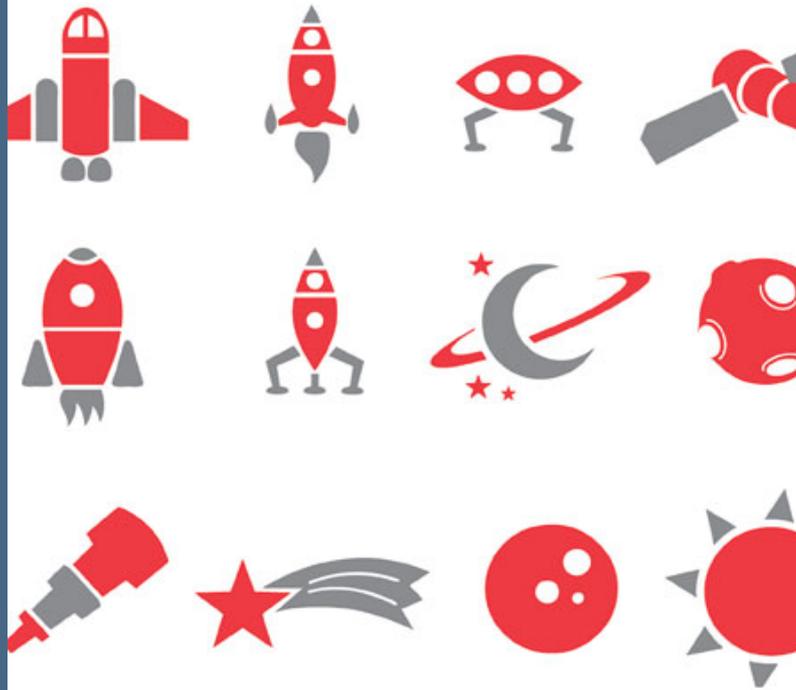


Is American Science in Decline?

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IS AMERICAN SCIENCE
IN DECLINE?



Yu Xie & Alexandra A. Killewald

Why Study Science/Scientists?

- Science is extremely important in today's society. Modern economy has been driven mainly by technological advances.

How Do **We** (Sociologists) Study Scientists?

- What's the most significant finding in the sociology of science literature in the past 60 years?
- Scientists are human beings. As such, they are motivated by self-interest.

What's Special about Science/Scientists?

- (1) The rewards to scientists are highly skewed.
- (2) Scientists are supposed to evaluate each others' work on the basis of merit and objective criteria (“universalism.”)
- (3) Scientists' work has a lot of positive “externality.”
- (4) Once discovered, scientific knowledge can be learned and used without incurring additional costs.

Origins of Modern Science

- European origin.
- Began with Copernicus.
- Scientists were amateurs, supported by either family wealth or rich patrons (very different from today's scientists).

Shifts in the World Center of Science

- Italy (16th century)
- England (17th century),
- France (18th century),
- Germany (19th century)
- U.S.A. (20th century)

A Prediction by a Japanese Historian of Science in 1962

- “The scientific prosperity of [the] U.S.A., begun in 1920, *will* end in 2000.”

Undisputed U.S. (5% of pop.) Leadership in Today's Science

- 40% of total research and development spending
- 38% of patented new technology inventions
- 45% of the world's Nobel Prize winners in physics, chemistry, and physiology or medicine through 2009
- 35, 49, and 63%, respectively, of the world's scientific publications, citations, and highly cited publications
- 75% of the world's top 20 universities

Characteristics of American Science

- Large-scale government and industrial support
- University-based, armed with a graduate school system
- Encouragement of innovation, open acceptance of immigrants, **peer-review**, and a flat system
- True transformation of science from a personal pursuit to a large paid profession

The Alarmist View

- 2007 report by the National Academy of Sciences (NAS): *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.*
- Highly influential.
- “Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position.”

Huge Policy Impact

- *Rising Above the Gathering Storm* became one of the most significant reports for U.S. science policy in recent U.S. history.
- Is there empirical support for the report?

Is There Evidence in Support of the Alarmist View?

- Yes.
- Two main aspects:
 - (1) Intense international competition, especially from East Asia
 - (2) Unfavorable labor market outcomes for scientists
- The two aspects may be related.

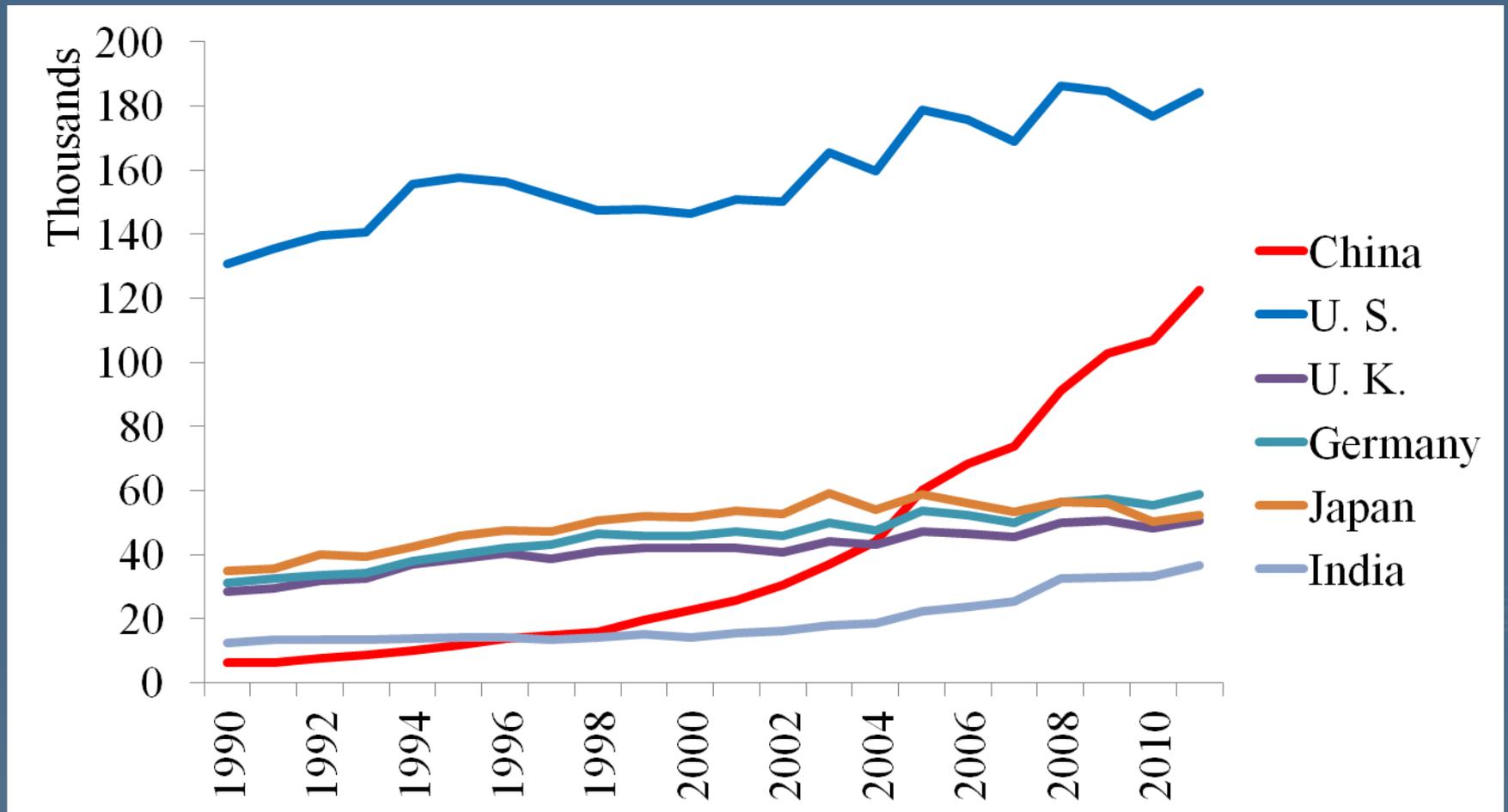
International Competition 1: Scientific Output

Average annual growth rate in S&E article output,
by country/region and field

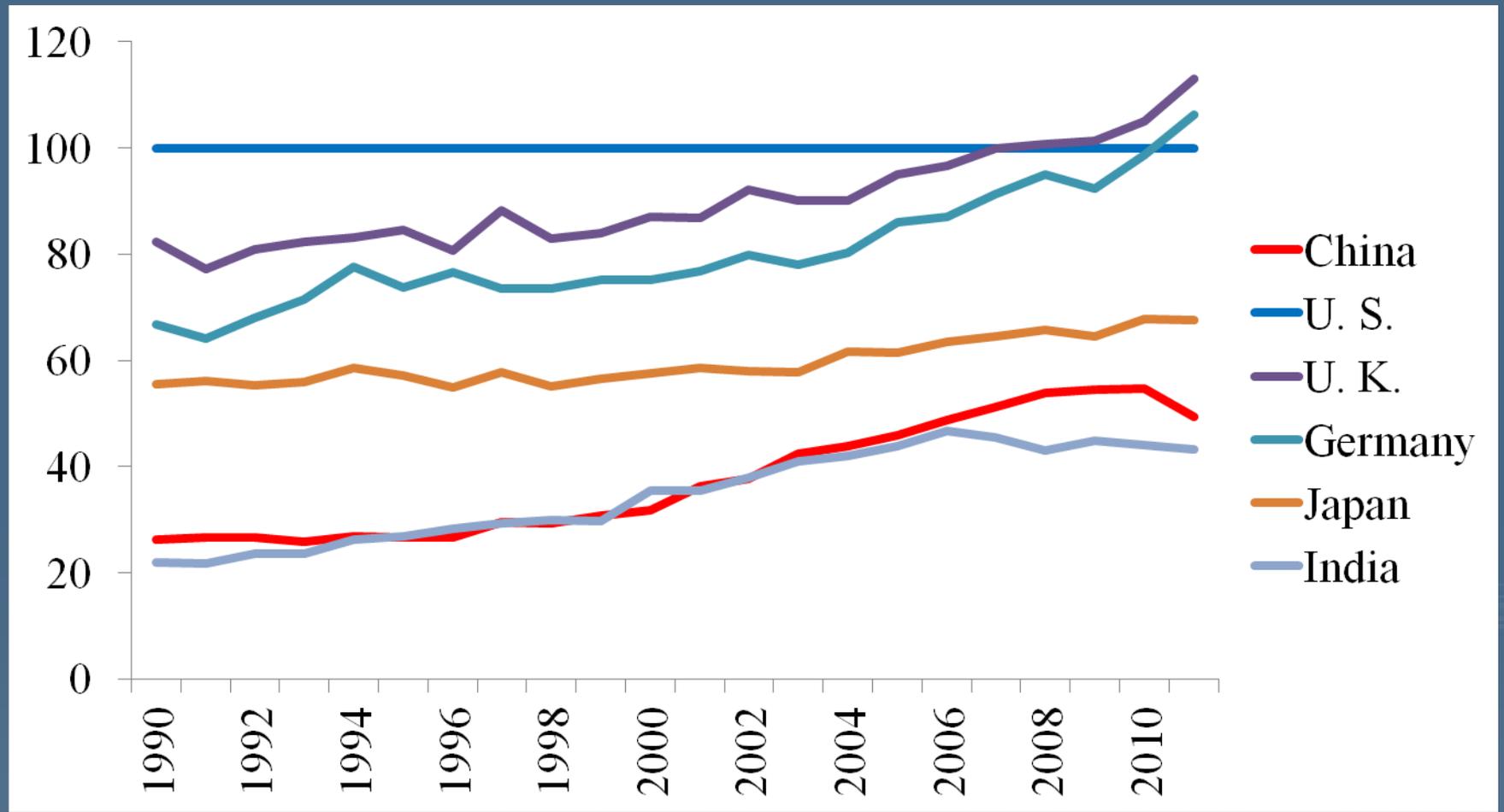
		United States	EU-15	Japan	East Asia-4
Biology					
	1988-1992	1.7	6.4	4.6	17.7
	1992-2003	1.1	4.1	3.9	16.0
Chemistry					
	1988-1992	4.2	5.7	6.6	33.3
	1992-2003	1.2	2.3	2.4	16.1
Physics					
	1988-1992	5.1	10.6	10.9	19.7
	1992-2003	0.3	3.4	4.4	14.3
Mathematics					
	1988-1992	-2.0	3.2	-8.1	18.1
	1992-2003	1.4	6.7	8.0	14.2

Source: National Science Foundation (2007).

China has become the second largest producer of scientific papers (Web of Science).

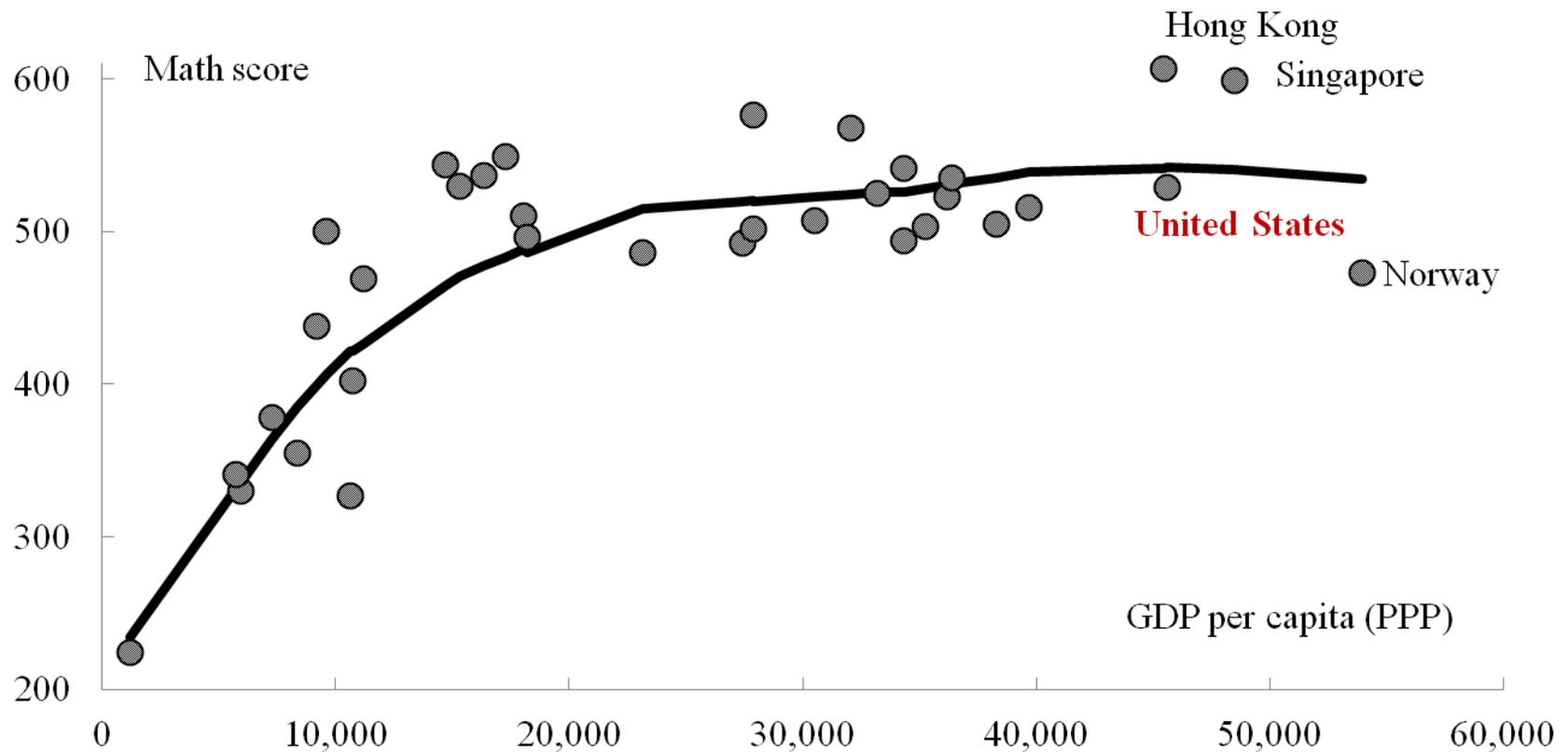


Quality Assessment: Average times cited per article as compared to the U.S. (%) (Web of Science)



International Competition 2: Math Achievement Comparison, TIMSS 4

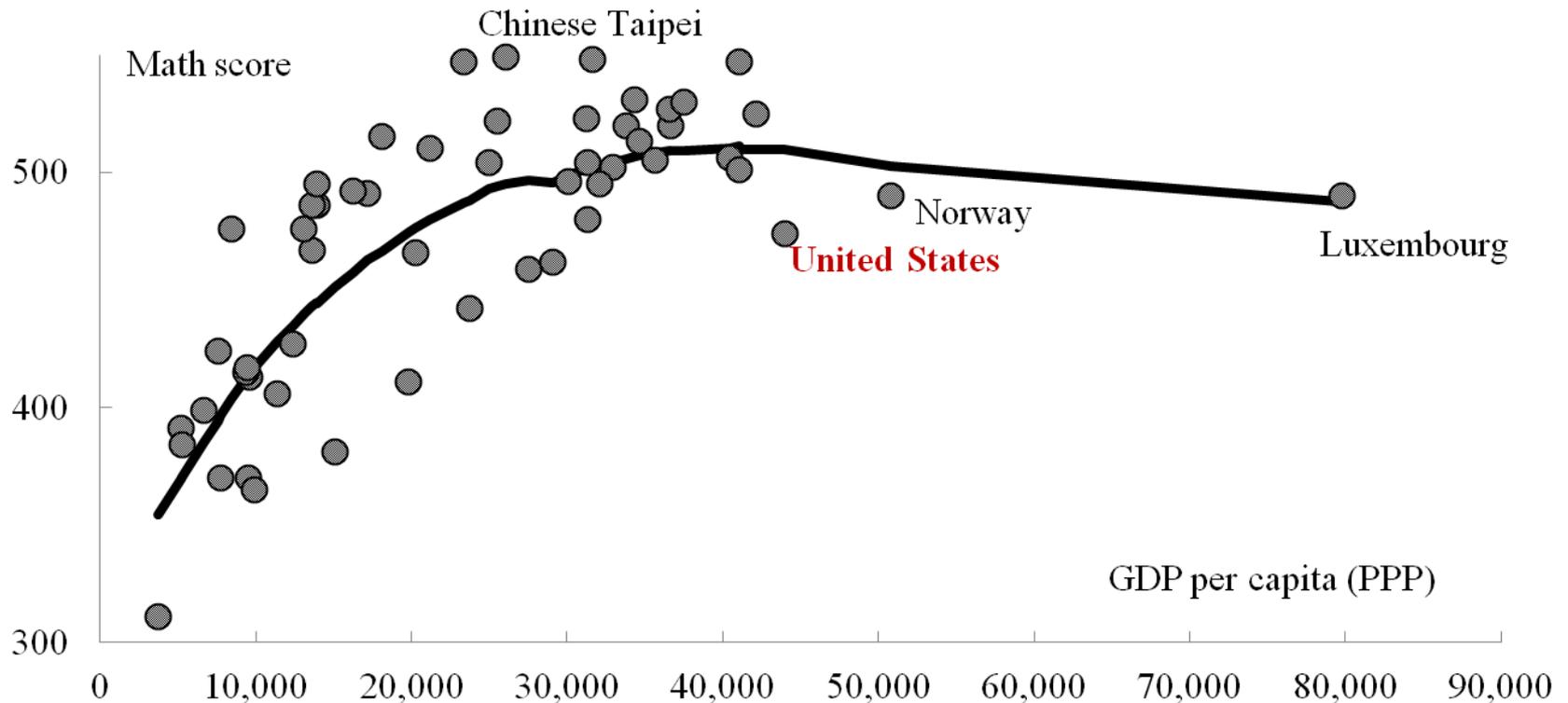
TIMSS 4th grade math scores by GDP per capita (PPP), 2007



Source: Penn World Table 6.3 (2009); Gonzales et al. (2008); United Nations (2009).

2006 PISA Results

PISA math scores by GDP per capita (PPP), 2006



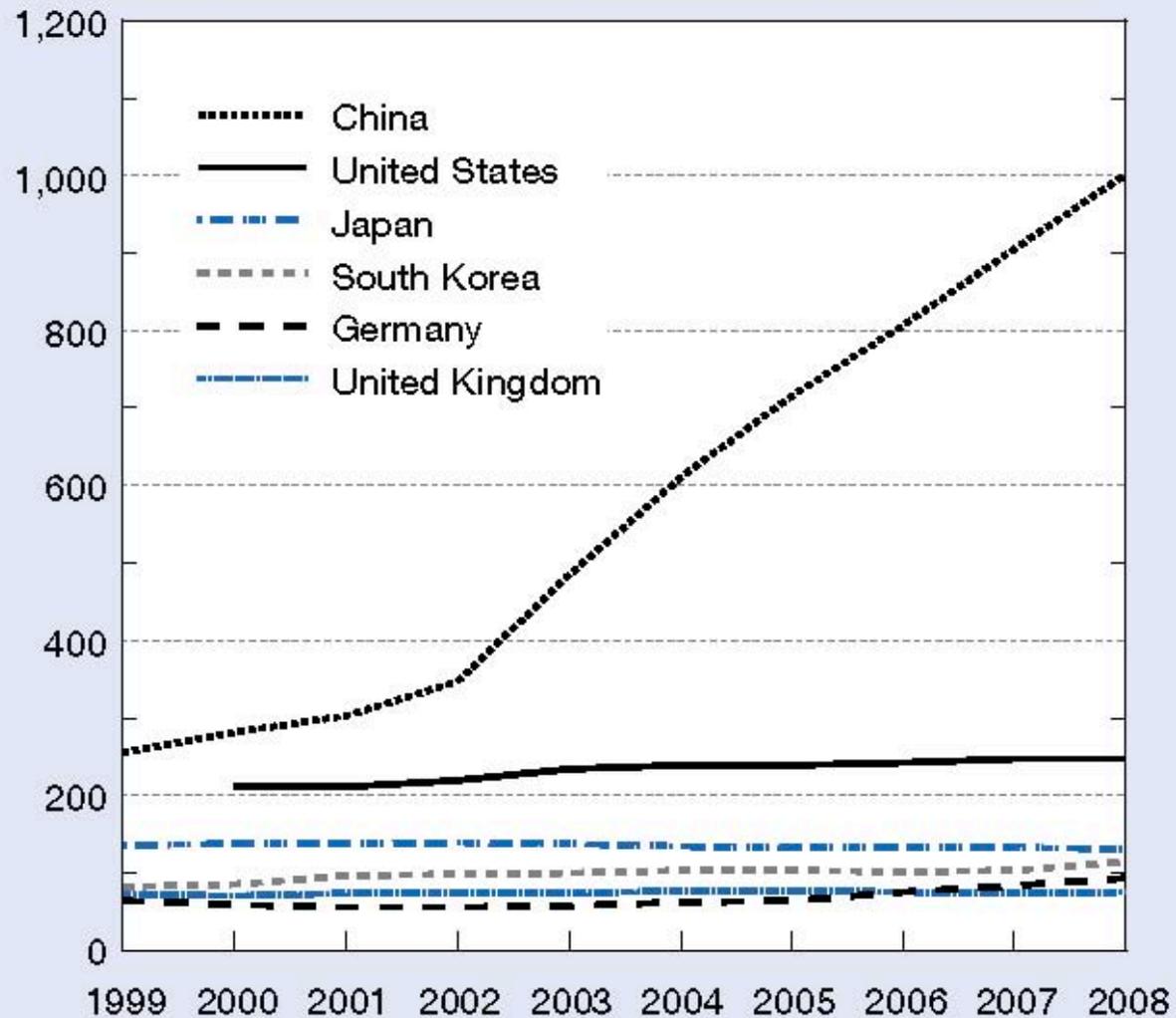
Source: Penn World Table 6.3 (2009); Gonzales et al. (2008); United Nations (2009).

International Competition 3: Science Degree Production

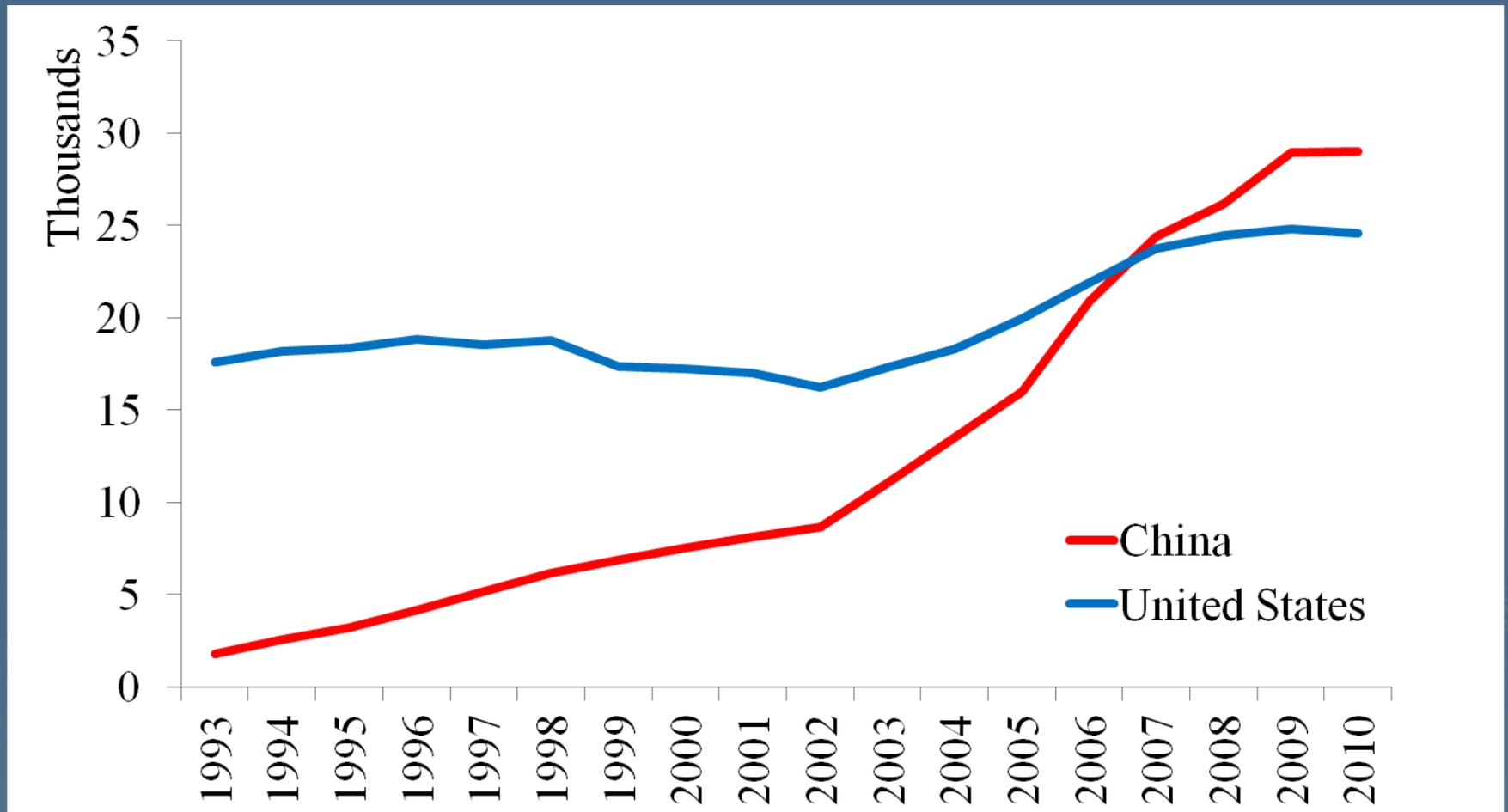
- China has far surpassed the U.S. in the production of science/engineering degrees at the bachelor's level.
- China has surpassed the U.S. in the production of science/engineering degrees at the doctoral level.

Figure 2-27
First university natural sciences and engineering degrees, by selected countries: 1999–2008

Thousands

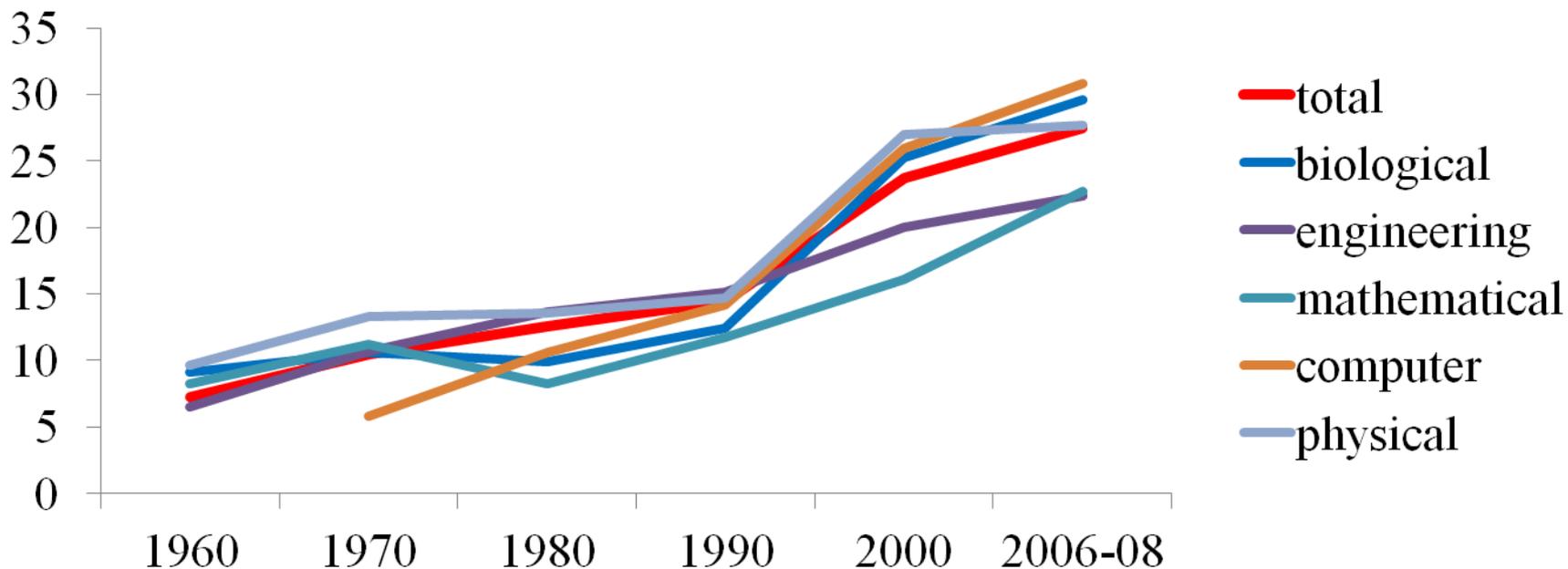


China has now overtaken U.S. in the production of S/E Ph.D.s



International Competition 4: Reliance on Immigrants

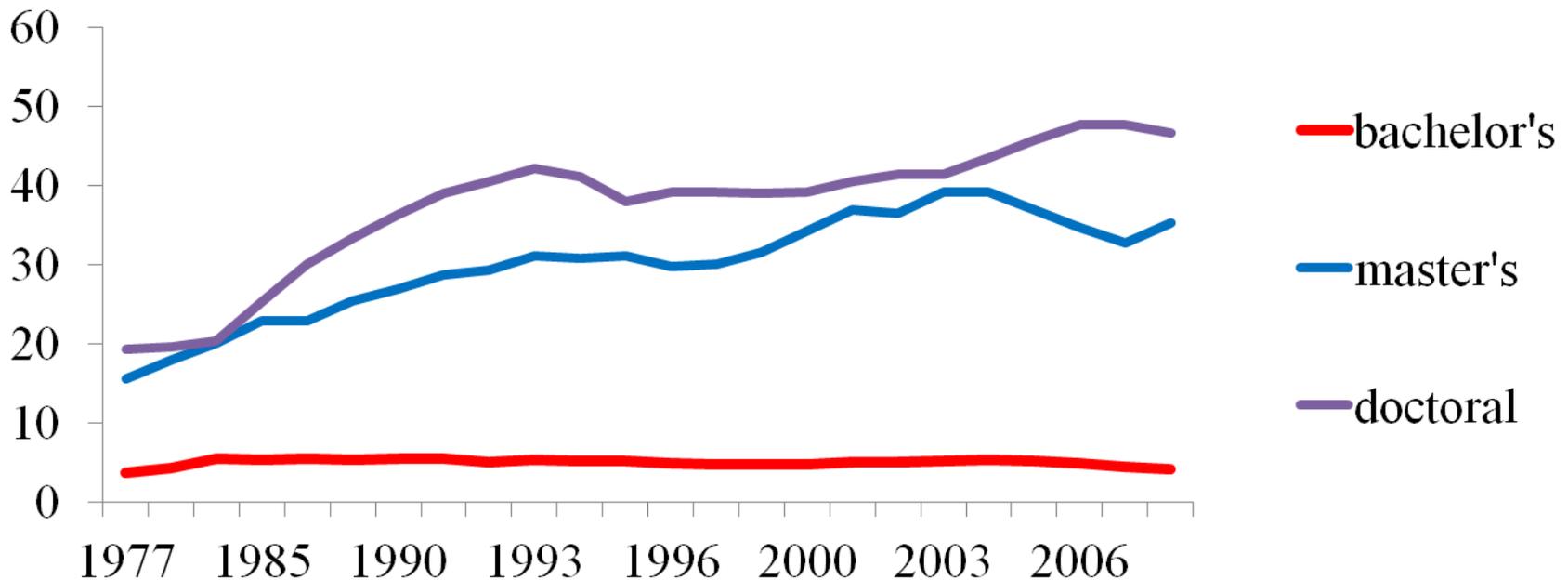
Percent immigrants among U.S. scientists, by field, 1960-2008



Source: U.S. Census 1960-2000; American Community Survey 2006-2008.

International Competition 4: Reliance on Foreign Students

Percent temporary residents among S/E degree recipients, by
level of degree, 1977-2008

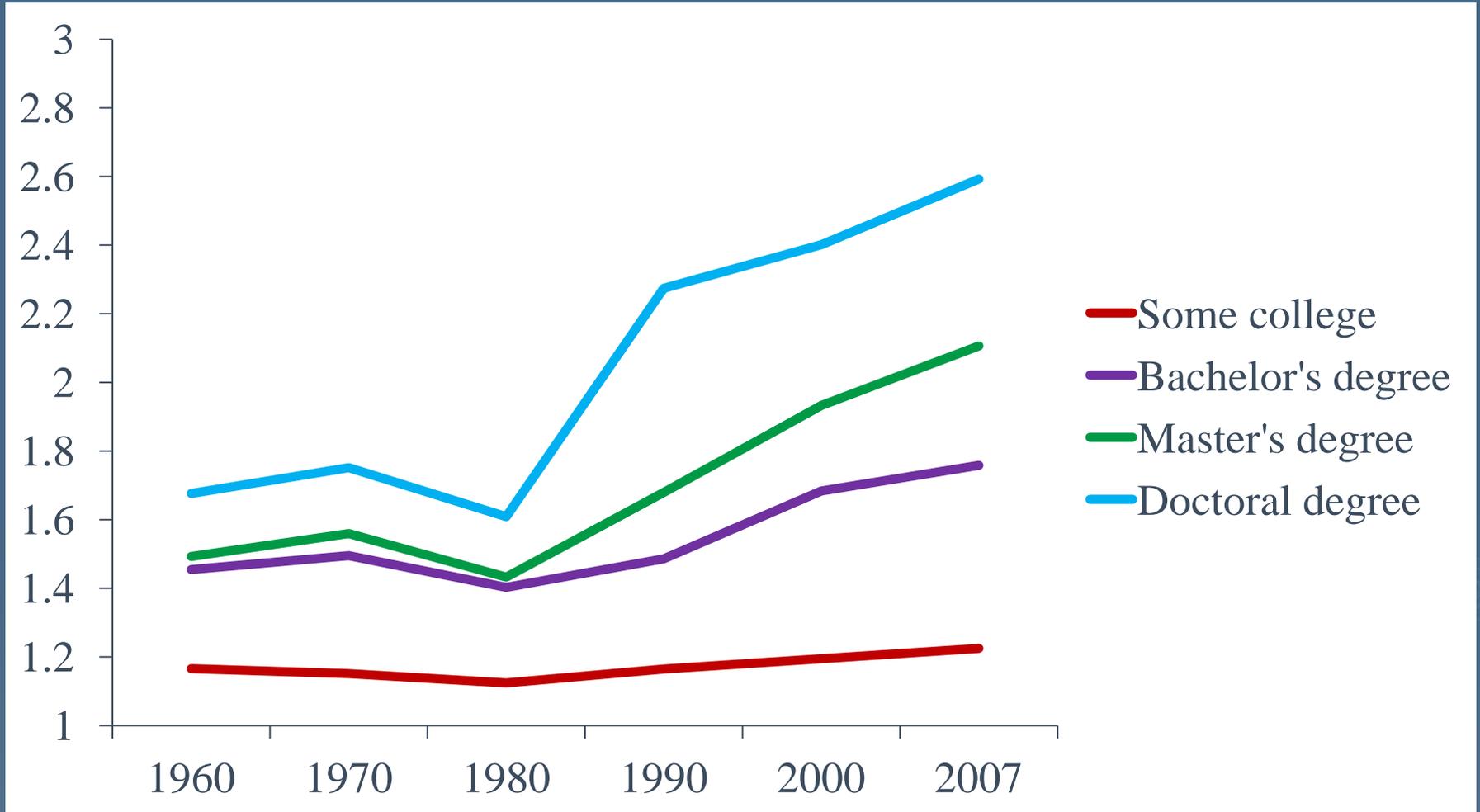


Source: WebCASPAR (2010).

The Twentieth Century

- American Century
- Education Century
- The two are linked.
- Productivity and economic growth in the U.S. have been driven by technology.
- Returns to skills have increased.

Estimated ratios in earnings between workers with postsecondary and workers with high school educations (males only, control for labor supply, Census & ACS data)



Unfavorable Labor Market Outcomes for Scientists

- Returns to education (human capital) have increased since the 1980s.
- However, after adjustment for inflation, scientists' earnings have stagnated.

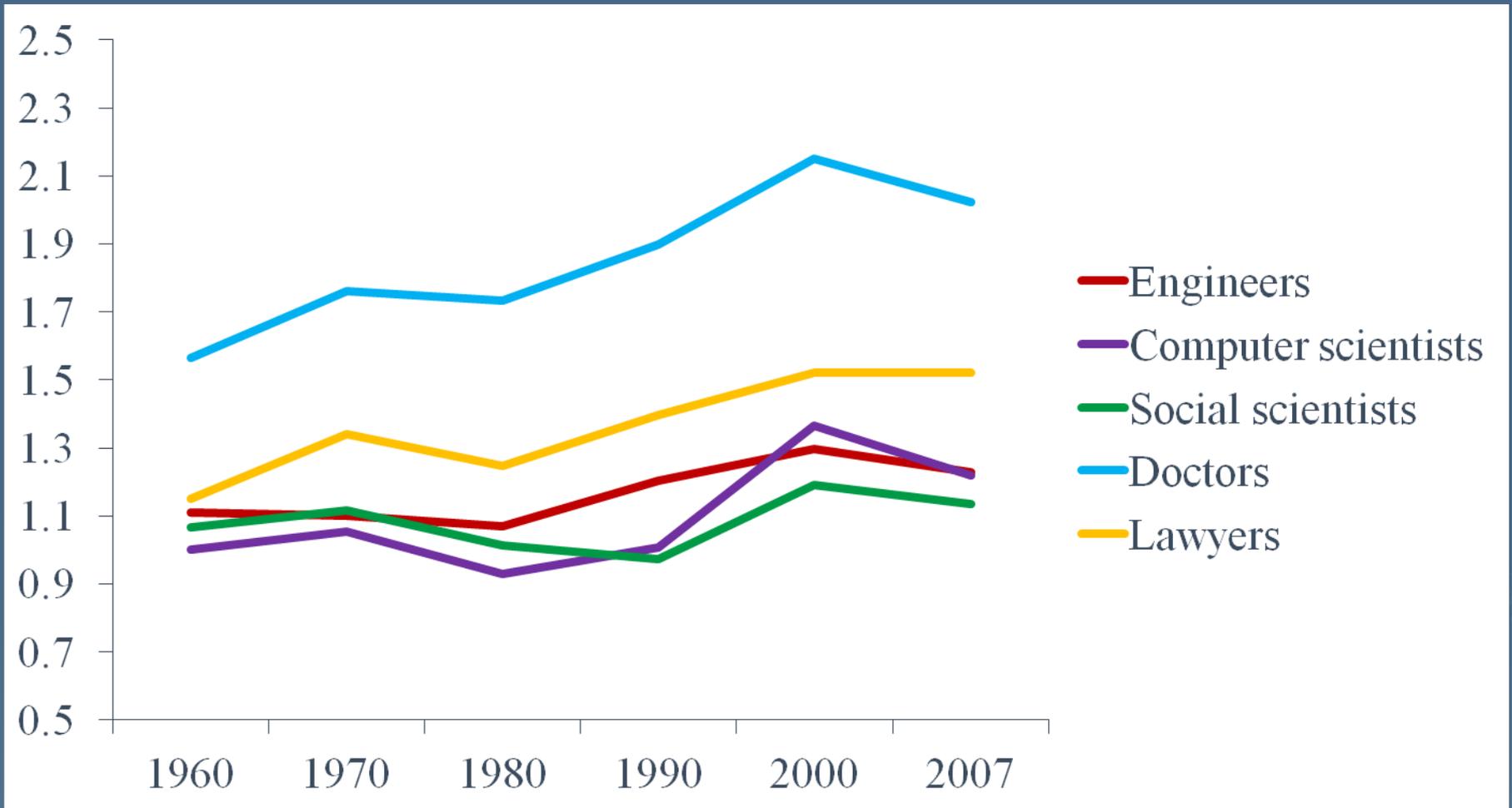
At the Absolute Level of Earnings

- For scientists and engineers at all three degree levels, the annual growth rate between 1960 and 2007 (in real dollars) was 0.5% or less.

Relatively Speaking

- Scientists' earnings have been declining, relative to those of other high-status professionals.
- The unfavorable trend is particularly pronounced at the doctoral level of education.

Ratio in mean earnings, other professionals to basic scientists (males, doctoral level, Census & ACS data)



A Puzzle

- Relative to applied scientists (engineers and computer scientists), nurses, medical doctors, and lawyers, basic scientists have lost ground.
- Our finding presents a puzzle: If the economy is driven by technology, why are other highly-educated professionals better rewarded than workers who produced technology?

Impact on Recruitment

- Has the declining earnings of scientists discouraged talented American youth from pursuing science careers?
- If there is a shortage, why has there been a decline in relative earnings?

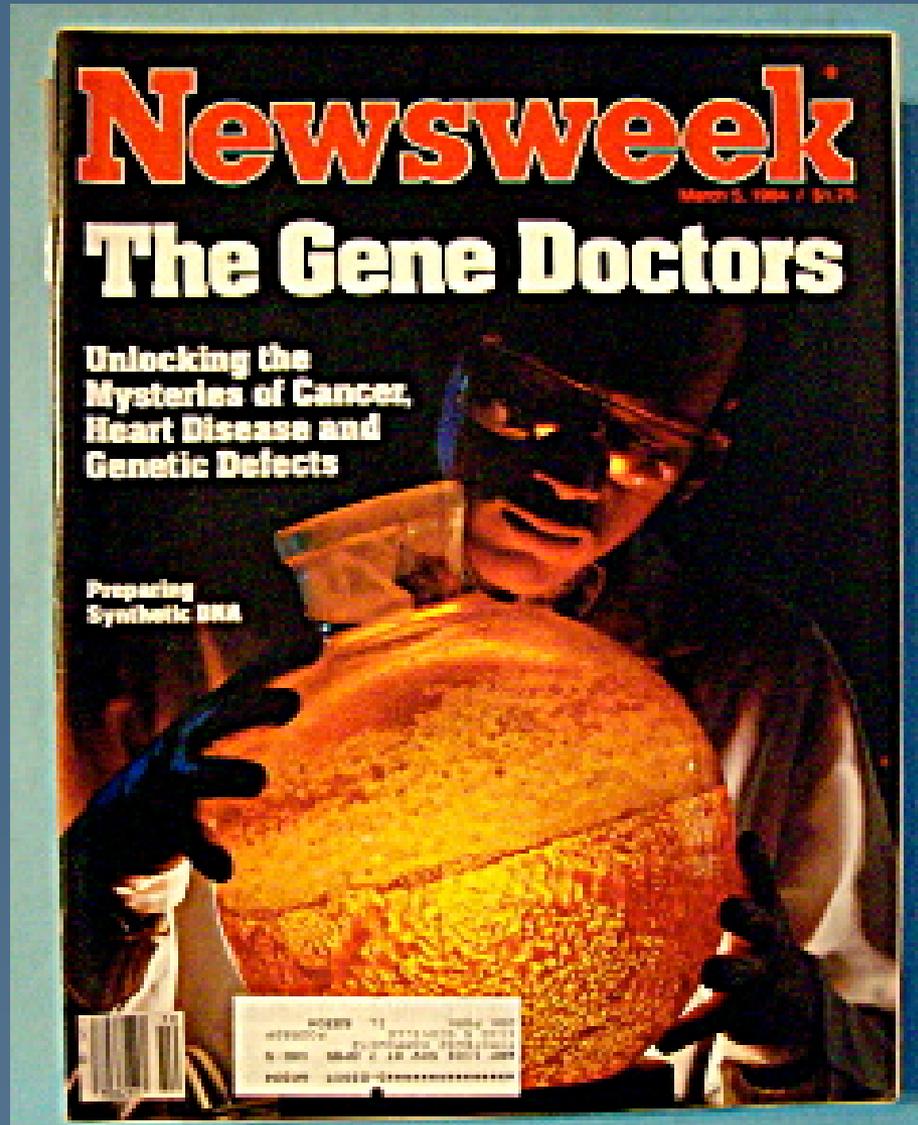
However

- Despite these problems, American science has not declined.
- Growth and continued strengths of American science can be shown as follows.

Growth of American Science Labor Force

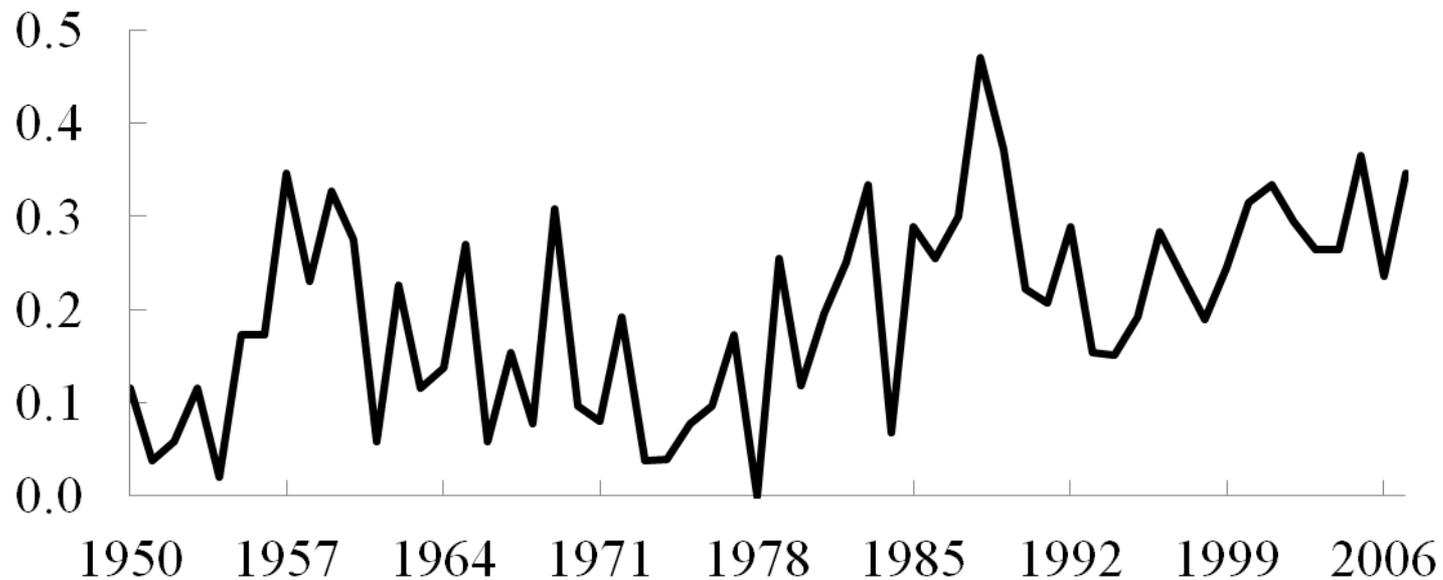
	1960	1970	1980	1990	2000	2007
Scientists among employed	1.3	1.8	1.9	2.3	3.0	3.3
Employed with college degree	11.1	14.7	22.4	25.7	29.6	32.9
Employed who are immigrants	6.0	5.7	8.0	8.8	12.5	17.0
Scientists among U.S.-born with college degree	11.2	11.7	8.1	8.2	9.0	8.6
Scientists who are immigrants	7.2	10.5	12.6	14.5	23.7	27.5

“Qualitative Data”



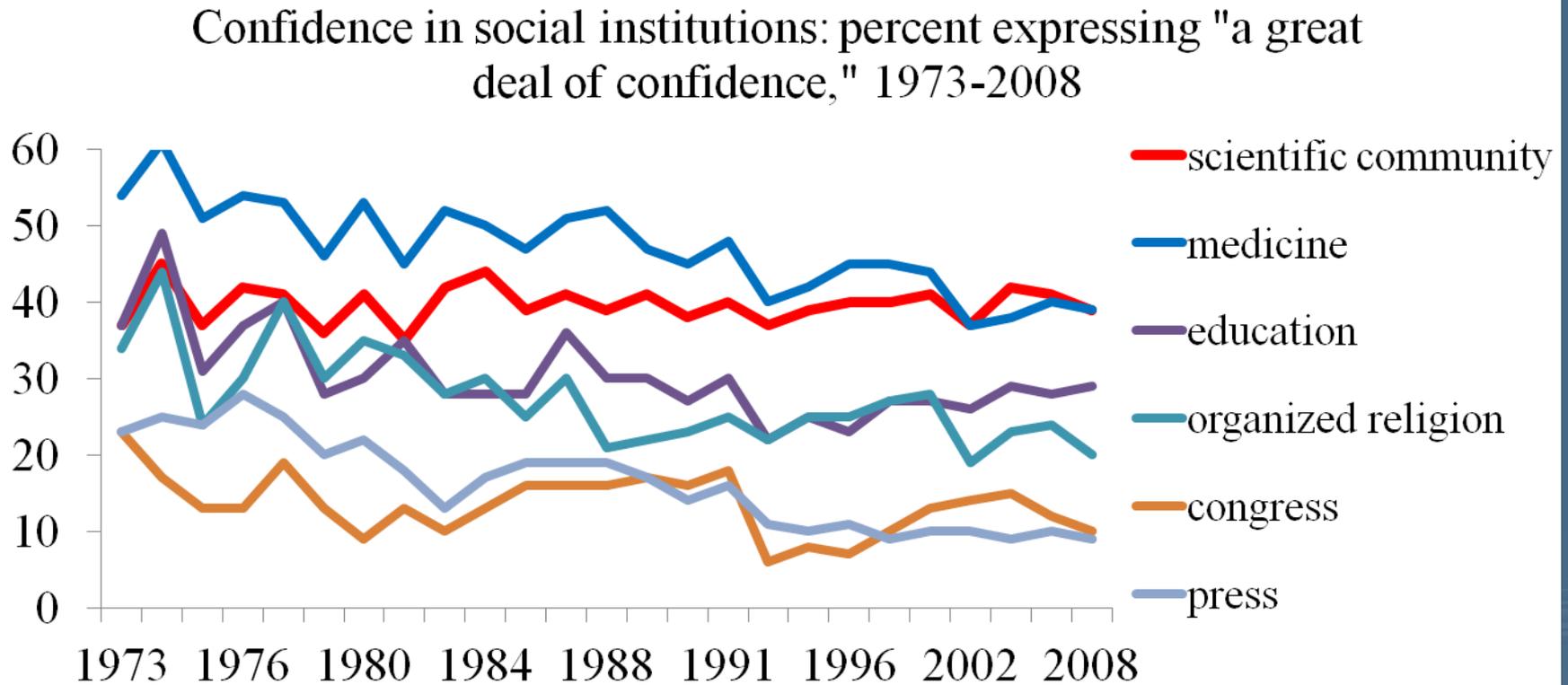
Growth of Public Interest in Science

Science coverage index in *Newsweek*, 1950-2007



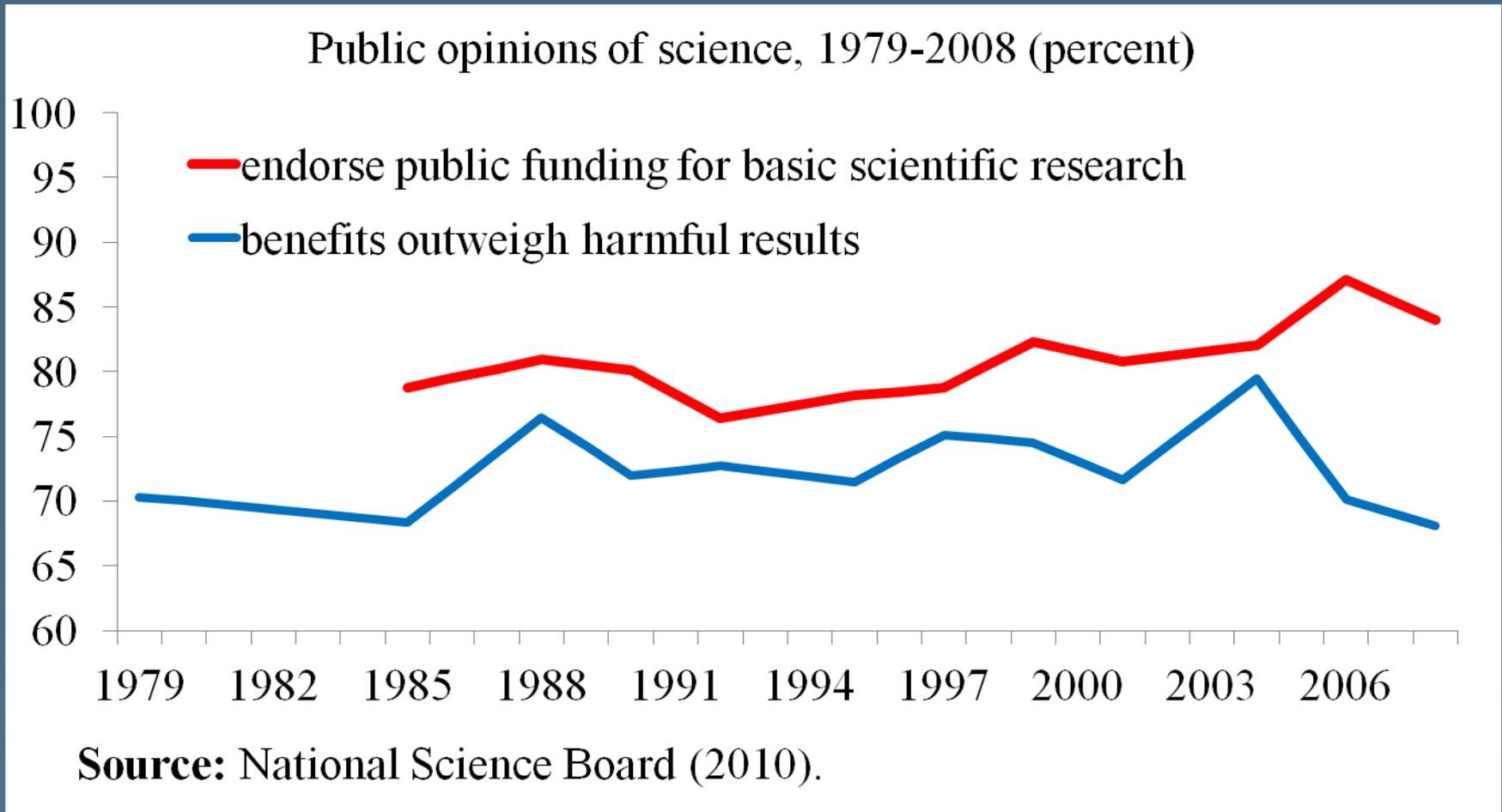
Source: *Newsweek* 1950-2007.

Continuing Confidence in Science



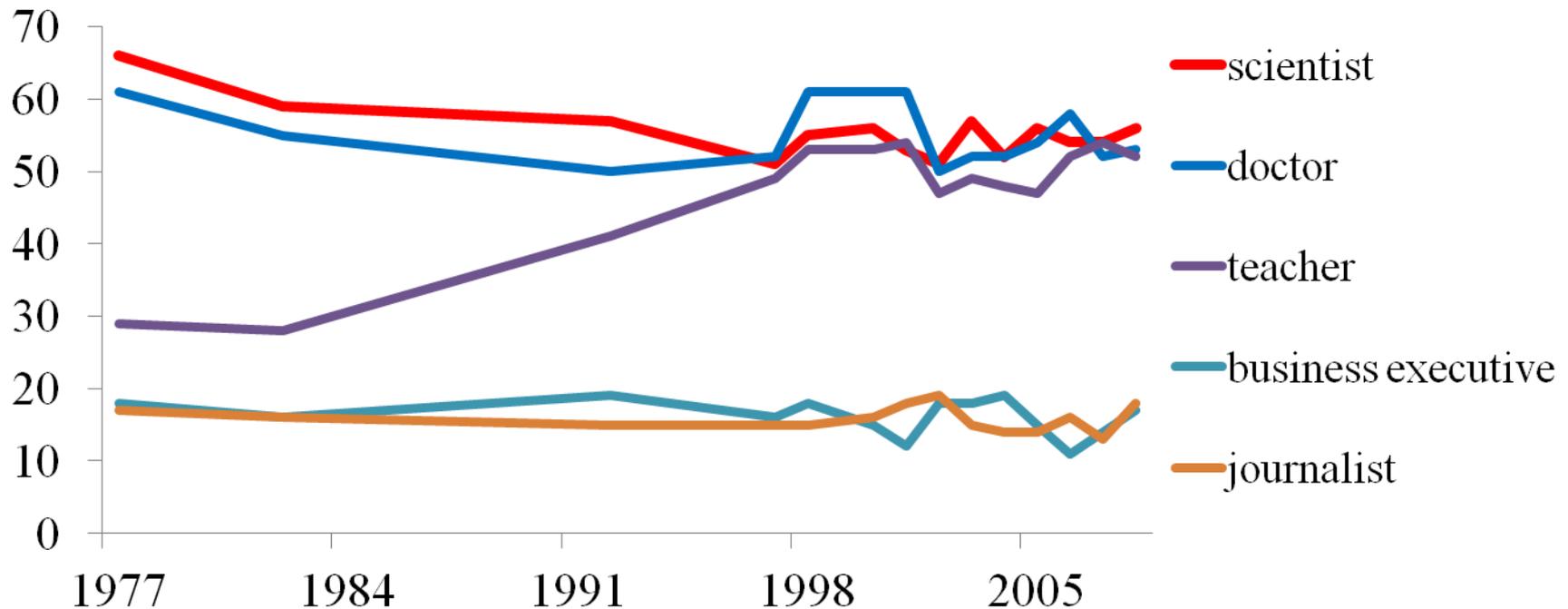
Source: National Science Board (2010).

Positive Public Opinions toward Science



The High (but slightly declining) Prestige of Scientists

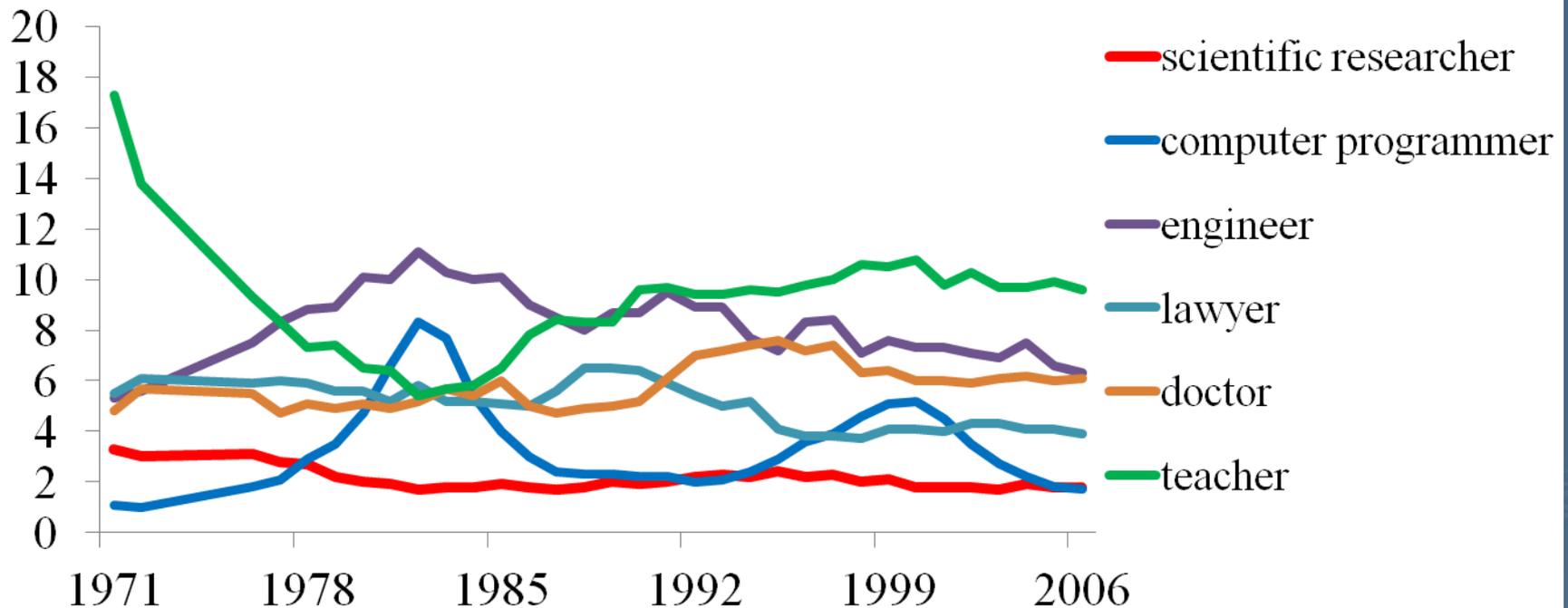
Occupational prestige: percent reporting "very great prestige,"
1977-2008



Source: National Science Board (2010).

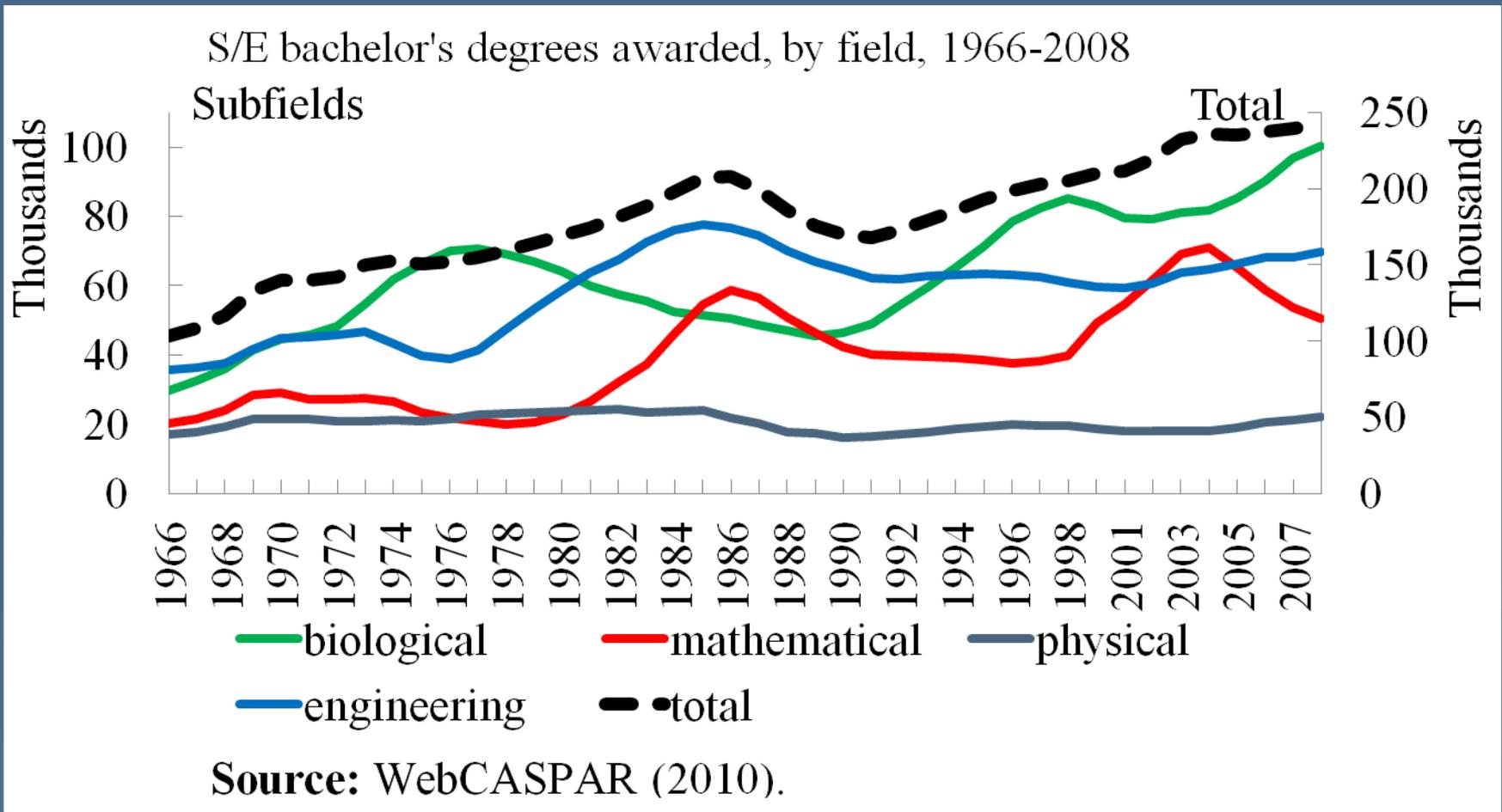
Steady (Slightly Declining) Interest of Freshmen in Science

Freshmen interest in science: probable occupation, 1971-2006
(percent)

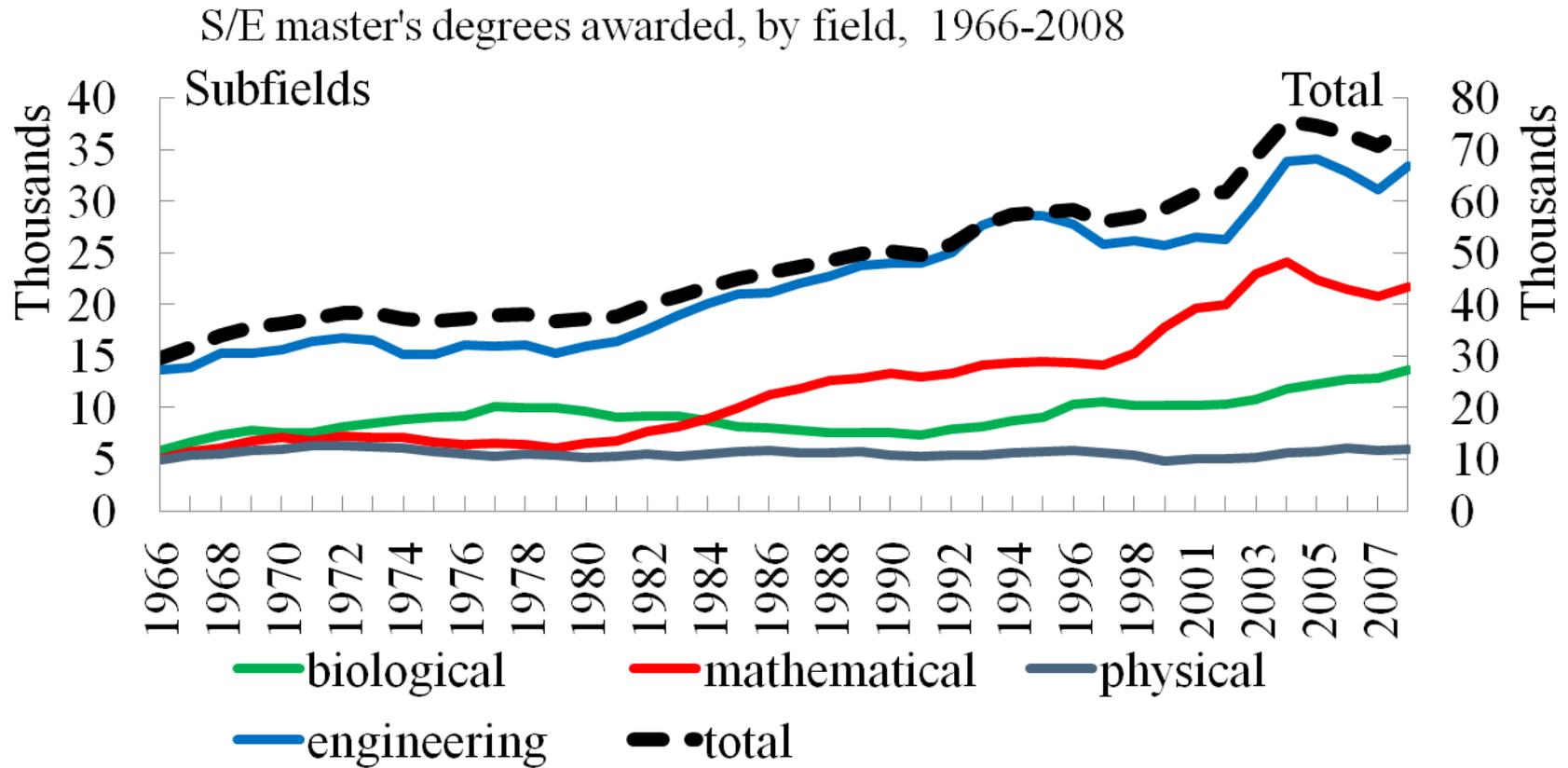


Source: Pryor et al. (2007).

Growth in Production of S/E Degrees, Bachelor's Level

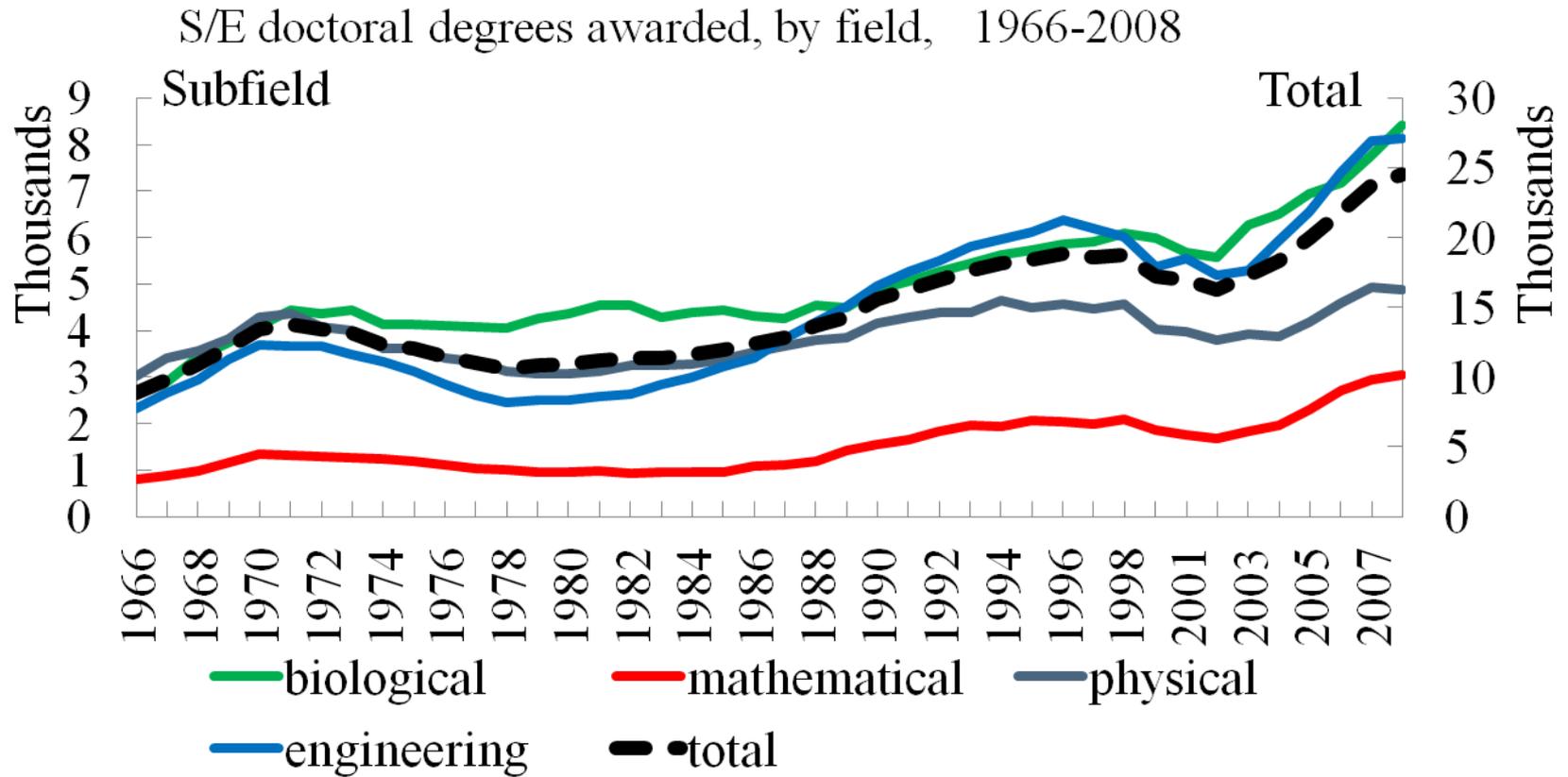


Growth in Production of S/E Degrees, Master's Level



Source: WebCASPAR (2010).

Growth in Production of S/E Degrees, Doctoral Level



Source: WebCASPAR (2010).

Bachelor's Degree and Science Major Attainment, by Gender and Cohort

	Male			Female		
	1972 cohort (NLS-72)	1982 cohort (HS&B)	1992 cohort (NELS)	1972 cohort (NLS-72)	1982 cohort (HS&B)	1992 cohort (NELS)
Bachelor's degree (%)	27.80	30.75	30.55	23.92	29.77	36.87
Among top 25% in math achievement	54.52	61.23	64.27	53.45	70.39	75.93
Science major given bachelor's degree (%)	28.66	31.39	28.28	10.22	13.66	13.21
Among top 25% in math achievement	36.92	41.52	38.75	15.73	20.89	19.33

A “Glut” Claim

- **“One out of three”**
- “The S&E employment of S&E graduates is also a fairly consistent one-third of S&E graduates” (2007 report released by the Urban Institute in response to the 2006 NAS report *Rising Above the Gathering Storm*)
- Misleading claim.

What Went Wrong with Previous Research?

- NSF tabulation of science majors includes social science majors.
- About half of all bachelor's science majors by this definition are in social science.
- Social science majors are preparatory majors for professional schools (law, business, medicine, education, public health, social work, etc.)
- 1/2 - 2/3 of S/E graduates actually work in S/E after we exclude social science majors.

Conclusion

- Is American science in decline?
- Our answer is a qualified no.
- This conclusion is based on the following facts:

Why Not?

- (1) The scientific labor force in the U.S. has grown.
- (2) Public interest in and support for science in American society has remained high.
- (3) American high school students are doing more course work and performing better in mathematics and science than in the past.

Why Not?

- (4) American universities have been producing new graduates in science at the bachelor's, master's, and doctoral levels in increasingly large quantities.
- (5) Most graduates with science degrees in the U.S. have found jobs related to their training.

Sources of Concern

- (1) International competition is real.
- (2) Earnings of scientists have been stagnating since the 1960s.

How Do We Reconcile Two Opposing Views?

- Why some claim that American science is declining while others claim that American science is doing well (actually too well)?

Our Answer

- There is no real contradiction.
- It is a matter of perspective.
- From an international perspective, America's leadership in science is declining.
- From a temporal perspective, America is actually doing better than before.

However

- The rise of other countries in science does not necessarily mean the decline of American science.
- I am optimistic about American science.

Two Reasons for Optimism

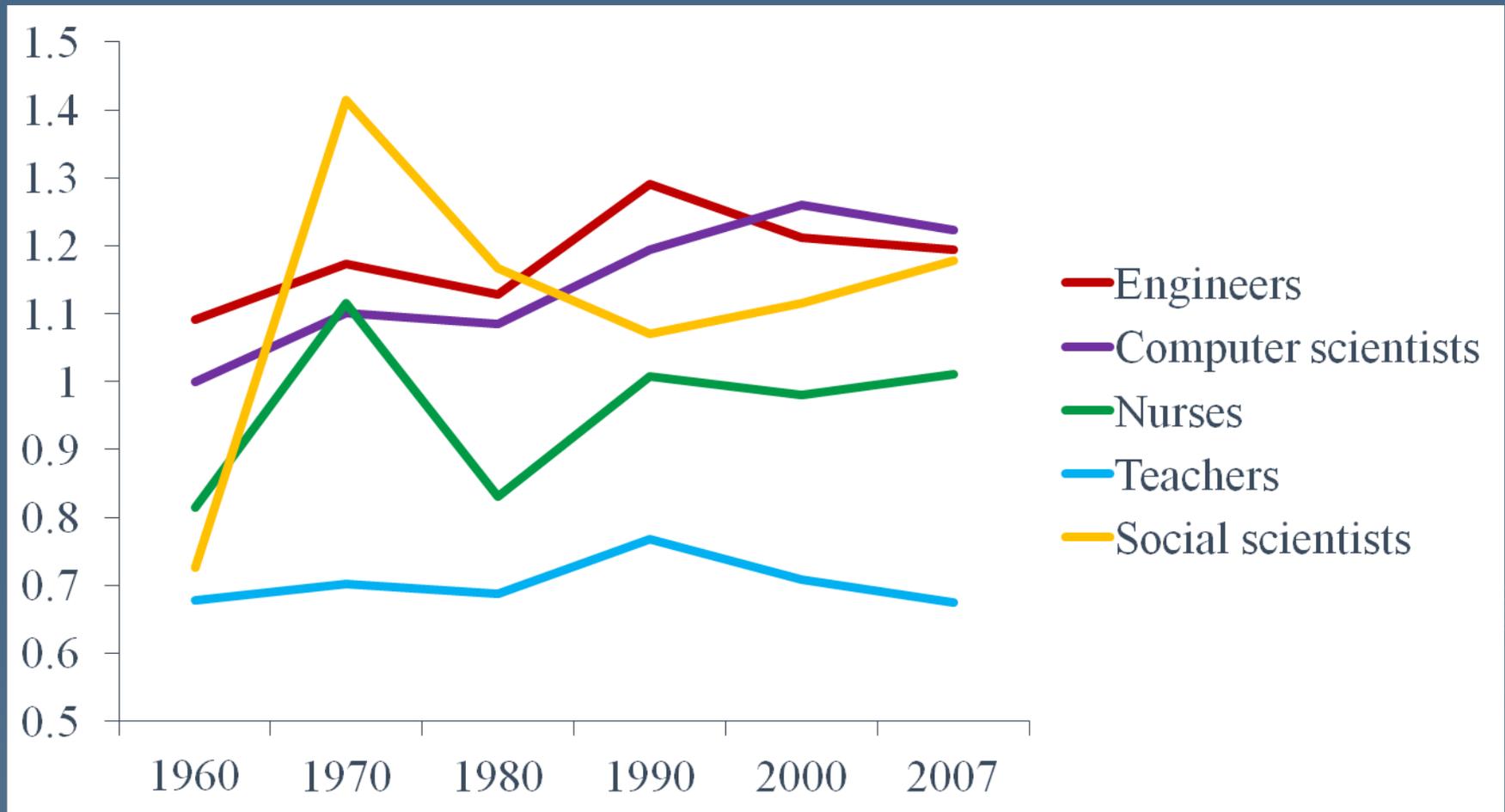
- (1) Science is a public good. Rapid development of science elsewhere helps American science.
- (2) America's real asset lies in its free, open, innovation-fostering culture. This cultural environment is ideal for science (universalism norm).

The End

Thank You!



Ratio in mean earnings, other professionals to basic scientists (males, bachelor's level, Census & ACS data)



Ratio in mean earnings, other professionals to basic scientists (males, master's level, Census & ACS data)

