csti Conseil Stratégique des Technologies de l'Information

STRATEGIC ADVISORY BOARD ON INFORMATION TECHNOLOGY

RESEARCH AND DEVELOPMENT IN INFORMATION SCIENCE AND TECHNOLOGY IN LARGE INDUSTRIALISED COUNTRIES

- STATISTICAL ANALYSIS OF INVESTMENTS
- REGULATORY AND FISCAL ASPECTS

SUMMARY REPORT

Canada, South Korea, the United States, Japan, the European Union, including Germany, Spain, Finland, France, Italy, the Netherlands, the United Kingdom, Sweden

October 2003

Study carried out for the

Strategic Advisory Board on Information Technology (CSTI, **Conseil stratégique des technologies de l'information**)

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The Strategic Advisory Board on Information Technology (CSTI) is chaired by French Prime Minister. Composed of leading entrepreneurs from industry and R&D, it is responsible for presenting recommendations to Government concerning major orientations in the field of information technologies.

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Contents

1 – Introduction

This summary report covers the main data and conclusions of the study entitled "R & D in Information Sciences and Technology and Communication (ICT) in the large industrial countries: statistical analysis of investments, regulatory and fiscal aspects, and patent indicators", carried out by the CSTI in December 2002 on the basis of an initial attempt to make a comparative analysis of public and private investment in the developed countries, the conclusions of which had been published in April 2002. The complete results of this study may be found in the main body (volume 2) and the appendices (volume 3) thereto.

There were two main objectives for this study:

1) to obtain an evaluation as recent as possible of investment volumes and trends, be they public or private, in ICT R&D in 12 large industrialized economies (the United States, Canada, Japan, Korea, France, Great Britain, Germany, Italy, the Netherlands, Sweden, Finland and Spain) ;

2) To assess the impact of the indirect support measures such as tax abatements on research. In addition to assessing these indirect funding methods, this part of the study sought to identify the fiscal and regulatory frameworks and their impact on ICT. For this purpose, only four countries were examined: the United States, Canada, the United Kingdom, and Germany.

The third part of this study, the use of patent statistics to pinpoint investment output in ICT R&D in terms of industrial innovation, shows that patent statistics constitute a fairly poor indicator in this regard, since there is a complex, non-linear relationship between R&D investment and patented industrial inventions. The poor results of this "patent statistics" part are not described here but may be found in the main section of the study.

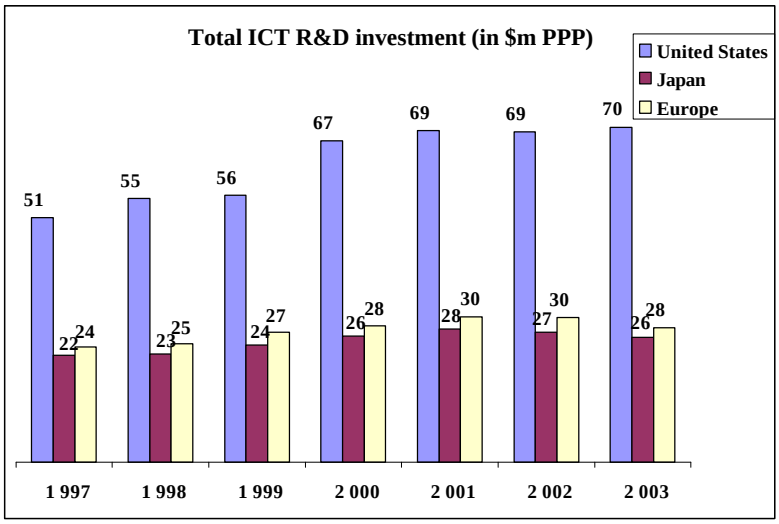
As for all statistical studies, these data and analyses are only of worth insofar as transparent, reliable measurement methods have been used. In this regard, the reader may consult the methodological abstract appended to this summary, or the detailed note on methods in the main part of the study, to gain knowledge of the main hypotheses on which the data are based.
Notwithstanding such limits, this report raises questions worthy of further study. Some of these are as follows:

- What are the ultimate consequences – economic, geopolitical, or social – of the overwhelming, nonetheless increasing, domination of the United States in ICT R&D?
- Can Europe, which today is falling behind despite the fact that it is a virtual "great power" in terms of human potential for ICT R&D, place all its scattered R&D forces behind a single, unifying industrial project at continental level, as such contrasting countries as Finland and Korea have done?
- Can the non-optimal balance between public and private funding in Europe – and France in particular – be improved? If so, how?

This study makes no claim to answer such questions, but merely raises them, on the basis of diagnoses drawn from the data which give a reasonable assessment of the relative scale and trends in a comparative international arena. Our goal would be achieved if this study led to the wide debate its conclusions call for, far beyond quibbles over figures but nevertheless using figures as an essential element in such debate.

Finally it should be noted that in our study, the values expressed by a monetary unit are in PPP (purchasing power parity) dollars. This is because for international comparisons it is essential not to refer to a unit in ordinary currency ($ or €) but to take account (using the PPP approach) of the true strength of a currency.

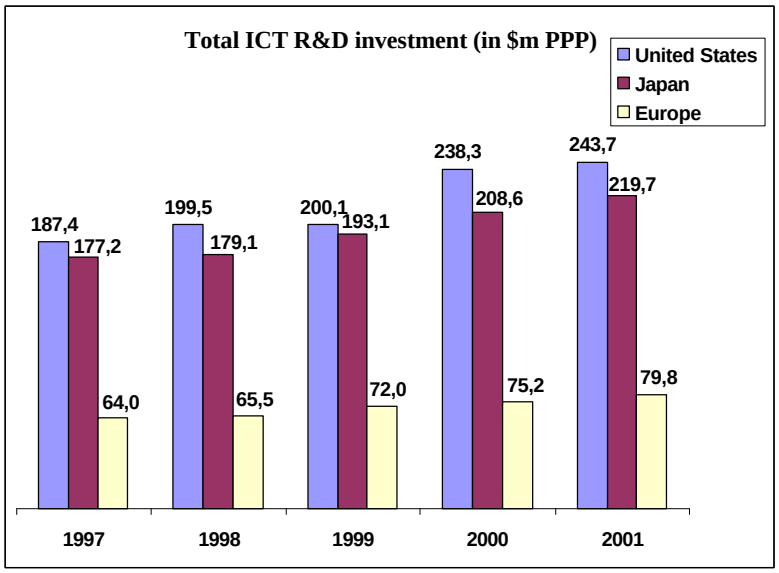
2 – In absolute value, ICT R&D investment in the United States is twice that of Europe and Japan



➔ In absolute value, the total investment in **ICT R&D made in the United States** ($51 bn in 1997, **$70 bn in 2003)** is **consistently more than double that of Europe** – 15 members – ($24 bn PPP in 1997, **$28 bn in 2003**)

Between 1997 and 2003, the gap between the United States and Europe increased by over 50%.

3 – In Europe, ICT R&D investment is three times less than in Japan and the United states in terms of expenditure per inhabitant, and 2 times less as a percentage of GDP

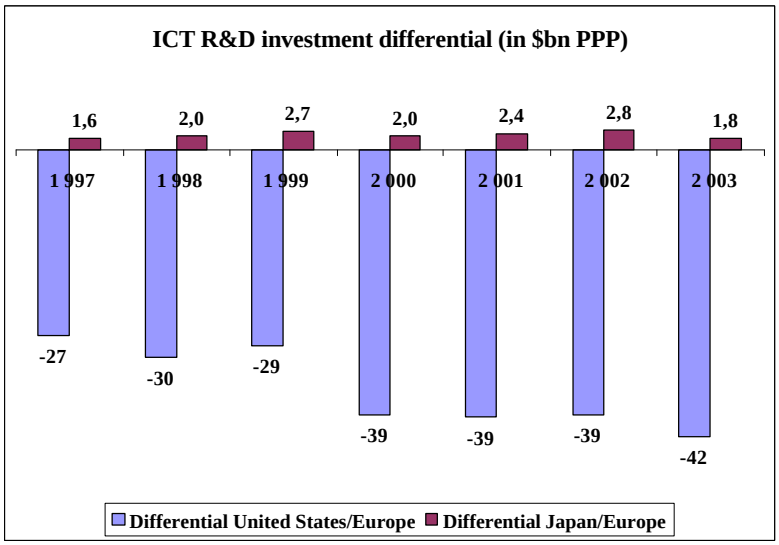


➔ **Japan and the United States spend some $200 PPA per inhabitant in ICT R&D, as against about $75 PPP in 15-member Europe.** Moreover, while this expenditure per head rose by 30% in the United States between 1997 and 2003, it rose only 25% in Europe. The same divergence can be observed for the **ICT R&D ratio with GDP but here the relation is 1 to 2 between Europe and the two other economies.**

4 – The differential for European ICT R&D investment intensity is more marked than that for R&D as a whole

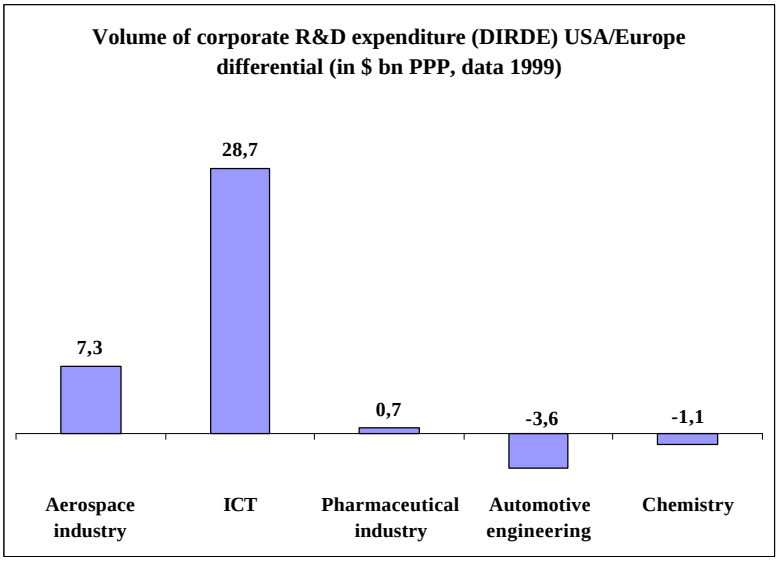
There is a greater gulf between the United States, Europe and Japan as regards the ICT R&D differential than there is for R&D as a whole. The R&D intensity differential (measured in expenditure per inhabitant) is 1 to 2 in favour of the United States overall. It is 1 to 3 for ICT R&D. The same can be observed for Japan.

5 – The gap is widening between Europe and the two other economies in ICT



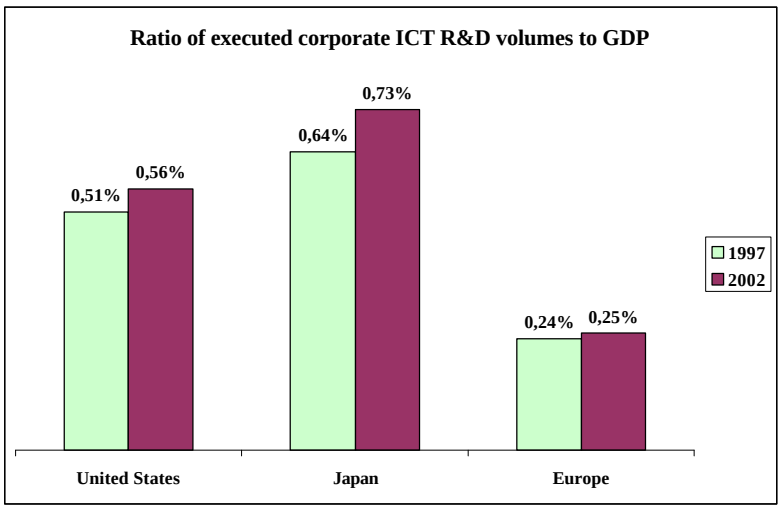
➔ The differential between American and European investments in ICT R&D is gradually widening, since in absolute value it has **grown from –27 to –42 billion dollars.** While in the United States investment rose 37% from 1997 to 2001, it rose a mere 16 - 17% in Europe and Japan. However, it has already been noted that ICT R&D in Japan per head is extremely high.

6 – ICT R&D is the only sector in which such a huge difference can be observed between Europe and the other large economies.



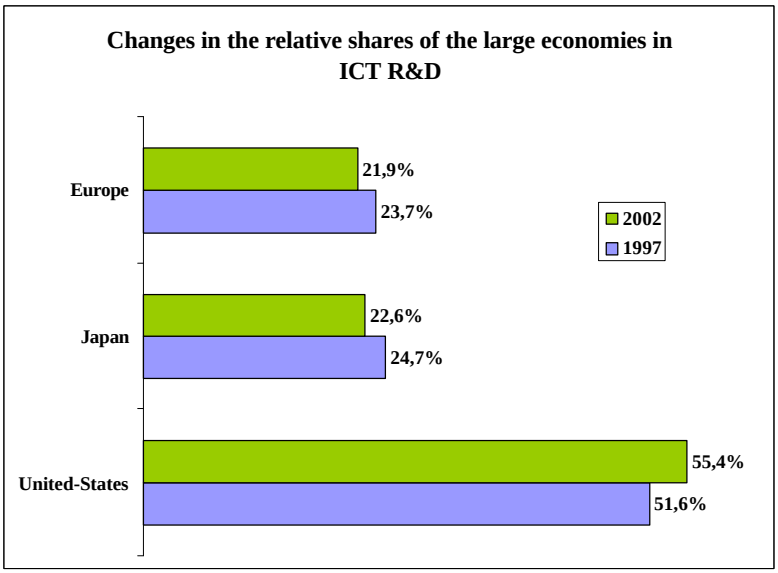
➔ **In no other technological R&D sector can such a huge negative difference be observed**, despite the fact that ICT is "empowering technology" which has a direct impact on performance in all sectors of activity.
Moreover it should be noted that apart from the aerospace industries (because of the military component) this hierarchy in the balance of R&D is a fairly accurate reflection of the external trade balance.

7 – Insufficient investment in ICT R&D by European business as a whole is the vital variable that can explain these differences.



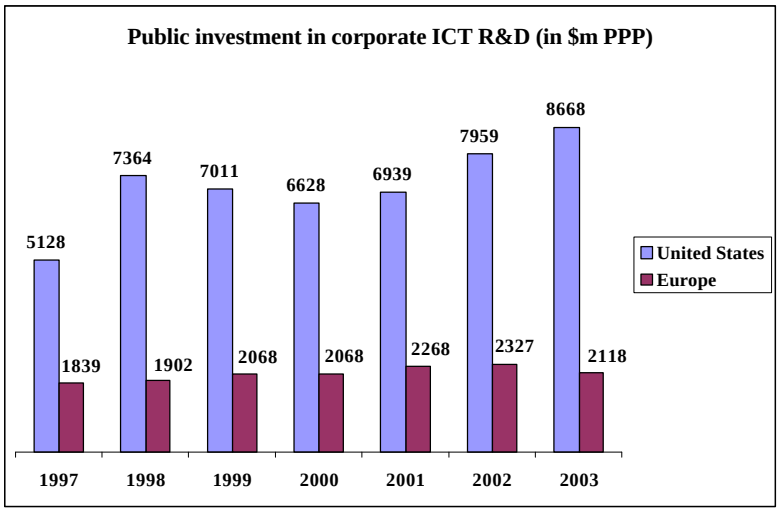
➔ The structure of investment in ICT R&D in the United States closely resembles that of Europe, with private credits amounting to some 82% as against 18% for public. In Japan State investment is even lower. However, despite the similar structures, European businesses invest two times less in ICT R&D than those in the United States, and three times less than Japanese businesses.

8 – The erosion of the European and Japanese shares of global investment in ICT R&D has been favourable to the United States.



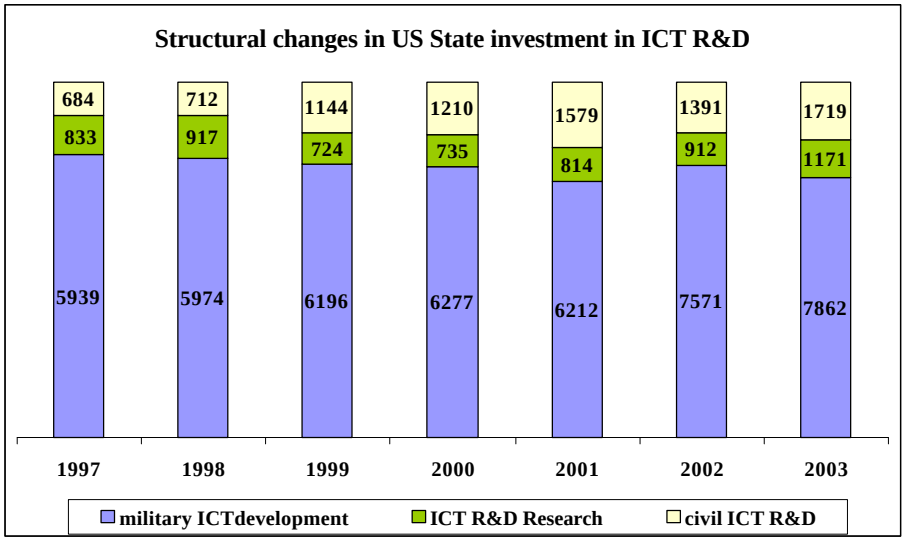
➔ The fall in the relative percentage of European and Japanese investment in global ICT R&D funded by business is roughly the same (-2 points loss of relative share). These four points are precisely the amount by which the relative share of American investment in ICT R&D has increased.

9 – The exceptional volume of public investment in ICT R&D accruing to American companies is the main reason for this

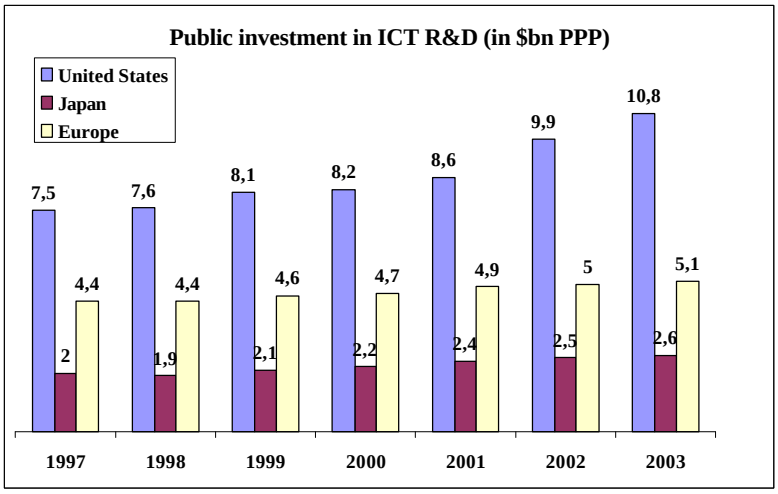


➔ The amount of public funding of ICT R&D in American companies, a large percentage of which is in defence, is the main reason for this. Military investment has always driven American R&D policy, especially in the ICT field. However, it has been stepped up markedly in recent years.

However, the fact that Japanese investment is high, albeit declining, without massive public funding of private R&D, shows that the American model is only one scenario among others for private-public associations and is due to the necessities of American military policy.

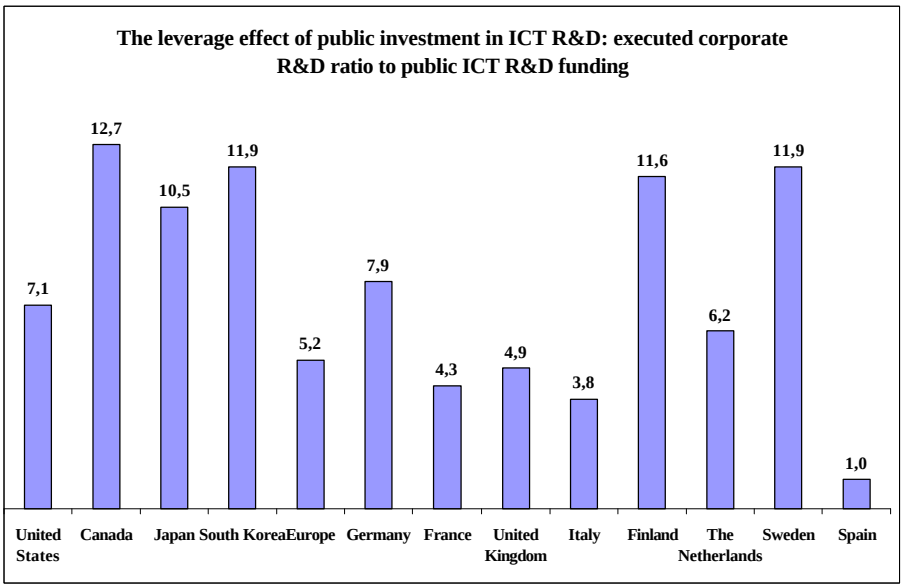


10 – Public investment in ICT R&D: Europe performs better, but the basic scenario remains the same



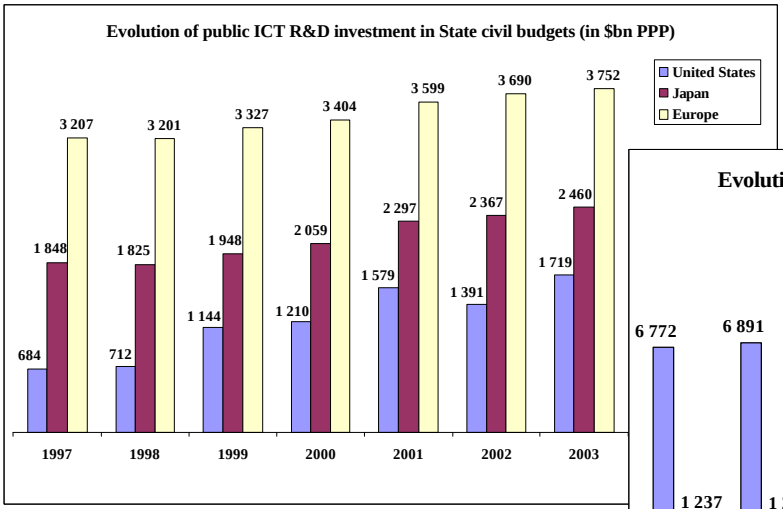
➔ Changing patterns of public investment in ICT R&D have changed the ranking of overall investment. Because its public investment in research in industrial technology (not including the aerospace industry) is low, Japan falls to third place. However, Europe is still only second, with a gap of 30% less investment than the United States between 1997 and 2003, and Japan shrank the gap between it and Europe by 16%.

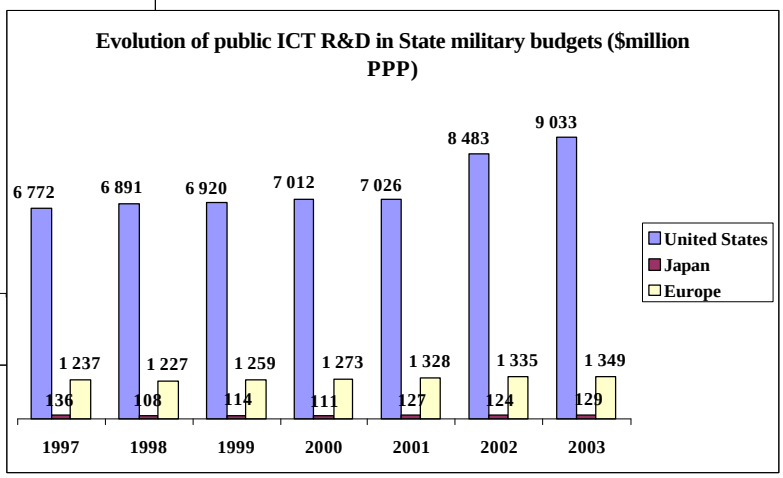
11 – The leverage effect of public ICT R&D investment on private funding is relatively insufficient in Europe, except in Finland and Sweden.



➔ The differential is lower in public investment in ICT R&D than in private. In this respect, Europe performs twice as well as Japan, and the differential with the United States is only 1 to 2.
Public and private investment levels are quite symmetrical. However, while public investment is considered to stimulate private investment, it must be said that there is $10.5 of private investment in Japan for every $1 of public investment, whereas $7.1 and a mere $5.2 are invested in the United States and Europe, respectively.

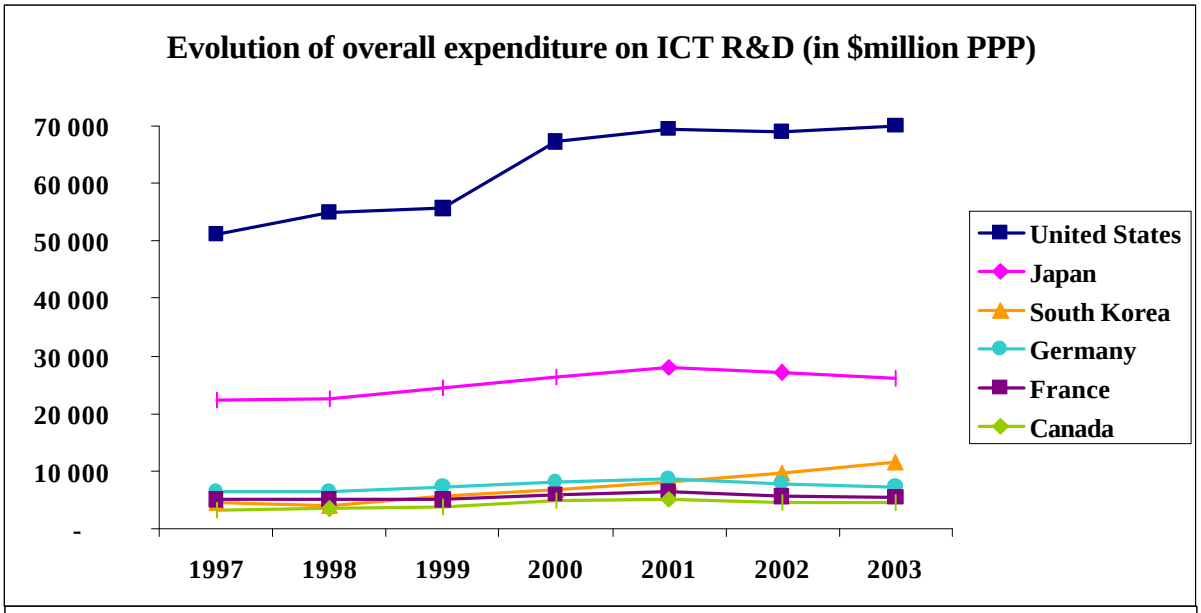
Thus, the problem with the European model is well and truly the overall volume of ICT R&D, and also the interaction of public funding with the industrial fabric and the return on investment in terms of innovation.

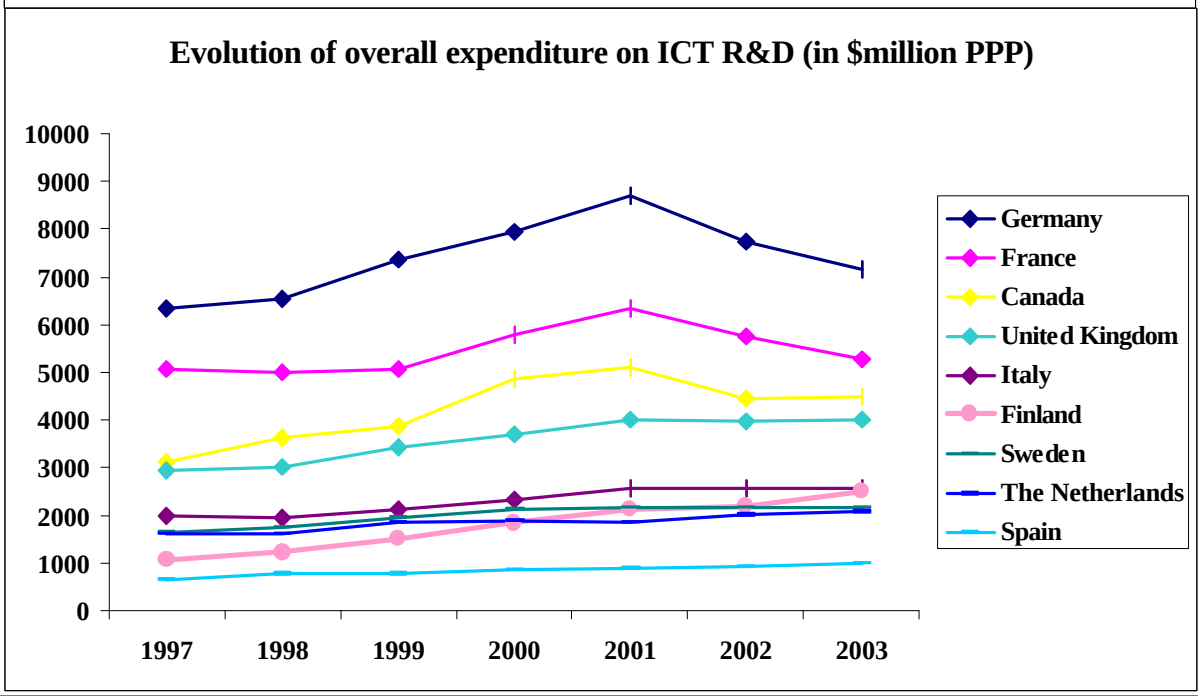




12 – ICT R&D types which differ greatly from one country to another in the 12 sampled

➔ **Outright leaders:** these are, of course, Japan and the United States. The latter accounts for a 50% relative share of world investment in ICT R&D, an increase of 1 point over the period. *However, Japan's relative share fell slightly*. On a lower scale in terms of absolute value, *Korea was gradually catching up on Japan*. Finland, showed the same "winning" profile but this was less clear in relative share due to the small volumes in absolute value.





➔ **The rest of the pack** is formed by a mixed bag of all the other countries the relative share of which is under 10%. However, their profile is not homogeneous. The large continental European economies (France and Germany) saw their relative shares slide over the past 7 years, with their ICT R&D volumes growing by 4% (France) and 13% (Germany), while the average for the 12 countries examined was 35%. Other countries such as the United Kingdom, Italy and Sweden, scored 20 points more and fell overall within the group average. 15-member Europe as a whole did much less well than these dynamic member States since the increase over the period was 16%; almost 20 points below the average.

13 – Contrasted public policies for ICT R&D in the twelve countries

The public funds allocated to ICT R&D increased by an average 41% between 1997 and 2003 for the twelve countries studied, but by only 15% for 15-member Europe. In some of these countries (including France, the United States, the United Kingdom and Europe as a whole) there was a distinct discrepancy between the relative good health of State-funded R&D and the paucity of private investment, as shown right.

➔ **Countries with average value**: not counting the voluntaristic countries (see below) it can be observed that only France, Italy and Japan were less than 10% below the 12-country average of 41%.

➔ All the other countries were **lagging behind**: Germany (+10%), the United Kingdom (+ 12%), and The Netherlands (+ 18%) recorded figures distinctly below the average growth in State ICT R&D budgets

There is a difference between the relative global share of public investment in ICT R&D and the relative share of private investment. A positive indicator means that there is an imbalance between public and private ICT R&D volumes.

United States	**3,3%**
Japan	**-6,3%**
South Korea	**-2,3%**
Germany	**-0,5%**
France	**3,1%**
Canada	**-1,6%**
United Kingdom	**1,4%**
Italy	**1,6%**
Finland	**-0,6%**
Sweden	**-0,6%**
The Netherlands	**0,3%**
Spain	**2,4%**
European Union	**9,0%**

Changes in public investment in ICT R&D

	1997	1998	1999	2000	2001	2002	2003
United States	100	102	108	110	115	132	144
Japan	100	97	104	109	122	126	131
Germany	100	99	103	107	111	109	110
France	100	101	102	122	141	136	139
United Kingdom	100	89	95	100	106	109	112
Italy	100	100	95	119	136	143	150
Canada	100	100	106	112	114	114	115
South Korea	100	114	129	154	190	212	233
The Netherlands	100	99	103	104	115	117	118
Spain	100	145	149	174	250	263	289
Finland	100	102	105	108	113	117	119
Sweden	100	102	115	147	187	211	222
Total	*100*	*101*	*107*	*113*	*122*	*133*	*141*
European Union	100	100	103	105	111	113	115

Voluntaristic: these are the countries with growth above the average for the twelve countries in public investment in ICT R&D. In this group of front runners are Korea with 133%, Sweden (122%) and the United States (44%).

14 – Contrasting public ICT R&D policies as regards support for businesses

The more or less active public policy for ICT R&D funding can also be seen in State backing of corporate R&D. Although the United States is the front runner in terms of absolute value, way ahead of France, Germany and the United Kingdom, the changes in index value differ markedly between the United States, Korea, Finland, Spain and the United Kingdom, where the ICT R&D funding for companies has increased sharply. All the other countries, including France, have seen private investment in ICT R&D stagnate or fall, even though in certain countries like France or Canada, public funding showed that an aggressive policy had been adopted. However, this benefited mostly State research institutions.

Volume of public ICT R&D funding in companies

	1997	1998	1999	2000	2001	2002	2003
United States	5 128	7 364	7 011	6 628	6 939	7 959	8 668
France	555	519	572	632	671	587	523
Germany	552	533	535	546	588	557	547
United Kingdom	303	330	405	440	463	475	488
Italy	239	210	215	252	303	249	244
South Korea	218	237	318	461	490	510	510
Canada	146	137	120	158	175	127	124
The Netherlands	79	73	73	72	73	74	72
Spain	44	40	37	45	41	74	72
Finland	38	49	63	74	75	70	71

Changes in public ICT R&D funding in companies

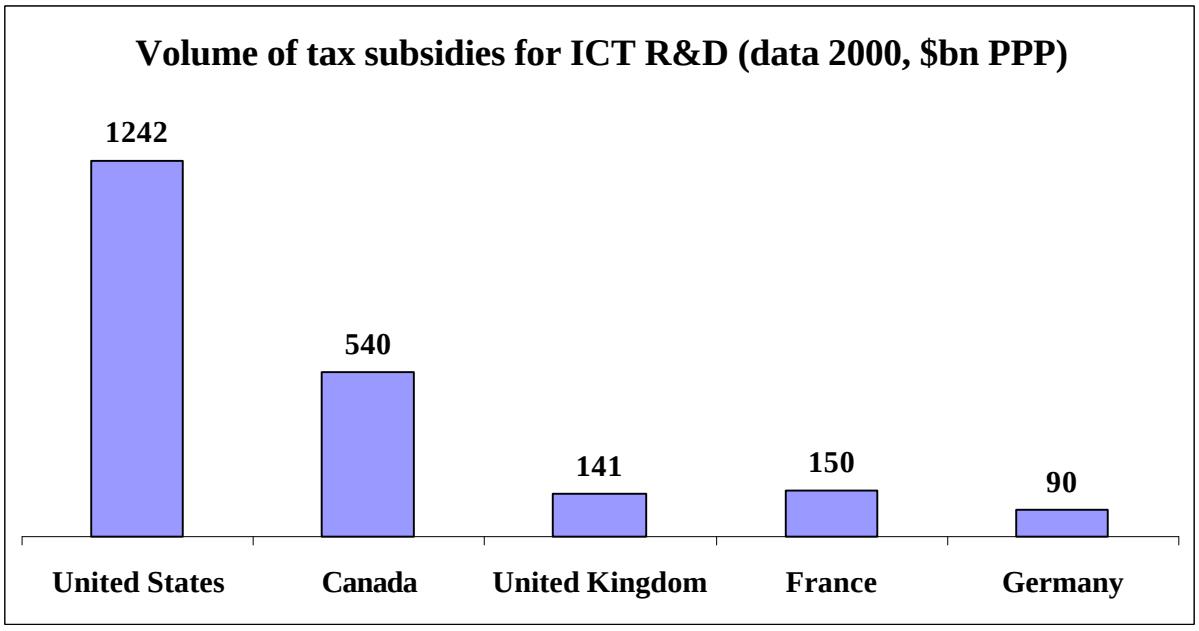
	1997	1998	1999	2000	2001	2002	2003
United States	100	144	137	129	135	155	169
France	100	94	103	114	121	106	94
Germany	100	97	97	99	107	101	99
United Kingdom	100	109	134	145	153	157	161
Italy	100	88	90	105	127	104	102
South Korea	100	109	146	211	225	234	234
Canada	100	94	82	108	120	87	85
The Netherlands	100	92	92	91	92	94	91
Spain	100	91	84	102	93	168	164
Finland	100	129	166	195	197	184	187

15 – The sharp fall in its indirect fiscal aids for corporate R&D sets France apart from the other large developed countries

Indirect funding, mostly comprising tax inducements, amplifies direct funding from public or private sources and plays a significant role in the interaction between public and private investment and corporate R&D levels. Although no country has a fiscal inducement mechanism specifically tailored for ICT R&D, **the latter is nevertheless always the first to benefit from these indirect tax measures, which, depending on the country, represent between 20 and 45% of the total cost of tax relief on R&D .**

In countries with a federal system such as the United States and Canada, local tax measures are added to the federal aids. Thus, in the United States, ***on top of the $753 million federal tax inducement there are $489 million from the states. Thus, the total state and federal tax subsidy for ICT R&D amounted to indirect aid of some 1.24 billion dollars***. Indirect tax subsidies for the period between 1997 and 2000 represented hidden funding worth 19% of the already considerable direct US funding of corporate ICT R&D. In 2000, Canadian corporate ICT R&D received a "tax subsidy" of $540 million PPP, via federal and provincial tax measures that are among the most favourable in the world. This should be placed alongside the $153 million PPP direct funding of ICT R&D for Canadian companies in the same year. It can also be noted that in the United Kingdom and Germany, albeit to a lesser degree than in the United States and Canada, fiscal support for R&D, and ICT R&D more especially, is growing.

In complete contrast with this global trend, France in the last ten years has seen a distinct decline in tax treatment in favour of R&D, with the same regulations in force, due to the fall in the number of companies allowed tax rebates on research in relation to the number of applicants. **This fall is reflected in all the indicators: number of companies benefiting divided by 2.6; total amount of "research tax relief" divided by 1.43.** This lessened impact of the tax lever is all the more worrying as direct public funding of corporate R&D fell from 19.8% in 1990 to 9.9% in 2000. This is unique to France. **Because it is the largest beneficiary of the tax measures (27% of the total amount of tax relief for research), the ICT sector is also the first affected by this fall in indirect fiscal support of R&D.**



16 – Estimation of ICT R&D investment in twelve countries: main methodological hypotheses

There are fearsome methodological problems when setting up a data base on ICT R&D investment in twelve countries, using the OECD R&D statistics, which are the only statistical references enabling international comparisons to be made but which are designed only for "sectoral" analysis. The data presented in this study are entirely based on a series of hypotheses using the all-purpose statistics of the OECD. **The purpose of this study was to reduce the uncertainty of the data by iterative refining of these hypotheses. As a result, it appears that the residual uncertainty in the values used is around 15%.** However, given that the relative impact of this uncertainty is the same for all the countries studies, it affects neither the hierarchy between countries nor the trends observed over seven years (1997-2003).

The first methodological difficulty was to define the ICT sector. We used the only standard international definition for corporate ICT R&D, which was decided in a series of OECD works. This defines the ICT sector using five activity codes borrowed from the international ISIC/CITI3 classification drawn up by the UN (Division: 30 - manufacture of office machines, accounting machines and IT equipment; Division: 32 - manufacture of radio, television and communication equipment and apparatus; Division: 33 - manufacture of medical, precision, optical and clockwork instruments; Division: 72 - IT activities and associated activities; Division: 64 – post and telecommunications, group 642 – telecommunications). These codes and subdivisions give a far from full description of the ICT field as a whole and as it appears today, and therefore, the extent of R&D associated with this field is not fully defined either. However, it may be considered that the uncertainty as to the full extent of corporate ICT R&D under this imperfect definition is no more than 10%.

The second major methodological difficulty was to align in the same analytical framework the series describing corporate R&D expenditure that can be classified under the aforementioned activity nomenclature, and the series concerning public funding which today is only categorised by wide socio-economic objectives such as defence, environment, energy etc. The national or international statistics currently available to us offer no solution whatever to this problem. ICT R&D funding by the State was assessed by making hypotheses – calibrated through field study and checking of sources – of the incidence of ICT R&D in three of these socio-economic objectives:

- R&D funding for "Defence": depending on the country, ICT R&D was assessed on the basis of an incidence hypothesis of 10 –15% of the credits for that objective;
- funding for "industrial production and technology": the incidence of ICT R&D was hypothesised as being between 15 and 30%, that for most countries being selected at 20%;
- the general fund for universities (FGU). The incidence of ICT R&D in this budget was estimated at between 4 and 6%, the hypothesis chosen for most countries being 4 %.

The uncertainty resulting from these hypotheses on the incidence of ICT R&D in national budgets can therefore be estimated at 15% maximum.

Finally it should be noted that the aggregate domestic spending on R&D for ICT is a figure for execution within the national borders. However, this aggregate is built up as the sum of two data which are "funded":

- "ICT domestic spending on R&D funded by companies and others", including R&D investments executed within France and funded either by French private companies, by non-resident capital for foreign companies' R&D, or by non profit-making organisations. The latter are only important for the United States and have been assessed separately.
- ICT domestic spending on R&D funded by the State, which includes both civil and military ICT R&D.