Appendix

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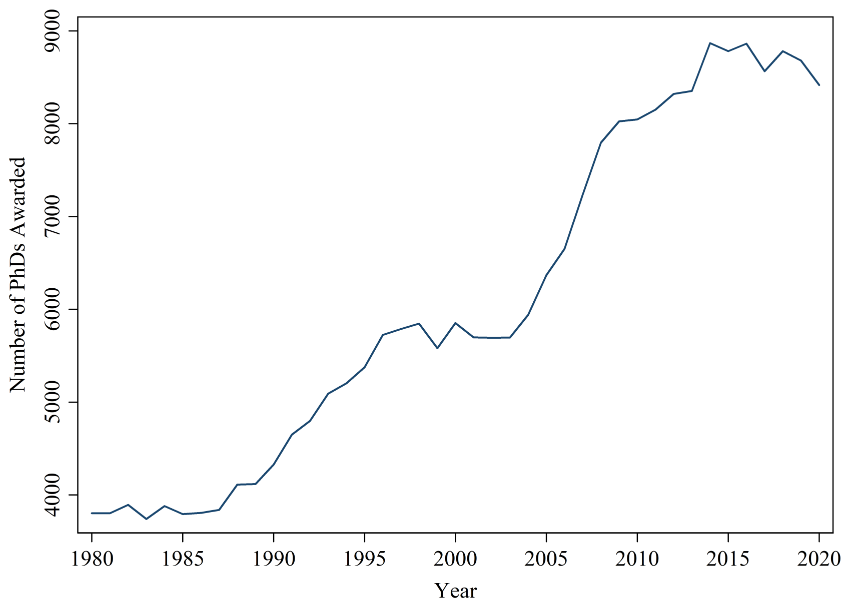
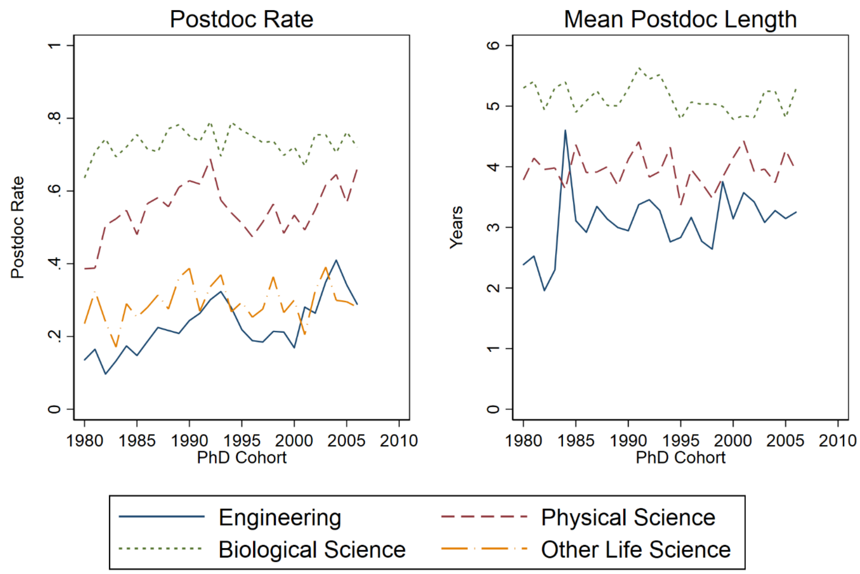
A Supplementary Figures and Tables

Figure A.1: Number of PhDs Awarded in Biomedical Fields by Year



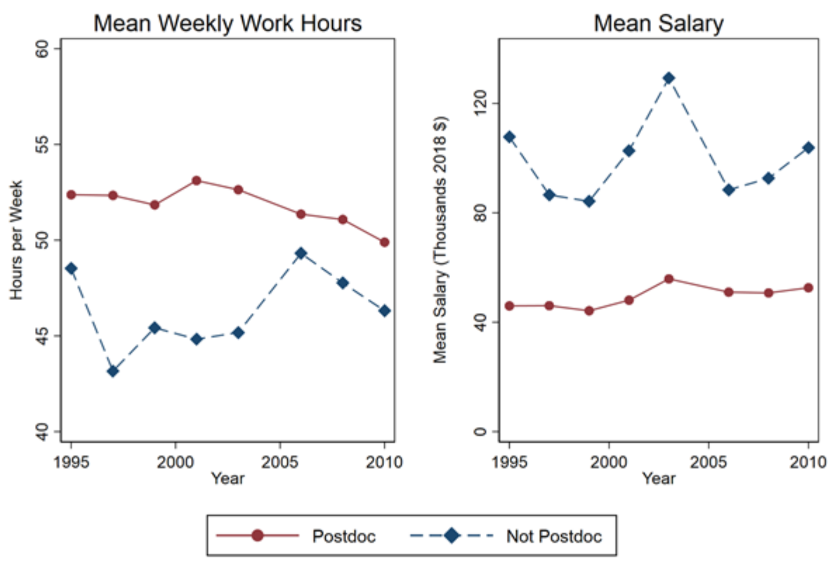
Notes: Figure A.1 shows the number of PhDs awarded in Biological and Biomedical Sciences in each year. Data is from the NSF's Survey of Earned Doctorates (SED).

Figure A.2: Postdoc Rate and Length by S&E Field



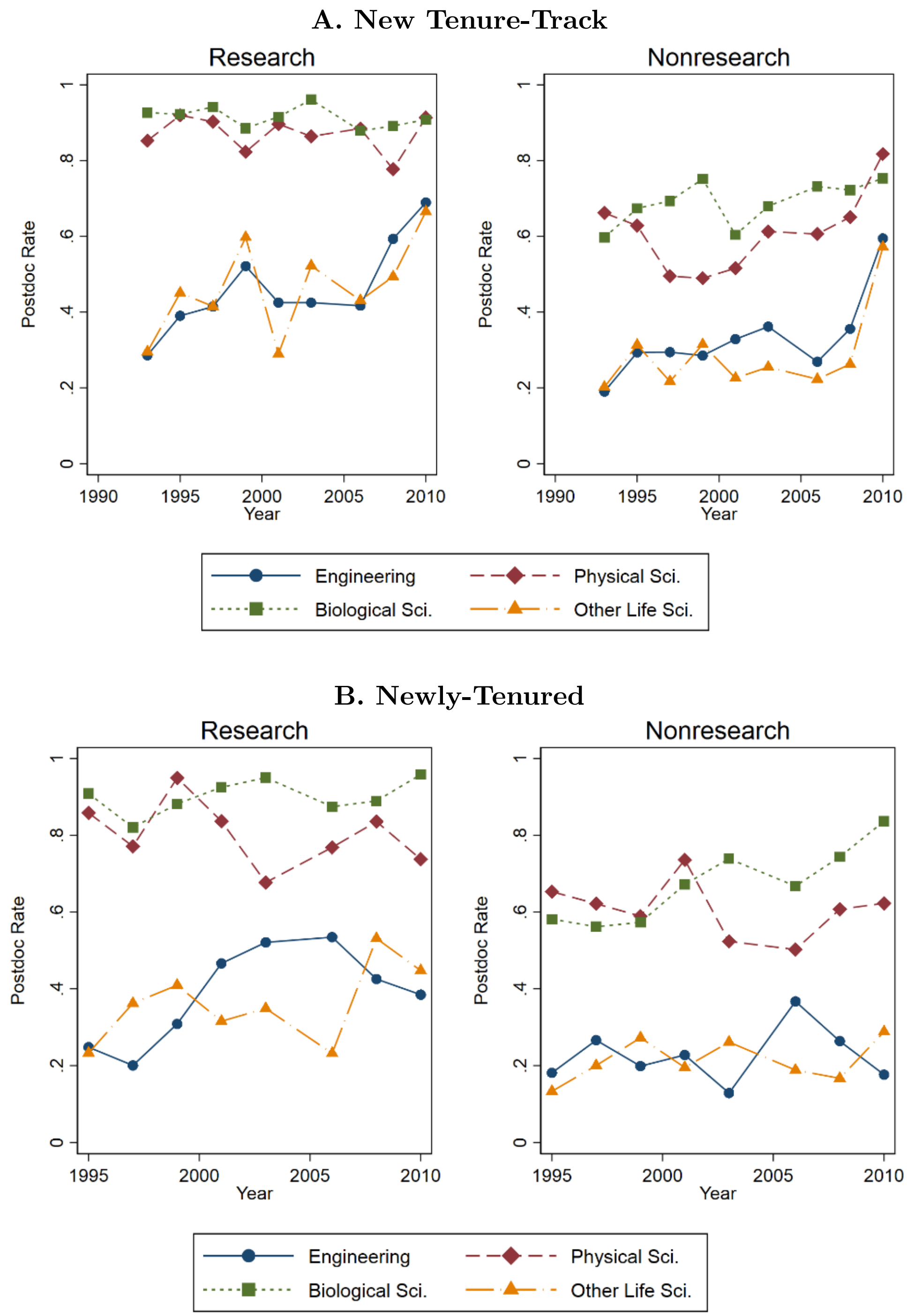
Notes: The left panel of Figure A.2 shows the proportion of doctorates in each PhD cohort that ever take a postdoc by broad field of study. The right panel show the mean length of postdoc training for all postdoc-trained PhD cohort members by broad field of study. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year.

Figure A.3: Work Hours and Pay by Postdoc Employment Status



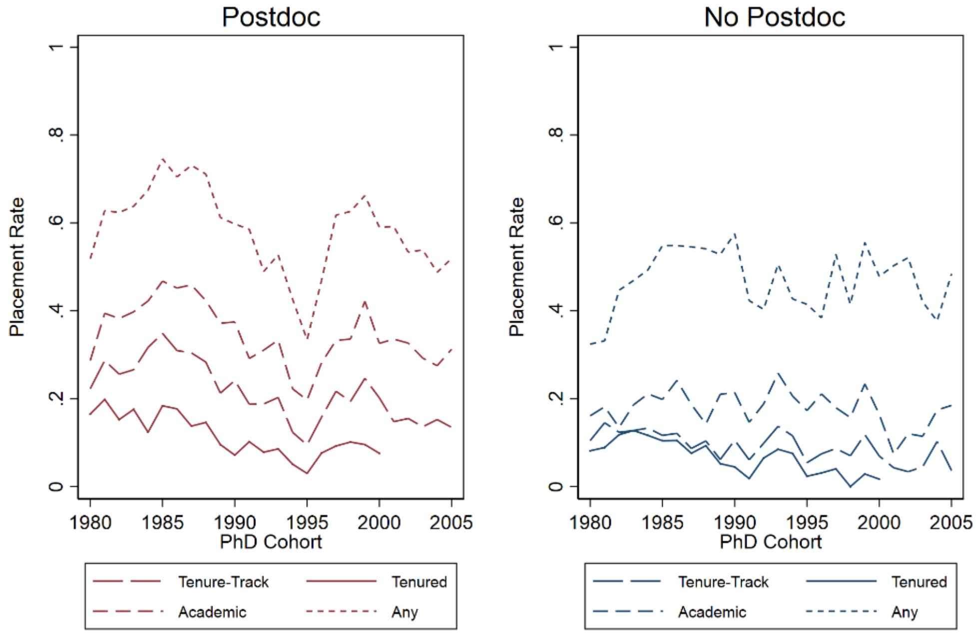
Notes: Figure A.3 shows the average work hours and salary for biomedical doctorates age 28-32 employed as postdocs in the given year compared to biomedical doctorates of the same age employed in industry in the same year. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year. Salary adjusted for inflation using the CPI-U.

Figure A.4: Postdoc Rate of New Tenure-Track and Newly-Tenured Faculty by S&E Field



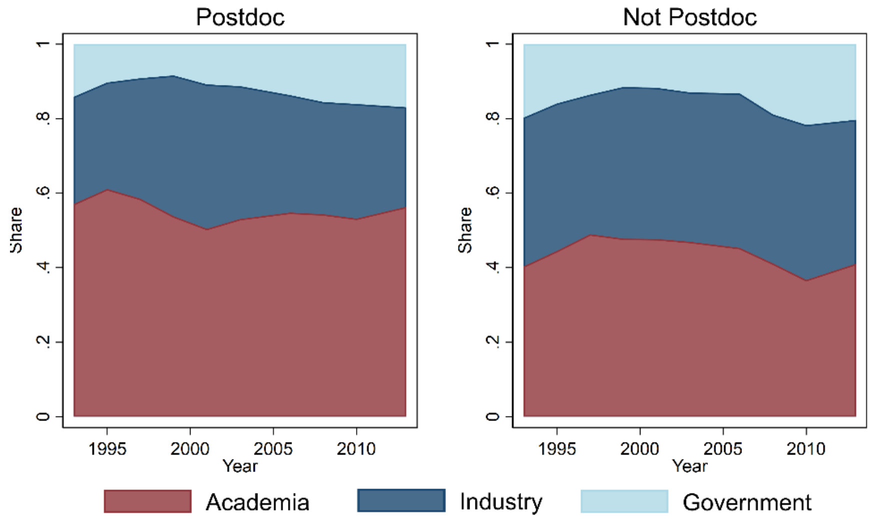
Notes: Figure A.4 shows the postdoc-share of individuals who first report being employed in a tenure-track position (Panel A) or tenured position (Panel B) in a given SDR wave by broad field of study. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year.

Figure A.5: Research Job Placement Rates by Prior Postdoc Status



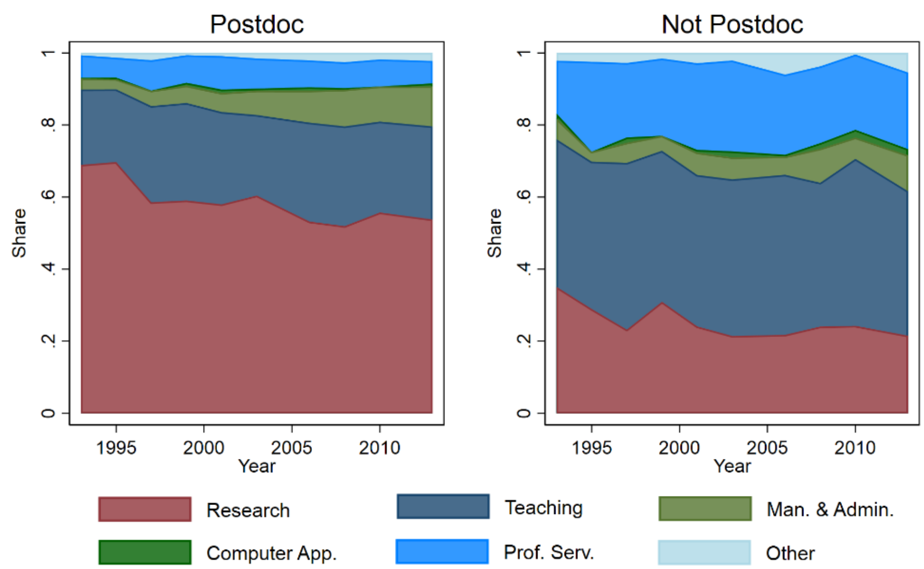
Notes: Figure A.5 shows proportion of biomedical doctorates who take the indicated academic research position (excluding postdoc positions) within 15 years post-PhD by PhD cohort and whether individual has postdoc training. We require that we observe an individual for the full 15 years post-PhD for "Tenured" calculations, but only require at least 10 years of observations for the other positions since these positions typically take less time to obtain relative to a tenured position. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year.

Figure A.6: Share of Biomedical Doctorates Working in Each Employment Sector



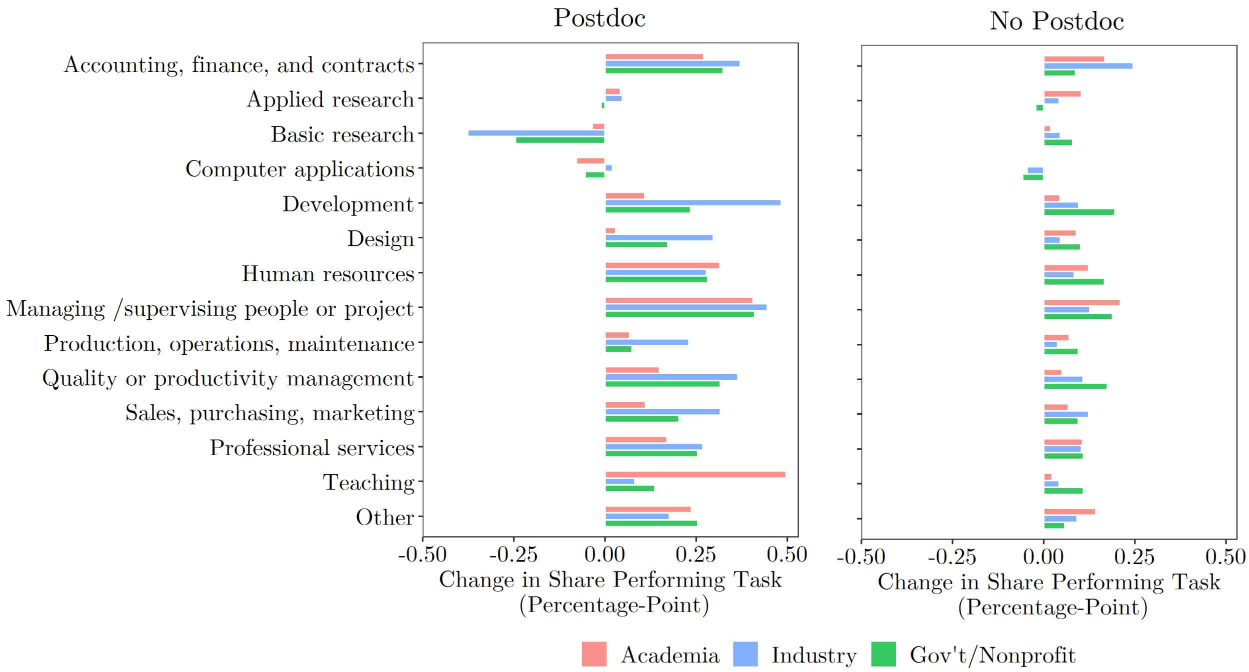
Notes: Figure A.6 shows the share of biomedical doctorates age 30 to 40 working in each employment sector by year and whether they have previous postdoc training; those employed as postdocs in the given year are excluded. "Government" sector includes both government and nonprofits. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year.

Figure A.7: Share of Biomedical Doctorates in Academia by Primary Work Activity



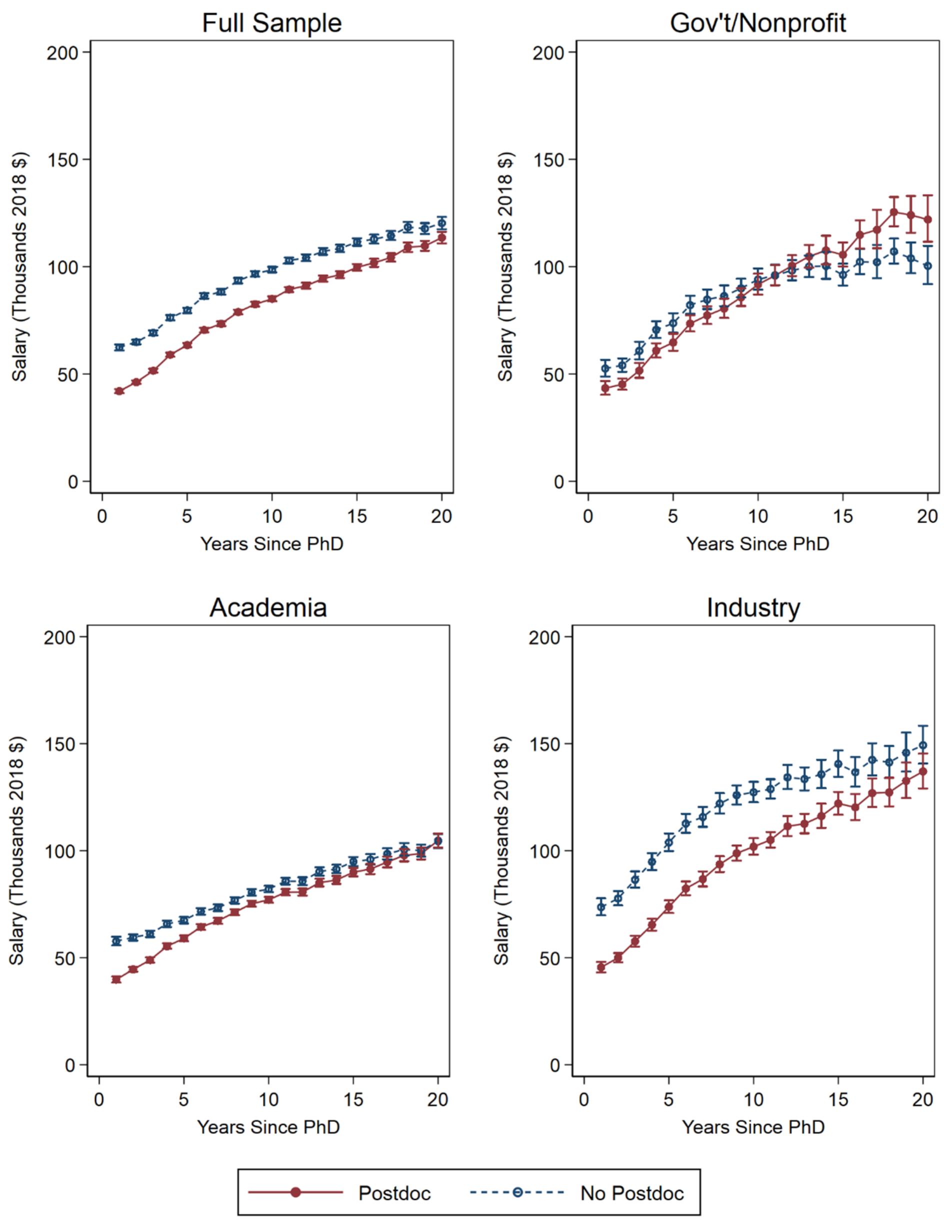
Notes: Figure A.7 shows the share of academia-employed biomedical doctorates age 30 to 40 in different reported primary job tasks by year and whether they have postdoc training; those employed as postdocs in the given year are excluded. Sample restricted to doctorates appearing in the NSF's Survey of Doctorate Recipients in any wave(s) between 1993 and 2015 and graduating as early as 1980. We restrict sample to doctorates who first appear in the SDR prior to 2010 due to SDR sampling changes starting in that year.

Figure A.8: Change in Tasks for Postdocs and Nonpostdocs By Sector



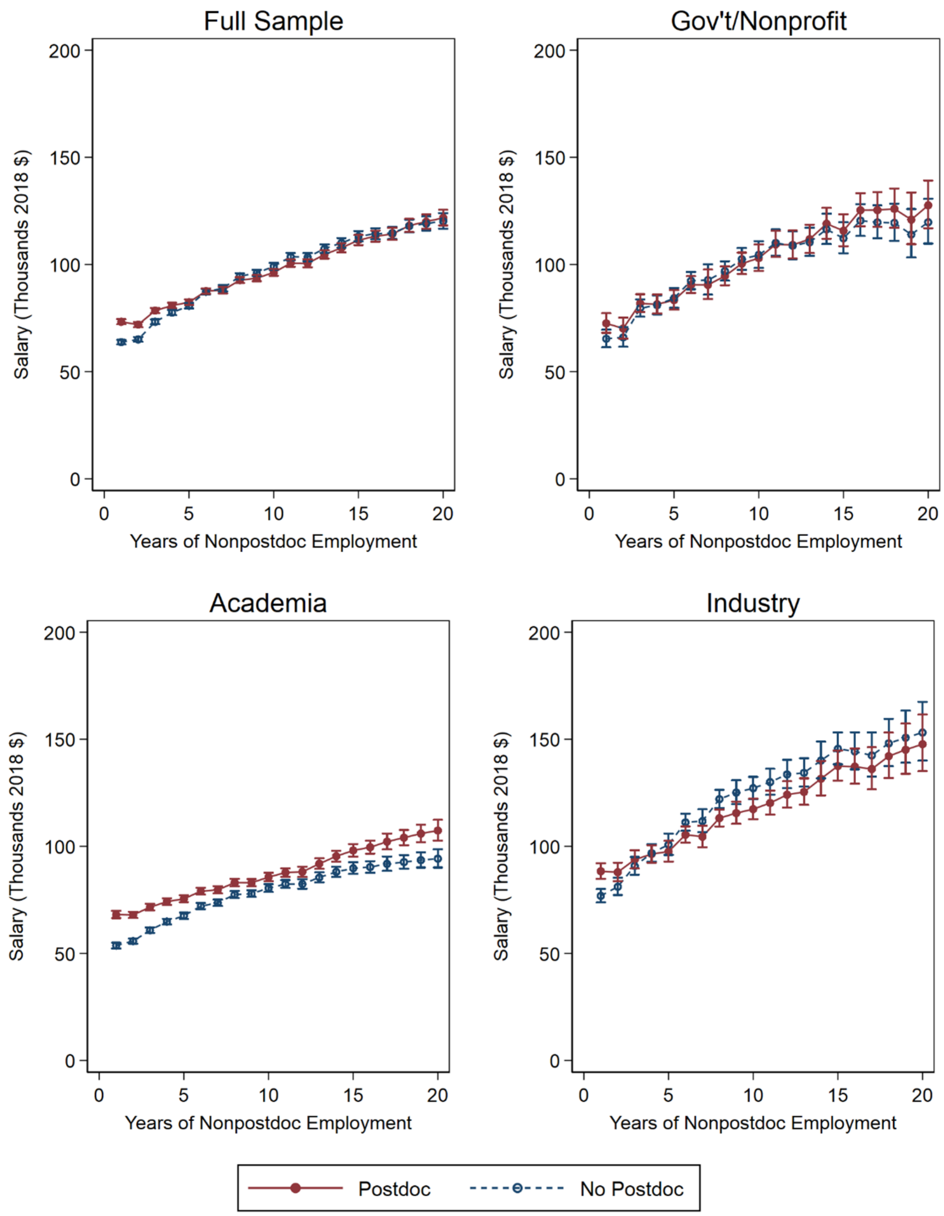
Notes: Figure A.8 gives the change in the share of postdocs and nonpostdoc performing tasks for at least 10% of work time among biomedical doctorates working in each sector. Greater magnitudes of task change represent greater degrees of mismatch in a given task. See Table A.3 and Table A.4 for the underlying data used to construct this figure.

Figure A.9: Average Predicted Salary Over Career by Postdoc-Trained Status: Postdoc Training as Experience, Postdoc Salary Observations Included



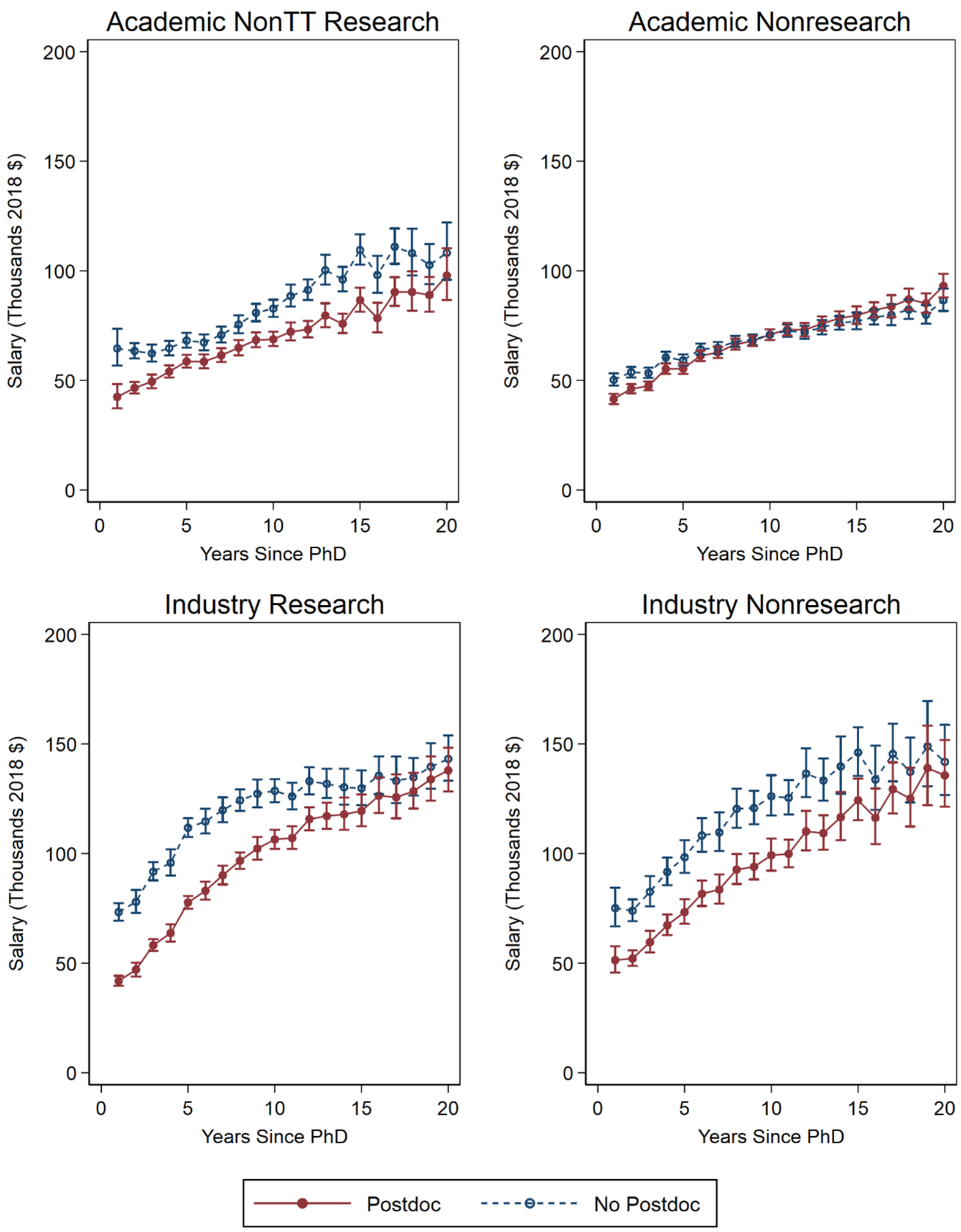
Notes: Figure A.9 shows the average of predicted salary profiles for biomedical doctorates with and without postdoc training generated by an augmented version of the specification found in Column (2) of Table 3 where we allow for interactions between the indicator variable for postdoc training and quartic polynomial in experience. The plots are generated by the following process: For each doctorate in the given employment sector sample, we generate two predictions of log(salary) in each year since PhD. The first prediction gives the log(salary) predicted if the person is assumed to have done a postdoc and the second prediction gives the log(salary) predicted if the person did not do a postdoc. Then, we average the predicted log(salary) across individuals in the given employment sector in each year since PhD and apply the exponential function to translate log(salary) into salary. We then plot these average predicted salary profiles with 95% confidence intervals in Figure A.9. Salary adjusted for inflation using the CPI-U.

Figure A.10: Average Predicted After-Postdoc Salary Over Career by Postdoc-Trained Status: Postdoc Training as Schooling, Postdoc Salary Observations Excluded



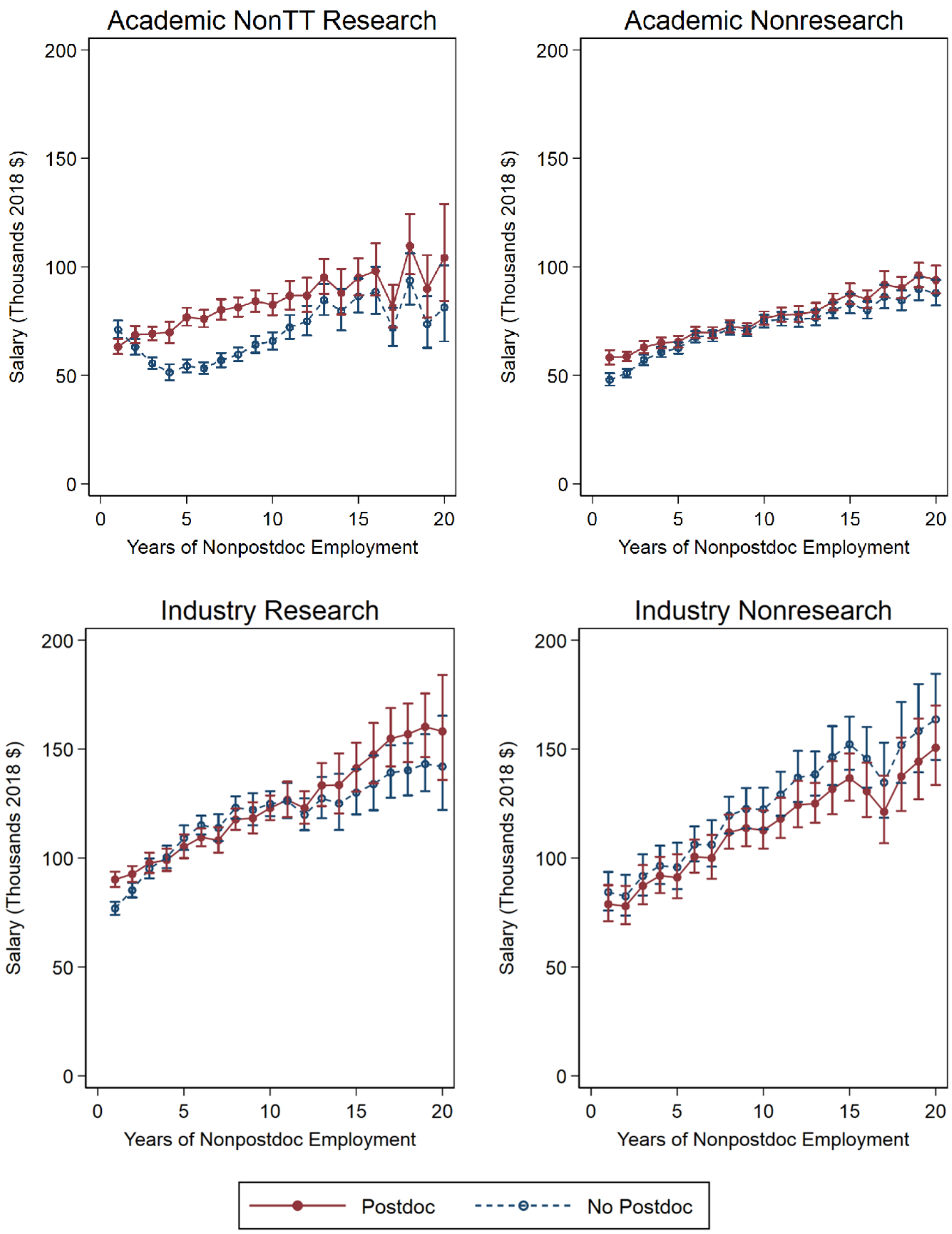
Notes: Figure A.10 shows the average of predicted salary profiles for biomedical doctorates with and without postdoc training generated by an augmented version of the specification found in Column (6) of Table 3 where we allow for interactions between the indicator variable for postdoc training and quartic polynomial in experience. The plots are generated by the following process: For each doctorate in the given employment sector sample, we generate two predictions of log(salary) in each year since PhD. The first prediction gives the log(salary) predicted if the person is assumed to have done a postdoc and the second prediction gives the log(salary) predicted if the person did not do a postdoc. Then, we average the predicted log(salary) across individuals in the given employment sector in each year since PhD and apply the exponential function to translate log(salary) into salary. We then plot these average predicted salary profiles with 95% confidence intervals in Figure A.10. The employment sector subsamples are based on each doctorate's sector of employment in the given year, rather than the sector of employment at ten years post-PhD, in the underlying specifications used to generate the predictions. Salary adjusted for inflation using the CPI-U.

Figure A.11: Average Predicted Salary Over Career by Postdoc-Trained Status and Subsector: Postdoc Training as Experience, Postdoc Salary Observations Included



Notes: Figure A.11 shows the average of predicted salary profiles for biomedical doctorates with and without postdoc training generated by an augmented version of the specification found in Column (2) of Table 5 where we allow for interactions between the indicator variable for postdoc training and quartic polynomial in experience. The plots are generated by the following process: For each doctorate in the given employment sector sample, we generate two predictions of log(salary) in each year since PhD. The first prediction gives the log(salary) predicted if the person is assumed to have done a postdoc and the second prediction gives the log(salary) predicted if the person did not do a postdoc. Then, we average the predicted log(salary) across individuals in the given employment sector in each year since PhD and apply the exponential function to translate log(salary) into salary. We then plot these average predicted salary profiles with 95% confidence intervals in Figure A.11. The employment sector subsamples are based on each doctorate's sector of employment at ten years post-PhD. Salary adjusted for inflation using the CPI-U.

Figure A.12: Average Predicted After-Postdoc Salary Over Career by Postdoc-Trained Status and Subsector: Postdoc Training as Schooling, Postdoc Salary Observations Excluded



Notes: Figure A.12 shows the average of predicted salary profiles for biomedical doctorates with and without postdoc training generated by an augmented version of the specification found in Column (6) of Table 5 where we allow for interactions between the indicator variable for postdoc training and quartic polynomial in experience. The plots are generated by the following process: For each doctorate in the given employment sector sample, we generate two predictions of log(salary) in each year since PhD. The first prediction gives the log(salary) predicted if the person is assumed to have done a postdoc and the second prediction gives the log(salary) predicted if the person did not do a postdoc. Then, we average the predicted log(salary) across individuals in the given employment sector in each year since PhD and apply the exponential function to translate log(salary) into salary. We then plot these average predicted salary profiles with 95% confidence intervals in Figure A.12. The employment sector subsamples are based on each doctorate's sector of employment in the given year, rather than the sector of employment at ten years post-PhD, in the underlying specifications used to generate the predictions. Salary adjusted for inflation using the CPI-U.

Table A.1: Biomedical SED Fine Fields of Study in Analytical Sample

SED Fine Field of Study
Anatomy
Bacteriology
Biochemistry
Biology/Biomedical Sciences, General
Biology/Biomedical Sciences, Other
Biomedical Sciences
Biometrics & Biostatistics
Biophysics
Biotechnology & Bioinformatics
Botany/Plant Biology
Cell/Cellular Biology & Histology
Developmental Biology/Embryology
Ecology
Endocrinology
Entomology
Evolutionary Biology
Genetics/Genomics, Human & Animal
Immunology
Microbiology
Molecular Biology
Neurosciences & Neurobiology
Nutrition Sciences
Parasitology
Pathology, Human & Animal
Pharmacology, Human & Animal
Physiology, Human & Animal
Plant Genetics
Plant Pathology/Phytopathology
Plant Physiology
Toxicology
Zoology

Notes: This table lists the biomedical fields represented in our analytical sample.

Table A.2: Primary Tasks Performed by Doctorates Before and After the First Six Years Post-PhD by Postdoc-Trained Status

Employment Sector:	Academia				Industry				Gov't/Nonprofits			
Period (Years Post-PhD):	First Six Years		After Six Years		First Six Years		After Six Years		First Six Years		After Six Years	
Group:	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc
Acct., Finance, and Contracts	–	–	–	1.50%	–	–	4.21%	4.21%	–	–	–	3.91%
Applied Research	17.65%	21.58%	20.45%	22.28%	45.98%	28.86%	40.23%	52.91%	40.58%	28.52%	47.83%	41.02%
Basic Research	14.85%	79.32%	18.21%	64.34%	5.75%	75.15%	4.21%	10.22%	9.42%	75.00%	15.22%	40.63%
Computer Applications	–	–	–	1.20%	6.90%	2.00%	7.28%	6.21%	–	–	–	–
Development	–	–	–	1.70%	18.39%	–	27.59%	25.85%	–	–	10.14%	8.59%
Design	–	–	–	–	–	–	–	4.61%	–	–	–	–
Human Resources	–	–	3.36%	1.00%	–	–	–	–	–	–	–	–
Managing People or Projects	8.40%	1.20%	21.29%	23.48%	19.16%	–	38.70%	37.27%	23.19%	–	49.28%	40.23%
Production, Operations, Maint.	–	–	–	–	–	–	–	3.81%	–	–	–	–
Quality or Productivity Mgmt.	–	–	–	–	–	–	4.60%	5.81%	–	–	–	–
Sales, Purchasing, Marketing	–	–	–	–	4.98%	–	8.05%	8.82%	–	–	–	–
Professional Services	13.73%	5.00%	13.45%	6.49%	24.90%	4.21%	31.80%	20.64%	25.36%	5.86%	23.19%	15.23%
Teaching	62.18%	4.30%	64.43%	33.67%	–	–	–	–	–	–	–	–
Other	3.08%	1.30%	7.56%	3.70%	7.28%	–	10.34%	9.02%	15.22%	–	15.22%	17.58%
N	357	1001	357	1001	261	499	261	499	138	256	138	256

Notes: In this table, we calculate the proportion of postdoc-trained and non-postdoc trained biomedical doctorates that report each given task as their primary work activity at least once 1) in their first six years post-PhD and 2) after their first six years post-PhD. We restrict the sample to biomedical doctorates that are employed in each employment sector at 10 years post-PhD and for whom we observe at least two times in their first six years post-PhD. For postdocs, we only consider observations in the first six years post-PhD that correspond to years employed as a postdoc; after six years post-PhD, we only consider observations corresponding to years after any and all years employed as a postdoc, and where the doctorate is employed in the given employment sector. For nonpostdocs, we only consider observations corresponding to years where the person is employed in the given employment sector. "–" reported in cells of insufficient size to be disclosed. N reports person counts.

Table A.3: Tasks Performed by Doctorates Working in Industry Before and After the First Six Years Post-PhD by Postdoc-Trained Status

Employment Sector:	Industry					
Period (Years Post-PhD):	First Six Years		After Six Years		Task Change	
Group:	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc
Accounting, Finance, and Contracts	22.61%	2.61%	47.13%	39.68%	24.52	37.07
Applied Research	67.82%	73.95%	72.03%	78.76%	4.21	4.81
Basic Research	33.33%	90.98%	37.93%	53.31%	4.60	-37.68
Computer Applications	32.95%	28.66%	28.35%	30.66%	-4.60	2.00
Development	55.56%	21.64%	65.13%	69.94%	9.58	48.30
Design	33.72%	18.64%	38.31%	48.30%	4.60	29.66
Human Resources	44.83%	23.25%	53.26%	51.10%	8.43	27.86
Managing People or Projects	72.41%	40.68%	85.06%	85.17%	12.64	44.49
Production, Operations, Maintenance	11.11%	7.01%	14.94%	30.06%	3.83	23.05
Quality or Productivity Management	29.12%	5.61%	39.85%	42.08%	10.73	36.47
Sales, Purchasing, Marketing	26.44%	4.01%	38.70%	35.67%	12.26	31.66
Professional Services	37.16%	8.82%	47.51%	35.67%	10.34	26.85
Teaching	21.07%	19.64%	25.29%	27.86%	4.21	8.22
Other	12.26%	3.61%	21.46%	21.24%	9.20	17.64
N	261	499	261	499	261	499

Notes: In this table, we calculate the proportion of postdoc-trained and non-postdoc trained biomedical doctorates that report spending at least 10% of their work time engaged in the given activity at least once 1) in their first six years post-PhD and 2) after their first six years post-PhD. We restrict the sample to biomedical doctorates that are employed in industry at 10 years post-PhD and for whom we observe at least two times in their first six years post-PhD. For both postdoc-trained and nonpostdoc-trained biomedical doctorates, we then report the percentage-point difference between the fraction of each performing each task within and after their first six years post-PhD, and refer to this measure as the "task change" of each group. For postdocs, we only consider observations in the first six years post-PhD that correspond to years employed as a postdoc; after six years post-PhD, we only consider observations corresponding to years after any and all years employed as a postdoc, and where the doctorate is employed in industry. For nonpostdocs, we only consider observations corresponding to years where the person is employed in industry.

Table A.4: Tasks Performed by Doctorates Before and After the First Six Years Post-PhD by Postdoc-Trained Status

Employment Sector:	Academia						Gov't/Nonprofit					
Period (Years Post-PhD):	First Six Years		After Six Years		Task Change		First Six Years		After Six Years		Task Change	
Group:	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc	No Pdoc	Pdoc
Accounting, Finance, and Contracts	10.92%	5.99%	27.73%	33.07%	16.81	27.07	33.33%	6.64%	42.03%	39.06%	8.70	32.42
Applied Research	56.02%	67.73%	66.39%	71.93%	10.36	4.20	77.54%	75.00%	75.36%	73.83%	-2.17	-1.17
Basic Research	64.15%	94.41%	66.11%	90.91%	1.96	-3.50	40.58%	92.97%	48.55%	68.36%	7.97	-24.61
Computer Applications	23.53%	29.77%	23.25%	21.88%	-0.28	-7.89	36.96%	34.38%	31.16%	28.91%	-5.80	-5.47
Development	18.21%	15.38%	22.69%	26.27%	4.48	10.89	28.26%	19.92%	47.83%	43.36%	19.57	23.44
Design	10.08%	21.18%	19.05%	24.08%	8.96	2.90	23.19%	19.53%	33.33%	36.72%	10.14	17.19
Human Resources	32.21%	26.17%	44.54%	57.74%	12.32	31.57	38.41%	22.27%	55.07%	50.39%	16.67	28.13
Managing People or Projects	63.03%	49.45%	84.03%	90.01%	21.01	40.56	71.74%	48.05%	90.58%	89.06%	18.84	41.02
Production, Operations, Maintenance	8.40%	10.89%	15.41%	17.58%	7.00	6.69	9.42%	8.59%	18.84%	16.02%	9.42	7.42
Quality or Productivity Management	9.52%	5.00%	14.57%	19.98%	5.04	14.99	23.19%	4.30%	40.58%	35.94%	17.39	31.64
Sales, Purchasing, Marketing	8.12%	3.10%	14.85%	14.19%	6.72	11.09	21.74%	6.64%	31.16%	26.95%	9.42	20.31
Professional Services	33.05%	9.99%	43.70%	26.97%	10.64	16.98	37.68%	10.55%	48.55%	35.94%	10.87	25.39
Teaching	90.48%	36.46%	92.72%	86.11%	2.24	49.65	30.43%	26.56%	41.30%	40.23%	10.87	13.67
Other	19.33%	4.40%	33.61%	28.07%	14.29	23.68	26.09%	5.86%	31.88%	31.25%	5.80	25.39
N	261	499	261	499	261	499	138	256	138	256	138	256

Notes: In this table, we calculate the proportion of postdoc-trained and non-postdoc trained biomedical doctorates that report spending at least 10% of their work time engaged in the given activity at least once 1) in their first six years post-PhD and 2) after their first six years post-PhD. We restrict the sample to biomedical doctorates that are employed in the given employment sector at 10 years post-PhD and for whom we observe at least two times in their first six years post-PhD. For both postdoc-trained and nonpostdoc-trained biomedical doctorates, we then report the percentage-point difference between the fraction of each performing each task within and after their first six years post-PhD, and refer to this measure as the "task change" of each group. For postdocs, we only consider observations in the first six years post-PhD that correspond to years employed as a postdoc; after six years post-PhD, we only consider observations corresponding to years after any and all years employed as a postdoc, and where the doctorate is employed in industry. For nonpostdocs, we only consider observations corresponding to years where the person is employed in industry.

Table A.5: Regression Controls

Variable Name	Variable Definition
female	Indicator variable for if reported as a female
age_phd	Age when earned PhD
asian	Indicator variable for if race reported as "Asian"
race_minority	Indicator variable for if race reported as non-Asian minority
foreign	Indicator variable for if reported as foreign-born
temp_res	Indicator variable for if reported being a temporary resident when earned PhD
married_phd	Indicator variable for if reported being married when earned PhD
child_phd	Indicator variable for if reported any children living at home when earned PhD
married_child_phd	Indicator variable for if reported being married and having children at home when earned PhD
female_interactions	A set of two-way interaction terms between female and all controls listed above
phd_length	Number of years between entering PhD program and earning PhD
phd_length_miss	Indicator variable for if PhD length missing — phd_length assigned average value when phd_length_miss=1
fellow	Indicator variable for if primary source of support during PhD was a fellowship or scholarship
TA	Indicator variable for if primary source of support during PhD was a teaching assistantship
RA	Indicator variable for if primary source of support during PhD was a research assistantship
edmother_ba	Indicator variable for if mother's highest level of education is Bachelor's degree
edmother_ma	Indicator variable for if mother's highest level of education is Master's degree
edmother_prof	Indicator variable for if mother's highest level of education is Professional degree
edmother_phd	Indicator variable for if mother's highest level of education is PhD
edfather_ba	Indicator variable for if father's highest level of education is Bachelor's degree
edfather_ma	Indicator variable for if father's highest level of education is Master's degree
edfather_prof	Indicator variable for if father's highest level of education is Professional degree
edfather_phd	Indicator variable for if father's highest level of education is PhD
profmd	Indicator variable for if earning or have already earned a professional degree such as MD
yrs_since_phd	Number of years since earned PhD
yrs_since_phd_sq	(Number of years since earned PhD)^2
yrs_since_phd_cub	(Number of years since earned PhD)^3
yrs_since_phd_quart	(Number of years since earned PhD)^4
year	A set of normalized year fixed effects
phdfy	A set of PhD cohort (i.e. graduation year) fixed effects
phdfield	A set of SED fine field of study fixed effects

Notes: This table lists the controls used in the salary regressions. These controls are also used in the research job regressions (excluding yrs_since_phd, yrs_since_phd_sq, yrs_since_phd_cub, yrs_since_phd_quart, and year).

Table A.6: LPM Estimates of Possible Postdoc Determinants

Dependent Variable: Postdoc Training		
temp_res	0.112***	(0.0417)
foreign	0.0335	(0.0338)
age_phd	-0.0108***	(0.00270)
asian	0.0167	(0.0318)
race_minority	-0.0119	(0.0282)
phd_length	-0.0178***	(0.00364)
phd_length_miss	0.00882	(0.0251)
married_phd	-0.0215	(0.0266)
child_phd	-0.0905	(0.0939)
married_child_phd	0.0305	(0.0974)
fellow	-0.000562	(0.0220)
TA	-0.00501	(0.0254)
RA	0.0269	(0.0183)
edmother_ba	0.0205	(0.0201)
edmother_ma	0.0112	(0.0246)
edmother_prof	0.0419	(0.0467)
edmother_phd	0.0213	(0.0520)
edfather_ba	-0.00435	(0.0188)
edfather_ma	-0.00252	(0.0236)
edfather_prof	0.0105	(0.0364)
edfather_phd	0.0113	(0.0260)
profmd	-0.155***	(0.0344)
female	-0.148	(0.104)
female_asian	0.000567	(0.0487)
female_minor	-0.0239	(0.0411)
female_age_phd	0.00458	(0.00342)
female_foreign	-0.0517	(0.0496)
female_tempres	0.0398	(0.0641)
female_married_phd	0.0168	(0.0381)
female_child_phd	0.0653	(0.122)
female_married_child_phd	-0.0710	(0.132)
Fixed Effects		
Field-Cohort	✓	
PhD University	✓	
N	4778	
R^2	0.352	

Notes: Table A.6 reports coefficient estimates of a LPM regression of an indicator variable for if a doctorate ever is employed as a postdoc on our salary regression controls. Observations are person level. Robust standard errors clustered on field-cohort in parentheses. See Table A.5 for the definition of each covariate. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: Postdoc Training and the Likelihood of an Academic Job

	Academic (Any)	Tenure-Track	Tenured
Postdoc Training	0.169***	0.167***	-0.0149
	(0.0206)	(0.0198)	(0.0526)
R^2	0.249	0.267	0.459
N	4778	4778	1583
Fixed Effects			
Field-Cohort	✓	✓	✓
PhD University	✓	✓	✓

Notes: See notes to Table 4. This table reports regressions results where the dependent variable for each column is an indicator variable for the type of job given by the column name which, unlike Table 4, are not restricted to research-focused jobs.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.8: Task Regression Sample Observations by Employment Sector

Employment Sector	In Sector in Year of Observation†		
	Postdoc	Non-Postdoc	Total
Panel A: Number of Observations (Person-Count)			
All Sectors	7541 (1804)	2674 (675)	10215 (2479)
Academia	4186 (1134)	1256 (333)	5442 (1467)
TT Research	1466 (509)	133 (58)	1599 (567)
Non-TT Research	776 (358)	185 (74)	961 (432)
Nonresearch	1944 (692)	938 (284)	2882 (976)
Industry	2211 (638)	893 (271)	3104 (909)
Research	1077 (412)	363 (137)	1440 (549)
Nonresearch	1134 (437)	530 (212)	1664 (649)
Gov't/Nonprofits	1144 (416)	525 (165)	1669 (581)
Panel B: Person Share: Row (Column) [Cell]			
All Sectors	0.73 (1.00) [0.73]	0.27 (1.00) [0.27]	1.00 (1.00) [1.00]
Academia	0.77 (0.63) [0.46]	0.23 (0.49) [0.13]	1.00 (0.59) [0.59]
TT Research	0.90 (0.28) [0.21]	0.10 (0.09) [0.02]	1.00 (0.23) [0.23]
Non-TT Research	0.83 (0.20) [0.14]	0.13 (0.11) [0.03]	1.00 (0.17) [0.17]
Nonresearch	0.71 (0.38) [0.28]	0.29 (0.42) [0.11]	1.00 (0.39) [0.39]
Industry	0.70 (0.35) [0.26]	0.30 (0.40) [0.11]	1.00 (0.37) [0.37]
Research	0.75 (0.23) [0.17]	0.25 (0.20) [0.06]	1.00 (0.22) [0.22]
Nonresearch	0.67 (0.24) [0.18]	0.33 (0.31) [0.09]	1.00 (0.26) [0.26]
Gov't/Nonprofits	0.72 (0.23) [0.17]	0.28 (0.24) [0.07]	1.00 (0.23) [0.23]

Notes: Regressions including measures of worker task histories or the degree of mismatch between tasks performed as part of current employment and those performed early in their career restrict to those biomedical doctorates in the analytical sample who are observed at least two times during the first six years post-PhD. Panel A lists the number of observations (and unique individuals) in each employment sector for the task regression sample by whether each observation is associated with a biomedical doctorate with postdoctoral training. Panel B gives the row, column, and total share of persons in each cell as calculated from Panel A. † = excludes observations for years when employed as a postdoc. Since a single worker may show up in different sectors at different times, the sum of the person counts exceeds the total number of persons included in the analytical sample.

Table A.9: Controlling for Task History and Current Tasks in Salary Regressions

Dependent Variable: log(salary)	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Task History Controls						
I. All Sectors			$N = 10215$			
Postdoc Training	-0.117***	-0.0716**	-0.0582*	-0.0748*	-0.0665**	-0.0696**
	(0.0321)	(0.0312)	(0.0310)	(0.0317)	(0.0308)	(0.0312)
R^2	0.301	0.343	0.346	0.346	0.354	0.362
II. Academia			$N = 5442$			
Postdoc Training	-0.0185	-0.0265	-0.0228	-0.0361	-0.0347	-0.0361
	(0.0415)	(0.0385)	(0.0372)	(0.0387)	(0.0374)	(0.0373)
R^2	0.422	0.463	0.470	0.469	0.481	0.486
III. Gov't/Nonprofit			$N = 1669$			
Postdoc Training	-0.103	0.00563	-0.0256	-0.0788	-0.0917	-0.0228
	(0.0789)	(0.0821)	(0.0854)	(0.0862)	(0.0641)	(0.0915)
R^2	0.703	0.722	0.714	0.717	0.724	0.733
Panel B: Current Job Task Controls						
I. All Sectors			$N = 10215$			
Postdoc Training	-0.117***	-0.100***	-0.0898***	-0.119***	-0.103***	-0.114***
	(0.0321)	(0.0303)	(0.0300)	(0.0309)	(0.0300)	(0.0300)
R^2	0.301	0.348	0.348	0.339	0.355	0.363
II. Academia			$N = 5442$			
Postdoc Training	-0.0185	-0.0313	-0.0361	-0.0711*	-0.0653*	-0.0722*
	(0.0415)	(0.0388)	(0.0373)	(0.0383)	(0.0367)	(0.0368)
R^2	0.422	0.455	0.462	0.459	0.475	0.479
III. Gov't/Nonprofit			$N = 1669$			
Postdoc Training	-0.103	-0.0698	-0.0741	-0.0400	-0.0274	-0.0280
	(0.0789)	(0.0811)	(0.0767)	(0.0930)	(0.0859)	(0.0916)
R^2	0.703	0.712	0.709	0.709	0.716	0.718
Postdoc Training Treated As:						
Experience	✓	✓	✓	✓	✓	✓
Schooling						
Included Task Control Sets						
Primary Activity		✓				✓
Primary or Secondary Activity			✓		✓	
Activity $\geq$ 10% of Work Time				✓	✓	✓

Notes: See Table 6 for industry sector results. This table reports regressions results based on the specification given in equation (9) where our sample includes all biomedical doctorates in the SDR graduating between 1993 and 2006 who are observed in at least two of their first six years post-PhD. Experience is defined as years since PhD graduation for all biomedical doctorates. For each doctorate, we keep only those person-year observations corresponding to years after any and all years employed as a postdoc, and we drop all observations within the first six years after Ph.D. so that postdoc and nonpostdoc observations are comparable. Subsamples are based on the employment sector associated with each person-year observation. In Panel A, we add controls for the history of tasks performed as part of previous employment. In Panel B, we add controls for the tasks associated with the current job. Robust standard errors clustered at individual-level are in parentheses. Estimates produced using survey weights. Specifications (1) - (6) include all controls listed in Table A.5. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.10: Adding Current Job Tasks as Controls

Dependent Variable: log(salary)	(1)	(2)	(3)	(4)	(5)	(6)
Employment Sector: Industry			$N = 6708$			
Postdoc Training	-0.158***	-0.171***	-0.167***	-0.179***	-0.170***	-0.174***
	(0.0410)	(0.0407)	(0.0402)	(0.0398)	(0.0396)	(0.0397)
R^2	0.400	0.419	0.422	0.421	0.428	0.431
Postdoc Training Treated As:						
Experience	✓	✓	✓	✓	✓	✓
Schooling						
Current Job Task Controls						
Primary Activity		✓				✓
Primary or Secondary Activity			✓		✓	
Activity $\geq$ 10% of Work Time				✓	✓	✓

Notes: This table reports regressions results based on the specification given in equation (9) where our sample includes all biomedical doctorates in the SDR graduating between 1993 and 2006 who are observed in at least two of their first six years post-PhD. Postdoc training is treated as experience such that experience is defined as years since PhD graduation for all biomedical doctorates. For each doctorate, we keep only those person-year observations corresponding to years after any and all years employed as a postdoc, and we drop all observations within the first six years after Ph.D. so that postdoc and nonpostdoc observations are comparable. Subsamples are based on the employment sector associated with each person-year observation. Robust standard errors clustered at individual-level are in parentheses. Estimates produced using survey weights. Specifications (1) - (6) include all controls listed in Table A.5. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.11: Coefficient Estimates on Task History Controls

Dependent Variable: log(salary)		
Postdoc Training	-0.126*	(0.0666)
Accounting Experience	-0.0898**	(0.0394)
Basic Research Experience	-0.0394***	(0.0108)
Computer App Experience	-0.00224	(0.0116)
Development Experience	0.00149	(0.0125)
Design Experience	0.0202	(0.0293)
HR Experience	0.0295	(0.0118)
Management Experience	0.0204**	(0.0103)
Production Experience	-0.0286	(0.0273)
Quality/Productivity MGMT Experience	0.00277	(0.0309)
Sales/Marketing Experience	-0.0351**	(0.0152)
Professional Services Experience	0.00652	(0.00873)
Teaching Experience	-0.0641**	(0.0264)
Other Experience	-0.0268	(0.0237)
N	3104	
R^2	0.518	

Notes: Table A.6 reports coefficient estimates on the (primary) task history controls included in the regression whose main results are report in Panel A column (2) of Table 6. Applied research is the base case and so estimates yield the value of spending an additional year in a job with the given primary task relative to a job where applied research is the primary task. Robust standard errors clustered at individual-level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Identifying Postdocs and Postdoc Length in SDR-SED Data

Our dataset is made up of three different sources that contain information about a doctorate's postdoc status. The first source is the SED, wherein respondents are asked "What best describes your (within the next year) postgraduate plans?" and "What is the status of your postgraduate plans (in the next year)?" Starting in the SED in 2004, respondents are also asked "Do you intend to take a 'postdoc' position?". Using these questions, we assign a person as doing a postdoc if the respondent says that, post-graduation, he/she plans to do either a: 1) postdoc fellowship, 2) postdoc research associateship, 3) traineeship, or 4) internship/ clinical residency, and also states that he/she 1) will be either returning to present employment, 2) has accepted a position, or 3) is in negotiation with one or more specific organizations.

The second source containing information on postdoc status is the SDR. In each SDR wave, doctorates are asked whether they are currently working and whether their current job is a "postdoc." If a doctorate reports being in a postdoc job in any SDR wave, then we consider them to have done a postdoc. The third source comes from the Special Topic Module included on the SDR 1995 and 2006 waves wherein respondents are asked how many postdoc positions they have ever held and the starting and ending dates for their last three postdoc positions. We follow Kahn and Ginther (2017) in referring to these as the SDR Retrospective Surveys. If a doctorate reports having done at least one postdoc on either SDR Retrospective Survey, then we count that person as having done a postdoc. If a doctorate reports never having done a postdoc on the Retrospective Surveys, then we label the person as having never done a postdoc. In rare cases, sources disagree about whether a person has ever done a postdoc. If SED states that a person plans to do a postdoc, but then they never report doing a postdoc in any SDR wave and they claim to have never taken a postdoc position in the SDR Retrospective Surveys, then we label the person as never having done a postdoc. If a doctorate ever claims to have done a postdoc in any SDR wave (including the SDR Retrospective Surveys), then we label them as having done a postdoc.

Next, we seek to determine which years a person was employed as a postdoc. We create a variable ("pdoc_year") that equals one if the doctorate was in a postdoc in the given year and equals zero if the doctorate was not in a postdoc in the given year. Once we form this variable, we will take its sum across years for each doctorate to measure each doctorate's duration (or "length") of postdoc training. If a person was found to have never done a postdoc (pdoc==0), then we label the person as not being employed in a postdoc for all years for which they appear (i.e., pdoc_year==0 for all years). If the person could be identified as a postdoc based solely on information from the SED, then we labeled the year of PhD receipt as being a year that the doctorate was employed as a postdoc. For those who report currently being in a postdoc position in an SDR wave, we have the year that they began that current employment and so label all years from the start of employment to that SDR wave as years in a postdoc. For doctorates in the SDR 1995 and/or 2006 wave ("SDR Retrospective Surveys"), we have information on the start and end dates of a person's last three postdoc positions, and so label any years within any of the reported postdocs as postdoc years. Additionally, we consider all years after the end of the last reported postdoc on the SDR Retrospective Surveys as being years where a doctorate was not in a postdoc, assuming we have no other evidence to suggest the person took up an additional postdoc after that time. Similarly, for doctorates who report having done at most three postdocs throughout their career in the SDR Retrospective Surveys, we label years preceding the start of their first reported postdoc as years that the person was not in a postdoc, assuming no additional evidence to suggest otherwise. Additionally, we label any years 1) between the end of the 2nd most recent postdoc and the start of the most recent postdoc or 2) between the end of the 3rd most recent postdoc and the start of the 2nd most recent postdoc as "non-postdoc" years. Lastly, we label as non-postdoc years any SDR year where a doctorate reports not being currently employed in a postdoc position.

In addition, we impute whether a year is or is not a postdoc year in special cases to avoid sample attrition. The need for imputation is due to two features of the SDR. First, the SDR is typically biennial, and so there is usually one year in between SDR waves, although there are two cases where there are two-year gaps: between SDR 2003 and 2006 and between SDR 2010 and 2013. Second, new sample members to the SDR have typically been added between one and three years after PhD receipt. This means that some doctorates may have one or two years between their PhD graduation year and entry into the SDR where postdoc status is missing.[67]

Our imputation strategy is as follows: if a doctorate reports not being in a postdoc in both the SDR wave before and after the gap year(s), then those gaps years are considered as non-postdoc years. Similarly, if a person reports being in a postdoc in both the SDR wave before and after the gap year(s), then those gap years are considered postdoc years. If a doctorate reports doing a postdoc in the SDR wave before a gap year, but reports not doing a postdoc in the SDR wave after the gap year, then we split the difference for gap years by assigning a value of 0.5 to our postdoc year variable. If a doctorate is surveyed in the SDR within three years, but has gap years preceding appearance in the SDR, then we assign a value of 0.5 if the person reports a postdoc position in his/her first SDR wave and assign a value of 0 if the person reports no postdoc position in his/her first SDR wave.[68] For biomedical doctorates first sampled in the SDR prior to SDR 2010, we are able to identify if a doctorate was ever a postdoc in 99% of cases. In 86% of cases, we are able to identify or impute whether or not a biomedical doctorate is employed as a postdoc in each year since PhD graduation.[69]

[67]Starting with SDR 2010, doctorates obtaining PhDs more than three years prior to the survey date were newly sampled; for these cases, there are many years where we cannot determine postdoc status, and so we will exclude these doctorates from our analytical sample.

[68]After our imputation strategy, the majority of doctorates who ever have a year where we fail to determine postdoc status are those who first appear in the SDR in the 2015 wave. The SDR 2015 wave was unique in that 80% of the SDR 2015 sample members were new to the survey, whereas in past cycles around 10% of the sample members were new. This was due to the SDR being expanded from 47,000 to 120,000 members, with members being added even when having graduated much earlier than 2015. Given this large increase in the number of new SDR members, it would be valuable for the SDR to once again include questions about previous postdoc experience, as was done for the 1995 and 2006 waves.

[69]In the analytical sample used in this study, we find that 77% of postdoc person-years occur in academia, 17%

C Bias-Adjusted Estimates of the Effect of Postdoc Training

C.1 Method for Estimating Bias-Adjusted Treatment Effects

Oster's (2019) bias-adjusted treatment effect estimator is motivated by the following data generating process:

$$Y = \beta X + \Psi\omega^0 + W_2 + \varepsilon,$$

where Y is the outcome of interest, X is a scalar treatment variable, ω^0 is a vector of observed controls, and W_2 and ε are unobserved.[70] Letting $W_1 \equiv \Psi\omega^0$, a proportional selection relationship can be defined as $\delta\frac{\sigma_{1X}}{\sigma_1^2} = \frac{\sigma_{2X}}{\sigma_2^2}$, where $\sigma_{iX} \equiv \text{cov}(W_i, X)$ and $\sigma_i^2 \equiv \text{var}(W_i)$ for $i \in \{1,2\}$, and where δ measures the level of selection on unobservables relative to observables. Let the coefficient and the R^2 obtained from a regression of Y on X ("uncontrolled regression") be denoted $\mathring{\beta}$ and $\mathring{R}$, respectively. Let the coefficient and the R^2 obtained from a regression of Y on X and ω^0 ("controlled regression") be denoted $\tilde{\beta}$ and $\tilde{R}$, respectively. Lastly, let the R^2 obtained from a hypothetical regression of Y on X, ω^0, and W_2 ("fully-specified regression") be denoted as R_{max}. Then, under some additional assumptions, Oster (2019) shows that a consistent bias-adjusted treatment effect (β^*) can be approximated by the following:

$$\beta^* \approx \tilde{\beta} - \delta\left[\mathring{\beta} - \tilde{\beta}\right]\frac{R_{max} - \tilde{R}}{\tilde{R} - \mathring{R}}.$$

Oster (2019) subsequently develops a consistent bias-adjusted treatment effect estimator that relaxes the additional restrictions used to derive the above approximation, and we use this more robust estimator to measure the sensitivity of our results to selection on unobservables.[71]

C.2 Bias-Adjusted Salary Regression Results

If postdoc-trained biomedical doctorates have lower ability at the time of PhD completion than those who forgo postdoc employment, then the postdoc salary penalty in industry reported in column (4) of Table 3 could potentially be explained by selection on unobserved ability at time of graduation. This explanation is unlikely for two reasons: First, Sauermann and Roach (2016) find that higher-ability biomedical doctorates plan on pursuing postdoc training, which would point to our estimates of a postdoc penalty being too conservative rather than too extreme.[72] Second, we include controls that are likely correlated with ability at time of graduation; these include field-by-cohort fixed effects, PhD university fixed effects, the education level of each biomedical doctorates'

occur in government/nonprofits, and only 6% occur in industry.

[70] A key assumption in what follows is that W_2 is orthogonal to W_1; therefore, W_2 should be viewed as the *residualized portion* of the unobservables after a hypothetical regression of the unobservables on ω^0. See Appendix A.1 of Oster (2019) for a discussion of this assumption.

[71] This method is implemented using the user-created Stata command `psacalc` accessible via Emily Oster's website.

[72] Ability is proxied by four measures in Sauermann and Roach (2016): 1) number of peer-reviewed publications, 2) fellowships from a federal agency, 3) their PhD program's National Research Council (NRC) ranking, and 4) respondent's assessment of their own research ability relative to peers.

mother and father, length of time in a graduate program, graduate program funding source, and various background characteristics that are likely related to ability.[73]

Nevertheless, we test whether residual variation in unobserved ability at time of graduation might explain the postdoc salary penalty in industry by estimating bias-adjusted treatment effects as formulated in Oster (2019) and report the results of this, and the results for other sectors (and subsectors), as a robustness check in Panel A of Table C.1 (and Table C.2). We find that the inclusion of controls, which are plausibly correlated with ability, pushes the estimated impact of postdoc training on future salary in a negative direction for all sectors in Table C.1, which is consistent with postdoc-trained biomedical doctorates having higher ability than their nonpostdoc-trained counterparts. While we are not able to pinpoint the causal impact of postdoc training in the absence of a valid instrument for postdoc attainment, under the plausible assumption that selection on unobservables acts in the same direction as selection on observables, we can bound the value for the causal impact by using the Oster (2019) method for estimating bias-adjusted treatment effects. To do so, we must select an upper-bound for the level of selection on unobservables relative to selection on observables (δ) and the R^2 that we would expect from a fully-specified model that we would be able to estimate if the unobservables were instead observable (R_{max}). We follow Altonji, Elder, and Taber (2005) and Oster (2019) in treating $\delta = 1$ as an upper-bound for the level of selection on unobservables relative to observables.[74] Oster (2019) suggests that researchers arguing for the stability of their results consistent with that of randomized treatment should consider an upper bound value of $1.3\tilde{R}^2$ for R_{max}, where $\tilde{R}^2$ is the R^2 obtained from the controlled regression. Thus, we use this R_{max} and $\delta = 1$ to calculate an upper-bound value for the impact of postdoc training on after-postdoc salary in each employment sector and subsector, which we report as θ^* in Table C.1 and Table C.2.

We find that each point estimate in Panel A of Table C.1 is negative and of greater magnitude compared to the estimate in the corresponding controlled regression, suggesting that, under the plausible assumption that selection on unobservables runs in the same direction as selection on observables, the magnitude of each estimate in column (4) of Table 3 is a lower-bound for the causal impact of postdoc training on after-postdoc salary, while each estimate reported as θ^* represents an upper-bound. The calculated upper-bounds all lie outside the 95% confidence interval of the corresponding estimate in column (4) of Table 3, indicating that correcting for selection on unobservables is potentially important.[75] Altogether, these results suggest that ability bias is unlikely

[73]Field-by-cohort fixed effects will be correlated with ability if individuals sort into different biomedical fields based on ability. PhD university fixed effects will be correlated with ability insofar as universities admit students to biomedical PhD programs based on individual ability (e.g., as measured by application materials including GRE scores and GPA) and insofar as different universities have different impacts on the human capital accumulation of PhD students. Parent's education level may proxy for socioeconomic background and possibly inherited traits impacting educational performance.

[74]As argued in Oster (2019), δ represents the relative degree of selection on the *residualized portion* of the unobservables (i.e., the variation in the unobservables unrelated to variation in the observables).

[75]Altonji, Arcidiacono, and Maurel (2016) note that in the context of evaluating the impact of college field choice on future earnings, "much of the variance in earnings at a point in time is due to measurement error or permanent

to explain the postdoc salary penalties. In industry, for example, our estimate of the true salary penalty in industry caused by postdoc training is somewhere between 15.8% and 26.2%, depending on the level of selection on unobservables and the degree to which inclusion of the unobservables as controls would increase the R^2 of the model.

When treating postdoc training as schooling in Panel B of Table C.1 and Table C.2, we find that the direction of selection bias is in the same direction as the results in Panel A when postdoc training is treated as experience. Of all the results in Table C.1 and Table C.2, only academic non-tenure-track research yields bias-adjusted estimates of the effect of postdoc training which push the estimate in a positive direction. This suggests that biomedical doctorates choosing a job in non-tenure-track research directly after graduation may be of higher ability compared to those who take a postdoc position, but our results suggest that postdoc training ultimately leads to higher earnings for those in this sector, which is consistent with postdoc training being an effective way to augment skills relevant to academic research.

C.3 Bias-Adjusted Research Job Regression Results

As with the impact of postdoc training on salary, unobservable ability at the time of graduation could potentially explain the impact of postdoc training on the ability of biomedical doctorates to obtain different types of research-focused jobs. Therefore, we test the robustness of our research job regression results reported in Table 4 to selection on unobservables using the Oster's (2019) method as before and report the results in Table C.3. We find that the results in Table 4 represent upper-bound estimates of the true impact of postdoc training on the likelihood of obtaining tenure-track and industry research jobs, whereas the bias-adjusted treatment effects represent lower-bounds. This finding, in conjunction with the direction of bias detected in the salary regressions in Panel A of Table C.1, is consistent with postdoc-trained biomedical doctorates having greater ability at the time of graduation compared to their nonpostdoc-trained counterparts, assuming that high-ability doctorates are more likely to obtain tenure-track and industry research positions. On the other hand, we find that correcting for selection on unobervables increases the positive effect of postdoc training on the chances that a biomedical doctorate works in any academic research job after-postdoc. This may indicate that doctorates of lower ability at time of graduation sort into postdoc training to augment their academic research skills in hopes of increasing their chance at nontenure-track research positions in academia, such as staff scientist positions. However, we find that, in all cases, the bias-adjusted treatment effect lies within one standard error of the estimates reported in

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and transitory shocks that occur after college decisions have been made" and thus are not a source of selection bias. The same argument can be made for the postdoc decision. It is important to note that the analysis in this section evaluates the sensitivity of our results to selection on unobserved ability *at the time of PhD graduation*, with the results based on movements in coefficients when controls determined by the time of PhD graduation are added to the regression specifications. It is not meant to test sensitivity to variables not determined by the time of PhD, such as tasks to be performed as part of future employment or as part of postdoc training that led to the accumulation of task-specific human capital (which is the focus of Section 6).

Table 4, indicating that the results are not especially sensitive to selection on unobservables.[76]

Table C.1: Sensitivity of Salary Regression Results to Selection on Unobservables by Sector

Sector:	All		Academia		Industry		Gov't/Nonprofit	
	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2
Panel A. Postdoc Training as Experience								
Uncontrolled	-0.0164	0.000	0.0815	0.003	-0.0675	0.001	0.0252	0.000
Controlled	-0.117	0.246	-0.00836	0.314	-0.158	0.400	-0.106	0.540
R_{max}	0.320		0.408		0.521		0.702	
θ^*	-0.174		-0.0775		-0.262		-0.510	
N	22512		11941		6708		3863	
Panel B. Postdoc Training as Schooling								
Uncontrolled	0.0212	0.000	0.118	0.006	-0.0384	0.000	0.0524	0.002
Controlled	0.001	0.245	0.0983	0.301	-0.0450	0.376	0.0177	0.528
R_{max}	0.317		0.391		0.488		0.686	
θ^*	-0.004		0.0835		-0.0518		-0.0835	
N	26312		13947		7898		4467	

Notes: We test if the results in columns (4) and (6) of Table 3 are robust to allowing for selection on unobservables using the methods developed in Oster (2019) in Panel A and Panel B, respectively; see notes to Table 3. We report both the estimated impact of postdoc training on log(salary) and the R^2 for regressions without any controls ("uncontrolled") and with all of the controls ("controlled") in our most general regression specification. We then calculate the estimated effect of postdoc training on after-postdoc salary (θ^*) given an equal degree of selection on unobservables as selection on observables ($\delta = 1$) and where we select R_{max} as equal to $1.3 * \tilde{R}^2$ where $\tilde{R}^2$ is the R^2 obtained from the controlled regression.

[76] We use the standard errors reported in Table 4. The results for tenured positions are quite sensitive to selection on unobservables — this makes sense given the sensitivity of the results to selection on observables, paired with the fact that inclusion of the observable controls increases the R^2 drastically relative to the uncontrolled regression.

Table C.2: Sensitivity of Salary Regression Results to Selection on Unobservables by Subsector

Sector:	Academia						Industry			
Subsector:	TT Res.		Non-TT Res.		Nonres.		Res.		Nonres.	
	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2
Panel A. Postdoc Training as Experience										
Unctrld.	-0.0962	0.002	-0.00343	0.000	0.0318	0.001	-0.0254	0.000	-0.101	0.002
Ctrld.	-0.174	0.349	0.159	0.531	-0.0416	0.453	-0.0832	0.482	-0.155	0.499
R_{max}	0.454		$0.611^{\dagger}$		0.589		0.626		0.649	
θ*	-0.339		$0.546^{\dagger}$		-0.135		-0.232		-0.273	
N	3996		1988		5957		3117		3591	
Panel B. Postdoc Training as Schooling										
Unctrld.	-0.00721	0.001	0.0364	0.000	0.0632	0.002	-0.00163	0.000	-0.0680	0.001
Ctrld.	-0.0500	0.0349	0.232	0.498	0.0481	0.419	0.0162	0.453	-0.0707	0.473
R_{max}	0.454		$0.572^{\dagger}$		0.544		0.589		0.615	
θ*	0.00102		$0.573^{\dagger}$		0.0316		0.0519		-0.0756	
N	4394		2408		7145		3801		4097	

Notes: We test if the results in columns (4) and (6) of Table 5 are robust to allowing for selection on unobservables using the methods developed in Oster (2019) in Panel A and Panel B, respectively; see notes to Table 5. We report both the estimated impact of postdoc training on log(salary) and the R^2 for regressions without any controls ("uncontrolled") and with all of the controls ("controlled") in our most general regression specification. We then calculate the estimated effect of postdoc training on after-postdoc salary (θ^*) given an equal degree of selection on unobservables as selection on observables ($\delta = 1$) and where we select R_{max} as equal to $1.3 * \tilde{R}^2$ where $\tilde{R}^2$ is the R^2 obtained from the controlled regression. † = we set $R_{max} = 1.15 * \tilde{R}^2$ since $1.3 * \tilde{R}^2$ exceeds the R^2 obtained from a controlled regression with person fixed effects.

Table C.3: Sensitivity of Research Job Regression Results to Selection on Unobservables

Research Job Type:	Any		Academic		Tenure-Track		Tenured		Industry	
	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2	$\hat{\theta}$	R^2
Uncontrolled	0.258	0.062	0.258	0.056	0.228	0.060	0.0811	0.071	0.153	0.023
Controlled	0.242	0.296	0.265	0.269	0.213	0.263	-0.0634	0.680	0.122	0.492
R_{max}	0.384		0.349		0.342		0.884		0.640	
θ*	0.231		0.271		0.202		-1.47		0.090	
N	4778		4778		4778		798		1786	

Notes: We test if the results in Panel B of Table 4 are robust to allowing for selection on unobservables using the methods developed in Oster (2019); see notes to Table 4. We report both the estimated impact of postdoc training on obtaining research jobs and the R^2 for regressions without any controls ("uncontrolled") and with all of the controls ("controlled"). We then calculate the estimated effect of postdoc training (θ^*) given an equal degree of selection on unobservables as selection on observables ($\delta = 1$) and where we select R_{max} as equal to $1.3 * \tilde{R}^2$ where $\tilde{R}^2$ is the R^2 obtained from the controlled regression.

D Does Postdoc Spell Duration Matter?

The results reported in column (4) of Table 3 estimate the impact of postdoc training on future salary, regardless of the length of postdoc training. If differences in salary between ex-postdocs and nonpostdocs in industry are driven by differences in task-specific human capital, we would expect ex-postdocs who spent the longest time in postdoc training—and therefore deferred on-the-job training in industry the longest—to suffer the largest after-postdoc salary penalties. To test this, we repeat the analysis in Table 3 after replacing the single indicator variable for if a biomedical doctorate is postdoc-trained with three indicator variables based on whether a doctorate participated in postdoc training for 1) no longer than three years, 2) greater than three years but less than six years, and 3) exceeding six years. Table D.1 reports the results. We first focus attention to specification (4) where postdoc training is treated as employment experience. The results suggest that postdocs finding a job in academia do not suffer a salary penalty regardless of how long they are employed as a postdoc. However, biomedical doctorates who spend any number of years employed as a postdoc experience a salary penalty in excess of 10% in industry, with those who spend the most time working as a postdoc suffering the largest penalty. In specification (6) we treat postdoc training as a form of schooling and find that the postdoc penalty in industry is no longer statistically significant for postdocs of any length. We also detect increases in after-postdoc salary for biomedical doctorates that spend greater than three years in postdoc positions and who find employment in academia; those with the longest postdocs tend to earn more, possibly due to postdoc employment serving as a holding position as one waits for an academic position at a research-intensive university, which are typically higher-paying than other entry-level positions in academia.[77]

To test whether the chances of obtaining a research job in academia, including a tenure-track research position, are increasing in the length of postdoc training, we repeat the analysis in Table 4 after replacing the single indicator variable for if a biomedical doctorate is postdoc-trained with the three indicator variables based on postdoc length. Panel B of Table D.2 shows that biomedical doctorates employed in postdoc positions of any length have greater chances than nonpostdocs in obtaining academic research and tenure-track research positions, with those with postdoc lengths exceeding three years having the greatest chances on landing these positions. Additionally, biomedical doctorates with postdoc lengths greater than three years are also more likely to obtain a research position in industry than those without any postdoc experience. The likelihood that a tenure-track researcher obtains tenure does not appear to be impacted by postdoc length. In general, doing a postdoc longer than three years leads to significantly greater chances of landing an academic research position, a tenure-track research position, and an industry research position.

[77] Andalib, Ghaffarzadegan, and Larson (2018) model postdoc positions using a queuing model. Cheng (2021) finds that remaining in postdoc training for longer periods increases the chances of securing a non-tenure-track academic position at research-intensive institutions.

Table D.1: Postdoc Salary Premia by Postdoc Length

Dependent Variable: log(salary)	(3)	(4)	(5)	(6)
Panel A. All Sectors	$N = 22512$		$N = 26312$	
0 years < Postdoc Length ≤ 3 years	-0.0245	-0.0535*	0.0142	-0.00439
	(0.0293)	(0.0291)	(0.0259)	(0.0262)
3 years < Postdoc Length ≤ 6 years	-0.0728***	-0.115***	0.0430*	0.00877
	(0.0252)	(0.0254)	(0.0225	(0.0228)
Postdoc Length > 6 years	-0.222***	-0.231***	-0.0135	-0.0134
	(0.0290)	(0.0293)	(0.0270)	(0.0277)
Panel B. Academia	$N = 11941$		$N = 13947$	
0 years < Postdoc Length ≤ 3 years	0.0609*	0.00406	0.0904***	0.0466
	(0.0361)	(0.0404)	(0.0323)	(0.0358)
3 years < Postdoc Length ≤ 6 years	0.0453	0.00226	0.155***	0.122***
	(0.0327)	(0.0360)	(0.0290)	(0.0314)
Postdoc Length > 6 years	-0.0537	-0.0517	0.133***	0.156***
	(0.0361)	(0.0408)	(0.0333)	(0.0395)
Panel C. Industry	$N = 6708$		$N = 7898$	
0 years < Postdoc Length ≤ 3 years	-0.0435	-0.122**	-0.0129	-0.0628
	(0.0523)	(0.0482)	(0.0459)	(0.0451)
3 years < Postdoc Length ≤ 6 years	-0.0942**	-0.139***	0.00540	-0.0238
	(0.0468)	(0.0458)	(0.0428)	(0.0433)
Postdoc Length > 6 years	-0.264***	-0.283***	-0.0791	-0.0736
	(0.0587)	(0.0620)	(0.0565)	(0.0595)
Panel D. Gov't/Nonprofit	$N = 3863$		$N = 4467$	
0 years < Postdoc Length ≤ 3 years	-0.0713	-0.112*	-0.0216	-0.0412
	(0.0483)	(0.0678)	(0.0440)	(0.0586)
3 years < Postdoc Length ≤ 6 years	-0.0329	-0.0762	0.0945***	0.0450
	(0.0370)	(0.0480)	(0.0347)	(0.0432)
Postdoc Length > 6 years	-0.267***	-0.171**	-0.00833	0.0918
	(0.0548)	(0.0681)	(0.0544)	(0.0616)
Postdoc Training Treated As:				
Experience	✓	✓		
Schooling			✓	✓
Fixed Effects				
Field + Cohort + Year	✓		✓	
Field-Cohort + PhD University + Year		✓		✓

Notes: See notes for columns (3) through (6) in Table 3. The only change relative to Table 3 is that we replace a single indicator variable for postdoc training with a set of three indicator variables based on a doctorate's length of postdoc training. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table D.2: Impact of Postdoc Length on Securing Job Type

	Any	Academic	Tenure-Track	Tenured	Industry
Panel A. Any Job					
0 years < Postdoc Length ≤ 3 years	···	0.0867***	0.111***	-0.0231	···
	···	(0.0258)	(0.0251)	(0.0634)	···
3 years < Postdoc Length ≤ 6 years	···	0.199***	0.201***	-0.00460	···
	···	(0.0232)	(0.0223)	(0.0533)	···
Postdoc Length > 6 years	···	0.234***	0.177***	-0.0299	···
	···	(0.0275)	(0.0298)	(0.0728)	···
R^2	···	0.256	0.270	0.460	···
N	···	4778	4778	1583	···
Panel B. Research Job					
0 years < Postdoc Length ≤ 3 years	0.138***	0.139***	0.105***	0.106	0.0578
	(0.0253)	(0.0245)	(0.0180)	(0.182)	(0.0518)
3 years < Postdoc Length ≤ 6 years	0.285***	0.321***	0.260***	-0.0286	0.165***
	(0.0215)	(0.0228)	(0.0179)	(0.177)	(0.0487)
Postdoc Length > 6 years	0.312***	0.340***	0.281***	-0.0949	0.131**
	(0.0260)	(0.0282)	(0.0248)	(0.197)	(0.0609)
R^2	0.308	0.285	0.280	0.682	0.496
N	4778	4778	4778	798	1786
Fixed Effects					
Field-Cohort	✓	✓	✓	✓	✓
PhD University	✓	✓	✓	✓	✓

Notes: See notes to Table 4. The only change relative to Table 4 is that we replace a single indicator variable for postdoc training with a set of three indicator variables based on a doctorate's length of postdoc training. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E Exploring Alternative Mechanisms for the Industry Postdoc Salary Penalty

Compensating Differential for Research Previous research finds that biomedical doctorates are willing to trade-off salary for the opportunity to participate in research: Stern (2004) finds that postdoctoral biologists pay a negative compensating differential to participate in science after their postdoc and Sauermann and Roach (2014) find that the PhD candidates most likely to pursue jobs in industrial R&D differ in the price that they are willing to pay to be allowed to publish. Table 4 shows that postdoc training enhances a biomedical doctorate's ability to obtain a research position in industry, and so one may wonder whether the industry postdoc salary penalty is explained by a greater concentration of postdocs in research-focused positions where scientists pay to do science.[78] However, in column (4) of Table 5 we find that postdoc-trained biomedical doctorates working in industry tended to earn less than their nonpostdoc-trained counterparts regardless of whether their job was primarily focused on research or nonresearch tasks.[79]

Sorting by Occupation or Employer Another possible explanation is that industry-employed biomedical doctorates with postdoc training tend to sort into different firms or occupations than biomedical doctorates without postdoc training. The SDR contains information on occupation, as well as a limited set of employer characteristics including size, location (state/country code), and type. We therefore estimate regressions where worker occupation, employer size, employer location, and employer type are included as controls.[80] Column ($4''$) of Table E.1 shows that including these controls does not eliminate the industry postdoc salary penalty. While we find no evidence that employer characteristics are a driver of the industry postdoc salary penalty, we cannot rule out this mechanism entirely as employer information in the SDR is limited, and so a linked employer-employee dataset of the doctoral workforce is necessary for a stronger test of this mechanism.[81]

[78] However, these previous studies also provide rationale casting doubt on this mechanism as an explanation for pay disparity between doctorates. First, Stern (2004) notes that his finding a negative compensating differential to participate in science depends critically on the inclusion of individual fixed effects made possible by the structure of his survey data which include the observation of multiple job offers for each postdoc at a given point in time. Second, Sauermann and Roach (2014) note that the scientists who report being willing to pay the highest price to be able to publish in industry are scientists of perceived higher ability and from top-tier institutions, and so tend to be more expensive to hire even if publishing is allowed.

[79] As an alternative, we consider a version of specification (4) from Table 3 which adds an indicator variable for whether an individual works in a job primarily focused on research and an indicator for if a job is primarily focused on managing people or projects: column ($4'$) of Table E.1 shows that augmenting (4) in this way has little effects on estimates, and if anything increases the magnitude of the postdoc salary penalty.

[80] Employer types in the industry employment sector include the following: 1) Private-for-profit, 2) Self-employed, not incorporated, 3) Self-employed, incorporated, and 4) Other. See SDR survey questionnaire for list of occupation codes. We use occupation-by-year fixed effects to control for occupation as this both allows the impact of a given occupation to change over time and also is robust to changes in occupational codes in the SDR that have occurred over time.

[81] Davis et al. (2021*a*) uses American Community Survey (ACS) and Longitudinal Employer-Household Dynamics (LEHD) data to create a new employer-employee linked dataset of the doctoral workforce. Davis et al. (2021*a*) contains a preliminary analysis of the returns to postdoc training for biomedical doctorates and finds that the postdoc salary

Seniority Pay Biomedical doctorates who forgo postdoc training to enter industry directly after graduation can build up seniority at the firm where they work earlier in their career than their postdoc counterparts. The existence of a return to employer-specific seniority would mean that when postdoc-trained biomedical doctorates enter a firm, they will tend to be paid less than nonpostdoc-trained colleagues, even if they are otherwise identical in terms of skill.[82] In each SDR wave, respondents are asked if they have the same employer as in the last SDR wave. Using responses to these questions, we construct a variable that measures seniority (i.e., how many years an individual has been at their current employer as of the given year) and augment our specification by including a quartic polynomial in seniority. Column ($4'''$) of Table E.1 gives the results: we find that including seniority as a control in the regressions does not diminish the estimated postdoc penalty in industry.

Table E.1: Industry Postdoc Salary Premium with Alternative Mechanisms as Controls

Dependent Variable: log(salary)	(4)	($4'$)	($4''$)	($4'''$)
	$N = 6708$		$N = 6392$	
Postdoc Training	-0.158***	-0.180***	-0.193***	-0.190***
	(0.0410)	(0.0426)	(0.0400)	(0.0402)
R^2	0.400	0.403	0.522	0.522
Postdoc Training Treated As:				
Experience	✓	✓	✓	✓
Schooling				
Controls				
Baseline	✓	✓	✓	✓
Research and Management Job indicators		✓	✓	✓
Firm Characteristics & Occupation FE			✓	✓
Seniority				✓

Notes: See notes for column (4) in Table 3. Here we add controls for potential mechanisms that could drive the relationship between postdoc training and after-postdoc salary. All specifications include field-cohort fixed effects, year fixed effects, and PhD university fixed effects. Postdoc training is treated as experience such that experience is defined as years since PhD graduation for all biomedical doctorates. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

penalty for nonacademic jobs remains after including both firm fixed effects and occupation fixed effects, although the magnitude of the penalty is reduced relative to specifications not including these controls. Given the differences in the data sources, and thus samples, used in this paper and in Davis et al. (2021*a*), the results are not directly comparable—see Davis et al. (2021*a*) for a fuller discussion.

[82] Barth (1997) finds evidence of within-firm seniority pay not explained by firm-specific human capital accumulation using Norwegian microdata.