SCIENTIFIC WORKFORCE

Why pursue the postdoc path?

Complex, diverse rationales require nuanced policies

By **Henry Sauermann**[1,2]* *and* **Michael Roach**[3]

Concerns have been raised about labor market imbalances that see a growing number of postdoctoral researchers pursuing a limited number of faculty positions (*1*–*4*). Proposed demand-side solutions include capping the duration of postdoc training or hiring more permanent staff scientists (*1*, *4*, *5*). Others focus on the supply side, arguing that Ph.D.'s need better information about labor market conditions and nonacademic career options (*4*, *6*, *7*). Unfortunately, it is not clear why Ph.D. students pursue postdoc positions and how their plans depend on individual-level factors, such as career goals or labor market perceptions. We describe evidence of a "default" postdoc and of "holding patterns" that suggest a need for increased attention to career planning among students, their mentors, graduate schools, and funders.

POLICY

We surveyed Ph.D. students at 39 research-intensive U.S. universities in the spring of 2010 and again in the spring of 2013. We also used online sources to hand-collect information on respondents' career outcomes. Details on survey strategy, sample characteristics, and measures are provided in the supplementary materials (SM, tables S1 to S3). We focus on 5928 respondents who, in 2010, were enrolled in Ph.D. programs in the biological and life sciences (37.47%), chemistry (11.23%), physics (14.27%), engineering (27.14%), and computer sciences (9.89%). Our featured analyses distinguish broadly between biological and life sciences and other fields; see SM for more detailed field comparisons (fig. S1 and table S3).

GOALS, INFORMATION, ABILITY. In 2010, ~79% of students in the biological and life sciences and 53% in other fields planned a postdoc. We examine how students' plans relate to three key factors: career goals, information about labor market demand, and proxies for ability. It is often assumed that Ph.D.'s do a postdoc primarily as a pathway to a research-oriented faculty position (*4*, *8*). We asked respondents to ignore job availability and rate the attractiveness of different academic and nonacademic career paths (see SM). Students planning a postdoc are more likely to have academic career goals (see the first figure). However, career goals are quite diverse even among these postdoc-planning students, with more than one-third not rating a research-oriented faculty position as their most attractive career. This may be surprising, given that the postdoc is not typically considered a stepping-stone toward nonacademic careers. However, 78% of respondents in the biological and life sciences and 42% in other fields believed that at least 1 year of postdoc training was required for a Ph.D.-level research and development (R&D) position in industry in their field (see SM). Unfortunately, there is little empirical evidence showing whether the postdoc benefits graduates pursuing nonacademic careers (*1*).

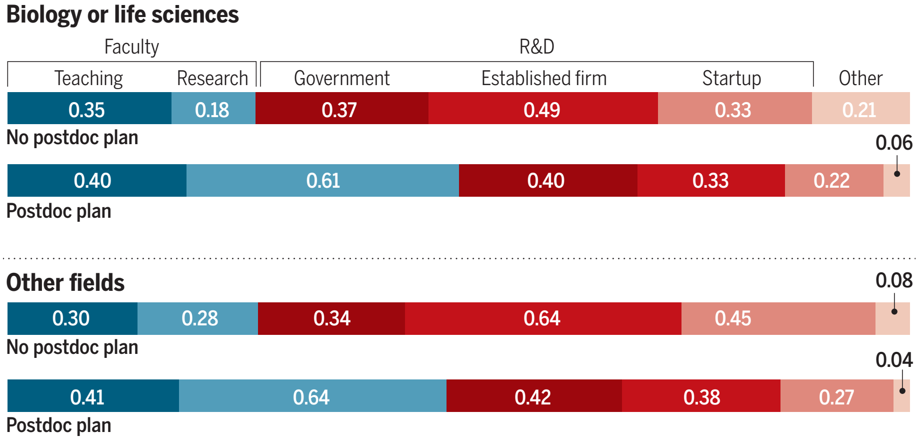
Postdoc plans may also depend on the perceived demand for full-time researchers. Limited job availability may discourage individuals from investing in low-paid postdoc training if the chances of obtaining full-time positions that reward this training are slim (*9*). On the other hand, challenging labor markets may encourage students to pursue a postdoc in order to become more competitive. We found that perceived job availability in academia and industry has no systematic relation with postdoc plans (tables S4 and S5). However, students' beliefs regarding how many years of postdoc are required to get a full-time position in their preferred sector—likely higher when the supply of graduates exceeds demand—are a strong predictor of postdoc plans.

If high-ability scientists have a greater chance of securing scarce full-time positions, they face a lower risk of "wasting" time in a postdoc and should be more likely to plan one. On the other hand, they may feel less of a need to increase their market value through postdoctoral training. To examine the role of ability, we used three objective proxies: respondents' peer-reviewed publications, fellowships from a federal agency, and their Ph.D. program's National Research Council (NRC) ranking. Respondents also subjectively assessed their research ability relative to peers. Biological and life scientists with higher scores on all measures are more likely to plan a postdoc (table S4). Fellowships, NRC ranking, and subjective ability also predict postdoc plans in other fields. This partly reflects that higher-ability students are more likely to aspire to faculty positions (see SM).

Only 62% of biological and life sciences students (56% in other fields) reported having thought about their careers to a large or great extent. Those who had thought more about their careers are less likely to plan a postdoc, especially in the biological and life sciences (table S4). This may reflect that many students see a postdoc as the "default" until they explicitly consider their long-term career paths (*4*). Advanced students are less likely to plan a postdoc, consistent with learning processes and a declining interest in faculty careers over time (*10*, *11*). Foreign students who are unsure whether to stay in the United States after graduation are more likely to plan a postdoc than those intending

Students' highest-rated careers

Share of students giving a particular career their highest attractiveness rating, putting job availability aside (careers rated independently, ties possible). *N* = 5911.



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to leave, perhaps because the postdoc keeps options open (table S5). Respondents who agreed to the statement "When I fail in something, I am determined to continue trying until I succeed" are more likely to plan a postdoc, which indicates that "persistence" may be important not just for scientific productivity (*12*) but also for career decisions.

CAREERS AND MARKETS. Of students who graduated by 2013, 74% took a postdoc in the biological and life sciences, compared with 46% in other fields (fig. S2). We asked postdoc respondents to the 2013 survey (N = 1006) why they did a postdoc. The most frequent reason was "A postdoc increases the chance to get my desired job." Among those without postdoc plans in 2010, the most frequent reason was "I experienced difficulty finding another job" (fig. S3). In conjunction with our earlier results, these patterns suggest that low demand for full-time researchers leads many students to plan postdoc training well before graduation, but also forces some into unplanned postdoc "holding patterns" afterwards (*13*). The observed transitions into postdocs were likely facilitated by plentiful positions (*4*), and demand for postdoc trainees may have been particularly strong because of funding from the 2009 American Recovery and Reinvestment Act.

14.75%
Respondents' estimate of the share of biological or life science Ph.D. graduates holding a tenure-track position 5 years after graduation

14.30%
Actual share reported by NSF 2012

10.60%
Actual share reported by NSF 2016

When asked whether they started the postdoc primarily to obtain a tenure-track faculty position, 60% of bio-life scientists and 51% of other scientists answered yes. When asked about their single most preferred career, 43% of respondents in the biological and life sciences and 44% in other fields chose faculty with a focus on research, but the majority preferred other career paths (fig. S4).

A common concern is that junior scientists—especially those aspiring to faculty positions—lack information about career prospects in academia (*1*, *9*, *14*). We asked respondents to estimate the share of Ph.D.'s in their field who hold a tenure-track position 5 years after graduation and compared their estimates with actual shares published in the Science and Engineering Indicators (*15*). Respondents are very accurate (see the box above and fig. S5), although more recent actual shares in the biological and life sciences have dropped below their expectations.

Given that not all Ph.D.'s aspire to faculty positions, graduates who actively pursue this path have a higher probability of becoming faculty than the population average (see SM). We asked postdocs who aspire to faculty positions to estimate the probability of their holding a tenure-track position 5 years after graduation. We see evidence of overconfidence among postdocs in the biological and life sciences but not in chemistry or physics (table S6). Overall, postdocs have a good sense of conditions in the academic labor market, although some may be overconfident regarding their own chances of securing a faculty position.

Finally, only 4% of biological and life sciences postdocs felt a "severe lack of information" regarding careers in academic research, but that share increased to 21% for research careers in government, 34% in established firms, 42% in startups, and 44% for nonresearch careers. Corresponding figures in other fields are not much lower (table S3), which suggests that a substantial share of junior scientists proceeded to the postdoc stage without sufficient information to evaluate nonacademic career options.

BETTER DATA, BETTER PLANNING. Many students plan postdocs yet do not aspire to the tenure track. A large share of postdocs prefers careers outside of academia. Thus, comparing numbers of graduates or postdocs to available faculty positions provides limited insight into labor market imbalances. Our results give urgency to the National Academies' (*4*) recommendation to collect better data on junior scientists' career aspirations, which would enable more nuanced comparisons of career goals and outcomes. Many graduates pursue a postdoc with the goal to obtain nonacademic positions, which highlights the need for data on whether and how nonacademic employers require and reward postdoctoral training (*4*, *16*).

We find that challenging labor markets encourage rather than discourage students to invest in postdoctoral training. Although this seems logical if students are strongly committed to a particular career, it provides an individual-level explanation for why the supply of postdocs does not decrease despite low demand for full-time researchers (*13*) and potentially contributes to persistent labor market imbalances (*9*, *14*). Whereas the recent National Academies report recommends that students make career plans early in the Ph.D. program, we argue that they should consider labor market conditions and career options before starting a Ph.D. program. Doing so may avoid escalating commitment to a research career and may prevent individuals from entering a postdoc holding pattern. Graduate schools could encourage career planning by requiring that applicants analyze different career options and justify why a Ph.D. is the most promising path forward. Funding agencies could implement similar requirements, especially in conjunction with moving a larger share of funding from research grants to training grants and individual fellowships (*4*, *5*).

Postdocs know that only a small share of graduates will obtain a faculty position, and warnings about limited job prospects in academia may have little impact on decisions to pursue postdocs and academic research. However, junior scientists require better information on nonacademic careers, consistent with concerns expressed by the National Academies and the National Institutes of Health (*4*, *6*). This holds in the biological sciences and in other fields. Better career information should come from advisers but also from sources such as postdoc offices, professional associations, or internships and experiential career development opportunities (e.g., as part of NIH's BEST program). Just as important, students need to actively access and process the available information and seriously consider the implications for their own careers (*4*, *7*). ■

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SUPPLEMENTARY MATERIALS

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Supplementary Materials for

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Ethics statement

This research has been approved by the Georgia Institute of Technology's Institutional Review Board. All survey respondents were ensured confidentiality. Respondents read a consent form prior to taking the online survey and agreed by clicking on a link to proceed.

Data and measures

Public-use data sets with selected variables are available at http://dx.doi.org/10.7910/DVN/DHSM1F. These data and the associated STATA code allow the replication of key descriptive results. The full micro-data cannot be released due to IRB disclosure restrictions and a confidentiality agreement with the respondents.

Survey methodology

To obtain the initial sample for the Science & Engineering PhD and Postdoc Survey (SEPPS), we identified 39 tier-one U.S. research universities with doctoral programs in science and engineering fields by consulting the National Science Foundation's reports on earned doctorates (*17*). We selected universities primarily based on program size while also ensuring variation in private/public status and geographic region. The 39 universities in our sample produced roughly 40% of the graduating PhDs in science and engineering fields in 2009. Tab. S1 and S2 show the distribution of universities and fields in our sample.

We collected roughly 30,000 individual names and email addresses from listings provided on departments' websites. In the Spring 2010, we invited these individuals to participate in the survey using a four-contact strategy (one invitation, three reminders) (*18, 19*). All surveys were conducted online, using the software suite Qualtrics (www.qualtrics.com). Adjusting for 6.3% undeliverable emails, the direct survey approach achieved a response rate (survey completion) of 30%. When individual contact information was not available, we used department administrators as a second channel to approach respondents. In those cases, we emailed administrators with the request to forward a survey link to their graduate students and our research assistants additionally called administrators on the telephone to encourage their cooperation. Overall, 84% of the responses were obtained directly from respondents and 16% were obtained through administrators.

As part of the 2010 survey, we asked respondents to provide us with a permanent email address that could be used for a follow-up survey. In the Spring of 2013, we conducted the second wave of the SEPPS by emailing the respondents from the first wave with a follow-up questionnaire. If respondents did not provide an email in the 2010 survey (20% of respondents), we used the original email address used to send out the 2010 survey. The 2013 survey again used a four-contact strategy and had an adjusted response rate of 53%. To examine potential differences between respondents and nonrespondents, we regressed response status in 2013 on key characteristics from the 2010 survey. We find that the likelihood of a response to the follow up was higher for respondents who were US citizens, married, did not have children, were further along in their PhD studies and had thought more about their careers. We include the relevant variables as controls in our regression analyses. Among respondents who completed the survey, item non-response was low (see Tab. S3); we dropped from the sample cases that had no response to the question regarding postdoc plans, career preferences, and field of study (see below). For individuals who responded in 2010 but not in 2013, research assistants searched online sources such as professional networking websites and lab homepages for career outcome information.

For our analyses of postdoc plans and postdoc transitions, we use only those respondents who were PhD students at the time of the 2010 survey, dropping respondents who had already graduated at that point. Collectively, the SEPPS2013 and online sources provided employment information for over 82% of these respondents. For our analysis of responses from postdocs in 2013, we also include data from individuals who were postdocs in both surveys, as long as they obtained their PhD degree after 2007 (17% of the postdoc sample).

Our sample covers a broad range of institutions and fields. At the same time, it should not be considered a random sample of the relevant populations. In particular, our respondents come from larger tier-one research universities and findings may not necessarily generalize to graduate students at smaller and lower-tier institutions. Our sample also includes only individuals who did their PhDs in the U.S. and thus does not speak to the motivations and experiences of scientists who obtained their doctorates abroad. Since foreign PhDs' career decisions are likely shaped by very different and heterogeneous influences (e.g., national policies regarding training and labor mobility, different sets of career options, U.S. visa regulations, etc.), studying this population likely requires very different approaches than studying U.S. graduates (*11, 20*). Given that both U.S. and foreign trained scientists shape U.S. STEM labor supply (*14, 21*), however, the career decisions of foreign graduates are an important area for future research.

Finally, we note that while the field distribution in our PhD sample roughly matches the distribution of PhD graduates in the natural sciences and engineering, our sample includes somewhat larger shares of students in smaller fields.[1] While our main analysis distinguishes broadly between the biological/life sciences and other fields, we provide descriptive insights for more detailed fields below.

Measures

SEPPS 2010

Postdoc (PD) plans. *Do you intend to pursue a postdoc after graduation?* (Yes/No)

Attractiveness of careers. *Putting job availability aside, how attractive do you personally find each of the following careers?*

- *University faculty with an emphasis on teaching*
- *University faculty with an emphasis on research or development*

[1] The comparable shares in the 2010 Survey of Earned Doctorates vs. SEPPS are: biomedical/life sciences 40% vs. 37%, chemistry 10% vs. 11%, physics 8% vs. 14%, computer sciences 7% vs. 10%, engineering 34% vs. 27%. SED shares are available at http://www.nsf.gov/statistics/2015/nsf15321/#chp2 (Table 10, accessed March 5, 2016).

- *Government job with an emphasis on research or development*
- *Job in established firm with an emphasis on research or development*
- *Job in startup/entrepreneurial firm with an emphasis on research or development*
- *Other (please specify):*

Respondents rated each career on a 5-point scale ranging from 1 (extremely unattractive) to 3 (neither attractive nor unattractive) to 5 (extremely attractive). Using these measures, we created a set of dummy variables indicating whether a particular career received a respondent's highest rating. This approach allows for ties, and a score of 0 on the dummy variable does not necessarily mean that a career is rated unattractive but rather that at least one other career was rated as more attractive.

Note that this question asked respondents explicitly to ignore job availability. As such, responses should reflect primarily career preferences rather than what careers respondents think might be attainable. Consistent with this objective, we find that perceptions of job availability in academia have no significant relationship with preferences for academic research (Tab. S4, Models 3 and 6, discussed in more detail below). While we cannot rule out that responses also reflect labor market conditions, survey based measures can provide rare and important insights into individual-level career preferences. Indeed, the recent National Academies report explicitly called for the collection of data on students' career aspirations and the BMW Working Group report recommended that survey questions on career aspirations be included in the SED and the SDR (*6*). Survey-based measures of career preferences have also been used successfully in prior work comparing career aspirations with career outcomes (*22*).

The options included in this question cover a wide range of careers, including research and non-research positions. NSF data suggest that over 70% of STEM PhD graduates enter research-oriented positions after graduation (*15, Fig. 3-14*). While our question included fewer options for non-research careers, the "other" option was deliberately kept open to accommodate a wide range of jobs. Consistent with that intention, respondents answering the open-ended portion of that option mentioned a wide range of non-research careers including, for example, science teacher, patent attorney, consultant, and science writer. While it would have been desirable to assess students' interest in specific non-research positions more explicitly, doing so would have considerably increased the set of options and risked survey fatigue and a lower quantity and quality of responses. Given that this paper focuses on postdoctoral research training, the primary purpose of this question is to assess respondents' preferences for different types of research careers, and more broadly for research versus non-research oriented jobs.

A general concern with self-reported measures of career preferences is that respondents may overstate preferences that seem socially desirable (e.g., research in academia) and give artificially low scores to preferences that may seem less socially desirable. To mitigate this concern, we stated in the survey invitation that responses would be kept strictly confidential. Our regressions also include a measure of perceived departmental norms regarding academic careers as a control, and this measure has no significant relationship with preferences for faculty careers (Tab. S4, Models 3 and 6).

Perceived labor market conditions in academia and industry. *What do you think is the probability that a PhD in your field can find the following positions after graduation (and any potential postdocs):*

- *University faculty with an emphasis on research or development*
- *Established firm job with an emphasis on research or development*

Respondents used slider scales ranging from 0 to 100 and anchored by "Low probability of finding a job", "medium probability of finding a job", and "High probability of finding a job". For ease of interpretability, we recoded this measure into 10 categories spanning 10 points each.

Postdoc requirements. *How many years of postdoc experience do you think are required on average to obtain each of the following positions in your field?*

- *University faculty with an emphasis on research or development*
- *Job in established firm with an emphasis on research or development*

Respondents indicated their answer on a multiple choice scale with the values 0, 1, 2, 3, 4, 5 or more. Higher (perceived) postdoc requirements may reflect that positions require advanced skills that are not acquired during the PhD. However, longer postdoc requirements may also result from labor market conditions, e.g., if an oversupply of graduates forces some to enter a postdoc "holding pattern" or if employers can choose from a large number of applicants and prefer more experienced ones even though the job could also be performed by PhDs with less postdoc experience.

Expected salary in industrial R&D. *What do you think is the starting total annual compensation (in US-Dollars), including salary, bonuses, and stock options, for the following position in your field?*

- *PhD level research or development position in an established firm*

Respondents indicated their estimate using a slider scale ranging from $0 to $200k. We recode this measure into 20 categories spanning $10k each. We use this measure to proxy for respondent's perceptions of the opportunity costs of pursuing a (low paid) postdoc.

Number of publications. *How many of each of the following list you as an author?*

- *Articles published or accepted in peer-reviewed journals*

Respondents used a multiple choice scale with the values 0, 1, 2, 3, 4, 5, 6, 7, 8 or more.

Number of fellowships. *Please indicate the number of the following awards or recognitions you have received for your research or performance while in the PhD program. Do not count awards or recognitions that can be primarily attributed to your advisor or lab.*

- *Federal or foundation sponsored scholarships or fellowships not attributed to your advisor*

Respondents used a multiple choice scale with the values 0, 1, 2, 3, 4, 5 or more.

NRC program ranking. We used data from a separate data source to proxy for the quality of the PhD program. In particular, we used programs' research activity ranking published by the National Research Council in the most recent report on PhD programs (*23*), matching respondents as closely as possible using their institution and field. The NRC reports two scores for each program (5^{th} and 95^{th} percentile); we averaged the two scores to obtain a single measure and assigned programs into 11 categories ranging from a rank higher than 10 (best) to a rank of 100 or below.

Subjective ability. *How would you rate your research ability relative to your peers in your specific field of study?*
Respondents used a 10 point scale anchored by "Among the least skilled" and "Among the most skilled". This measure may reflect objective ability but also respondents' "overconfidence" in their own ability (*24*).

Thought about career. *Generally speaking, to what extent have you thought about your future career plans?*
Respondents used a 5-point scale anchored by "not at all", "small extent, "some extent", "large extent", and "great extent".

Time in the PhD program. Respondents used a dropdown menu to report the year in which they started their current PhD program. We compute time in the program as 2010 minus the year of program start.

Persistence. *How well does the following statement describe you? "When I fail in something, I am determined to continue trying until I succeed."*
Respondents used a 5-point scale ranging from "Not at all like me" to "Just like me".

Career norms in lab/department. *In your lab/department, to what extent are PhDs encouraged or discouraged to pursue the following career:*

- *University faculty with an emphasis on research or development*

Respondents answered using a 5-point scale anchored by "strongly discouraged" and "strongly encouraged". Given the strong skew of this measure, we created a new dummy variable indicating whether this career was strongly encouraged (score of 5 on the original measure, coded as 1) or not strongly encouraged (score<5, coded as 0).

U.S. citizenship. Respondents indicated whether they were a U.S. citizen (Yes/No).

Plans to stay in the U.S. *After completing your current degree and any postdocs, which of the following best describes your future plans?*

- *Stay in the US permanently*
- *Work in the US for a few years and then move back to my home country*
- *Move back to home country right away*
- *Move to some other country*
- *Don't know yet*

This question was asked to non-U.S. citizens only. For our analysis, we collapse this measure into three categories (staying in the U.S. for a few years or permanently (54%); leaving the U.S. after completing the training (14%), don't know yet (32%)).

Male. Respondents indicated their gender.

Married. Respondents indicated whether they were married or in a marriage-like relationship.

Children. Dummy variable that equals 1 if the respondent had at least one child under the age of 18.

Field of study. Respondents used a dropdown menu to report which option best fit their field or area of specialization (see Tab. S2). For descriptive analyses, we aggregate fields into 2 major fields (biological/life sciences and other fields) or into 5 fields (biological/life sciences, chemistry, physics, engineering, and computer sciences). All regression models include a full set of dummy variables to control for the most detailed fields.

SEPPS 2013 and online sources

Current status. *Which of the following best describes your current status?*

- *PhD student or candidate*
- *Postdoctorate or research fellow*
- *Working full or part-time (e.g., in a university, company, startup, national lab, etc.)*
- *Currently not working*

For respondents to the SEPPS2010 who did not respond to the 2013 survey, we searched for employment status using online sources, primarily individual profiles on professional career networks.

Prior postdoc. *Have you completed a postdoctorate or research fellowship position?* (Yes/No)
This question was asked to respondents who indicated that they were currently working full-time or currently not working. For respondents to the SEPPS2010 who did not respond to the 2013 survey, we searched for evidence of a prior postdoc using online sources. A concern with gathering information from online sources is that individuals' profiles may be incomplete or out of date such that individuals are coded as not having done a postdoc even if they did a postdoc. To explore this issue, we collected information from online sources also for individuals who had responded to the SEPPS 2013. We find that for 88% of the respondents who reported that they had done a postdoc and for whom online profiles could be found, online profiles also listed the postdoc experience.

Main reason for doing postdoc. *How important were the following factors in influencing your decision to do a postdoc?*

- *I experienced difficulty finding another job*
- *I wanted to have more time before deciding on my long-term career*
- *A postdoc increases the chances to get my desired job*
- *I wanted to deepen my skills in a particular area*
- *Other (please specify):*

In survey module for current postdocs only. Even though the question was framed as importance, respondents could choose only one option, likely their most important reason.

Did postdoc for faculty position. *Did you decide to pursue a postdoc primarily because you wanted to obtain a tenure track faculty position in the future?* (Yes/No)
This question was included in the module for current postdocs only.

Most preferred career. *Assuming you had the choice, which of the following would be your most preferred career?*

- *University faculty with an emphasis on research or development*
- *University faculty with an emphasis on teaching*
- *Government or research institute with an emphasis on research or development*
- *Startup firm with an emphasis on research or development*
- *Established firm with an emphasis on research or development*
- *Other career*

Respondents could select exactly one of these options.

Estimate of share of PhDs in TT positions. *What do you think is the percentage of PhDs in your field holding a tenure track faculty position five years after graduation?*
Respondents indicated their answer on a sliding scale ranging from 0 to 100. This question was included in the module for current postdocs only.

Estimate of own probability of holding TT position. *In your opinion, what is the probability that you will hold a tenure track faculty position five years from now?*
Respondents indicated their answer on a sliding scale ranging from 0 to 100. In module for current postdocs only. Asked only if respondents indicated that University faculty was their most preferred career.

Information about career options. *Generally speaking, do you feel that you have enough information about the following career options to make a good decision regarding which one(s) to pursue?*

- *University faculty with an emphasis on research or development*
- *University faculty with an emphasis on teaching*

- *Government or research institute with an emphasis on research or development*
- *Startup firm with an emphasis on research or development*
- *Established firm with an emphasis on research or development*
- *"Alternative" non-research careers*

For each option, respondents answered on a 3 point scale with the anchors "severe lack of information", "could use more information" and "enough information". For descriptive purposes, we report the share of respondents selecting the response "severe lack of information". This question is clearly subjective in nature and respondents who indicate a lack of information may do so both because information is objectively lacking (*1, 5*) and because they did not access the information that is available.

Analyses

In the following, we provide more detail on the analyses reported in the main text, in the same order. We complement this discussion with a number of additional analyses.

Summary statistics by field

Table S3 shows summary statistics for the full sample and for each main field.

Most attractive careers by postdoc plans

Figure S1 complements Figure 1 by showing most attractive careers by postdoc plan separately for each main field.

Regressions predicting postdoc plans

We performed regression analyses to examine the correlations between postdoc plans and our key variables, while controlling for factors such as demographic characteristics, time in the program, and detailed field of the PhD. We note that the data do not allow us to establish the causal nature of the observed relationships between variables. However, by exploring the relationships between important yet typically unobserved variables, the results provide suggestive evidence regarding some of the assumptions and concerns that are salient in the current discussion.

Table S4 shows the main regression separately for the respondents in the biological/life sciences and in other fields. All models are estimated using multiple logistic regression and we report marginal effects (i.e., the coefficient indicates the change in the dependent variable for a one-unit change in the independent variable). To account for potential non-independence of observations, we cluster standard errors at the level of the university.

Models 1 and 4 use postdoc plans as the dependent variable. In addition to the results discussed in the main paper, we find that postdoc plans have a negative relationship with expected salaries in industrial R&D. This result may reflect that students who believe that salaries in industry are high are less willing to bear the opportunity costs of doing a low-paid postdoc (*21, 25*). In unreported models, we also explore nonlinearities in the relationship between ability and postdoc plans, i.e., the possibility that students at the low end of the ability distribution are more likely to plan postdocs than those in the middle (e.g., due to a lack of other job opportunities). We find no evidence that lower ability students are more likely to plan postdocs.

Models 2 and 5 further examine the relationship between career preferences and postdoc plans by including a set of measures indicating whether a particular career received the respondent's highest attractiveness rating (ties possible, see Fig. 1). Postdoc plans are strongest among those students who find a faculty research career most attractive, lower for those interested in teaching or in R&D jobs in government, and lowest for those interested in industrial R&D or "other" careers. Including the measures of career preferences significantly reduces some of the other coefficients, in particular those of ability ($Chi^2(4)=17.53$, $p<0.01$ in the life sciences, and $Chi^2(4)=20.15$, $p<0.01$ in other fields). A potential explanation is that high ability individuals are more likely to aspire to faculty positions, which in turn makes them more likely to plan a postdoc. To explore this possibility, models 3 and 6 examine which respondents are more likely to rate this career path as most attractive. The results are consistent with our expectation: higher ability students are more likely to find the faculty career most attractive. We also observe that students who had thought more about their career or were more advanced in their programs are less likely to rate this career most attractive.

Table S5 reports three supplementary analyses. First, we explore whether the role of job market perceptions or ability depends on students' career goals by estimating regressions separately for students who find academic research most attractive (model 1) and for those who find industrial R&D most attractive (model 2). Consistent with the prior results, perceived job availability has no relationship with postdoc plans. Complementing the main result that perceived postdoc requirements are associated with postdoc plans, we now see that perceived requirements in industry are significantly related to plans only in the sample of students attracted to industry careers while requirements in academia are associated with postdoc plans only among those attracted to academic research. Ability measures continue to strongly predict postdoc plans among those aspiring to industrial R&D but have weaker coefficients among students aspiring to academic positions ($Chi^2(4)=13.70$, $p<0.01$). Thus, the latter students appear to give less weight to their ability and performance when planning postdoctoral training.

Second, advanced students may have thought more about their careers and respond more strongly to perceived labor market conditions than early stage students. To examine this possibility, we run regressions separately for the sample of students who were in their 4^{th} or higher years of the program (models 5 and 6) and for more junior students (models 3 and 4). Roughly 69% of the more advanced students had thought about their careers to a large or great extent, while 31% had thought about their careers not at all or only to some extent. The qualitative results are similar in the two samples, although the ability measures have somewhat stronger coefficients among advanced students ($Chi^2(4)=8.08$, $p<0.10$).

Finally, we split the sample by U.S. vs. non-U.S. citizenship status (Tab. S5, models 7-10). Comparing the results, we observe that the role of labor market expectations and career preferences is similar in the two samples. Ability and the degree to which students had thought about their careers appear to have weaker coefficients among non-citizens (though the differences are not statistically significant), perhaps suggesting that other factors that are not relevant for citizens play a larger role. The survey allows us to explore this possibility further. In particular, it includes a question that asked non-citizens about their mobility plans, i.e., whether they planned to stay in the U.S. after completing their training, leave the U.S. (returning home or to some other country), or whether they were unsure about their plans. When we include this variable, we find that foreign students who plan to stay and especially those who are unsure are more likely to plan a postdoc. This result provides interesting insights into possible drivers of postdoc plans among non-citizens specifically, but also reinforces the earlier finding that the postdoc may serve as a default for students who have not thought much about their future plans or want to keep their options open (in this case with respect to the stay/return decision).

Comparing postdoc plans and actual transitions

The second wave of the SEPPS and online sources for non-respondents allow us to examine the correspondence between postdoc plans and actual postdoc positions (Fig. S2). While plans and actual postdoc positions match for most individuals, some individuals who had planned a postdoc did not end up doing one, while some who had not stated plans in 2010 later did a postdoc (14% of postdocs in the bio/life sciences and 24% of postdocs in other fields).

The 2013 survey asked postdocs about the primary reason for taking their current position, offering a number of pre-defined answers as well as an open entry field for "other". Fig. S3 shows the distribution of these reasons separately for postdocs with pre-graduation postdoc plans and for those who reported no postdoc plans in 2010. In a separate question, respondents indicated whether they did the postdoc primarily to obtain a tenure track faculty position – the share of respondents who did so is higher among postdocs who had postdoc plans in 2010 than among those who reported no postdoc plans.

Considering the findings in this and the prior sections, we conclude that most postdoc experiences are planned prior to graduation and seen as a natural step towards academic but also non-academic careers. Among postdocs who had not reported postdoc plans in 2010, the main reasons include difficulties finding another job (especially in the biological/life sciences) and the desire to have more time before deciding on a long-term career (especially in other fields).

Postdoc career preferences

The 2013 survey asked postdoc respondents to indicate their most preferred career, assuming they had the choice. Fig. S4 shows the share of respondents choosing a particular career. Table S3 shows statistics by field.

Postdoc labor market perceptions

Fig. 2 showed biological/life science postdocs' average estimates of the share of PhD students in their fields holding tenure track positions five years after graduation as well as actual figures from the NSF Science and Engineering Indicators 2012 (including the best publicly available information at the time of the 2013 survey) and from the Indicators 2016 (not available in 2013 but showing the most recent data).[2] Fig. S5 shows estimates separately for those students who most prefer a faculty career and those who most prefer other careers. This figure also shows these results for postdocs in other fields. As noted in the main text, the average estimate is very close to the actual numbers. However, there may be heterogeneity across individuals, with some being too pessimistic and others being too optimistic. Examining the distribution of estimates, we find that the share of respondents with an estimate below 10% is 36.6% in the life sciences, compared to 33% in other fields. The share of respondents with an estimate over 20% is 17.4% in the life sciences and 21.1% in other fields.

Taken together, the results suggest that postdocs have quite accurate perceptions of the share of PhD graduates obtaining tenure track positions. Unfortunately, the 2010 survey did not include this question and we cannot assess the accuracy of respondents' expectations when they were still students, i.e., prior to starting the postdoc. Future research is needed to examine the accuracy of students' expectations, whether and how expectations change over time, and what information sources or adjustment processes drive any existing changes. Recent work using retrospective methods suggests that changes in preferences for different types of careers occur primarily during the PhD, with changes between the PhD and Postdoc stages being more limited (*11*). However, it is not clear whether this insight generalizes to dynamics of labor market expectations.

Approximating conditional probabilities of obtaining tenure track positions

For those postdocs who indicated that University faculty was their most preferred career, Tab. S3 reports their estimates of the probability that they themselves will hold a tenure track position after 5 years. As noted in the main text, this estimate should not be compared directly to the NSF-reported base rates in the PhD population (shown in Figs. 2, S5) since not all graduates actively pursue a faculty position. There is no published benchmark for the probability that a postdoc who actively pursues a faculty position can obtain such a position. However, in fields where it is reasonable to assume that a postdoc is typically required for tenure track positions, we can approximate conditional probabilities by excluding from the denominator PhD graduates who do not do a postdoc and postdocs who report that they did not do the postdoc to get a tenure track position (method 1) or by excluding from the denominator graduates who do not do a postdoc and postdocs who report that academic research is not their most preferred career (method 2). This approach allows us to take the unconditional probability that a PhD graduate will hold a tenure track position (given in the Science and Engineering Indicators 2016) and approximate a benchmark probability that is conditional upon doing a postdoc and actually pursuing a faculty position (taken from the SEPPS).

For example, 74.10% of biology/life sciences graduates in our sample did a postdoc, 60.21% of surveyed postdocs in that field indicated that they did the postdoc primarily to obtain a tenure track faculty position, and 43.08% of surveyed postdocs indicated faculty research as their most preferred

[2] The Science and Engineering Indicators report actual figures with a lag. The 2012 Indicators reported data for 2008, the 2014 Indicators reported data for 2010. The most recently published 2016 Indicators report data for 2013 (http://www.nsf.gov/statistics/2016/nsb20161/uploads/1/6/chapter-3.pdf, accessed April 26, 2016).

career. The adjusted denominator to compute conditional success rates would thus be 0.7410*0.6021=0.4461 using method 1, and 0.7410*0.4308=0.3192 using method 2. Using the most recent base rate reported by NSF in 2016 (0.1060), the conditional success rate would be estimated as 0.1060/0.4461=0.2376 using method 1 and 0.1060/0.3192=0.3321 using method 2. This compares to postdocs' estimate of their own chances of obtaining a faculty position of 0.5002, suggesting that postdocs in the biological and life sciences tend to be overconfident regarding their own chances of success. Tab. S6 reports these estimates for the biological/life sciences, for chemistry and for physics. We do not compute these figures for engineering and the computer sciences since graduates in these fields may also be able to pursue faculty positions without a postdoc.

Note that these calculations assume that graduates without a postdoc as well as postdocs who indicate that they did not do the postdoc primarily to obtain a tenure track position (method 1) or that they prefer other careers (method 2) will not compete for faculty positions. To the extent that these individuals are competing for faculty positions, conditional probabilities would be lower than suggested by our calculation. At the same time, the NSF-reported shares of graduates entering tenure track positions do not account for possible differences in labor market conditions faced by graduates from different programs. To the extent that graduates from elite programs have an advantage in labor markets, their conditional probabilities may be higher than our calculations, while students graduating from lower-tier programs may have lower chances of obtaining tenure track positions. Systematic program-level statistics on career outcomes are not currently available, but collecting and publishing such data on a regular basis would be very valuable for junior scientists as well as research on scientific labor markets (*1, 9, 14*).

While our findings regarding overconfidence should be considered very preliminary, they may have important implications. In particular, overconfidence may explain why too many individuals enter into competitive situations (*24, 26*), in our context, the competition for scarce faculty positions. Since we find evidence of overconfidence in the biological/life sciences but not in chemistry or physics, it appears that the observed overconfidence does not reflect some general human trait but is related to particular features of the field. One possibility is that biological/life sciences students experience stronger norms encouraging academic research than students in other fields (see our measure of norms in Tab. S3), which may lead to more "wishful thinking" and biases in assessments of one's career prospects. To the extent that overconfidence is partly due to – or enabled by – noisy signals about one's own ability (*26*), advisers and program administrators should consider how they can give students informative and unbiased feedback about their research ability and the associated career prospects.

Fig. S1. Most attractive career. Based on independent ratings of the attractiveness of each career, putting job availability aside (ties possible). N=5,911.

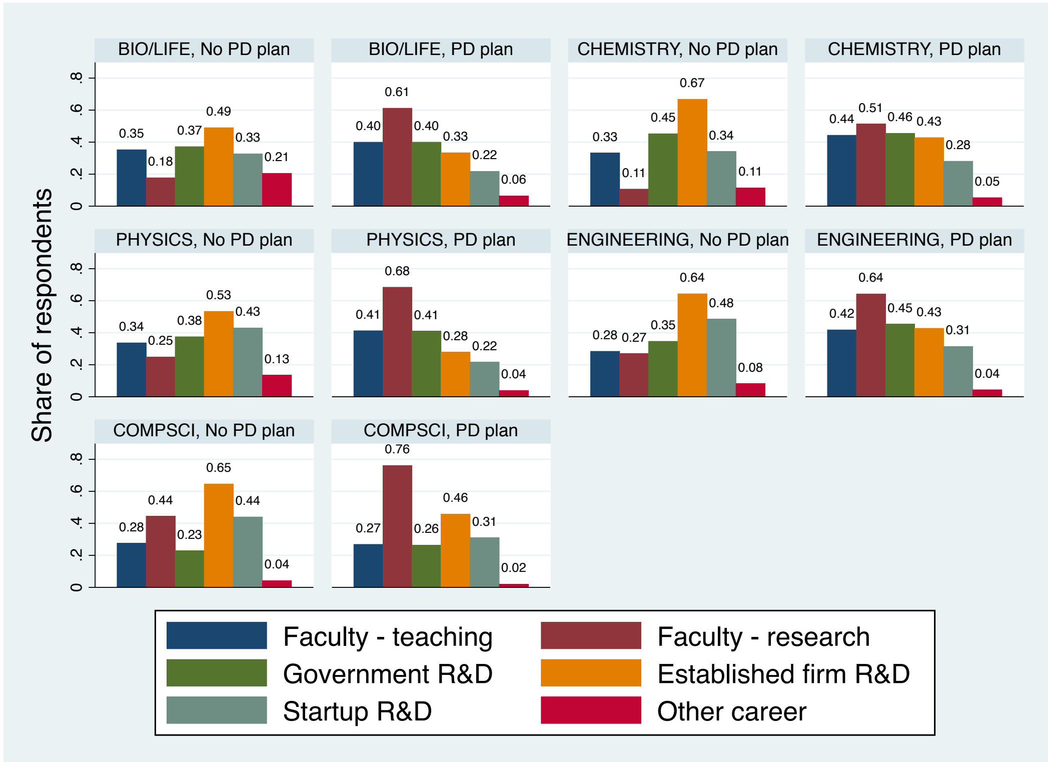


Fig. S2. Correspondence between postdoc plans and actual postdoc positions. Sample of respondents who graduated by 2012 and for whom information on post-graduation positions is available. N=2,510.

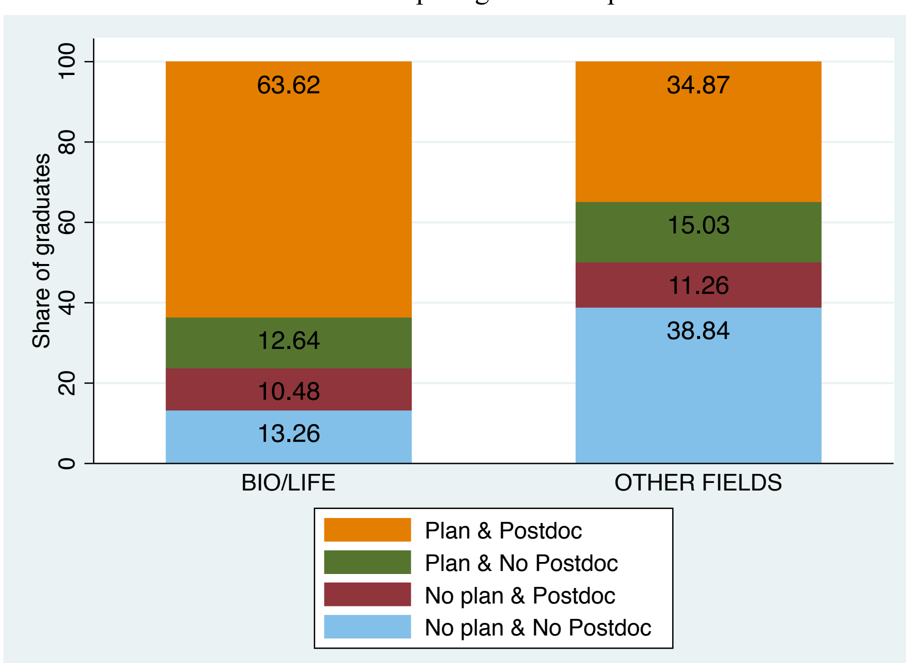


Fig. S3. Reasons for doing a postdoc, by field and postdoc plan. Postdoc respondents to the SEPPS 2013 who were PhDs in 2010. N=843.

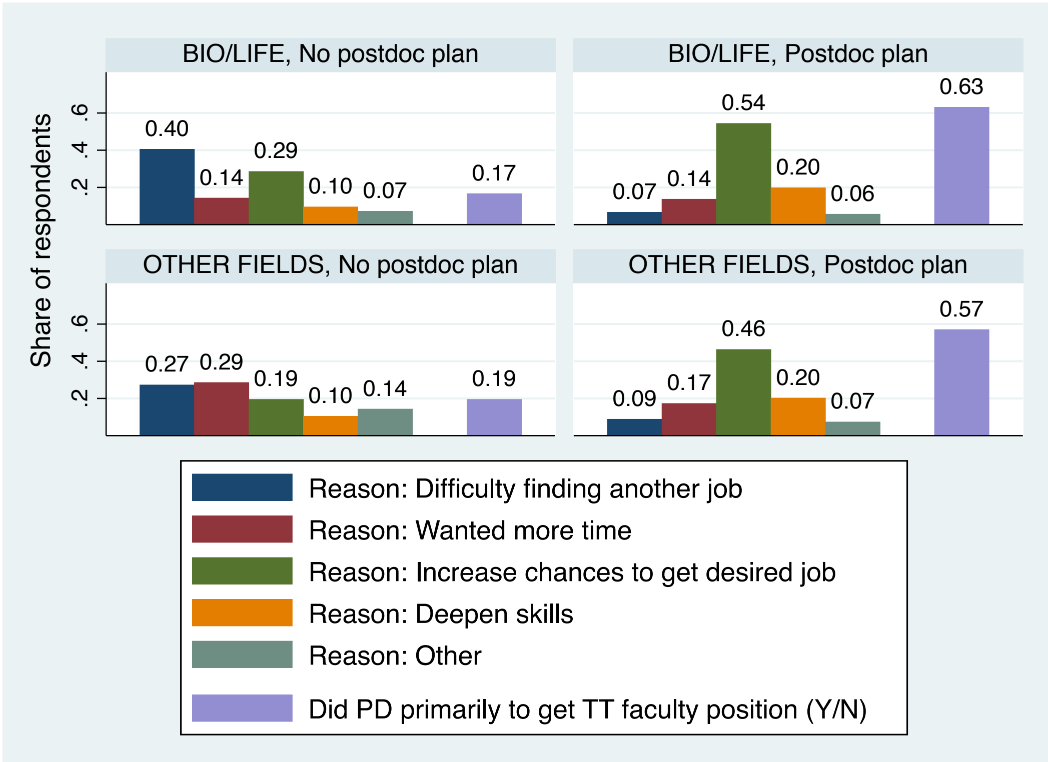


Fig. S4. Share of postdoc respondents indicating a particular career as their most preferred (one option only), assuming they had the choice. N=1,006.

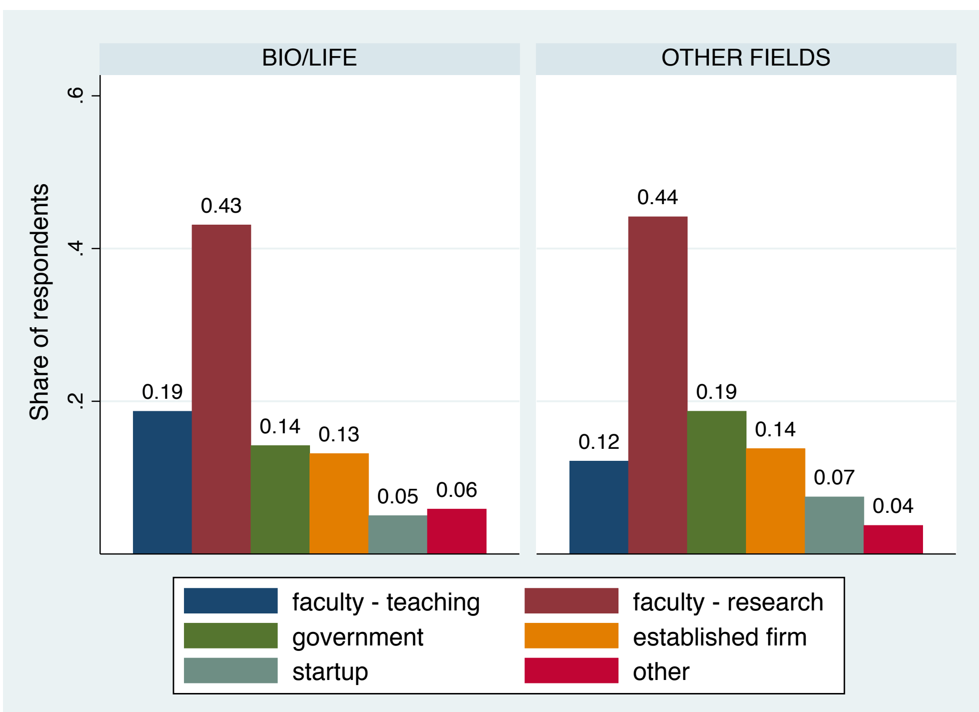
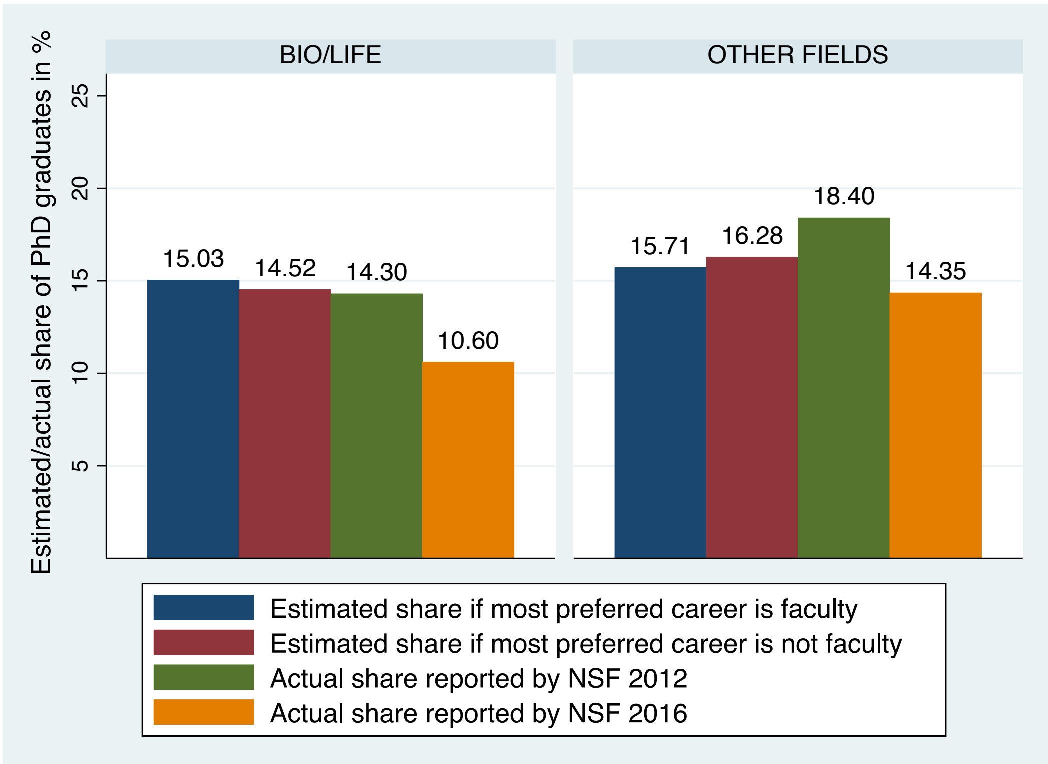


Fig. S5. Postdocs' estimates of the share of PhDs holding tenure track positions 5 years after graduation and actual shares reported by NSF. N=995.



Tab. S1. Distribution of universities in the SEPPS2010 sample

University name	N	%
CALIFORNIA INSTITUTE OF TECHNOLOGY	85	1.44
COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK	106	1.79
CORNELL UNIVERSITY	180	3.04
DUKE UNIVERSITY	165	2.79
EMORY UNIVERSITY	114	1.93
GEORGIA INSTITUTE OF TECHNOLOGY	66	1.12
HARVARD UNIVERSITY	118	2.00
IOWA STATE UNIVERSITY	116	1.96
JOHNS HOPKINS UNIVERSITY	237	4.01
MASSACHUSETTS INSTITUTE OF TECHNOLOGY	204	3.45
MICHIGAN STATE UNIVERSITY	163	2.76
NORTH CAROLINA STATE UNIVERSITY	219	3.70
NORTHWESTERN UNIVERSITY	93	1.57
OHIO STATE UNIVERSITY MAIN CAMPUS	94	1.59
PENN STATE UNIVERSITY	103	1.74
PRINCETON UNIVERSITY	132	2.23
PURDUE UNIVERSITY MAIN CAMPUS	287	4.85
RENSSELAER POLYTECHNIC INSTITUTE	28	0.47
STANFORD UNIVERSITY	69	1.17
TEXAS A & M UNIVERSITY	99	1.67
UNIVERSITY OF CALIFORNIA-BERKELEY	313	5.29
UNIVERSITY OF CALIFORNIA-DAVIS	259	4.38
UNIVERSITY OF CALIFORNIA-IRVINE	42	0.71
UNIVERSITY OF CALIFORNIA-LOS ANGELES	82	1.39
UNIVERSITY OF CALIFORNIA-SAN DIEGO	220	3.72
UNIVERSITY OF CALIFORNIA-SAN FRANCISCO	69	1.17
UNIVERSITY OF CHICAGO	133	2.25
UNIVERSITY OF FLORIDA	228	3.86
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN	240	4.06
UNIVERSITY OF MARYLAND COLLEGE PARK	71	1.20
UNIVERSITY OF MICHIGAN-ANN ARBOR	168	2.84
UNIVERSITY OF MINNESOTA-TWIN CITIES	157	2.66
UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL	201	3.40
UNIVERSITY OF SOUTHERN CALIFORNIA	37	0.63
UNIVERSITY OF TEXAS AT AUSTIN	153	2.59
UNIVERSITY OF WASHINGTON	284	4.80
UNIVERSITY OF WISCONSIN-MADISON	263	4.45
WASHINGTON UNIVERSITY IN ST. LOUIS	174	2.94
YALE UNIVERSITY	140	2.37

Tab. S2. Distribution of fields in the SEPPS2010 sample

Field	N	%
BIOLOGICAL/LIFE SCIENCES - general	164	2.77
Biochemistry/biophysics	371	6.26
Cell/molecular biology	397	6.70
Developmental biology/embryology	82	1.38
Ecology	218	3.68
Genetics	211	3.56
Immunology	129	2.18
Microbiology	186	3.14
Neuroscience	356	6.01
Pharmacology	80	1.35
Agriculture/food sciences	9	0.15
Environmental life sciences	18	0.30
CHEMISTRY - general	73	1.23
Analytical chemistry	75	1.27
Inorganic chemistry	126	2.13
Medicinal/pharmaceutical chemistry	26	0.44
Organic chemistry	183	3.09
Physical chemistry	183	3.09
PHYSICS - general	108	1.82
Astronomy/astrophysics	108	1.82
Biophysics	75	1.27
Condensed matter/low-temperature physics	205	3.46
Optics/photonics	73	1.23
Nuclear physics	57	0.96
Particle physics	166	2.80
Applied physics	54	0.91
ENGINEERING - general	52	0.88
Aerospace/aeronautical engineering	63	1.06
Bioengineering/biomedical	358	6.04
Chemical engineering	296	4.99
Computer engineering	130	2.19
Electrical engineering	280	4.72
Materials science	197	3.32
Mechanical engineering	233	3.93
COMPUTER SCIENCE	586	9.89

Tab. S3. Descriptive statistics. The “0/1” after a variable name indicates dummy coding version.

		Full sample					Bio/Life	Chemistry	Physics	Engineering	Comp. Sci
		N	Mean	SD	Min	Max	Mean	Mean	Mean	Mean	Mean
2010 SEPPS	Postdoc plan	5,928	0.63	0.48	0	1	0.79	0.62	0.77	0.44	0.34
	Most attr: faculty teaching	5,924	0.37	0.48	0	1	0.39	0.40	0.40	0.34	0.27
	Most attr: faculty research	5,928	0.49	0.50	0	1	0.52	0.36	0.59	0.43	0.55
	Most attr: government	5,920	0.39	0.49	0	1	0.39	0.45	0.40	0.39	0.24
	Most attr: industry (established firm)	5,918	0.45	0.50	0	1	0.37	0.52	0.34	0.55	0.58
	Most attr: startup	5,911	0.31	0.46	0	1	0.24	0.30	0.27	0.41	0.40
	Most attr: other	5,928	0.07	0.26	0	1	0.09	0.08	0.06	0.07	0.03
	Job availability faculty research	5,793	4.15	2.64	0	9	3.94	4.21	3.88	4.60	3.98
	Job availability industry	5,798	6.03	2.25	0	9	5.39	6.00	5.63	6.82	6.82
	PD requirements faculty research	5,905	2.71	1.28	0	5	3.44	2.48	3.16	2.03	1.39
	PD requirements industry	5,873	1.14	1.24	0	5	1.79	1.02	1.11	0.56	0.39
	PD requirements faculty 0/1	5,905	0.96	0.21	0	1	1.00	1.00	0.99	0.93	0.77
	PD requirements industry 0/1	5,873	0.56	0.50	0	1	0.78	0.59	0.59	0.32	0.25
	Salary industry	5,819	8.69	2.49	0	19	7.87	8.52	8.53	9.39	10.30
	Publications	5,890	1.63	2.00	0	8	1.80	1.83	1.81	1.45	0.97
	Fellowships	5,870	0.62	0.94	0	5	0.77	0.48	0.44	0.60	0.50
	NRC ranking	5,912	3.20	2.38	0	10	3.54	3.48	3.85	2.49	2.56
	Subjective ability	5,928	6.07	1.60	0	9	6.15	6.03	5.86	6.13	5.94
	Thought about career	5,922	3.71	0.89	1	5	3.79	3.72	3.60	3.68	3.62
	Time in program	5,928	3.37	1.56	1	6	3.56	3.24	3.34	3.14	3.44
	Persistence	5,921	4.00	0.75	1	5	4.03	4.02	3.95	4.03	3.87
	Lab norms pro faculty research	5,897	0.39	0.49	0	1	0.50	0.34	0.34	0.28	0.39
	U.S. citizen	5,928	0.69	0.46	0	1	0.80	0.76	0.70	0.61	0.46
	Male	5,923	0.60	0.49	0	1	0.42	0.55	0.77	0.72	0.81
	Married	5,905	0.40	0.49	0	1	0.44	0.38	0.33	0.39	0.39
	Children	5,928	0.08	0.27	0	1	0.08	0.05	0.06	0.08	0.10
2013 SEPPS/ online sources	Status: Postdoc	1,535	0.47	0.50	0	1	0.64	0.45	0.52	0.28	0.24
	Status: Employed	1,535	0.48	0.50	0	1	0.29	0.50	0.43	0.69	0.76
	Status: Not employed	1,535	0.05	0.21	0	1	0.07	0.05	0.05	0.03	0.00
	Any postdoc (SEPPS & online sources)	2,510	0.57	0.50	0	1	0.74	0.56	0.61	0.40	0.32
2013 SEPPS Postdocs only	PD reason: difficulty finding job	1,006	0.11	0.31	0	1	0.10	0.22	0.11	0.11	0.05
	PD reason: need more time	1,006	0.16	0.36	0	1	0.13	0.12	0.14	0.24	0.36
	PD reason: job chances	1,006	0.47	0.50	0	1	0.52	0.37	0.52	0.30	0.38
	PD reason: deepen skills	1,006	0.20	0.40	0	1	0.19	0.24	0.16	0.26	0.08
	PD reason: other	1,006	0.07	0.25	0	1	0.06	0.04	0.06	0.10	0.13
	Did PD to get TT faculty position	1,002	0.56	0.50	0	1	0.60	0.49	0.57	0.45	0.58
	Most preferred: faculty teaching	1,006	0.16	0.37	0	1	0.19	0.15	0.13	0.10	0.10
	Most preferred: faculty research	1,006	0.44	0.50	0	1	0.43	0.36	0.48	0.42	0.55
	Most preferred: government	1,006	0.16	0.37	0	1	0.14	0.20	0.20	0.21	0.03
	Most preferred: industry (established firm)	1,006	0.13	0.34	0	1	0.13	0.16	0.07	0.17	0.23
	Most preferred: startup	1,006	0.06	0.24	0	1	0.05	0.09	0.06	0.08	0.10
	Most preferred: other	1,006	0.05	0.22	0	1	0.06	0.04	0.06	0.02	0.00
	Estimated share of PhDs in TT 5 yrs	995	15.28	12.68	0	100	14.75	16.17	14.64	16.26	19.93
	Own probability of TT in 5 yrs	585	50.77	30.33	0	100	50.02	68.93	40.56	54.71	55.92
	True share of TT PhDs per NSF '12	1,069	16.05	4.81	14.3	37.8	14.30	16.50	16.50	15.50	37.80
	True share of TT PhDs per NSF '16	1,069	12.20	1.86	10.6	14.6	10.60	14.30	14.30	14.60	13.80
	Info severe lack faculty teaching	998	0.08	0.27	0	1	0.07	0.04	0.07	0.14	0.05
	Info severe lack faculty research	992	0.04	0.21	0	1	0.04	0.05	0.03	0.08	0.05
	Info severe lack government	992	0.19	0.39	0	1	0.21	0.16	0.12	0.19	0.11
	Info severe lack industry (established firm)	988	0.28	0.45	0	1	0.34	0.17	0.28	0.16	0.08
	Info severe lack startup	988	0.37	0.48	0	1	0.42	0.32	0.35	0.28	0.19
	Info severe lack non-research careers	930	0.43	0.49	0	1	0.44	0.40	0.40	0.45	0.27

Tab. S4. Logistic regressions predicting postdoc plans. Standard errors clustered by university in brackets. Marginal effects shown. *=sig. 5%, **=sig. 1%.

	Bio/Life Sciences			Other fields		
	1	2	3	4	5	6
	logit	logit	logit	logit	logit	logit
	PD plan	**PD plan**	**Most attractive: Faculty research**	**PD plan**	**PD plan**	**Most attractive: Faculty research**
Job availability faculty research	0.003	0.000	0.005	0.004	0.003	0.003
	[0.004]	[0.003]	[0.004]	[0.003]	[0.003]	[0.003]
Job availability industry	0.001	0.004	-0.008	-0.008*	-0.005	-0.005
	[0.005]	[0.004]	[0.005]	[0.003]	[0.003]	[0.005]
PD requirements faculty	-0.004	0.004	0.006	0.032**	0.042**	-0.019*
	[0.010]	[0.010]	[0.012]	[0.009]	[0.008]	[0.009]
PD requirements industry	0.047**	0.042**	0.002	0.067**	0.051**	0.028**
	[0.007]	[0.007]	[0.010]	[0.008]	[0.005]	[0.008]
Salary industry	-0.009*	-0.010*	-0.004	-0.009**	-0.005	-0.004
	[0.004]	[0.004]	[0.004]	[0.003]	[0.003]	[0.003]
Publications	0.018**	0.009	0.027**	0.001	-0.002	0.015**
	[0.005]	[0.005]	[0.005]	[0.004]	[0.004]	[0.004]
Fellowships	0.028**	0.017*	0.028*	0.020*	0.006	0.024**
	[0.009]	[0.008]	[0.011]	[0.010]	[0.008]	[0.008]
PhD program NRC rank	-0.010**	-0.007*	-0.014**	-0.013**	-0.008*	-0.011**
	[0.003]	[0.003]	[0.005]	[0.004]	[0.004]	[0.003]
Subjective ability	0.022**	0.015**	0.038**	0.032**	0.021**	0.043**
	[0.006]	[0.005]	[0.009]	[0.006]	[0.005]	[0.004]
Most attractive: faculty teaching		0.017			0.053**	
		[0.016]			[0.013]	
Most attractive: faculty research		0.224**			0.273**	
		[0.016]			[0.013]	
Most attractive: government R&D		0.020			0.070**	
		[0.021]			[0.016]	
Most attractive: industry R&D		-0.074**			-0.165**	
		[0.017]			[0.014]	
Most attractive: startup R&D		-0.040**			-0.082**	
		[0.014]			[0.015]	
Most attractive: other career		-0.153**			-0.167**	
		[0.024]			[0.024]	
Thought about career	-0.072**	-0.058**	-0.047**	-0.023*	-0.018	-0.025**
	[0.013]	[0.013]	[0.018]	[0.010]	[0.010]	[0.009]
Time in PhD program	-0.032**	-0.025**	-0.034**	-0.016*	-0.004	-0.026**
	[0.006]	[0.007]	[0.010]	[0.007]	[0.006]	[0.005]
Persistence	0.061**	0.045**	0.060**	0.040**	0.036**	0.027*
	[0.011]	[0.011]	[0.013]	[0.011]	[0.011]	[0.011]
Lab norms pro faculty	0.019	0.019	-0.007	0.024	0.001	0.017
	[0.015]	[0.011]	[0.020]	[0.013]	[0.013]	[0.015]
Male	0.029	-0.015	0.158**	0.033	0.016	0.080**
	[0.016]	[0.017]	[0.018]	[0.018]	[0.016]	[0.019]
US citizen	-0.006	0.003	-0.094**	-0.019	-0.009	-0.157**
	[0.021]	[0.019]	[0.035]	[0.019]	[0.019]	[0.019]
Married	-0.031	-0.033	-0.031	-0.027	-0.024	-0.014
	[0.024]	[0.020]	[0.020]	[0.014]	[0.013]	[0.017]
Children	0.022	-0.001	0.052	0.008	-0.016	0.040
	[0.033]	[0.028]	[0.036]	[0.033]	[0.029]	[0.031]
Detailed field of PhD fixed effect	incl.	incl.	incl.	incl.	incl.	incl.
Observations	2,083	2,083	2,083	3,444	3,444	3,444

Tab. S5. Supplementary analyses. Logistic regression, standard errors clustered by university in brackets. Marginal effects shown. *=sig. 5%, **=sig. 1%.

	Most attractive: Faculty research	Most attractive: Industry R&D	Early cohort		Advanced cohort		U.S. citizen		Non-U.S. citizen	
	1	2	3	4	5	6	7	8	9	10
	logit	logit	logit	logit	logit	logit	logit	logit	logit	logit
	PD plan	**PD plan**	**PD plan**	**PD plan**	**PD plan**	**PD plan**	**PD plan**	**PD plan**	**PD plan**	**PD plan**
Job availability faculty research	0.003	0.005	0.005	0.002	0.002	0.001	0.004	0.002	0.002	0.000
	[0.004]	[0.004]	[0.004]	[0.003]	[0.004]	[0.003]	[0.003]	[0.003]	[0.005]	[0.004]
Job availability industry	-0.001	-0.006	-0.002	-0.001	-0.007	-0.002	-0.004	-0.001	-0.005	-0.003
	[0.003]	[0.004]	[0.003]	[0.003]	[0.004]	[0.003]	[0.003]	[0.003]	[0.006]	[0.005]
PD requirements faculty	0.047**	0.000	0.012	0.021*	0.022*	0.033**	0.009	0.021**	0.025	0.028*
	[0.007]	[0.012]	[0.011]	[0.010]	[0.010]	[0.010]	[0.007]	[0.007]	[0.013]	[0.012]
PD requirements industry	0.008	0.106**	0.060**	0.048**	0.056**	0.046**	0.052**	0.042**	0.067**	0.060**
	[0.007]	[0.009]	[0.007]	[0.007]	[0.007]	[0.006]	[0.006]	[0.005]	[0.010]	[0.008]
Salary industry	-0.008*	-0.012**	-0.011**	-0.007**	-0.007	-0.009*	-0.007**	-0.008**	-0.013**	-0.007
	[0.003]	[0.003]	[0.003]	[0.003]	[0.004]	[0.004]	[0.003]	[0.002]	[0.005]	[0.004]
Publications	0.002	0.002	-0.000	-0.005	0.014**	0.008*	0.009**	0.003	0.008	0.002
	[0.004]	[0.004]	[0.004]	[0.005]	[0.004]	[0.004]	[0.003]	[0.003]	[0.006]	[0.006]
Fellowships	-0.007	0.025**	0.028*	0.021*	0.023**	0.007	0.025**	0.012	0.022	0.009
	[0.008]	[0.008]	[0.011]	[0.010]	[0.009]	[0.008]	[0.008]	[0.007]	[0.015]	[0.013]
PhD program NRC rank	-0.010**	-0.011**	-0.010	-0.005	-0.013**	-0.009*	-0.009**	-0.006	-0.012**	-0.007
	[0.003]	[0.004]	[0.005]	[0.005]	[0.004]	[0.003]	[0.004]	[0.003]	[0.004]	[0.004]
Subjective ability	0.009*	0.024**	0.021**	0.013*	0.034**	0.024**	0.033**	0.021**	0.012	0.008
	[0.005]	[0.007]	[0.007]	[0.006]	[0.005]	[0.005]	[0.006]	[0.005]	[0.008]	[0.008]
Most attractive: faculty teaching				0.035*		0.041*		0.037**		0.024
				[0.014]		[0.018]		[0.011]		[0.029]
Most attractive: faculty research				0.245**		0.263**		0.266**		0.222**
				[0.014]		[0.012]		[0.013]		[0.018]
Most attractive: government R&D				0.056**		0.043**		0.044**		0.073**
				[0.018]		[0.017]		[0.013]		[0.025]
Most attractive: industry R&D				-0.129**		-0.132**		-0.125**		-0.166**
				[0.013]		[0.016]		[0.015]		[0.028]
Most attractive: startup R&D				-0.079**		-0.052**		-0.071**		-0.045*
				[0.015]		[0.020]		[0.014]		[0.022]
Most attractive: other career				-0.166**		-0.187**		-0.180**		-0.133**
				[0.024]		[0.025]		[0.025]		[0.041]
Foreign: not sure if stay									0.090*	0.124**
									[0.037]	[0.032]
Foreign: plan to stay									0.013	0.069*
									[0.035]	[0.033]
Thought about career	-0.011	-0.053**	-0.024**	-0.017	-0.064**	-0.055**	-0.049**	-0.036**	-0.019	-0.020
	[0.010]	[0.010]	[0.009]	[0.009]	[0.013]	[0.012]	[0.009]	[0.009]	[0.017]	[0.017]
Time in PhD program	-0.008	-0.008	-0.045**	-0.031*	-0.011	-0.002	-0.024**	-0.012*	-0.019*	-0.011
	[0.006]	[0.009]	[0.013]	[0.012]	[0.011]	[0.009]	[0.006]	[0.005]	[0.009]	[0.008]
Persistence	0.027**	0.055**	0.039**	0.035**	0.055**	0.042**	0.046**	0.035**	0.043**	0.045**
	[0.008]	[0.010]	[0.010]	[0.010]	[0.012]	[0.010]	[0.009]	[0.009]	[0.014]	[0.012]
Lab norms pro faculty	0.011	0.006	0.031*	0.014	0.007	-0.004	0.020	0.011	0.021	-0.012
	[0.015]	[0.015]	[0.014]	[0.015]	[0.016]	[0.016]	[0.012]	[0.010]	[0.019]	[0.017]
Male	0.004	0.028	0.050**	0.017	0.014	-0.012	0.019	-0.007	0.072**	0.028
	[0.017]	[0.017]	[0.018]	[0.016]	[0.020]	[0.020]	[0.014]	[0.012]	[0.027]	[0.024]
US citizen	0.030*	-0.013	-0.028	-0.028	0.001	0.025				
	[0.014]	[0.018]	[0.019]	[0.019]	[0.019]	[0.019]				
Married	-0.008	-0.006	-0.023	-0.025	-0.034	-0.031*	-0.033	-0.033*	-0.018	-0.015
	[0.014]	[0.018]	[0.023]	[0.019]	[0.017]	[0.014]	[0.018]	[0.015]	[0.028]	[0.024]
Children	-0.033	0.013	-0.031	-0.055	0.043	0.017	0.015	-0.013	0.032	0.012
	[0.029]	[0.044]	[0.036]	[0.032]	[0.028]	[0.025]	[0.028]	[0.024]	[0.039]	[0.035]
Detailed field of PhD fixed effect	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.
Observations	2,683	2,503	2,923	2,923	2,604	2,604	3,906	3,906	1,605	1,605

Tab S6. Approximating the probability of obtaining a faculty position conditional upon doing a postdoc and pursuing a faculty research position. N=484.

	Bio/Life	Chemistry	Physics
1 Share of graduates who did any postdoc	0.7410	0.5629	0.6120
2 Share of postdoc respondents who did postdoc for tenure track position (method 1)	0.6021	0.4944	0.5686
3 Share of postdoc respondents with academic research as most preferred career (method 2)	0.4308	0.3596	0.4805
4 Denominator method 1 (line 1*line 2)	0.4461	0.2783	0.3480
5 Denominator method 2 (line 1*line 3)	0.3192	0.2024	0.2941
6 Share of PhD graduates holding TT positions 5 years after graduation; NSF 2016	0.1060	0.1430	0.1430
7 Conditional probability method 1 (line 6/line 4)	**0.2376**	**0.5138**	**0.4109**
8 Conditional probability method 2 (line 6/line 5)	**0.3321**	**0.7065**	**0.4862**
9 Respondents' estimated own probability of holding tenure track position in 5 years	0.5002	0.6893	0.4056
95% confidence interval for estimated own probability	[0.47;0.53]	[0.61;0.77]	[0.35;0.46]

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