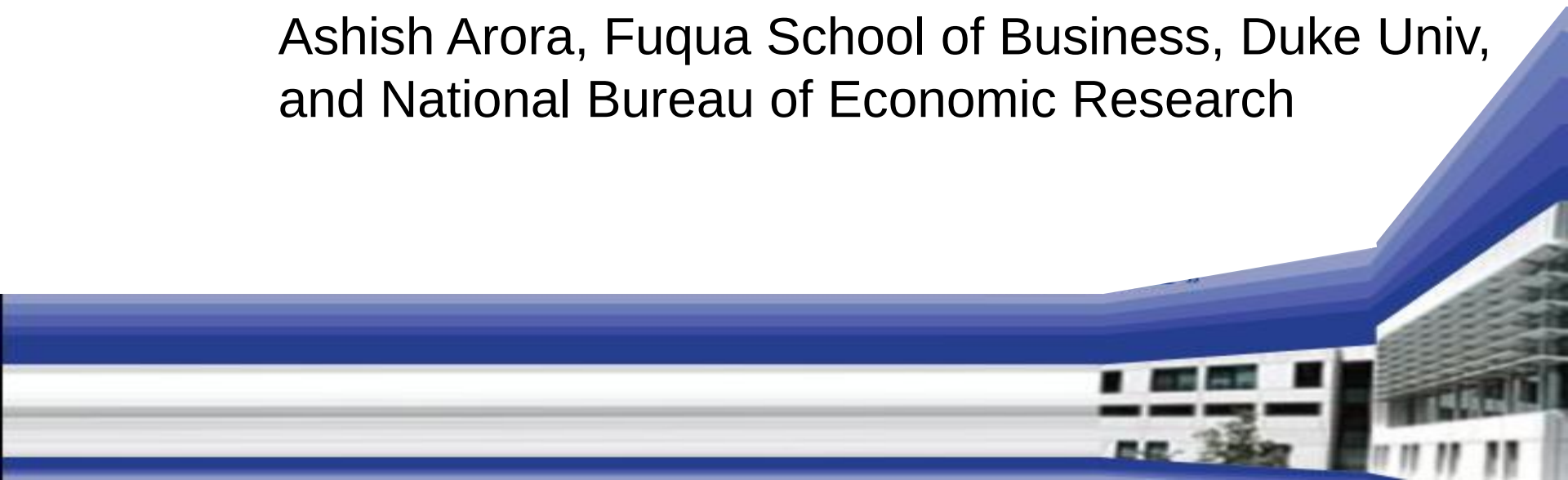
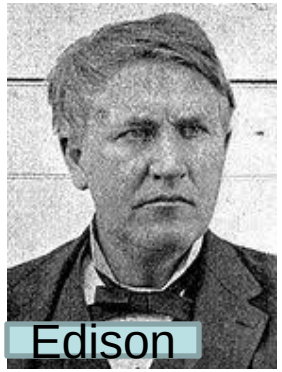
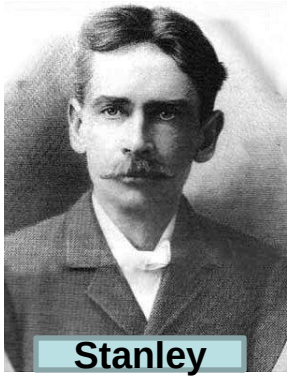
Back to the future? The evolving division of innovative labor and the changing locus of innovation in the American economy

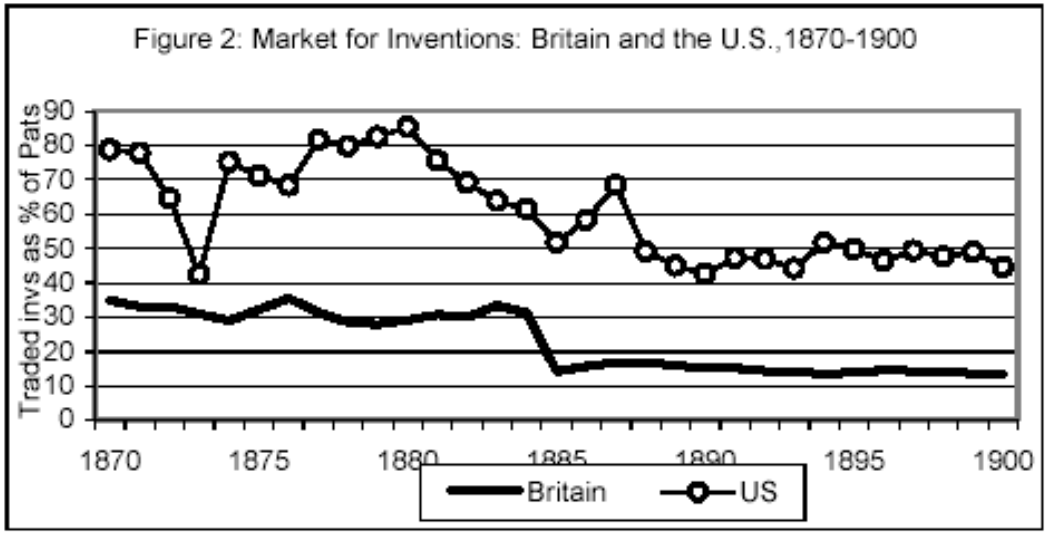
Ashish Arora, Fuqua School of Business, Duke Univ, and National Bureau of Economic Research



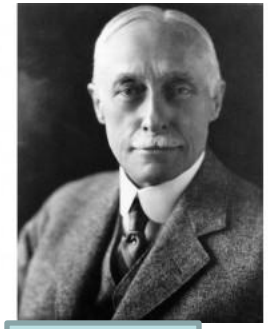
Golden age of independent inventors, 1850-1900


Edison


Stanley



: The figure shows the ratio of all assignments to patents issued in the U.S.; whereas for Britain, the ratio comprises assignments and licenses relative to patents issued.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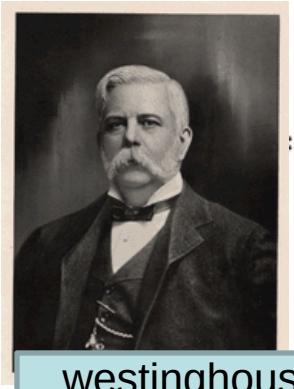

westinghouse


Thompson

- Independent inventors
  - Assigned patents to multiple firms
  - Decline nationally after 1890
  - Specialized intermediaries
- Corporations
  - External technology and inventions
  - Internal R&D as quality control, absorp capacity

Sources: Lamoreaux and Sokoloff, Usselman,

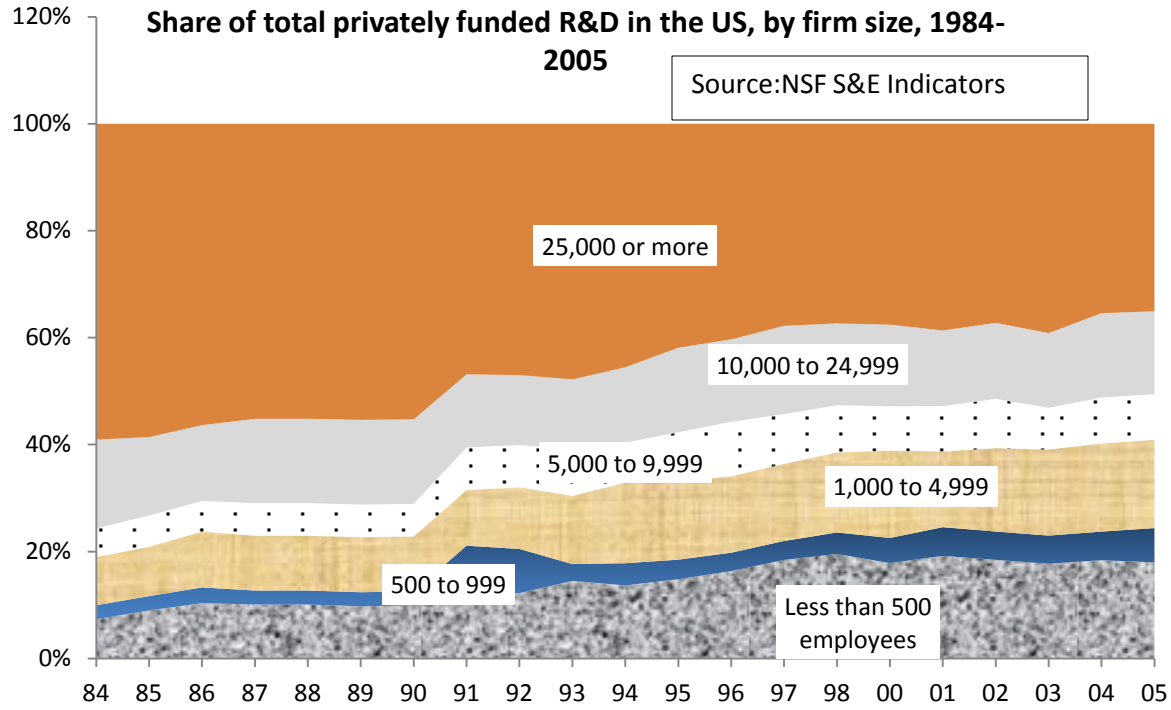
Rise of industrial research and innovation after WWI

"I am fully convinced that it has never, is not now, and never will pay commercially, to keep an establishment of professional inventors, or of men whose chief business it is to invent" … the duties of the patent department … (should be) … first and foremost on examining patents or inventions submitted by the public for consideration and second on examining descriptions of inventions forwarded by the company's employees." T.D. Lockwood, on the "Duties of the patent department", at AT&T, 1885. (cited by *Lamoreaux and Sokoloff, 1999)*

Why Internal Research

- Firm growth through innovation
- Assess and evaluate external technology
  - The original function of corporate R&D
- input for internal invention
  - Source of inventions
  - Guide internal search
  - Anti-trust
- Other:
  - Attract smart people
  - Signal to regulators or customers
  - Window on future

The Golden age of American Corporate R&D?



Diminishing role of large firms in industrial R&D in the US post 1980, market for technology, M&A, outsourcing …

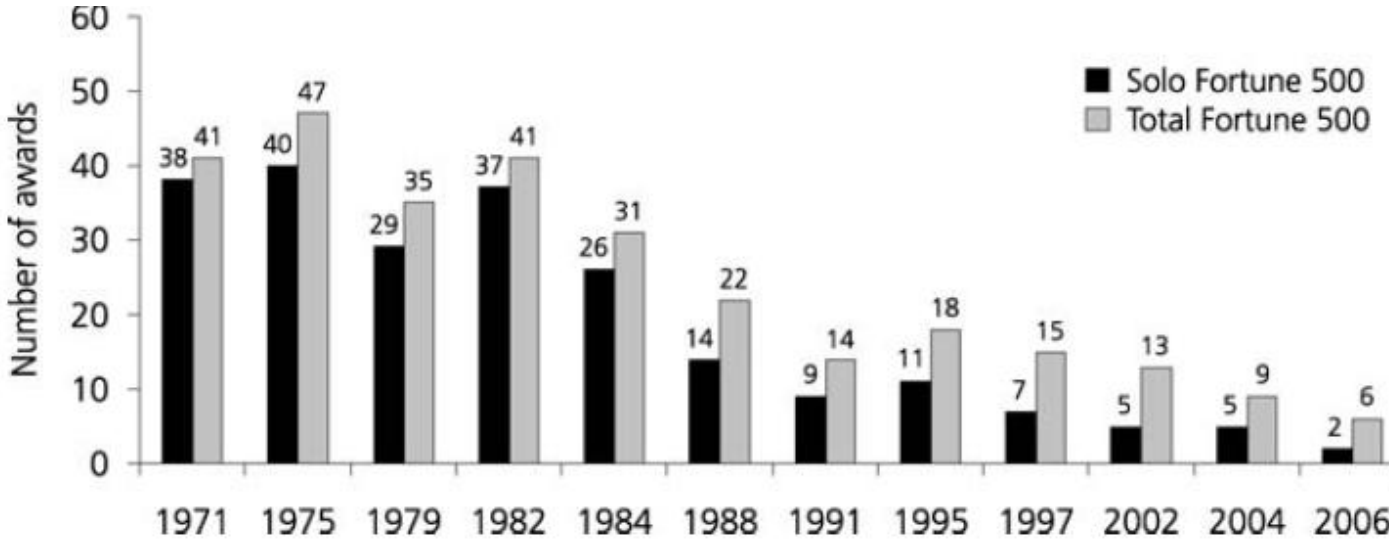
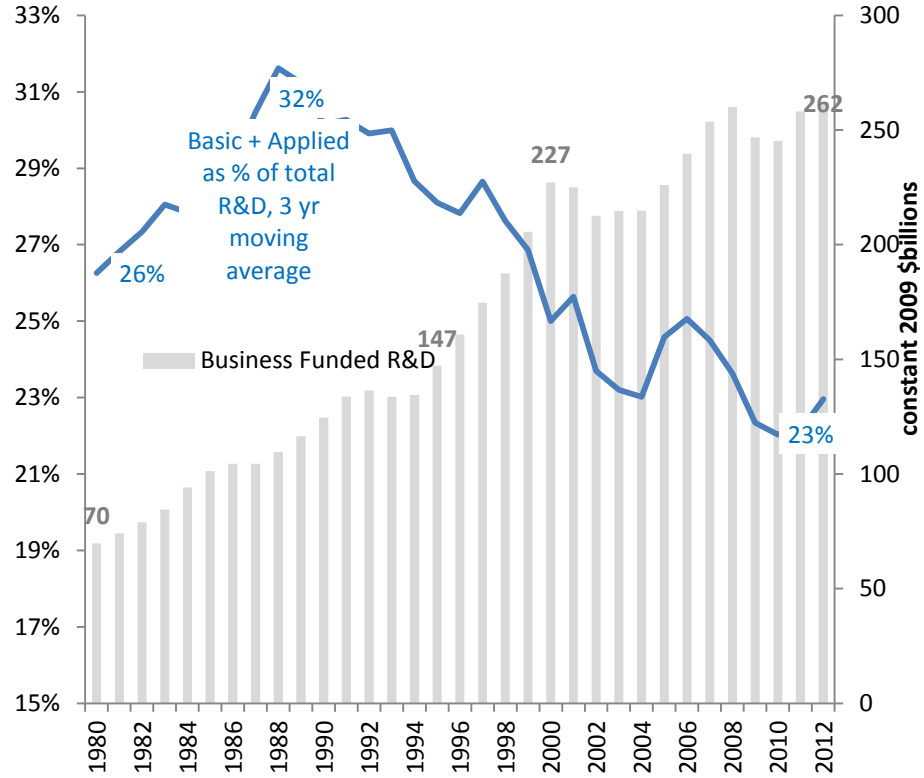


Figure 2 R&D 100 award winners from the Fortune 500. Block and Keller, 2009.

Post 1990 - US firms are withdrawing from research

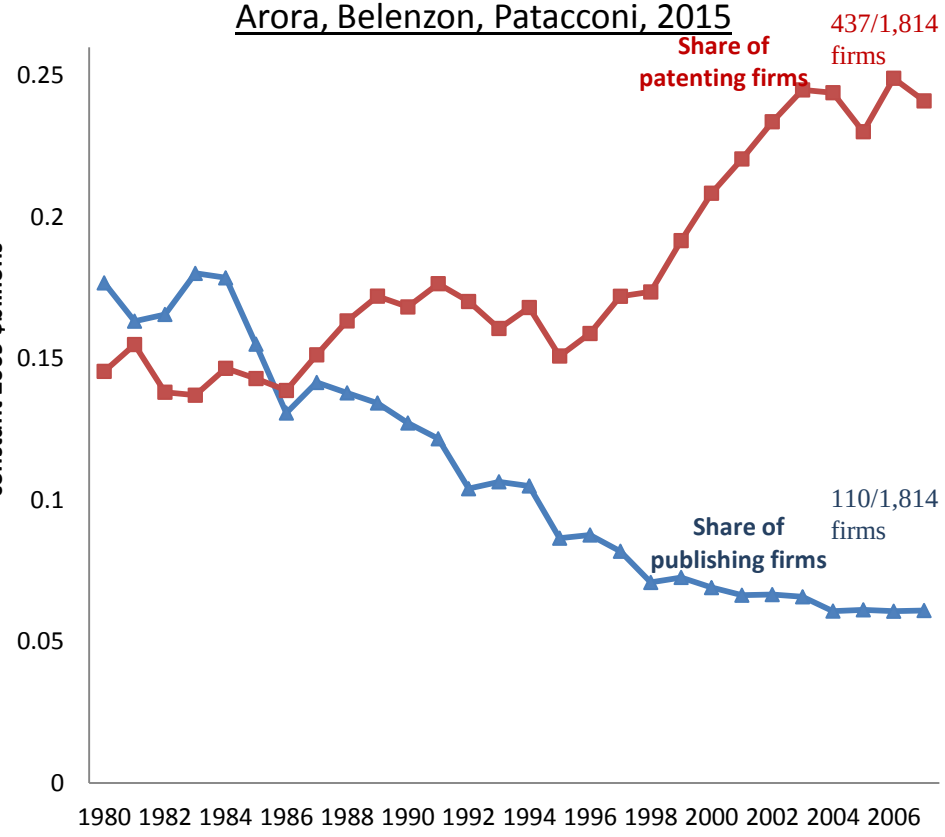
US business expenditure on basic and applied research, as share of total business funded R&D, 1980-2012, 3 year moving average, and total business funded R&D in constant 2009 dollars



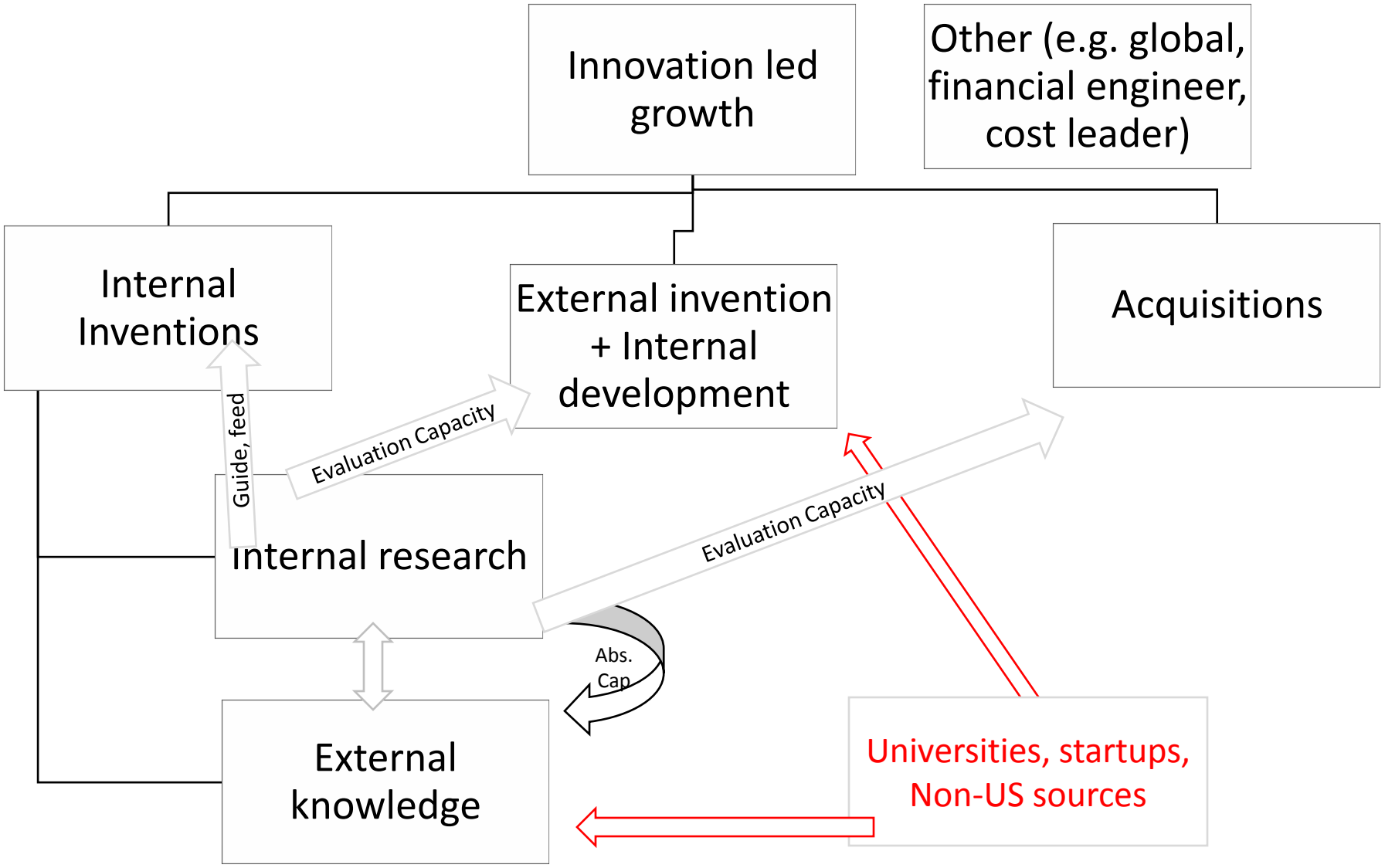
Source: NSF S&E Indicators, 2016, Appendix tables 4.6-4.8

Share of publishing and patenting US public firms, 1980-2007,

Arora, Belenzon, Patacconi, 2015



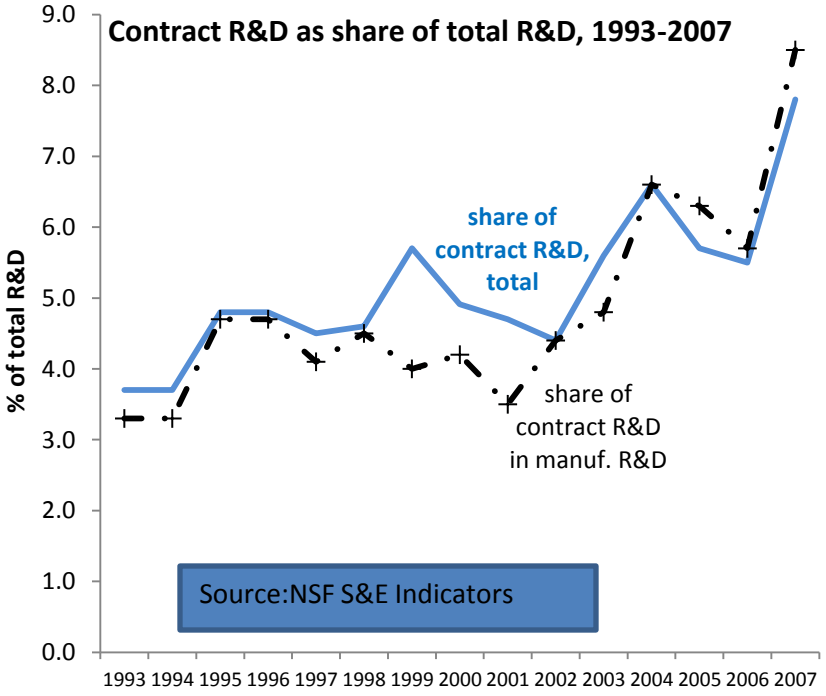
Role of corporate research in corporate innovation



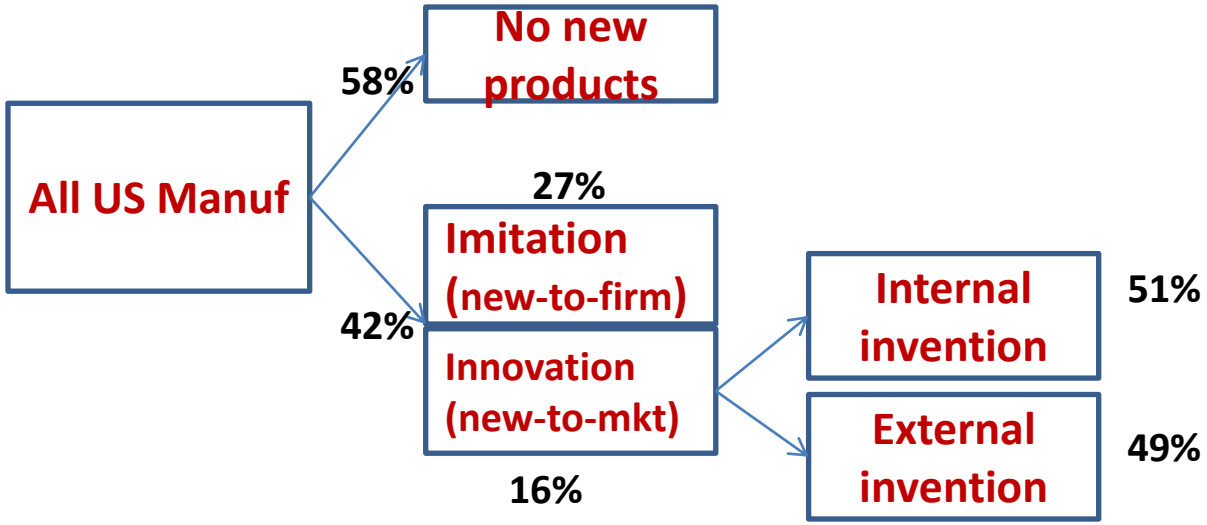
US distribution of technology licensing receipts by sector 2002, $B; *Carol Robbins, BEA 2006, tab 7*

Sector	**Licensing of Rights to Use IP Protected as Industrial Property**	Licensing of Rights to Use IP Protected by **Trademarks**	Licensing of Rights to Use IP Protected by **Copyright**	Licensing of Rights to Use a business format under a **franchise**	Payments for rights to use **Natural Resources** and Other intangibles	Total
Manufacturing	**59.5**	9.4	1.0	2.9	-	72.8
Trade and Transp	**1.0**	6.9	0.1	5.1	-	13.1
Information	**1.9**	4.9	6.6	0.0	0.1	13.5
Fin and Ins	**0.2**	0.7	0.0	1.4	0.0	2.4
Prof and Bus Serv	**3.0**	0.2	1.6	1.5	0.4	6.7
Other Industries	**1.0**	0.7	0.1	4.8	0.8	7.5
Total	**66.6**	22.8	9.4	15.7	1.3	115.9

- Market Transactions: Supply side
  - Inventor perspective:
    - Contract
    - License
    - Get acquired - Patent re-assignment data? (Carlos Serrano)



Demand Side: Innovator Perspective



Sources of external invention

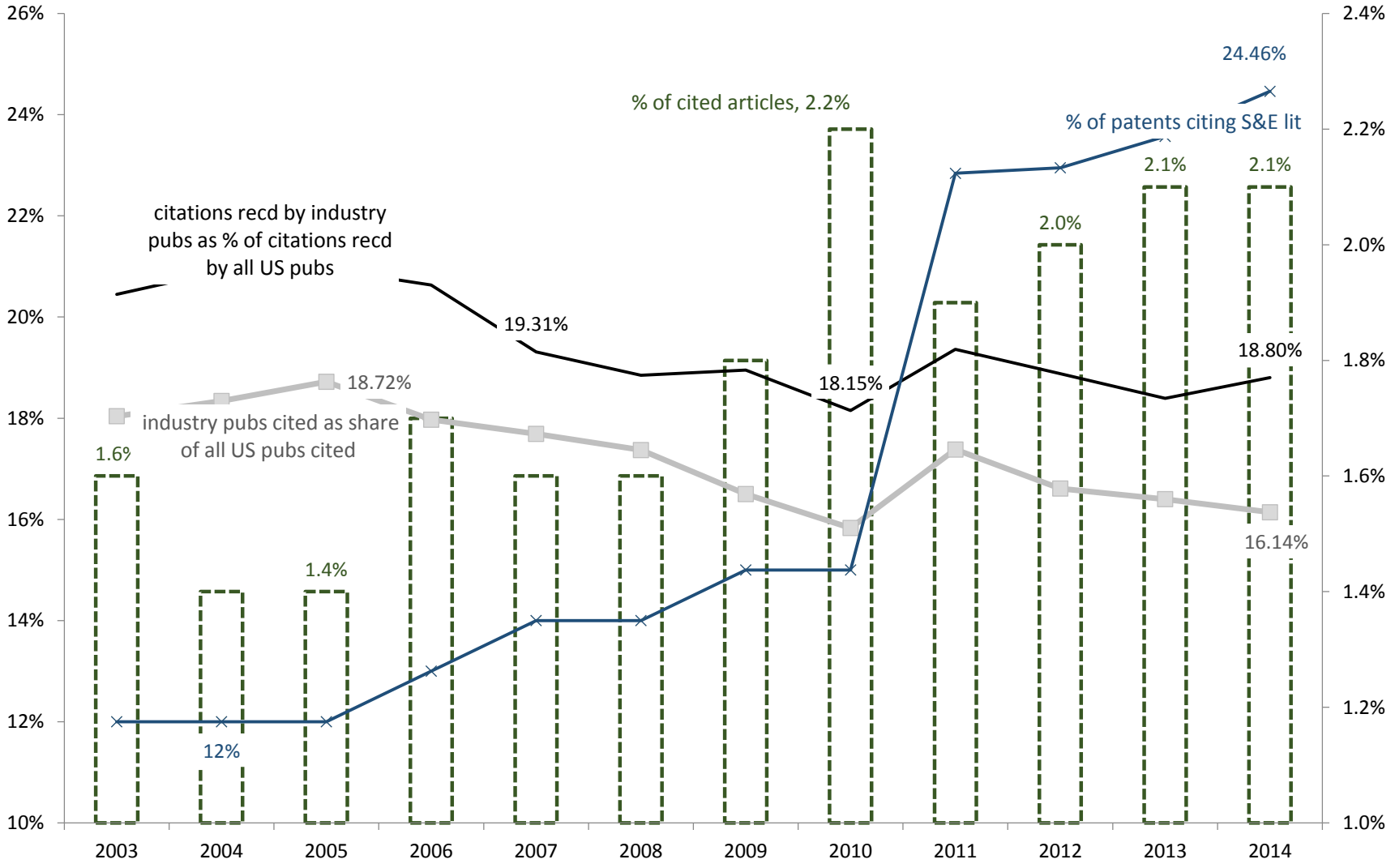
Supplier	14
Customer	27
Other Firm	8
Consultant Serv provider	8
Ind. Inventor	7
Univ	5
All specialists	17

JV	M&A	LIC	Contract	Informal	Market	Market only
61	10	13	21	37	37	16

Channels for acquiring external innovation

Innovation and the Sources of Invention in American Manufacturing, 2007-09:
Arora, Cohen, Walsh, *Research Policy 2016*

Knowledge for invention: Citations by US Patents to S&E articles

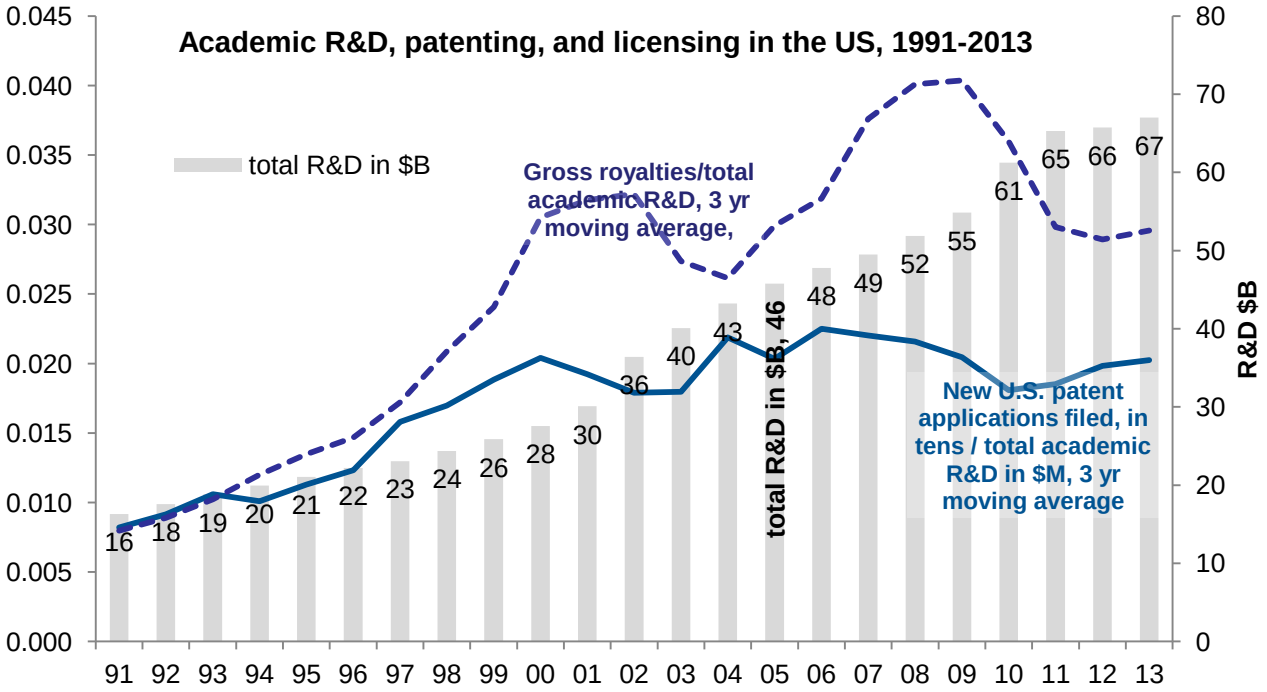


NSF S&E Indicators 2014 and 2016

Division of innovative labor: technology specialists & intermediaries

Source:NSF S&E Indicators

	Domestic net sales		Business-performed R&D/ sales (%)		Company-funded R&D/ sales (%)	
	2006	2007	2006	2007	2006	2007
All	6,642,500	7,027,049	3.7	3.8	3.4	3.5
Chemicals	524,160	589,918	9.3	8.5	9.2	8.4
Computer and electronic	612,885	699,520	7.6	7.9	7.5	7.9
SW and comp serv	376,638	304,952	9.0	11.2	8.7	10.9
Aero and defense manuf	243,110	263,321	11.2	11.5	4.9	5.1
R&D and related services[d]	86,945	89,166	**24.3**	**25.5**	**17.1**	**18.0**
Automotive manufacturing[e]	686,841	655,250	2.4	2.4	2.4	2.4
All other	4,111,921	4,424,922	1.3	1.4	1.3	1.3



What we need more data on

- Sources of invention
  - Internal
  - Partners (customers, suppliers)
  - Others (Startups, universities, ...)
- Sources of knowledge
  - Corporate
  - University
  - ?
- Flows of external knowledge
  - *Citations?*
  - *Text matching?*
- Flows of external invention
  - Licensing
  - Contract
  - M&A
  - *JV? Collaboration?*