECD countries
(non-OECD countries are in a different set of colours)

GERD (billion $) in OECD and non-OECD countries
(2004, 2005 & 2006)

The following should be underscored about the above figures, which do not only reflect ICT R&D:

- As of 2004, China has ranked fourth among the 'major powers' in terms of gross domestic expenditure on R&D and its overall GERD volume is about to exceed Japan's.
- A country such as India has a gross domestic expenditure on R&D (GERD) roughly at a par with France's.
- Although countries such as Brazil and Russia have not reached the same magnitude, they exceed the $20 billion threshold for GERD, thus ranking them ahead of all European countries, except for Germany and France.
- Although they are under the 10 billion-dollar threshold, countries such as Taiwan, Singapore, and Israel, where the ICT R&D effort is known to be sizeable, have attained high R&D

intensities (volume of business R&D as a % of GDP), which are higher than the reported intensities for the 9 OECD countries analysed in the first part of the study.

4.3 - From the estimate of total R&D to the estimate of business ICT R&D in non-OECD countries

We shall combine two hypotheses to go from the estimate of all business-financed GERD[14] in the non-OECD countries to the specific area of business-financed ICT R&D:

- The first hypothesis is based on the ***global mean ratio of business-financed ICT R&D compared to all business-financed R&D***. This is shown in sub-chapter 4.3.1 below.
- The global mean value should be adjusted empirically by taking into account the extent of the industrial structure's ICT orientation in each country.

4.3.1 - Mean global value of ICT R&D ratio compared to total business R&D

The mean global value, used by the Battelle estimates, is taken from a study by the Booz Allen Hamilton consulting firm. This value is shown in indicator 4.2. below.

Indicator 4.2. – Breakdown of global industrial R&D per sector

Breakdown of global business R&D per sector

Other 7%	Chemistry, Energy 7%
Telecommunications 2%	Process technologies 8%
Aeronautics, space & defence 3%	Automotive industry 18%
Consumer goods 4%	Medical & pharmaceutical 21%
Software & the Internet 5%	Electronics & IT 25%

Based on the above data that compiles the global mean of business-financed R&D per sector, industrial ICT R&D weighs about 32% of the total (this figure is broken down into 25% for 'electronics & IT, including telecommunication equipment', 2% for telecom services, and 5% for the software & Internet industry).

[14] For emerging countries, our suggested empirical method is only for measuring business R&D. As was the case for the 9 studied OECD countries, compiling publicly funded ICT R&D is not possible. The comparison of ICT R&D volumes between developed and emerging countries can only be from the perspective of business R& D.

Notably, the global mean given by Booz Allen Hamilton is perfectly in line with what we reported for 6 (out of the 9) OECD countries in the first part of the study. On the whole, the business ICT R&D in those 6 countries accounts for one-third (give or take 2%) of total business expenditure on R&D.

Only South Korea and Finland (where ICT R&D accounts for a little more than 50% of all business-financed R&D) among the 9 studied OECD countries are well over this mean while Germany and EU-25 are significantly under the mean (both with a ratio to the order of 20% for the same indicator).

4.3.2 - Measuring the ICT R&D share of the industrial structure in non-OECD countries

The South Korean, Finnish and German examples suggest that the reported global mean (32%) should be corrected by a factor reflecting the extent of the industrial countries' ICT orientation.

Since 2005,[15] the OECD working with the European Patent Office (EPO) has been publishing a *Compendium of Patent Statistics* on the patents 'with triad coverage' filed at the EPO (i.e., aside from targeted EPO protection across Europe, applications for the same patents are also filed with the Japanese Patent Office and the US Patent & Trademark Office). Based on international patent classification (IPC) codes, the OECD-EPO publication measures thirty patent-applicant countries' relative share of total ICT-related patent applications. Specifically, for a given country, the Compendium provides the ICT-related patents share of all patents with international coverage filed by the country.

Due to very acute differences in business cultures regarding patent protected innovation, non-OECD countries only account for a small share of total ICT-related patent applications worldwide. For instance, in 2003 (latest available data), Japan's relative share of the world total of ICT-related patents accounted for 17.9% whereas China's share was a mere 1.8% (ratio of nearly 1 to 10). Yet in 2003, Japan business-enterprise expenditure on R&D was only 30% higher than China's (ratio of 1 to 1.3).

The share of ICT-related patents versus total patents filed by patent applicants in a given country is much more meaningful when measuring the extent of the ICT R&D orientation of business in a given country. Indeed for a given country, there is no reason to believe that the ICT sector, all things being equal, would resort less to patent protection than other sectors would.

[15] This document was updated in September 2006 and we are referring to this edition.

Table 4.3 compiles the ICT-related patents share of total patent applications in several non-OECD countries.

Table 4.3. ICT-related patent share of total patent applications in several non-OECD countries

	% ICT-related patents	**Gap with global mean**
Singapore	62.70%	1.80
Taiwan	45.00%	1.29
Israel	41.80%	1.20
China	38.80%	1.11
Russia	23.80%	0.68
Brazil	15.70%	0.45
India	14.80%	0.43
Global mean	34.80%	1.00

The above table highlights that some countries (Israel, Singapore, Taiwan, and to a lesser extent China) have ICT-oriented R&D (similar to Finland or South Korea in the 9 studied OECD countries) whereas other countries (Russia and Brazil) have a weaker 'ICT orientation' than the global mean.

India is probably a special case. While the ICT-related patent share of total R&D patents in the country is fairly low (14.8%), this is probably because ICT R&D in India is focussed on software development, which is not patentable under international patent applications. Therefore, the share of ICT R&D (see 'ICT-related patent' indicator in table 4.3) may be largely underestimated in this country, if one only looks at this patent indicator.

Notably, in the 9 OECD countries, the country ranking order for ICT-related patents versus total patents filed by applicants in a given country, on the one hand, and for business ICT R&D volumes, on the other, is exactly the same. Also, country-by-country, the ratio for the 'ICT-related patent share' closely parallels the ratio for business 'ICT R&D compared to total business R&D.[16]

[16] The curves of the two ratios overlay each other only for the ICT R&D ***financed by business***, and understandably so, since it is chiefly firms that use patenting to protect their R&D results.

4.3.3 - Estimate of business ICT R&D in non-OECD countries

For compiling the estimates (importantly, these are only estimates for which orders of magnitude are more important than absolute values) of business ICT R&D in non-OECD countries, the global mean of ICT R&D compared to all business R&D is 'adjusted' by the indicator 'gap with the global mean' in table 4.3 (except for India and Brazil where a neutral coefficient of 1 is applied), to reach a weighted mean, country-by-country.

Thus, the estimate (%) of the ICT R&D share of total business R&D for the 7 non-OECD countries varies, as can be seen in Table 4.4 below.

Table 4.4 – Estimate (%) of ICT R&D share of total business R&D for the 7 non-OECD countries

	Mean ICT R&D ratio	ICT specialisation coefficient	Recalculated ICT R&D ratio
Singapore	32%	1.8	57.6%
Taiwan	32%	1.29	41.3%
Israel	32%	1.2	38.4%
China	32%	1.11	35.5%
Russia	32%	0.7	22.4%
Brazil	32%	1	32.0%
India	32%	1	32.0%

Then, one applies to the figures in table 4.2 (total expenditure on R&D, inclusive of all sectors, for the 7 non-OECD countries) the % figures in column 3 of table 4.4 to get an estimate of business ICT R&D in the 7 countries. The figures in table 4.5 reflect this recalculation.

Table 4.5. – Estimate of ICT R&D of the 7 non-OECD countries

	Recalculated ICT R&D ratio	**Estimate business ICT GERD (billion $)**		
		2004	**2005**	**2006**
China	35.5%	38.7	44.1	48.4
India	32.0%	10.7	11.6	12.4
Brazil	32.0%	7.3	7.8	8.0
Russia	22.40%	3.9	4.6	4.9
Taiwan	41.3%	4.9	5.7	5.9
Israel	38.4%	2.3	2.6	2.8
Singapore	57.6%	1.3	1.6	1.7
Total		69.1	78.1	84.2

If now (and only for 2004 because the estimates are more reliable) we compare these figures with the estimates for business ICT R&D in the 9 studied countries, we reach the numbers listed in table 4.6 below.

Table 4.6. – Business ICT R&D in the 9 studied countries

Series 1	Current $, billion	**Series 2**	PPP$, billion
China	38.7	**United States**	54.9
India	10.7	**Japan**	28.6
Brazil	7.3	**South Korea**	11.5
Russia	3.9	**Germany**	8.2
Taiwan	4.9	**France**	6.3
Israel	2.3	**Canada**	4.9
Singapore	1.3	**United Kingdom**	4.3
		Sweden	2.7
		Finland	2.4
Total 1	***69.1***	***Total 2***	***123.8***
		EU-25	***25.6***

(2004 data)

A term-to-term comparison of the two series of figures (7 non-OECD countries: series 1; 9 OECD countries: series 2) cannot be done since the first series is in billions of current dollars while the second is in dollars at parity of purchasing power (except the figure for the United States that is the reference country).

However, by comparing the series, we can make the following deductions, with little margin of error.

- The ICT R&D of the above 7 non-OECD countries accounts for about half of the intramural ICT R&D performed and financed in the 9 studied countries, which account for more than 90% of the R&D of OECD countries.
- A country such as China has an ICT R&D that may already be higher than Japan's, thus ranking China second worldwide.
- A country such as India with an ICT R&D to the order of €10 billion is already ahead of all the European countries.
- A country such as Taiwan weighs as much as Canada and more than the United Kingdom.
- A country such as Israel weighs as much as a country such as Finland and yet the Finnish ICT R&D effort is exceptional.

4.4 - Qualitative aspects of ICT R&D developments in non-OECD countries

The recent *OECD Science, Technology and Industry Outlook 2006* report provides a detailed analysis of the internationalisation of R&D (Chapter 4 appended to this volume). The *2007 Global R&D Report* (R&D Magazine, special issue, September 2006, www.rdmag.com) completes the OECD report. Neither document specifically addresses ICT R&D.

However, although they are not specific, several qualitative factors in the reports should be underscored.

4.4.1 - What is the outlook for R&D growth in non-OECD countries?

Indicator 4.3 below shows the growth rate of business R&D in several non-OECD countries.

Indicator 4.3 – Growth rate of business R&D

(2004-2005) Growth rate of business R&D

China India Singapore Russia Israel South Korea Taiwan Brazil

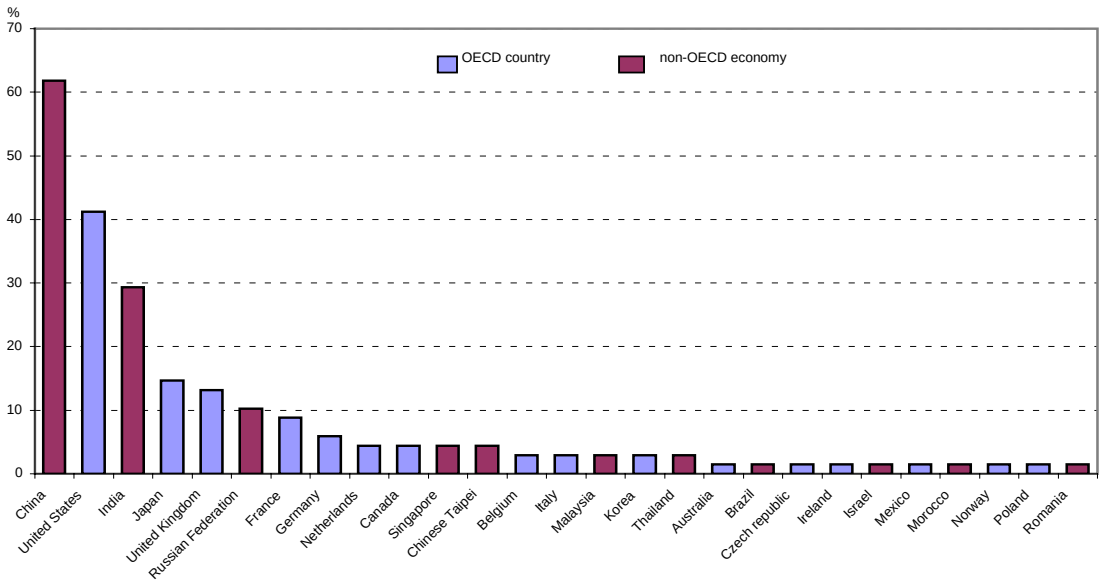
First, the growth rates are in line with the growth rates of their respective economies, on the whole. But notably, R&D growth rates in non-OECD countries are consistently much higher (except in the case of Brazil) than the reported growth rates for the 9 OECD countries that were studied in the first part of this paper.

This means that not only are these non-OECD countries already producing a sizeable share of the global R&D (and specifically of the ICT R&D) **but**, due to this growth differential, ***the non-OECD countries (if growth continues at this rate) will also eventually be generating in 5 to 8 years ICT R&D volumes very similar to the volumes reported for all the developed countries. The build-up of ICT R&D in the non-OECD countries is hardly marginal and, in the short run, not taking account of the ICT R&D in these countries would mean seriously underestimating global ICT R&D volumes.***

4.4.2 - R&D in emerging countries: sharply different appeal depending on the country

Indicator 4.4 below (from *OECD Science, Technology and Industry Outlook 2006*) shows the results of an UNCTAD survey of a panel of western R&D department executives and measures (% of answers) their R&D location priorities in non-OECD countries.

Indicator 4.4. – Most attractive R&D locations in non-OECD countries



Unsurprisingly, China and India stand out as the most attractive R&D locations in the emerging countries. Both countries combine the advantage of boasting a strong market potential and the largest mass of well-trained researchers able to participate in offshore R&D activities. The correlation between the extent of the appeal of non-OECD countries and the size of their research population is clearly highlighted in indicator 4.5 below (from 2007 Global R&D Report, R&D Magazine, September 2006).

In the indicator, the abscissa gives R&D intensity measured by the GERD as a % of GDP and the ordinate the number of scientists and engineers per million people in a given country. The size of the circles reflects annual amount of R&D spending per country noted. Countries such as Israel, Sweden,

and Finland already show very high R&D intensity levels (more than 3% of GDP), leaving limited room for advance, for the sustained growth of (ICT and other) R&D activities.

On the other hand, countries such as China, India, and Brazil have huge ‘pools’ of researchers, whereas their R&D intensity is still weak (to the order of 1%), leaving a high margin of potential for the development of R&D (in general, and of ICT R&D in particular) in the upcoming years.

Indicator 4.5. – World of R&D 2005

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