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Measuring the Impacts of Federal Investments in Research

Session II: Aggregate Impact of Federally-Supported Research on the US Economy and Quality of Life

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Approach and overview

- View is from 30,000 feet
- Trends in spending
- Aggregate empirical relationship between R&D and productivity

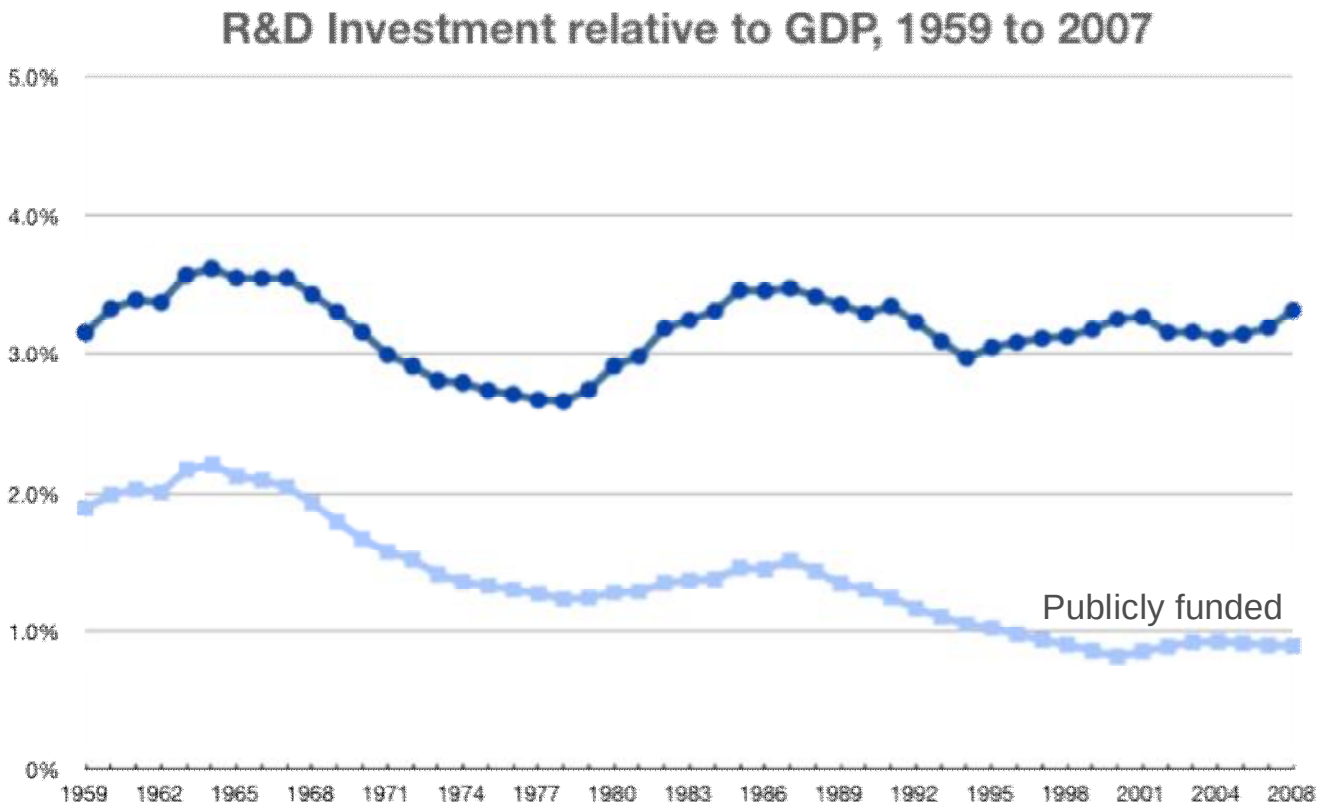
Use data from BEA/NSF R&D satellite account

- .... capitalizes R&D as investment, with result that
- R&D adds to top line GDP and to national saving
- Investment in R&D is a macroeconomic statistic in this account. R&D assets are an asset class, etc.
- The account is a preview of changes to be made in US national accounts in 2013 (soon!)

R&D satellite account includes:

- R&D investment and stocks by major performer and major funder from 1959 on
- R&D investment and stocks for 13 industries (own-produced + purchased from the R&D services industry) from 1987 on
  - Look at private/public shares
  - Look at trends in industry R&D intensities
  - Merge with industry TFP estimates

R&D investment rate has been stable since the early1980s .....



Source: Author's calculations using BEA estimates.

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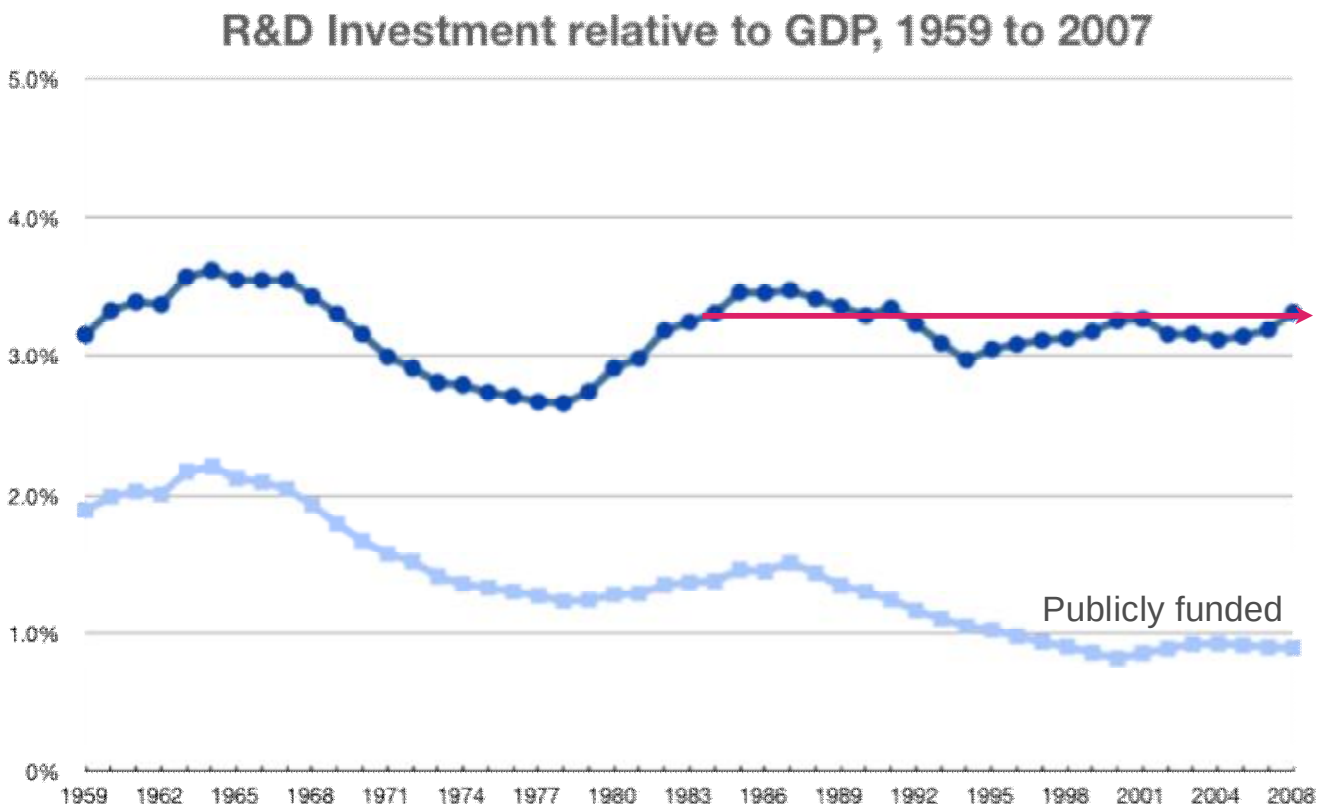
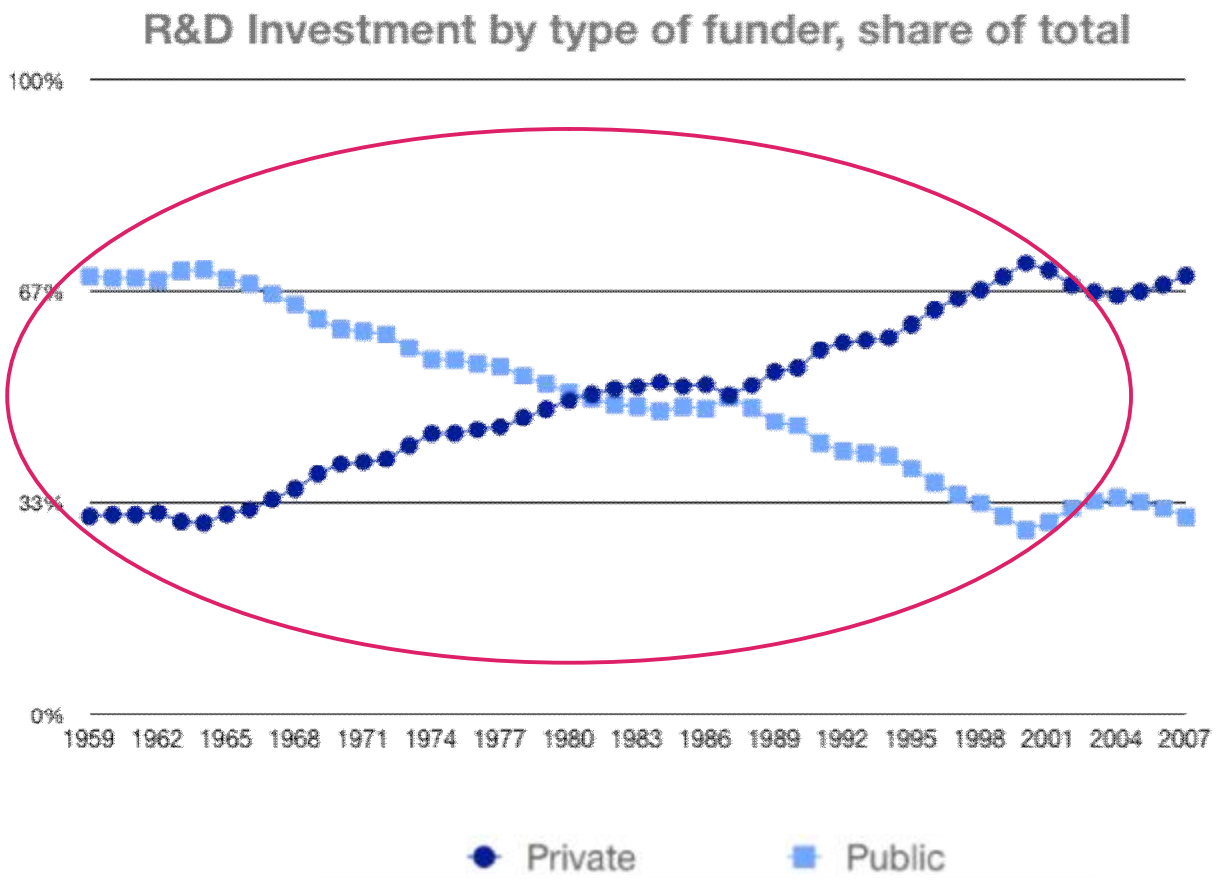


3.2 percent of existing GDP

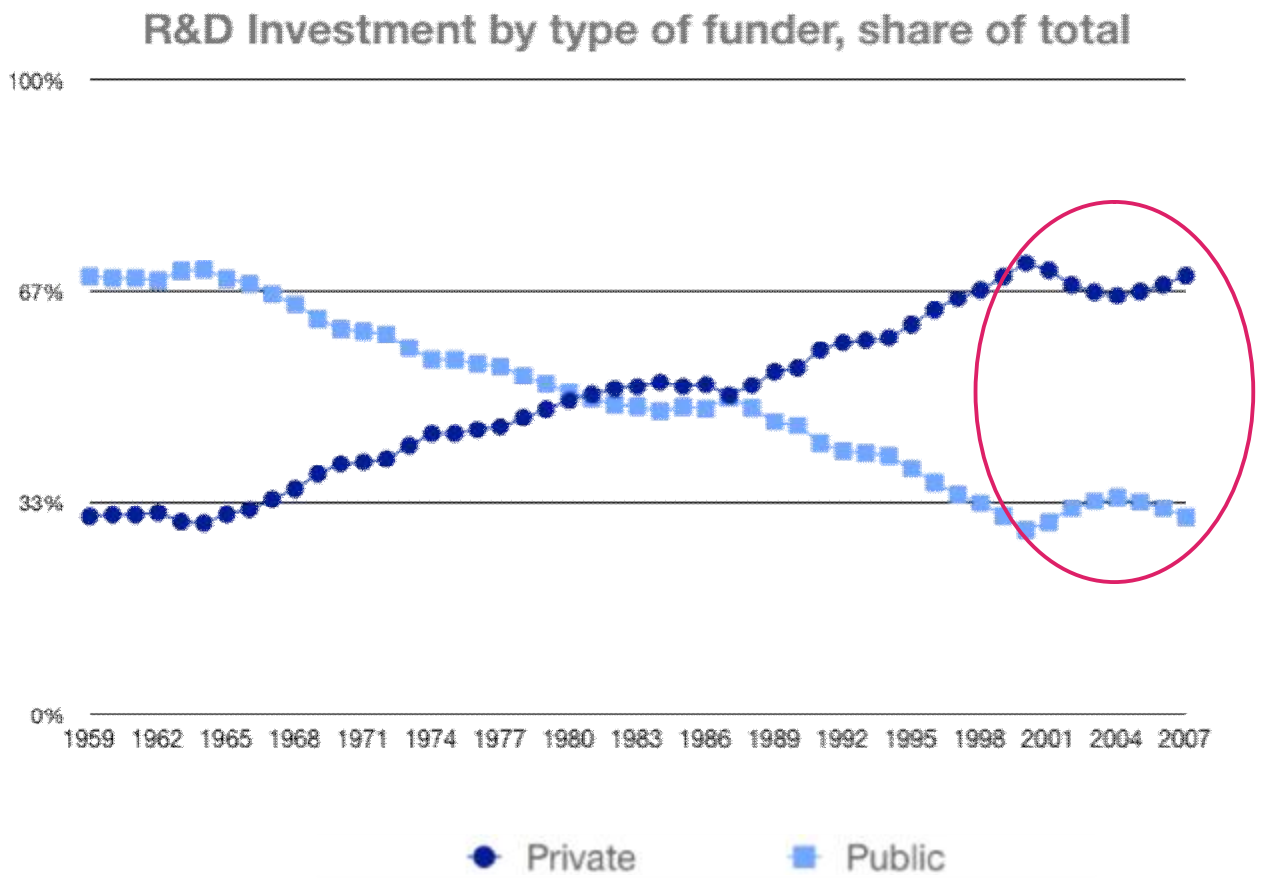
Source: Author's calculations using BEA estimates.

After 40 years of public/private reversal of relative importance.....



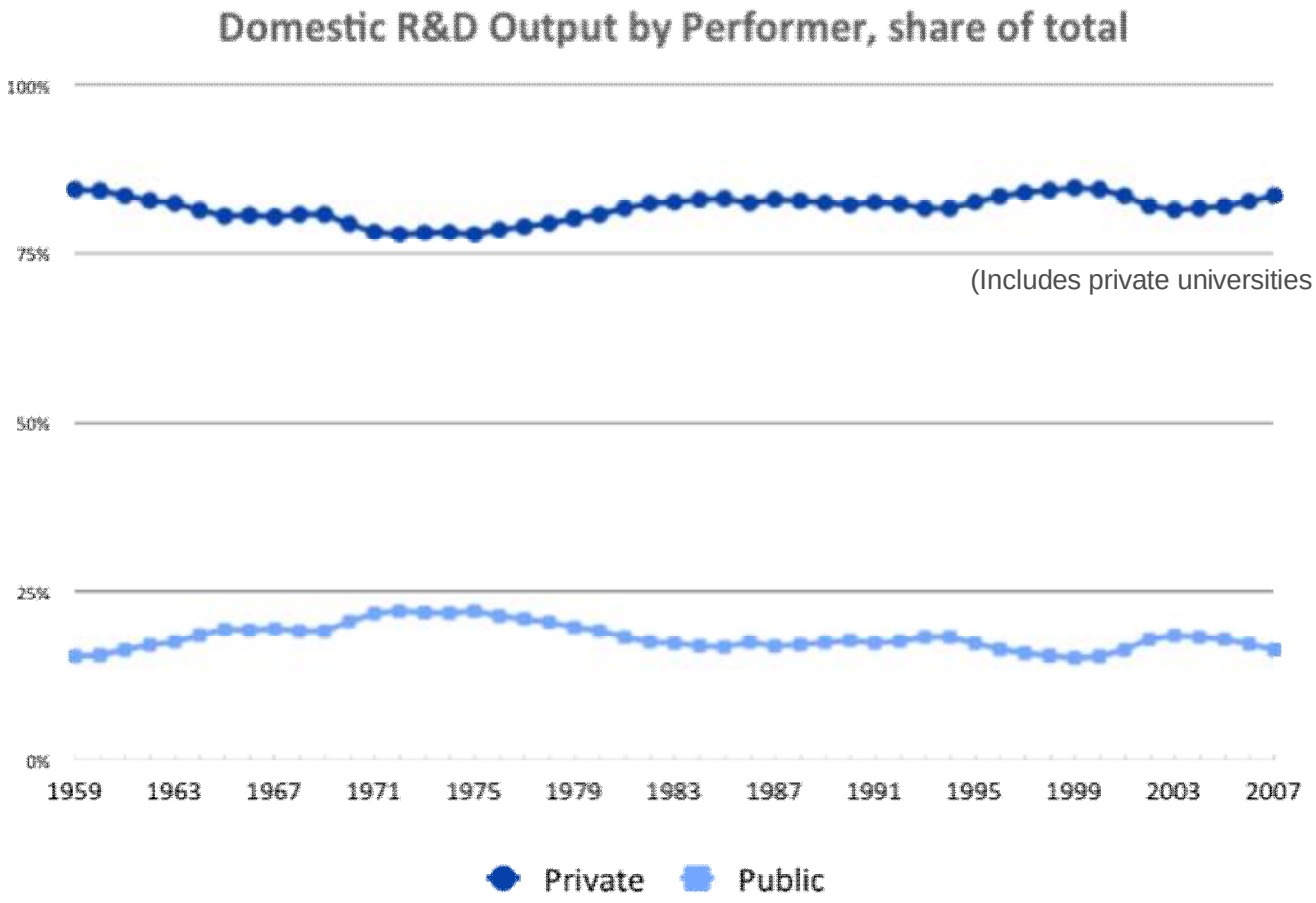
Source: Author's calculations using BEA estimates.

... stability of late



Source: Author's calculations using BEA estimates.

No trend in broad performance shares



(Includes private universities and nonprofits)

US Nominal R&D Investment and Domestic R&D Output has been well maintained …

Nominal R&D investment
% change ann. rate

	1990 to 2000	2000 to 2007	Memo: 2007 bil.$
Total Nominal R&D Investment	5.3	5.2	405.7
Business	8.0	4.8	269.6
Government	0.4	6.1	117.0
Universities (incl. public)	7.0	8.7	10.6
Nonprofits	6.3	5.7	8.4

Source: Author's calculations using BEA estimates (Funder basis)

Nominal domestic R&D output
% change ann. rate

	1990 to 2000	2000 to 2007	Memo: 2007 bil.$
Total Nominal R&D Output	5.3	5.1	407.5
Business	5.6	4.8	301.5
Government	2.0	5.1	62.5
Universities (incl. public)	5.1	6.7	23.5
Nonprofits	5.8	5.6	17.2

Source: Author's calculations using BEA estimates (Performer basis)

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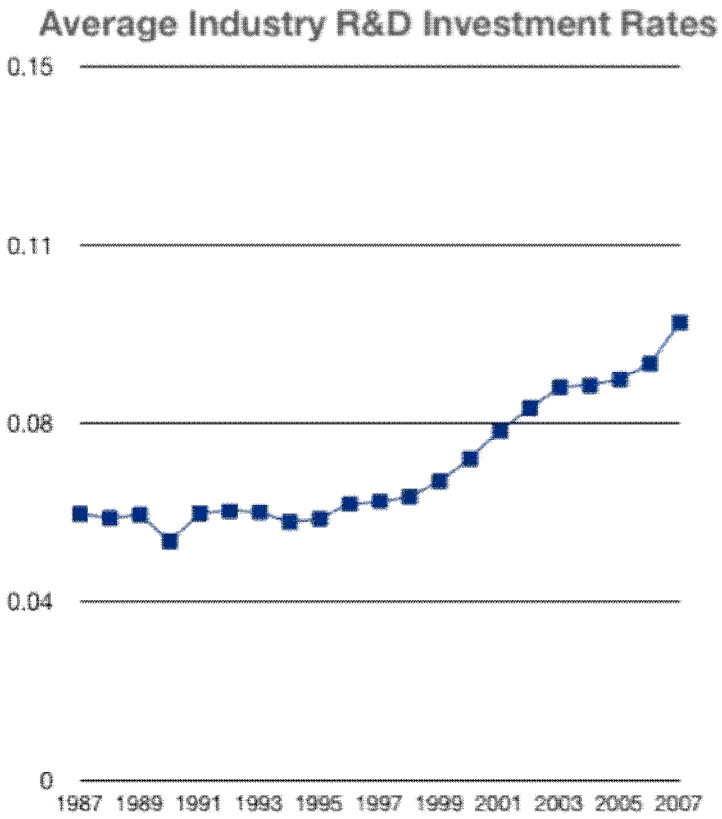
US Private Business R&D Intensity has been on the rise.....

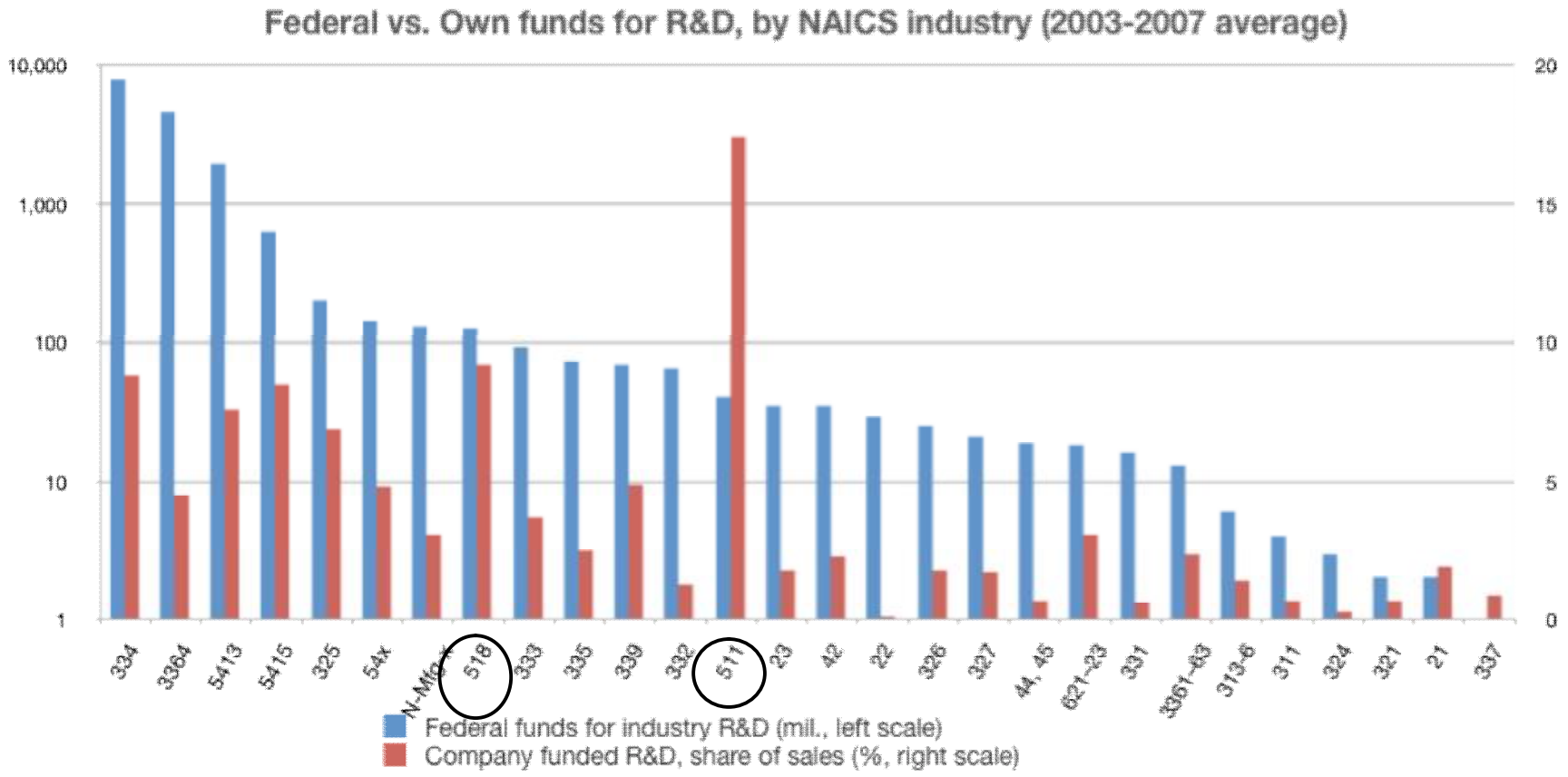


NB: Industry R&D Investment relative to gross output, average for 13 BEA industries

- The stable R&D to GDP share masks a significant rise in private industry R&D intensities....
- (because the share of GDP contributed by R&D performing industries is falling)
- NB: Investment = funder basis

Rough correlation between R&D subsidies to industry and industry own funds

... with certain information industries an exception



Source: Author calculations using NSF data;
excludes the R&D services industry

What are the implications for productivity?

- The new BEA data are limited in terms of industries that match available TFP estimates.
- When matched to TFP estimated using the disaggregated BEA industry data (unpublished updates to Corrado et al. 2007), only 8 industry sectors are available (4 major manufacturing sectors, 3 services sectors/industries, and one all other)
- The span of time is the last 20 years.
- The IT/Internet-driven productivity episode dominates the first part of the available data whereas increased services productivity growth dominates the 2000s.

A productivity decomposition

- Consider the economy as consisting of 2 sectors, a knowledge- using sector (Y) and a knowledge-producing sector (N).

- Assume the N sector is entirely "upstream" of the Y sector, and that Y must pay N a certain share of its output (s^Y $\approx$ R&D intensity, when N is R&D producing sector) to use its services. This enables us to derive:

$$\Delta \ln TFP^{measured} = \Delta \ln TFP^{Y} + s^{Y} \Delta \ln TFP^{N}$$

- i.e., observed productivity is the sum of (1) productivity in "final operations" sector plus (2) a contribution from the knowledge producing sector.

U.S. Aggregate Productivity Growth

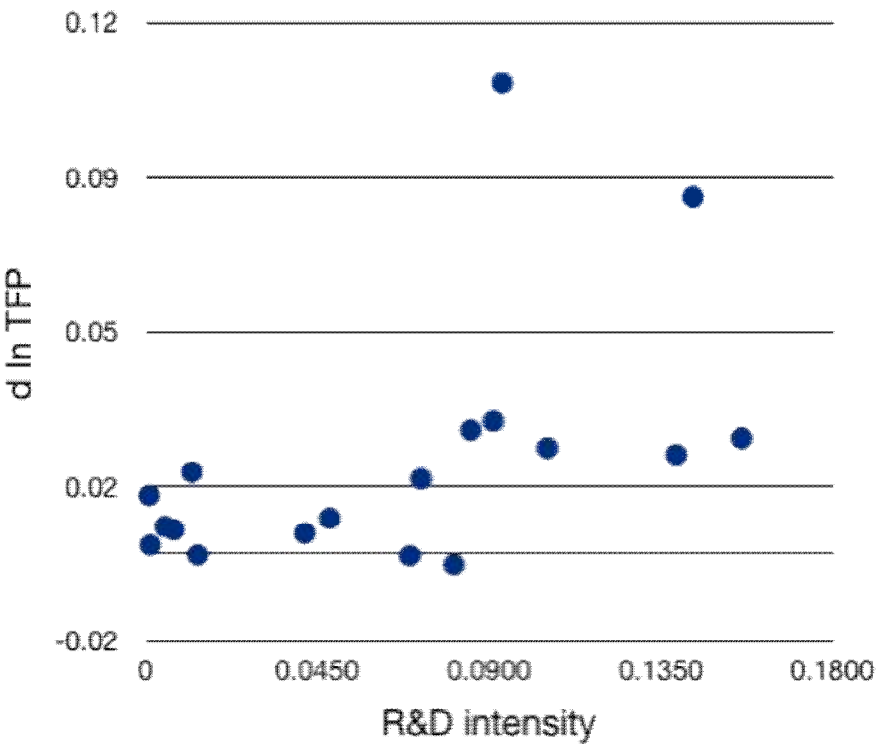
	1987 to 1995	1995 to 2001	2001 to 2007
1. Total private*	**0.8**	**1.1**	**1.7**
2. Excl. major non-market**	**1.2**	**1.4**	**1.8**
3. Average of BEA industries	**0.7**	**1.6**	**2.4**

Note. All changes calculated as log differences. Figures do not account for increases in labor quality.

* Built from BEA industry-level data as in Corrado *et al* (2007).

** Excludes the education, health, and owner-occupied real estate industries.

The decomposition using the BEA data .....



- The 1990s and 2000s trends are taken separately
- Each point in the scatter plot is a TFP trend-R&D intensity pair for one industry for one period.
- If the implied constant (an estimate of TFP^{Y}) is small or indistinguishable from zero, then R&D is all there is to productivity change.

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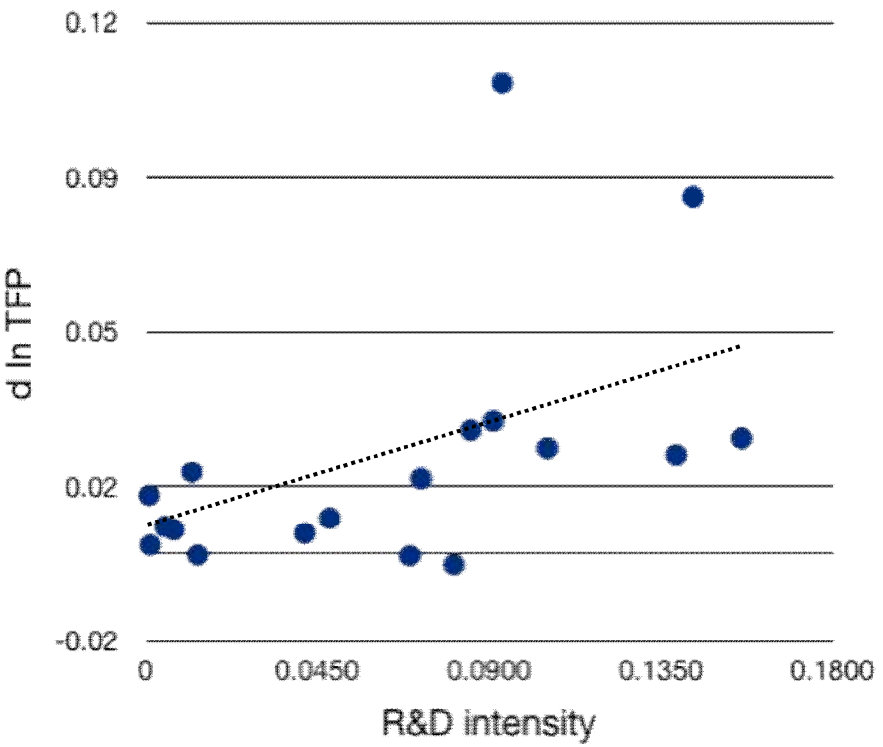

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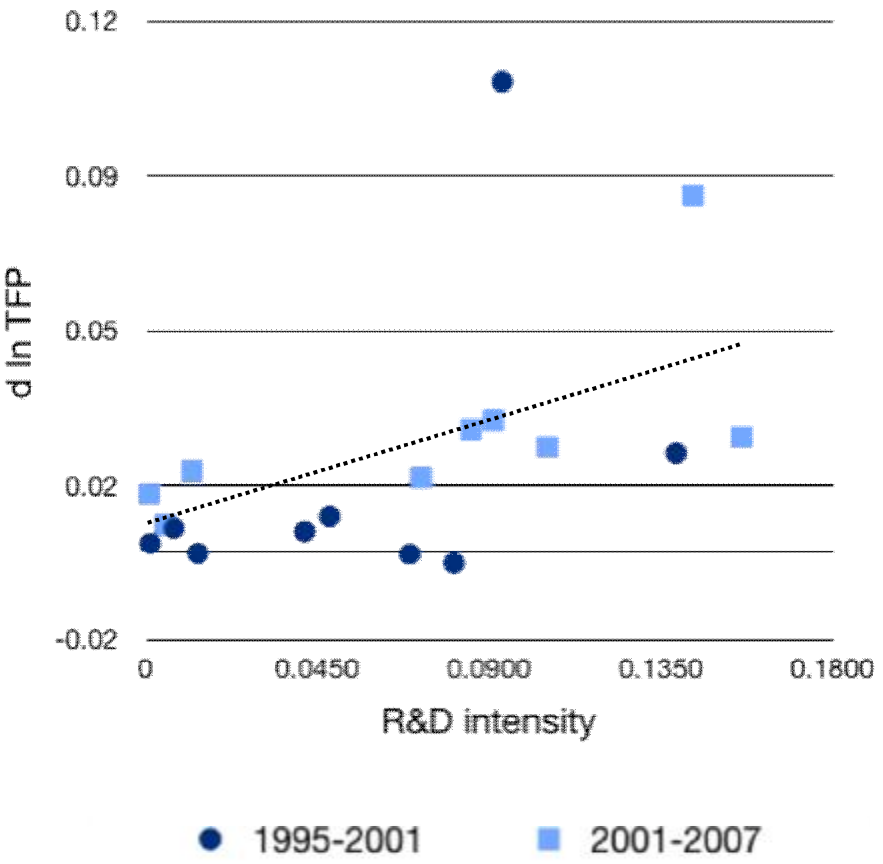

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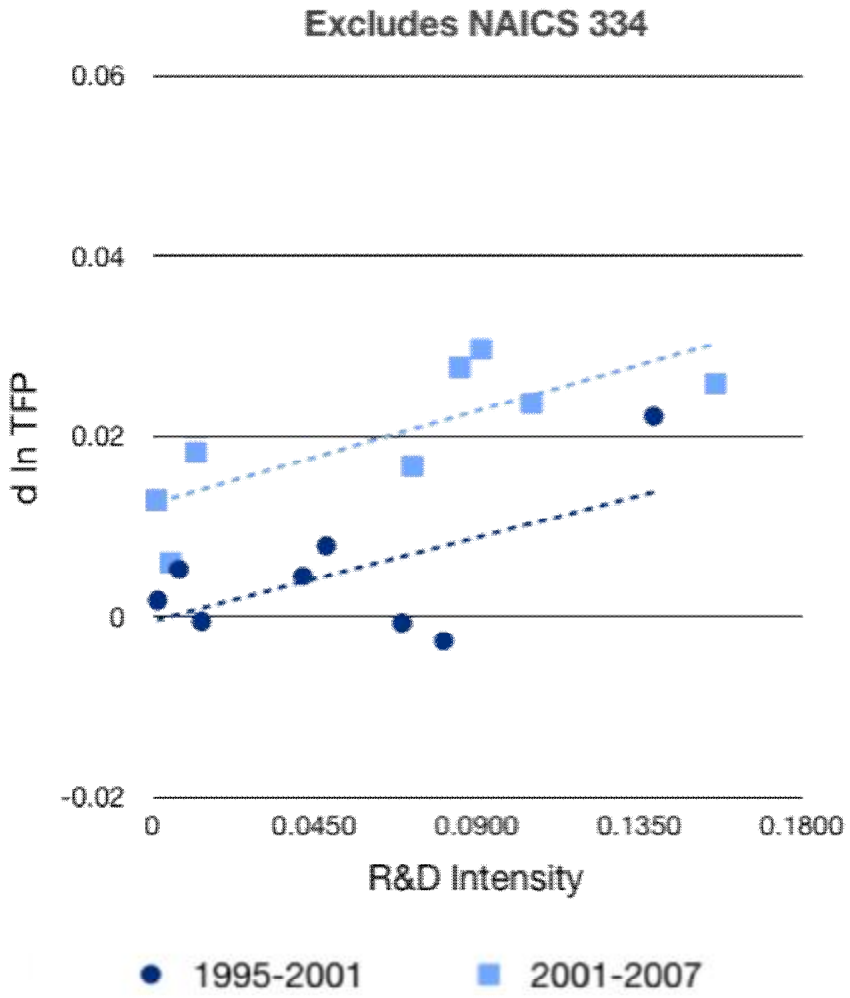
Much too few observations to draw hard conclusions ...



- But results are consistent with R&D as sole driver of the productivity gains in the 1990s.
- .... unfortunately, also evidence that R&D contributed only 30% of the average industry productivity gain in the 2000s.

Additional comments

- Data are not up to the task of measuring impacts of investments in life sciences on human health (yet!).
- The approach is not limited to industry productivity decomposition -- e.g., decomposition by geographies

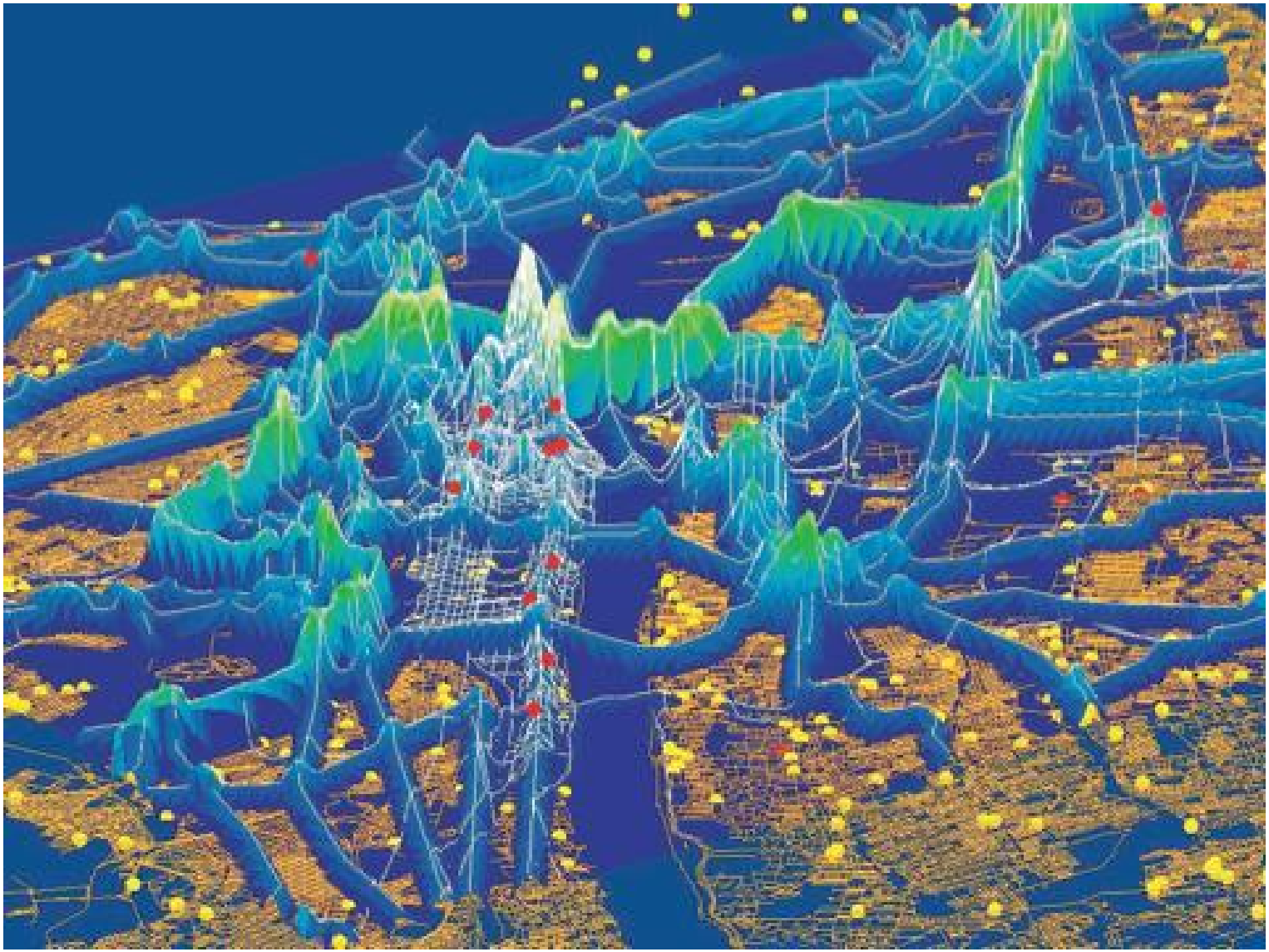
What is the public/private split and where do we go next?

- Lessons from the commercialization of the Internet
- Lessons from globalization. What to make/ do about the dwindling US manufacturing share?
- Lessons from broad view of innovation. (i.e., “its more than science”)

Lessons from the 1990s and 2000s -- the Internet, not the microprocessor

- In a recent working paper, I argue the 1990s and 2000s are a consistent productivity episode, with the Internet and demand for networked devices key drivers of economic activity
- ..... that is, my research supports the view that it was IBM, MCI, and Merit **working with the NSF** to set up the first T1 line in 1987 that was key to the events that followed
- This is a classic role for government -- create infrastructure, help close “valleys of death” (energy!) in the commercialization of science.
- ..... does not necessarily imply federal funds should be correlated with industry own funds.

Density of the information structure in Manhattan (white lines)
All dots are R&D labs. The red ones are ATP award winners -- and all concentrated along major fiber optic trunk lines.
What does this suggest for policy?



What to make of the dwindling US manufacturing share?

- Private business R&D intensities **and** government support for R&D (academic and other) have risen/rebounded of late
- .... while the manufacturing/R&D-performing industries share of total value added continues to fall.
- The US may be more and more a “designed in California, made in China” economy but the well-maintained R&D investment rate implies **a continually expanding R&D knowledge base.**
- What does this suggest about policy?

Investments in other intangibles (such as design): R&D complement? R&D diffusion? or not R&D?

- Firms innovate based on science as well as from investments in a range of intangibles: product design, new business processes, staff knowledge building, etc.
- Research estimates place 2007 business spending on R&D at 16 percent of spending on all intangibles. How much of that 84 percent is downstream “leverage” from successful R&D (marketing and the like)?
- Is variety in design a form of modern-day diffusion, or just plain non-technological? Do we conduct **science and innovation** policy differently from science policy?

Where's the science? Where's the R&D tax credit? What does this suggest for policy?

Thank you.

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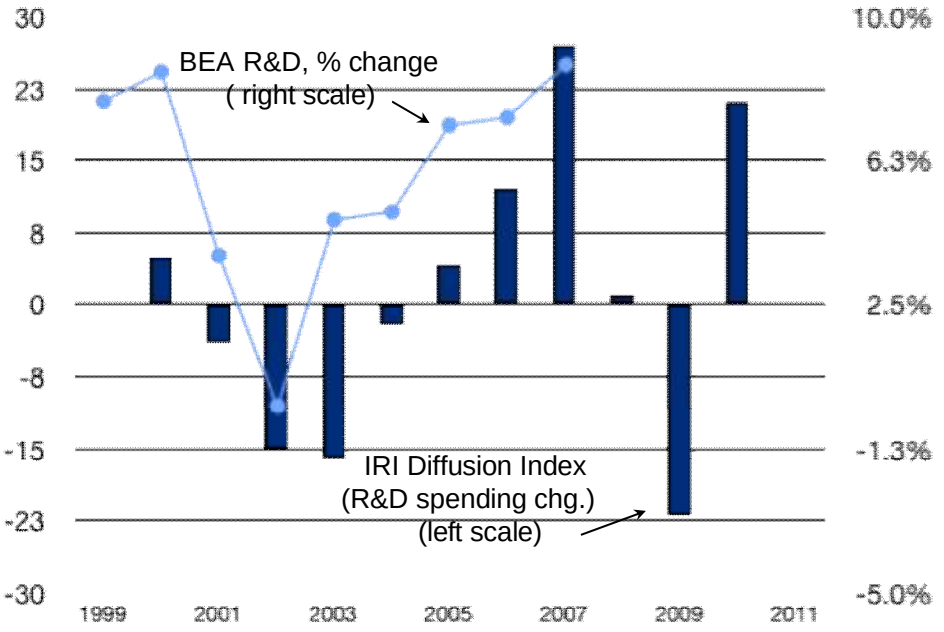
US Nominal R&D Investment since1990 has been well maintained.....but what about the great recession?

R&D Investment, % change ann. rate

	1990 to 2000	2000 to 2007
Nominal R&D Investment	5.3	5.2
Private	7.9	4.8
Public	0.8	6.2

Source: Author's calculations using BEA estimates.
(Funder basis)

R&D Investment in recent years



Note--IRI diffusion index lagged one year. R&D investment is in current dollars.

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*** Accounts for increases in labor "quality".

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