KNOWLEDGE ABUNDANCE AND THE GLOBAL NETWORK OF SCIENCE

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CHALLENGE: U.S. POLICY

- Expanding frontier of science
- Shrinking budgets
- Globally mobile talent pool
- Distributed knowledge, around the world
- Integration crucial (smart people are everywhere)
- Global knowledge sourcing
  - Collaboration, cooperation, strategic decisions

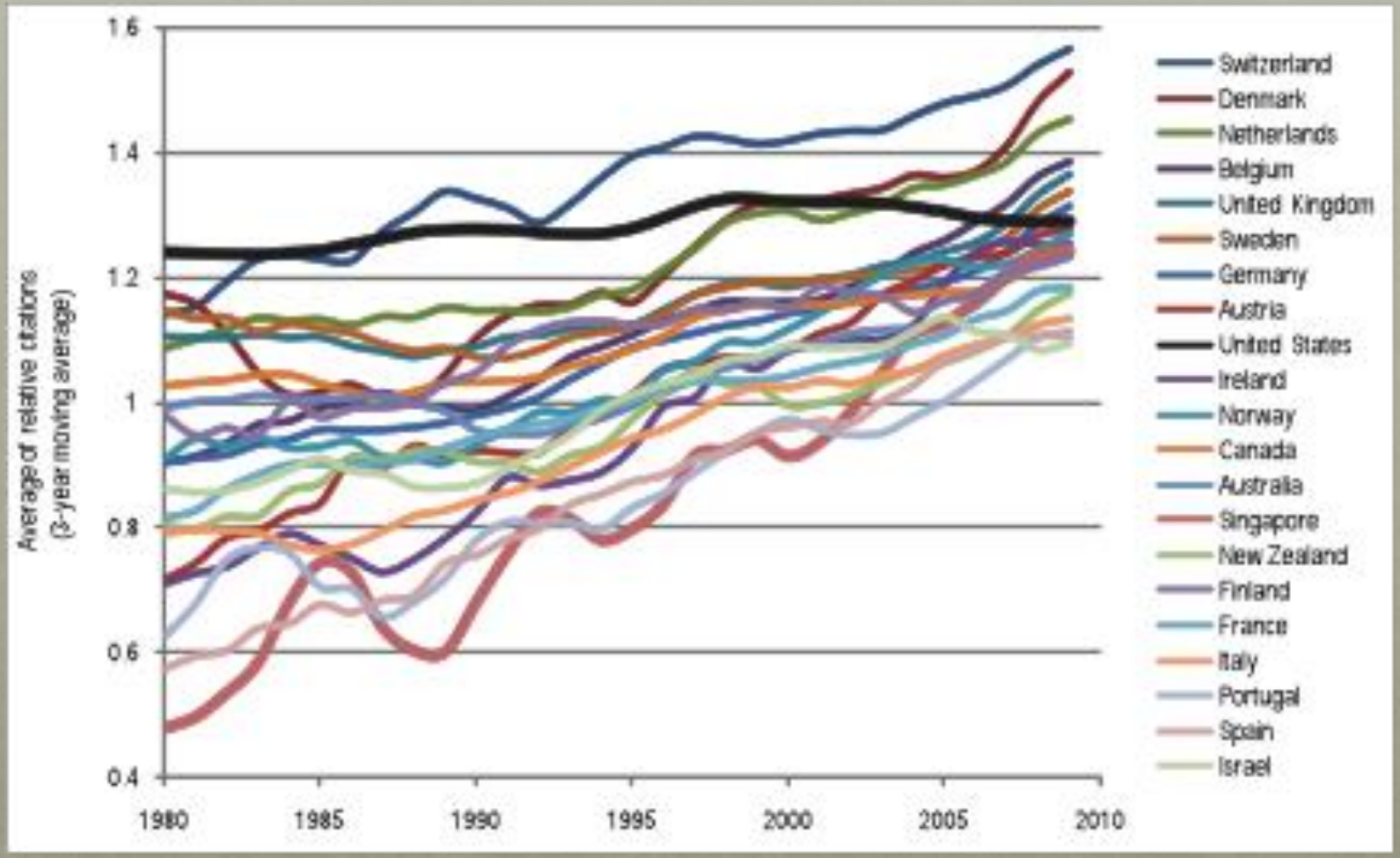
CHANGING LANDSCAPE

- 1990 ➔ 6 countries contributed 90 % R&D
- 2008 ➔ 13 countries (not inc. EU)
- Global $ on R&D ➔ 2 % world GDP ~$1.1 trillion
- Developing countries doubled R&D spending
- Number of researchers - 5.7 million (2002) to 7.1 million (2007)
- EU-15 surpassed U.S. in SCI impact factors in 1994
- Switzerland surpassed U.S. in 1985
- Since 1993, 7 EU member states have surpassed U.S. in quality

SHIFTS AT NATIONAL BORDERS

- Of all papers international collaboration has risen from 25 percent (1996) to 36 percent (2008)
- US collaboration low (%age terms) at 29%
- International collaboration rises as national systems get smaller
  - Lesser developed, small countries have very high rates of collaboration
- Coauthorships has grown 75 % from 1975 to 2005
- Interdisciplinarity of co-authorship has grown 5 percent between 1975 and 2005;
- Networks of researchers have grown

FLAT U.S. QUALITY MEASURES



30 Years – Average of relative citations – Calculated by Science-Metrix

CONTRIBUTIONS TO SCIENCE BY COUNTRIES

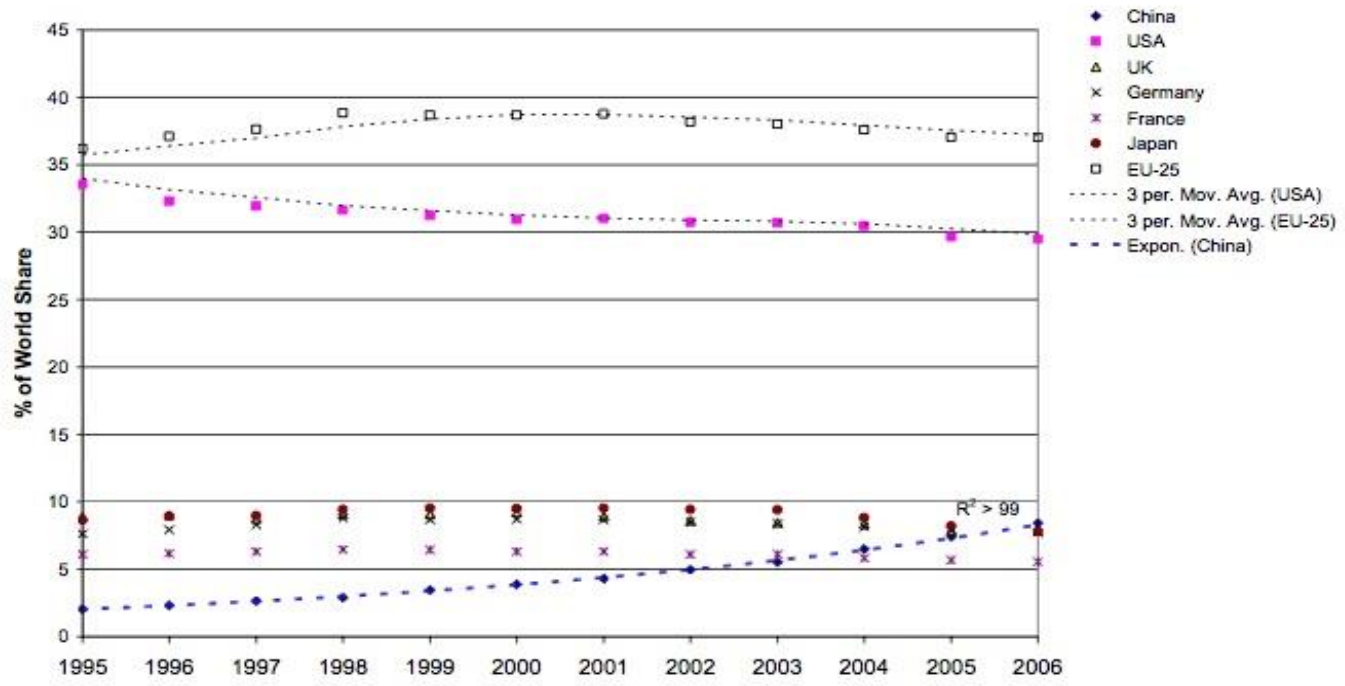
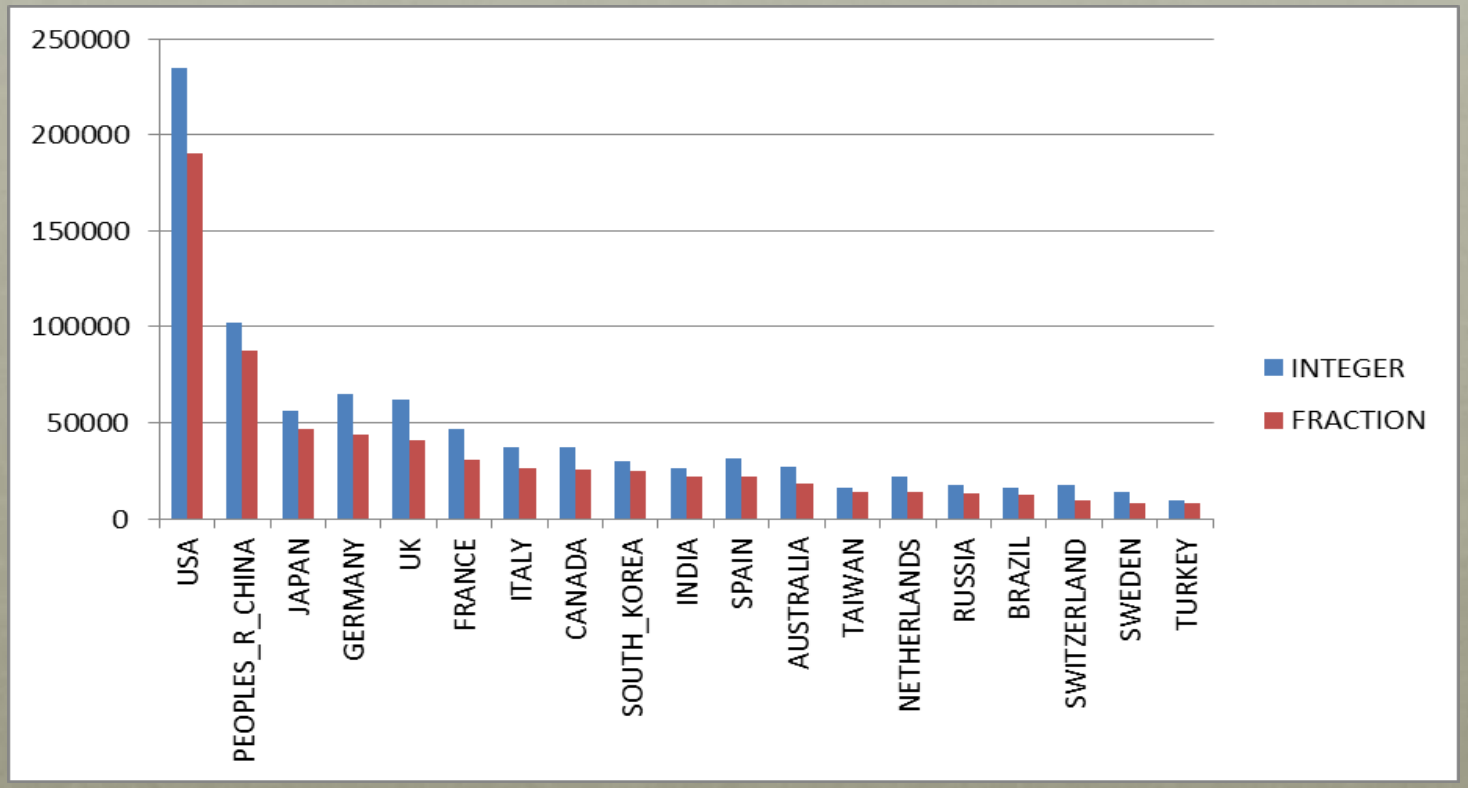


Figure 1: Percentages of world shares of publications held by six leading countries and the EU-25, 1995-2006.

10 years

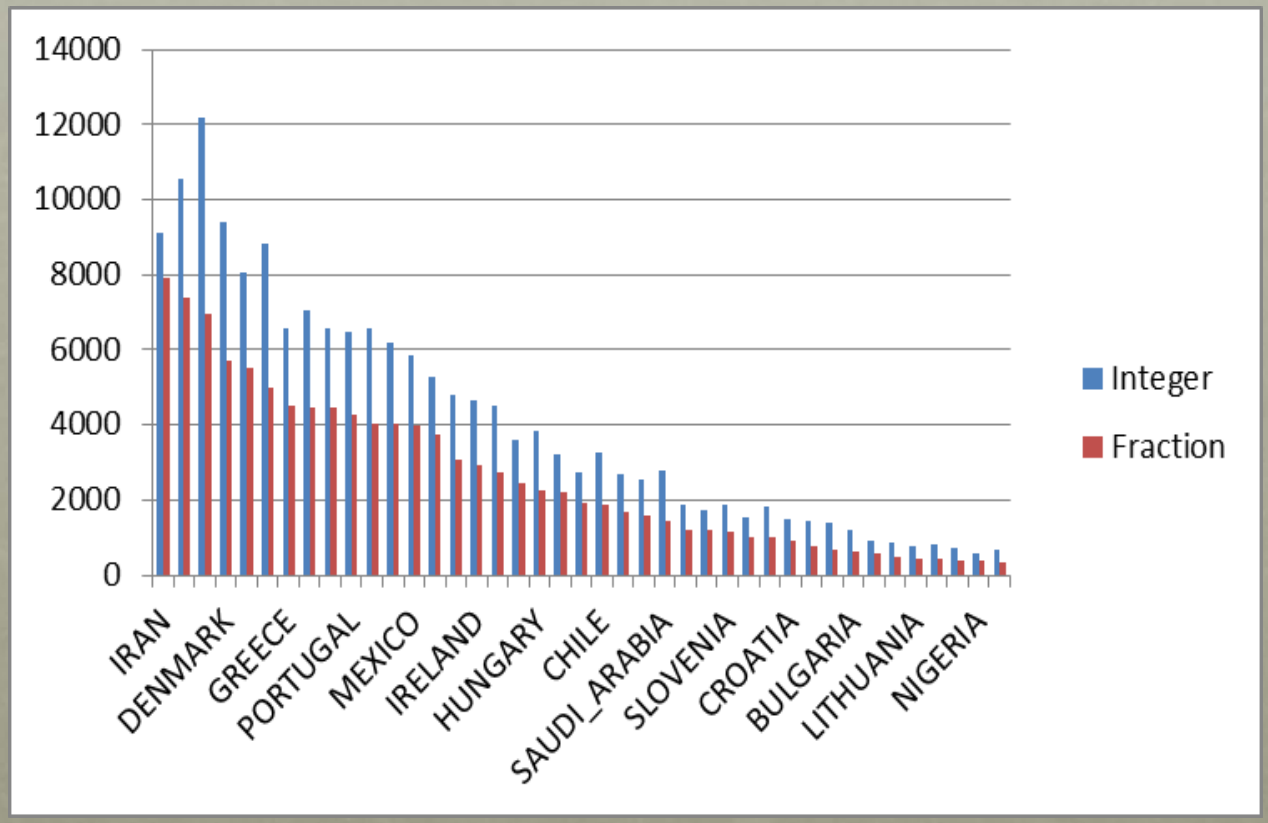
Source: Leydesdorff & Wagner, Scientometrics, 2008

2011 COLLABORATION BY COUNTRY

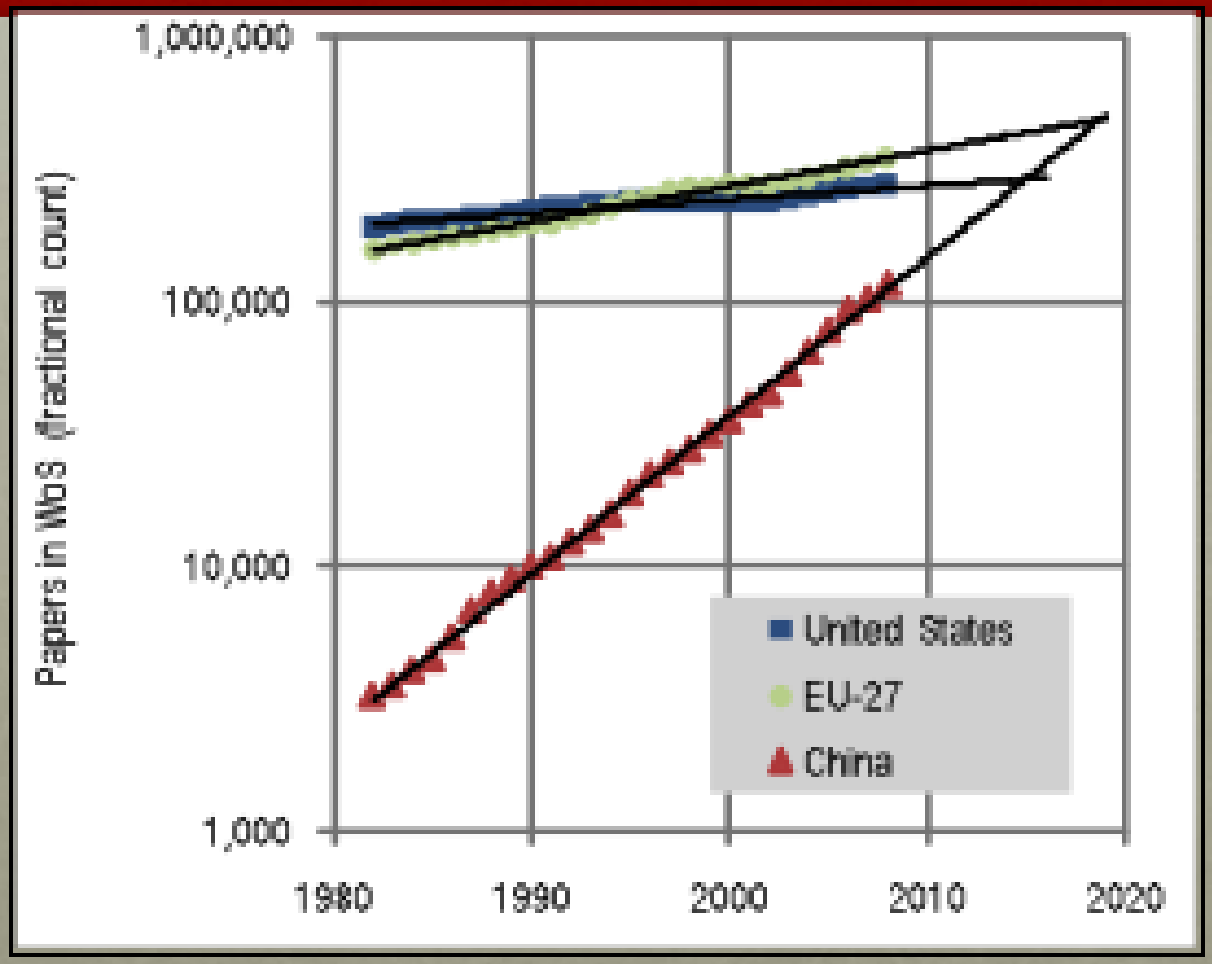


Top 20 Countries

NEXT 40 COLLABORATORS, 2011

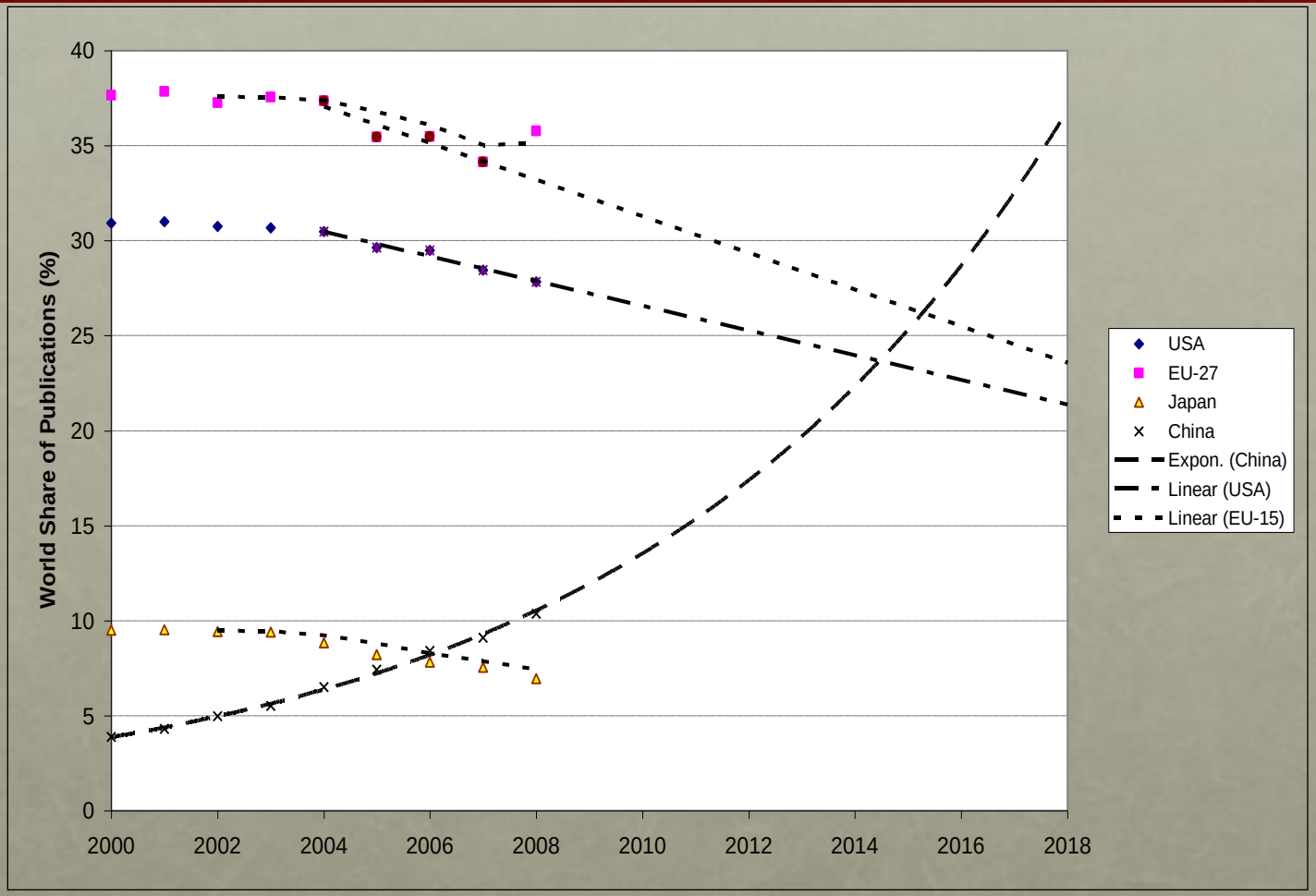


RISE OF CHINA



Over 30 years – Thomson-Reuters data Calculated by Science-Metrix

EXTENSION OF TRENDS

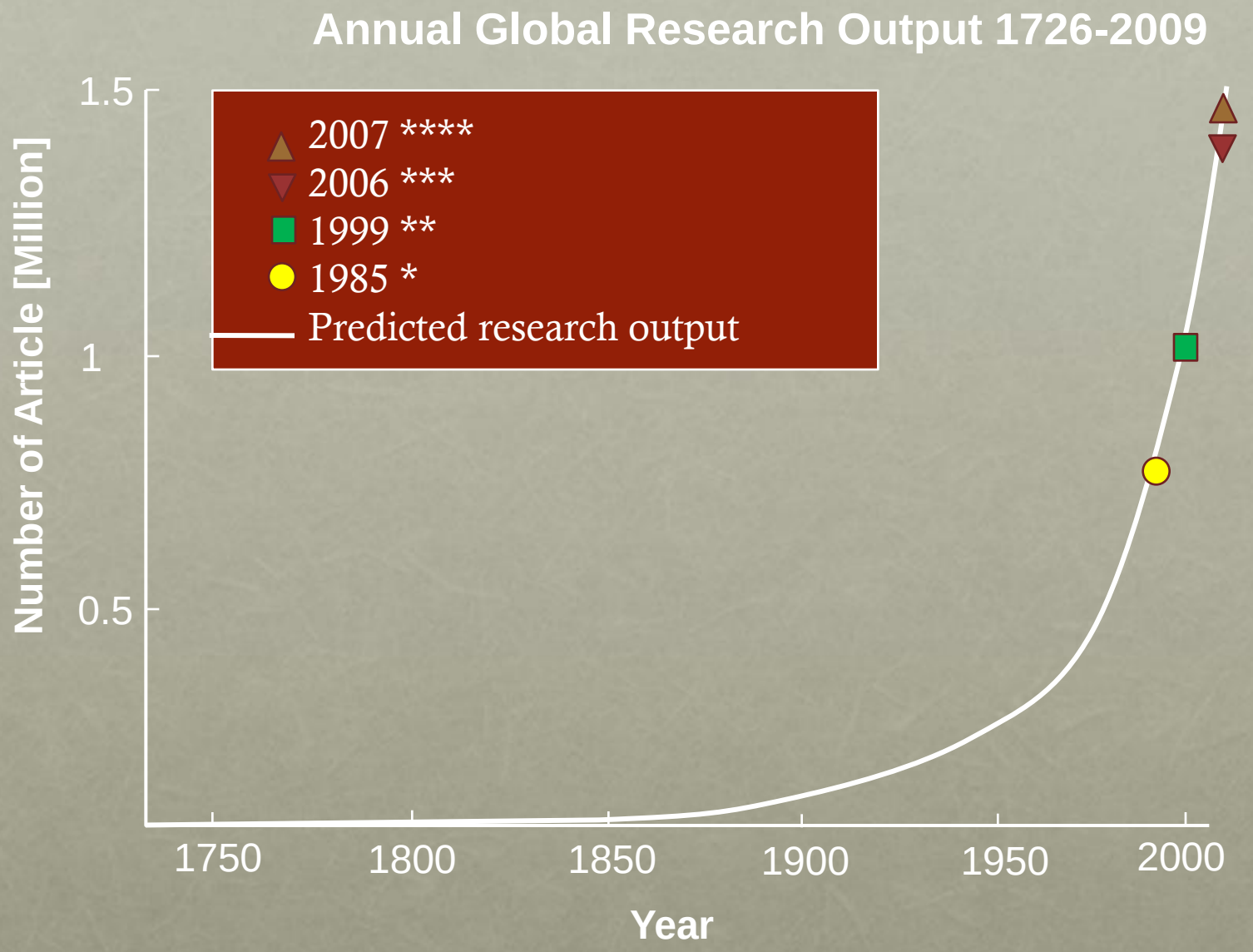


Source: Leydesdorff & Wagner, Scientometrics, 2008

SCIENCE KEEPS GROWING

- Scientific research publications growing in number
- Sources are proliferating
  - Open source journals
  - E-journals
  - National, disciplinary sources
- Pre-publication venues (e.g., arXiv)
- Data to fuel science is also growing spectacularly!
- Growth in itself now new… variety of sources is new

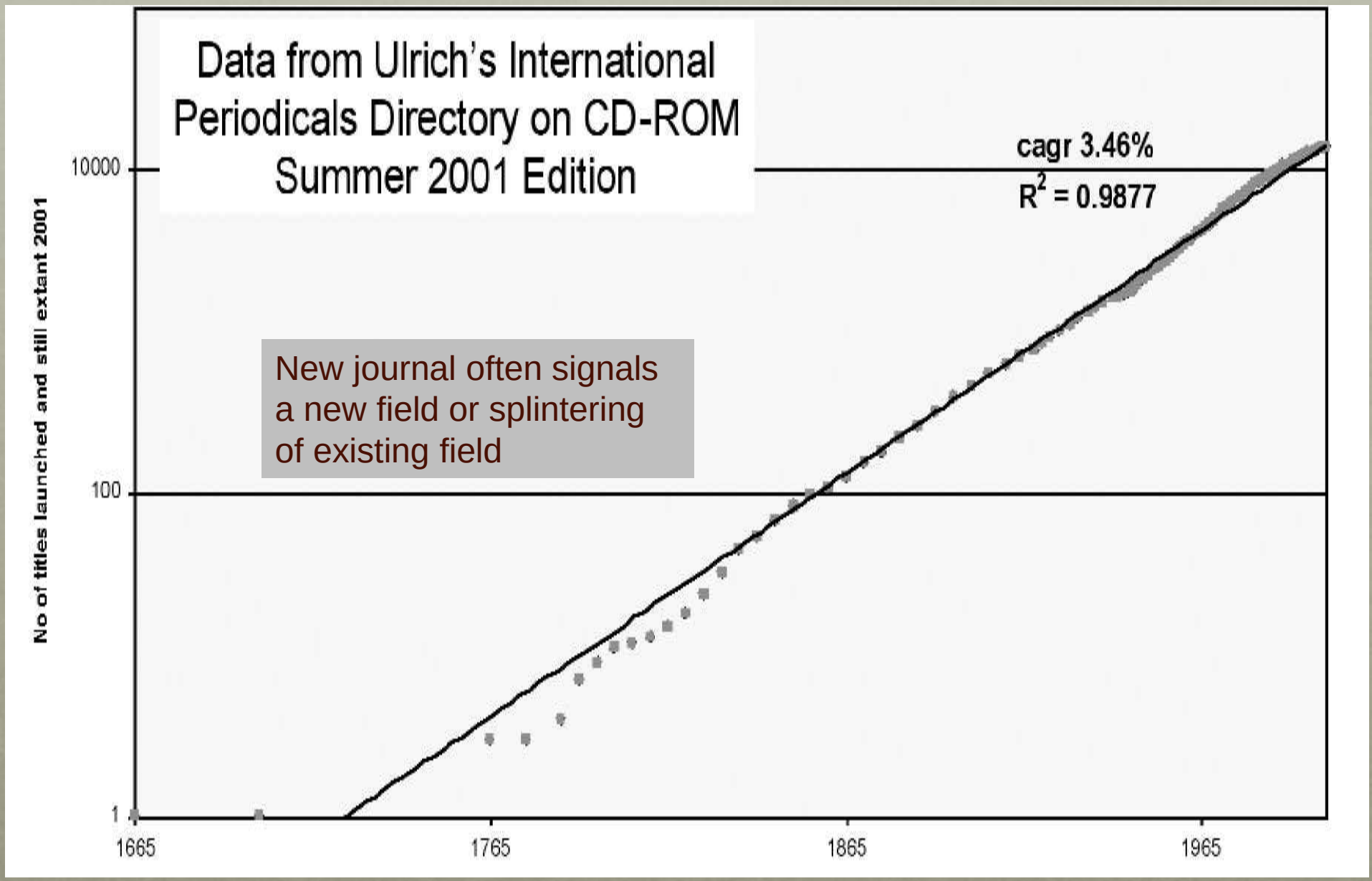
Just how big is "science"?



Research Output in Numbers of Articles, 1726-2009

Source: Jinha, A. (2010). Article 50 million: An estimate of the number of scholarly articles in existence. Learned Publishing, 32(3), 258-263.

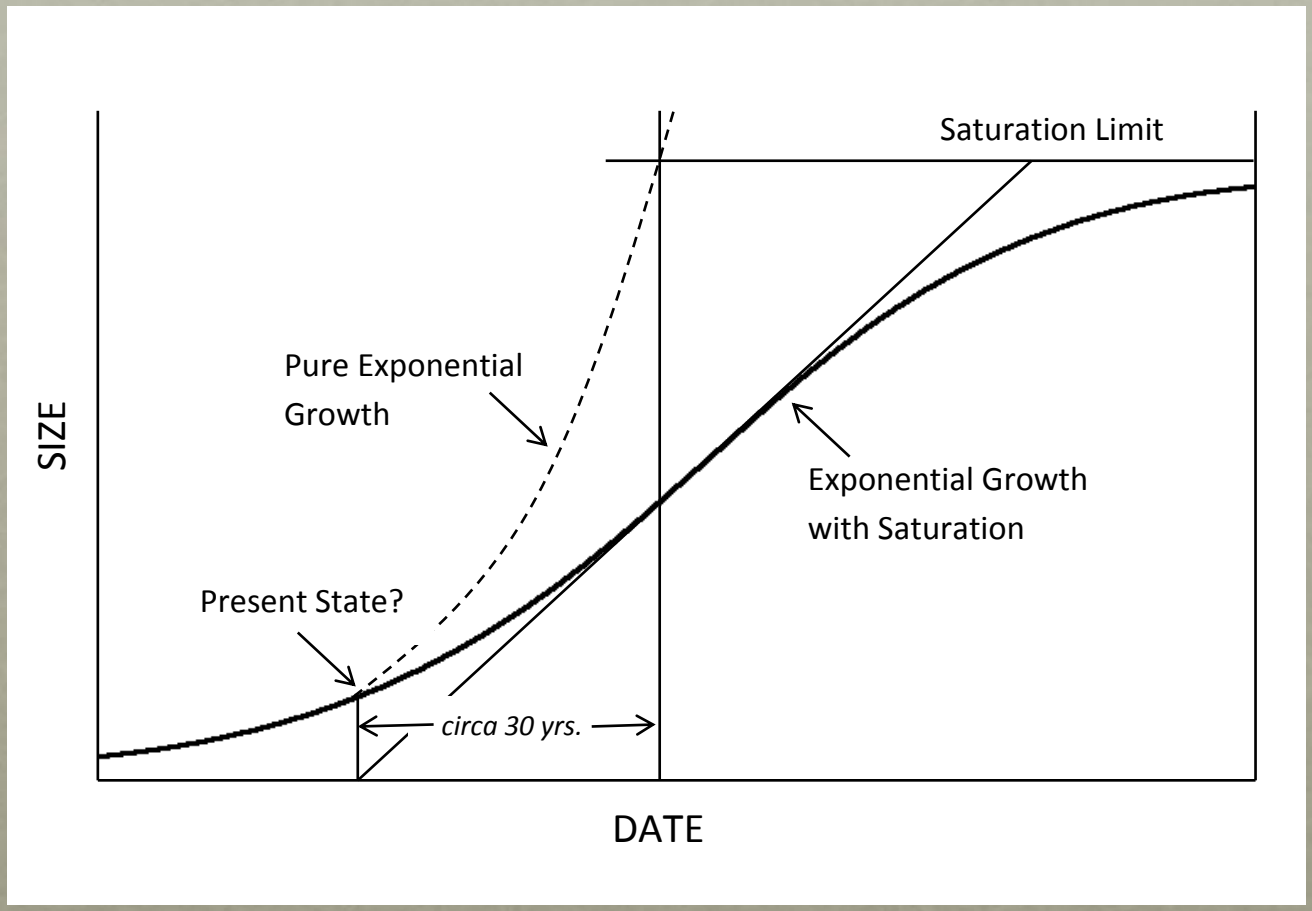
Active refereed scholarly/academic journal title growth since 1665 (log sc



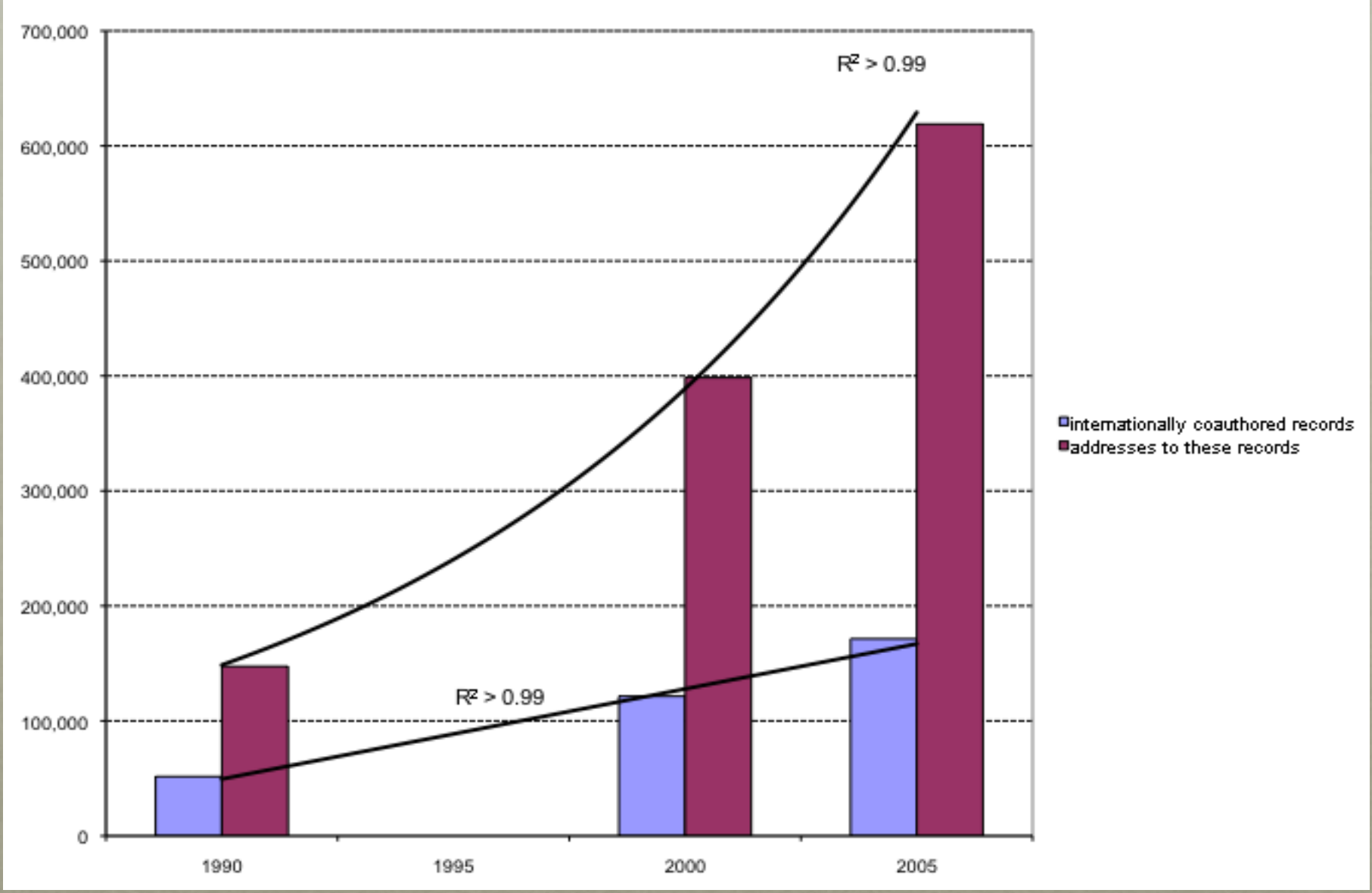
M. Mabe (2002) The growth and number of journals, *Serials*, 16(2), 191-197.

Father of "bibliometrics" – Derek de Solla Price – 1960s

Central Form of the Logistic Curve



D. De Solla Price, Science Since Babylon, New Haven: Yale University Press

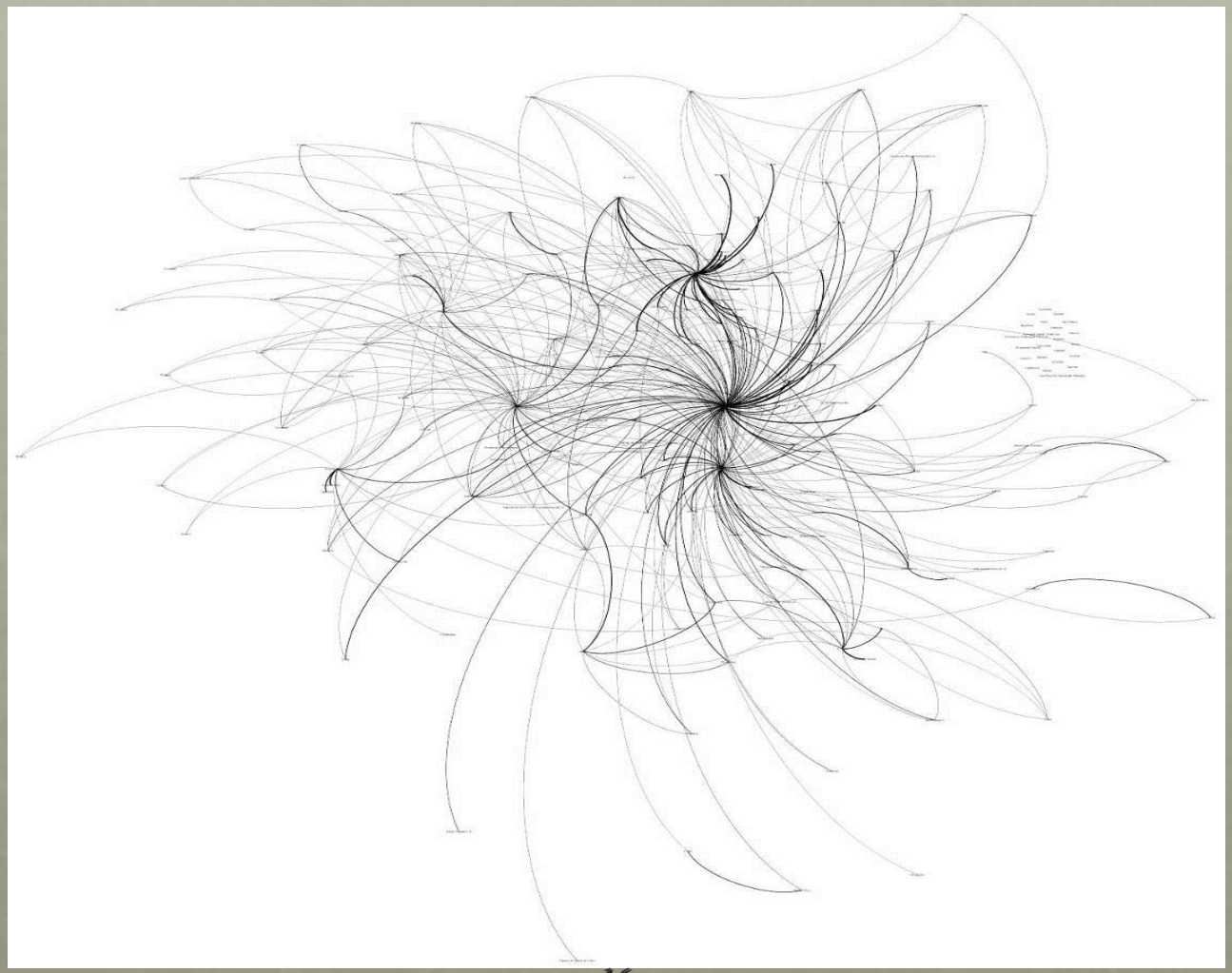


Growth of International Collaboration in Science, 1990-2005

Source: Leydesdorff & Wagner, Scientometrics, 2008

GLOBAL LINKS 1996-2003

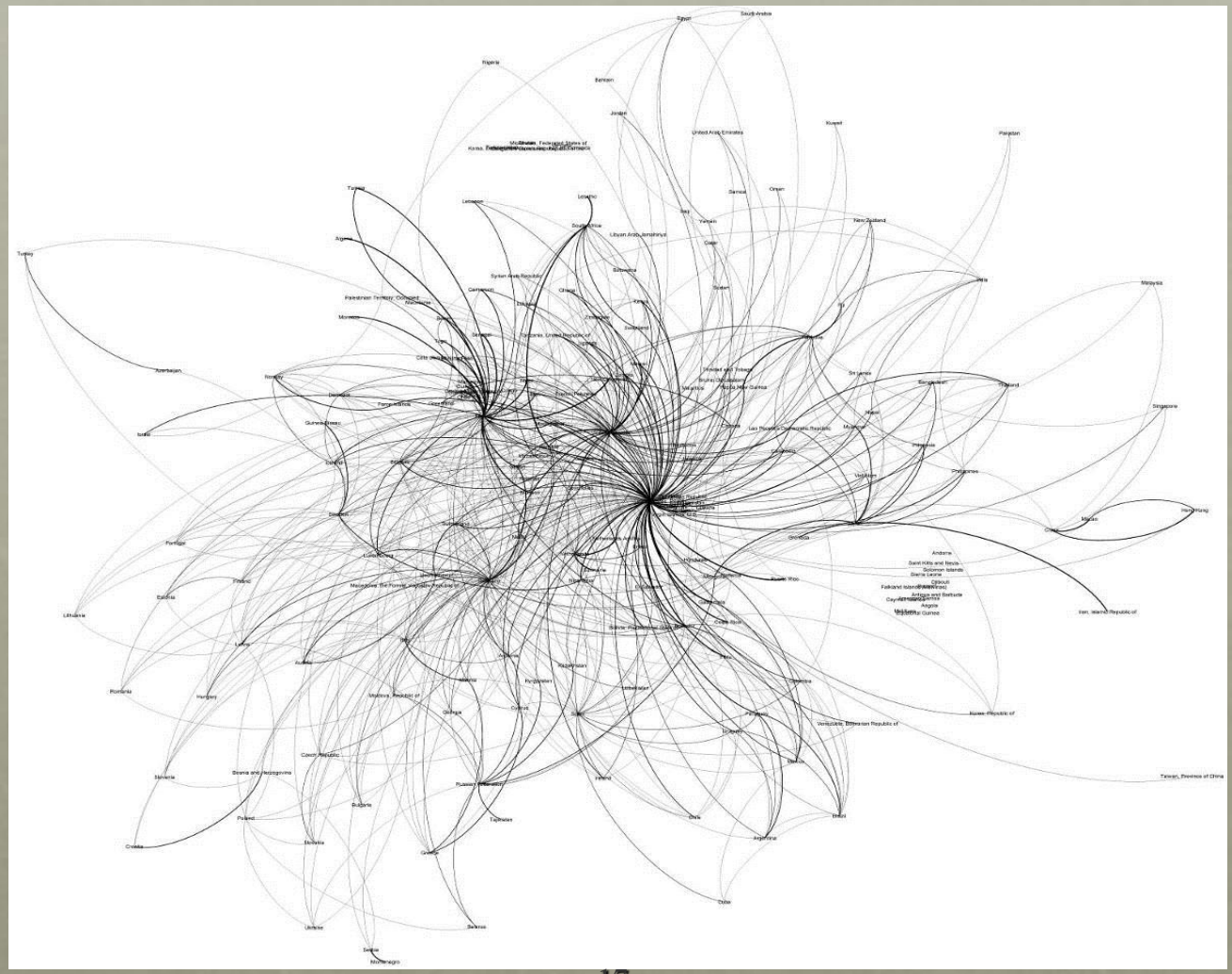
7 years



Calculated by Elsevier from Scopus data – Royal Society

GLOBAL LINKS 2, 2004-2008

4 years



Calculated by Elsevier from Scopus data – Royal Society

VASTLY MORE THAN IS COUNTED

- Formal counts *understate* output
- Web of Science holds 3 percent of all output
  - ~97 % of all scientific publications are not indexed
    - Wagner & Wong, 2011
- Even if only 80 percent, *it is a lot of unseen publications*
- Add to arXiv, RePec, Researchgate, Mendeley, VIVO
  - Back to 'splintering of sources' pre-1960

Of this, increasing amounts are collaborative, interdisciplinary

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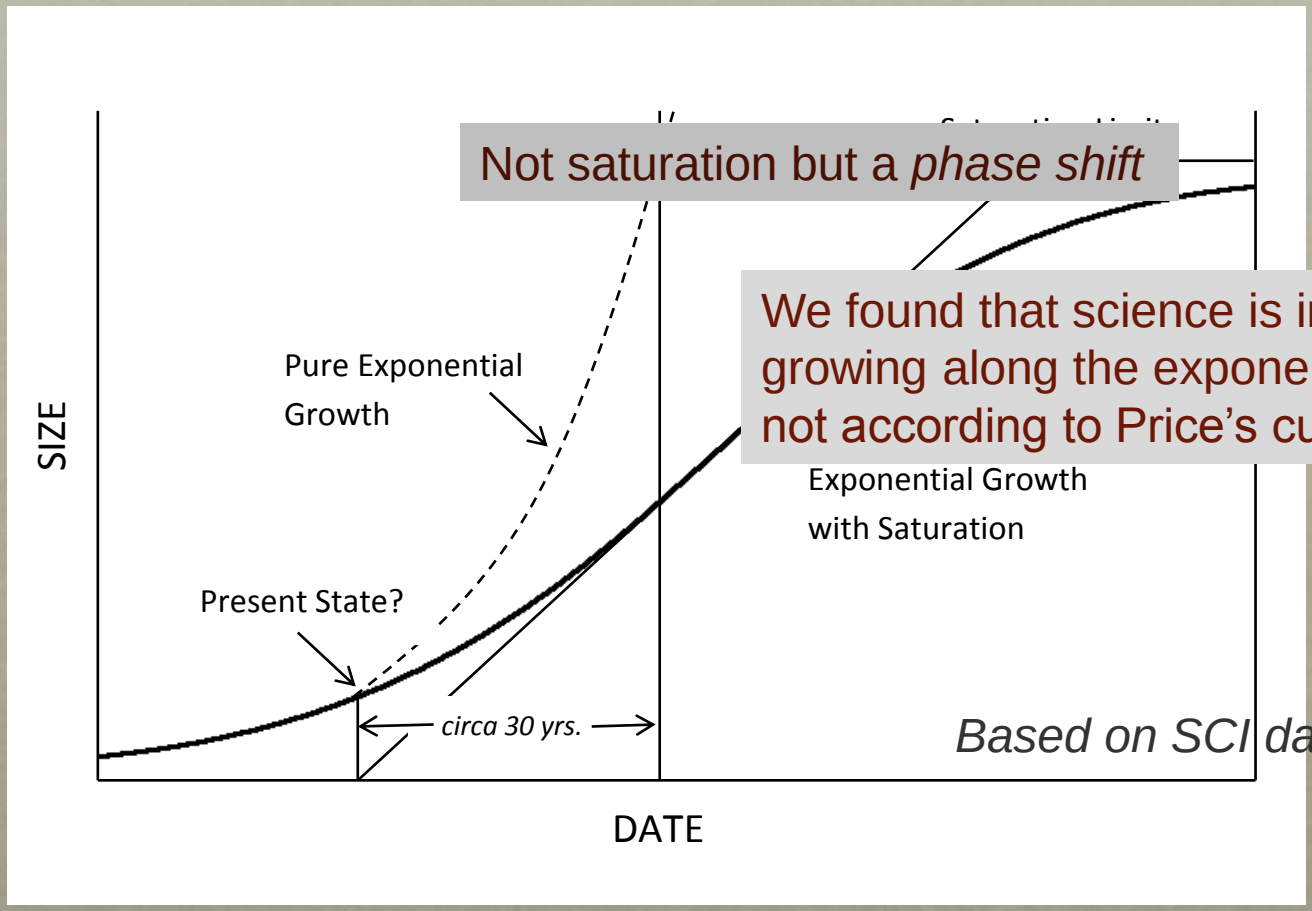

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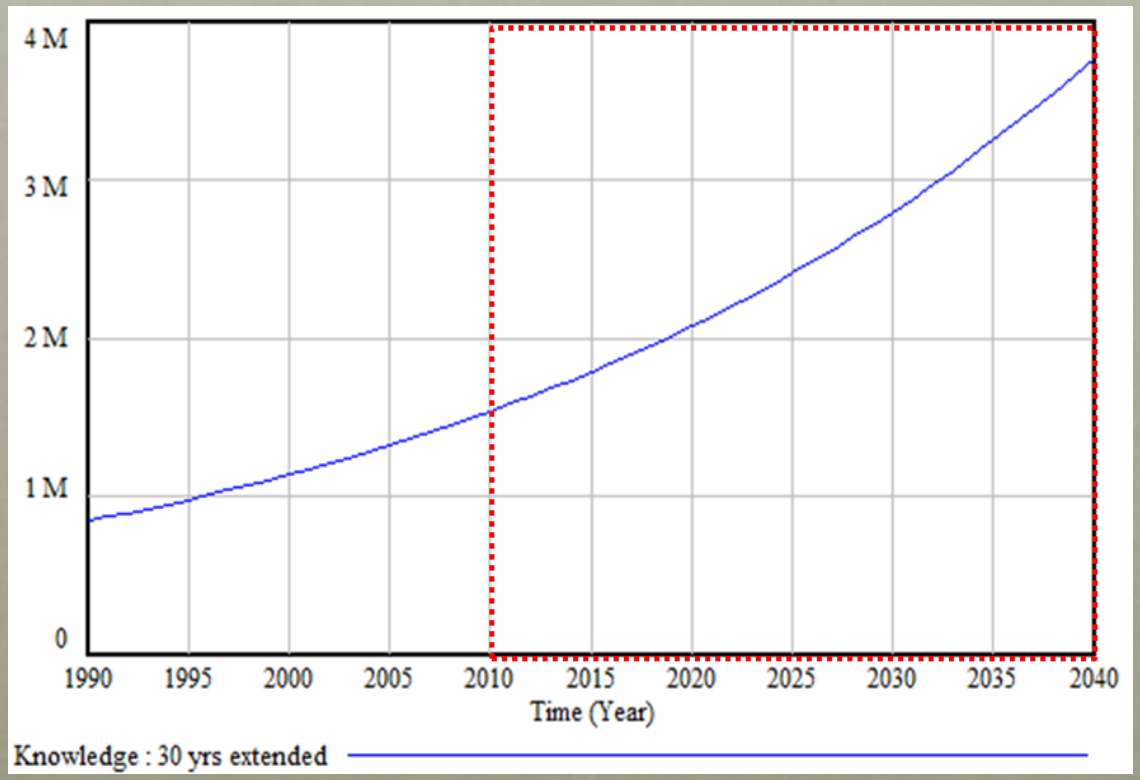
GROWTH PROJECTION



CHALLENGE: U.S. POLICY
(REDUX)

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POLICY ACTIONS

- Shift focus from 'frontiers' to usefulness
- Move from "input" ($$$) to output and use model
- Move from production to integration
- Move from national to local-global
- Move from funding national scholars to "best in the world" regardless of location
- Measure policy success by local application

- Back up slides

PHASE SHIFT IN KNOWLEDGE SYSTEM

- Exponential growth cannot go unabated (Price)
- Could get to saturation, but did not

What else has happened to the growing system?

- Physical limitations change so as not to impede growth
- Carrying capacity must shift to absorb larger numbers
- Exponential growth leads to phase shift:

Could this have occurred? Has System entered a different state?

SCARCITY TO ABUNDANCE

- Openness
  - Think "Wikileaks," medical information, ancestry
- Disciplinary convergence, interdisciplinarity
  - "Consilience" of E.O. Wilson
- Multiple sources of information
  - Walter Cronkite to Newser.com
  - Scientific data is widely available ("data deluge")
  - Many more sources and consumers of science

DYNAMICS OF ABUNDANCE

- Emergent, self-organization of collaboration - global
- Networking of researchers
- Reciprocity and distribution of exchange

- Localization of knowledge use
- Incentives (pull versus push)
- Object-focused research (demand driven)