Open innovation and Clusters
Impact on R&D in the US context

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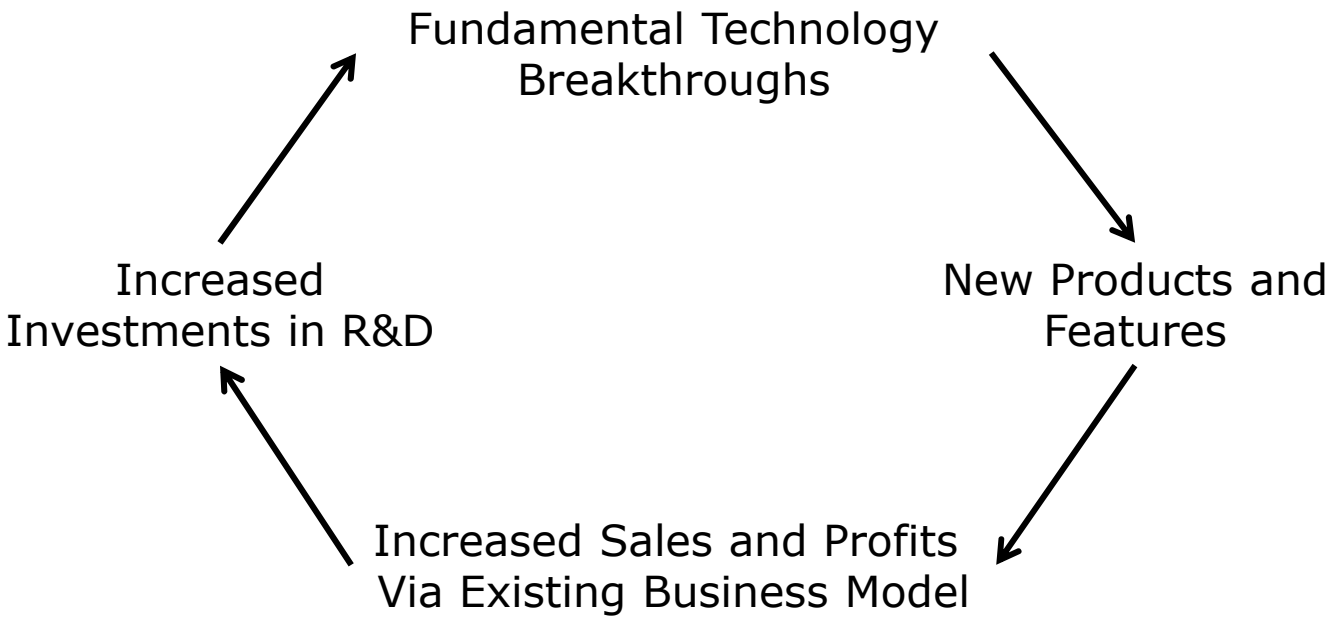
Chapter 7

The economics of innovation in the bio-medical industry – MGT 403

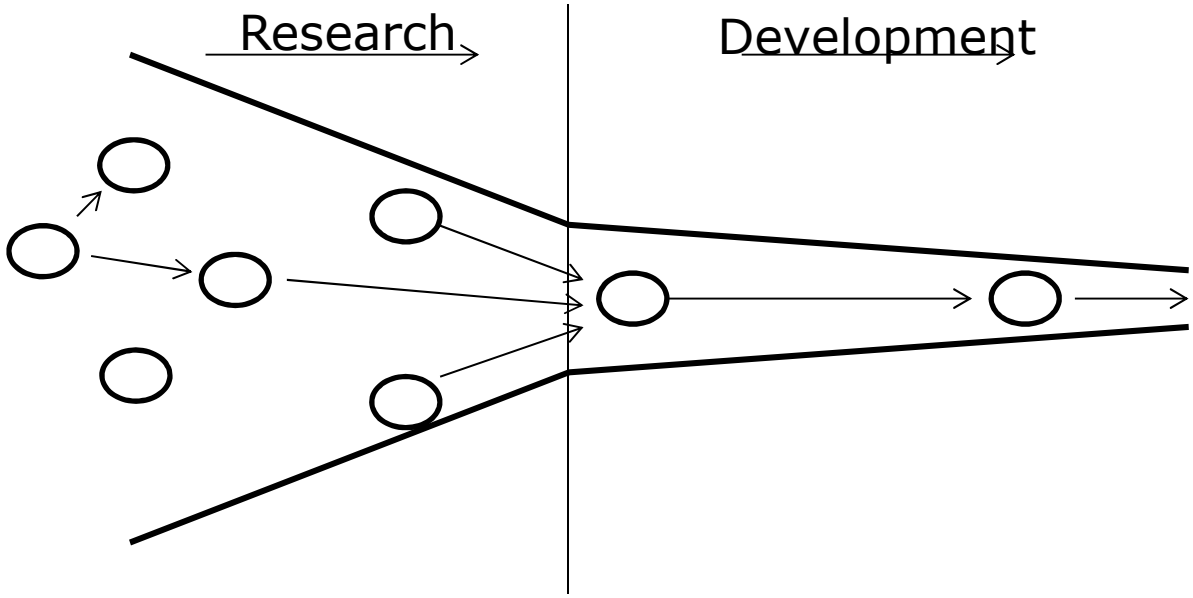
Spring 2019

Open Innovation

Virtuous circle of closed innovation

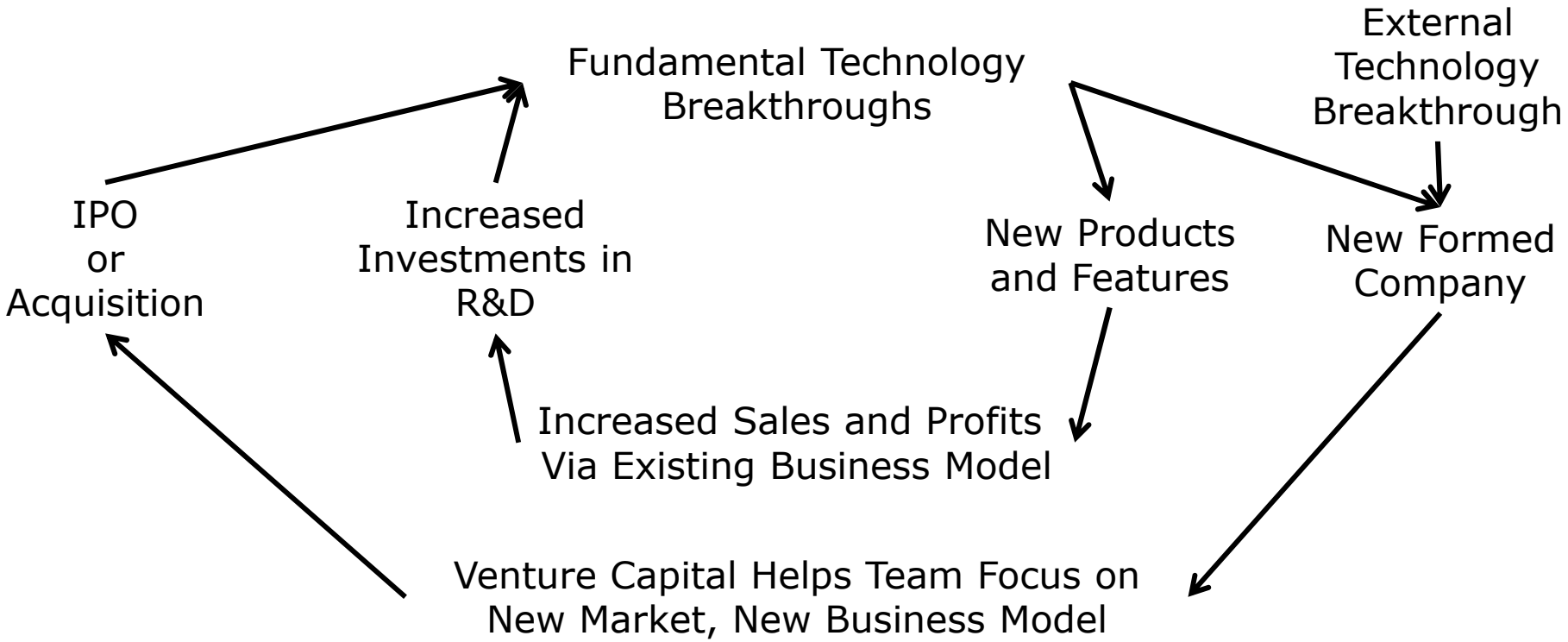


Closed Innovation

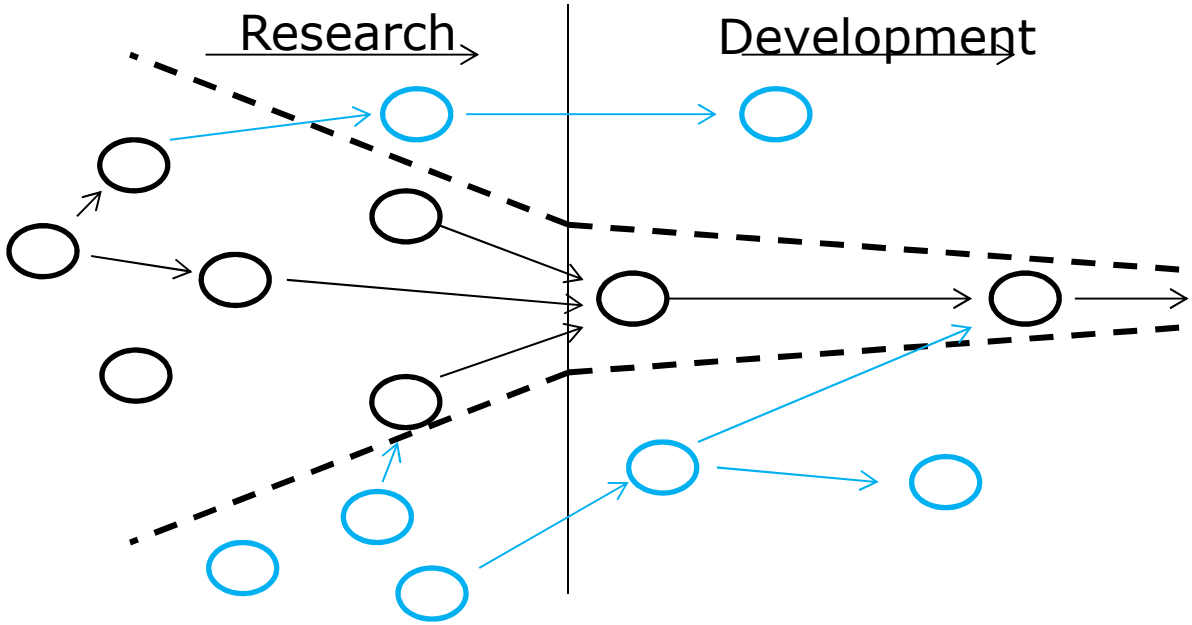


Henry Chesbrough, 2006

The source of open innovation: the virtuous circle is broken



Open Innovation



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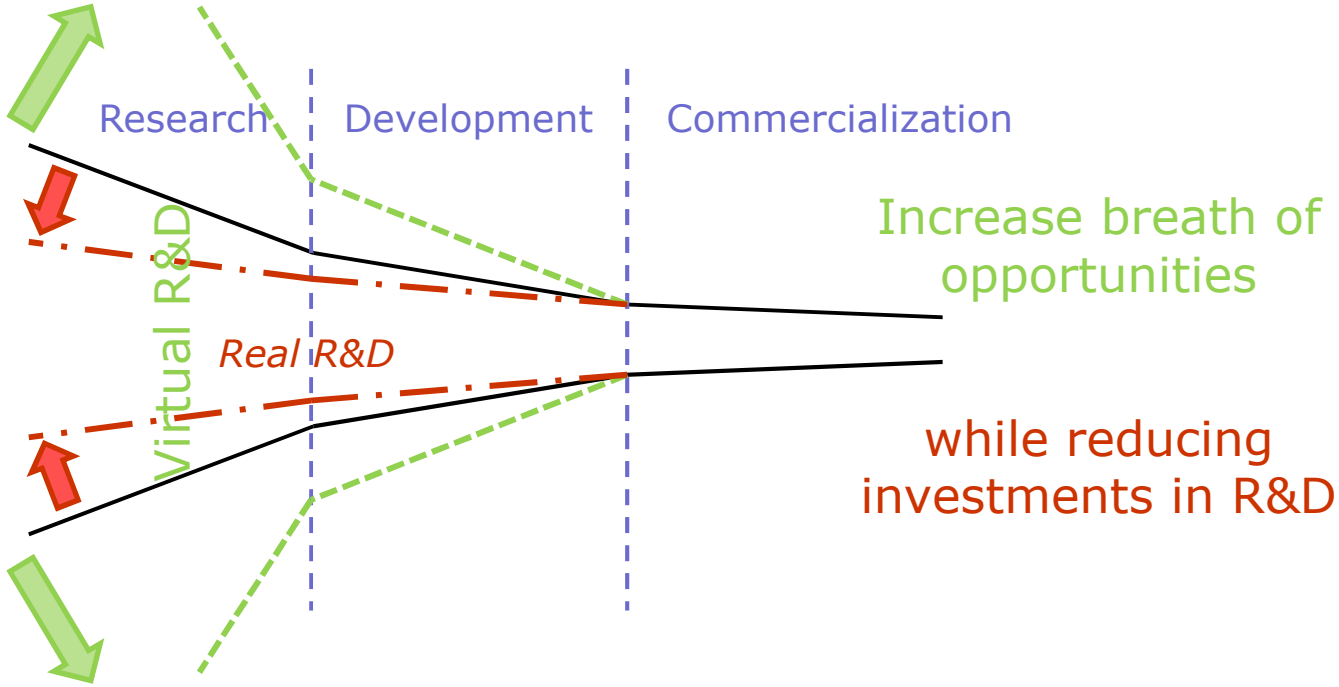
Why is it interesting?



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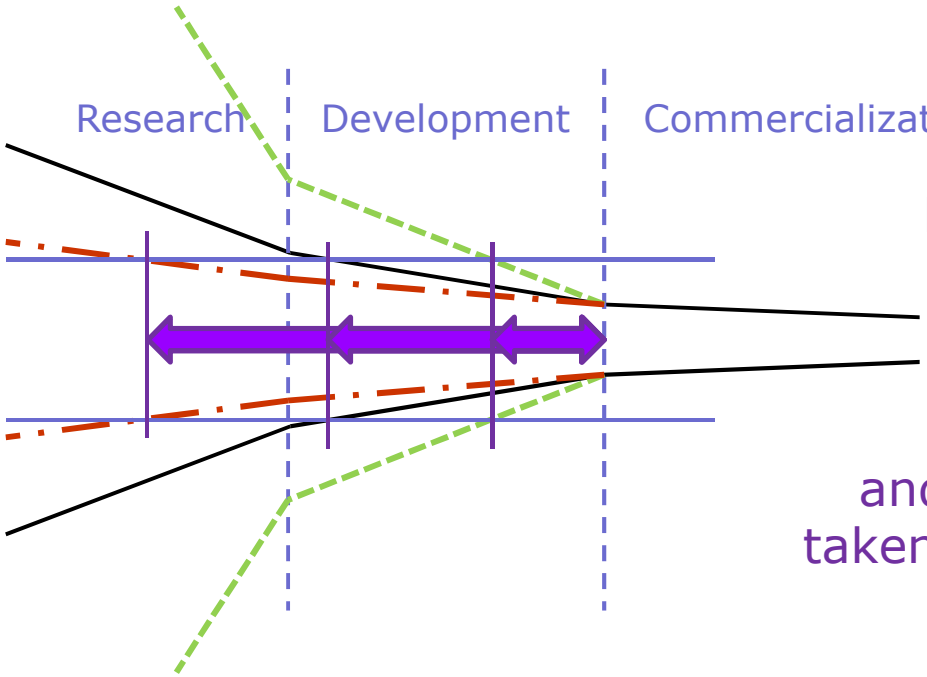


Reduce time
to market

and minimize risk
taken by the company

Now this comes at a cost…

- Field is broader but **accessible to competitors**
- Project is de-risked and decision comes later but at a **higher cost**
- More resources are (virtually) available but
  - product quality and evolution are more **difficult to control**
  - you **lose internal knowledge**

In favor: delay investment

- Transfer risk to third parties
  - No risk of having to write-off poor investments
  - Strategy of the company perceived as less chaotic

- Short term returns on investment
  - Higher readability for investors
  - Flexible M&A
    - Increased strategic flexibility (faster adaptation to market changes)
    - Larger choice for solutions
    - Taping into a broad number of societies / project
    - Potentially more innovative solutions

But: if you delay investment…

- Increase the cost of each option
  - artificial global cost increase of innovation
  - value capture by the entities taking the risk (investors / management)
    - Investors will invest in various technologies. Some will fail and they will recover their investments through a small number of successful ventures
- Less control on each product
  - no control on development
  - loss of know-how
- Difficulty to integrate new products
  - NIH syndrome
  - Absence of internal development means often lack of knowledge around the product

Closed vs. Open Innovation

- Ideas originate from the inside of the company
  - Large R&D center
  - IP to protect internal innovation from competition
- Labor mobility: limited
  - High fidelity of employees towards employer
- Internal Investment on R&D
  - Revenues generated by sales invested in internal fundamental research
  - Little reliance on external sources of financing
- Few weak start-ups
- Limited role of universities in innovation
  - Research for research's sake
  - No culture of technology transfer

- Ideas coming from various sources
  - Smaller, more flexible research entities
  - IP as a commercial asset
- Labor mobility: high
  - Employees will change company over their career
- External Investment on R&D
  - Revenues generated by sales invested also in acquiring external research
  - Driven by financial institutions
- Numerous start-ups
- Universities as key players
  - Combination of fundamental and applied research projects.
  - Development of Tech Transfer Offices and technology transfer policies

Elements for successful open innovation

- Pool of well educated people
- Pool of ideas
  - That may circulate (favor confrontation)
  - That could be protected (avoid free rider syndrome)
  - That could be valorized
- Based on fundamental research
- In an open, well equipped environment
- With a source of financing
  - For evolution of fundamental concepts
  - For their transformation into products
- Developed products shall generate sufficient ROI
  - Ability to create and capture value

The case of the biomedical industry

Productivity crisis

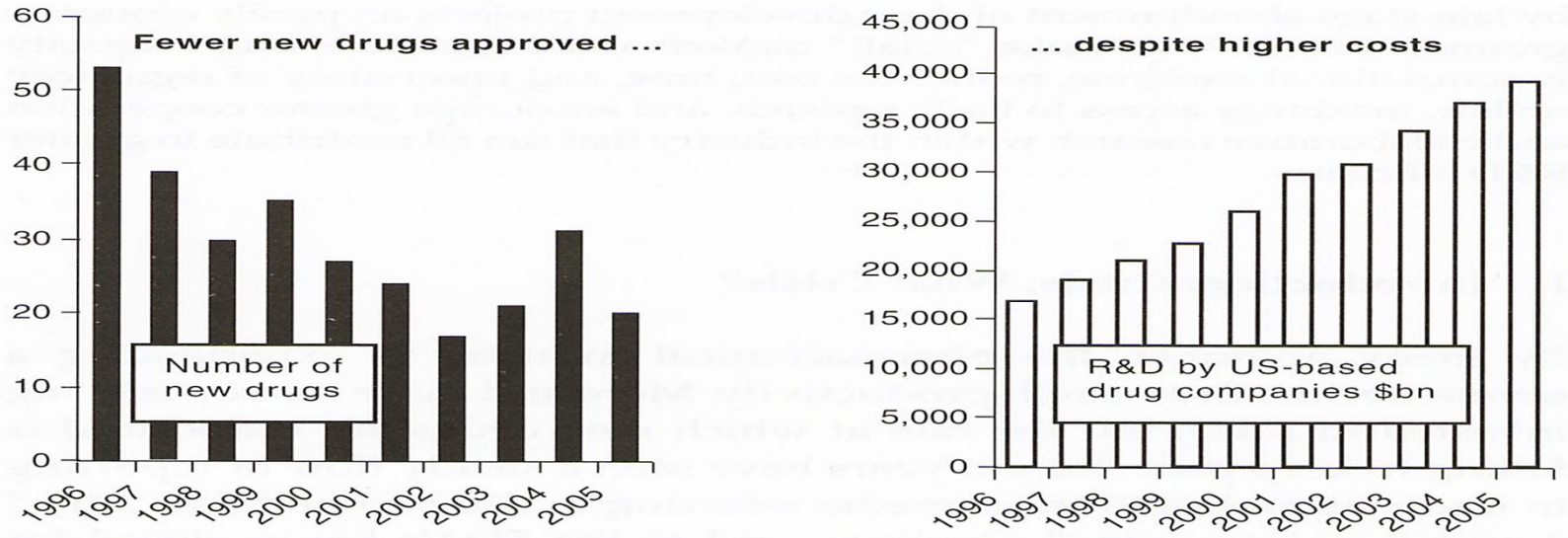


Figure 1.1
The productivity crisis.

Efficiency loss: possible reasons

- No more low hanging fruits
  - Classical R&D models have reached their limits
  - Increased complexity of product manufacturing / difficult to transform research results in viable products
  - Reduced marginal impact of each additionally invested dollar

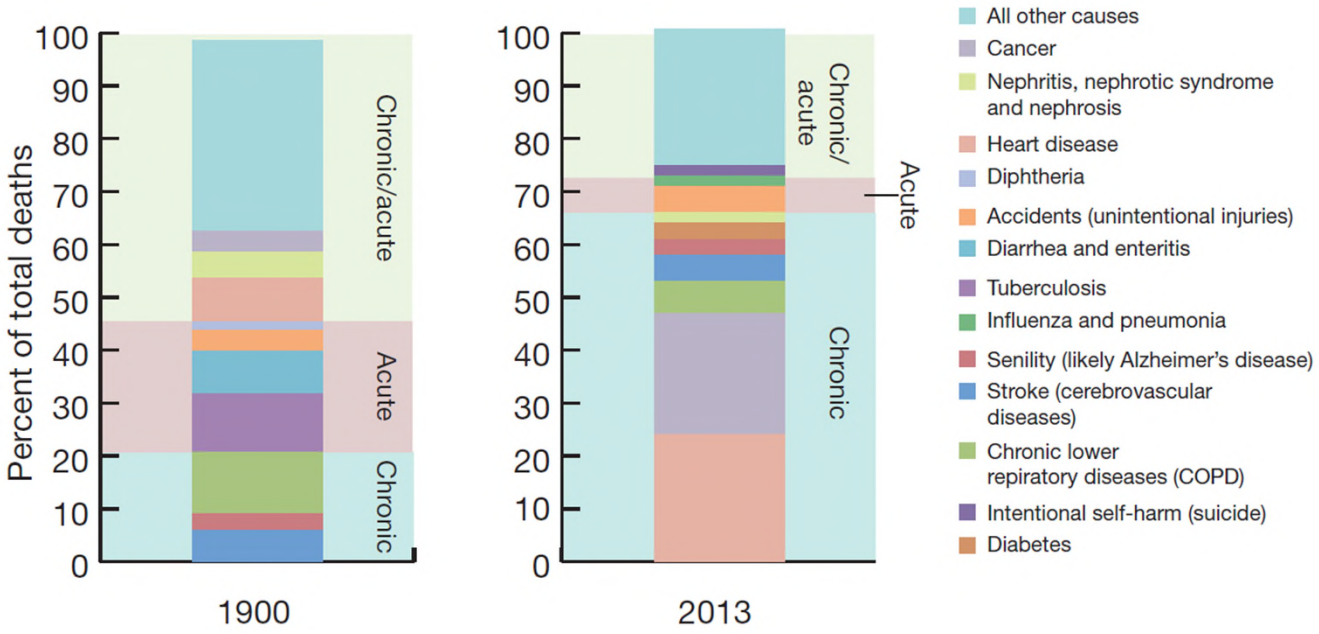
Drug discovery approaches

- Serendipity / ancestral observation of the effects of a complex compound and isolation of the active ingredient
- Random generation of large libraries of molecules similar to known active compounds and tested on cell cultures
- Understanding of biological mechanisms, target identification, building of (complex) models simulating the targets, generating libraries of molecules interacting with the targets
- Personalization of the target. Consideration of interrelated mechanisms. Molecules are only active on specific subsets of patients

Efficiency loss: possible reasons

- No more low hanging fruits
  - Classical R&D models have reached their limits
  - Increased complexity of product manufacturing / difficult to transform research results in viable products
  - Reduced marginal impact of each additionally invested dollar
- Shift in focus from acute to chronic
  - Long term patients / economic rent
  - Higher complexity in the target treatment (e.g. long term effects)
  - Interaction with other medical conditions (more difficult to demonstrate effect)
  - Need for more collaboration between disciplines

From acute to chronic



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  - Need for more collaboration between disciplines
- Central place of public safety / increased regulatory burden
  - More administrative time / not devoted to research
  - Lower efficiency of invested money

Science vs. Business

	Science	Business
Score kept by:	Peer review Grant givers	Capital Market
Measured by:	Reputation	Profitability
Synonymous with:	Publication	Secrecy

However: blurry boundary

- Large companies engaged in basic research
- Entrepreneurial companies key players in commercializing innovations
- Universities influenced by industrials needs

Raise of science-based businesses

- Demise of the central corporate research laboratories
- Increasingly active expectations by universities to capture financial returns
- Emergence of a companies basing their business model on the combination of participating in the creation and advancement of science and attempt to capture related financial returns
  - Linked to the maturity of the scientific foundations
  - Vehicle to further develop and commercialize fruits of academic research

Challenges faced by biotechnology as science-based business

- Risk Management Problem
  - Encouraging and rewarding risk taking on long time horizons
- Integration problem
  - Combining knowledge across highly diverse disciplinary bodies
- Learning problem
  - Need for cumulative learning over the life of the company

Elements for successful open innovation (reminder)

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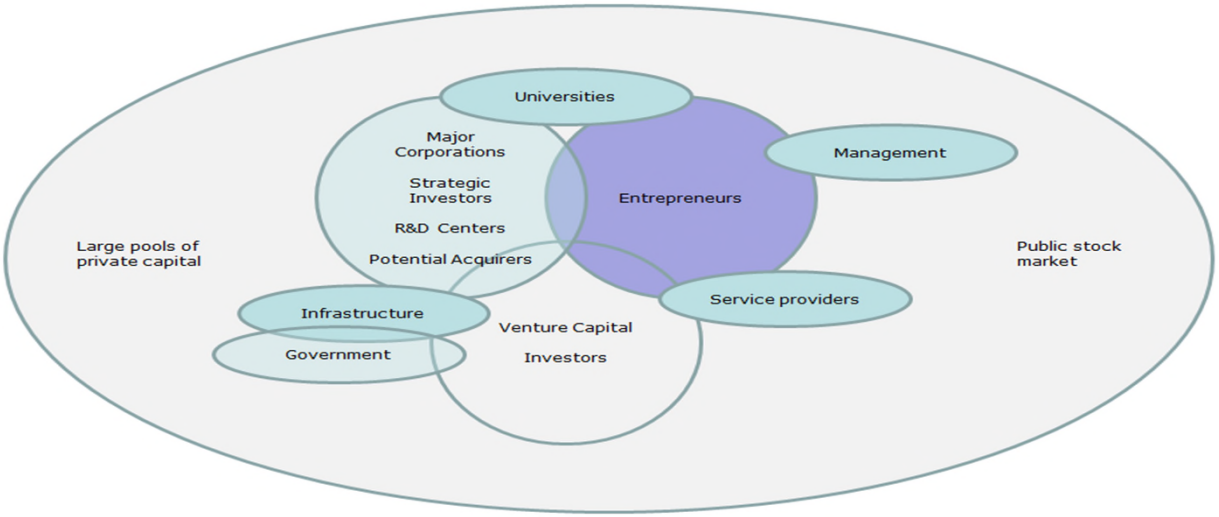
Clusters

Clusters of Innovation



«The right combination of factors and policies can unleash the inherent entrepreneurial capacity of society, energize individual initiative, and create individual and collective benefit»

More than a «classical» business cluster

- Business cluster: geographic concentration of a critical mass of interconnected companies and institutions
- Gain competitive advantage through
  - Economies of scale
  - Reduced transaction costs
- Some examples:
  - Plastic injection near Oyonnax
  - Watches in the Vallée de Joux
  - Dialysis equipment around Mirandola
  - Chemistry and pharma around Basel
  - Orthopedic implants in the Biel-Solothurn region

Role of the state…

- Universities
  - Open collaboration with private industry
  - Creation of Industrial Parks in cooperation with companies
  - Source of education in entrepreneurship, business and science

- Government
  - Provides transparent rule of law, safe stable society, infrastructures
  - Funding of research effort
  - Create environment that favors transfer of university innovations to private corporations

Running the business…

- Entrepreneurs
  - Ready to take big risks for big rewards
  - Willing to seek outside equity capital to finance such goal
    - Comes at high price diluting ownership
  - Recycling in subsequent startups instead of retaining control of their venture

- Venture Capital
  - Structured financing driving companies to
    - Value creation
    - Scaling
    - Early exit
  - Aligning interests
    - Carried interest compensation
    - Limited fund life

The big players…

- Mature corporations
  - Collaborate with emerging firms
    - Contractual agreements
    - Equity investments
    - Partnerships and acquisitions
  - Don’t look for incremental growth and look for radical and disruptive innovations

- Industrial Research centers
  - Reservoir of talents
  - Reservoir of technologies
  - Able to spot the projects in start-up companies

Supporting the players…

- Service Providers / Management
  - Lawyers / accountants / recruiters / bankers / incubators / accelerators
    - Ready to defer fees in exchange of shares
    - Specialized in working with start-ups
    - Functional expertise is primary – industry specific is secondary

Behavioral aspects…

- Mobility of resources
  - Ventures are created and die or successfully exit
  - Capital, people, knowledge and technology are continually on the move
    - Capital staged to achieve the next major milestone
    - People rotation from one start-up to another
    - Use expertise to start / invest in a new company
    - Technology is protected by IP that can be traded
- Entrepreneurial process
  - Structures and title less important than team process and flexible leadership
  - Less formal planning / more short-cycle experiment
  - Entrepreneur conveying a vision of the enterprise
  - Failure is a possible (probable) outcome

Behavioral aspects…

- Global strategic perspective
  - Focus on large markets with little competition
  - Look globally for opportunities, financing, talents and resources
- Alignment of interests
  - Investments aligns investors, entrepreneurs, management and employees to strive for big win
  - Create environment of collaboration despite competition
- Global ties among COI's
  - Establish links (weak or strong) with other COI's
    - Access to people, expertise, market
    - Rapid sharing of knowledge and technology

To conclude on clusters

More than concentration, it's the nature and behavior of components that is distinctive

- Components
  - Universities
  - Government
  - Entrepreneurs
  - Venture Capital
  - Mature corporation
  - Industrial research centers
  - Service providers
  - Management
- Behaviors
  - Mobility of resources
  - Entrepreneurial Process
  - Global Strategic Perspective
  - Alignment of interests
  - Global linkage among COI

Open Innovation – Clusters

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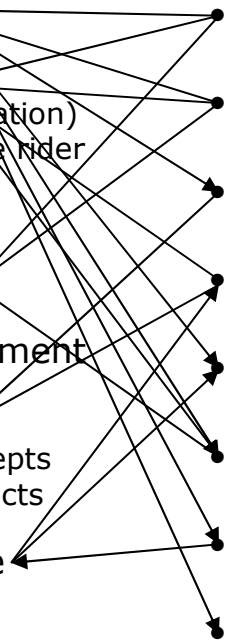


Universities

Government

Entrepreneurs

Venture Capital

Mature corporation

Industrial research centers

Service providers

Management

Open Innovation – Cluster – the Boston case

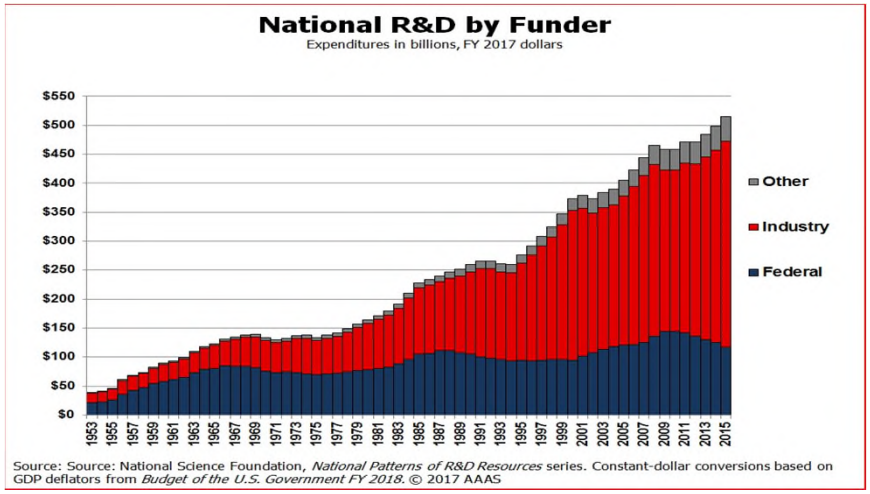
Boston: an American example of a Life Sciences cluster

- Importance of the **government** as a actor in **fundamental research**
- Importance of **government** as an actor in developing **education**
- Geographical **concentration of brains**
- Geographical **concentration** of established **industrial actors**
- Creating a **favorable business environment**
- Implementation of **efficient tools** for the **protection of ideas**
- Implementation of **efficient tools** for the **financing** of projects

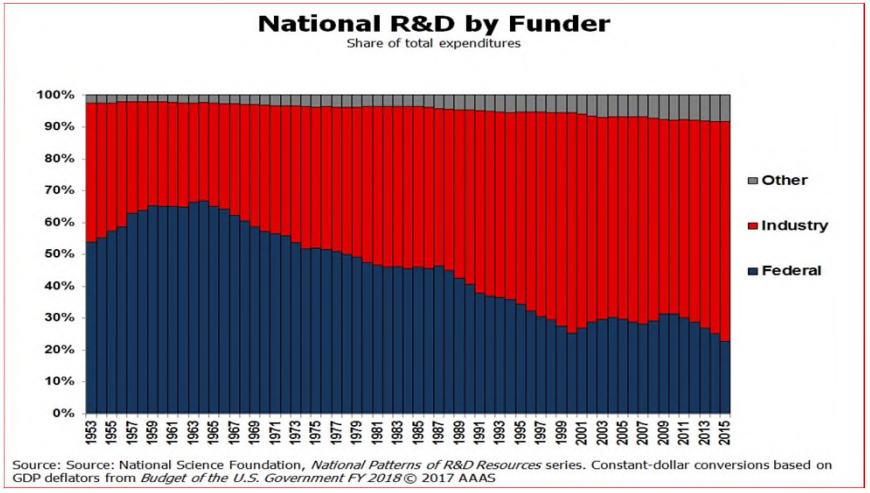
Basic research: a governmental strategical goal

- WW2 production efforts: a catalyst to a new implication of US government in basic research
- "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which they have waged this war, we can create a fuller and more fruitful employment and fuller and more fruitful life" (Franklin D. Roosevelt)
- Veenar Bush commissioned to study ways to capitalize on its military and scientific advanced in peace time
  - Need to increase funding federal funding of basic research at university level
  - Too high dependency on basic research imported from Europe

Who is investing in R&D (US 1953-2015)

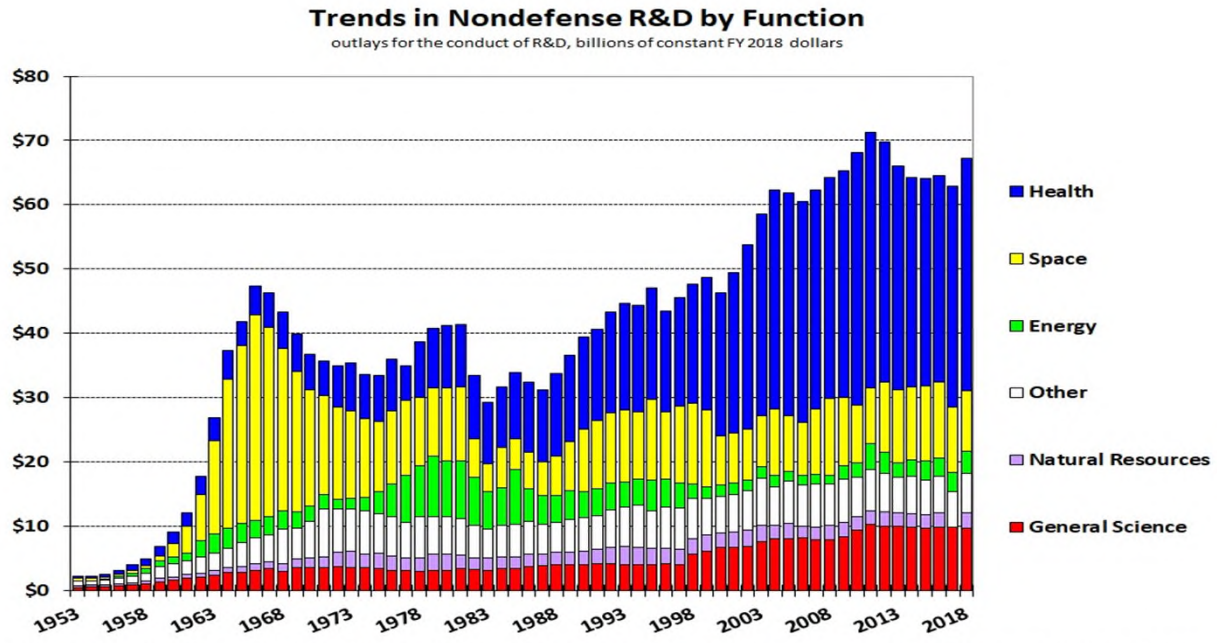


Source of R&D financing
2017 Constant$ Millions



Source: National Patterns of R&D Resources;
National Science Foundation
http://www.nsf.gov

Public R&D Money:
a strong focus in Life Sciences



Source: AAAS, based on OMB Historical Tables in *Budget of the United States Government FY 2019*. Some Energy programs shifted to General Science beginning in FY 1998. © 2018 AAAS

Increasing scientific output

Global Output

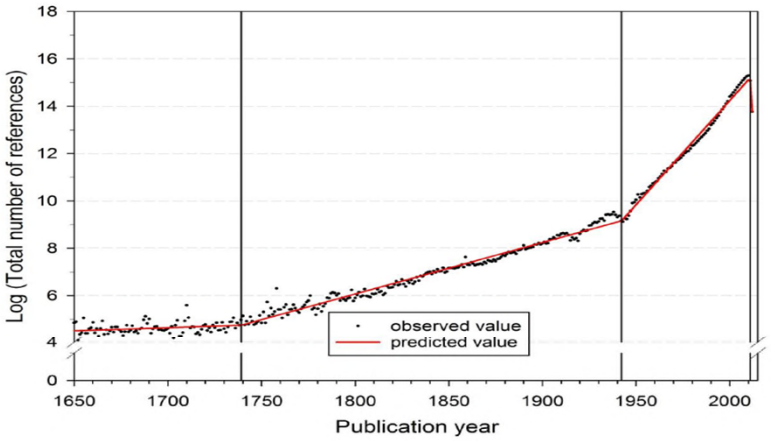


Figure 3. Segmented growth of the annual number of cited references from 1650 to 2012 (citing publications from 2012)

Medical Output

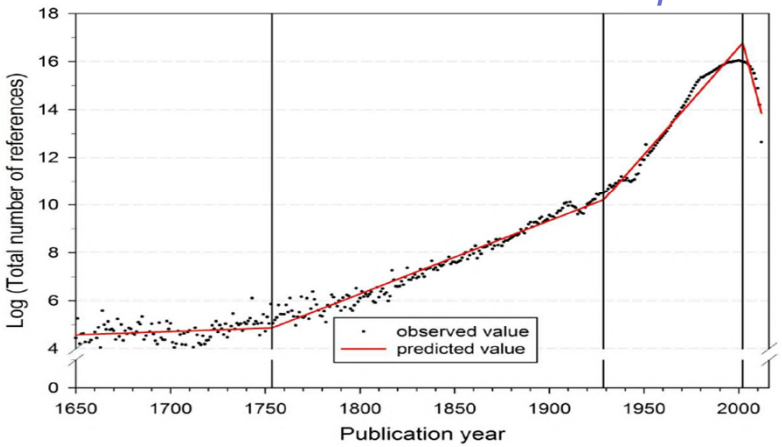
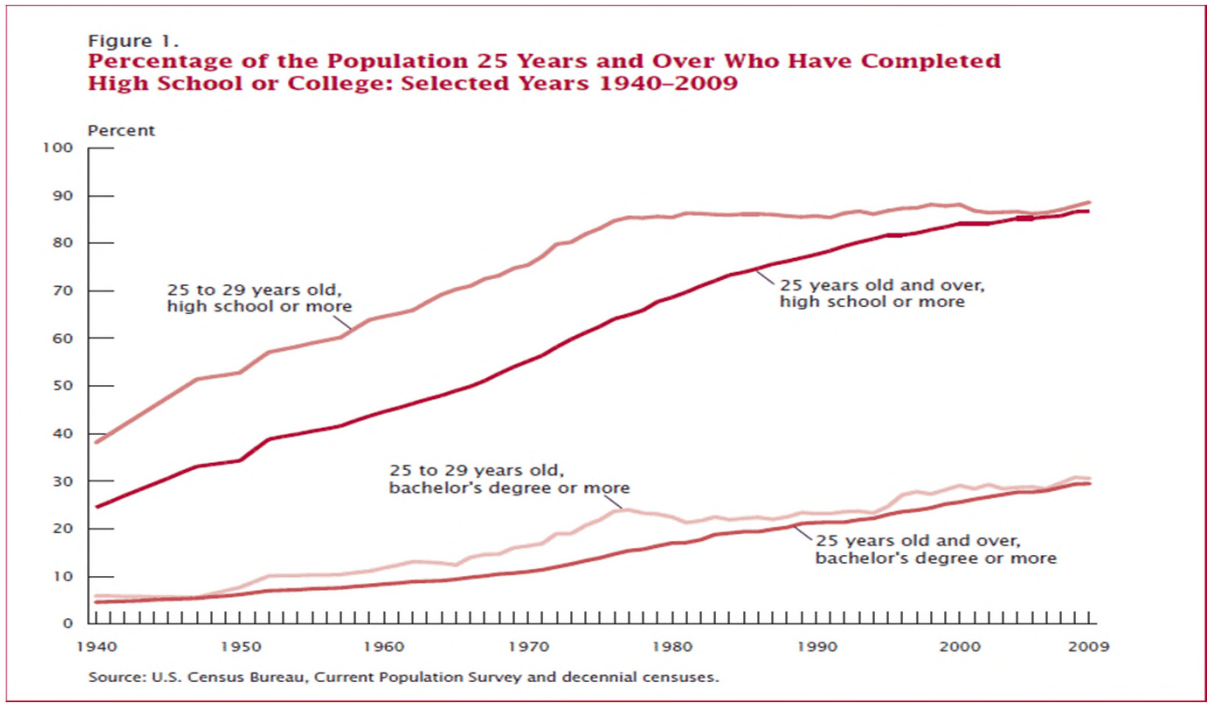
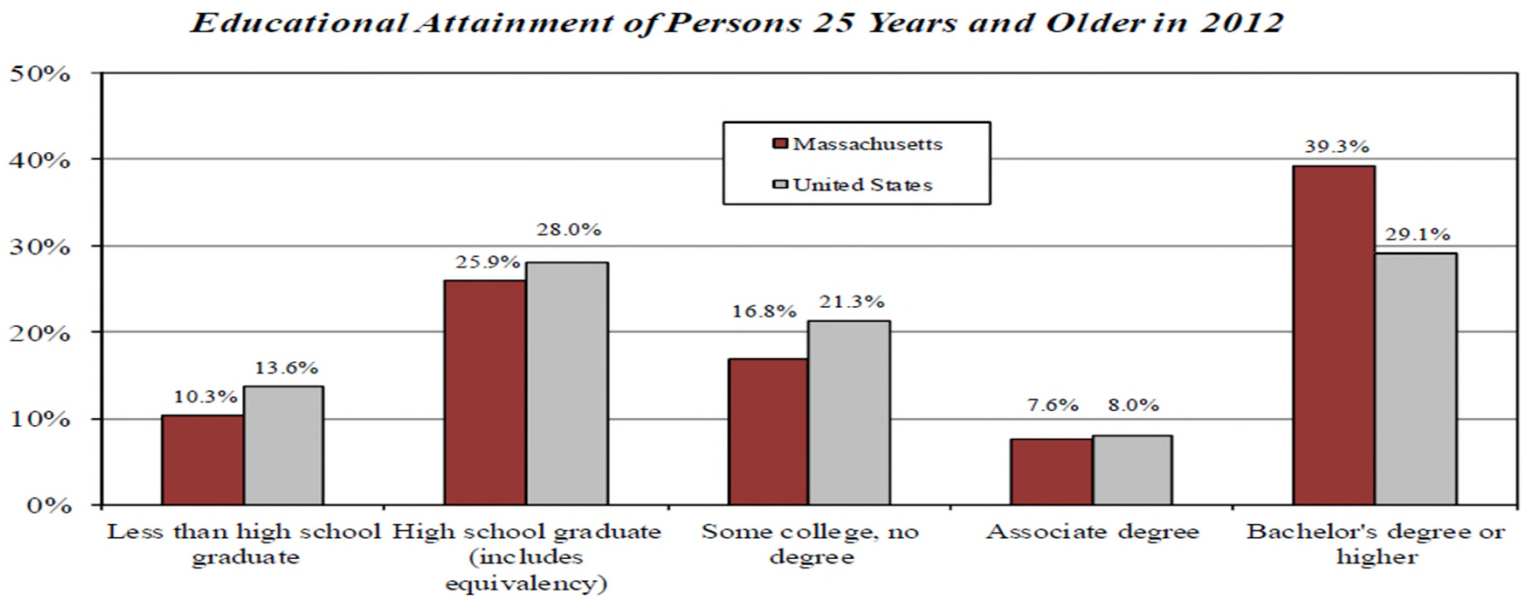


Figure 5. Segmented growth of the annual number of cited references from 1650 to 2012 in the medical and health sciences (citing publications from 1980 to 2012)

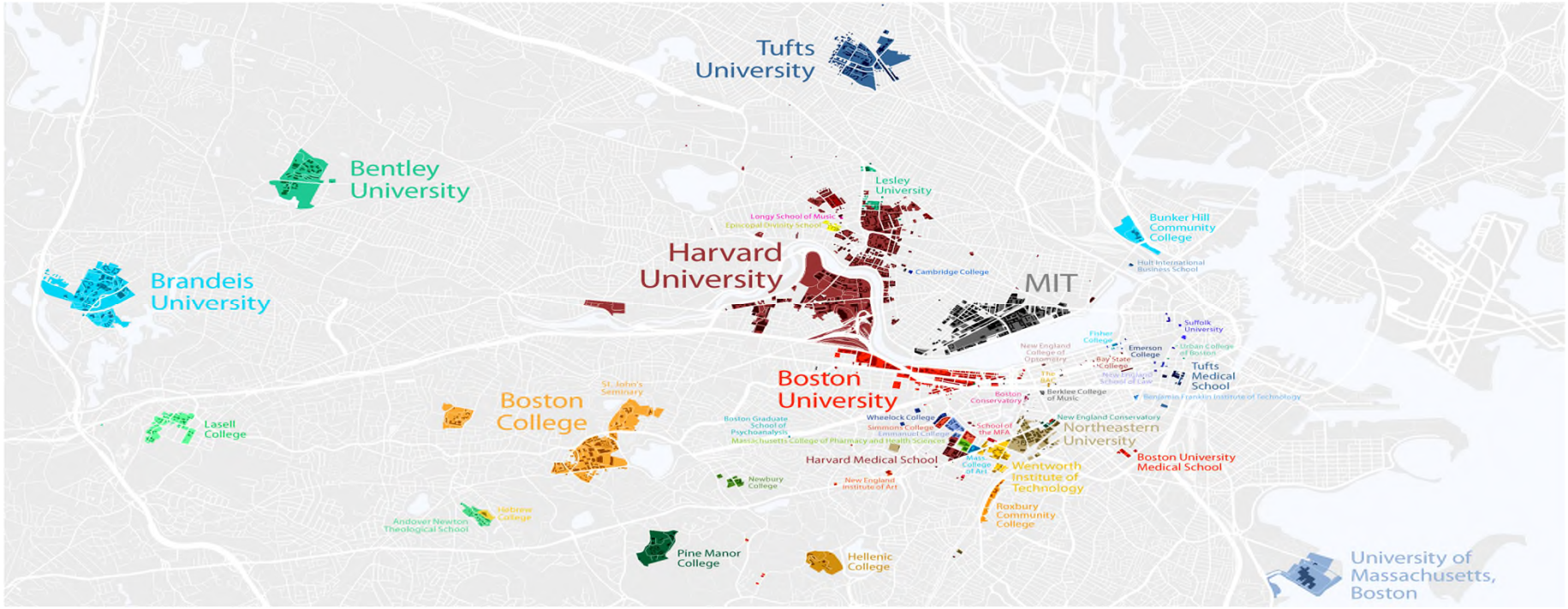
Increasing educated Human Ressources



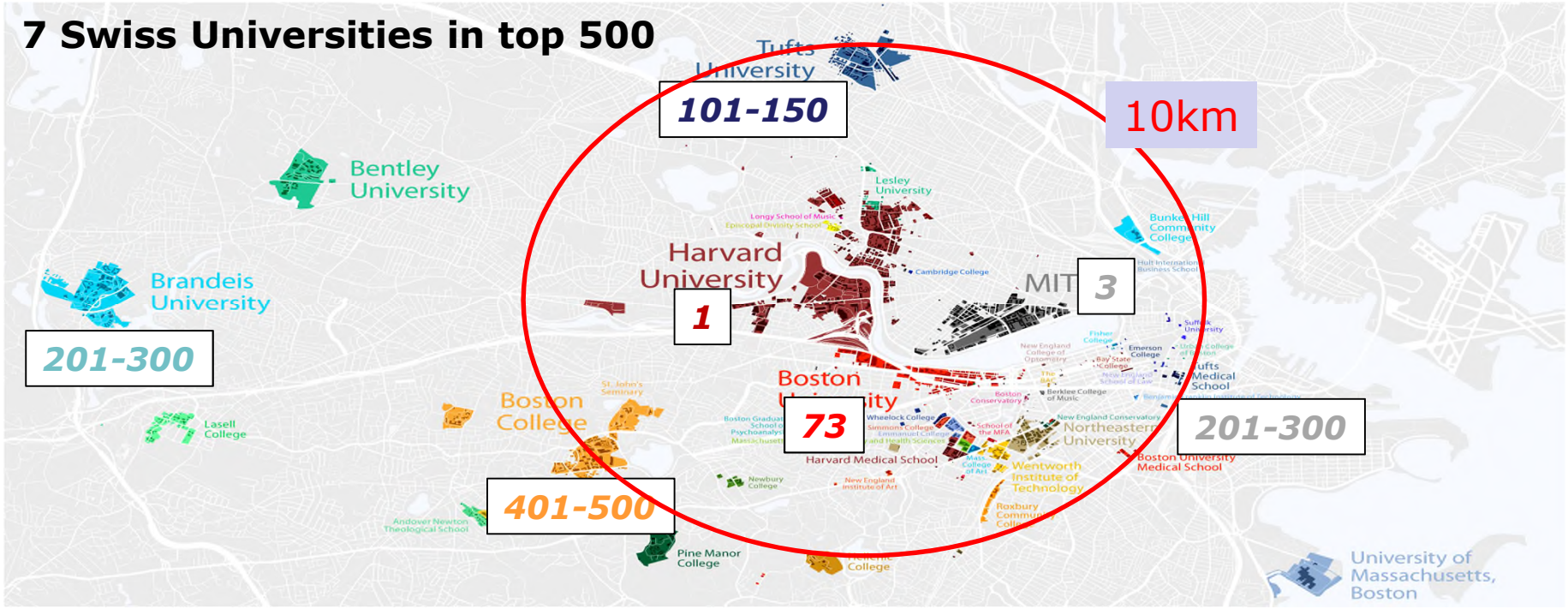
Educational level



Boston academic environment



In the Shanghai ranking



Number of students

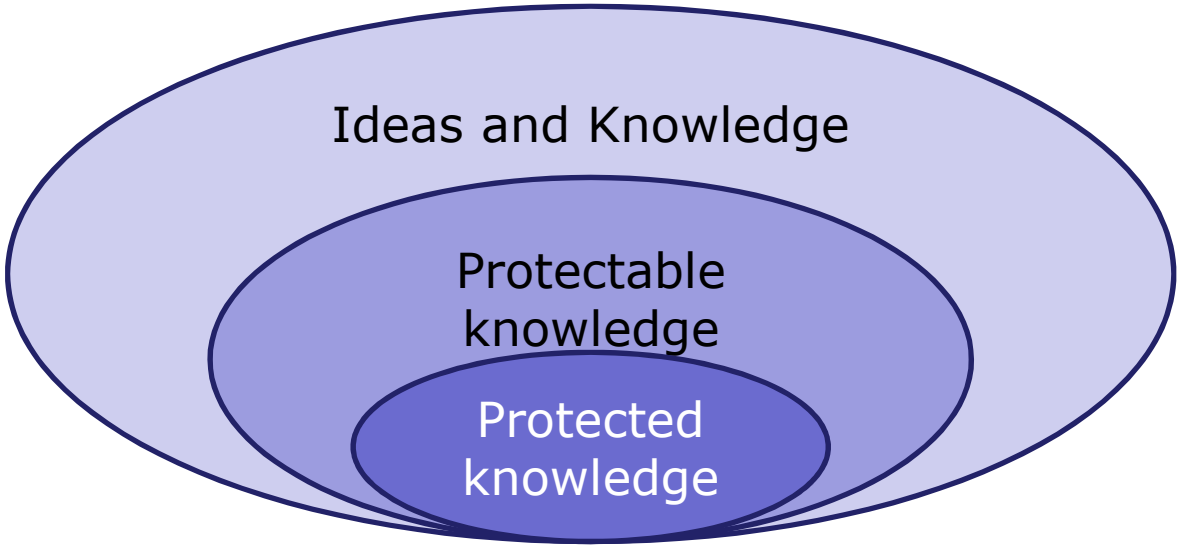
University	Nb of students		University	Nb of students
Harvard	20’050		ETHZ	18’500
MIT	10’900		Uni Zürich	26’300
Boston University	31’750		Uni Genève	16’500
Tufts	9’500		Uni Basel	9’750
Brandeis	5’000		EPFL	9’900
Northeastern	20’750		Uni Bern	17’500
Boston College	14’400		Uni Lausanne	14’000
Total	**112’350**		**Total**	**112’450**

Mature corporations / Research centers

Government

- Rules
  - Act to promote growth and opportunity
    - Global Entrepreneur in Residence Program
    - Go around the H1-B visa limitations
- Investments
  - 1 billion US$ invested in the MLSC (Massachusetts Life Science Center)
    - Internships
    - Investments in infrastructure
- Leadership
  - Investment in accelerator programs (e.g. 1 million US$ in the MassChallenge)

Ideas and IP



Patents | Copyrights | Trade Secrets | Trademarks

Patents

- Patents are legal agreements between a country and an physical or moral person (inventor / applicant) that give the right to the inventor / applicant to prohibit anyone to manufacture, distribute, sell his invention in the country

  - for a given duration of time (generally 20 years)
  - against regular payment of a financial fee
  - and sufficient disclosure of the invention

Patents

- To be patentable, an invention has to be:
  - Novel (different from prior art)
  - Inventive / non evident (not just a combination of knowledge)
  - Industrialisable

Patents philosophy

- Reward inventors who take risks by granting them an exclusivity period to recover their investment
- Force inventors to disclose the content of their invention to encourage and facilitate further innovations
- Avoid inventions to stay on a shelf by asking financial contribution to maintain a patent
- Limit the time of exclusivity to keep a competitive market

Patent system well suited for Healthcare Innovation

- Easy to describe clearly the invention
  - A molecule (pharma), a mechanical or electronical piece of equipment (medical devices), a well defined, controlled and documented manufacturing process
- Easy to determine novelty and inventiveness
  - Unambiguous description allows simple analysis
- Technological evolution cycle and lifecycle of products similar to duration of patents
- Large upfront investments in R&D at risk with later high return potential

- But easy to imitate
  - Simplicity of description means that innovation may easily be understood, copied and improved

US as a favorable territory to IP

- Bay-Dole Act (technology transfer)
  - Allow research institutions to file patents on research conducted with federal money
  - Define rules for the valorization of such patents with incentives for inventors and research institutions

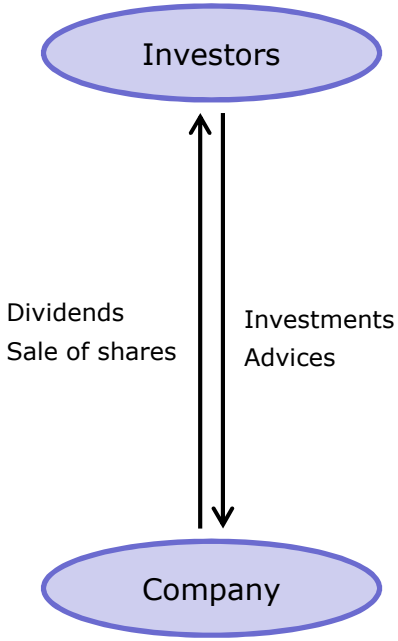
- Hatch-Waxman
  - Protects innovative drugs by providing term extensions of patents under certain conditions
  - Provides incentives to imitators to challenge weak patents and simplifies the registration (and approval) of generic drugs: only bioequivalence has to be shown.

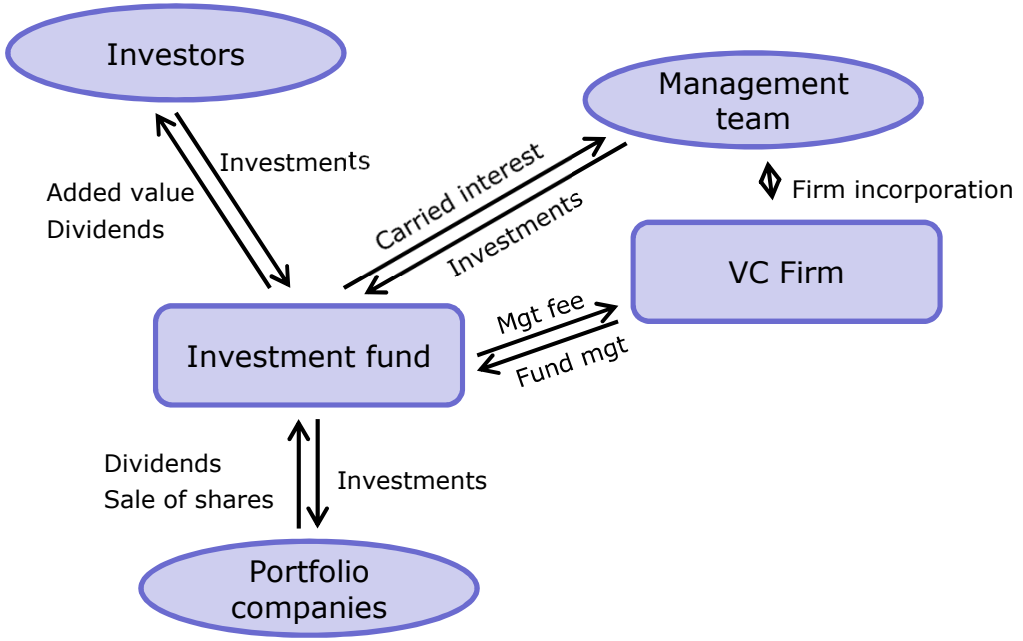
Sources of funding

- Business angels
  - Generally small amounts
  - Former successful and wealthy business people
  - Want to invest their own money in new ventures
  - No special reporting

- Venture capital
  - Larger amounts
  - Professional investors
  - Acting for third parties
  - Have to report to their fund providers on the success of their investments

Angels vs. VCs





VC Investment Philosophy

- Financial approach based on risk management:
  - You invest in a portfolio of early stage companies
  - Some will fail (as few as you can)
  - Some will have some success (a vast majority)
  - (Very) few will be (very) large success and will generate most of your revenue (and compensate for losses)

Impact on innovation

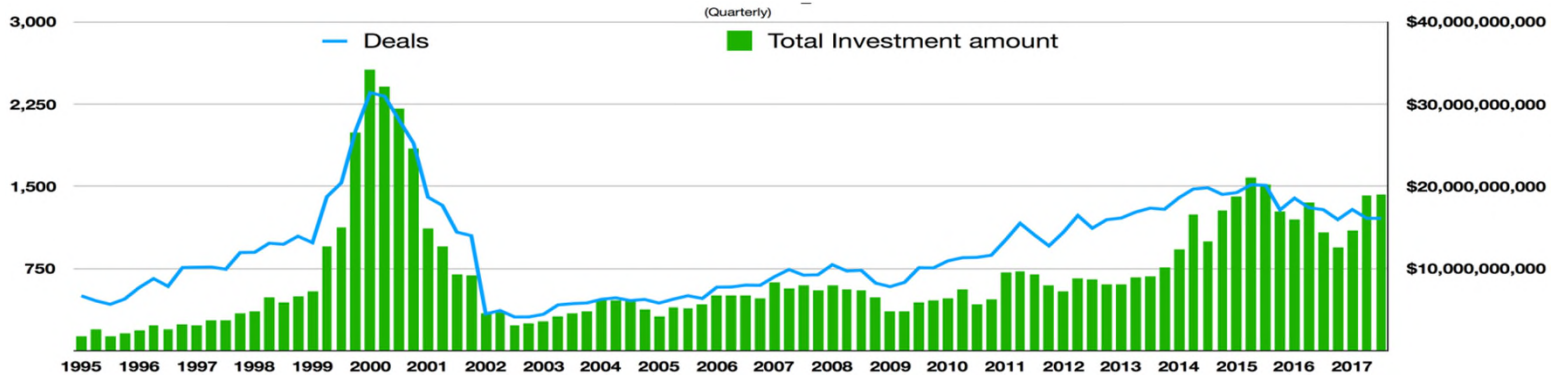
- Decision taken based on financial reasoning mostly
  - Stop in case of early failures
  - Limited re-orientation

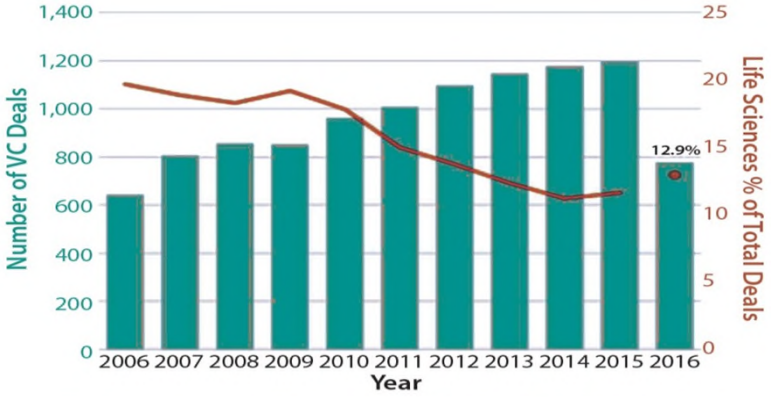
- Focus on innovations that could present a high return on investment
  - Beauty competition
  - Higher differenciation
  - More risk

VC in the US

- Historical birthplace of the VC industry
- 15 billion US$ invested in 2015
  - Life science: second largest sector with ~3 billions US$ invested in ~150 deals
  - LS represents ~20% of money invested and ~12% of deals

VC in the US


(Quarterly)
Deals
Total Investment amount
3,000
2,250
1,500
750
$40,000,000,000
$30,000,000,000
$20,000,000,000
$10,000,000,000
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017


Number of VC Deals
Life Sciences % of Total Deals
1,400
1,200
1,000
800
600
400
200
0
25
20
15
10
5
0
12.9%
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year

Take home messages

- The global market evolution (raise of biotechnology and innovation crisis) has pushed companies to seek alternative business models
  - Growth by Merger and Acquisitions
  - Diversification by outsourcing and open innovation

- Open innovation, which has emerged in the electronics and computer industry, has spread to life sciences, supported by a favorable North American environment

- To enable such an approach to develop successfully, a series of factors must be brought together. A way to represent them is the Cluster of Innovation