Lezione 3.3

Benefici per le comunità scientifiche

(per dettagli: Investing in Science, ch. 3)

Demand and supply of knowledge output

$$\mathbb{E}(PV(Y_t)) = \sum_{t=0}^{T} (s_t \cdot \mathbb{E}(Y_t) \cdot \mathbb{E}(m))$$

- $\mathbb{E}$: Expectation operator
- *PV*: Present Value
- *Y*: Social cost of producing knowledge outputs (not just publications, but any other scientific communications)
- s_t: Social discount factor at time *t*
- *m:* Multiplier of impact of a publication

The empirical estimation of the value of knowledge output (1)

$$PV_{C_u} = \sum_{t=0}^{\mathcal{T}} s_t \cdot (K_t + L_{st} + L_{ot} + OP_t + EXT_t),$$

which can be rewritten as

$$PV_{C_u} = \sum_{t=0}^{\mathcal{T}} s_t \cdot (K_t + L_{ot} + OP_t + EXT_t) + \sum_{t=0}^{\mathcal{T}} s_t (L_{st})$$

- *PVCu:* Present value of use costs
- *st:* Social discount factor at time *t*
- *K:* Economic value of capital
- *Ls:* Labor cost of scientists
- *Lo:* Labor cost of administrative and technical staff
- *OP:* Other operating costs
- *EXT:* Negative externalities

The empirical estimation of the value of knowledge output (2)

$$PV_{pub} = \sum_{t=0}^{T} [(n_{st}\ y_{st})(w_{st}\ h_{st})] / (1 + SDR)^t$$

- PV_{pub}: Present value of scientific publications
- n_s: Number of scientists
- y_s: Number of papers produced by each scientist
- w_s: Level of earnings per hour per scientist
- h_s: Average hours of working time for the production of a scientific paper
- *SDR:* Social discount rate

Measuring the influence of publications

$$\frac{dpub_t}{dt} = \theta \cdot pub_t \cdot \left[1 - \frac{pub_t}{\omega}\right]$$

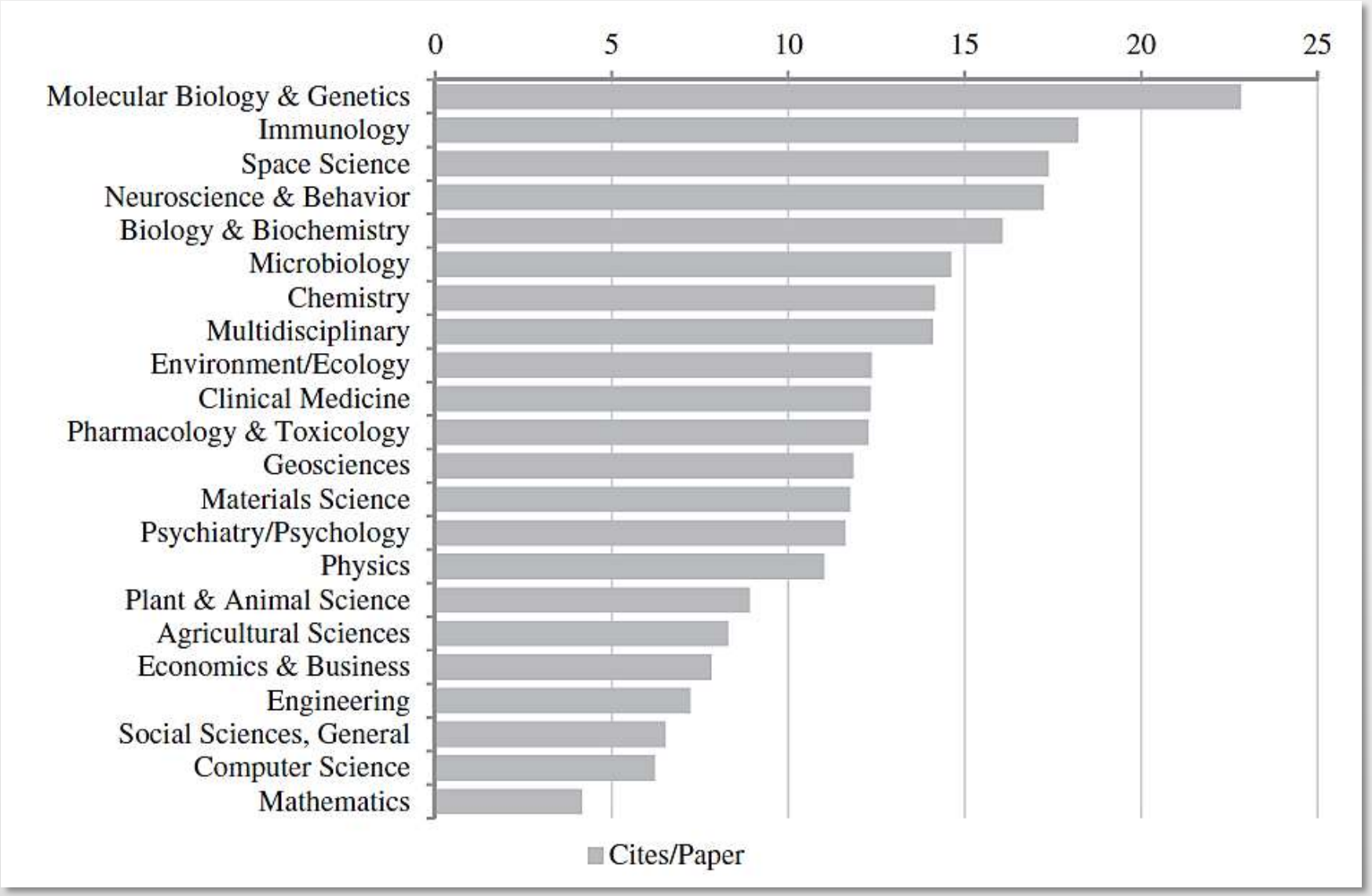
- *pub:* Total number of papers produced by scientists
- *dt:* Financial discount factor at time *t* = *(1, … ,*T)
- θ > 0: an instantaneous growth rate parameter
- ω > 0: the equilibrium limit size of knowledge output growth

LHC and LEP experiments

- Cumulative number of papers to 2012 from LHC and LEP experiments, compared

Experiment	Experiment Papers (Including Preprints)	Published Experiment Papers	Experiment Papers Cited in the Literature	Literature Cited by Experiment Papers
LEP				
ALEPH	636	589	383	3,233
DELPHI	736	670	417	3,644
L3	605	549	381	3,563
OPAL	694	634	475	4,037
CDF	3,077	2,386	1,641	6,616
D0	2,383	1,769	1,176	4,744
LHC				
ALICE	1,579	945	382	2,963
ATLAS	2,529	1,921	1,195	4,862
CMS	2,580	1,603	1,030	4,640
LHCb	735	585	248	1,608

Average number of cites per paper in a number of fields



Metrics comparisons across disciplines

Scientific Field	Average *H-index*	Average Number of Authors	Individual *H-index*
Cell biology	24	3.90	15
Computer science	34	2.57	22
Mathematics	15	2.95	8
Pharmacology	39	3.08	23
Physics	30	2.66	18

Scientists' annual salaries for selected countries and years (1)

Country	Scientific Field and Experience Level	Median (EUR)	Ref. Year	Source
Austria	All fields: senior researcher	66,038	2010	Ates and Brechelmacher (2013)
Finland	All fields: senior researcher	48,387	2008	Ates and Brechelmacher (2013)
Germany	All fields: entry-level	49,810	2018	https://www.payscale.com/research/DE/Job=Research_Scientist/Salary
United Kingdom	All fields: scientist	34,509	2018	https://www.payscale.com/research/UK/Job=Research_Scientist/Salary

Scientists' annual salaries for selected countries and years (2)

France	All fields: scientist	38,736	2018	https://www.payscale.com/research/FR/Job=Research_Scientist/Salary
Italy	All fields: scientist	30,492	2018	https://www.payscale.com/research/IT/Job=Research_Scientist/Salary
Poland	All fields: senior academic	32,078	2010	Ates and Brechelmacher (2013)
United States	Biotechnology	64,932	2015	https://www.payscale.com/
United States	Material science	74,744	2015	https://www.payscale.com/
United States	Clinical research	59,504	2015	https://www.payscale.com/

Case study: the LHC influence on the literature

$$\mathbb{E}(pub_t) = \alpha_1\alpha_2 \exp\left[-\beta_1(\mathcal{T} - \mathrm{t})\right]\left[1 - \exp\left[-\beta_2(\mathcal{T} - \mathrm{t})\right]\right],$$

where:

$\alpha_1 = 65{,}000$, the expected total number of authors of publications during the entire time span considered;

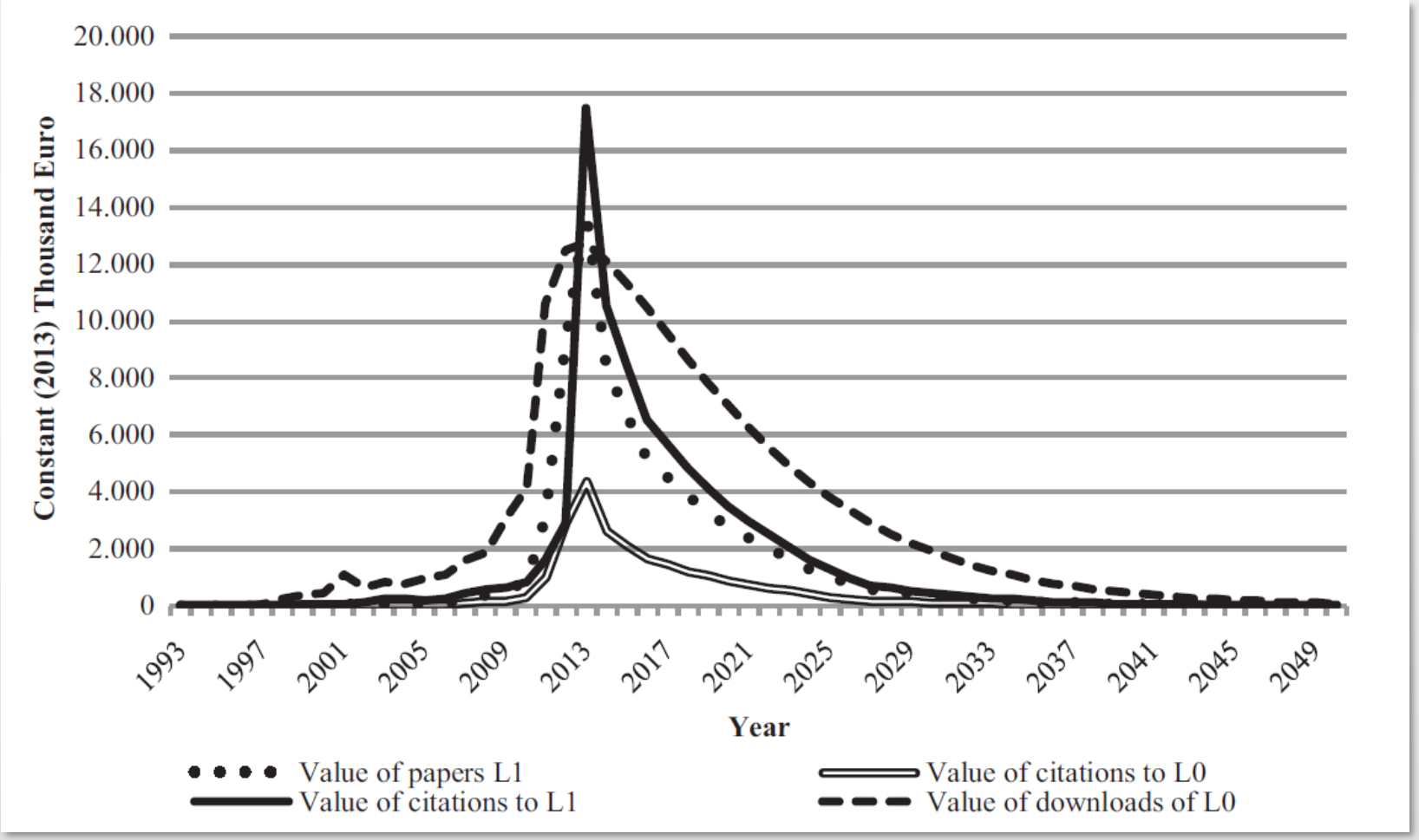
$\alpha_2 = 2$, a proxy of their yearly productivity;

$\beta_1 = 0.18$ and $\beta_2 = 0.008$, two parameters determining the shape of the curve, based on the observed pattern of publications related to the LEP;

$\mathcal{T} = 50$, the total number of years considered;

$t = (0, \ldots, 50)$, the number of each of the remaining years from 2006, the start year of estimations, to the end of the simulation period (2056).

Economic value per year of LHC literature: constant thousand EUR 2013



Legend:

- Citations to LCH papers (L0);
- citations of the first wave of external papers (L1);
- value of the first wave of external papers (L1);
- value of downloads of LHC papers (L0)