Lezione 1.2
Paradigmi della produzione di scienza e panoramica di alcuni benefici sociali

Il nuovo contratto sociale

Gibbons M 1999 Science's new social contract with society, in Nature, vol 402, supp, 2 december, C81

-Gibbons (1999) highlights the decline of the traditional 'contract' whereas universities provide fundemental research while company labs applied research and product development.

- He points to a new pattern based on four ingredients:
- A) co-evolution of science and society,
- B) contextualization of science rather than its ambition to universality,
- C) the production of socially robust knowledge within certain boundaries,
- D) the construction of narratives of expertise.

- Il nuovo contratto sociale (segue)

- This more complex pattern implies in a broad sense a deeper permeability of science and society. Something, in my opinion, most private investors and law makers are not yet fully aware, as the example of legislation and practice shows, where intellectual property is still seen as an act of individuals.

- See Pagano (2014), who writes that " the privatization of knowledge and its direct transformation in the most valuable proprietary asset of the firm" is the "most extreme and most meaningful step " of a the more traditional monopolisation of capital process through the ownership of machineries that embody past knowledge, a core idea of Marx.

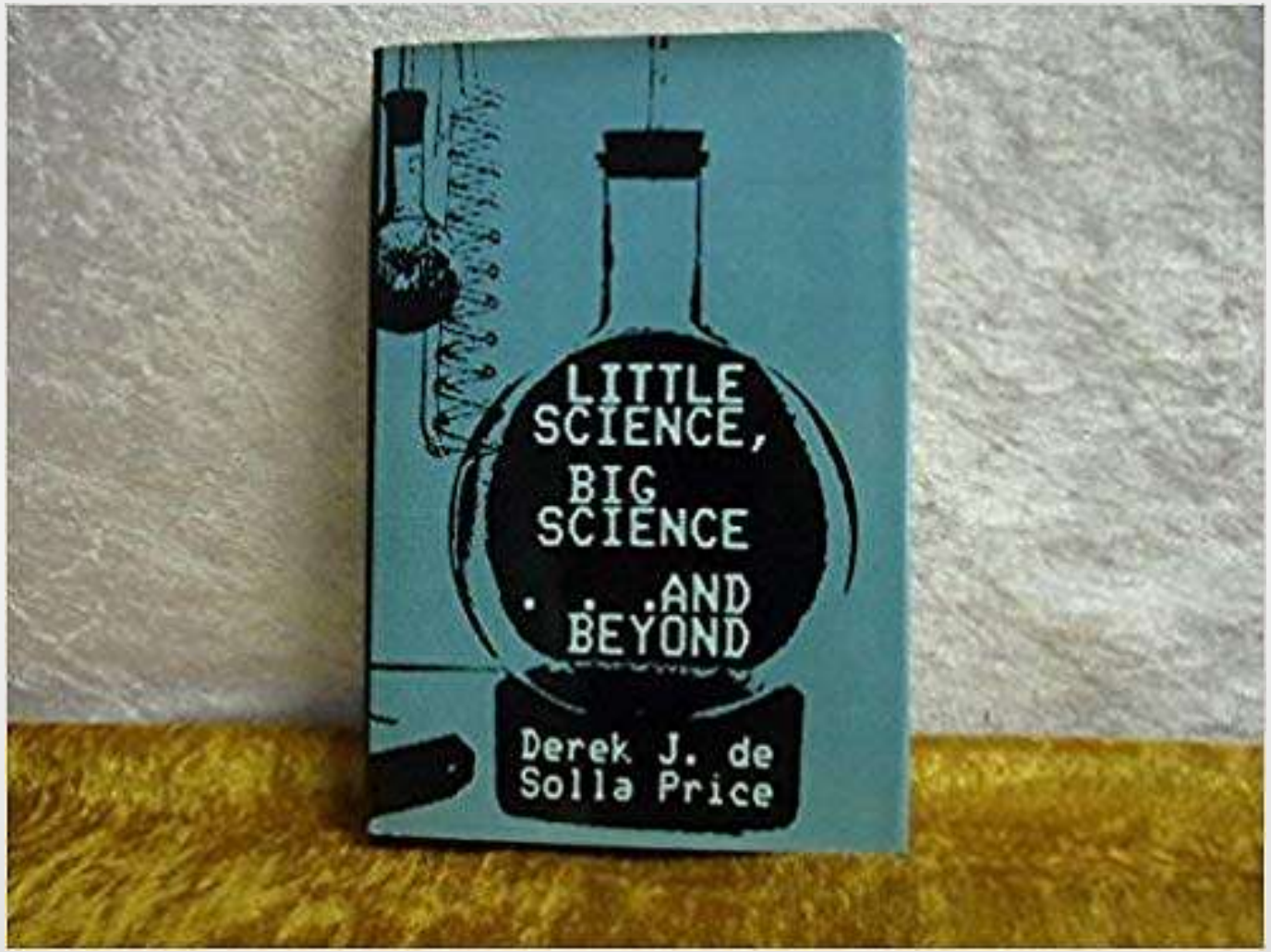
The usefulness of useless knowledge

"From a practical point of view, intellectual and spiritual life is, on the surface, a useless form of activity… I shall concern myself with the **question of the extent** to which the pursuit of these useless satisfactions proves unexpectedly the source from which undreamed of **utility is derived**"

Abraham Flexner
Founding Director,
Institute for Advanced Study, Princeton
The Usefulness of Useless Knowledge 1939

Courtesy of @InstituteforAdvancedStudy

Little science, big science... And beyond



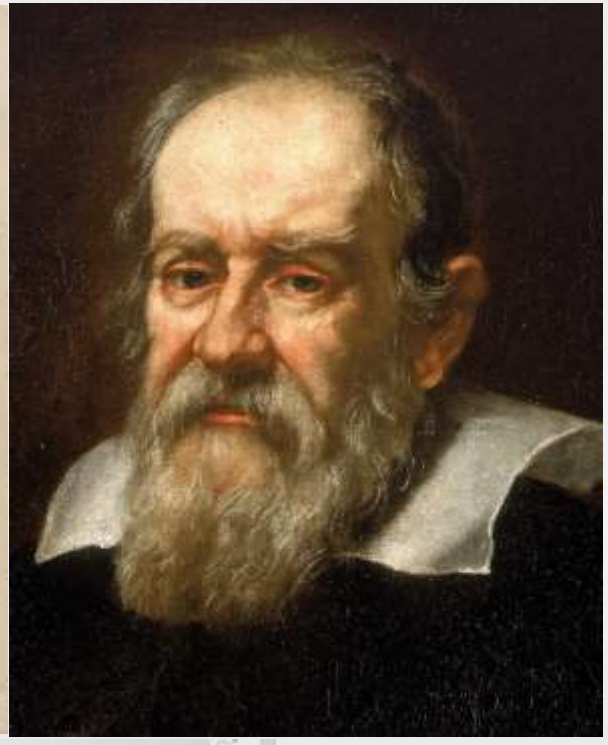
Courtesy of @TodayinScienceHistory

The 1962 Brookhaven National Laboratory Lectures by **Derek De Solla Price**, physicist and historian of science

Little science: small costs and huge benefits

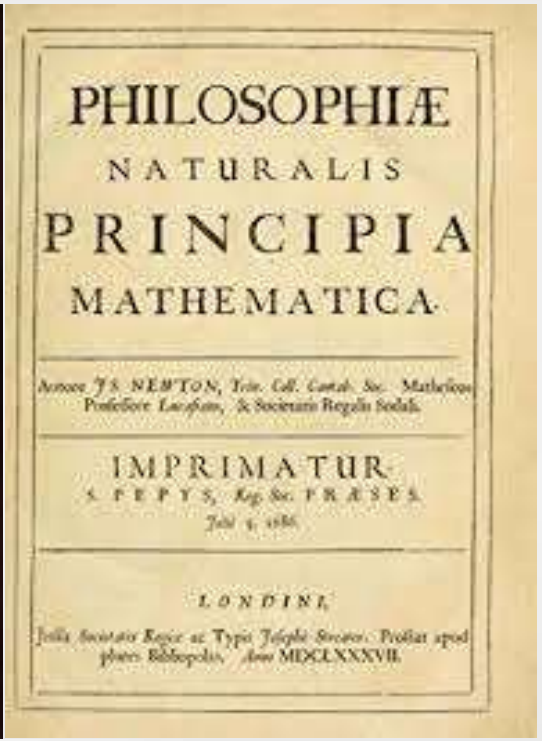
Galileo Galilei


SIDEREVS
NVNCIVS
MAGNA, LONGEQVE ADMIRABILIA
GALILEO GALILEO
PATRITIO FLORENTINO
PERSPICILLI
QVATVOR PLANETIS
MEDICEA SIDERA
NVNCVPANDOS DECREVIT
VENETIIS,



1564-1642

Isaac Newton


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA
IMPRIMATUR
S. PEPYS, Reg. Soc. PRÆSES.
LONDINI,

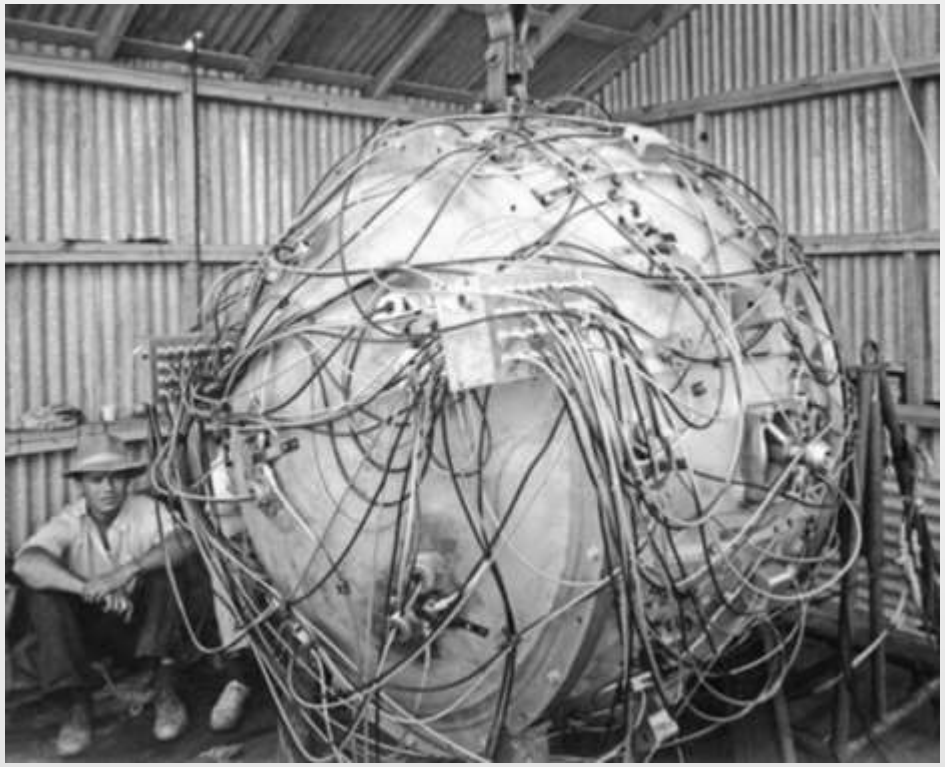
1642-1726

No CBA needed

Big science for the military: huge costs, uncertain benefits

The Manhattan Project

- **Top-down**
- Military-industrial complex
- National ownership
- Rigid mission and governance
- Political loyalty and secrecy



Courtesy of @RareHistoricalPhotos

Courtesy of @DennisD.McDonald'sWebSite

Gadget, the world's first atomic bomb

CBA impossible

A new paradigm: research infrastructures

ESFRI
Roadmap

- Bottom-up
- Scientific communities
- Open science
- International coalitions
- Multiple users and shared governance
- Cosmopolitan ecosystem

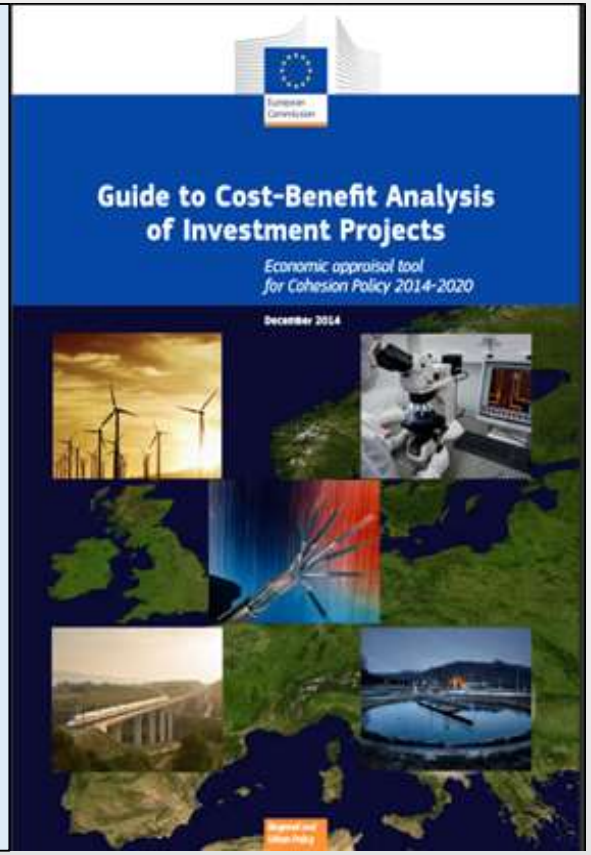
Courtesy of @Airbnb

The European Molecular Biology Laboratory (EMBL) *Heidelberg*

CBA feasible and helpful

The cost benefit analysis model

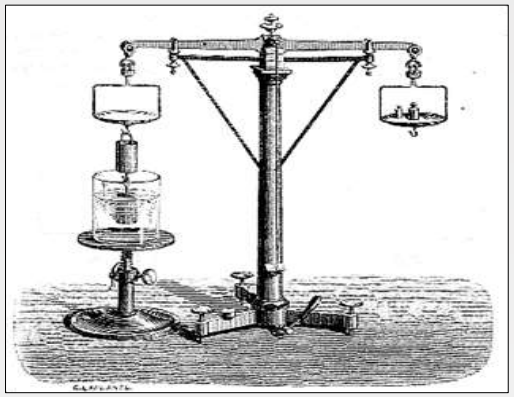
- The expected net present value of the RI
- over the time horizon
- is defined as the difference between expected benefits
- including the citizens' willingness to pay for knowledge
- and social costs
- valued at shadow prices
- discounted at the social discount rate



Measuring the measurable

For example:

$$\sum_{j=1}^{J} \sum_{t=0}^{\mathcal{T}} s_t \cdot \Pi_{jt}$$



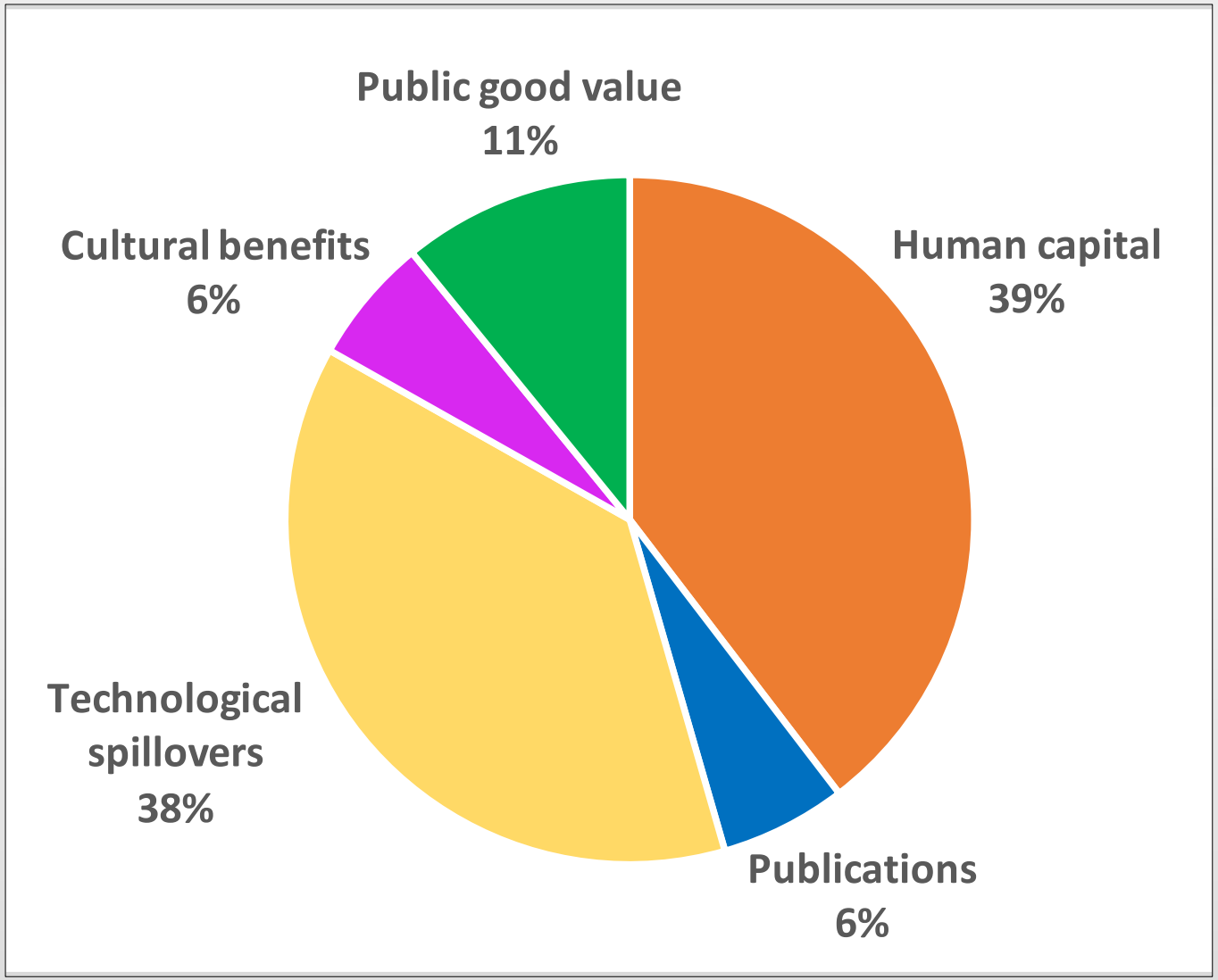
BENEFITS

- Technological spillovers
- Scientific publications
- Human capital
- Benefits of innovation
- Cultural benefits
- Public good value

COSTS

- Economic value of capital
- Labor cost of scientists
- Other staff costs
- Other operating costs
- Environmental impact

The net benefits of High Luminosity LHC to 2038



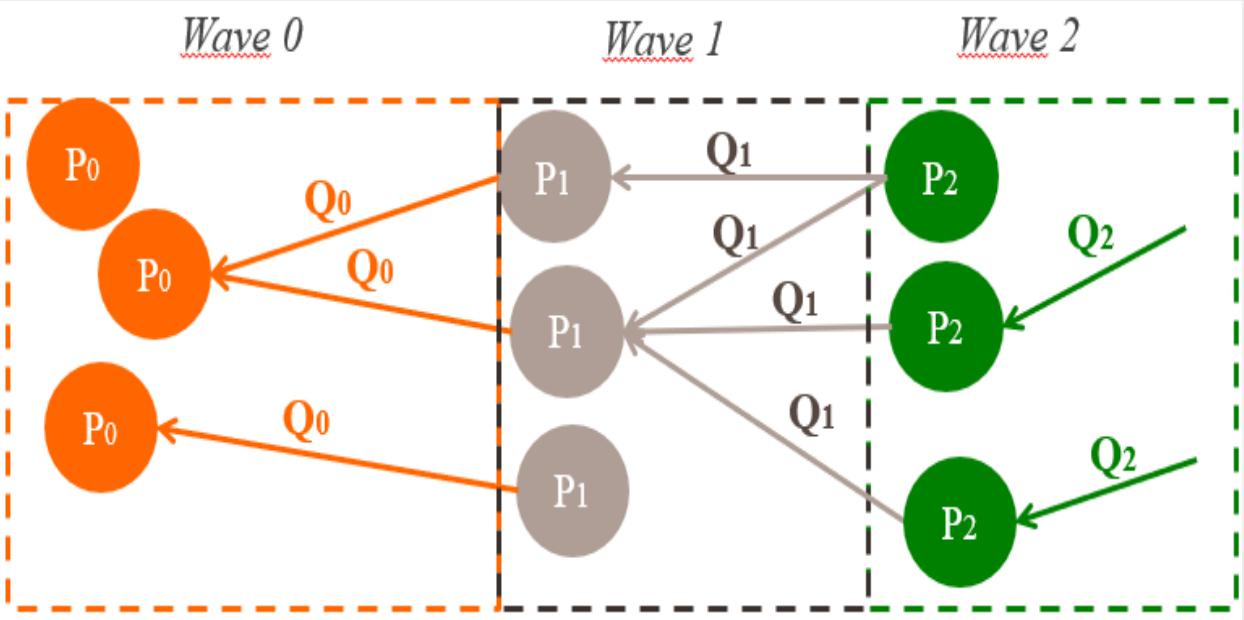
Net Present Value	2.2
Benefit cost ratio	1.8

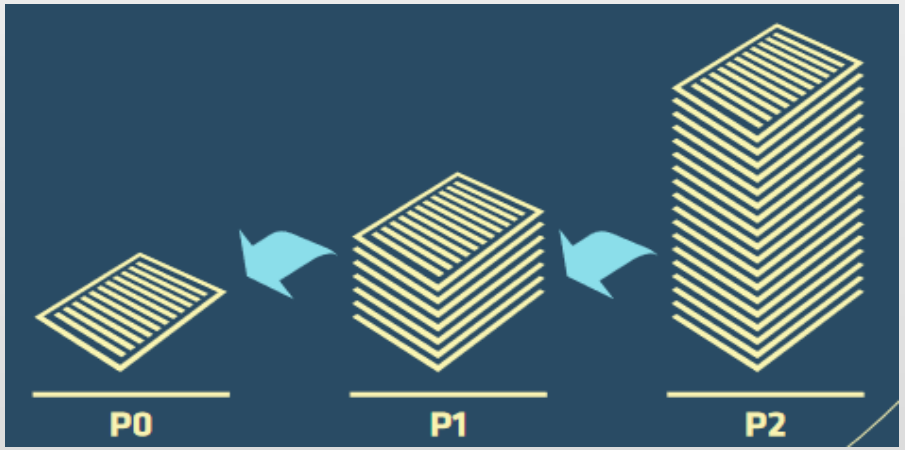
Courtesy of @CERN

Counterfactual: LHC without HL

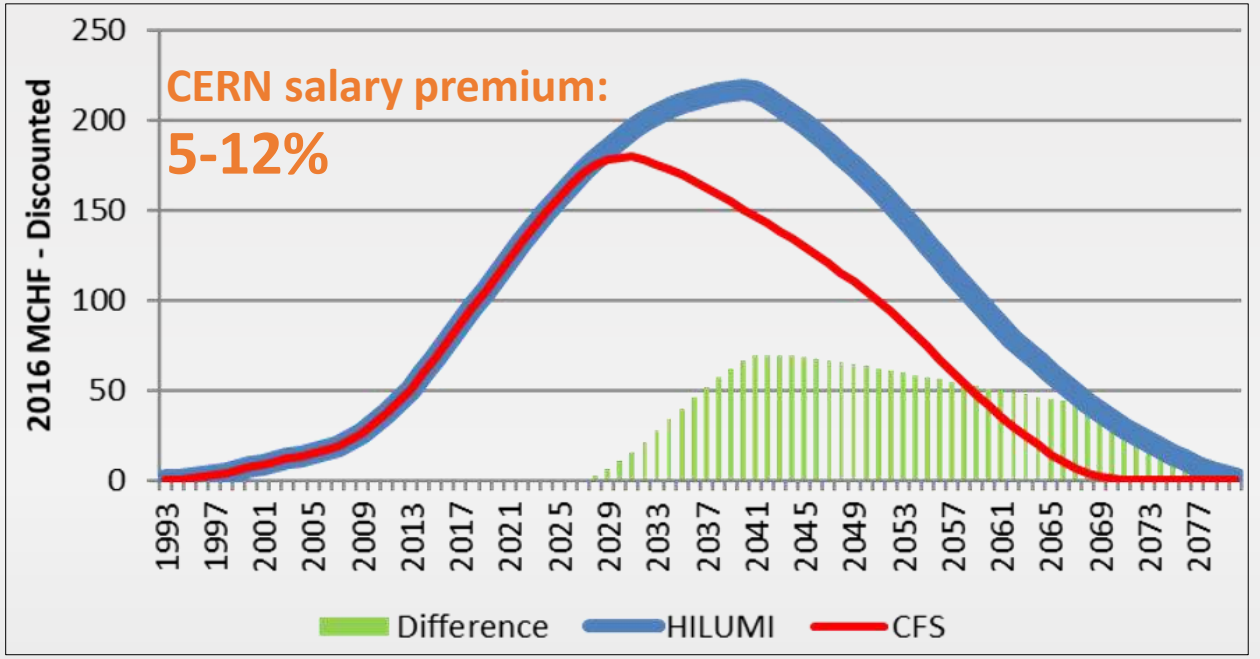
Publication factories and human capital

Value = scientists' time





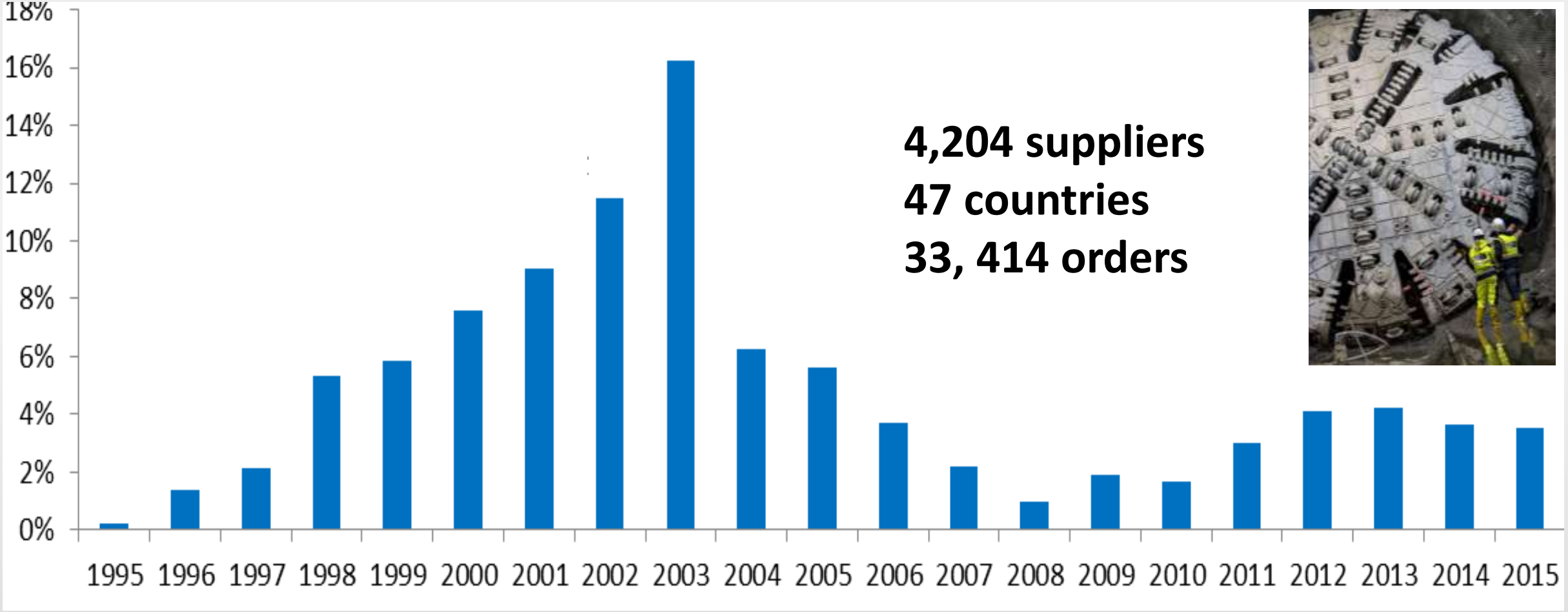
Value = skills acquired by ESR



Courtesy of @CERNCourier

Learning hubs for firms

The procurement activity of CERN 1995-2015

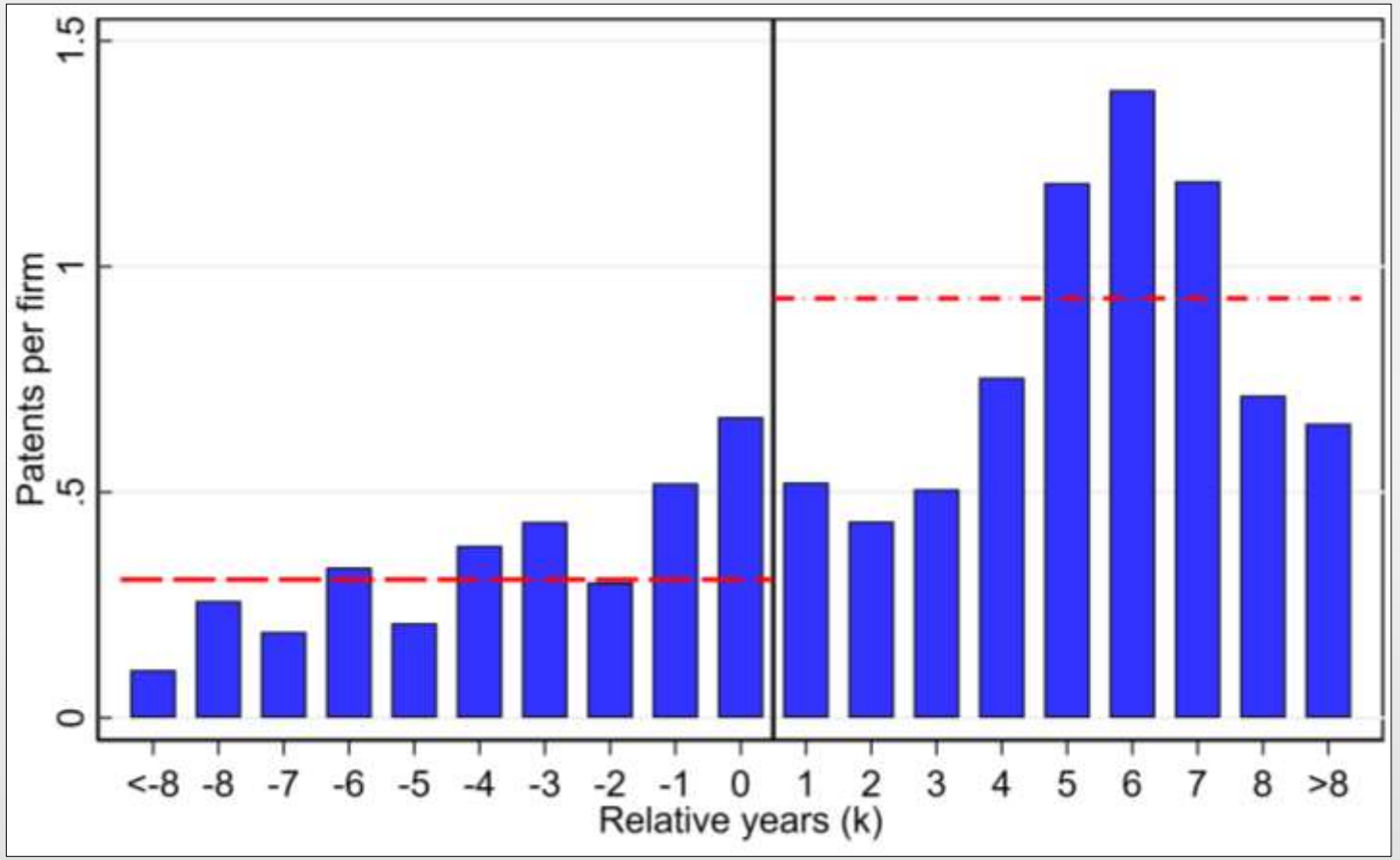


- Volume of the orders by year %; Orders > 10,000 CHF

Technological spillovers

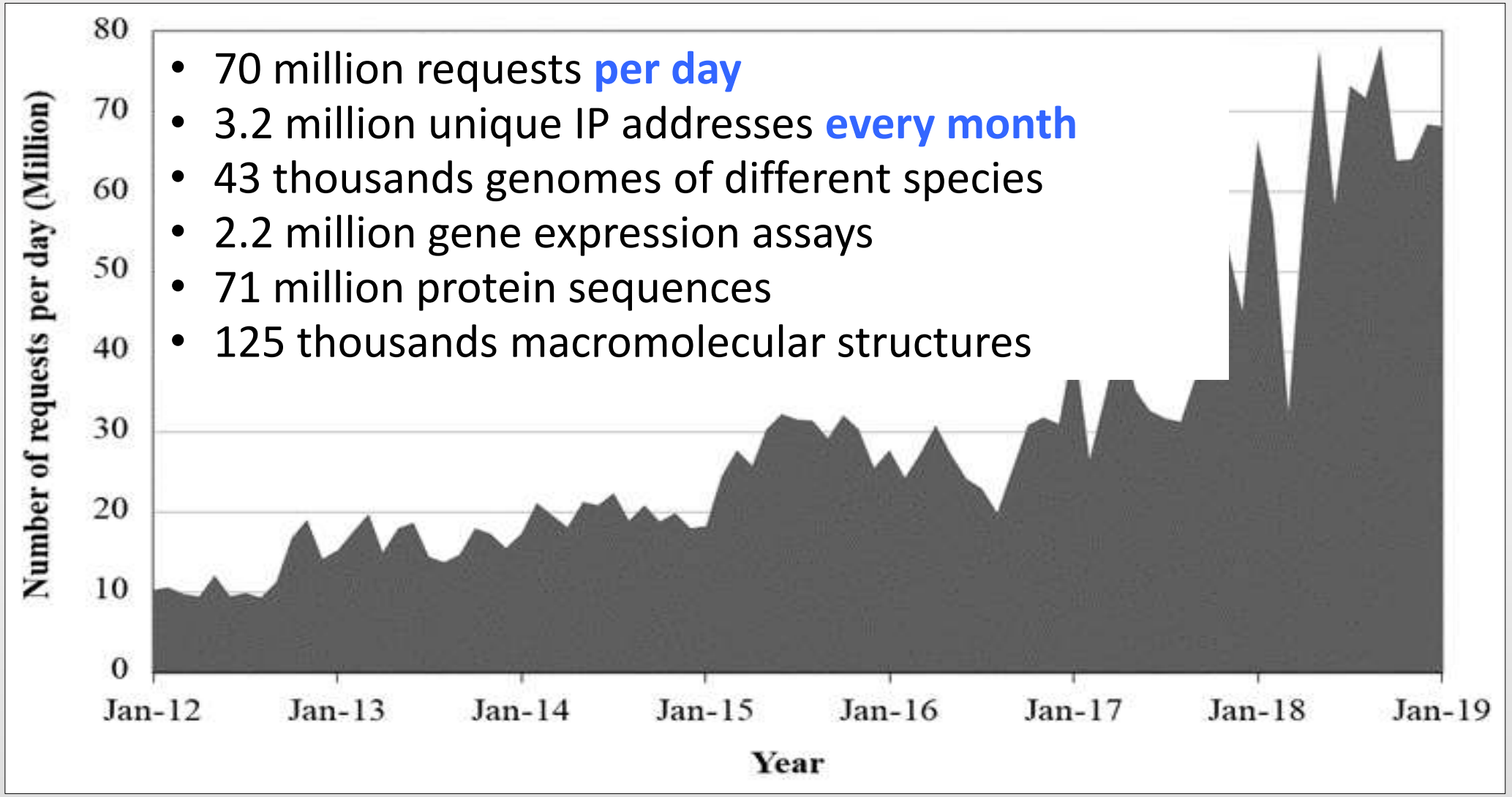
Value = change of firms' economic performance

- Procurement event
- R&D
- Innovations
- Productivity
- Sales
- Profitability



Technological spillovers from big data

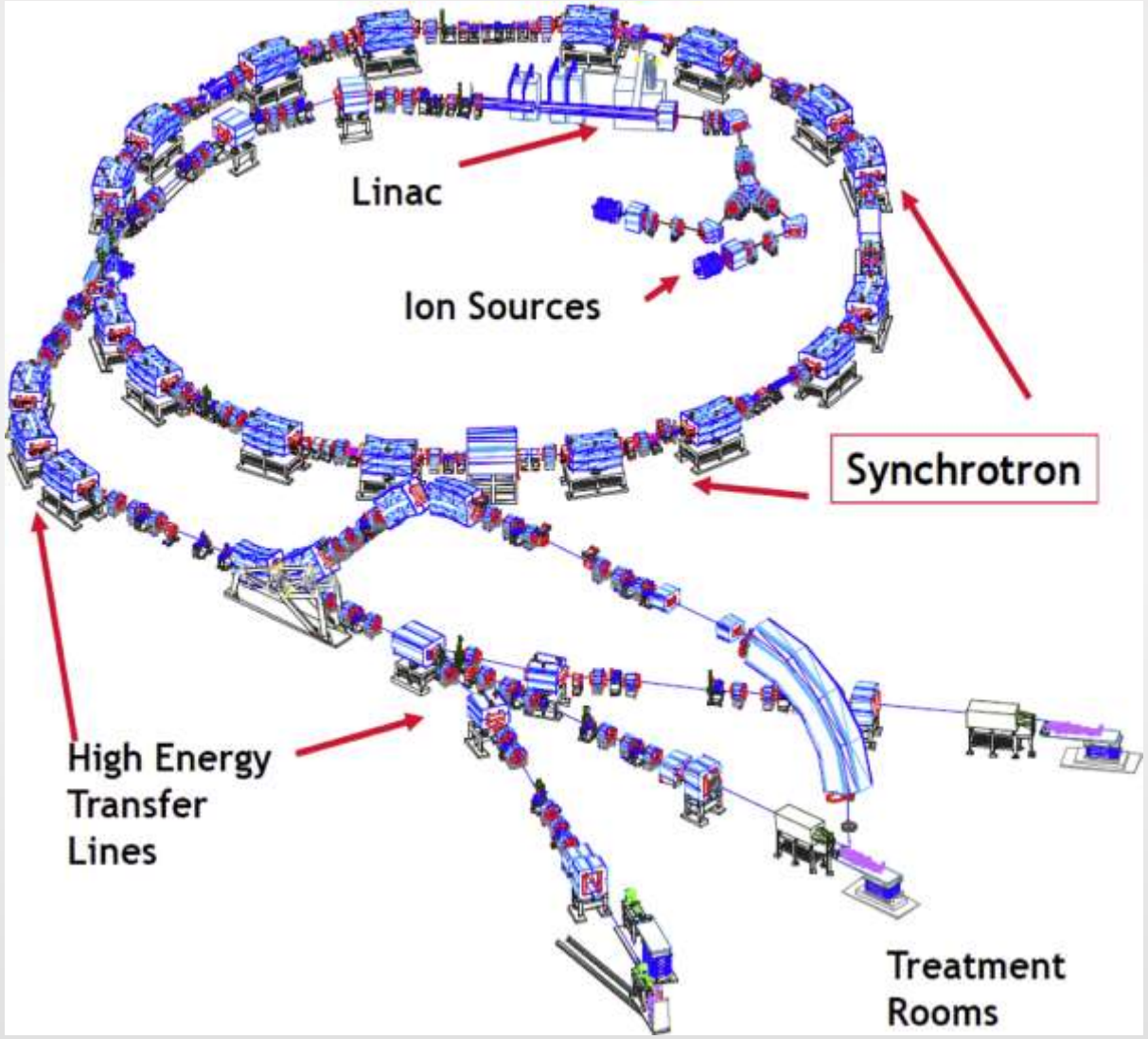
Value = research time saved



EMBL - European Bioinformatics Institute

- **Source:** Courtesy of ©EMBL-EBI

Benefits from innovation: an example



Value = statistical lives saved

Tumor and other diseas treated:

National Centre For Oncological Hadrontherapy (CNAO)

Source: Courtesy of ©CNAO

Cultural benefits

Value = travel cost method

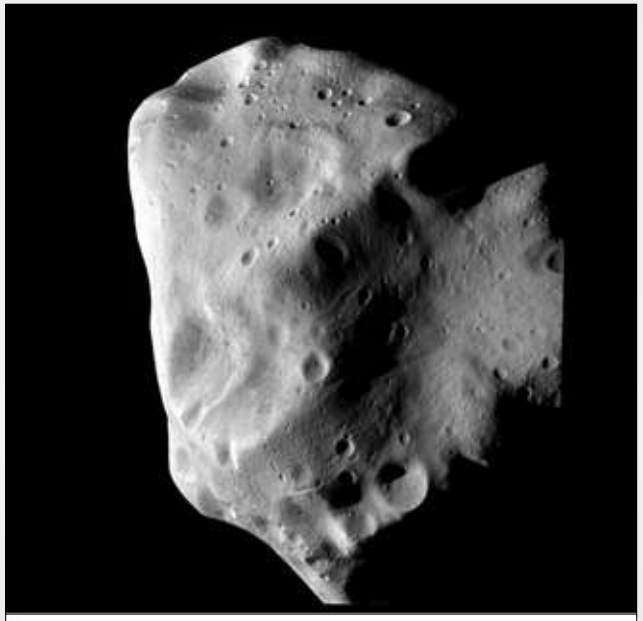
Courtesy of @KennedySpaceCenter

The NASA Kennedy Space Center

Value = opportunity cost of time

INVADER ID

Help us track changes in coastal environments by identifying marine invertebrates.



HUBBLE ASTEROID HUNTER

Help us find asteroids in images from the Hubble Space Telescope!

Zooniverse

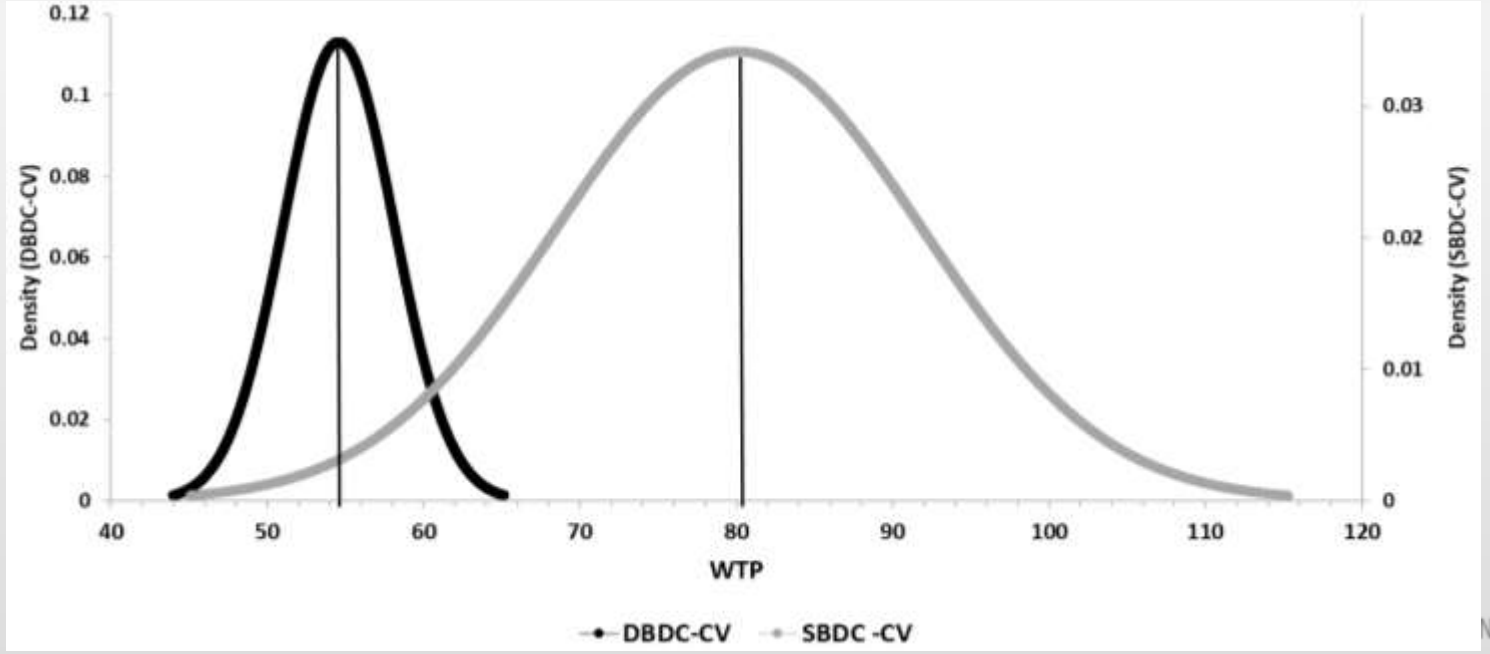
Public good value

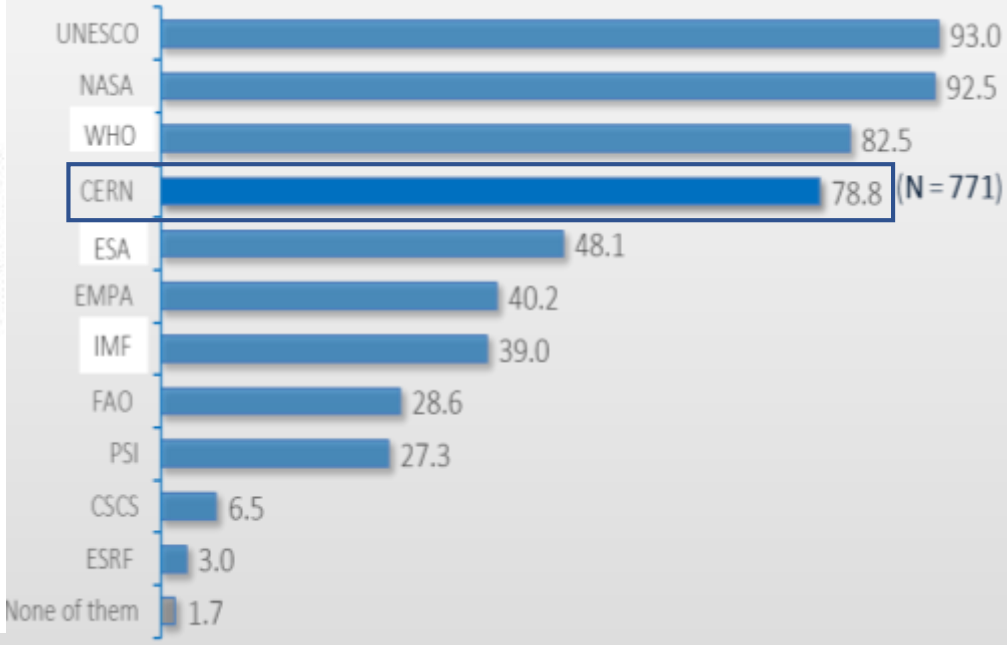
Value = Contingent Valuation Experiment

- CV experiments about CERN future accelerators
- Representative samples of citizens
- France: 1000 interviews
- Switzerland: 1000 interviews
- **Willingness-to-Pay CHF 54 > implicit taxation CHF 6**

Ethics Committee

Swiss Federal Act on Data Protection

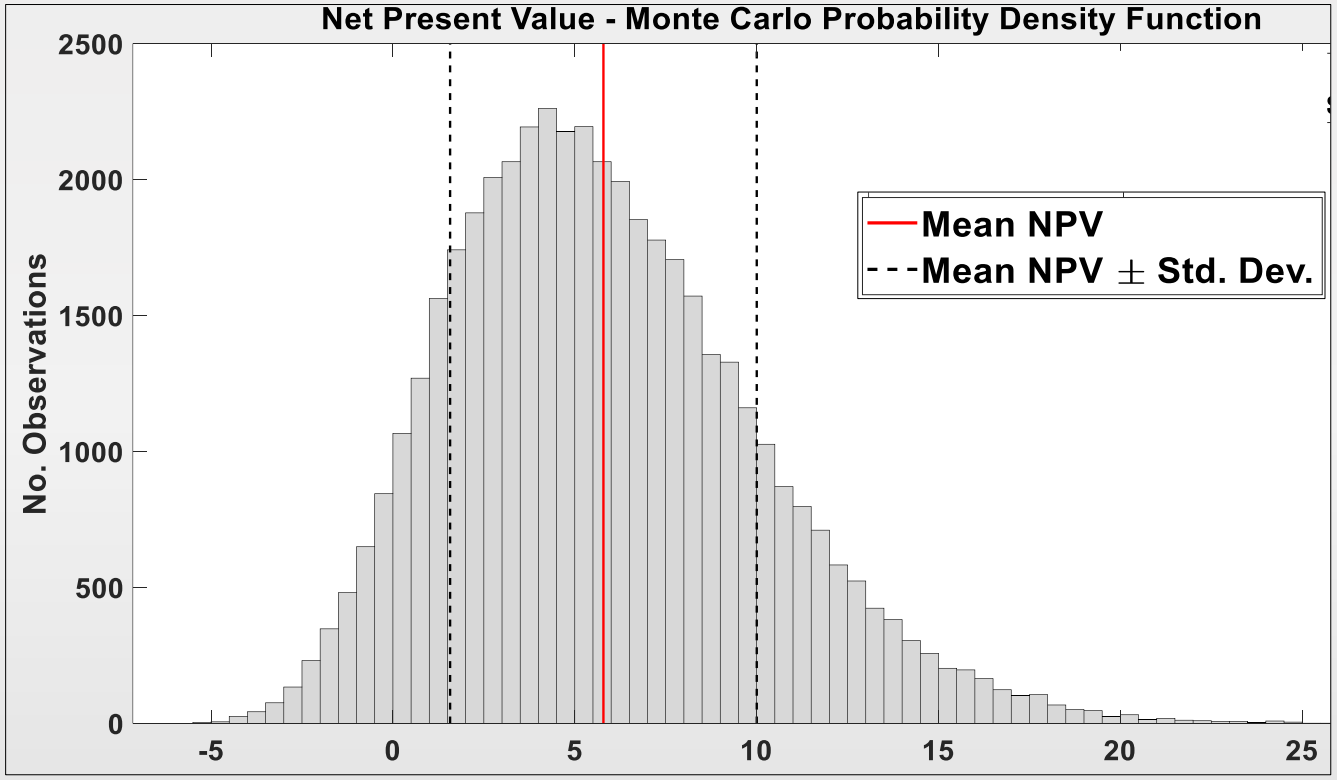




Summing up: benefits and costs

Stochastic Net Present Value of LHC + High Luminosity LHC

Benefits baseline	**25.6**
Scientific publications	0.6
Human capital	8.4
Technological spillovers	10.2
Cultural benefits	3.3
Public good value	3.1
Costs baseline	**22.3**
Net Present Value baseline	**3.3**



Source: Bastianin, Florio (2018); Florio, Forte, Sirtori (2016)

Conclusions

- A new paradigm of science production
- Are Social Benefits > Costs?
- B>C possible, even for basic research
- Measurable benefits:

  Technological Spillovers
  Human Capital
  Cultural Goods

- Unmeasurable benefits: “Useless” Knowledge
- A gift from the current to the future generations
- We invest today in science
- They will discover tomorrow its use and value

Courtesy of @SKA

Courtesy of @Societàitalianadipediatria