Academia or Industry?

Ability, Preferences, and STEM Doctorate Early Career Choices

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ABSTRACT

In recent decades, an increasing share of STEM doctorates have entered employment in industry. A common explanation for this trend is that the rapidly growing number of doctorates are competing over a limited number of tenure-track faculty positions, with the highest ability doctorates staying in academia while lower ability doctorates seeking employment in "alternative" careers in industry. Recent evidence, however, suggests that many doctorates prefer to work in industrial R&D rather than stay in academia. As such, it is unclear whether ability or preferences explain who obtains a tenure-track faculty position and who leaves for industry. We explore this question using longitudinal survey data from a cohort of more than 3,000 STEM doctorates surveyed while in graduate school and then again in full-time employment. These data allow us to observe both ability and stated preferences prior to graduation, thereby enabling us to tease apart their separate effects in determining employment in tenure-track faculty or industrial R&D positions. We find that ex ante stated career preferences, rather than ability, explain which doctorates enter industry positions relative to those who become tenure-track faculty. At the same time, among doctorates who remain in academia ability strongly predicts who obtains a tenure-track faculty position over a non-tenure track research or teaching position. In other words, career preferences predict of who remains in academia or leaves for industry, but among those who stay in academia ability predicts who becomes a tenure-track faculty. In ongoing analyses (to be completed soon), we explore underlying mechanisms including job applications and job offers, as well as additional outcomes such as job satisfaction in different careers. Overall, our results suggest that future research as well as policy discussions should consider more explicitly the role of individual preferences for different types of careers, and that the role of ability may be less clear than assumed in discussions focusing on limited labor market opportunities.

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1 Introduction

The US has been producing a growing number of STEM PhDs over the past decades (National Science Board, 2022). A rising share of PhD graduates, however, transition into full-time positions in industry, rather than entering "traditional" tenure-track faculty positions. In 2013, for example, the share of PhD graduates holding tenure-track positions 3-5 years after graduation was less than 20%, down from 27% in 1993 (National Science Board, 2016). A common interpretation of this pattern is that it reflects limited labor market opportunities in academia – forcing many graduates to take "alternative" careers in other sectors (National Academies, 2018; Stephan, 2012). Assuming that universities make offers primarily to the best and brightest one would then also expect that academia is drawing from the top of the ability distribution, while those entering industry careers may be of lower ability.

Raising doubts about this narrative, recent work suggests that many graduates do not aspire to pursue academic careers. Indeed, in some fields the majority of PhD candidates indicate a stronger interest in industry than in academia even ignoring job availability (Roach & Sauermann, 2017a). Even many postdocs express a strong interest in industry careers (Sauermann & Roach, 2016). Reasons include an interest in applied (vs. basic) research and commercialization activities, access to resources that may be more available in large firms than academic labs, greater financial compensation, but also lower preferences for autonomy or other factors that have long been claimed to distinguish faculty positions. Thus, although common discussions focus on the role of limited academic demand in shaping PhD's labor market outcomes, much of what we see may reflect the preferences enacted by graduates pursuing different types of careers.

A key open question is what role ability plays in shaping individuals' career transitions. Are higher ability graduates more likely to have a preference for faculty positions? Can academia "cherry pick" the best and brightest, with others pursuing careers in industry? Or do some high ability doctorates have a preference for industry, thereby allowing firms to attract talented scientists to work on cutting-projects and contribute to innovation, entrepreneurship, and economic growth? Answers to these questions are not only important for scholars to understand STEM career paths but may also have important implications for educational policies and the competitiveness of R&D organizations in different sectors of the economy.

We study the role of both ability and preferences in shaping career outcomes using unique longitudinal data from more than 3,000 PhD graduates who entered research careers in either academia or industry.[1] These data include a survey that provides information about preferences, ability (proxied by NRC ranking, publications, and other indicators) and PhD experiences prior to graduation. Repeated follow-up surveys provide insights into into employment and job characteristics several years after graduation. We complement the survey with outcome data from LinkedIn and other sources. Given that we observe individuals for up to nine years, we are also able to address the complication that many graduates engage in postdoc training before entering their first full-time employment.

A first key finding is that ability is only weakly correlated with the desire to pursue faculty careers. Thus, both those who pursue academic careers and those who prefer industry span the whole distribution of ability, including highly productive individuals from top tier institutions. Second, while career preferences strongly predict who enters academic vs. industry careers, ability does not. Thus, the average ability of those entering industry is not lower than that of those entering tenure track positions. Ability does, however, predict whether a graduate entering academia obtains a tenure-track faculty position versus a non-tenure track position.

We perform a number of additional analyses that provide more detailed insights. Among others, we use job application and job offer data to disentangle supply and demand side, and we utilize survey data on job satisfaction to show that satisfaction is similarly high in both industry and academia. At the same time, graduates who do not find employment in their preferred career report somewhat lower job satisfaction than those who do. Finally, we explore potential differences by broadly defined field.

Our results contribute to the literature on STEM careers and associated policy debates in multiple ways. First, although much of the current discussion focuses on demand side constraints, we highlight the role of supply-side individuals' preferences in shaping career outcomes. Although such preferences may of course be partly endogenous, they deserve attention in future research and in our interpretation of observed labor market outcomes. Second, we show that those who enter industrial R&D are not systematically of lower ability than those

[1] To focus our analysis, we drop from the sample graduates who enter careers in other sectors such as government research institutes or who are not engaged in research or development.

entering tenure-track careers. This is important given the critical role that highly qualified human capital plays in fostering research productivity and shaping the competitive position of the national research enterprise. Finally, much of the existing research on scientists and scientific productivity has looked at researchers once they have entered their first full-time job (e.g., using SDR data). Using novel data that trace scientists from their time in the PhD program into their first jobs, we explore potential selection effects: Although we find little evidence of selection by ability, future research should consider the implications of the strong observed selection based on career preferences, which in turn reflect desires for factors such as income, autonomy, or different types of research.

2 Data and Measures

2.1 Data

Studying the role of ability and preferences in shaping career outcomes presents two key empirical challenges. First, ability and preferences are often unobservable. As such, many studies infer ability or preferences from observed wages and employment decisions (Brown & Medoff, 1989; Ouimet & Zarutskie, 2014; Sorenson et al., 2021) or account for them through fixed effects (Abowd et al., 1999; Bhaskarabhatla et al., 2021; Kim, 2018; Sorkin, 2018; Stern, 2004). While such approaches can be extremely useful, they typically do not allow researchers to investigate the separate roles of both ability and preferences. Second, most data sources observe workers after they have made their first employment choice, making it difficult to distinguish selection into different types of firms from treatment effects of the employment context on ability or preferences (Elfenbein et al., 2010; Sørensen, 2007). For example, when observing individuals' preferences after they have entered industrial R&D positions, it is difficult to discern whether these preferences determined individuals' decision to work in industry or whether industry employment influenced their preferences.

We overcome these challenges through a longitudinal survey that includes direct measures of individuals' ability and stated preferences *prior* to entry into the job market.[2] We also draw upon subsequent survey responses on startup job applications and job offers, starting compensation, and ex post job attributes and reasons for job choice to examine underlying mechanisms and

[2] This survey was approved by the Georgia Tech IRB, Protocol #09152 and Cornell University IRB, # 1707007286A003.

alternative explanations. Although our data have their own limitations, they allow us to provide valuable insights on PhDs' sorting into different types of careers.

Our survey follows a cohort of science and engineering PhDs from 39 top-tier U.S. research universities from graduate school to their first industry employment. We selected universities based primarily on PhD 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 (National Science Foundation, 2009). Respondents were contacted through their university email address listed on department websites and invited to participate in an online survey that asked about their graduate school experience and career goals, using up to three reminders. Respondents were first surveyed in 2010 or 2013 while in graduate school (*PhD survey*, 10,781 respondents, 30% response rate adjusted for undelivered emails) and then again after graduation in 2013 or 2019 after they had transitioned into full-time employment (*employment survey*, 73% adjusted response rate). Together, the *PhD* and *employment surveys* provide detailed micro data on individuals' stated preferences and characteristics up to 3 years prior to their first industry employment, as well as information on their job search and first full-time job, including starting pay and employer characteristics.

A particular empirical (and conceptual) challenge is the fact that many PhD graduates engage in postdoctoral training. Although this training is typically performed in academia, and a postdoc is typically considered a necessary condition for obtaining a tenure-track position, taking a postdoc position does not mean that graduates will remain in academia for their full time careers (Kahn & Ginther, 2017). As such, postdoc positions are transitory, and we need sufficiently long observation periods to see graduates' first full-time employment in positions other than postdocs. Our longitudinal survey strategy provides such a long observation period.

Our sample consists of 3,370 PhDs who entered U.S. employment in tenure-track university faculty, non-tenure track research or teaching university positions, or industrial R&D-related occupations between 2010-2019 and for whom we have complete data from the *PhD survey*. We restrict the industry sample to R&D-related occupations because these are the most prevalent first industry occupations for science and engineering PhDs (82.5% of industry-employed respondents in our data) and are most comparable to research faculty. Industry R&D-related occupations are identified based on survey-reported work activities (i.e., respondents who reported that they spend 40-100% of their time on basic research, applied research, and/or

development work activities). We exclude PhDs who were in non-R&D positions such as consulting and finance, or full-time teachers and administrators.

2.2 Variables

2.2.1 *Employment in Academia or Industry*

To identify whether an individual's first job was in academia or industry, we rely upon the *employment survey* which asked respondents to provide information on their first job. We code three different outcomes:

- *Tenure track* faculty positions: This includes PhDs who report holding a tenure-track faculty positions, which may vary in the degree to which they involve teaching as well as administration.
- *Non-tenure track* academic positions: This includes PhDs holding full-time employment positions in academia but these are not tenure track.
- *Industry R&D*: This includes PhDs who were employed full-time in industrial R&D positions.

In our sample, 26.2% of PhDs are in tenure-track faculty positions, 14.6% are in non-tenure track university positions, and 59.2% are in industrial R&D positions.

2.2.2 *Ability*

Prior research has used a variety of proxies for unobserved worker ability, including educational attainment, work experience, and prior wages (Agarwal & Ohyama, 2013; Åstebro et al., 2011; Elfenbein et al., 2010; Hamilton, 2000; Ouimet & Zarutskie, 2014). Others have either measured or controlled for ability through individual fixed effects (Abowd et al., 1999; Babina et al., 2019; Kim, 2018; Stern, 2004). Given that our sample consists of PhDs at the beginning of their careers, commonly used proxies either do not vary (e.g., level of education) or are unavailable (e.g., prior wages). Instead, we follow recent work by employing a fine-grained measure of ability that is particularly relevant when considering PhD employment outcomes and performance: the quality of PhD students' university department (Agarwal & Ohyama, 2013; Cohen et al., 2020; Roach & Sauermann, 2015).

Department rank is a useful proxy for PhD ability given that highly ranked departments are more selective in admitting PhD students and provide more rigorous scientific training. PhDs

from higher ranked departments are also likely to have better employment prospects and expect to be more productive in their R&D activities than PhDs from lower ranked departments. Perhaps most important for this study, PhD department ranking is an observable signal to both academic and industry employers of a PhD's potential ability and should be particularly important for novice scientists and engineers that lack full-time experience as either faculty or industrial R&D personnel (Agarwal & Ohyama, 2013; Spence, 1973). Finally, while wages may reflect ability as well as preferences (via preference-based compensating differentials, see Stern (2004)), our measure is less likely to reflect preferences, making it better suited to examine the separate roles of ability and preferences in shaping employment outcomes.[3]

To construct our ability measure, we matched respondents' university departments to the National Research Council's (NRC) survey-based rankings of doctoral programs, which reflect aspects such as research funding, faculty publication productivity, and student research activity (National Research Council, 2010).[4] To facilitate interpretation, we reverse-coded PhD department rank so that positive regression coefficients indicate a positive relationship between ability and the outcome variable. Given the skewed distribution of this measure, we use the natural log in regression analyses, as well as categorical variables for ability quartiles.[5]

In our sample, PhD department rank reflects 677 different university departments across a broad range of fields. As such, this measure is much more fine-grained and closer to the individual level than commonly used coarse ability measures such as highest degree (e.g., high school, bachelor's, master's) or years of education (for notable examples see Abowd et al., 1999; Card, 1996; Hamilton, 2000). At the same time, PhD department rank does not vary across individuals within a department.

2.2.3 *Preferences*

Ex ante preferences can be conceptualized with respect to careers in academia or industry, as well as to specific job attributes such as autonomy and risk. Although our focus is on the former,

[3] Although we interpret PhD department rank as a proxy for ability, it may also reflect other factors such as university status.
[4] PhD department rankings are not available for some university departments. In such cases, we used the broad field average (e.g., the average of all engineering departments when a specific engineering department ranking is missing).
[5] Results are substantively identical when using the raw measure.

we also measure certain job attribute preferences that are particularly relevant in the context of R&D occupations and that help us understand our career preference measures.

Preferences for specific job attributes. We measure preferences for five job attributes featured in the science careers literature that may distinguish individuals drawn to employment in academia or industry (see §2.3). First, we build on the Survey of Doctorate Recipients (National Science Foundation, 2008) to measure respondents' preferences for autonomy ("freedom to choose research projects") and income ("financial income") by asking them to rate the importance of these job attributes on a 5-point scale ranging from "not at all important" (1) to "extremely important" (5). Second, we measure individuals' preferences for basic research ("research that contributes fundamental insights or theories"), applied research ("research that creates knowledge to solve practical problems"), commercialization ("commercializing research results into products or services"), and managerial ("management/administration") work activities on a 5-point scale ranging from "extremely uninteresting" (1) to "extremely interesting" (5). Finally, we proxy for risk tolerance using a lottery-type question that asked respondents: "Imagine you have the choice between winning $1,000 for sure or winning $2,000 with a 50% chance. Please indicate which option you prefer." Respondents answered using a 10-point scale that ranged from "strongly prefer 100% chance to win $1,000" to "strongly prefer 50% chance to win $2,000." Higher values reflect a greater willingness to choose a riskier outcome with a higher potential payoff, which we interpret as a greater tolerance for risk.

Academia and industry career preferences. We measure career preferences using a question in the *PhD survey* that asked respondents "Putting job availability aside, how attractive do you personally find each of the following careers?", where careers included "university faculty with an emphasis on research or development" and both "startup firms' and "established firm with an emphasis on research or development", as well as other careers not considered in this study such as government or research institute. Respondents rated each career independently using a 5-point scale ranging from "extremely unattractive" (1) to "extremely attractive" (5). We created combined "industry" career preference by taking the maximum attractiveness of a career in a startup or established firm. By explicitly asking respondents to disregard current labor market conditions, we seek to capture their career preferences independent of factors that may affect career outcomes, such as perceived job availability (Roach & Sauermann, 2017b; Stephan, 2012).

Given that the ratings of career attractiveness are not mutually exclusive, we employ a multi-step process to construct relative measures of career preferences. First, we code as *academic types* respondents who reported the attractiveness of a university faculty career was greater than their attractiveness of an industry career. We interpret this as a preference for a tenure-track faculty career and not a preference to remain in academia in a non-tenure track research or teaching position. Second, we code *industry types* as PhD who reported the attractiveness of an industry career as greater than their attractiveness of a university faculty career. Finally, PhDs who reported that an academic and an industry career were equally attractive are coded as *indifferent types* and are used as the comparison group in our regression analyses. In our sample, 31.1% of respondents are academic types, 42.6% are industry types, and 26.3% are indifferent types. Figure 1 illustrates the share of each type by field of study. An advantage of these broader career preferences over preferences for specific job attributes is that they likely reflect preferences for a more comprehensive "bundle" of job attributes offered by different types of careers, as well as other unobserved factors such as social influences (Azoulay et al., 2017; Sørensen, 2007; Stuart & Ding, 2006) or occupational identity (Akerlof & Kranton, 2000).

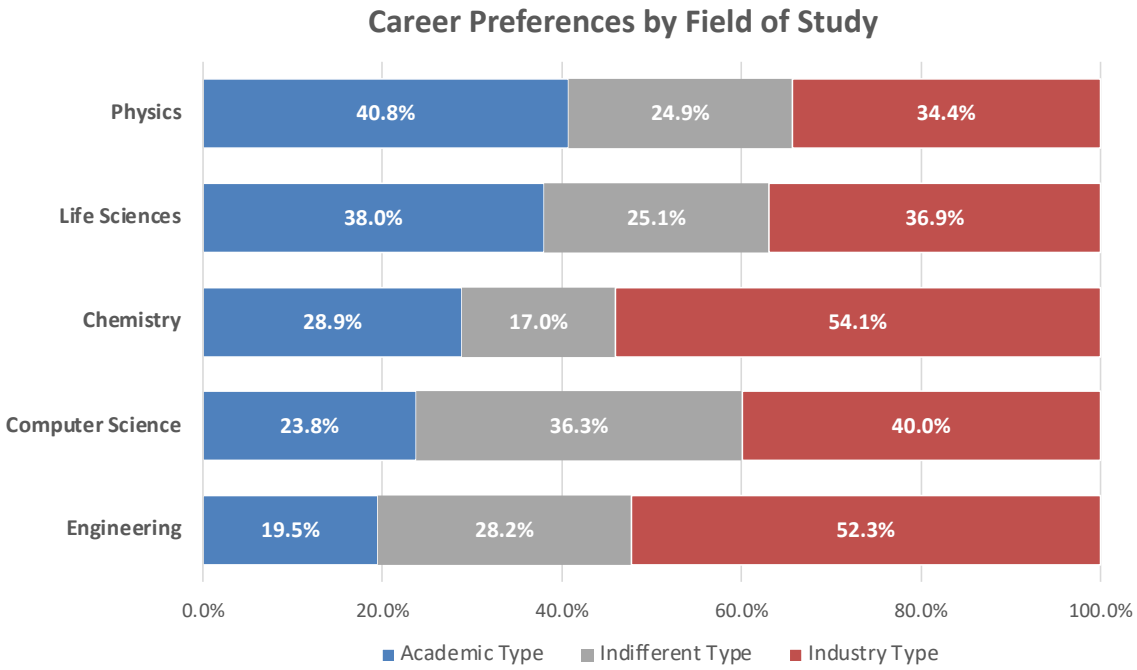


Fig. 1: Shares of academic, indifferent, and industry types while in graduate school by broad field of study. Sample is PhD survey respondents who transition to full-time tenure-track faculty or industrial R&D positions after graduation and any postdoctoral positions (n=2,865).

To provide insights into underlying differences between career preferences, we regress academic and industry career preferences onto preferences for specific job attributes discussed above as well as other relevant variables. The predicted values from a linear probability model plotted in Figure 2. We first note that higher ability PhD (i.e., those from higher ranked departments) have a significantly higher probability of being academic types, suggesting a potential correlation between ability and preferences. Focusing preferences we see that relative to industry types, academic types exhibit significantly stronger preferences for autonomy and basic research activities, and significantly weaker preferences for financial pay, applied research, and commercialization work activities. Men have a significantly higher probability of being academic types while U.S. citizen PhDs have a significantly lower probability compared to foreign-born PhDs who require a work visa.

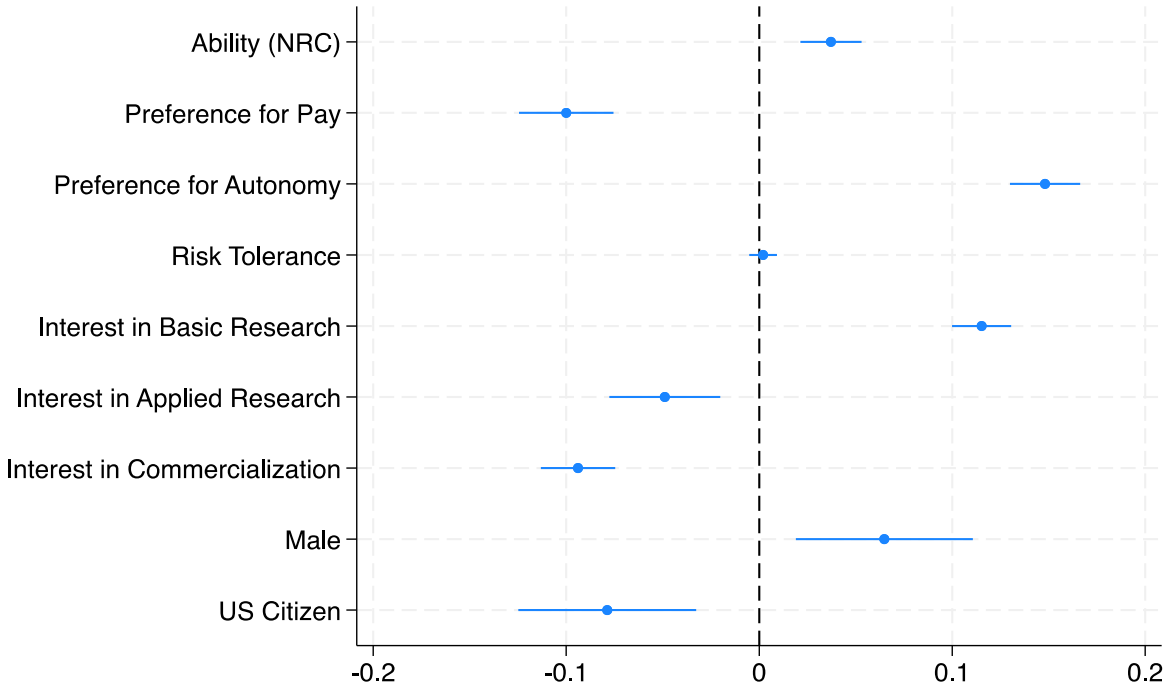


Fig. 2: Coefficient plot from a linear probability model comparing preferences for specific job attributes between academic types (1) to industry types (0). Indifferent types are excluded from this analysis to focus on academic and industry types (n=2,164).

To examine descriptively if higher ability PhDs are indeed overrepresented among academic types, we report in Figure 3 the share of academic, indifferent, and industry types by ability quartiles. Interestingly, we see that among the highest ability doctorates in the top quartile the

share of academic and industry types is nearly identical at approximately 38%, while among the lowest ability doctorates industry types are clearly overrepresented at 44% compared to 29% who are academic types. Although this does suggest that academic types are more concentrated in higher ranked departments and industry types are more widely distributed, importantly it shows that among the highest ability PhDs – that is, those mostly likely to be able to choose their preferred career path – both academic and industry types are equally represented.

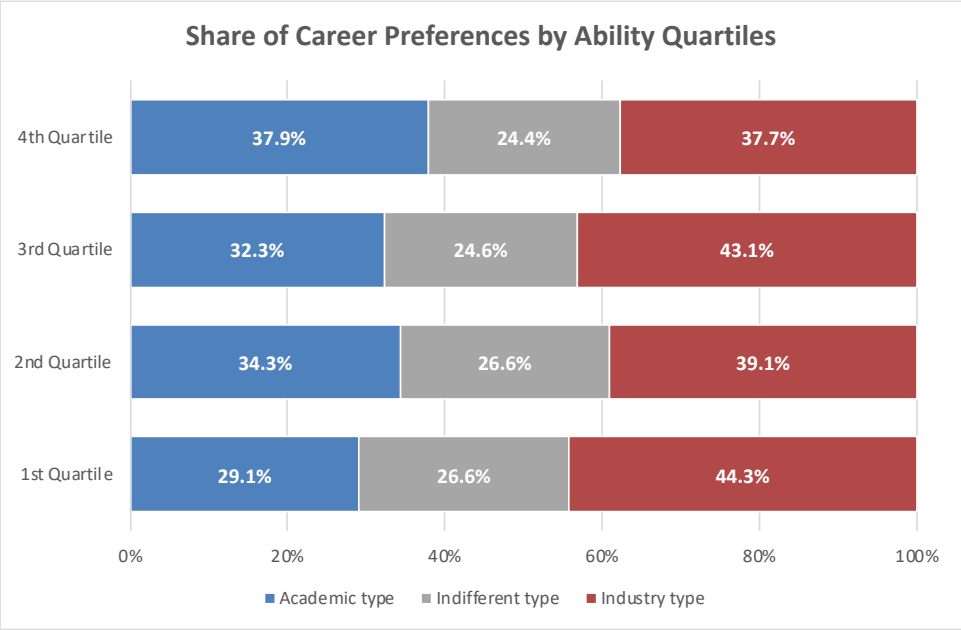


Fig. 3: Shares of academic, indifferent, and industry types by ability quartile. (n=2,865).

2.2.4 *Control Variables*

An important consideration in PhD careers is whether they do a postdoc prior to their first full-time employment. Although our sample focuses on full-time employment, we also asked whether a PhD had done a postdoc. In our sample, 44.6% had done a postdoc before transitioning to a full-time academic or industry position. Among tenure-track faculty, 71.0% had done a postdoc while among those who remained in industry only 35.9% had done a postdoc, indicating that nearly two-thirds of PhDs who work in industry leave academia immediately after graduation and do not do a postdoc at all. We control for whether a PhD has done a postdoc or not in our regression analyses.

We control for several *demographic characteristics*, including gender, marital status, and children. Given that job choices of international students may be constrained by their need to secure a work visa after graduation (Roach & Skrentny, 2019), we also use survey responses to distinguish graduates who are U.S. citizens or permanent residents from foreign PhDs who require a work visa for industry employment in the U.S. We use PhD *degree field fixed effects* for 14 detailed fields within the broader fields of life sciences, chemistry, physics, engineering, and computer science.

2.2.5 *Survey Measurement Issues*

There are general concerns when using survey data. One is common methods bias, which can occur when dependent and independent variables are measured using the same method (e.g., rating scales) and may result in inflated correlations between variables (Podsakoff et al., 2003). This is not a concern for our study since our dependent and independent variables are measured using different scales or data sources such as LinkedIn. A second concern with self-reported survey measures is that respondents may overstate preferences that seem socially desirable, especially in the eyes of peers or advisors. We partly addressed this concern by assuring respondents in the survey invitation that all responses would be kept strictly confidential. While any remaining social desirability bias may affect descriptive statistics (e.g., shares of academic types), it would affect regression analyses only to the extent that it is associated with unobserved respondent characteristics that are correlated with other featured variables. Our rich set of control variables should capture much of this typically unobserved heterogeneity.

3 Results

We first examine how career preferences and ability relate to transitions into industrial R&D versus tenure-track positions. We then analyze their role in predicting whether individuals who enter academia obtain tenure-track vs. non-tenure track positions.

3.1 Ability and preferences as predictor of tenure-track vs. industry positions

We first present in Fig. 3 the shares of PhDs in full-time employment in tenure track positions or industrial R&D by ex ante career preferences. We see that the vast preponderance of industry types (92.8%) are eventually employed in industrial R&D positions, while roughly half of academic types (50.2%) are in tenure track academic positions.

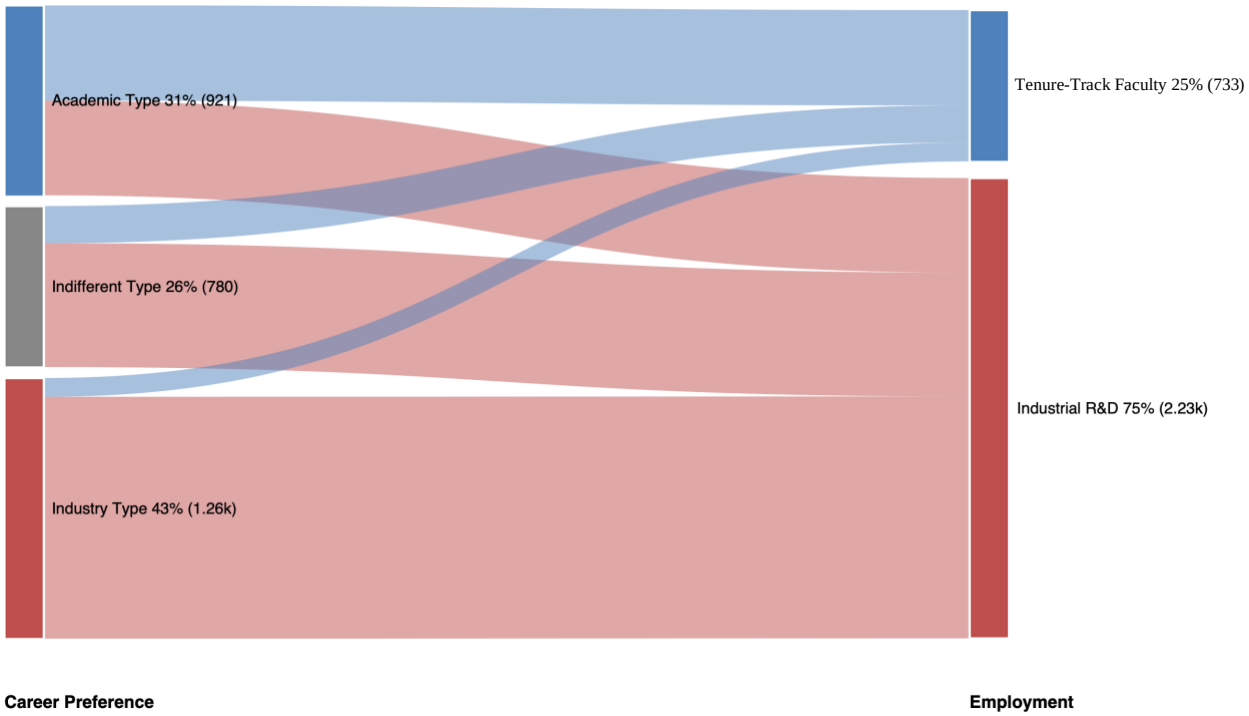


Fig. 3: Shares of PhDs employed in tenure-track faculty or industrial R&D by ex ante career preferences (n=2,963).

Table 1 reports results from a series of linear probability models with tenure track employment (1) versus industrial R&D employment (0) as the dependent variable. Model 1 is the baseline specification that include ability, measured as NRC department rank, and other control variables. We see that PhDs from higher-ranked departments have a significantly higher probability of obtaining a tenure-track faculty position. This may because PhDs from higher ranked departments account for a disproportionate share of tenure-track faculty across a wider range of departments, while PhDs who go into industry come from a wider distribution of departments. Individuals who did a postdoc also have a significantly higher probability of remaining in academia as tenure-track faculty.

Model 2 includes ex ante career preferences, which we see are strong predictors of whether a PhD enters a tenure-track position or works in industry. Relative to indifferent types, academic types have a significantly greater probability of becoming faculty while industry types have a significantly lower probability (i.e., a greater probability of working in industry). To put these estimates into perspective, after controlling for demographics and degree field academic types have a 44.4% predicted probability obtaining tenure track faculty position, compared to 23.3%

for indifferent types and only 9.9% for industry types. Once preferences are included in the regression, ability no longer predicts tenure track positions over industry. Given that Fig. 3 shows that academic and industry types are equally represented among the highest ability PhDs, one interpretation of the results in Model 2 is that high ability PhDs self-select into academia or industry primarily based on their preferences rather than ability.

Model 3 include preferences for specific job attributes. Although career preferences explain a great deal of the variation between who works in academia or industry, certain job attribute preferences remain significant. PhDs with stronger ex ante preferences for autonomy and conducting basic research have a greater probability of remaining in academia as faculty, while those with stronger preferences for financial pay and commercialization have a stronger probability of working in industry. More risk tolerant PhDs also have a lower probability of remaining in academia. Model 4 excludes ex ante career preferences with largely consistent results with Model 3. In both models PhDs who did a postdoc also have a greater probability of working in academia, which is consistent with the belief that a postdoc is an important – and often required – step on the path to an academic career.

Model 5 examines whether publications, an alternative proxy for ability, explain who takes tenure track positions. Given that academic types who aspire to a faculty career are likely to publish as extensively as possible to strengthen their chances of obtaining a tenure-track faculty position, while industry types may invest less effort in publishing, we restrict the sample to only academic types to sharpen our focus and mitigate potential endogeneity. In addition, since the number of publications and research times vary considerably across fields, we mean-center publications by detailed field of study. As such, this variable can be interpreted as whether PhDs with above (below) average number of publications are more (less) likely to obtain a faculty position. We find that academic types with above average publications have a somewhat higher probability of remaining in academia, which is consistent with publications being an important criterion for obtaining a tenure-track faculty position. As noted earlier, however, publication count may not only capture ability but also strategic publishing behavior.

Table 1 – Linear probability regressions predicting tenure-track faculty vs. industrial R&D

Model	1	2	3	4	5
Ability (NRC ranking)	0.022*	0.009	0.007	0.014	0.010
	(0.009)	(0.007)	(0.007)	(0.008)	(0.018)
Academic type		0.211***	0.163***		
		(0.025)	(0.025)		
Indifferent type		Omitted	Omitted		
Industry type		-0.134***	-0.094***		
		(0.018)	(0.020)		
Pref. pay			-0.048***	-0.070***	-0.045*
			(0.012)	(0.011)	(0.021)
Pref. autonomy			0.043***	0.073***	0.104**
			(0.010)	(0.010)	(0.033)
Risk tolerance			-0.006*	-0.005	-0.006
			(0.003)	(0.003)	(0.007)
Pref. basic research			0.023**	0.046***	0.009
			(0.007)	(0.006)	(0.028)
Pref. applied research			-0.005	-0.015	-0.034
			(0.011)	(0.012)	(0.031)
Pref. commercialization			-0.027***	-0.046***	-0.031
			(0.007)	(0.008)	(0.017)
Pref. management			0.011	0.010	0.012
			(0.007)	(0.007)	(0.017)
Mean-centered publications					0.053*
					(0.026)
Male	-0.006	-0.021	-0.010	0.003	-0.035
	(0.016)	(0.017)	(0.017)	(0.017)	(0.035)
US citizen	-0.003	0.006	-0.009	-0.021	-0.005
	(0.017)	(0.016)	(0.016)	(0.017)	(0.045)
Years to PhD	0.004	0.009	0.010*	0.008	0.010
	(0.005)	(0.005)	(0.005)	(0.005)	(0.012)
Postdoc experience	0.247***	0.167***	0.154***	0.187***	0.254***
	(0.024)	(0.026)	(0.026)	(0.024)	(0.046)
Job year FE (2010-2019)	Y	Y	Y	Y	Y
Degree field FE (15)	Y	Y	Y	Y	Y
Obs	2865	2865	2865	2865	825
R2	0.141	0.240	0.260	0.220	0.211

NOTES: Linear probability models predicting employment in tenure-track faculty (1) or industrial R&D (0) positions. Degree field fixed effects for 15 fields of life sciences, chemistry, physics, engineering, and computer science. Robust standard errors clustered on university in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.2 Tenure and non-tenure track academic positions

The prior section focused on transitions into faculty vs. industry positions. We now turn to the question how ability and preferences relate to transitions into different types of positions within academia, i.e., tenure vs. non-tenure track. Among the 1,048 PhDs in our sample employed in academia, 64.4% are tenure-track faculty and 35.6% are non-tenure track research and teaching positions.

Table 2 Model 1 shows that PhDs from higher ranked university departments, our proxy for ability, have a higher probability of obtaining a tenure-track faculty position. Model 2 include mean-centered number of publications as an alternative proxy for ability and PhDs with above average publications have a significantly greater probability of obtaining a tenure-track faculty position. Across both models PhDs with a stronger preference for autonomy and males also have a greater probability of obtaining a tenure-track faculty position. These results show that while higher ability PhDs are indeed more likely to become faculty as widely presumed, it is not the case that the majority of high ability remain in academia and lower ability PhDs leave for industry. Models 3 and 4 replicate the first two while include career preferences. Interestingly, academic types are no different from indifferent types in their probability of obtaining a tenure-track position, while industry types have a significantly lower probability. On the one hand this suggests that even among academic types, ability rather than preferences explains who transitions to a tenure-track faculty position. On the other, it raises the perplexing question of why industry types remain in academia in non-tenure track positions rather than leaving for their preferred career in industry. Models 5 and 6 exclude preferences for specific job attributes and we see that the ability and career preference effects remain largely unchanged.

Table 2 – Linear probability regressions predicting tenure-track vs. non-tenure track

Model	1	2	3	4	5	6
Ability (NRC ranking)	0.061**	0.060**	0.059**	0.057**	0.061**	0.058**
	(0.017)	(0.018)	(0.018)	(0.019)	(0.018)	(0.019)
Mean-centered publications		0.065**		0.059*		0.062*
		(0.024)		(0.024)		(0.024)
Academic type			0.026	0.031	0.042	0.044
			(0.048)	(0.049)	(0.042)	(0.042)
Indifferent type			Omitted	Omitted	Omitted	Omitted
Industry type			-0.135*	-0.128*	-0.148**	-0.139**
			(0.055)	(0.054)	(0.051)	(0.050)
Pref. pay	0.000	-0.003	0.004	0.002		
	(0.021)	(0.021)	(0.021)	(0.021)		
Pref. autonomy	0.059*	0.050*	0.035	0.027		
	(0.023)	(0.023)	(0.024)	(0.024)		
Risk tolerance	-0.008	-0.008	-0.008	-0.008		
	(0.006)	(0.005)	(0.005)	(0.005)		
Pref. basic research	0.022	0.014	0.012	0.003		
	(0.024)	(0.024)	(0.025)	(0.026)		
Pref. applied research	-0.003	-0.007	0.001	-0.002		
	(0.026)	(0.025)	(0.025)	(0.024)		
Pref. commercialization	-0.014	-0.010	-0.006	-0.002		
	(0.015)	(0.015)	(0.016)	(0.016)		
Pref. management	0.003	-0.004	0.005	-0.002		
	(0.012)	(0.012)	(0.013)	(0.013)		
Male	0.038	0.039	0.026	0.027	0.030	0.029
	(0.037)	(0.038)	(0.038)	(0.039)	(0.036)	(0.037)
US citizen	-0.041	-0.029	-0.035	-0.024	-0.031	-0.018
	(0.041)	(0.041)	(0.040)	(0.041)	(0.038)	(0.039)
Years to PhD	-0.006	-0.012	-0.003	-0.009	-0.001	-0.007
	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)
Postdoc experience	0.143***	0.125***	0.134***	0.118**	0.135***	0.120**
	(0.033)	(0.035)	(0.034)	(0.036)	(0.032)	(0.035)
Job year FE (2010-2019)	Y	Y	Y	Y	Y	Y
Degree field FE (15)	Y	Y	Y	Y	Y	Y
Obs	1048	1048	1048	1048	1048	1048
R2	0.096	0.103	0.108	0.114	0.103	0.112

NOTES: Linear probability models predicting employment in tenure-track faculty (1) or non-tenure track research and teaching positions (0). Degree field fixed effects for 15 fields of life sciences, chemistry, physics, engineering, and computer science. Robust standard errors clustered on university in parentheses. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.3 Supplementary analyses

We are currently performing a number of additional exploratory analyses that would be available at the time of the workshop. These include:

- Interactions between ability and preferences. Although our main analysis treats preferences and ability as independent predictors of career transitions, it is conceivable that ability acts as an "enabler" that allows those of higher ability to enter their desired careers (in particular, tenure track positions), while those of lower ability may have to take even non-preferred careers if those are more readily available (perhaps non-tenure track positions). We will explore this conjecture using interactions and split sample analyses.
- Job applications and job offers. The employment survey asked graduates whether they had applied for jobs in different sectors (E.g., tenure track vs. industry) and whether they received any offers. We will analyze these responses to get a better understanding of the role of preferences and labor supply (reflected in applications) as well as demand side conditions (reflected in offers) (see also Roach & Sauermann, 2023).
- The employment survey includes a question on job satisfaction. We plan to use this measure to explore whether average job satisfaction differs depending on whether graduates enter tenure track positions, non-tenure track academic jobs, or industry jobs. Moreover, we will explore whether job satisfaction is higher if a graduate enters his or her "preferred" career vs. a career that was not preferred (E.g., an academic type taking an industry R&D position).
- We will explore differences across fields using split sample analyses (e.g., life sciences vs. physical sciences vs. engineering).

4 Discussion

Our study contributes to the literature in multiple ways. First, we highlight heterogeneity in PhD student career preferences: While many graduates conform to common stereotypes by aspiring to tenure track positions, many do not. Such heterogeneity has been pointed out before (Roach & Sauermann, 2010; Sauermann & Roach, 2012), but it has not yet entered into our standard "models" of the scientific labor market. By showing that ex ante preferences are strong predictors of ex post outcomes, we highlight the importance of greater attention to preferences generally, and heterogeneity in particular. More generally, our study also complements prior research that has focused on labor market conditions and constraints (the demand side) by

highlighting the important role of demand, and by providing initial insights into their interplay (e.g., in our analysis using job applications and offers).

Second, there is a concern that many graduates are not able to find their desired careers, leading to negative consequences of "mismatch". By utilizing ex ante preferences (rather than assuming universal desire to pursue tenure track positions), we provide novel insight into the actual rates of "mismatch", as well as potential predictors. We also examine the implications of mismatch for job satisfaction. The results inform current debates about the causes and consequences of mismatch, as well as the need for policy action.

Third, some observers assume that it is the high-ability individuals who end up in tenure track positions, while it is the less able ones who are pushed into "alternative" careers such as industry. We scrutinize this belief using data that allow us to disentangle proxies of ability from potentially confounding career preferences. A first important finding is that career preferences and ability are not strongly related – those aspiring to industry careers are not of systematically lower ability. The second finding is that the average ability in industry is not lower than in tenure track positions. This suggests that both sectors have access to similarly qualified human capital.

In auxiliary analyses, we provide insights into a large but understudied pool of individuals – those in non-tenure track positions. We do find that these have, on average, lower ability, confirming the notion that they may include people who strongly pursue academic careers but were not able to obtain tenure track positions. However, average ability is still high, suggesting the need for future research on the paths that lead individuals to take non-tenure track positions.

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