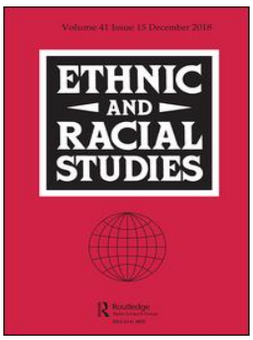

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The very ivory tower: pathways reproducing racial-ethnic stratification in US academic science

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ABSTRACT

We theorized that income racial-ethnic stratification among academic scientists is perpetuated by inequality of scientific capital including institutional prestige, research funding, publishing, and tenure. We tested our model with original survey data of US biologists and physicists ($n = 1{,}160$). Findings indicated that white scientists reported higher incomes than non-white scientists despite no significant differences in productivity, funding, or institutional status. Black scientists reported earning the lowest pay, while Hispanic scientists reported incomes statistically similar to those of white scientists. We also observed racial-ethnic inequality in promotion to tenure, which indirectly contributed to racial-ethnic stratification in pay. While overrepresented in our sample relative to the US population, East Asian scientists experienced particular disadvantages in promotion. Our findings challenge the Model Minority Myth, and they have implications for our understanding of the reproduction of a racial order, even in science, a field characterized by explicit overtures of tolerance and inclusion.

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KEYWORDS Academic science; racial-ethnic stratification; white domination; model minority myth; bamboo ceiling; leaky pipeline

Academic science touts a "universalistic" ethos that values merit and diversity (Merton 1973), but it often falls short of these standards, with researchers pointing to its stratification (Long and Fox 1995; Nature Editorial 2016). While previous research gives considerable focus to inequality in science based on gender (e.g. Kulis, Sicotte, and Collins 2002; Morgan 2000; Xie and Shauman 2003), fewer studies focus on stratification in science based on race and ethnicity. This is puzzling given that racial minorities are considerably underrepresented in the top ranks of science (Beutel and Nelson 2005). Still fewer studies focus on the mechanisms specific to academic science that might contribute to growing racial and ethnic inequalities (Allison, Long, and Krauze 1982; Burris 2004).

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In this article, we investigate four potential pathways for racial-ethnic stratification of income among US academic scientists: institutional prestige, research funding, publishing, and promotion. We explore differences among white, black, Hispanic, and Asian scientists, disaggregating the latter by region of origin. Specifically, we ask whether racial-ethnic minorities experience structural disadvantages compared to whites in academic science. We tested hypotheses with original data from a large survey of US biologists and physicists, two classical "hard science" disciplines. Understanding how race/ethnicity operates to hinder career advancement in academic science, which is purportedly meritocratic, may shed light on how similar patterns play out in other elite occupations.

Racial-ethnic status and science in America

Despite the growing racial and ethnic diversity of the US, some racial-ethnic minority groups remain underrepresented in science (National Science Foundation 2019). Diversity in science has benefited from the immigration reforms of 1965 and 1990, as well as the Chinese Student Protection Act of 1992, each of which facilitated an influx of Hispanic and Asian immigrants and provided legal status for some already living in the US (Corley and Sabharwal 2007; Taylor 2013). Studies indicate that immigrants now make up about twenty-five per cent of the US scientific workforce (Lowell 2010). For instance, although Asian immigrants and non-immigrants comprise only about five per cent of the population, they represent eighteen per cent of the US science and engineering workforce (although most are not US-born) (Guterl 2014). Yet, immigrant and nonimmigrant Hispanics make up eighteen per cent of the US population but encompass only seven per cent of the US science and engineering workforce (Flores 2017; National Science Foundation 2019). Black Americans make up thirteen percent of the US population but only six percent of those in science occupations (National Science Foundation 2019).

Although immigrant and racial-ethnic minority representation in science degree attainment has been improving (National Science Foundation 2019), science occupations remain highly stratified by race and ethnicity. Whites – who comprise the largest share of US society (62%) – are nevertheless *overrepresented* in scientific careers, accounting for sixty-nine per cent of the science and engineering workforce. We are only just beginning to learn whether these demographic trends are producing gradations of privilege in science beyond representation – that is, in terms of stratified outcomes like income disparities – for certain racial-ethnic minority groups.

Research suggests, for example, that racial-ethnic minorities are only marginally represented in elite, research-oriented universities, which tend to have access to more funding and higher pay for faculty than non-research

institutions (Beutel and Nelson 2005; National Science Foundation 2019). In their analysis of top university research departments, Beutel and Nelson (2005) found that blacks and Hispanics account for only four per cent of faculty in science and engineering departments while Asian scientists represent twelve per cent. Overall, black and Hispanic scientists are more likely to hold non-tenure track positions and less likely to achieve tenure when they do hold tenure track positions, compared to their white and Asian counterparts (Beutel and Nelson 2005; Perna, Nettles, and Bradburn 2000). Although these gaps in racial-ethnic representation point to inequities in academic science, we know less about the nature of these inequities and what broader racial and ethnic social structures may be contributing to science stratification.

Theories about the restructuring of the American racial landscape could offer clues about stratification in science. Some scholars argue that group boundaries are fading between whites, Hispanics and Asians, but racial boundaries for black Americans remain persistent (e.g. Lee and Bean 2004). These scholars hint that labour market disadvantages among immigrant groups mainly derive from slow processes of assimilation and acceptance of these groups by the white majority. Applied to science occupations, we should expect Hispanic and Asian scientists to be advantaged relative to black scientists but not white scientists.

Similarly, the "middleman minority" hypothesis places some immigrant minority groups (e.g. Asians and Hispanics) in an "intermediary position" between a majority group (i.e. whites) and segregated minority groups (i.e. black Americans) (Douglas and Saenz 2008). Focused primarily on minority entrepreneurs, the hypothesis conceptualizes some middleman minorities as "sojourners" who intend to return to their country of origin while others become "settlers" in the host society (Douglas and Saenz 2008; Ecklund and Park 2005). Middleman minority status also arises from restricted access to opportunity structures resulting from discrimination and hostility in the host country.

Notably, these theories miss important group differences between immigrant groups, particularly among ethnic groups of Asians, that could have meaningful implications for stratification in science. In the US, Asians (broadly speaking) are pegged as "model minorities" given their higher average levels of educational attainment, socioeconomic status, and representation in science and engineering occupations, when compared to blacks and Hispanics (Xu and Lee 2013). Asians' achievement, which in some instances has surpassed that of whites, has led some to conclude that Asians have "escaped" marginalization because of economic structures based on supposed norms of meritocracy (Sabharwal 2017, 190; Xu and Lee 2013).

Critics, however, note that the "model minority" narrative overlooks important within-group differences (Museus and Kiang 2009). Studies also indicate

that Asians are not exempt from the challenges of racialization and its effect on occupational inequality (Sabharwal 2017; Xu and Lee 2013), often facing what Wu and Jing (2011) describe as a "bamboo ceiling" in academic science: the higher the academic rank, the lower the representation of Asian scientists. Studies also indicate that Asian American scientists earn lower salaries than other US citizen and non-US citizen faculty, despite research productivity surpassing these groups (Corley and Sabharwal 2007; Sabharwal 2017). More broadly, evidence suggests that income disparities vary widely between Asian groups in the US. In fact, a recent report notes that the highest income inequality within racial groups is found among Asians (Kochhar and Cilluffo 2018). Disaggregating Asians into country or region of origin, stark differences in incomes levels emerge. For instance, South Asians earned the highest median income in 2015 at $100,000 per year, followed by Southeast Asians at $80,000 per year, and East Asians at $70,000 to $75,000 per year (López, Ruiz, and Patten 2017). Questions remain, however, whether these patterns hold in academia, and how incomes among Asian scientists compare to those of other scientists.

Scientific pathways to stratification

Meritocratic explanations for differential outcomes remain popular in academic disciplines of the sciences because they prioritize rational epistemology. In their study of gender inequality perceptions in science and technology, for instance, Cech and Blair-Loy (2010) found that fourteen per cent of women – most of whom occupy senior positions – attributed gender inequality to women's lack of experience, and another twenty-seven per cent attributed it to lack of motivation or commitment. A narrative of meritocracy legitimates the success of individual scientists in terms of publishing, funding, holding positions at prestigious institutions, and ultimately pay, as earned. Bourdieu (1975), however, argues that the mechanisms of legitimation in science are not purely apolitical. Rather, the "stakes" of scientific authority are two-sided, simultaneously interested in intellectual coherence as well as "struggles for domination" among those who are "unequally matched."

Seen in this way, prestige, publications, research funding, and tenure serve as particular forms of unequally distributed scientific capital that facilitate and legitimize the work of some more than others. As several studies note, scholarly productivity in the form of publications and departmental prestige serve as forms of capital that shape career advancement opportunities (e.g. Burris 2004). Faculty hiring in higher education also reflects unequally distributed capital associated with prestige, as highly ranked programmes hire almost exclusively from other top programmes rather than purely on the basis of merit (Burris 2004; Clauset, Arbesman, and Larremore 2015). Better positioning at more elite, research-oriented institutions, especially those with the

largest endowments, might result not only in better pay but more institutional resources for the advancement of one's research agenda. Perhaps tragically, but necessarily, those with high status are best positioned to define the means of attaining status in a scientific career.

Social location in a field structured by unequal resources has implications for racial-ethnic representation and stratification. Differential access to funding, mentorship, and institutional prestige produce a cumulative advantage or disadvantage that can be consequential for promotion and pay (Allison, Long, and Krauze 1982). Mechanisms specific to academic science such as publishing frequency, acquisition of research funding, and tenure produce a "leaky pipeline" that contribute to growing racial-ethnic inequalities in science (Spalter-Roth and Erskine 2007). Importantly, the "leaky pipeline" in academic science starts with inequalities in the US elementary and secondary education systems. A recent report by the U.S. Department of Education (2018) indicated that, when compared to all schools, high schools with more than 75% black and Hispanic students offered math and science courses (especially calculus and physics) at a lower rate. Moreover, evidence suggests that black and Hispanic students are often tracked to lower level science courses in high school thereby decreasing their chances of future pursuit of science in college and beyond (Zuniga, Olson and Winter 2005).

Limited access to resources persists for underrepresented racial and ethnic minorities into academic science careers. Ginther et al. (2011) show, for instance, that black and Hispanic scientists consistently fall behind non-minority scientists in access to funding. They found that black applicants were ten per cent less likely to be awarded grants from the National Institute of Health (NIH) compared to other applicants net of qualifications.

The current study

Previous studies have illuminated patterns of under-representation in science along racial-ethnic lines as well as racial-ethnic stratification in funding and mentoring, but we know less about racial-ethnic stratification in terms of publishing, promotion, institutional prestige, and pay among scientists. We attempt to fill these gaps by investigating what mechanisms specific to academic science, if any, systematically favour or disfavour different racial or ethnic groups, and whether racial-ethnic identity moderates the salience of particular pathways. In short, we investigate the conditions under which access to scientific capital is stratified by race and ethnicity.

Two theoretical foundations frame our expectations, namely that science is a social field in which actors compete for status with particular forms of unequally-distributed capital (Bourdieu 1975), and that despite the increasing racial-ethnic diversity of the US because of immigration, institutional racism nevertheless serves to perpetuate white dominance (Omi and Winant 2014).

Figure 1 depicts our theoretical model summarizing the hypothesized relationships. Specifically, we hypothesize:

H1: White scientists have higher odds of working in elite institutions than non-white scientists (Pathway 1).

H2: White scientists have higher odds of procuring research funding than non-white scientists (Pathway 2).

H3: White scientists publish more frequently than non-white scientists (Pathway 3).

H4: White scientists have higher odds of being promoted with tenure than non-white scientists (Pathway 4).

H5: White scientists receive higher incomes than non-white scientists.

H6: Differences in (a) institutional prestige, (b) research funding, (c) publication frequency, and (d) career promotion mediate racial-ethnic differences in income among US scientists.

Data and methods

Our data came from a survey of 3,482 US biologists and physicists collected in 2015 by Abt SRBI. We examined the disciplines of biology and physics for several reasons. First, to the degree that racial stratification occurs within constrained networks of discipline-specific scholars, it is helpful to narrow the focus. Our findings therefore do not necessarily generalize to scientists at large, but rather should be interpreted only as representing biology and physics. That said, these disciplines are important to the extent that they are widely considered to be central disciplines for the natural sciences.

Investigators implemented a two-stage stratified sampling process, beginning with the construction of a sample frame of research institutions and universities. Specifically, they developed a list of 289 biology departments and

Figure 1. Pathways to racialized income stratification: a theoretical model.

285 physics departments, each ranked by number of scientific publications from 2001 to 2011 as indicated by the Web of Science (WOS), an online database featuring articles from over 12,000 scientific journals. Researchers then stratified the lists by status to ensure representation of research-intensive (elite) and less research-intensive (non-elite) organizations and randomly sampled twenty-six biology departments and fifty-two physics departments among those that had active websites. Elite status was determined by assessing research productivity (article citations in WOS), publication rankings, and qualitative interviews with key informant scientists. In the second stage of sampling, researchers compiled a list of scientists from each of the sampled institutions that they then stratified by career stage (graduate students, mid-career scientists, and senior scientists) as well as gender.

Altogether, 1,989 scientists completed the survey, yielding a response rate of fifty-seven per cent. Preliminary analysis revealed that immigrants in our sample were both overrepresented among graduate students and disproportionately non-white. Since, as a group, graduate students tend to publish less, receive less funding, and earn less income than scientists who had earned a PhD, we excluded them from our final sample to minimize conflation of patterns correlated to both race and temporary immigration. We also dropped all respondents who we could not classify into a racial-ethnic group, resulting in a final *n*-count of 1,160, meaning that our analysis does not include those who identify with more than one racial-ethnic group.

Variables

We constructed racial-ethnic categories from two measures on the survey. The first asked if respondents were "Hispanic, Latino, or Spanish origin" and the second asked respondents to choose the best description of their ethnicity. Options for the latter included "Black, African, Caribbean," "Caucasian, White, European," "Central Asian/Arab," "East Asian (Chinese, Japanese, Korean, Taiwanese, etc.)," "South Asian (Indian, Pakistani, Bangladeshi, etc.)," and "Other." We classified all respondents who affirmed being "Hispanic, Latino, or Spanish origin" as Hispanic and omitted non-respondents and those who selected "Other" to construct a system of six dichotomous variables representing racial-ethnic group (see Table 1).

The measurement of income, our primary outcome variable, followed the General Social Survey with adjustments to account for the relative prestige of scientific careers. The survey asked,

> In which of these groups did your total family income, from all sources, fall last year, before taxes, that is. Total income includes interest or dividends, rent, Social Security, other pensions, alimony or child support, unemployment compensation, public aid (welfare), armed forces or veteran's allotment.

Table 1. Descriptive statistics and racial-ethnic group averages: RASIC US survey 2015.

			Racial-Ethnic Group Averages[a]					
Variable	*n*	Full Sample Mean or %	White (*n* = 839)	Black (*n* = 16)	Hispanic (*n* = 61)	Central Asian (*n* = 9)	East Asian (*n* = 171)	South Asian (*n* = 64)
White	1,160	70%	–	–	–	–	–	–
Black	1,160	1%	–	–	–	–	–	–
Hispanic	1,160	6%	–	–	–	–	–	–
Central Asian	1,160	1%	–	–	–	–	–	–
East Asian	1,160	17%	–	–	–	–	–	–
South Asian	1,160	5%	–	–	–	–	–	–
Income	1,132	9.10 (2.91)	9.60 (2.68)	6.82** (2.84)	9.04 (3.26)	8.49* (1.52)	7.84*** (3.14)	7.34*** (2.77)
Publications	1,158	2.55 (1.38)	2.60 (1.41)	2.08 (1.39)	2.86 (1.13)	2.81 (1.06)	2.32 (1.33)	2.27 (1.36)
Tenure	1,160	46%	53%	24%	42%	16%*	27%***	20%***
No funding	1,159	13%	10%	30%*	2%*	41%	25%***	19%
Elite	1,160	39%	38%	39%	35%	5%*	47%	43%
Biology	1,160	73%	72%	80%	87%**	89%*	75%	56%
Female	1,158	28%	28%	61%*	31%	51%	31%	20%
Married	1,158	80%	79%	38%**	85%	99%*	82%	77%
Discrimination	1,159	63%	57%	96%**	76%*	70%	83%***	61%
Immigrant	1,157	45%	27%	58%*	58%***	65%	95%***	98%***

Notes: All data were weighted and excluded non-response. Standard deviations in parentheses. *$p < .05$, **$p < .01$, ***$p <. 001$ (two-way tests).
[a]Levels of significance based on results of t-tests, white used as reference category.

Response categories ranged from 1 = "Less than $30,000" to 15 = "More than $1,000,000." Respondents had an average income between categories 6 ($60,000 to $74,999) and 7 ($75,000 to $89,999).

We assessed four pathways to racialized income stratification. First, we considered institutions classified as elite or non-elite during the stratified sampling process to indicate institutional prestige, as it relies to a large degree on reputation and research productivity. We take the higher levels of research to be reasonably indicative of institutional resources. About thirty-nine per cent of the weighted sample were at elite institutions, with racial-ethnic representation ranging from five per cent of Central Asian respondents to forty-seven per cent of East Asian respondents (Table 1). Second, the survey asked, "Which of the following best characterizes how much research funding you have had, in the past 3 years, relative to other researchers in your discipline at universities in the United States?" A non-trivial share of respondents (twelve per cent) reported that they did not know, which we interpreted to mean that they received *some* funding but did not have a sense of the relative level. To preserve these cases, we dichotomized responses such that a value of one was assigned to the response "No research funding" and a value of zero was assigned to the responses "Below average research funding," "Average research funding," "Above average research funding," and "Don't know." Thirteen per cent of the total sample reported no research funding, ranging from a low of two per cent among Hispanics to a high of forty-one per cent among Central Asians.

Third, we asked scientists to "indicate the number of your writings (solo authored or co-authored) that have been published or have been accepted for publication within the past 3 years in refereed journals (not counting abstracts)." Responses ranged from 0 = "0" to 8 = "More than 200," though the total share of scientists affirming categories six through eight was only about six per cent. We therefore truncated the variable publications by collapsing responses five through eight such that they ranged from 0 = "0" to 5 = "More than 20." Finally, we operationalized career stage as an indicator of tenure, with a value of 0 representing mid-career scientists (e.g. postdoctoral fellows, assistant professors, and research scientists) and a value of 1 representing senior scientists (i.e. associate professors and professors). Control variables included nativity (immigrant = 1), gender (female = 1), marital status (married = 1), and discipline (physics = 0, biology = 1), since metrics related to publishing and income might vary by discipline. More than eighty per cent of East Asians and South Asians were born outside the US. Further, because discrimination might hinder achievement (Pager and Shepherd 2008), especially in terms of hiring, promotion, and pay, we controlled for whether respondents have ever experienced discrimination in their work life as a scientist. Specifically, the survey asked scientists whether they experienced discrimination because of their regional background, their language or

Table 2. Binary logits of elite status, no funding, and tenure among US scientists.

	Elite Status				No Funding				Tenure			
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Independent Variable	e^b	*SE*	e^b	*SE*	e^b	*SE*	e^b	*SE*	e^b	*SE*	e^b	*SE*
Racial group												
White	.91	.21	–	–	.63	.21	–	–	2.10**	.59	–	–
Black	–	–	.94	.62	–	–	2.84	1.98	–	–	.55	.46
Hispanic	–	–	.81	.27	–	–	.20*	.16	–	–	.60	.21
Central Asian	–	–	.08*	.08	–	–	7.65*	6.37	–	–	.11***	.06
East Asian	–	–	1.43	.37	–	–	2.08	.78	–	–	.51*	.17
South Asian	–	–	1.11	.53	–	–	1.20	.60	–	–	.34**	.13
Biology	1.12	.70	1.15	.71	.85	.23	.87	.23	1.26	.23	1.24	.22
Female	.83	.11	.85	.11	.60*	.13	.60*	.14	.59***	.08	.60***	.08
Married	.74	.12	.75	.12	.93	.25	.92	.25	1.85**	.42	1.87**	.42
Discrimination	.97	.19	.94	.19	1.28	.43	1.23	.43	.98	.27	.96	.26
Immigrant	.99	.21	.91	.21	1.78	.59	1.71	.61	.55***	.07	.55***	.08
Elite	–	–	–	–	.55	.19	.55	.19	.43***	.09	.43***	.09
No funding	.58	.17	.57	.17	–	–	–	–	1.04	.32	1.08	.34
Tenure	0.44***	.09	.43***	.09	.94	.28	.96	.29	–	–	–	–
Publications	1.05	.08	1.07	.07	.44***	.07	.45***	.07	1.67***	.14	1.68***	.14
N	1,151		1,151		1,151		1,151		1,151		1,151	
Pseudo *R*-squared[a]	.03		.04		.16		.18		.16		.16	

Notes: All data were weighted and excluded non-response. *$p < .05$, **$p < .01$, ***$p < .001$ (two-way tests).

[a]Pseudo R-squared values were obtained by replicating the logistic procedure with the non-survey logistic command in Stata, considering the trimmed weights as "importance weights" rather than "sampling weights."

accent, their religion, their sex or gender, their national origin, their marital status, or their sexual orientation. If respondents indicated discrimination on any of these dimensions, a value of one was assigned. Otherwise, we assigned a value of zero. More than three of four Hispanic, East Asian, and black scientists reported some form of discrimination.

Analytical strategy

We examined data in two stages. In the first stage, we conducted a series of t-tests to determine whether racial minority groups differed significantly from white scientists in terms of both outcome measures and key controls. Because group sample sizes varied widely, these initial bivariate analyses provided important confirmation of whether observable patterns in the data were significant or simply random. To control for potential confounding variables, our second stage of analysis entailed multivariable regression of variables representing each of the four pathway variables as well as income, our most exogenous outcome. We used binary logits to estimate models of the three dichotomous pathways (institutional prestige, funding, and career stage), and ordinary least squares to regress the continuous measures, publications and income.

Though outside the scope of the current paper, we acknowledge that the four pathways are likely to be interdependent. Racial stratification in funding, for instance, can have an impact on racial stratification in publications, which might then impact tenure and promotion. Our contention, however, is that subjective processes occurring within each of the four pathways independently contribute to racial-ethnic stratification in income. In models for each of the four pathways, then, we also controlled for each of the other three to determine net stratification, and we controlled for all four pathways in our model of income. We conducted Sobel tests (Baron and Kenny 1986) to measure the significance of indirect paths.

For each multivariable analysis, we tested two models. The first regressed outcomes only on the racial category of "white." These models avoided inflation of standard errors because of the relatively small sample size of some of the racial minority groups. But because some racial minority groups have more privilege in science than others, we also regressed each outcome on the full set of dichotomous racial categories while suppressing the white category. Taken together, both sets of analyses can be interpreted to address hypotheses, the first with more certainty and the second with more nuance.

Findings

We found that white scientists on average reported higher incomes than other racial groups, though differences between white and Hispanic scientists were not significant (Table 1). We also observed that differences in publishing

frequency were not significant between racial groups, but compared to Central, East, and South Asian scientists, a larger percentage of white scientists in our sample had tenure. Specifically, white scientists accounted for about 60% of non-tenured PhDs in our sample, compared to about 80%–85% of scientists with tenure (see Figure 2). Significantly larger shares of black and East Asian scientists than white scientists reported no funding, and Central Asian scientists were significantly under-represented at elite institutions. In fact, with only one exception–a significantly smaller share of Hispanic than white scientists reported no funding–all significant differences between racial groups across all outcome measures favored white scientists.

We then turned to multivariable analyses to control for both pathway interdependence and potentially confounding variables. Binary logits (Table 2) reveal that white and non-white scientists, on average, are statistically similar in terms of both institutional prestige (Model 1) and research funding (Model 3). But when suppressing white scientists as the reference category, we did observe some racial patterns. Supporting H1, Central Asian scientists had ninety-two per cent lower odds than white scientists of working at an elite school net of controls (Model 2). And supporting H2, Central Asian scientists had 665% higher odds than white scientists of reporting no funding. Contrary to H2, however, Hispanic scientists had 80% lower odds than white scientists of reporting no funding.

Table 2 also reports results for binary logits modelling career stage. Consistent with H3, white scientists had 110% higher odds of being tenured than

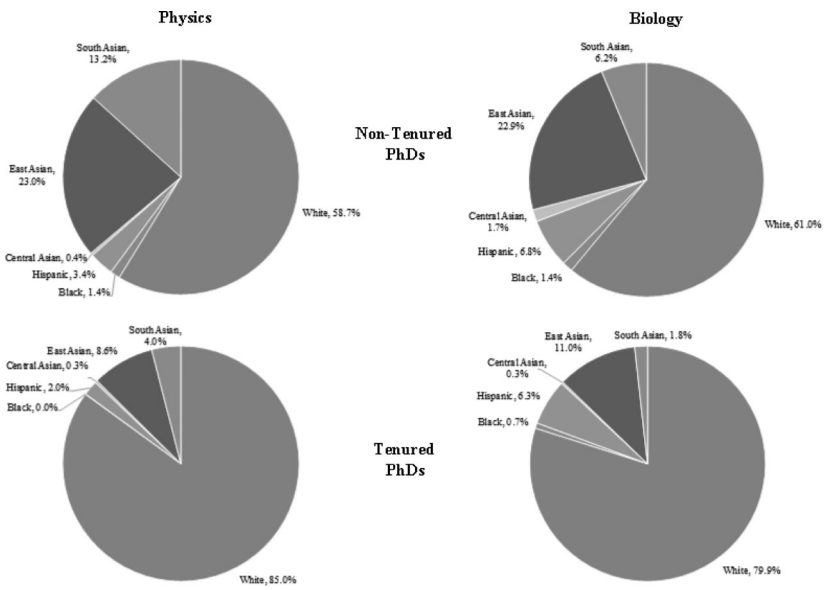

Figure 2. Racial-ethnic distribution of physicists and biologists by career stage.

non-whites (Model 5). Model 6 reveals that differences between white and both black and Hispanic scientists were not significant. That said, white scientists had 49% higher odds than East Asian scientists, 66% higher odds than South Asian scientists, and 89% higher odds than Central Asian scientists of being tenured, net of controls and other pathways of stratification.

Table 3 reports results from OLS regression analyses for publication frequency. In support of H3, South Asian scientists reported fewer publications (b = −.40) than white scientists, but contrary to H3, Central Asian scientists reported .84 more publication categories. We also reported estimated regression equations for income in Table 3. In support of H5, white scientists reported higher incomes (b = .63) than non-white scientists in Model 9. When suppressing the white category (Model 10), results indicated that white scientists reported 1.11 higher income categories than black scientists, .69 higher income categories than East Asian scientists, and .66 higher income categories than South Asian scientists. Of the four hypothesized pathways of stratification, institutional prestige and research funding were not significant, but tenure and publication frequency each significantly correlated with income net of racial categories and controls. Specifically, tenured scientists earned 2.64 more income categories than non-tenured scientists, and for every incremental rise in publication categories, income categories increased by .39.

Sobel tests based on Model 10 suggested that significant pathways toward racial-ethnic stratification in income depended on the racial-ethnic

Table 3. Ordinary least squares regressions modelling publications and income among US scientists.

	Publications				Income			
	Model 7		Model 8		Model 9		Model 10	
Independent Variable	*B*	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Racial group								
White	.12	.17	–	–	.63*	.24	–	–
Black	–	–	−.15	.30	–	–	−1.11*	.48
Hispanic	–	–	.19	.24	–	–	−.41	.38
Central Asian	–	–	.84*	.42	–	–	−.59	.88
East Asian	–	–	−.24	.18	–	–	−.69*	.31
South Asian	–	–	−.40*	.17	–	–	−.66*	.32
Biology	−.48***	.09	−.50***	.09	.41	.21	.40	.21
Female	−.30*	.15	−.31*	.14	.64***	.16	.65***	.16
Married	−.01	.13	−.03	.13	1.73***	.17	1.72***	.17
Discrimination	.19	.15	.19	.14	−.34	.19	−.33	.19
Immigrant	.37**	.13	.42**	.12	−.43	.28	−.41	.29
Elite	.07	.11	.09	.10	−.10	.21	−.09	.21
No funding	1.06***	.17	−1.04***	.18	−.10	.33	−.07	.34
Tenure	.80***	.13	.79***	.13	2.64***	.25	2.64***	.25
Publications	–	–	–	–	.40***	.06	.39***	.06
Intercept	2.37***	.27	2.49***	.20	5.07***	.38	5.72***	.33
N	1,151		1,151		1,127		1,127	
R-squared	.21		.22		.44		.44	

Notes: All data were weighted and excluded non-response. *$p < .05$, **$p < .01$, ***$p < .001$ (two-way tests).

comparison group. Figure 3 summarizes direct and significant indirect paths between racial-ethnic status and income. Income differences between white and black, East Asian, and South Asian scientists proved to be most robust, with direct effects remaining significant even net of all four pathways of stratification. Still, income stratification between these groups also operated indirectly through career promotion. Specifically, white scientists had higher odds of being tenured than scientists in each of these groups, and tenured scientists earned significantly higher income. Income differences between South Asian and white scientists were also partially mediated by publishing ($z = -2.33$, $p = .0198$). That is, South Asian scientists published less, on average, than white scientists, and publishing had a positive net relationship with income.

While t-tests and multivariable regressions suggested that career promotion and income differences between Hispanic and white scientists were each not significant, Sobel tests revealed that the indirect path from race to income via tenure was significant ($z = -5.19$, $p < .0001$). Combining direct ($-.41$) and indirect ($-.51 \times 2.64 = -1.35$) paths, Hispanic scientists on average earned 1.76 fewer income categories than white scientists. Multiple paths were also operating for Central Asian scientists, though with more complexity. Specifically, indirect paths via tenure ($z = -5.84$, $p < .0001$) and publications ($z = 1.97$, $p = .0493$) had countervailing effects. While Central Asian scientists published more, on average, than white scientists, they were less likely to have been promoted with tenure. Combining direct ($-.59$) and indirect ($-5.78 + .33 = -5.45$) pathways of stratification, Central Asian scientists earned 6.04 fewer income categories than white scientists.

Discussion

According to Bourdieu (1975), the practice of science necessarily entails the dual interests of knowledge production *and* social dominance. Scientists as agents compete for status and legitimacy in a field structured by the unequal distribution of particular forms of scientific capital: prestige, research funding, publications, and tenure. Interestingly, our analyses revealed virtually no inequality among racial-ethnic groups in terms of publishing frequency, a critical indicator of productivity in academia. But despite the popular notion that achievement in science is meritocratic (Cech and Blair-Loy 2010), findings nevertheless revealed that white scientists earned more, on average, than racial-ethnic minorities, independent of their attainment of scientific capital.

We also observed racial-ethnic inequality in the distribution of scientific capital. Specifically, white scientists had higher odds than Central Asian scientists of being positioned at elite, research-oriented institutions and having at least some research funding, and they had higher odds than Central, East, and

South Asian scientists of being tenured. For both biologists and physicists, the collective share of all racial-ethnic minorities accounting for scientists with tenure was about half the share of racial minorities accounting for non-tenured PhDs (Figure 2). In fact, analyses of our theoretical model suggested that inequality in career promotion served as a significant indirect pathway for income advantages in pay for white scientists compared to all other racial-ethnic groups (Figure 3). That we observed these differences independent of a measure of perceived discrimination suggests their potentially implicit

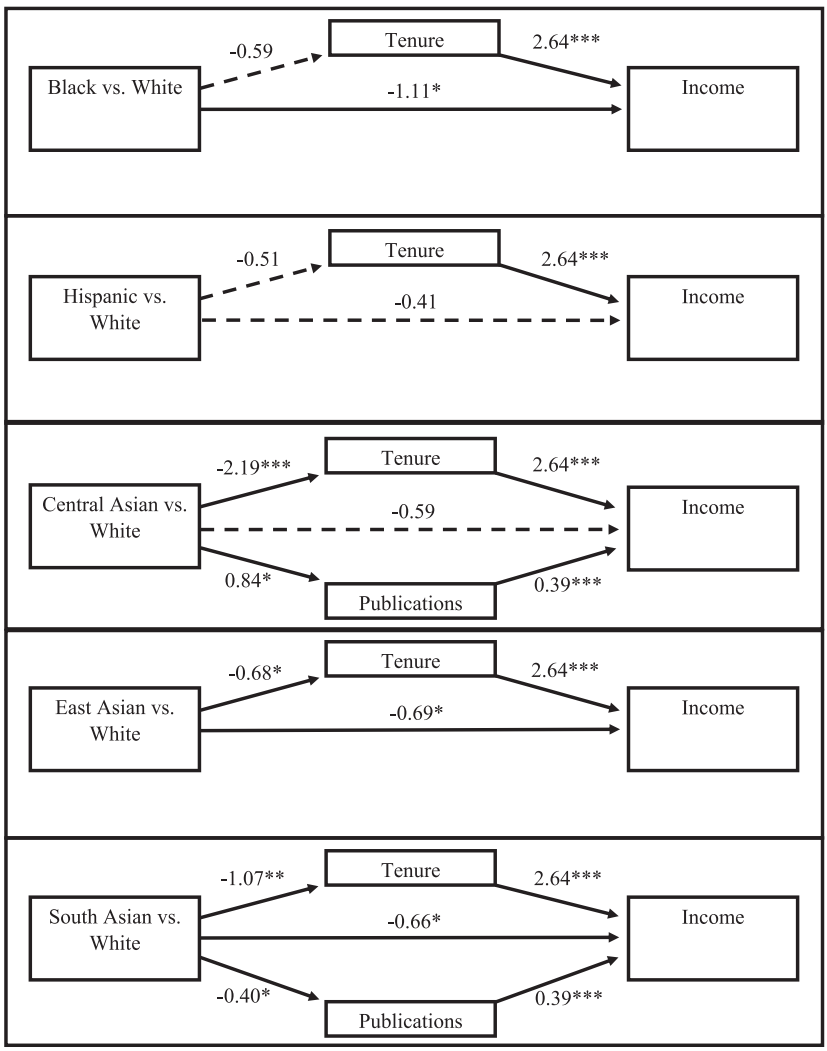

Figure 3. Regression coefficients for pathways of income stratification among US scientists by racial-ethnic status. Dashed lines indicate non-significant relationships. *$p < .05$, **$p < .01$, ***$p < .001$ (two-way tests).

and institutionalized nature. We speculate, then, that differences in pay between white and non-white scientists relate to hidden biases that manifest in tenure decision processes.

Though we did not test it directly, our findings also align with the "middleman" minority hypothesis (Douglas and Saenz 2008), as black scientists reported the lowest average income, while income differences between white and Hispanic scientists were not significant (though Hispanic scientists earned less pay than white scientists indirectly via differences in tenure). Asian scientists reported incomes between those of black and Hispanic scientists. Also consistent with the hypothesis, immigrant status played an important role in marginalizing members of "middle" groups. Notably, East and South Asian scientists – each of which earned significantly less than white scientists net of scientific capital – were comprised by 95 and 98% immigrants, respectively. And supplemental analysis (available upon request) revealed that among Hispanic scientists, immigrants earned significantly less than non-immigrant white scientists while non-immigrants earned significantly more.

Findings also challenged the Model Minority Myth. While Asians are overrepresented in STEM compared to their share of the national population (National Science Foundation 2019), and East Asians constituted the single largest minority group in our sample of biologists and physicists, they remained marginalized relative to white scientists. Collectively, the underrepresentation of Asians in the highest ranks of science and its impact on income inequality corroborates prior evidence of a "bamboo ceiling" of career advancement (Hyun 2009; Mosenkis 2010; Wu and Jing 2011). That said, we also observed differences between Asian scientist subgroups based on region of origin (cf. Museus and Kiang 2009). East Asian scientists reported the third-lowest average income, and a quarter – or about double the full-sample average – reported having no research funding. South Asian scientists, meanwhile, earned the second lowest average incomes among all racial-ethnic groups. The shares of South and Central Asian scientists promoted to senior status (twenty and sixteen per cent, respectively) were less than half that of the full sample (forty-six per cent). And five per cent of Central Asian scientists worked at elite institutions, compared to thirty-nine per cent of the full sample.

Limitations

Importantly, this study is not a comparison across industries, so we cannot determine how income stratification in science compares to other sectors of the economy. That said, science represents an elite profession in the US with high standards for entry and strong competition for tenure track positions. Scientists studied here also operated primarily in the academy, where

expressed desires for inclusion are often articulated (Puritty et al. 2017). Our data, however, suggests several barriers for total racial-ethnic inclusion. In other words, the academy itself is a site of white privilege.

The cross-sectional nature of our data prevented closer inspection of causal direction of the relationships between forms of scientific capital, and we could not directly discern whether dynamics related to mentorship contributed to deficits among minorities along these lines. We also cannot rule out that later entry of minority scientists, relative to white scientists, into these fields might also be contributing to their lower representation in senior ranks. The findings, therefore, warrant more study on whether interpersonal dynamics related to cross-racial mentor-mentee relationships contribute to the perpetuation of racial-ethnic stratification in science.

And given the particularly high proportion of black and East Asian scientists reporting some form of discrimination (Table 1), overt interpersonal racism may also be reproducing inequality in science. Of all racial-ethnic groups, black scientists reported the lowest average incomes, though notably, black and Central Asian scientists constituted particularly small groups in the sample. While it is noteworthy that the differences in average income between these groups were significant and robust, our data cannot speak directly to the causal mechanism explaining differences for these groups. In addition to the low representation, which can inflate standard errors, the self-reported nature of survey items may also contribute to underreporting of achievement by racial-ethnic minorities. Nevertheless, observed patterns support explanations related to hidden bias, lack of mentorship, inadequate socialization for negotiating salary, and other processes related to broader structures of systemic racism in US society. They therefore warrant more study on racism, both interpersonal and systemic, in the US academic science workplace, as well as more targeted study of smaller minority groups.

Implications

These limitations aside, our findings present novel evidence of racial-ethnic stratification among US biologists and physicists. They also point toward other important research questions that should be taken up in future work. While we do not implement an intersectional frame, for instance, scholarship suggests that processes reproducing racial-ethnic stratification perhaps exacerbate gender inequality as well (Collins and Bilge 2016; Crenshaw 1991). To the extent that pathways to racial-ethnic inequality in income differ by racial-ethnic group, they may also differ by gender within racial-ethnic groups.

The underrepresentation of racial-ethnic minorities in science also results in the dearth of mentors with shared racial-ethnic identities for graduate

students and early-career scientists (Brunsma, Embrick, and Shin 2017; Mervis 2013). If productivity is a function of professionalization, most racial-ethnic minority groups, including some Asian groups, appear to be at a disadvantage. Indeed, unequal access to scientific resources is mutually reinforcing, and early differences can accumulate over the course of a career in science (Ginther et al. 2011). The "bamboo ceiling" phenomenon among Asian scientists comports with the "leaky pipeline" hypothesis, a broader concept of underrepresentation (Blickenstaff 2005; Goulden, Frasch, and Mason 2009; Spalter-Roth and Erskine 2007). Recent literature on racial and gender inequality in scientific occupations suggest that women and racial-ethnic minorities not only enter scientific careers to a lesser degree than white men, but they also disproportionately drop out of science as careers progress to more senior stages. Our findings suggest that racial-ethnic disparities in income will persist to the degree that racial-ethnic minorities are disproportionately selected out of scientific careers.

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