

US Universities and Academic Science Careers: Storm Clouds on the Horizon

For Presentation at:

**COSEPUP, National Academies of Science:
*The Arc of the Academic Research Career:
Issues and Implications for U.S. Science
and Engineering Leadership***

Acknowledgements / Disclaimers

Gender Differences in Academic Careers joint with:
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Future of the Biomedical Workforce joint with:
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Ginther and Kahn's research was funded in part by NIH Grant R01-AG036820 and Ginther received funding from NSF Grant SES-0353703.

The use of NSF data does not imply NSF endorsement of the research, research methods, or conclusions contained in this report.

Overview

- **Examine how academic career path has evolved 1980-2008**
 - **PhD Student production**
 - **Academic & Non-Academic employment**
 - **Tenured & Tenure track jobs**
 - **Non-track jobs**
- **Case study of Biomedical Careers**
- **Early academic careers**
 - **How the postdoc affects subsequent career outcomes.**
- **Some thoughts about the challenges facing academic science in the near- and long-term.**

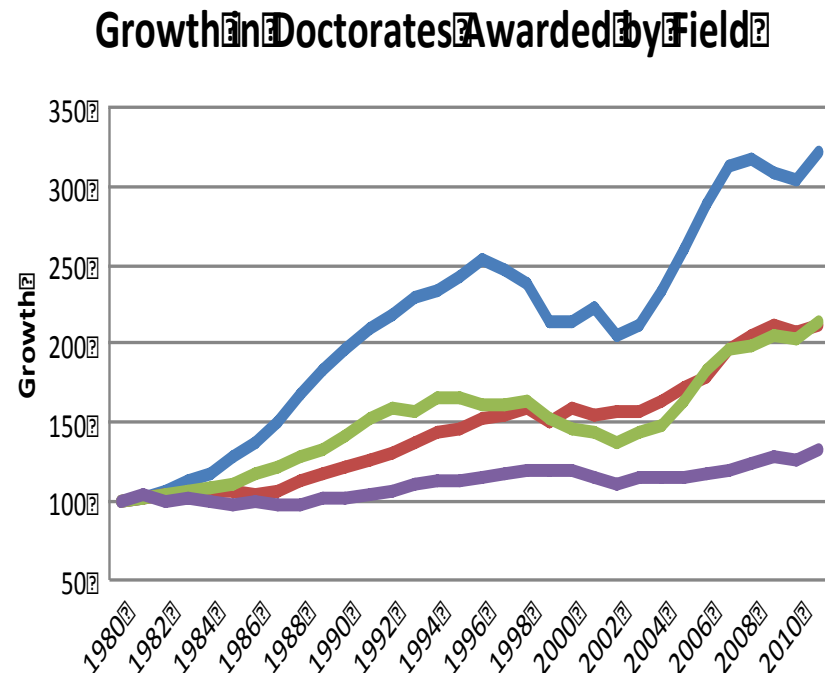
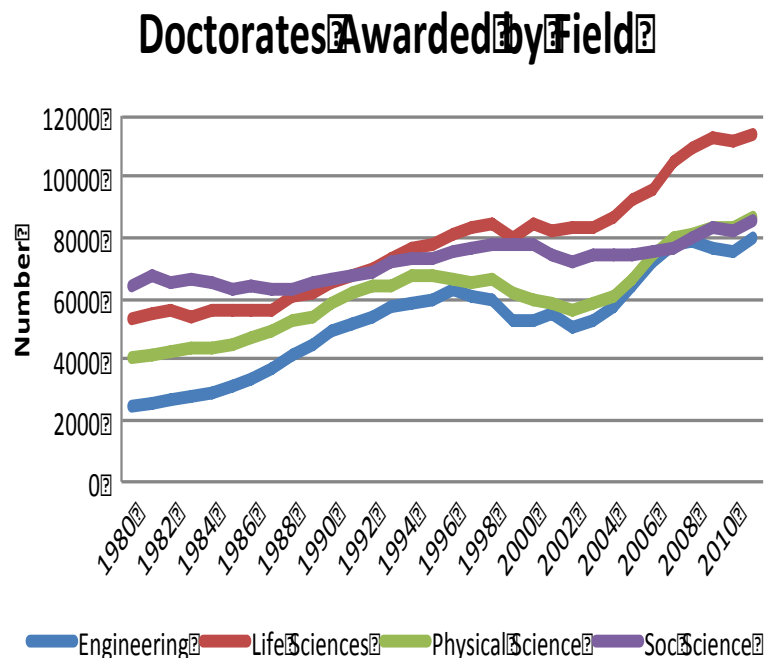
Data

- Much of this work is based on the 1980-2008 waves of the Survey of Doctorate Recipients.
 - 2010 wave just became available, but it is not included in this analysis
- Biomedical Data supplemented with information from the BLS's Occupational Employment Statistics and other sources.
- When thinking about Academic Science, important to recognize that each field has a separate labor market.

Data

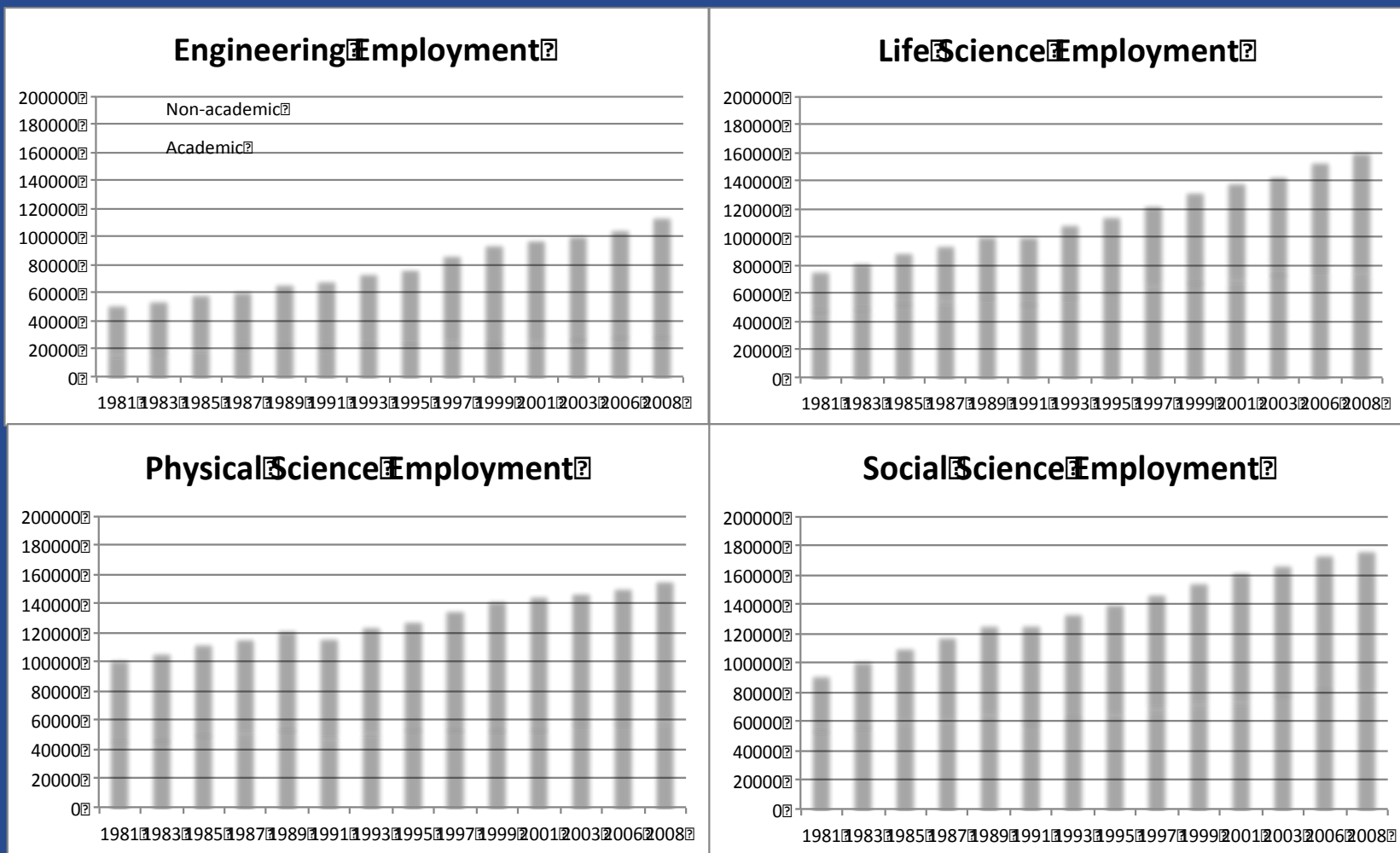
- **Science is grouped into four broad categories:**
 - **Life Science**
 - **Biomedical**
 - **Agriculture and Environmental**
 - **Physical Science**
 - **Chemistry and Physics**
 - **Geosciences**
 - **Math and Computer Science**
 - **Social Science**
 - **Psychology & Other Social Sciences**
 - **Engineering**

Doctorates Awarded by Field



Since the 1990s, Life Science has awarded the most doctorates (driven by biomedicine). Social science awards a high number of doctorates but growth has been flat. Engineering doctorates awarded since 1980 have more than tripled (Source 1980-2011 Survey of Earned Doctorates).

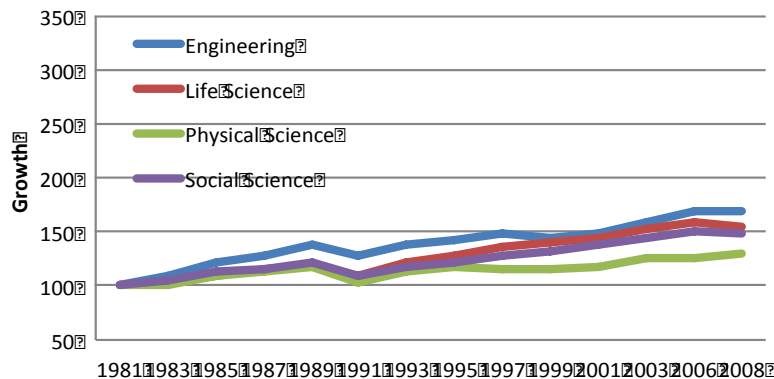
Academic and Non-Academic Employment by Field



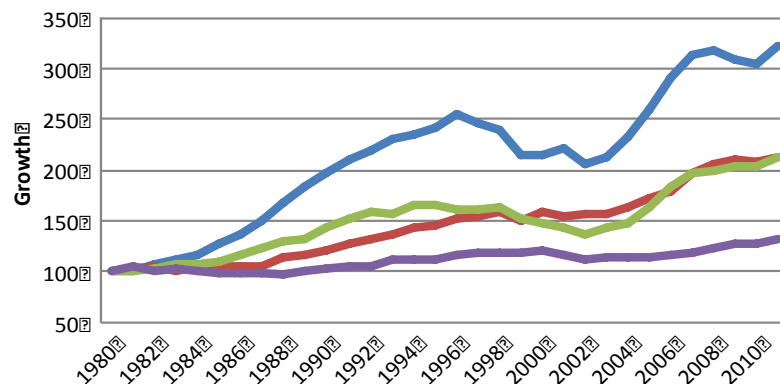
With the exception of Life Sciences, the majority of US trained doctorates are employed in the non-academic sector (Source 1981-2008 Survey of Doctorate Recipients).

Academic and Non-Academic Employment Growth

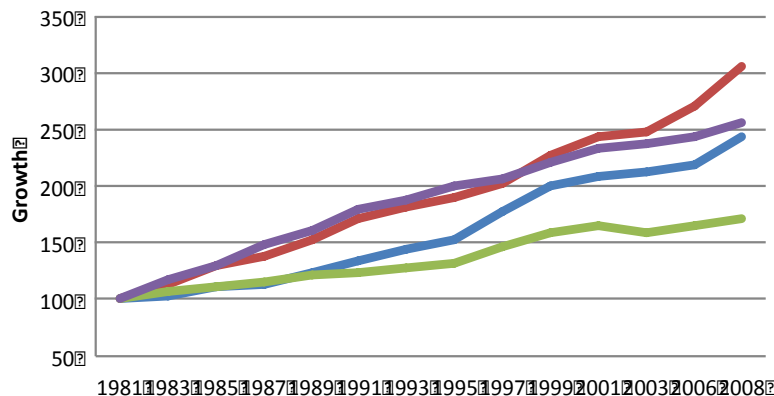
Academic Employment Growth



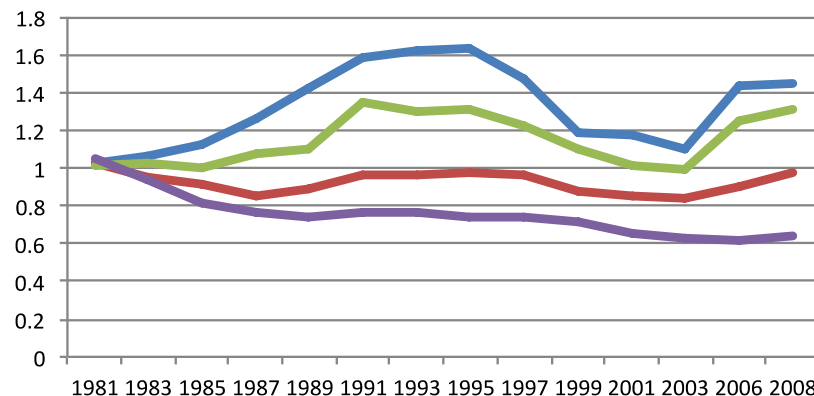
Growth in Doctorates Awarded



Non-Academic Employment Growth



Ratio of PhD / Employment Growth

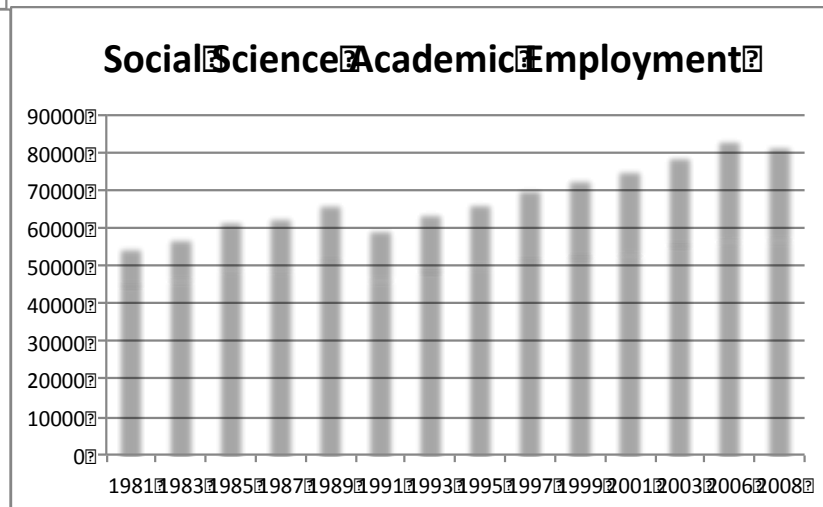
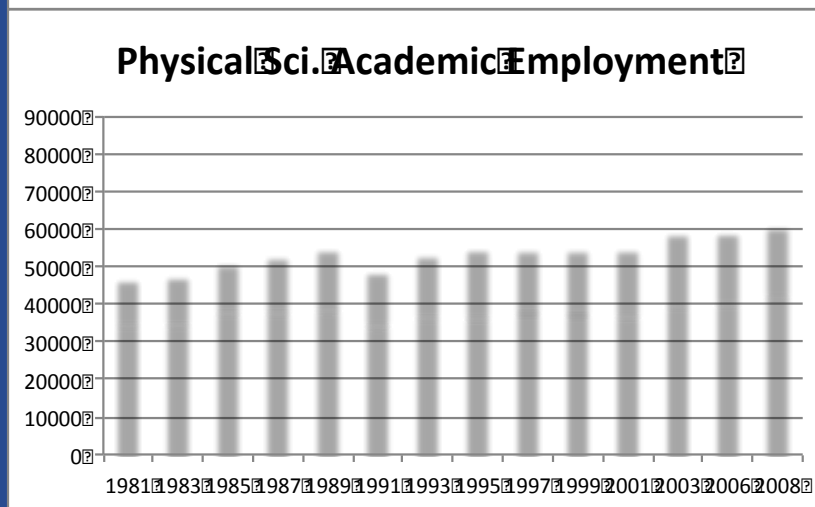
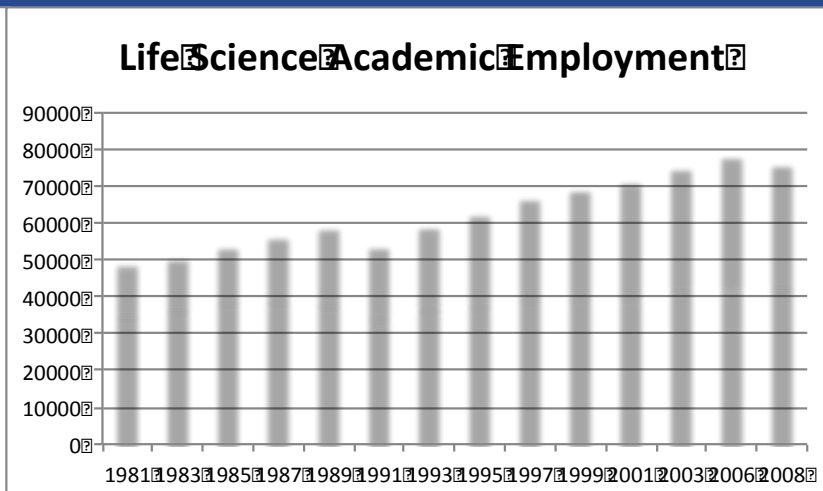
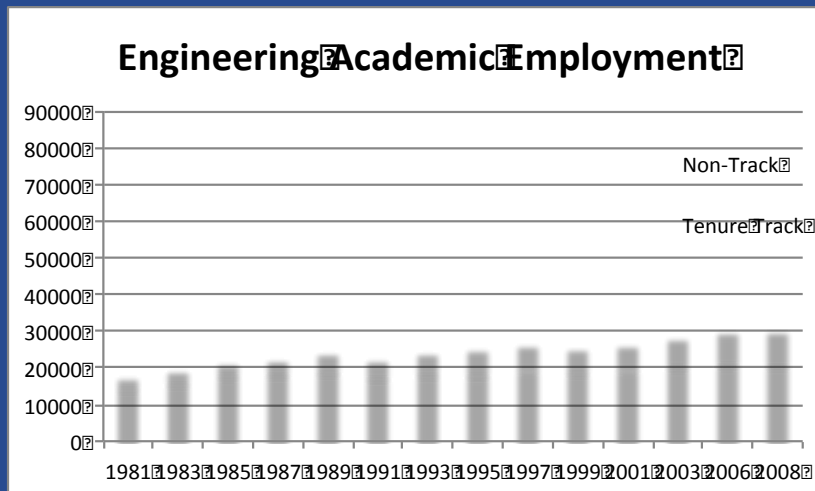


Non-academic employment growth accounts for the majority of jobs for doctorates since the 1980s. (Source 1981-2008 Survey of Doctorate Recipients).

Employment Growth

- Academic Employment Growth has been much lower than Non-Academic Employment Growth
- However, PhD Production for Life and Physical Sciences has doubled and for Engineering has tripled.
- Physical Science and Engineering are producing more PhDs than jobs available in the US
 - **Are Foreign PhDs returning to home countries?**
- Life Science PhD and Employment growth are roughly equal
- Social Science producing PhD growth less than employment growth

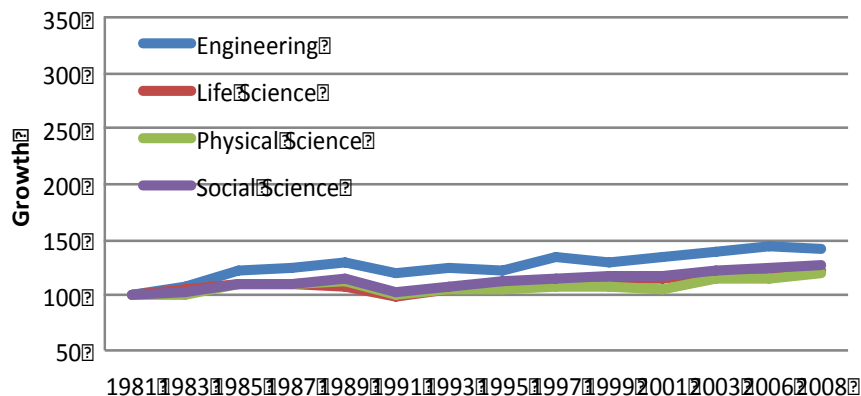
Tenure Track and Non-track Academic by Field



Life Science and Social Science are the largest fields. Growth evident in non-track positions (Source 1981-2008 Survey of Doctorate Recipients) •

Tenure Track and Non-track Academic Growth

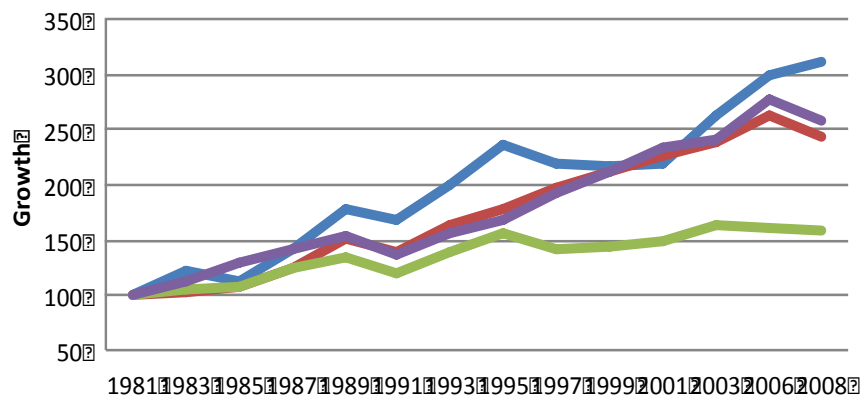
**Tenure Track Faculty Growth
1981-2008**



With the exception of Engineering, Tenure Track Faculty Growth has been essentially flat.

The overwhelming majority of growth has been in non-track academic jobs.

**Non-Track Academic Growth
1981-2008**



PhD production has outpaced academic employment growth in every field except Social Science.

(Source 1981-2008 Survey of Doctorate

Recipients) •

The Academic Labor Market

- **In academia, Supply of PhDs has outstripped Demand.**
- **While the non-academic sector has absorbed many of these doctorates, given the recent economic crisis and jobless recovery, it is not clear that it will continue to do so.**
- **The gap between Supply and Demand will likely grow larger given the current financial issues facing academic institutions.**

Biomedical Research Workforce ACD Working Group (ACD BMW)

- Working Group co-chaired by Shirley Tilghman and Sally Rockey.
- Charge
 - Develop a model for a sustainable and diverse U.S. biomedical research workforce that can inform decisions about training of the optimal number of people for the appropriate types of positions that will advance science and promote health.
 - Based on this analysis and input from the extramural community, make recommendations for actions that NIH should take to support a future sustainable biomedical infrastructure.
 - Reported to the ACD in June 2012.
 - http://acd.od.nih.gov/Biomedical_research_wgreport.pdf
 - Supplementary Web Site
http://report.nih.gov/investigators_and_trainees/ACD_BWF

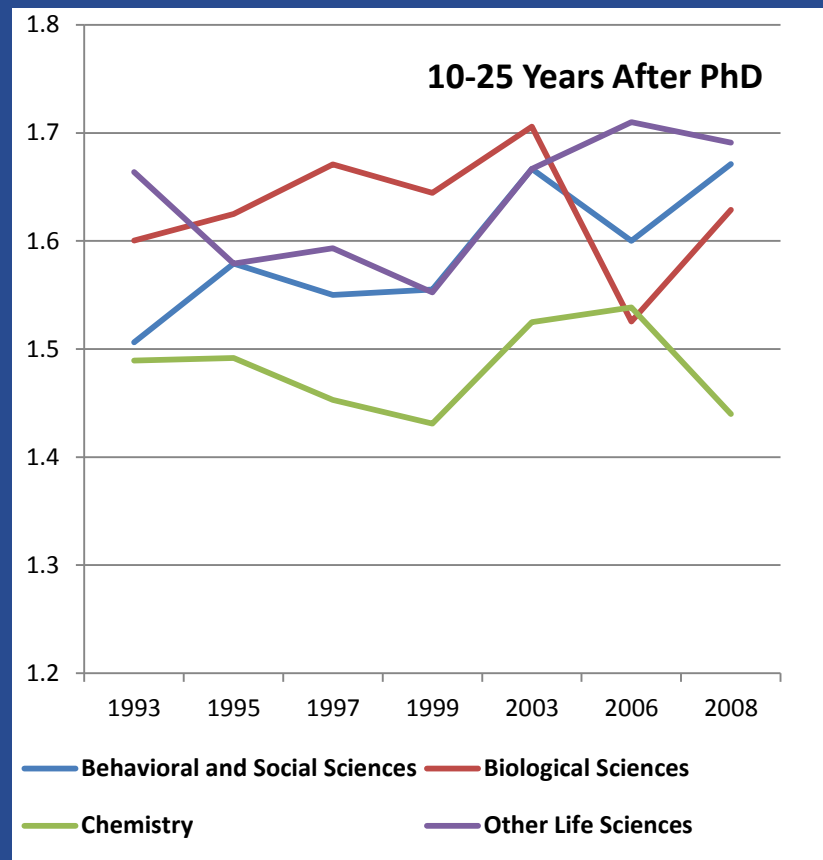
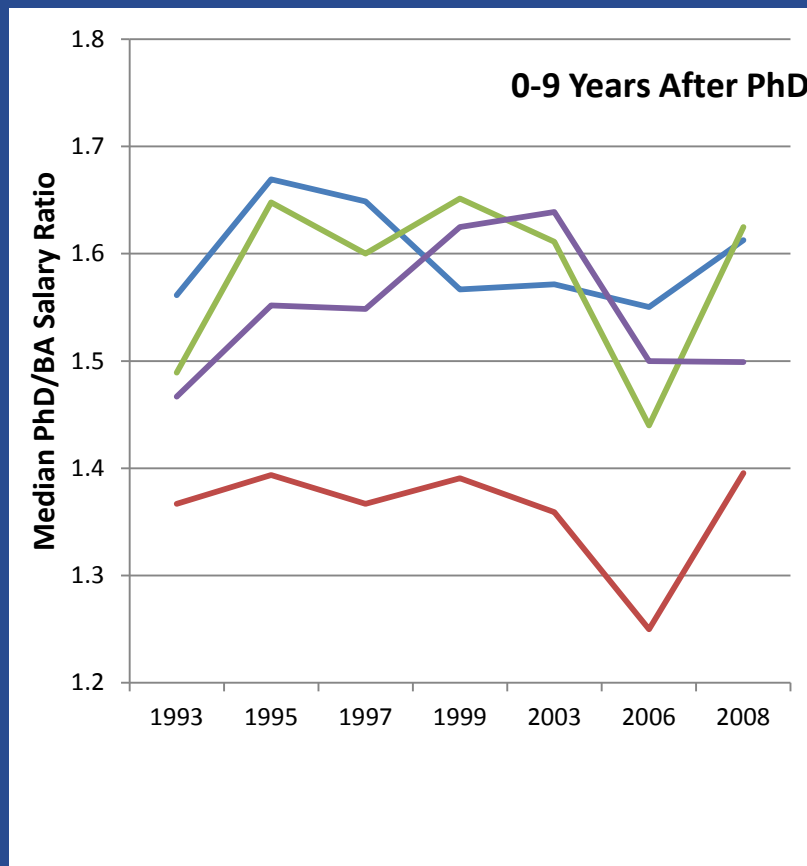
Biomedical Workforce

- **Presenting Results from that report and its supplemental material on:**
 - **Salaries**
 - **Job Match**
 - **Research Space**
 - **Early Career Issues**

Biomedical Analysis: Field Definitions

- **Basic Biomedical**—(Biochemistry, Bioinformatics, Biological Sciences, Biomedical Engineering, Biophysics, Biotechnology, Cell Biology, Developmental Biology/Embryology, Endocrinology, Genetics, Immunology, Microbiology, Molecular Biology, Neurosciences, Nutritional Science, Parasitology, Pharmacology, Pharmaceutical Chemistry, Physiology, Toxicology, Veterinary Medicine, Zoology)
- **Clinical Sciences** (Biometrics and Biostatistics, Environmental Health, Epidemiology, Exercise Science, Health Sciences, Health Administration, Nursing, Pharmacy, Public Health, Rehabilitation Services, Physicians in Academic Medicine)
- **Behavioral & Social Sciences** (Anthropology, Audiology/Speech Pathology, Demography/Population Studies, Sociology, Psychology)
- **Other Life Sciences** (Agricultural and Food Sciences, Environmental Life Sciences)
- **Chemistry**

Comparison: Median PhD/Median Bachelor's Salary, by Field



Source: NSF SESTAT, prepared for ACD BMW

Early career Biomedical PhDs have the lowest PhD/Bachelor's salary ratio

There is no salary difference between fields later in career

Comparison: Salary Across Broad Fields by Years of Experience

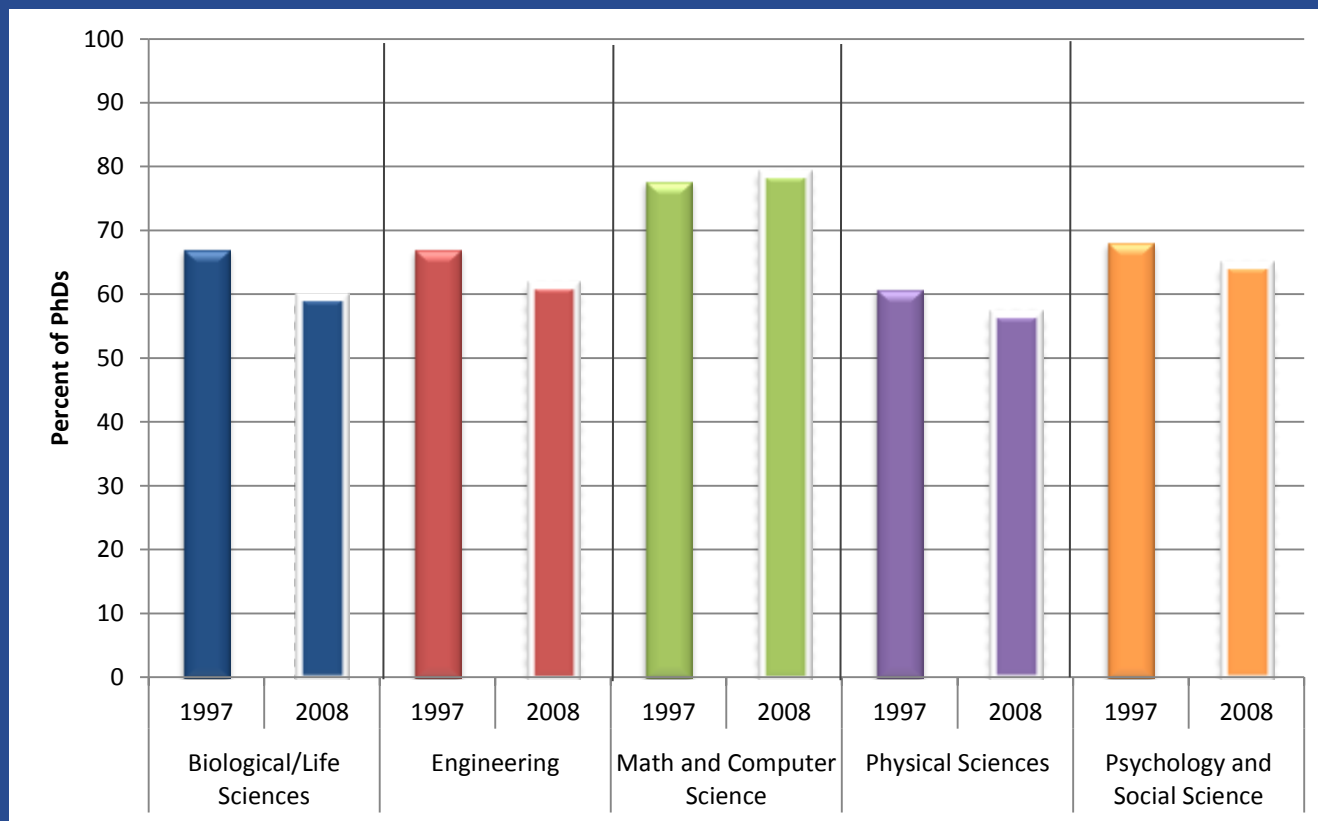
Years Since PhD	Bio Med	Comp Math	Physical Science	Social Science	Engineer
0	51,594	66,804	57,775	55,532	72,992
10	87,766	99,972	94,180	87,853	113,314
30	123,959	109,277	122,148	107,321	133,292

Source: NSF Survey of Doctorate Recipients, prepared for ACD BMW

Starting salaries are the lowest in biomedicine, but there is some catch-up late career.

Engineers have the highest salaries over their careers.

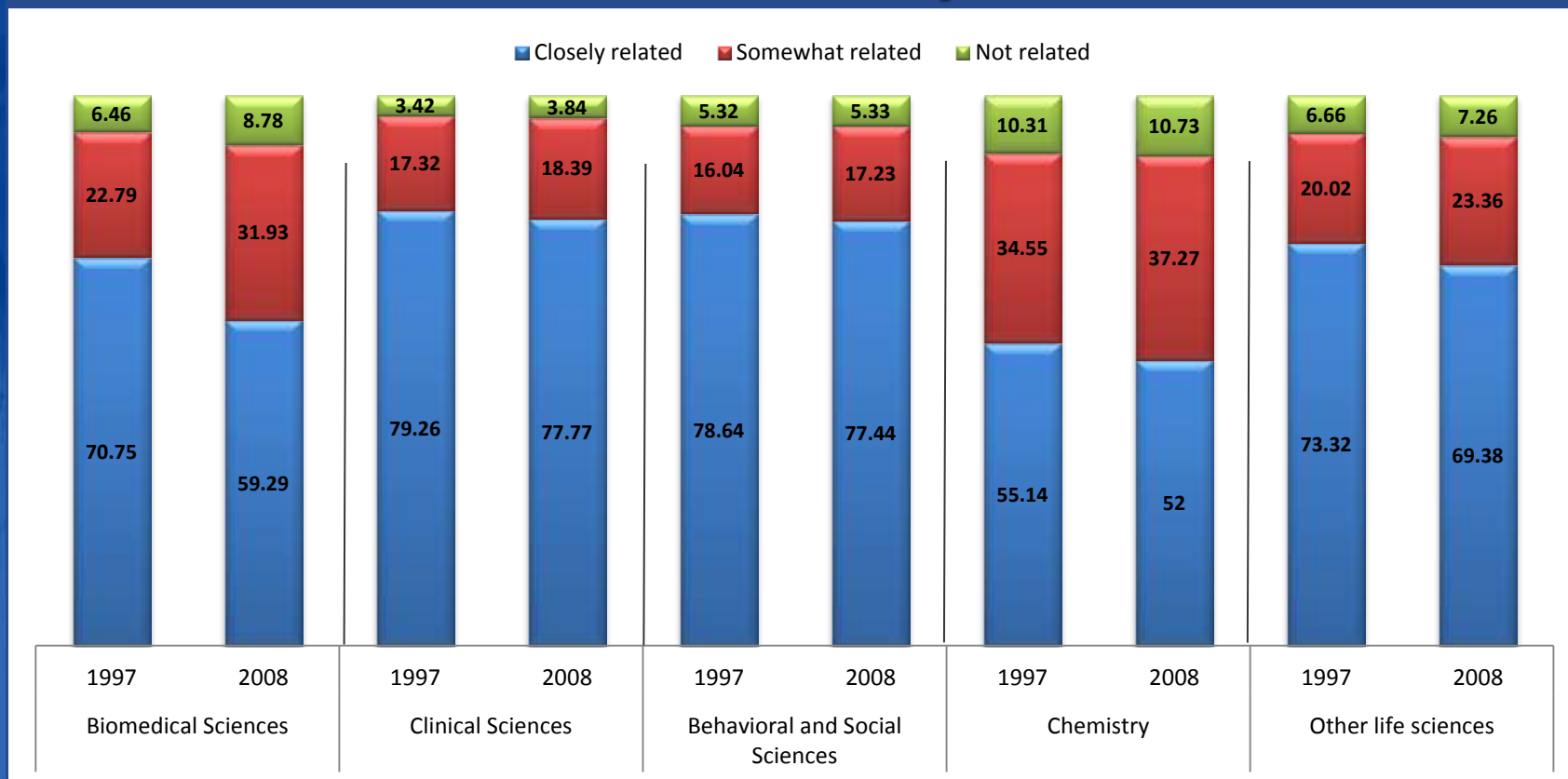
Job Match: Relationship between science and engineering PhD field and occupation



Source: NSF Survey of Doctoral Recipients,
prepared for the ACD BMW

Across S&E PhD fields, 50-80% of graduates are employed in occupations that closely match their PhD field.

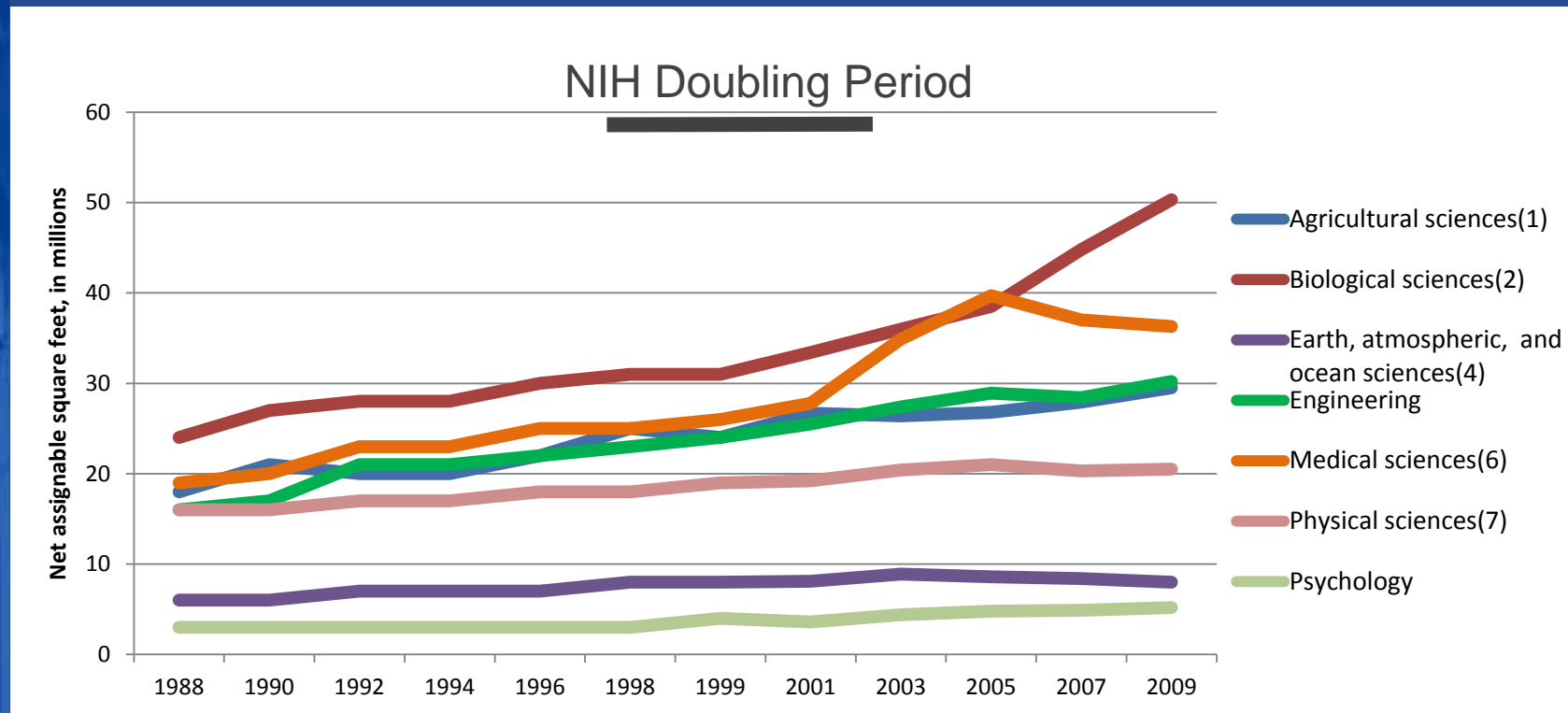
Job Match: Relationship between PhD Field and Occupation



Chemistry has the lowest proportion of PhDs working in a closely related field

Within Life Sciences, Biological Sciences fields have the lowest proportion of PhDs working in a related occupation.

University Assignable Research Space, by Field



Source: NSF Survey of Science and Engineering Research Facilities, - prepared for the ACD BMW

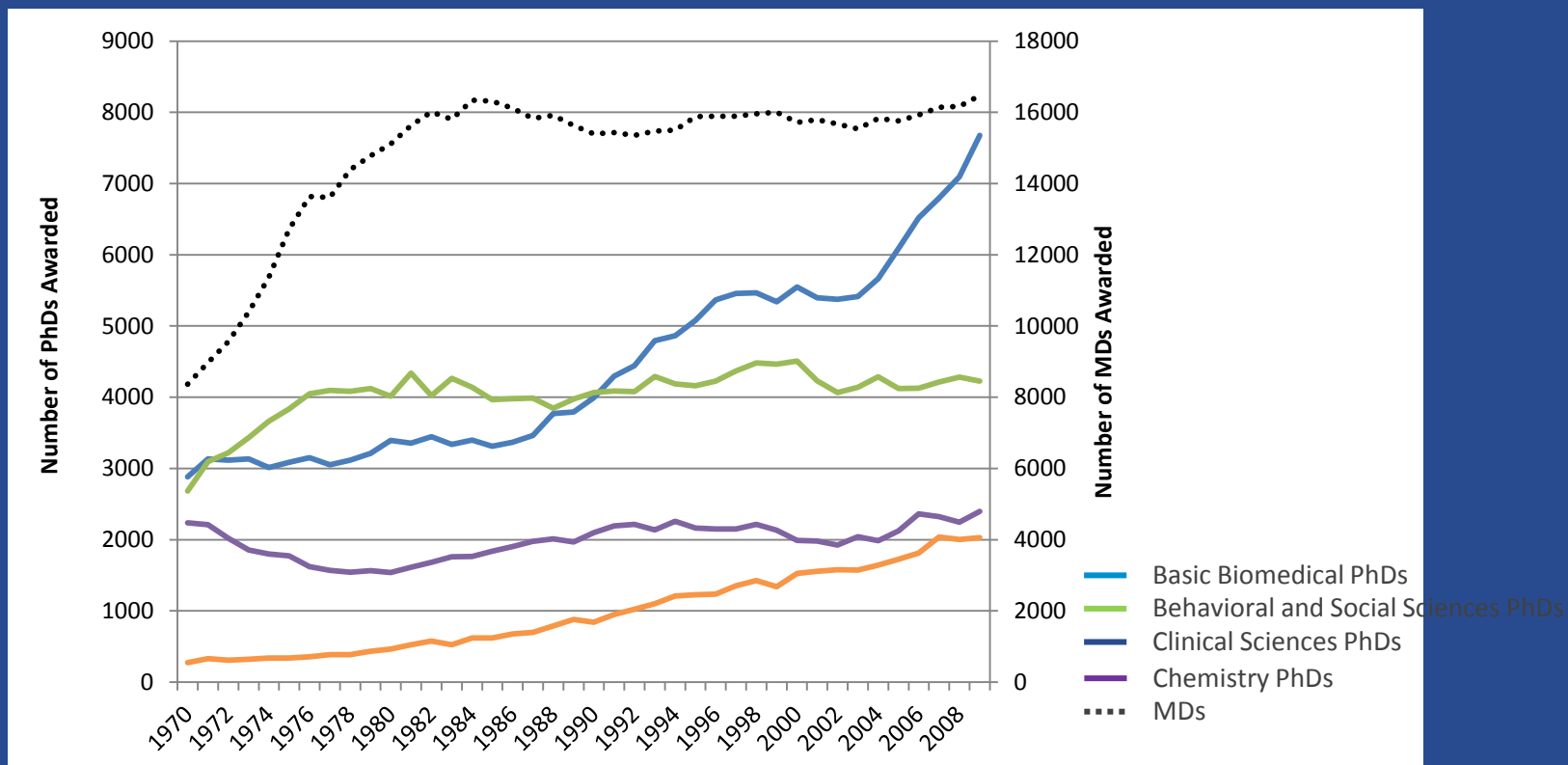
Assignable space increased for most fields, and in particular in the biological sciences.

Who filled that research space? Non-track scientists.

Early Careers of Academic Scientists

- Many of the changes resulting from the NIH's the Biomedical Research Workforce Working Group focused on PhD and Postdoctoral training.
- Here I present some analysis of the postdoc as well as information on the demand for biomedical researchers.

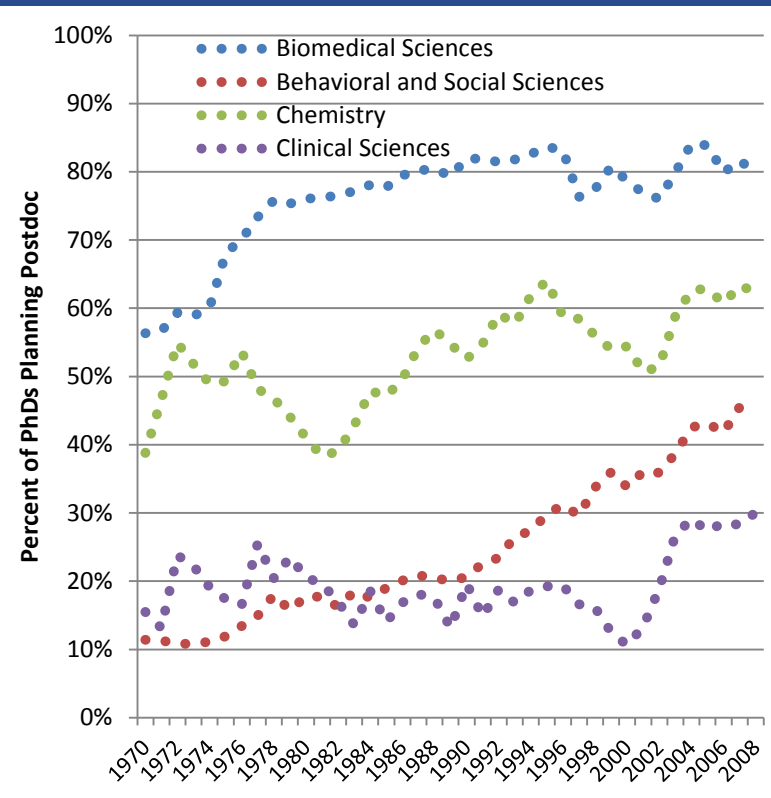
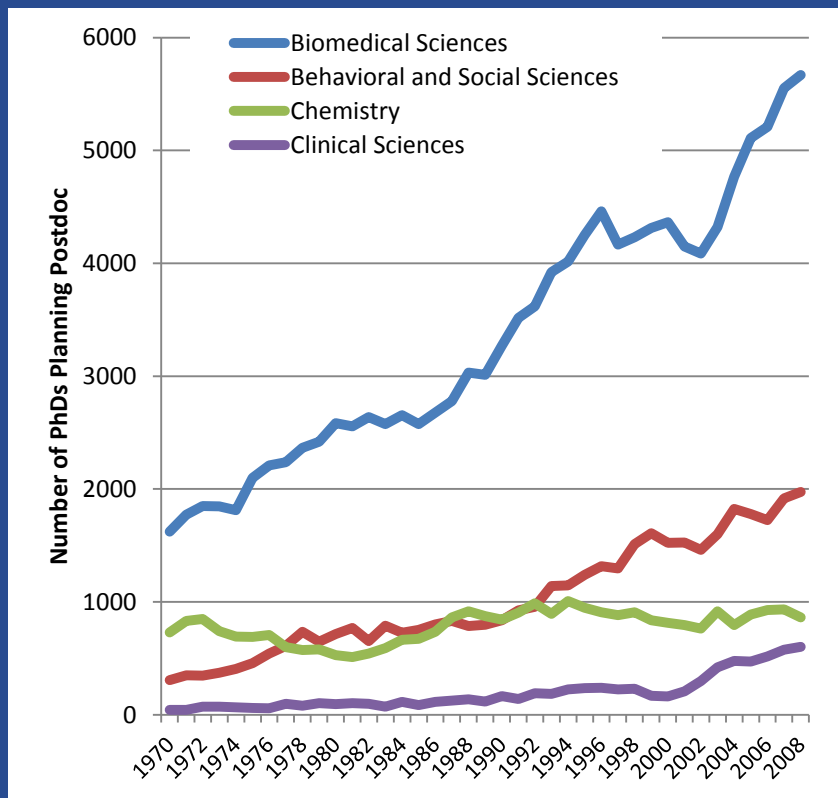
Training: US Graduate Degrees Awarded, by Field



Source: NSF Survey of Earned Doctorates, prepared for the ACD BMW

Stable production of Chemistry PhDs since 1970 and MDs since 1980
 Stable production of Clinical Sciences and Behavioral PhDs since 1998
 Increasing production of Biomedical PhDs that coincides with end of NIH
 Doubling (1999-2003)

Training: US PhDs with Postdoctoral Research Plans



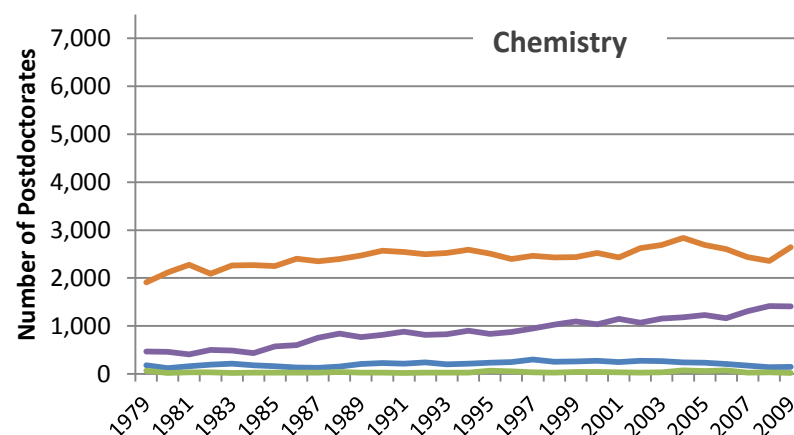
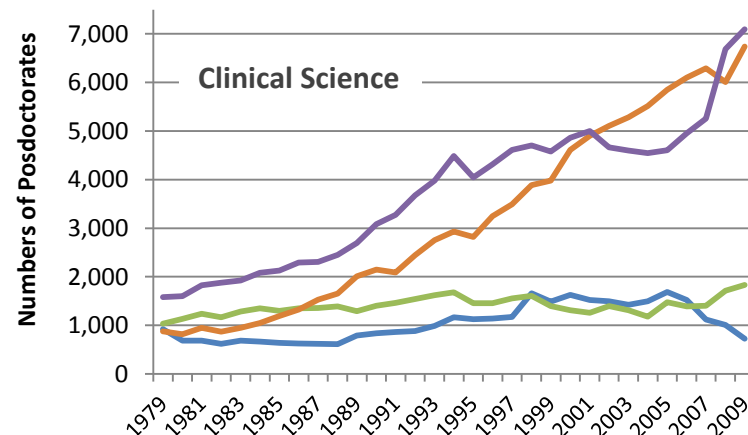
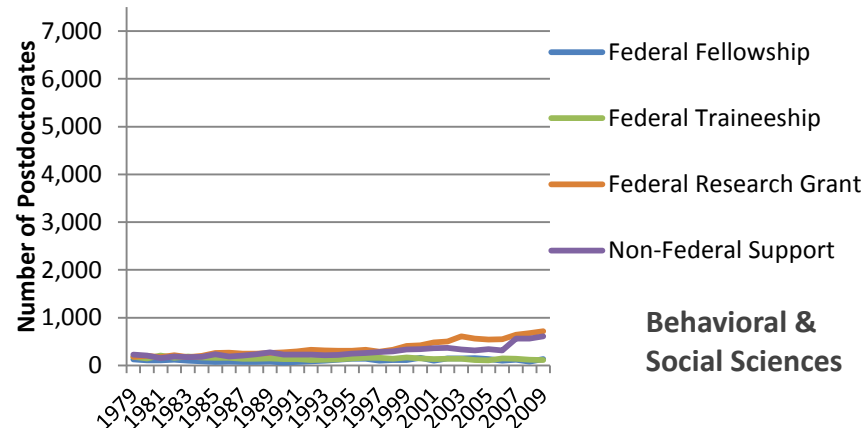
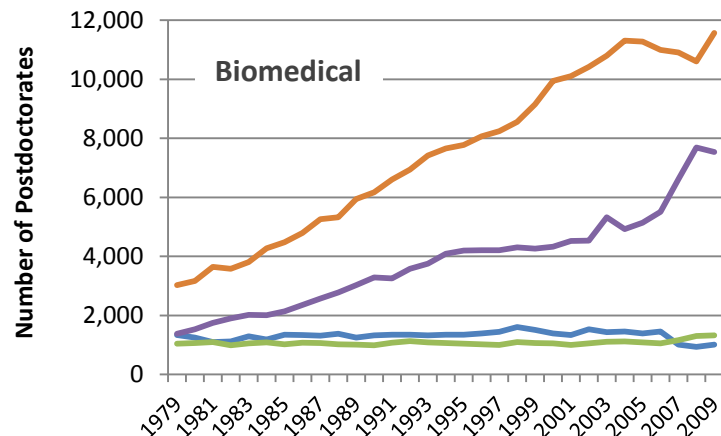
Relatively stable percentage of biomedical PhDs planning postdocs since mid-1980s, even with increasing number of PhDs produced

Increasing number of social sciences PhDs planning postdocs

Jump in percentage of clinical sciences PhDs planning postdocs

Source: NSF Survey of Earned Doctorates, prepared for ACD BMW

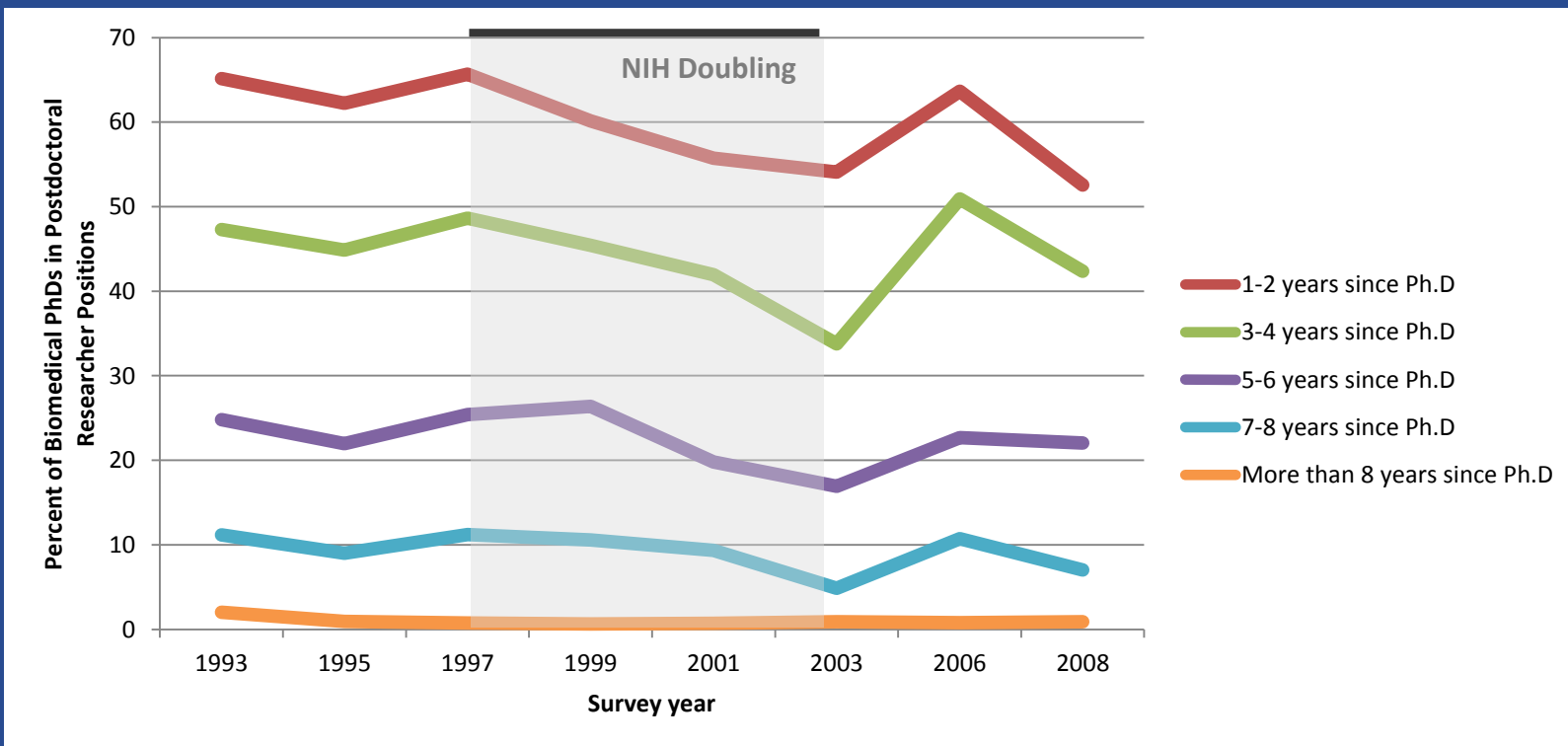
Postdoctorates, by Field and Type of Support



Field-specific volume of postdocs; only in Chemistry are numbers stable
Field-specific mix of federal and non-federal grant support

Source: NSF Survey of Graduate Students and Postdocs, prepared for ACD BMW

Training: US-Trained Biomedical PhDs in Postdoctoral Researcher Positions, by Years Since Degree



Source: NSF Survey of Doctorate Recipients, prepared for ACD
BMW

Over 60% of Biomedical PhDs started their careers in postdocs in the 1990s. The percentage taking postdocs fell during the doubling.

Training: Fields with more postdocs

■ Fields where postdocs are more likely (top 10):

genetics	developmental biology
Biochemistry	molecular biology
immunology	cellular biology
Endocrinology	biophysics
Microbiology	neuroscience

→ 7 are in the top 10 fields of %PhDs NIH funds as postdocs

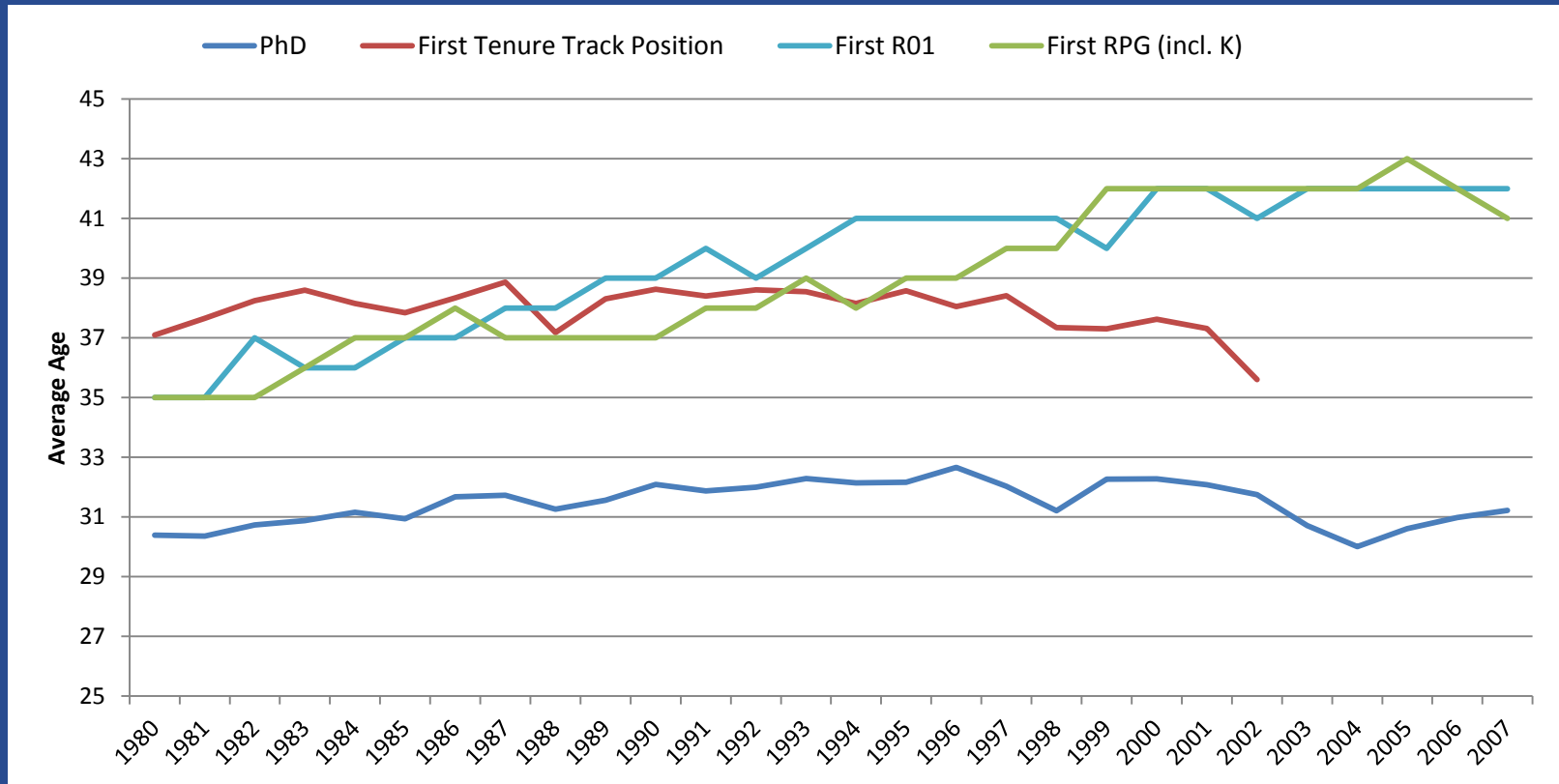
■ Fields where postdocs are less likely:

biometrics/stats	pharmaceutical science
nursing	rehabilitation
kinesiology	health science, other
public health	environmental health
veterinary medicine	health sciences general

→ 9 are in the bottom 10 fields of %PhDs NIH funds as postdocs

Source: NIH ACD BMW report

Biomedical Doctorate Academic Career Milestones, by Age

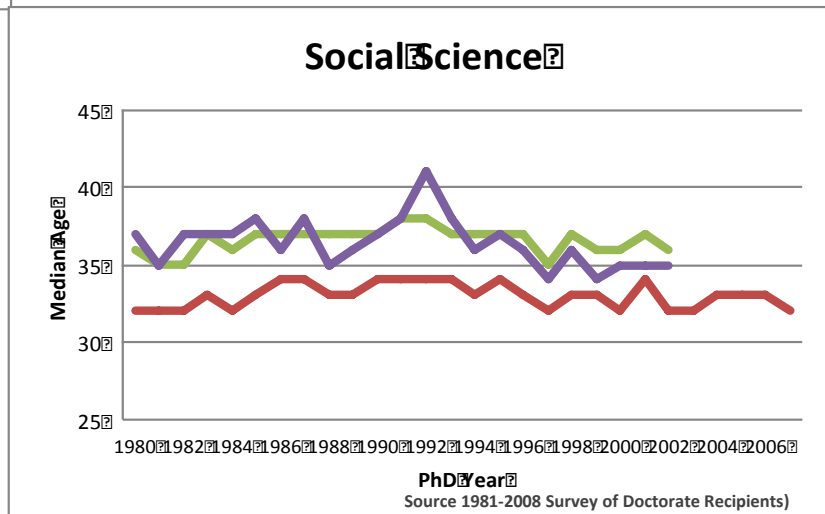
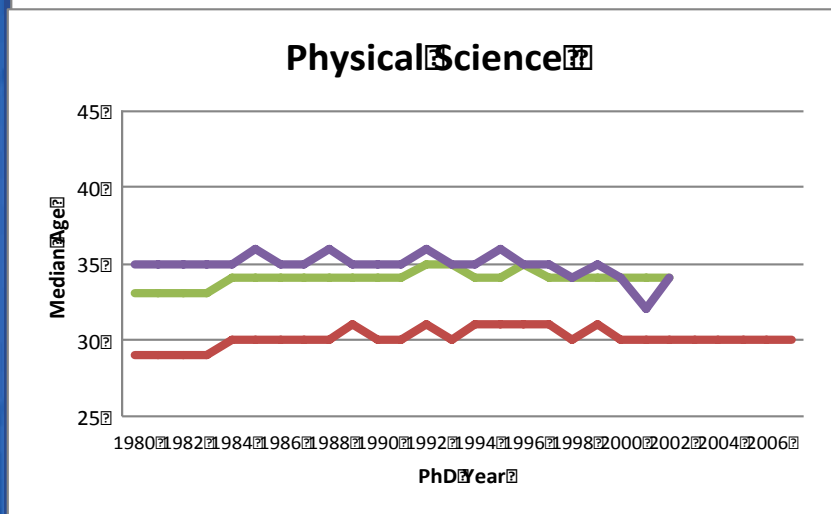
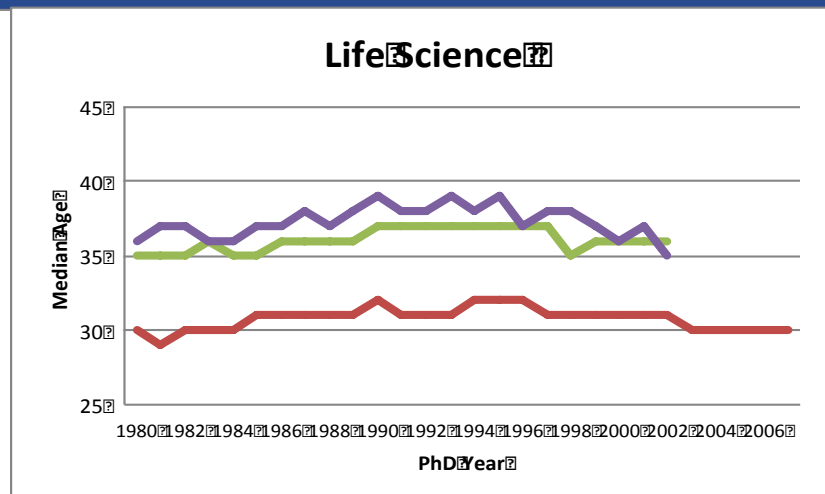
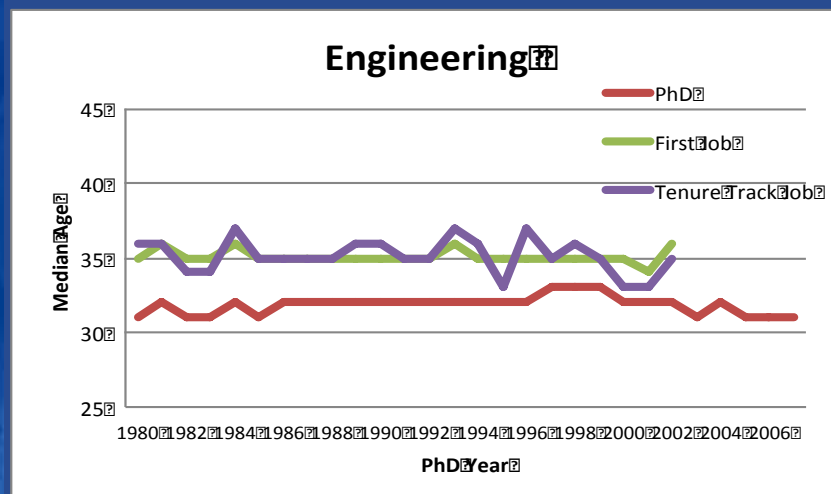


Source: NSF Survey of Earned Doctorates and NIH IMPAC II, Prepared for the NIH ACD BMW report

There is a increasing divergence between age at PhD and age at first R01/RPG for biomedical doctorates

There appears to be a decoupling of tenure track jobs and first NIH R01/RPG

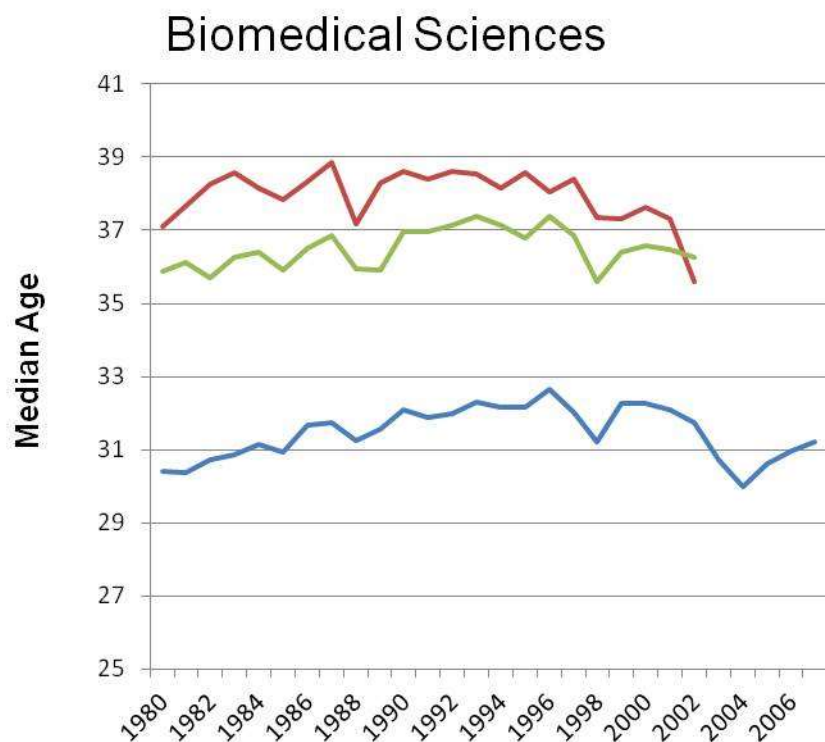
Age at PhD, First Non-Postdoc Job & First Tenure Track Job by Broad Field



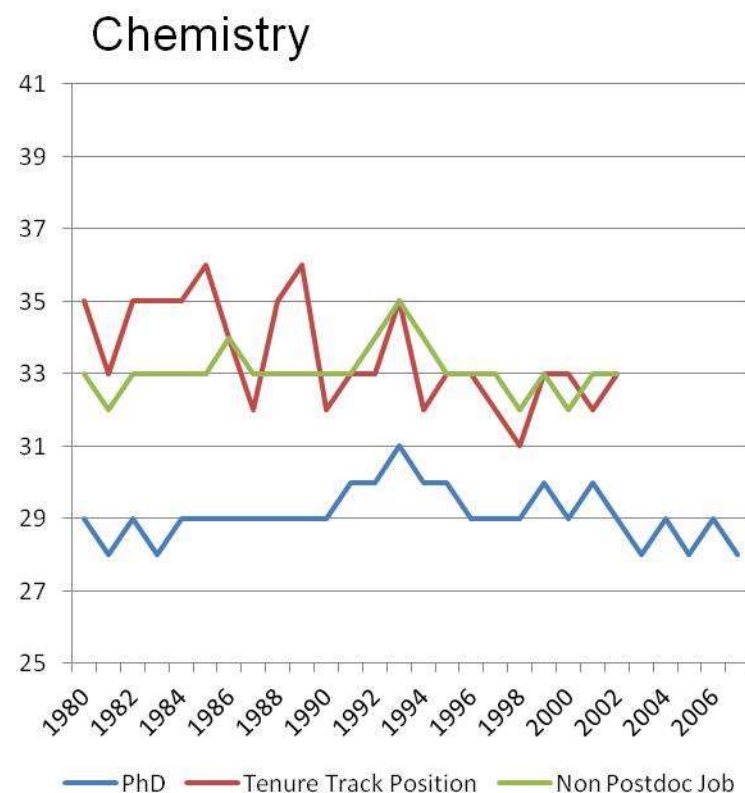
Source 1981-2008 Survey of Doctorate Recipients)

Gap between age at PhD and age at First Non-Postdoc Job is largest in Life Sciences because of prevalence of postdocs.

Age at First PhD, First Non Postdoctoral Job, First Tenure Track Job, for US trained Doctorates



Source: Survey of Earned Doctorates
prepared for ACD BMW

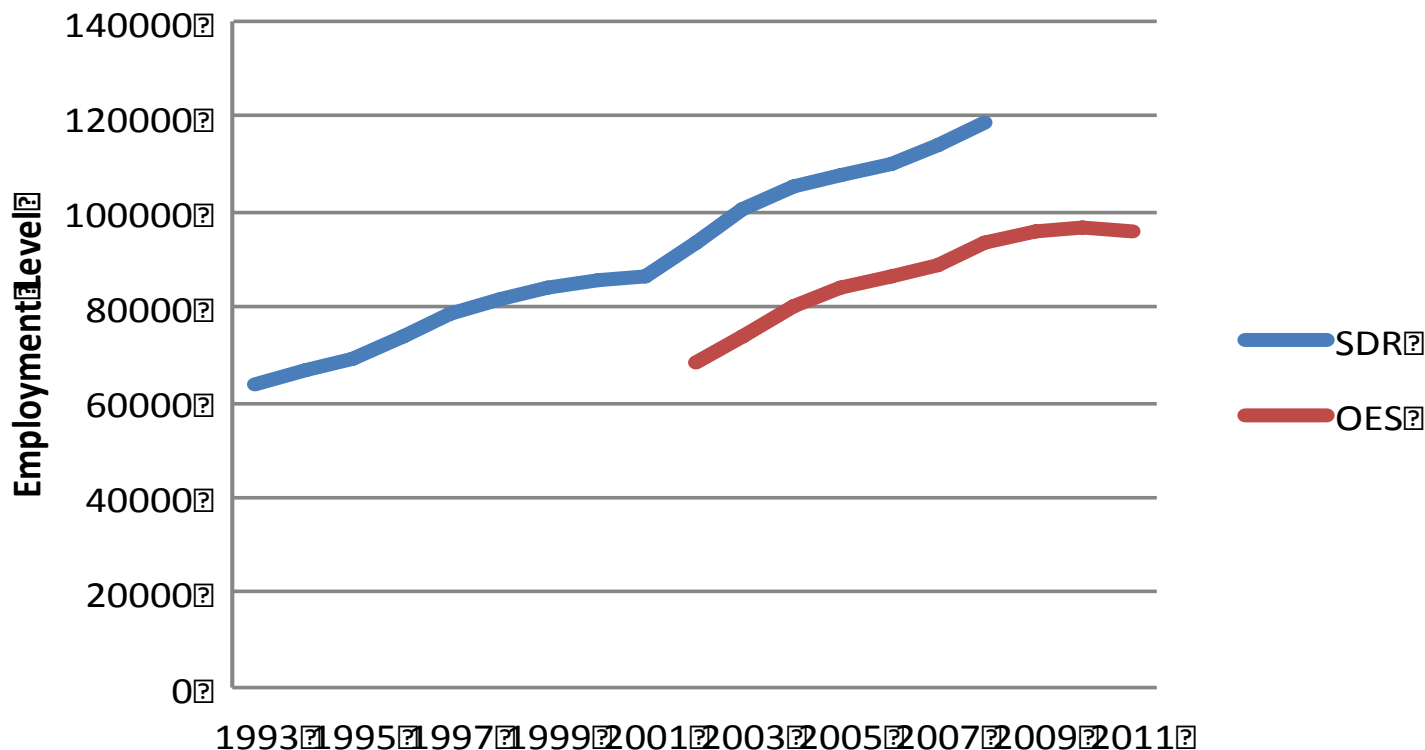


Gap between age at PhD and age at First Non-Postdoc Job is largest in Biomedical Sciences because of postdocs.

Biomedical Job Creation Data

- Used data from the Survey of Doctorate Recipients
- Combined with Occupational Employment Statistics
 - Estimated share of PhDs in occupations based on SDR
 - Data available 2002 – 2011
- Examined levels and the number of jobs added each year
- OES estimates suggest that the demand for biomedical PhDs has declined precipitously

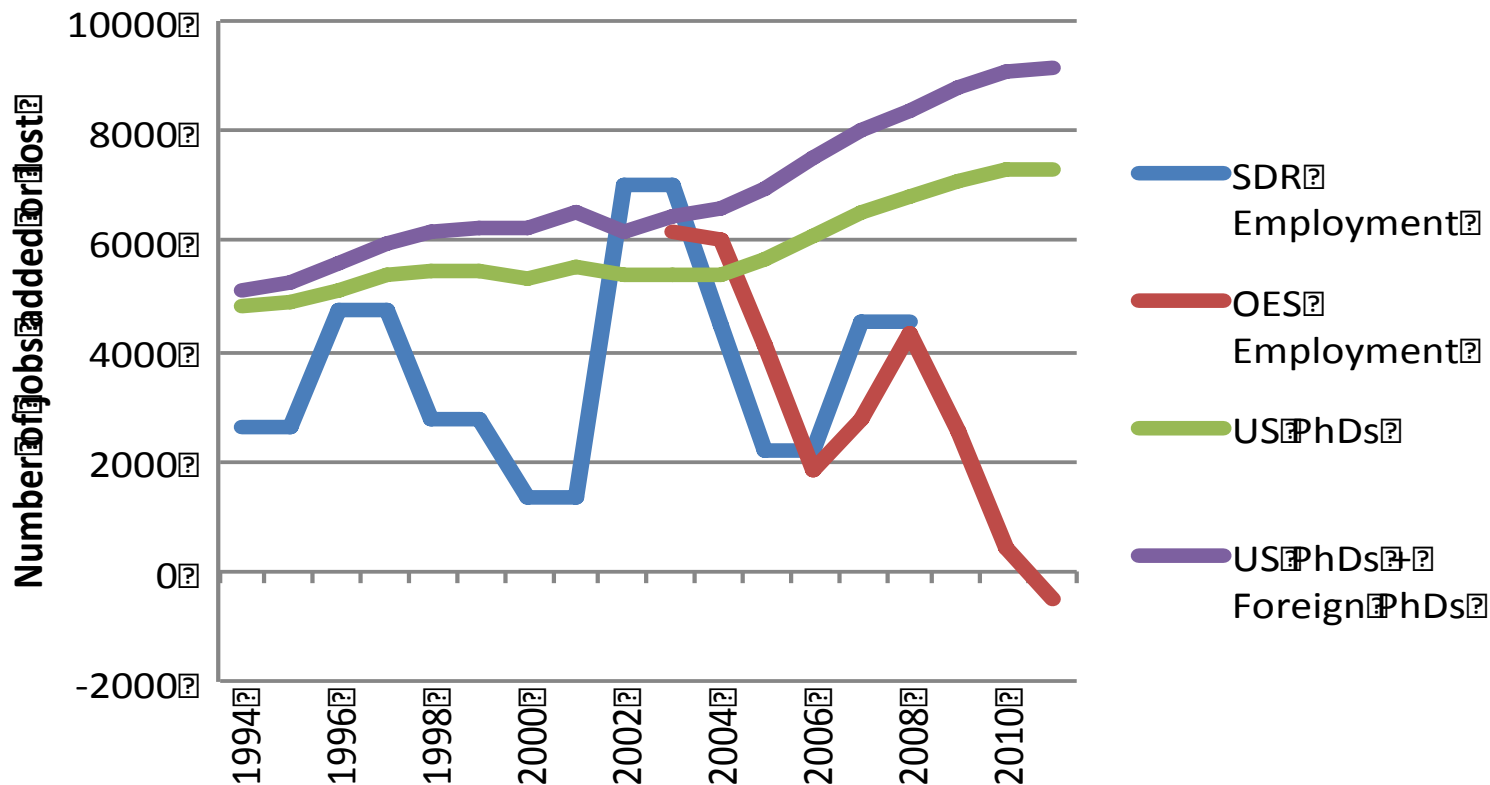
Estimated PhD Employment in Biomedical Occupations 1993 - 2011



Source: NSF Survey of Doctorate Recipients, and BLS Occupational Employment Statistics , Prepared for the NIH ACD BMW report

SDR level of employment is higher (and more accurate)
However, SDR and OES trends are similar in overlapping
years

Change in Biomedical Employment Levels Compared to Doctorates Awarded 1993 - 2011



Source: NSF Survey of Doctorate Recipients, NSF Survey of Earned Doctorates, and BLS Occupation Employment Statistics, prepared for the NIH ACD BMW report

Since 2003 57,541 PhDs awarded compared to ~27,808 biomedical jobs created.

In 1997 –small gap between employment & PhDs 71% were working in jobs closely related to field. In 2008 this number dropped to 60%

Storm Clouds Threaten Higher Education

- Federal and State Funding for Higher Education is decreasing.
 - Decreases in federal research funding may result in the US losing a generation of scientists
 - Decreases in state funding make education less affordable shutting out lower-income students.
- Emphasis on measuring the Return on Investment in Higher Education may lead to unintended consequences.
 - Florida proposal to have differentiated tuition by major (increasing the price of the humanities)
 - Federal Research funding is a public good

Academic Science Faces Additional Headwinds

- Growth in science PhDs being driven by foreign students and women
 - As other nations build academic science infrastructure we will lose trained students to other countries including Korea, China and EU.
- Average K-12 student is not well-prepared for college courses, let alone more challenging courses in STEM fields
- Science careers (especially biomedical careers) are unattractive because of lengthy training period and uncertain job prospects.
- Science is dominated by white men, whereas the US population is becoming increasingly diverse.

Conclusions

- Tenure Track Academic Jobs are becoming increasingly scarce
 - Academic institutions have hired greater numbers of non-track PhDs compared with tenure track PhDs.
- PhD production in all fields except Social Science is growing at a faster rate than academic employment in those fields.
- In many fields, match between degree and employment has decreased
- Taken together, this suggests that the supply of STEM PhDs exceeds demand in many, but not all fields.
- The Postdoc has an important impact on subsequent career outcomes.