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# THE "SWING OF THE PENDULUM" FROM PUBLIC TO MARKET SUPPORT FOR S&T:

*Who is leading the way?*

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# Structure of the Argument

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## 1. The perception today:

- the private side of R&D funding and performance dominates the S&T systems of the most advanced (technologically and economically) countries today;
- S&T and innovation are, it seems, pushed forward by private incentives.
- increasing reliance on market-based mechanisms to promote innovation

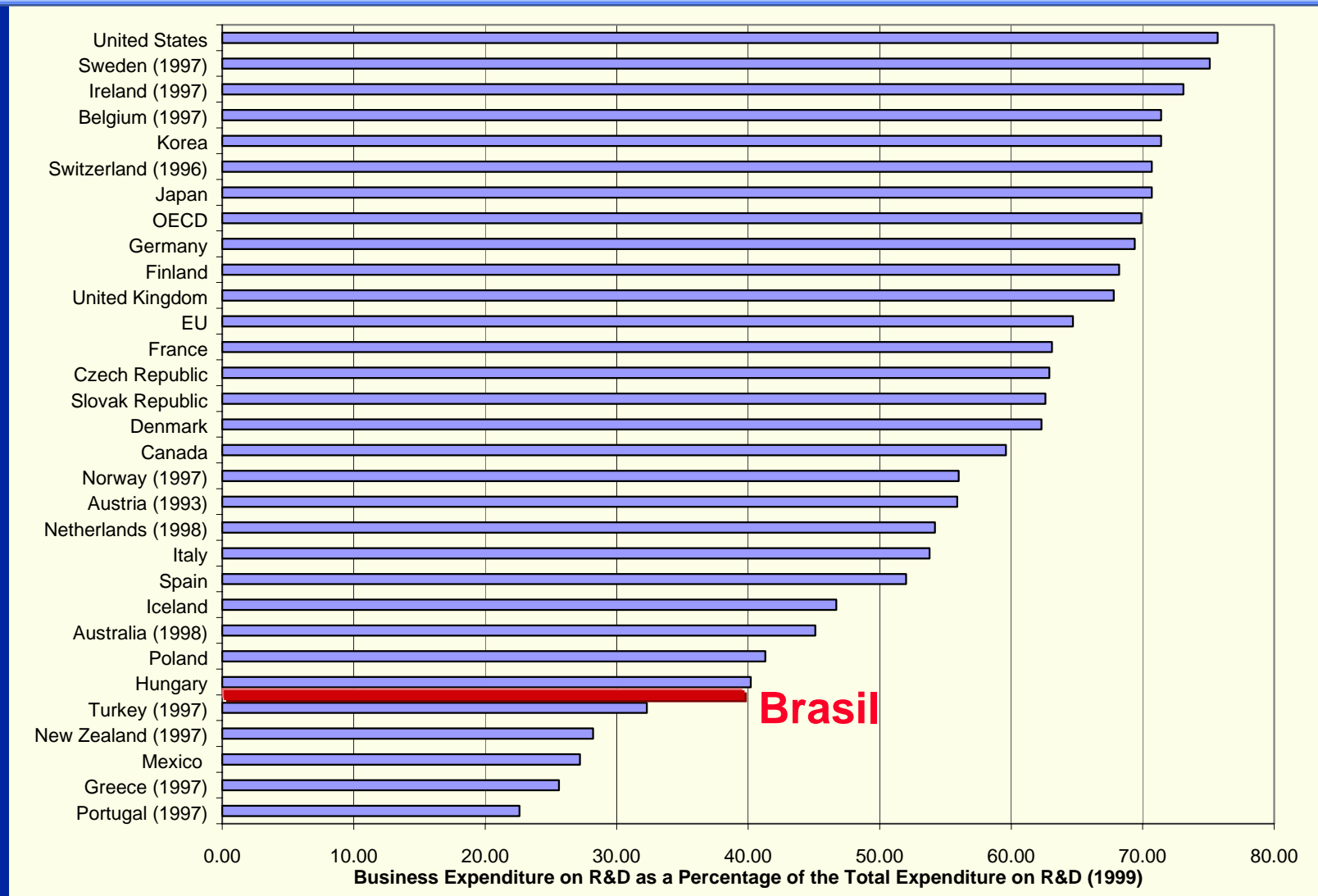
## 2. The analytical perspective on systems of incentives to promote science and technology

## 3. The historical analysis: looking at the trajectory of expenditure on science and technology in the US; there is a shift, but at the same time an “infrastructure” has been created

## 4. The structural analysis: looking at how expenditures are allocated across institutions and scientific areas shows that the “public has not pulled back” from core concerns

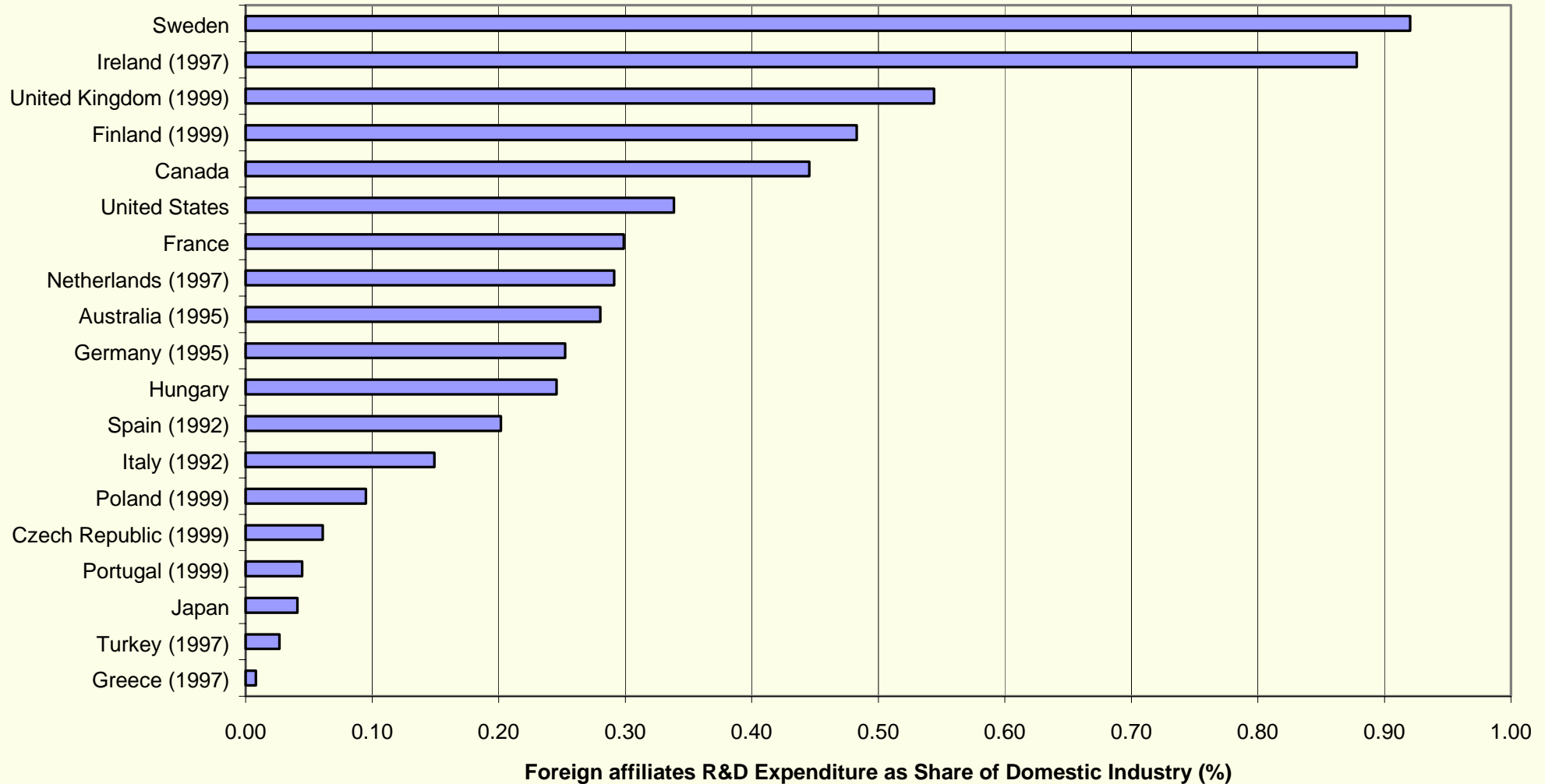
## 5. Policy implications: the role of diversification...

# The Perception - 1: **BERD / GERD**



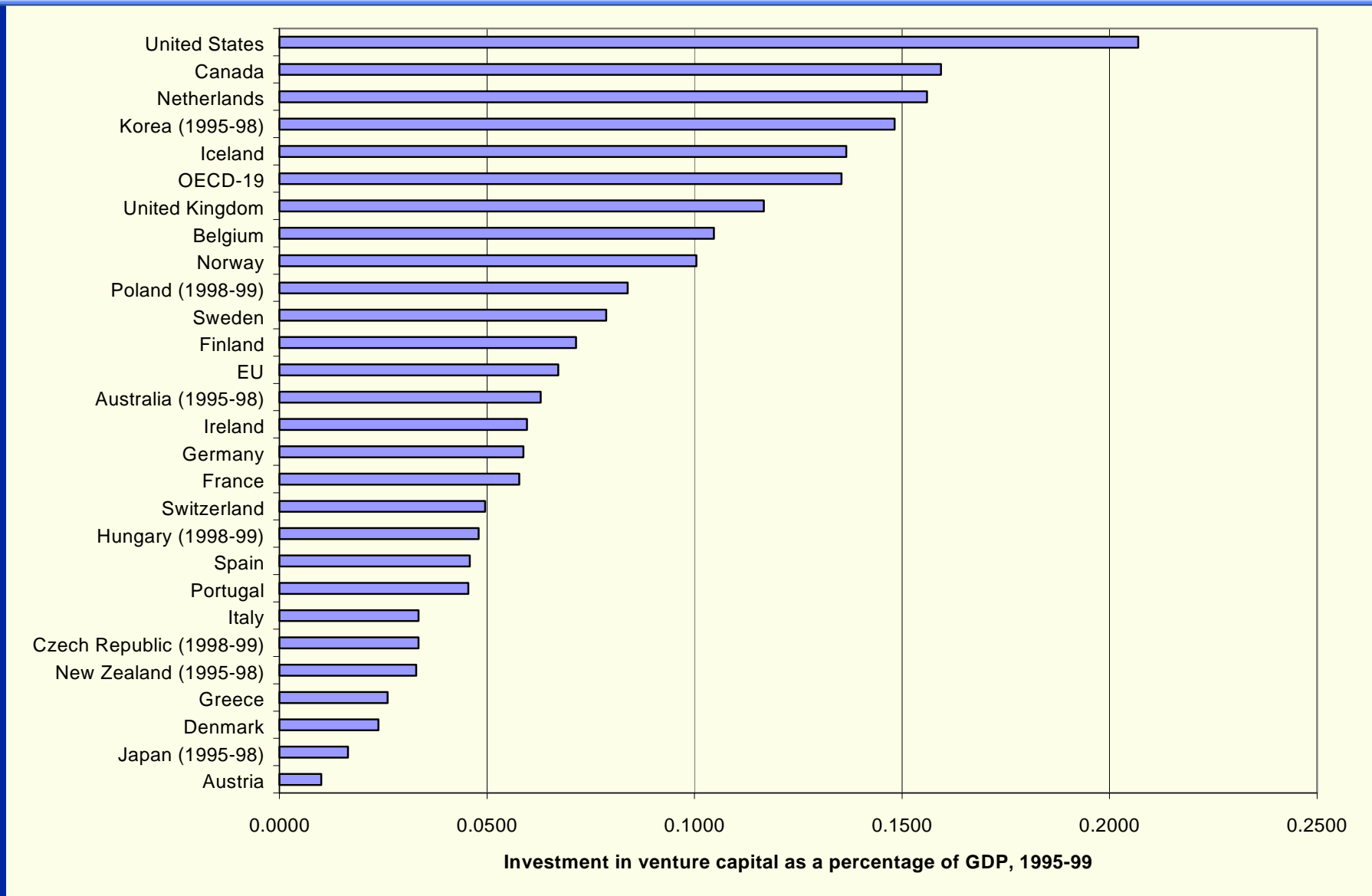
With the exception of the less developed OECD countries, business expenditure on R&D accounts for the majority of total expenditure, and has an overwhelming share (close or above  $\frac{3}{4}$ ) in the most developed countries

# The Perception – 2: Foreign affiliates



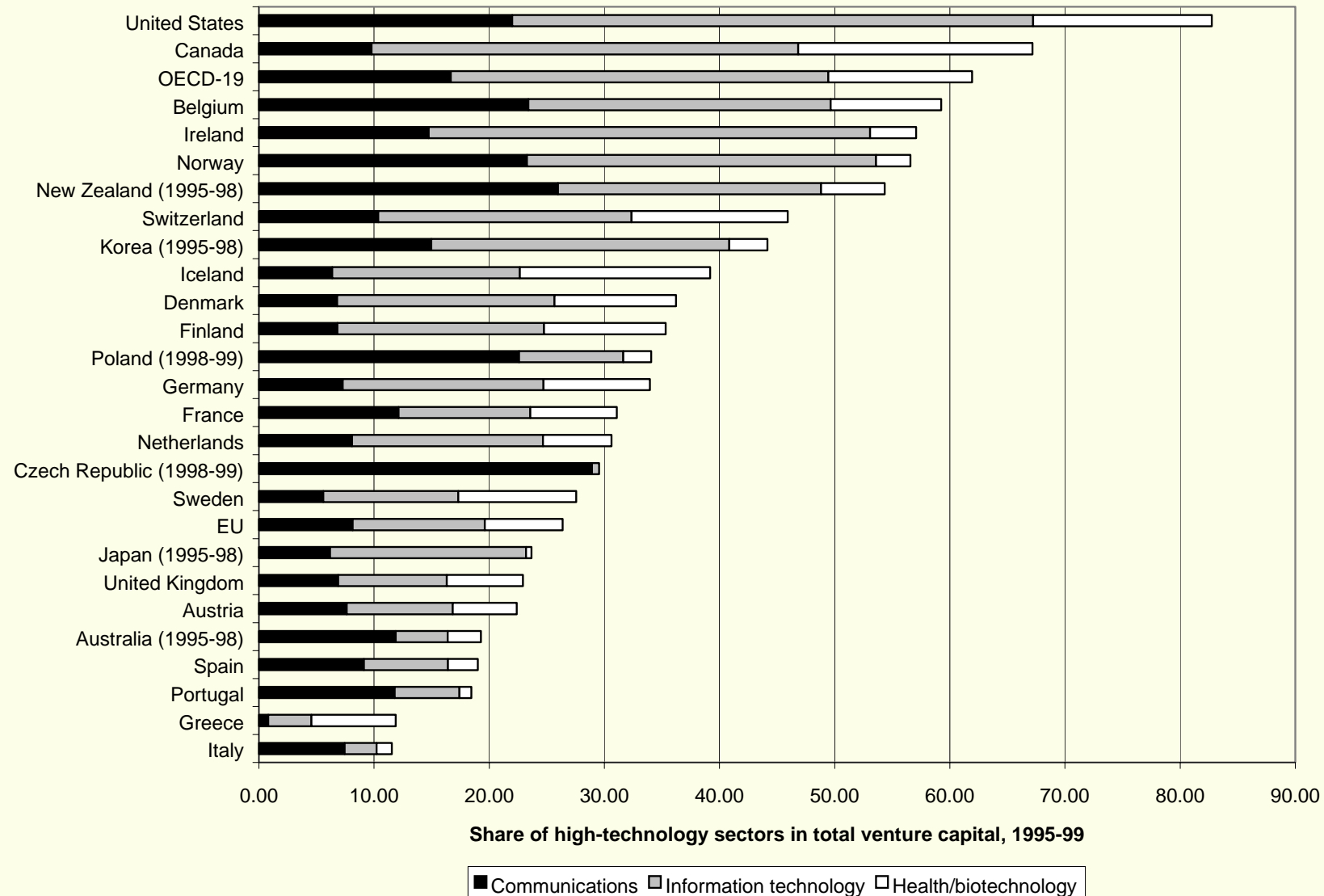
But, for some countries (Sweden, Ireland), the business expenditure is driven in large part by foreign affiliates, rather than domestic companies. In the US domestic firms are dominant.

# The Perception – 3: **Venture Capital**



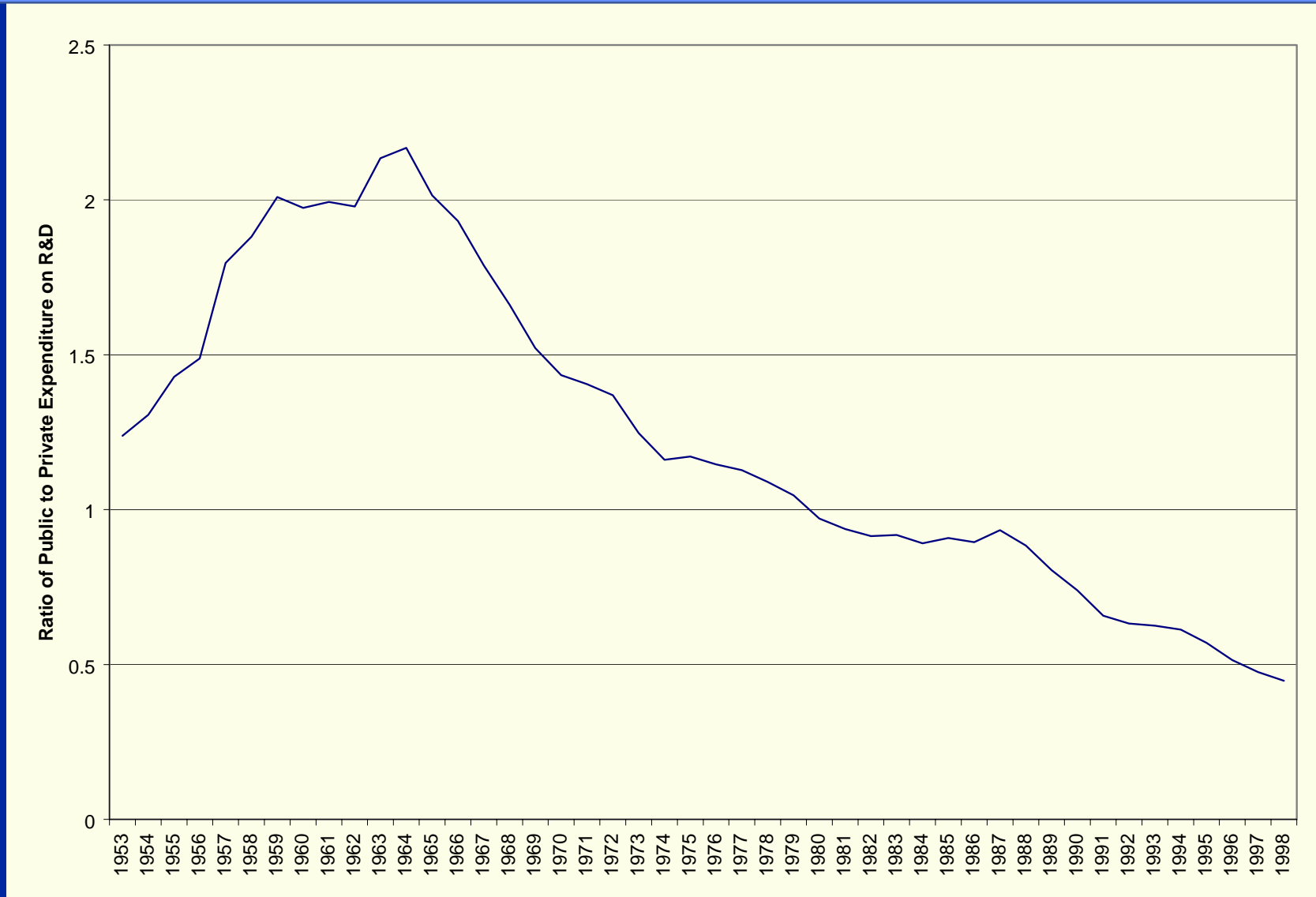
The US is also leading the way in innovation-promoting financial incentives such as venture capital...

# The Perception – 4: High-Tech Ventures



... but the US dominates much more pervasively when one considers the share of venture capital devoted to high-technology ventures.

# A Long-lasting and persistent trend



There is a persistent and long decreasing trend in the ratio of **public vs. private expenditure** in the US

# Private mechanisms for S&T : US

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Although there is a long tradition of supporting property rights in the US (it is part of the original US Constitution), in the 1980s and onwards there has been an increasing intensification of filings and granting of **patents**, namely due to:

- ➡ **The creation of a federal court focusing on patent litigation**
- ➡ **The Bayh-Dole Act**, which has permitted outcomes of federal-funded (publicly funded) research to be patented
- ➡ **The increase breadth of patent claims allowed by the US Patent Office**
- ➡ **Widening of national patent and intellectual property rights to the global level (namely through the WTO Trade-Related Aspects of Intellectual Property Rights, or TRIPS, agreements)**



# The empirical evidence...

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Analysis suggests that, at least in the case of the US, but increasingly in the OECD as a whole, the “pendulum” is swinging towards private incentives, and that this corresponds to the current economic and political demands of our time.

## Is this so?

**...this question is too simplistic!**

countries should not rush to emulate the apparent swinging of the pendulum towards private incentives.

# The Analytical Perspective - 1

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*The “standard” ways of promoting science and technology:*

- ➡ **Private incentives**, by awarding property rights to the creator, in which case private resources are devoted to innovative and scientific effort
  
- ➡ **Public incentives**, by publicly supporting science and technology, and requiring R&D results to remain public or to serve public purposes (as in defense procurement, for example)

# The Analytical Perspective - 2

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*Why do we not rely only on public incentives?*

- ➡ It is crucial to mobilize the creative and entrepreneurial capacity of individuals and firms
- ➡ The market is very effective at adapting, ameliorating and diffusing technologies
- ➡ Many firms, especially in specific sectors such as pharmaceuticals and semiconductors, currently hold a substantial part of the available scientific and technological capacity
- ➡ Public allocation of resources may not adequately meet the technological and business opportunities that may entice firms and individuals to engage in creative effort

# The Analytical Perspective - 3

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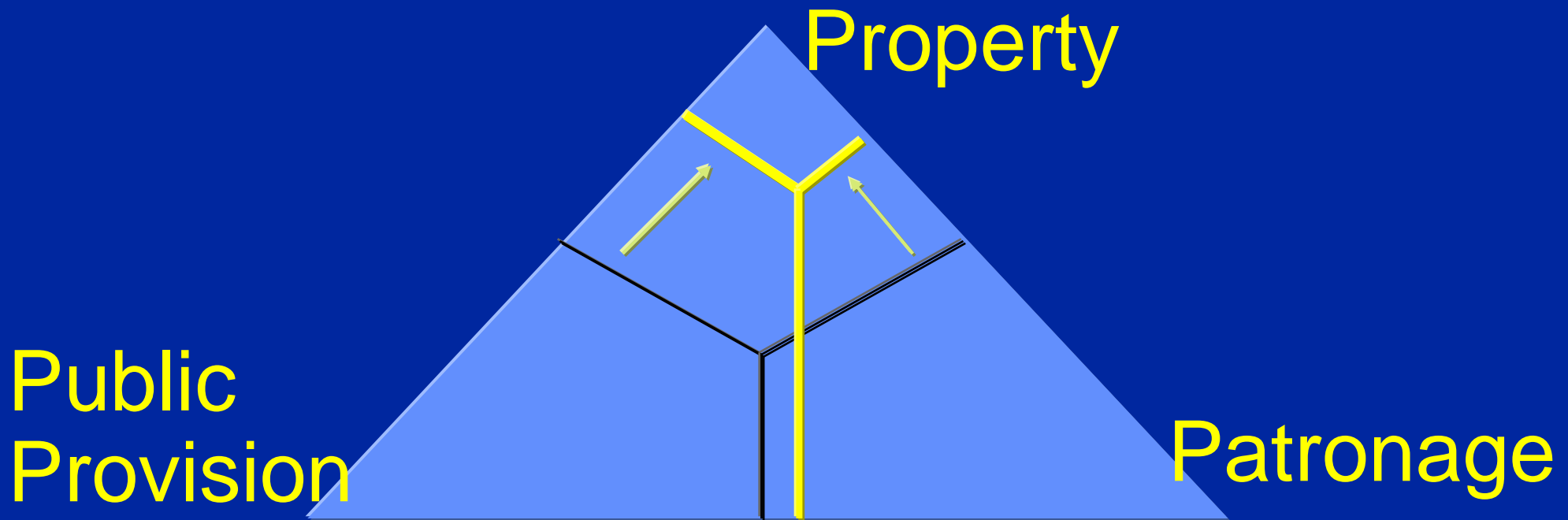
*Why do we not rely only on private incentives?*

- ➔ Externalities (spillovers) from new technologies entail that private investment is often sub-optimal
- ➔ The market may lack the incentives for “public good” types of objectives that require scientific and technological advancements
- ➔ Private incentives are inadequate to stimulate long-term, basic research
- ➔ The overall science and technological system relies on institutions and activities that are primarily publicly funded (universities, for example)

# A serious threat: “*the tragedy of the commons*”

...Paul David(2000)

ill-considered public support for expanding legal means of controlling access to information for the purpose of extracting **private economic rents** is resulting in the “over-fencing of the public knowledge commons” in science and engineering



The need for open, collaborative research...

# The Analytical Perspective - 4

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*What, then, is the right balance between private and public incentives?*

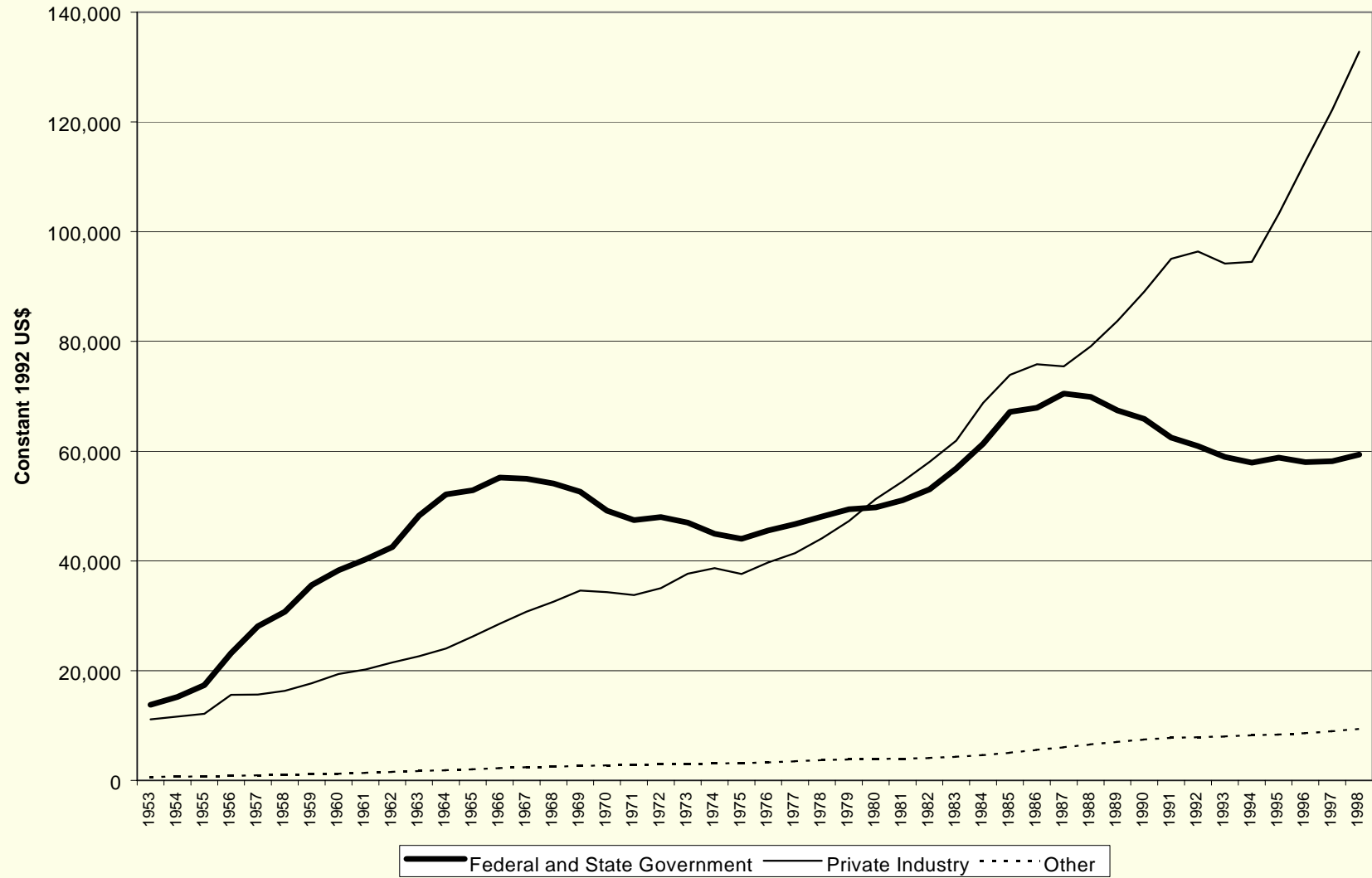
➔ At the conceptual level, it is difficult to answer this question, other than to say that there *should* be a balance, rather than going all the way to private or to public incentives alone

➔ Mostly an empirical question:

- Is the balance adequately meeting the **social and economic demands** for new science and technology, as expressed by economic and political expressions?
- Is the balance adequately facing not only our current demands, but making the **investments needed** to meet the challenges of the future?

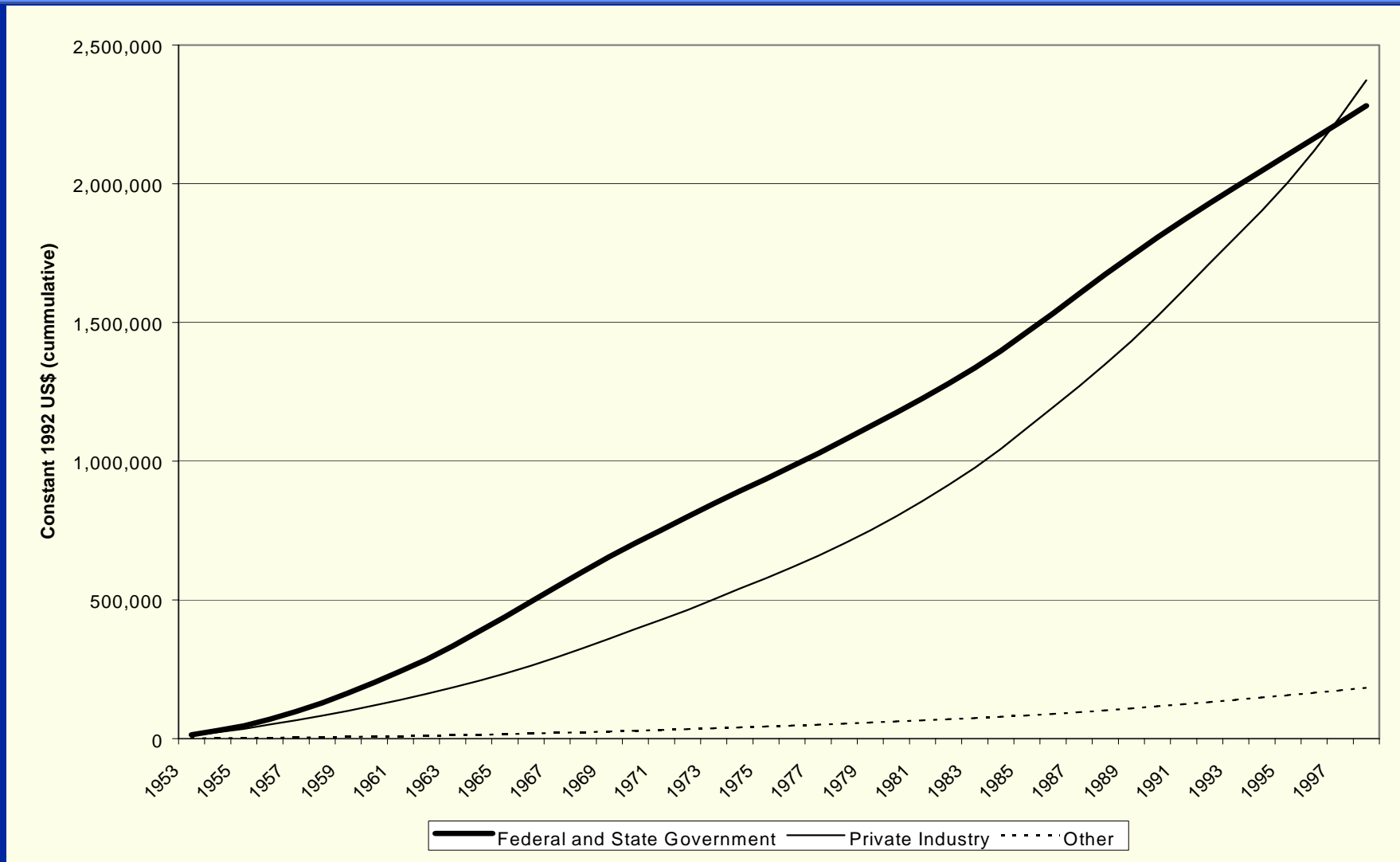
...see, for example, Paul Rommer (2000)

# The Historical Analysis - 1



Private spending on R&D has been on an increasing trend, while public spending has decreased (in real terms) from the highs reached in 1987 and has remained stable at around 60 billion through the 1990s.

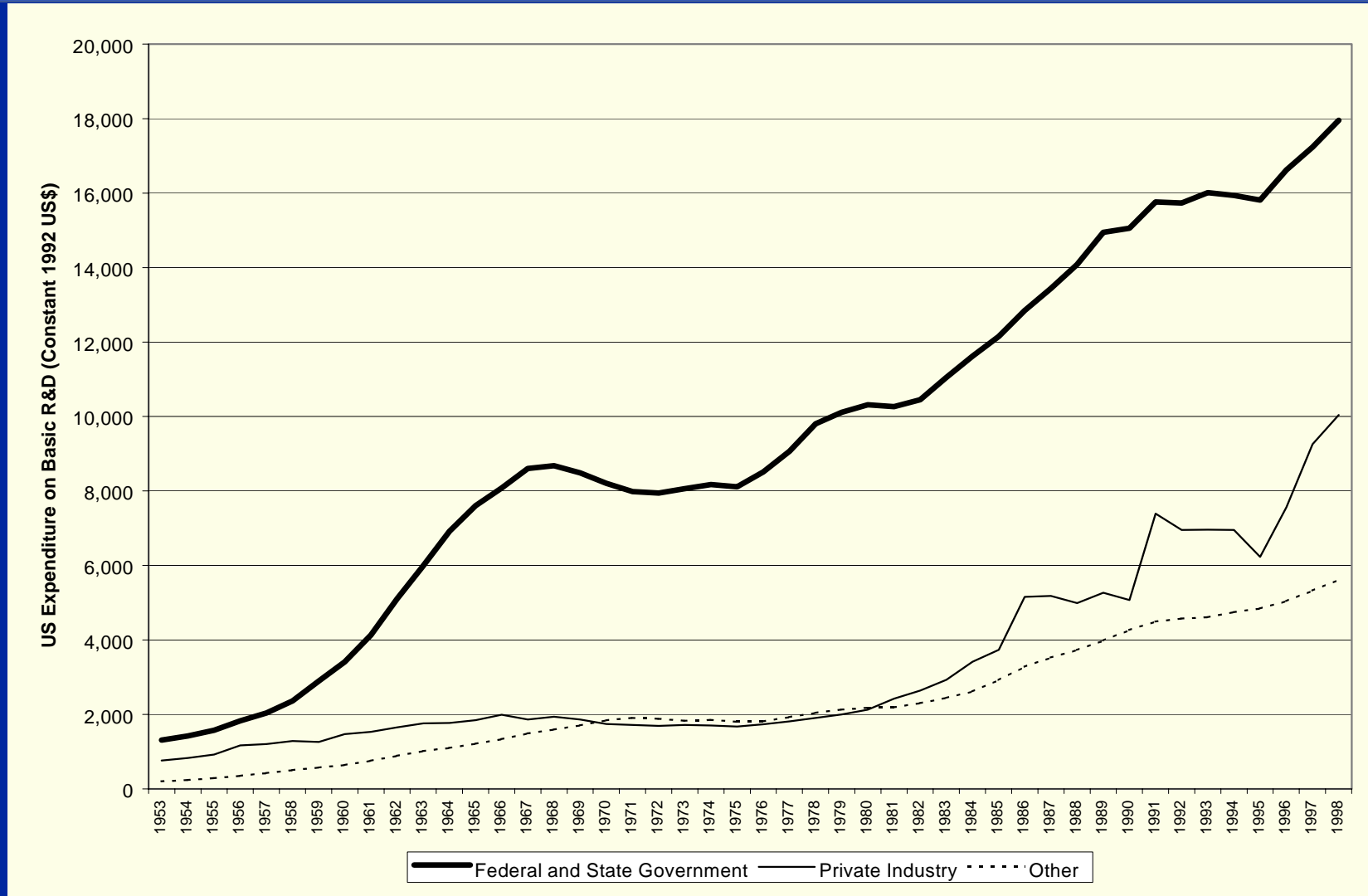
# The Historical Analysis – 2: **cumulative terms**



**BUT**, in cumulative terms, the public support is only now being surpassed by the private support to R&D. The “integral” reflects long-lasting investments in basic science, equipment and institutions such as the modern US research university, on which both private and public R&D depends, namely to train people.

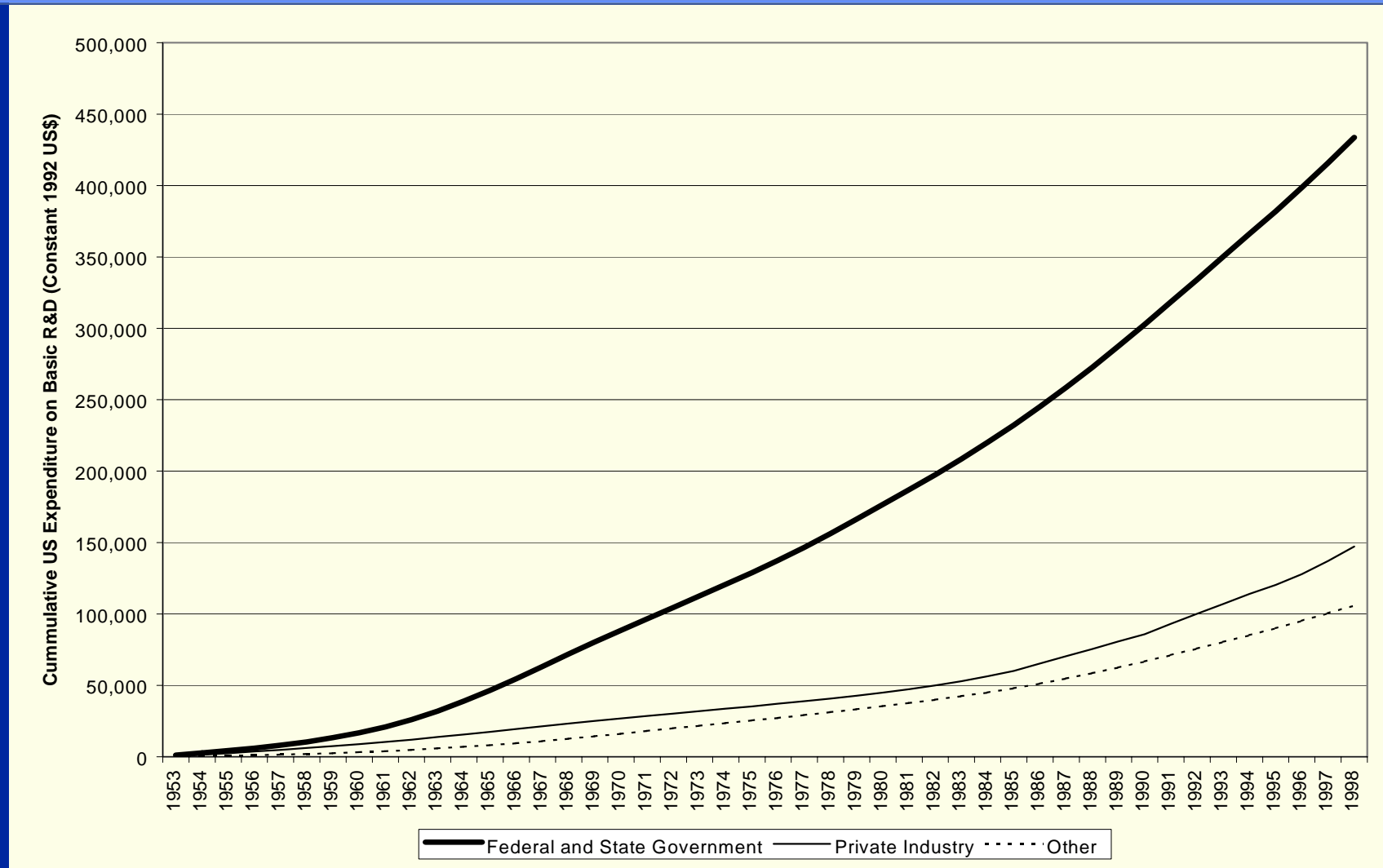


# The Structural Analysis – 1: **BASIC R&D**



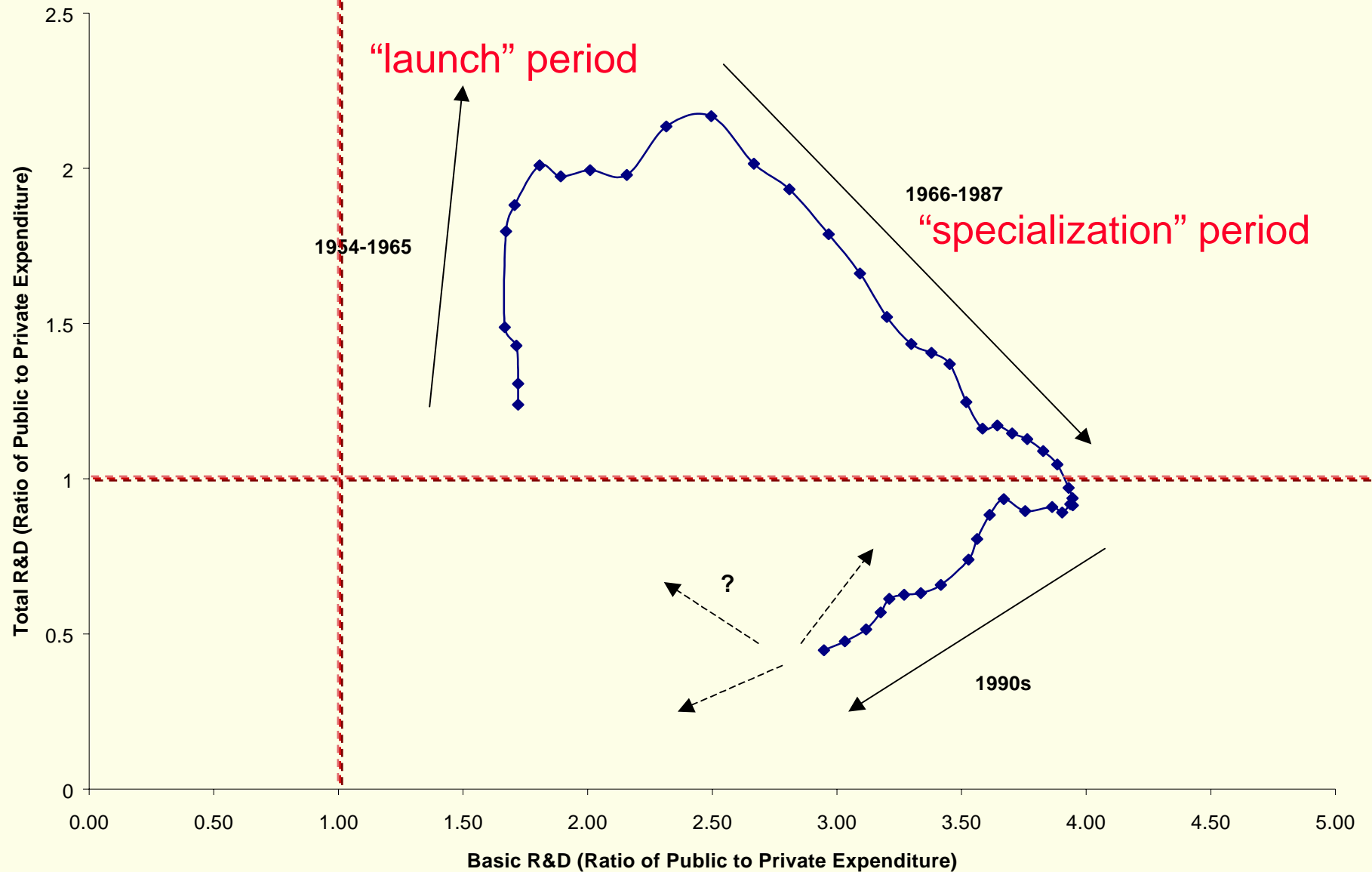
The “public” has not retreated from funding *basic* R&D, on the contrary, it is even pushing upwards private spending on basic R&D

# The Structural Analysis – 2: **cumulative basic R&D**

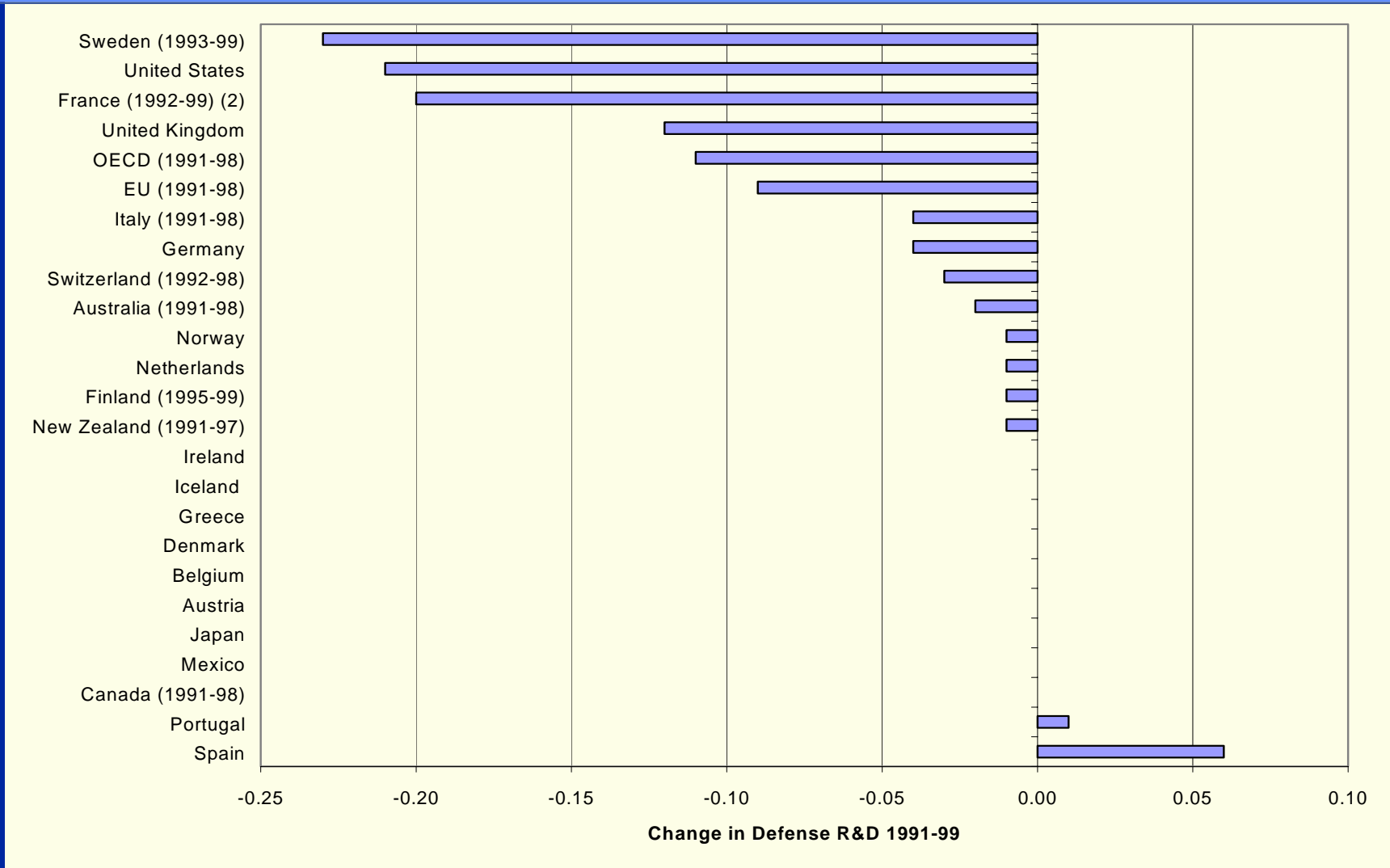


The “cumulative” investment in basic R&D continues to be led, by an overwhelming margin, by public expenditure: the US is investing in its long-term scientific future using mostly public, rather than private, incentives. Still, it is possible to see an increasing relative importance of private funding (see next slide)

# The Structural Analysis – 3: **public / private expend.**

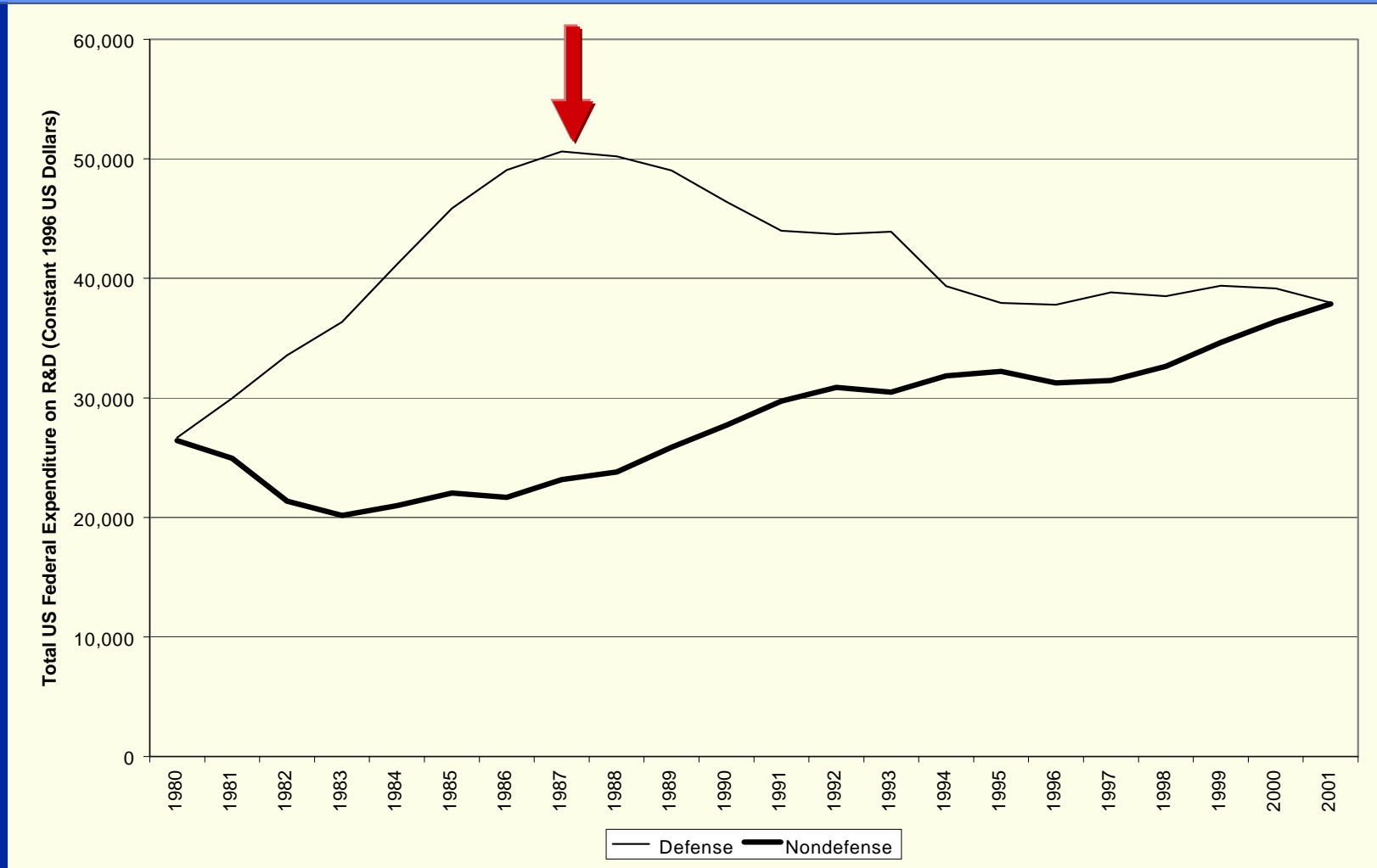


# The Structural Analysis – 5: **Change in Defense R&D**



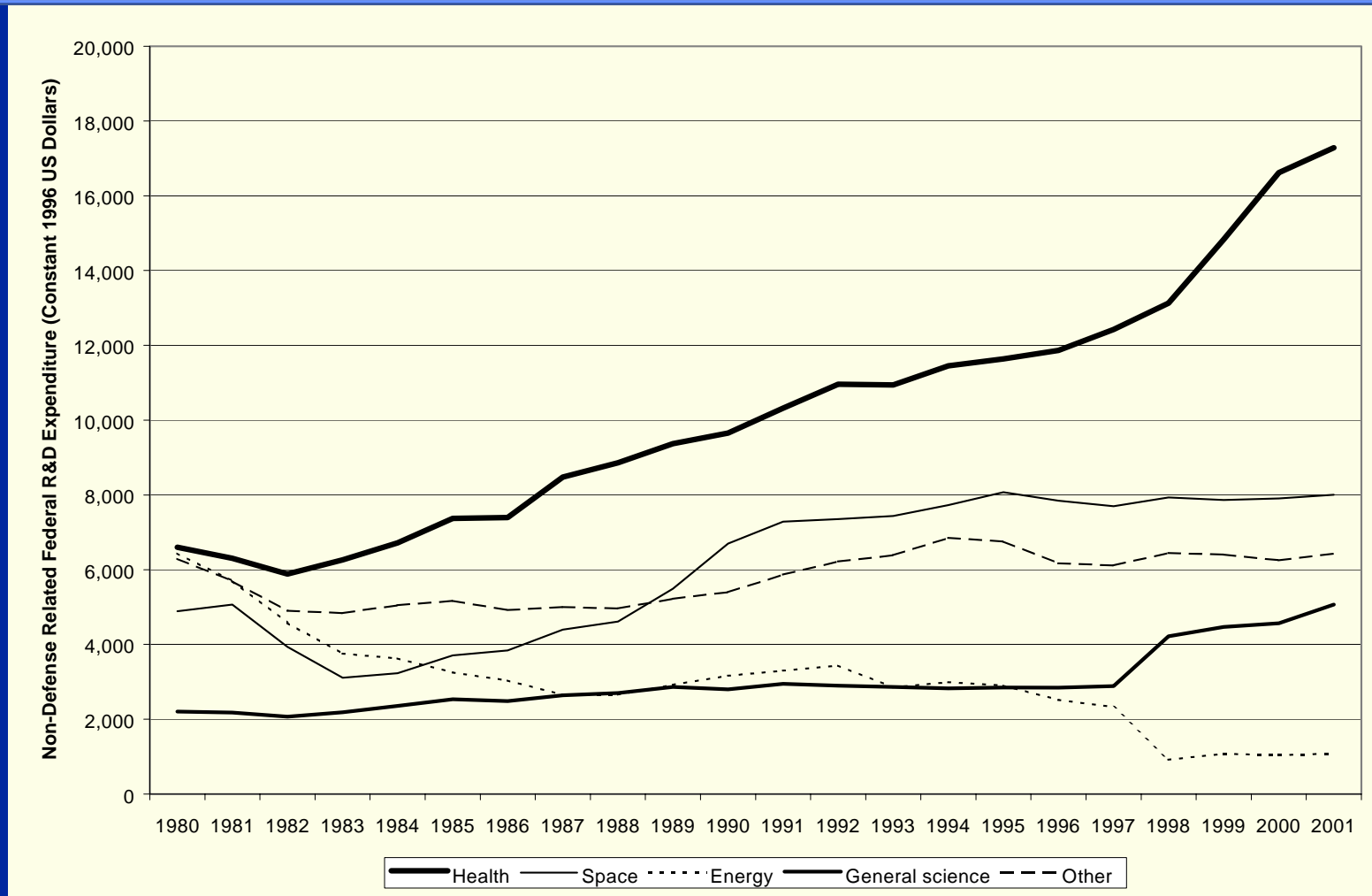
It is important to note that much of the retreat in public funding, overall but especially in the US, is related with the pulling back of financial support to defense-related R&D

# The Structural Analysis – 6: **rise of non-defense R&D**



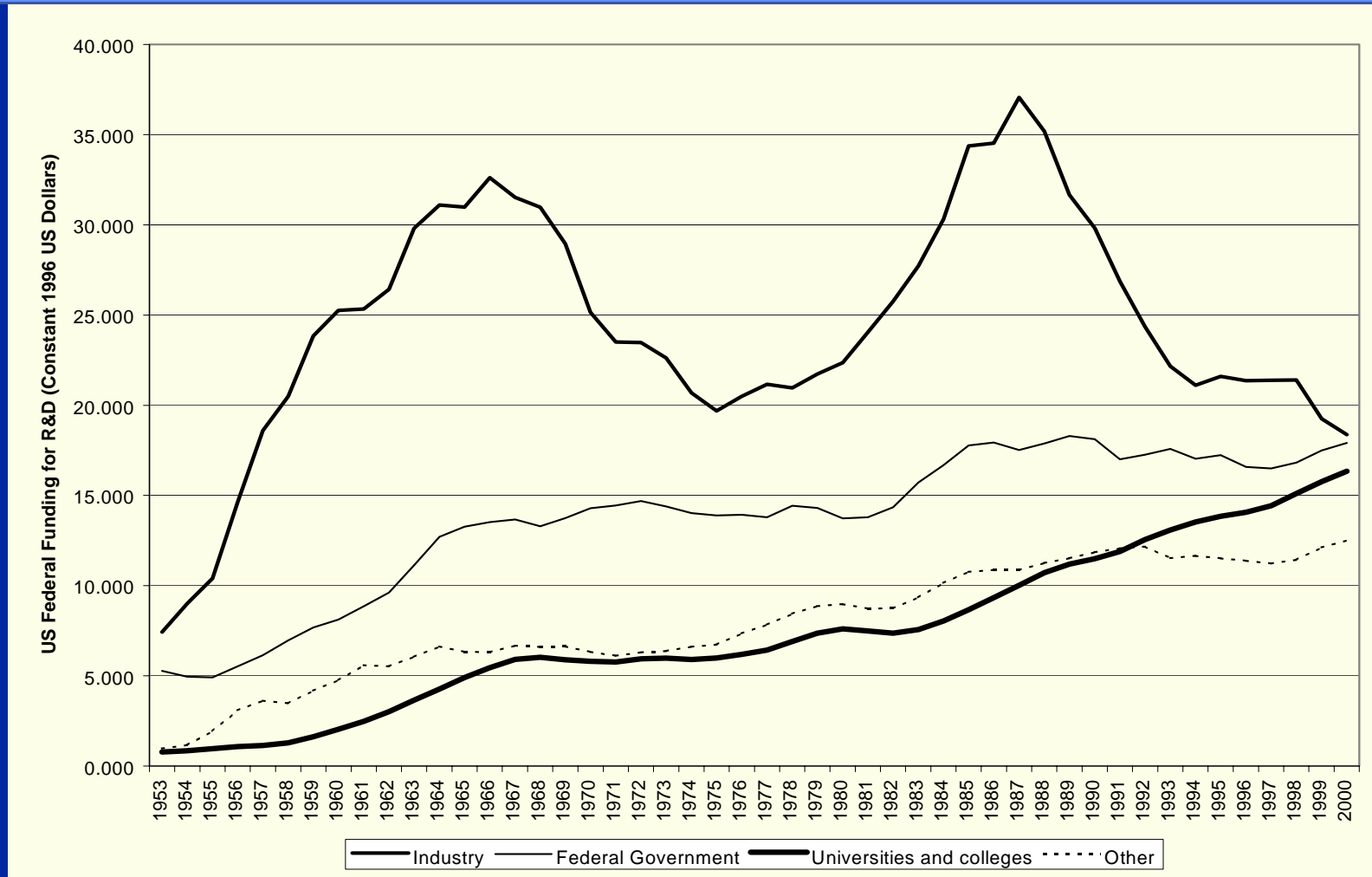
In fact, for the first time since 1980, the non-defense related R&D public expenditure in the US is equal to the defense related expenditure. It is also important to note that the abrupt decrease in public expenditure of 1987 is related with the start of the decrease of the defense-related expenditure. The non-defense public expenditure on R&D in the US is on an increasing trend for more than 20 years. So where is the new public money is going?

# The Structural Analysis – 7: **Non-defense R&D**



The growth in non-defense public R&D expenditure has been going mostly to health and to basic science. In 1999 the US Congress has committed itself to double the funding of the National Institutes of Health (which funds research in health-related areas) and of the National Science Foundation (which funds basic science). Preliminary budget requests of the Bush administration for 2003 comply with this commitment, putting the funding of the National Institutes of Health at close to US\$ 30 billion.

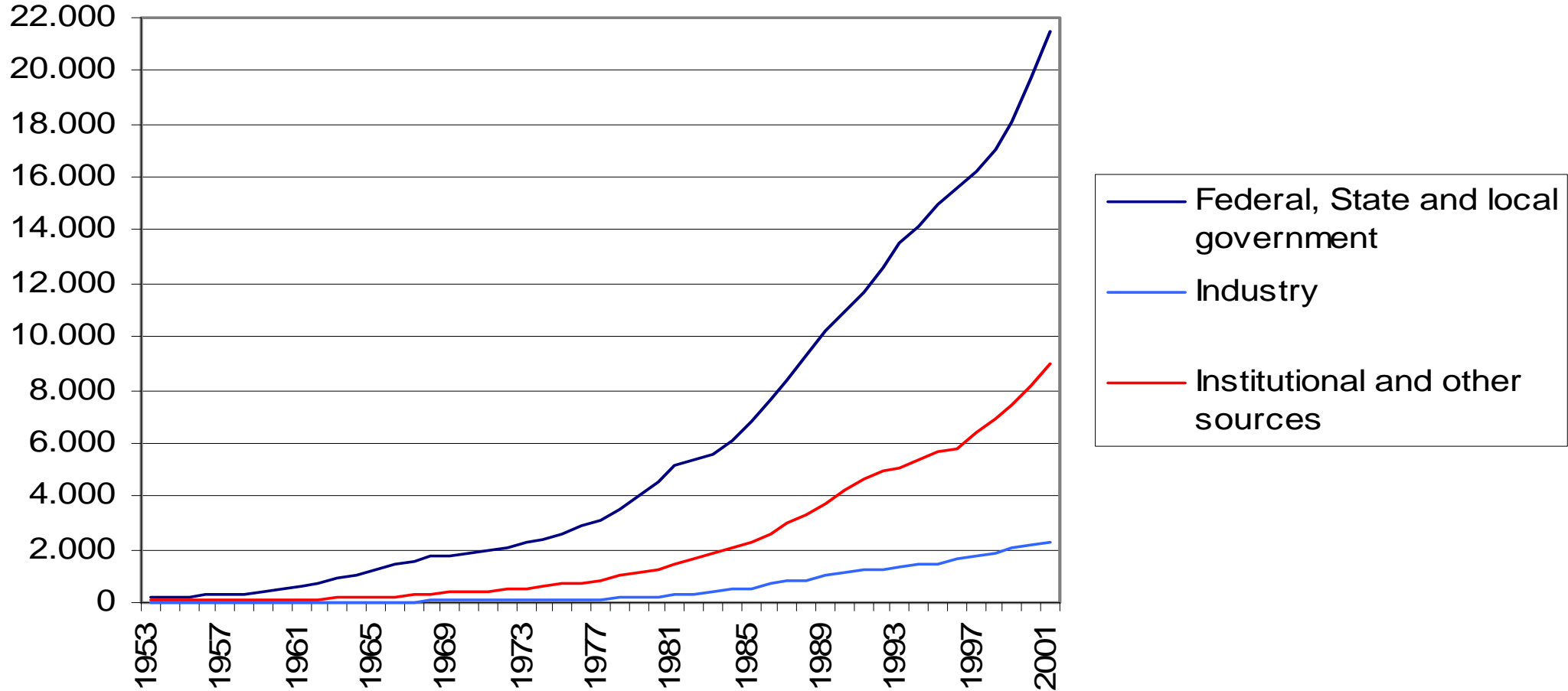
# The Structural Analysis – 8: **public allocation of R&D**



The public allocation of R&D resources to universities has exhibited a persistent increasing trend over the last half a century. While historically federal labs and private industry have received most of the federal funds (private industry with two great peaks by the mid 1960s and by the mid 1980s), if current trends continue universities will be the main receivers of public support to R&D in the US.

# Funding the university – 1

dollars in millions



Public funds were always the main source of funding for R&D activities in the US and the value is increasing. Public funding continues to support “core areas” of scientific interest where private funds are not sufficient to meet the goals of the US S&T policy. Furthermore, private funding is minimal (7% in 2001) despite strong industry-relationship linkage.

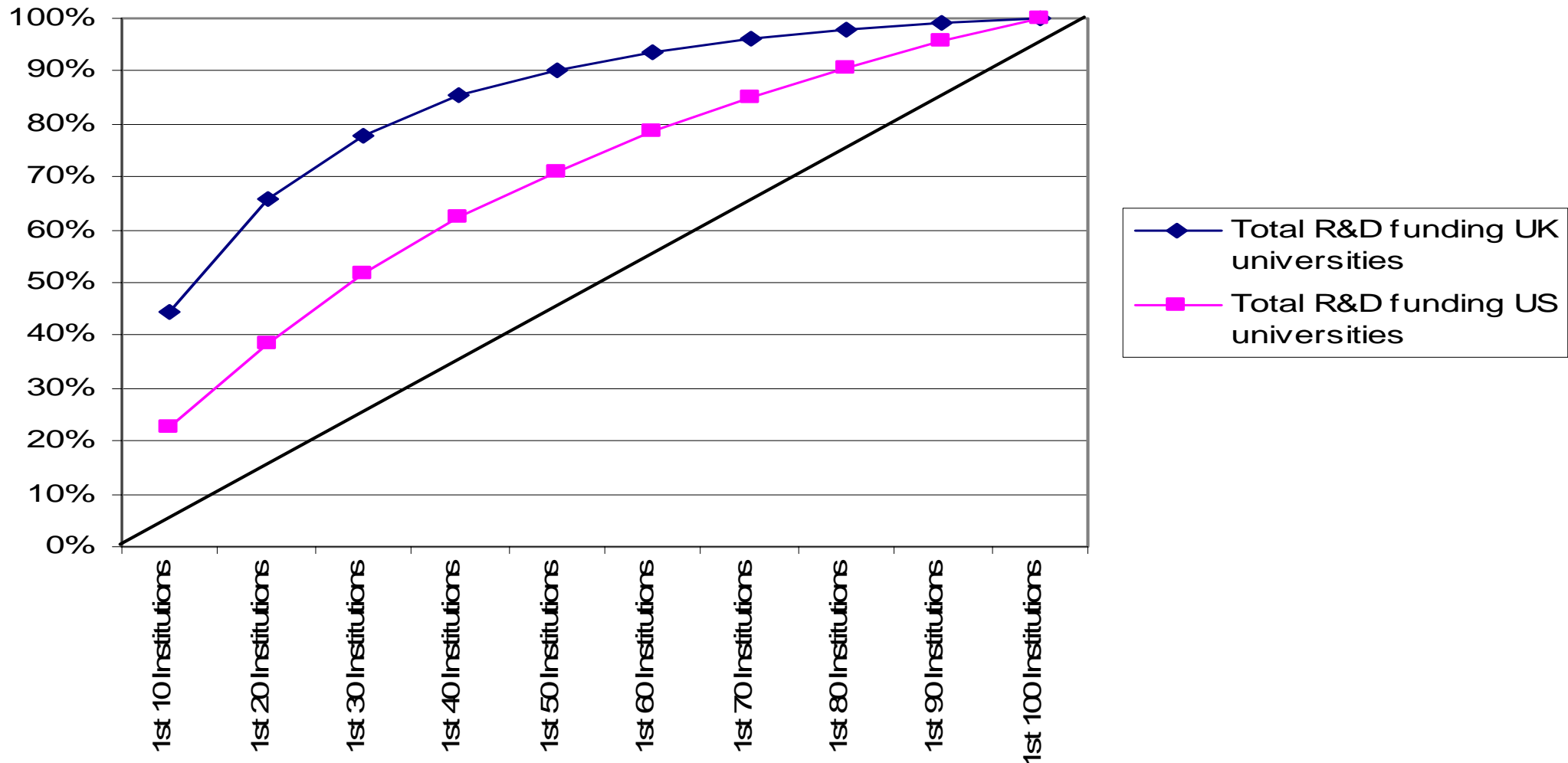


# Funding the university – 2

	Total revenues (millions \$)	Licensing and royalties (millions \$)	% of total
<b>All universities</b>	\$ 227,000 M	\$ 1270 M	0.56%
<b>Columbia U.</b>	\$ 2,038 M	\$ 193 M \$ 100-20 M <sup>1</sup>	9.5% 4.9-5.9%
<b>University of California</b>	\$ 8,500 M	\$ 100 M \$ 75 M (net)	1.18% 0.88%
<b>Stanford University</b>	\$ 2,400 M	\$ 43 \$ 36.6 <sup>2</sup>	1.79% 1.52%
<b>Florida State</b>	\$ 2646 M	\$ 36	1.36%
<b>University of Wisconsin - Madison</b>	\$ 1696 M	\$ 32	1.89%
<b>Univ. Minn.</b>	\$ 1135 M	\$ 26.5 <sup>3</sup>	2.33%
<b>Harvard (03)</b>	\$ 2349 M	47.9	2.03%
<b>Cal Tech (03)</b>	\$ 531 M	\$ 26.7 <sup>4</sup>	5.02%

Despite the growth of Offices of Technology Licensing in universities, the Intellectual property related revenues to university are still small and only available for a few...

# Funding the university – 3



Despite US R&D funds are much more concentrated in the US higher education system than in the UK higher education system as a whole (3% in the US/58% in the UK) there is less differentiation between the first one hundred R&D US universities meaning a more even competition for R&D funds and the presence of a massive and diversified higher education system to support them.

# The Structural Analysis - 9

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*What does the historical and structural analysis show?*

- ➔ To say that the pendulum is swinging from the public to the private set of incentives for R&D in the US is an oversimplification
- ➔ Even if at an aggregate level that is the case, if one considers “aggregation over time” (the integral taking into account past investments) public and private expenditure on R&D in the US are on par
- ➔ Additionally, public support has not been scarce for long term scientific endeavors (NSF, support to basic science), nor to those areas in which there is demand for R&D that the private sector alone is not tackling (health, NSF), nor to those institutions that depend on public support to maintain their institutional integrity (universities) so that they can persist in playing their unique and fundamental role.

# Policy Implications

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- It is a “rush” to understand the **different nature** of private and public incentives for S&T
- **“Blanket” recommendations** to enhance property rights or to limit public resource allocation, based on the US experience, **may be misguided**
- Even if there is a clear shift towards more private incentives in the US, there is a long history of past investments and a current division of labor or specialization that **cannot be replicated** in systems with a lower scale and complexity
- The key message from the US history is that of a **diversity of policies** and **increasing “institutional specialization”** and clarification of the role of the private and public incentives to support S&T

# Emerging questions: *Governance of S&T*

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- Institutional structures for Governance
- Steering and funding:
  - How to define *priorities*?
  - Basic vs applied/oriented R&D?
  - Public vs private targets?
  - Assessment and evaluation?
  - Institutional and/or Project-based funding?
- The Role of Governments
  - Funding and evaluation?
  - University and/or Government R&D?
  - Fostering the demand for R&D?