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College Major Restrictions and Student Stratification

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Underrepresented minority (URM) college students have been steadily earning degrees in relatively less-lucrative fields of study since the mid-1990s. A decomposition reveals that this widening gap is principally explained by rising stratification at public research universities, many of which increasingly enforce GPA restriction policies that prohibit students with poor introductory grades from declaring popular majors. We investigate these GPA restrictions by constructing a novel 50-year dataset covering four public research universities' student transcripts and employing a staggered difference-in-difference design around the implementation of 29 restrictions. Restricted majors' average URM enrollment share falls by 20 percent, which matches observational patterns and can be explained by URM students' poorer average pre-college academic preparation. Using first-term course enrollments to identify students who intend to earn restricted majors, we find that major restrictions disproportionately lead URM students from their intended major toward less-lucrative fields, driving within-institution ethnic stratification and likely exacerbating labor market disparities.

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College Major Restrictions and Student Stratification*

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Abstract

Underrepresented minority (URM) college students have been steadily earning degrees in relatively less-lucrative fields of study since the mid-1990s. A decomposition reveals that this widening gap is principally explained by rising stratification at public research universities, many of which increasingly enforce GPA restriction policies that prohibit students with poor introductory grades from declaring popular majors. We investigate these GPA restrictions by constructing a novel 50-year dataset covering four public research universities' student transcripts and employing a staggered difference-in-difference design around the implementation of 29 restrictions. Restricted majors' average URM enrollment share falls by 20 percent, which matches observational patterns and can be explained by URM students' poorer average pre-college academic preparation. Using first-term course enrollments to identify students who intend to earn restricted majors, we find that major restrictions disproportionately lead URM students from their intended major toward less-lucrative fields, driving within-institution ethnic stratification and likely exacerbating labor market disparities.

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1 Introduction

U.S. college graduates from underrepresented minority (URM) groups have persistently earned about 25 percent lower wages than similarly-educated non-URM workers. This ethnicity wage gap results from both labor market frictions – like hiring discrimination and less-extensive job networks – and differences in accumulated human capital driven by differential access to high-quality schools, within-school academic programs, and colleges.[1] Recent evidence that Black-white wage convergence at the top of the wage distribution has largely occurred *within* education group (Bayer and Charles, 2018) has generated growing interest in ethnic stratification between higher- and lower-return college degrees (e.g. Bleemer, 2022). This study characterizes and decomposes long-run trends in an important dimension of collegiate human capital – college major attainment – and then carefully examines an understudied class of university policies that appear to explain key dynamics in URM and non-URM graduates' degree attainment in lucrative fields of study.

Average wages vary widely by college major (Altonji, Arcidiacono, and Maurel, 2016), with some majors offering a relative wage premium that exceeds the average return to a college degree (Card, 1999). We begin by constructing and validating an index of each major's economic value by estimating majors' wage value-added within gender, ethnicity, age, and cohort bins among mid-career 2009-2019 American Community Survey respondents.[2] We use the resulting statistics to document the average wage premium of the majors earned by URM and non-URM college graduates since the 1950s. Figure 1 reveals that the gap between the average premiums associated with URM and non-URM graduates' majors had nearly disappeared by the late 1970s birth cohorts but has since been steadily rising: in recent years, URM graduates have earned majors with about 3 percent lower average wages than those earned by their non-URM peers.

College major stratification – the separation of non-URM and URM students into more- and less-lucrative college majors – thus provides a meaningful countervailing force against the antidiscrimination policy momentum toward closing ethnicity wage gaps in the United States (Lang and

[1]For seminal studies on ethnicity gaps in the collegiate workforce, see Darity and Mason (1998) and Bertrand and Mullainathan (2004) on hiring discrimination, Ioannides and Loury (2004) on job networks, Card and Krueger (1992) on school quality, Card and Giuliano (2016) on K-12 academic programs, Neal and Johnson (1996) on resulting human capital gaps, and Altonji and Blank (1999) for a review.

[2]See Figure A-1 for evidence that major premium statistics effectively capture causal major-specific returns for interested on-the-margin students, the relevant group for our analysis below, from one quasi-experimental design.

Lehmann, 2012).[3] We investigate the sources of this growing stratification by constructing a dataset covering annual degree attainment and average major premiums by ethnicity at every U.S. college and university, permitting an observational decomposition of ethnic stratification into within- and between-institution components. While over a third of the rise in ethnic stratification across college majors can be explained by rising URM enrollment at universities where most students earn relatively lower-premium majors – which tend to be less-selective and for-profit institutions – two-thirds of the rise can be explained by *within*-institution dynamics over time, driven in particular by a sharp rise in ethnic stratification at public research universities. While public research universities enroll a third of U.S. undergraduates, they account for almost half of both current within-institution stratification and of universities' recent trend toward greater stratification.

As a result, we turn our focus to potential mechanisms that could explain the increasingly inequitable distribution of college majors that has disproportionately arisen at public research universities. While college major attainment is often described as a choice that manifests student preferences, a distinctive feature of public research universities is the increasing prevalence of major restriction policies that explicitly limit students' access to certain majors based on their introductory course grades. Table 1 demonstrates these policies' pervasiveness by documenting the restrictions imposed on five of the highest-premium majors at the 25 top-ranked public universities in the U.S. These universities enroll about 750,000 undergraduates, or half of all students at top-100 universities (and 7 percent of *all* undergraduates), and over 20 percent of their graduates earn degrees in these lucrative majors. Three-quarters of the majors imposed a GPA restriction in 2019, including every nursing major and nearly all mechanical engineering and finance majors. In contrast, fewer than ten percent of the same majors at top-ranked private universities have formal restrictions, though many limit access to high-premium majors using low grades and other 'soft' discouragement mechanisms (Armstrong and Hamilton, 2013).

We quantify the role of major restriction policies in generating ethnic stratification by constructing a new detailed database covering the 900,000 students who enrolled at four public research

[3] Bayer and Charles (2018) show that the Black-white 90th percentile wage gap experienced positional convergence between 1970 and 2014 (partialing out changes in the wage structure), but even in 2014 most workers were from pre-1980 birth cohorts; major choice trends may have slowed or reversed convergence among young workers. Black et al. (2006) find evidence that college majors explained 2.7 (1.4) percentage points of the Black-white (Hispanic-white) wage gap among 1993 workers, who were mostly members of the 1930-1970 birth cohorts.

universities – the University of California campuses at Berkeley, Davis, Santa Barbara, and Santa Cruz – between 1975 and 2018 and employing a staggered difference-in-difference research design around the introduction of 29 major restrictions. Estimating two-way fixed effect models at the department level, we show that major restrictions lead students with below-average academic preparation and first-year academic performance to earn degrees in alternative fields of study.[4] As a result, newly-imposed major restrictions cause the share of URM students who declared the restricted major to decline by an average of 20 percent, matching the observational difference in URM attainment between the restricted and unrestricted majors shown in Table 1.[5]

Finally, we trace the college majors attained by students who exit restricted majors by adding students' major *intentions* as an additional fuzzy difference in our difference-in-difference design and studying restrictions' impact on the degree attainment of intended majors. Students' intentions are estimated by random forest algorithms trained (on pre-restriction data) to predict major declaration using first-term course enrollment. We find that restricting a major has divergent effects on the URM and non-URM students who intend to complete it: on average, URM students with a strong (0.2) predicted intention to earn the restricted major end up in fields with over 1 percent lower average wages than similar-intention non-URM students after the restriction's implementation. A simulation exercise employing these estimates suggests that major restrictions can largely explain the rise in ethnic stratification across UC college majors since the mid-1990s.

This study primarily contributes to three strands of prior literature. First, we provide a new measure of collegiate human capital and document a growing ethnicity gap with important ramifications for the relative wages of Black and Hispanic workers.[6] Our college major index generalizes the Science, Technology, Engineering, and Mathematics (STEM) categorization often used as a proxy for the economic value of college majors (e.g. Carrell, Page, and West, 2010; Mourifie, Henry, and Meango, 2020), despite the existence of many high-premium non-STEM majors (e.g. nursing and business) and low-premium STEM majors like soil science and agronomy. Several

[4] We find no evidence that major restrictions decrease enrollment among students with a *comparative* disadvantage in the restricted field; the students who exit restricted majors have similarly low grades across all disciplines.

[5] Because course catalogs provide imprecise information about which cohorts were 'grandfathered' or otherwise unimpacted by new major restrictions, the estimated models allow $\pm$1-year 'transition' windows around restriction implementation. We do not find evidence of differential pre-trends in students' demographics or preparedness nor evidence of sensitivity to alternative estimation strategies (e.g. Sun and Abraham, 2021).

[6] Sloane, Hurst, and Black (2021) use a similar index of majors' economic value to study the gender wage gap.

studies have characterized and investigated dynamics in ethnic stratification across more- and less-selective universities (e.g. Chetty et al., 2020; Bleemer, 2022), another potentially important but more controversial dimension of collegiate human capital (Bleemer, 2021; Mountjoy and Hickman, 2020). The observed difference in average major premiums across URM and non-URM graduates could explain three percentage points (about ten percent) of the ethnicity wage gap among young college-educated workers, though we only have a single quasi-experiment to causally validate the magnitudes of our estimated premiums.[7]

Second, we provide evidence highlighting the role of an understudied class of university policies that appear to be driving this growing stratification. A number of studies have analyzed between-institution differences in STEM attainment by ethnicity (e.g. Arcidiacono, Aucejo, and Hotz, 2016), but we show that two-thirds of the growth in ethnic stratification across majors can be explained by within-university trends. Similarly, a large literature examines the demand side of major choice – students' subjective expectations and preferences (e.g. Wiswall and Zafar, 2015, 2018, 2021) – but the disproportionate growth of stratification at public research universities suggests an important role for supply-side policy variation like those universities' burgeoning major restriction policies.[8] We provide causal evidence that the imposition of major restriction policies disproportionately leads URM students to earn less-lucrative college majors, generating ethnic stratification at public research universities with macro-level wage ramifications.

Our findings also call attention to three inefficiencies of major restriction policies. First, restrictions' disproportionate presence in high-premium and STEM majors reduces the U.S. human capital stock (National Academies, 2007). Second, restrictions mute potential match effects between students' major choices and their comparative skill advantages and preferences (Kirkeboen,

[7]The ethnicity wage gap has generally been closing across education groups since the 1940s, but in recent years the gap among college-educated workers has slightly *grown* in both absolute and relative terms; see Figure A-2. Gerard et al. (2021) show that race-neutral skill-based job sorting contributes to the racial wage gap in Brazil.

[8]Altonji, Arcidiacono, and Maurel (2016) do not mention major restrictions in their handbook chapter's discussion of the 'supply side' of college major choice, but several other university policies have also been shown to shape students' major choices, including major-specific price discrimination (Stange, 2015; Andrews and Stange, 2019), major-specific incentive payments (Denning and Turley, 2017), and differential grading standards (Arcidiacono, Aucejo, and Spenner, 2012; Stinebrickner and Stinebrickner, 2014; Butcher, McEwan, and Weerapana, 2014). Differences in pre-college academic preparation (Arcidiacono and Koedel, 2014) and peer composition (Brenoe and Zolitz, 2020) can also influence within-institution stratification. However, none of these explanations are both widespread and particularly prevalent at public research universities or have been shown to differentially discourage URM students from lucrative majors, suggesting their second-order role in the growth of ethnic stratification.

Leuven, and Mogstad, 2016). Third, restrictions are most binding for interested and academically-promising students with limited pre-college educational opportunity, a group of students likely to receive above-average returns from lucrative college major attainment (Bleemer and Mehta, 2021).

Finally, our study contributes two methodological innovations with broad applicability in applied microeconomics. Our primary contribution identifies treatment effects on individuals who *intend* a policy-impacted behavior – in our context, declaring a restricted major – by explicitly characterizing intentions (predicted using pre-implementation data) and then estimating a difference-in-difference model with predicted intention as the (fuzzy) second difference.[9] Triple-difference interactions with demographic characteristics identify heterogeneous treatment effects among students who intend restricted majors. We also introduce a two-way fixed effect decomposition of grades into additive student and course-term effects (following Abowd, Kramarz, and Margolis, 1999) to characterize university students' within-course academic performance, permitting cross-student comparisons over long time horizons and between disciplines despite variation in grading standards that challenges the interpretation of traditional grade point averages.[10]

We begin in Section 2 by documenting the growth in ethnic stratification across majors in U.S. higher education, decomposing its between- and within-institution components, and motivating the potential role of major restriction policies at public research universities. Section 3 describes our detailed UC student data. Section 4 presents difference-in-difference evidence that major restrictions decrease URM enrollment by pushing out academically-disadvantaged students. Section 5 shows that restrictions disproportionately lead URM students to earn lower-premium degrees, and Section 6 uses those estimates to simulate the stratification effects of UC's major restrictions. Section 7 concludes. A series of online appendices consider alternative major premium statistics, analyze recent growth in *between*-institution stratification, further investigate restrictions' causal mechanisms using a comparative case study, and consider major restrictions' effects on *gender* stratification as well as Asian, Black, and Hispanic students' disaggregated major attainment.

[9]Students also report intended majors on their applications, but those are generally non-binding and may be strategically and selectively reported; our estimates reflect an incentivized measure of students' revealed preferences.

[10]Caulkins, Larkey, and Wei (1995) and Wittman (2020) suggest similar two-way fixed effect specifications.

2 Motivation

Stratification arises when some sub-populations are less likely to achieve desirable opportunities than others for (even partly) non-voluntary reasons (Darity, 2005). We begin by quantifying the growth in ethnic stratification by college majors in the U.S., decomposing its sources, and providing observational evidence suggesting an important role for major restriction policies.

2.1 Aggregate Trends in the Ethnic Stratification of U.S. College Majors

Let $R \in U, N$ denote the ethnicity of underrepresented minority (URM) and non-URM workers.[11] We index the average collegiate human capital obtained by R members of birth cohort t by $E_t(W_m|R)$, where W_m is the average wage (conditional on demographics) earned by college graduates who earned major m compared to a baseline major, which we assign to be general agriculture.[12] We refer to our estimates of W_m as major m's "major premium". A comparison between the quasi-experimental wage effect of shifting students across UC Santa Cruz majors (Bleemer and Mehta, 2021) and the expected wage effect based on average differences in the premiums associated with students' majors suggests that W_m effectively indexes majors' economic value, qualitatively but also perhaps quantitatively (see Figure A-1).

Let Δ_R be an ethnic difference operator, so that *aggregate* college major stratification at t is:

$$S_t^{Agg} \equiv \Delta_R[E_t(W_m|R)] \equiv E_t(W_m|N) - E_t(W_m|U) \tag{1}$$

Figure 1 presents aggregate college major stratification by birth cohort for all college-educated and employed 2009-2019 American Community Survey (ACS) respondents. It shows that URM students have long tended to complete lower-premium majors, but that this gap had fallen to less than one percentage point in the 1970s before widening to 2.6 percentage points by the mid-1990s.[13] Appendix A shows that the same stratification trends are observed when major premiums

[11]URM designates Black, Hispanic, and Native American/Alaskan workers.

[12]See Appendix A for a formal definition of W_m and Table A-1 for our estimates of W_m. We abstract from all dimensions of collegiate human capital orthogonal to major attainment.

[13]Ethnic stratification has followed similar trends among both male and female college graduates, though the gap has been persistently larger among male graduates (see Figure A-3).

are estimated in different periods, restricted to a single gender or ethnicity, conditioned on local geography, or replaced with median earnings by major (following Sloane, Hurst, and Black, 2021).

2.2 Decomposing Ethnic Stratification Between and Within Institutions

We decompose the sources of the recent rise in ethnic stratification by college major using data on the annual number of college graduates by institution, major, and ethnicity since 1995 from the Integrated Postsecondary Education Data System (IPEDS). These data permit estimation of several time-varying probabilities for each four-year U.S. degree-granting institution i, including $P_t(i)$, $P_t(i|R)$, $P_t(m|R)$, and $P_t(m|i, R)$. Given that $E_t(W_m|i, R) = \sum_m P_t(m|i, R)W_m$ denotes each ethnic group's average major premium within institution i, aggregate stratification can be disaggregated across institutions:

$$S_t^{Agg} = \sum_i [P(i|N)E_t(W_m|i, N) - P(i|U)E_t(W_m|i, U)] \tag{2}$$

Institution i suffers *within-institution* (major) stratification when its URM graduates tend to complete lower-premium majors than their non-URM counterparts:

$$S_t(i) \equiv \Delta_R[E_t(W_m|i, R)] = \sum_m W_m \Delta_R[P_t(m|i, R)] \tag{3}$$

On the other hand, $\sum_i \{E(W_m|i, N)\Delta_R[P_t(i|R)]\}$ captures *between-institution* stratification, which is positive whenever URM students disproportionately attend institutions whose (non-URM) students specialize in low-wage majors. It follows that aggregate stratification is the sum of between-institution stratification and a URM-weighted average of within-institution stratification:

$$S_t^{Agg} = \sum_i \{E(W_m|i, N)\Delta_R[P_t(i|R)]\} + \sum_i P_t(i|U)S_t(i) \tag{4}$$

The within-institution component of Equation 4 can then be decomposed into two parts: (1) the reallocation of URM students into historically more-stratified universities ("static") and (2) increased stratification (relative to 1995) at the universities where URM students enroll ("dynamic"):

$$S_t \equiv \sum_i \{E(W_m|i, N)\Delta_R[P_t(i|R)]\} + \sum_i P_t(i|U)S_{95}(i) + \sum_i P_t(i|U)[S_t(i) - S_{95}(i)] \quad (5)$$

Figure 2 implements Equation 5 annually across all 3,600 four-year colleges and universities in the U.S., estimating W_m from the ACS and all relevant probabilities from IPEDS.[14] It shows that dynamic within-institution stratification has played the largest role in driving the increase in ethnic stratification of college majors since the 1990s, explaining about 65 percent of the growth as URM students' universities increasingly stratify by major. There has also been substantial growth in between-institution stratification, which was negative in the late 1990s – indicating that institutions that disproportionately graduate URM students specialized in higher-premium majors – but that this relationship had flipped by 2019. While URM students have always been more likely to graduate from institutions that were historically internally stratified, this tendency has slightly declined over time, making the static within-institution component the least impactful contributor to ethnic stratification's recent growth. In general, the figure shows that within-institution stratification has been a persistently large and swiftly-growing contributor to the college major ethnicity gap, explaining over 2.2 log points of the 2.8 point gap in 2019.

Appendix B shows that the growth of between-institution stratification can be largely explained by the growing population of college-eligible URM students being accommodated at less-selective and for-profit institutions that specialize in low-premium majors (see Page and Scott-Clayton, 2016). However, the remainder of the present study primarily focuses on the larger but relatively-understudied within-institution component of ethnic stratification.

Dynamic within-institution stratification can be further decomposed into the contributions of each sector of American colleges and universities, permitting direct observation of which institutions appear most responsible for ethnic stratification's recent growth. We partition higher education into six sectors – the top 26 public universities discussed above, other R1 universities and R2 universities (following the Carnegie Classification), other public universities, and non-

[14]Assuming that students graduate at about age 22, the dynamics and magnitude of aggregate college major stratification are very similar whether tracked by birth year in the ACS (Figure 1) or by graduation year in IPEDS (Figure 2). Institutions outside the fifty states are omitted, and expected W_m is assumed to be equal across ethnicities in institution $\times$ year cells in which no graduates of one ethnicity are observed.

profit and for-profit private universities – and find that within-institution stratification increased in all six sectors. However, Table 2 shows that stratification within institutions increased to the greatest extent at public research universities, especially at the top 26 public universities. Figure 3 shows that in 2019, public research universities issued about a third of URM students' degrees but accounted for 46 percent of within-institution stratification and for 45 percent of the growth of dynamic within-institution stratification. These findings suggest that closer analysis of the inordinately-impacted public research university sector is most likely to reveal the root causes that are driving the recent national rise in ethnic stratification by college major.

2.3 Potential Demand-Side Explanations for Ethnic Stratification

Why are public research universities with high URM enrollment becoming increasingly stratified across college majors? Two "demand-side" explanations find little support in available evidence. First, shifts in the labor market could have reduced URM students' wage return to high-premium majors, decreasing their incentive to earn degrees in those fields. For example, increasing racial discrimination in occupations associated with high-premium majors could reduce URM students' incentives to choose those majors. However, while the (uniformly-positive) wage return to high-premium majors does appear to be lower for URM students than for non-URM students, that gap has steadily shrunk over time, rejecting the possibility that declining economic incentives to earn high-premium majors explain the observed trend in ethnic stratification.[15]

Second, the steadily-expanding share of URM college enrollment in the U.S. may imply that URM college students are increasingly negatively-selected relative to non-URM students, which could increase URM students' relative effort costs of completing high-premium majors. However, growth in college-going has been *slower* among URM than among non-URM high school graduates, suggesting that the increase in URM enrollment has more likely been driven by demographic shifts across the U.S. population than by increases in college-going among negatively-selected URM populations that previously had not enrolled in college.[16] The ethnicity gap in average SAT

[15] See Figure A-4.

[16] See Figure A-5. The inflow of URM college students tended to be absorbed by less selective institutions (Appendix B), which may have contributed to the increase in *between*-institution stratification documented above. However, dynamic within-institution stratification partials out this between-institution variation.

scores at public research universities also appears to have narrowed in recent years, suggesting that negative selection on pre-college academic preparation is unlikely to explain the observed widening of ethnic stratification within institutions.[17]

We thus find little evidence to suggest that student demand-side factors were first-order contributors to the growth in within-institution stratification by college majors since the mid-1990s, though we do not present definitive evidence against demand-side explanations. The next subsection, however, proposes a more promising institutional supply-side explanation.

2.4 Major Restriction Policies and Supply-Side Stratification

Recent growth in ethnic stratification across college majors has occurred disproportionately at public research universities, a sector in which many institutions have implemented major restriction policies that regulate access to designated fields of study (see Table 1). Departments generally justify major restrictions by arguing either that capacity constraints resulting from sharp increases in student demand require access limitations or that lower-performing students cannot succeed in challenging fields of study.[18] They may also result from increasing interest in 'prestige' departments that stratify students to improve their degrees' signal value (MacLeod and Urquiola, 2015).

Major restriction policies take one of three forms: (1) an average grade requirement in introductory courses; (2) an internal application favoring academic performance, extracurricular participation, and professed interest; or (3) an external application submitted prior to students' enrollment at the institution. We refer to the first of these types as 'mechanical' restrictions and the second two as 'discretionary', since the latter facilitate more nuanced decisions over who is permitted into restricted majors.[19]

[17]See Figure A-6, which is restricted to average SAT scores at the four selective University of California campuses discussed in the next section. In other words, ethnic stratification grew even as the URM students at public research universities became (measurably) better equipped to complete restricted majors, suggesting that increased student filtering was unnecessary. Appendix C presents evidence that average differences in academic preparation by ethnicity only stratify students across majors in the presence of major restriction policies.

[18]Thinly-stretched resources from 'over-enrollment' could reduce educational quality (Bound and Turner, 2007; Bound, Lovenheim, and Turner, 2010), in part through larger classes (Bettinger and Long, 2017). Bleemer and Mehta (2021) show that lower-performing students receive *above*-average wage returns from earning an economics major.

[19]These restrictions are often complemented by 'soft' restrictions like low introductory course grades and verbal discouragement, but we focus on easier-to-observe mechanical and discretionary restrictions for empirical tractability.

We examine the plausibility of an important relationship between major restriction policies and ethnic stratification by investigating the observational relationship between restriction policies and URM enrollment shares among the public research universities and lucrative majors whose restrictions are documented in Table 1. Table 3 reports estimated coefficients from linear regressions of each major's 2019 URM share on the presence of mechanical and discretionary major restriction policies, with fixed effects absorbing differences in average URM shares across universities and fields. While about eleven percent of graduates from those universities' lucrative majors were URM, only about eight percent in restricted majors (25 percent fewer) were URM. The second column shows that this gap is wholly driven by mechanical restrictions, on which we will focus for the remainder of this study; there is no measurable relationship between the presence of discretionary restrictions and college majors' URM shares.

In sum, the descriptive and observational findings presented in this section suggest that mechanical major restriction policies may play an important role in the recent growth in colleges' ethnic stratification across college majors. The remainder of our study presents a series of quasi-experimental analyses designed to evaluate the causal relationship between college major restrictions and the average premium of majors earned by impacted URM and non-URM students, and to examine how much of the rise of ethnic stratification across college majors can be explained by major restriction policies.

3 Data

We analyze the causal stratification ramifications of major restriction policies by studying the restrictions implemented by four public research universities in California: the University of California campuses at Berkeley, Davis, Santa Barbara, and Santa Cruz.[20] For reference, these are among the country's most selective institutions, each admitting between 21 and 64 percent of freshman applicants in 2010.

We observe student outcomes at these campuses using a novel student enrollment database

[20]All but one of the UC restrictions implemented in our study period were mechanical restrictions, so below we estimate the overall average effects of major restriction policies. These particular four universities were selected because of data availability.

collected as part of the UC ClioMetric History Project (Bleemer, 2018). The sample includes all undergraduate students who first enrolled at each of four University of California campuses in the observed sample period: UC Berkeley (1975 to 2016), UC Davis (1980 to 2018), UC Santa Barbara (1986 to 2018), and UC Santa Cruz (1975 to 2018).[21] The data include students' first year of enrollment, gender, ethnicity, high school, and California residency; underrepresented minorities (URM) are defined to include Black, Hispanic, and Native American students. The data also cover each of the courses completed by each student and their grades in each course. For students who enrolled after 1993, we link the data to UC undergraduate application records that include SAT score, high school GPA, and family income.[22] Finally, we observe students' pre-college access to college-level coursework by linking public California high schools to 1997-2016 California Department of Education school records, which identify school-years in which each Advanced Placement or International Baccalaureate course was available.[23]

Table 4 shows every formal major restriction policy that has been implemented by the four UC campuses since the 1970s, before which no restrictions have been identified. Each restriction's first year is defined as the year prior to the major restriction first appearing in the school's course catalog, since that entering cohort is typically the first that would face the new binding major requirement. For major restrictions that are no longer implemented, a 'Last Year' is also recorded, again referring to the final cohort that likely faced the restriction. Restrictions with GPA thresholds at or below 2.3 (a C+ average in the requisite courses) are omitted, both because of their prevalence and because they are unlikely to bind in most cases. Each campus has imposed about 12 restricted majors over the past 50 years. Major restrictions are seldom removed, though Davis's restrictions tend to be more numerous and shorter-lived than those at other campuses. Berkeley and Davis's Computer Science departments have implemented restrictions twice.

Major restrictions stratify students by their university course performance, with higher-performing students permitted to enroll in restricted fields of study. Student grade point averages (GPAs) are typically used to measure course performance, but comparing GPAs over time and across disciplines is challenged by differential grading standards. Figure A-7 presents average course

[21] Ethnicity is observed after 1975 (Berkeley and Santa Cruz), 1987 (Santa Barbara), or 1990 (Davis).

[22] All statistics produced using admissions data are replicated from Bleemer and Mehta (2020).

[23] California Department of Education course-level school information available at http://www.cde.ca.gov/ds/sd/df/filesassign.asp.

GPAs by division at UC Berkeley throughout the sample period, showing large and growing gaps in average grades by discipline: Science and Engineering courses had average grades about 0.2 GPA points below the Humanities in 1970, but the gap had grown to almost 0.4 GPA points by the mid-2010s. The distributional shape of available grades may also differ by discipline. We abstract from these between-field differences by measuring students' academic performance with "normed GPAs":

$$nGPA_i = \frac{1}{|C_i|} \sum_{c \in C_i} \frac{GPA_{ic} - \overline{GPA}_c}{sd(GPA)_c} \tag{6}$$

where student i's GPA is defined as the average number of standard deviations by which their grade differed from the average grade in each of their courses (set C_i). Students with high normed GPAs are those who consistently out-perform their peers in their chosen courses. We also characterize students' overall average academic performance in college by their individual GPA fixed effect ("GPA FE") from a two-way fixed effect model that regresses GPA on individual and course fixed effects (following Abowd, Kramarz, and Margolis, 1999).[24]

Table 5 presents descriptive statistics of the majors offered at each of the four UC campuses. Each campus offered an average of 54 majors in each year of the sample period, with an annual average of 83 students per major (s.d. 110). The average major was 53 percent female and 19 percent URM. There were 29 newly-imposed major restrictions during the period covered by the data – with 5-10 at each of the four campuses – and 25 restrictions imposed in the period when ethnicity is observed. The total sample includes about 900,000 students who enrolled in 6,200 major-cohort pairs.

Table 5's final column shows characteristics of majors soon to implement major restrictions. Those majors are twice the size of average majors, averaging 187 annual students. Only 13 percent of their students are URM, likely reflecting the fact that many of these majors are in STEM or other technical fields that tend to have below-average URM enrollment. Figure 4 shows that URM students who attained these soon-to-be-restricted majors had earned lower introductory course grades in those fields than non-URM students by about 0.3 standard deviations, further motivating

[24]Students' GPA fixed effect is a remarkably persistent characteristic; when separate individual effects are estimated for students' first two years of courses and their later courses (among students with over 4 courses in each period), the resulting within-student correlation is 0.77. URM students arrive at UC with lower GPA FEs – by 0.38 points – and do not converge to their non-URM peers, remaining 0.36 below after their third year. See Figure A-8.

the potential for restrictions to differentially impact URM students.

4 Major Restrictions and Departmental Composition

4.1 Empirical Methodology

We investigate the effect of major restrictions on majors' student composition by using a difference-in-difference event study design to estimate the effect of imposing new restrictions on the composition of students who declare those restricted majors. Each newly-imposed major restriction in the sample period is considered an 'event,' omitting restrictions that were imposed within two years of the major's creation (prohibiting pre-period estimation), for fewer than four years (prohibiting estimation of longer-run effects), or with GPA thresholds of C+ (2.3) or below. We employ the resulting 29 events in a staggered two-way fixed effect model estimated over the unbalanced panel of all majors in all available years at the four campuses:

$$Y_{cmy} = \alpha_{cm} + \gamma_{cy} + \sum_{t=-7}^{8} \beta_t \mathbb{1}\{y + t = P_{cm}\} + \epsilon_{cmy} \tag{7}$$

where Y_{cmy} is a compositional feature of campus c's major m in cohort year y (like log number of students), α_{cm} and γ_{cy} are campus-major and campus-cohort fixed effects, and P_{cm} is the first cohort-year that faced major m's restriction at c. For example, $Y_{UCB,Econ,1990}$ could represent the log number of students whose first year of enrollment was 1990 and who declared an economics major (whether or not they ultimately earned a degree) at UC Berkeley. Standard errors are clustered by campus-major.[25] We interpret the estimated $\hat{\beta}_t$ coefficients when $t > 0$ as the effect of implementing a major restriction policy on departmental enrollment, which assumes the absence of any other substantive policy changes that particularly impacted restricted majors at the same time that the restrictions were implemented.

[25]The estimates presented below are qualitatively and largely quantitatively unchanged when the event study coefficients are estimated using a "stacked" event study approach with common treatment effects across cohorts (Sun and Abraham, 2021) as implemented by Novgorodsky and Setzler (2019). See Figure A-9. Figures A-10 to A-12 visualize the full observed treatment effect heterogeneity by plotting major-restriction-specific estimates of Equation 7 for several outcomes.

Major restrictions' first year of implementation is measured with noise; course catalogs typically do not specify which cohort will be the first to face the major restriction, and the timing of restrictions' catalog inclusion may differ by campus or department. As a result, we estimate treatment effects relative to $t = -3$, but care should be taken to not over-interpret β_{-2} through β_0, which likely represent transitional (or 'phase-in') years for the imposition of each restriction. The discussion below highlights changes between the pre-period before $t = -3$ and the period after $t = 0$. We present estimates of β_{-6} through β_{-4} to test for evidence that would reject parallel trends for each outcome prior to restrictions' implementation.

4.2 Findings

Panel (a) of Figure 5 shows β estimates and 95-percent confidence intervals from Equation 7 for the log number of students who declare newly-restricted majors before and after the imposition of the restrictions. The estimates suggest that major restrictions are put into place about five years after a major begins growing relative to other fields. Imposing the restriction causes an immediate cessation of this growth in the average department, with longer-run enrollment stabilizing around 10 percent below peak enrollment (similar to the pre-growth enrollment level), despite the observed increased student demand in that major.[26]

What were the characteristics of the students denied from the major as a result of newly-implemented major restrictions? The next two panels of Figure 5 shows that the proportion of female students in newly-restricted majors remained unchanged, but that the average proportion of URM students declined by 3.3 percentage points. Given the 10 percentage point decline in all major declarations and average pre-restriction URM share of 13 percent, this implies that URM students were over twice as likely to exit the major as a result of the restriction than non-URM students (about 25 vs. 12 percentage points).[27]

[26] This average decline is larger than the estimated enrollment decline at Union College's economics department after the implementation of a GPA restriction (Schmidt, 2021).

[27] The share of majors who were URM fell by 2.0-3.3 percentage points, depending on whether pre-transition or transition years are selected as a baseline (Table 6, and $0.25 \approx (-0.02/0.13) + (-0.10)$). This and similar estimates below of the characteristics of major restriction 'compliers' – that is, students who would have declared the major if not for the restriction – require assuming that the major restriction did not impact the likelihood of major declaration of students who would otherwise have *not* declared the major. If major restrictions encouraged positively-selected students to declare that major (perhaps for educational prestige), then these could overestimate the true effect.

How did major restrictions differentially impact students with different levels of measured academic preparation? The left panel of Figure 6 shows that newly-restricted majors' enrollees were substantially higher-performing college students, earning average grades over 0.1 standard deviations higher than their peers. Their higher grades reflect those students having stronger academic preparation prior to arriving at UC. Among freshmen students who submitted standardized test scores with their undergraduate applications, students who attained restricted majors had higher average SAT scores by almost 40 points out of 2400 (Figure A-13), suggesting that the students who exited newly-restricted majors had average SAT scores as much as 300 points – a full national standard deviation – lower than the average student declaring the major.

Panel (b) of Figure 6 shows that major restrictions yield students with higher normed GPAs in their first-term courses in that discipline. This is partly by construction, since some of these courses would have been used to calculate the introductory course GPAs used to determine access to restricted majors. Panel (c), however, shows a near-identical effect on declared majors' average first-term normed GPAs in *other* disciplines.[28] These results imply that students who exit restricted majors had average normed first-term GPAs about 0.75 standard deviations lower than the major's average, even when their GPA is calculated using only courses outside the major's discipline.[29] The similarity between Panels (b) and (c) suggests that major restrictions do not target students on the basis of their comparative advantages – that is, students with particular academic strengths in the restricted field – but instead target students whose academic performance is generally stronger across *all* fields (absolute advantage).[30]

These results, summarized in Table 6, indicate that major restrictions reduce the number of students who declare restricted majors, with URM students far more likely to exit those major than non-URM students.[31] However, these estimates may be biased by the mechanical outflow of

[28]Mathematics and Statistics courses considered in-discipline for all fields, since those courses are often required by (and included in the GPA calculations of) many restricted majors.

[29]Major restrictions had little estimable effect on the GPA gap between URM and non-URM students earning restricted majors; both before and after restrictions' implementation, URM students in those majors earned 0.2 lower normed in-discipline GPAs in both introductory and upper-division courses. See Figure A-15.

[30]The correlation between in-discipline and out-of-discipline first-term normed GPAs is 0.84, which implies that GPA restrictions offer little scope for revealing field-specific comparative advantage.

[31]Figure A-14 shows that restrictions arrested growth, increased majors' average preparation, and decreased majors' URM share at each of the Berkeley, Santa Barbara, and Davis campuses. Interestingly, major restrictions have no observable immediate effects at Santa Cruz, suggesting that its restrictions were generally non-binding. Indeed, Figure A-19 shows that Santa Cruz's economics restriction was non-binding for its first seven years.

students from the restricted major into 'control' majors, which would upwardly bias the estimated βs away from 0 by moving the control majors in the opposite direction of the restricted majors. We investigate the importance of this mechanical relationship by conducting a placebo bootstrap exercise, pulling 1,000 draws of 29 campus-year pairs as placebo restrictions and re-estimating the difference-in-difference models over each set. These bootstraps permit estimation of empirical p-values for one-sided tests of the statistical significance of the presented β estimates, shown in the last row of Table 6. For example, the 3.31 percentage point decline in the URM share of restricted major attainment is a larger decline than all but 3.7 percent of the placebo estimates, suggesting that the observed decline is very unlikely to be explained by cross-major mechanical correlations.

Major restrictions appear to filter out students with general academic disadvantages as opposed to students with disadvantages specific to the field of study. Appendix C uses a case study of two campuses' economics majors, only one of which is restricted, to further investigate the mechanisms by which restrictions limit URM students' access to lucrative majors. It shows that URM students' poorer pre-college academic opportunity and preparedness fully explain the observed decline in URM enrollment. The next section devolves this section's department-level analysis to the student level in order to understand where students flow after they exit restricted majors.

5 Major Restrictions and College Major Attainment

Characterizing the effects of major restriction policies on students' stratification across majors requires knowledge of the counterfactual majors students would attain as a result of the restrictions. We identify these alternative majors by observing the attainment of students who *intend* to earn restricted majors before and after the restrictions are implemented.

5.1 Empirical Methodology

We approximate students' revealed-preference major intentions by leveraging information from their first-term course enrollments, which they select in the first weeks after arriving on campus.[32]

[32]Some previous studies have proxied UC students' major intentions using the 'intended majors' reported on their undergraduate applications (e.g. Arcidiacono, Aucejo, and Hotz, 2016), but these self-reported intended majors are

Because a wide variety of courses are available to students in their first term, their choices reveal substantial information about their major intentions.

Let M_{im} indicate whether student i declares a major in field m, with m reflecting a campus-major pair.[33] In order to isolate students' major intentions absent the access limitations of major restriction policies, we begin by constructing a within-campus training sample of 50 percent of students between four and five years before major m's restriction's implementation for each restricted major m. We then predict training-sample students' declaration of major m by indicators for enrollment in each available first-term course, gender, and URM status using a random forest estimator (Ho, 1995).[34]

We employ the resulting prediction algorithm to estimate $\hat{M}_{im}$ for every student at that campus between six years before the restriction and four years after it (excluding the training sample).[35] Students with higher $\hat{M}_{im}$ took courses that more strongly suggest their intention to major in m. Courses strongly predict major choice: the correlation between M_{im} and $\hat{M}_{im}$ is 0.37 in the out-of-sample students four to five years before the major restriction's implementation and remains 0.31 three to four years after implementation. Students who declare major m three years before the major's implementation have a mean (s.d.) $\hat{M}_{im}$ of 0.13 (0.18).[36]

Figure 7 plots the evolution of students' revealed-preference major intentions ($\hat{M}_{im}$) around the imposition of the 20 major restrictions with estimable intentions in our sample.[37] Intentions to

non-binding, can be strategically selected, and are not reported by about one-third of students (Bleemer, 2020). We focus instead on students' revealed preferences.

[33]Students are associated with their final declared majors. Students who drop a major and declare another are no longer indicated as having declared the first major.

[34]We estimate each model using the default settings of the $randomForestSRC$ R package, version 2.12.0, which estimates 500 classification trees with no minimum node size. Courses with fewer than five enrollees in the training data are omitted. The sample is reweighted to give equal aggregate weight by gender and URM status. If fewer than 40 students in the training data declared the major, 50 percent of $t-3$ students are added to the training data.

[35]About one-third of University of California students are transfer students from community colleges. Major restrictions are binding for both freshman and transfer students, and both are maintained in the estimation sample.

[36]Figure A-16 shows that the full distributions of $\hat{M}$ overall and for students who declare the major slightly shift to the left over time, as departmental changes in introductory course sequences erode our capability to predict students' intended majors, but the small magnitudes of the shift among both URM and non-URM students suggest little reason to expect these shifts to bias our baseline estimates.

[37]In particular, we estimate models of the form: $\hat{M}_{im} = \zeta_m + \sum_{t=-6}^{6} \beta_{it} \mathbb{1}\{y_i + t = R_m\} + \epsilon_{im}$ by weighted least squares, with weights equal to the inverse number of students at that campus so that each major is equally weighted in the analysis (matching the previous section). The standard errors are clustered by major and by student and assume that $\hat{M}_{im}$ are observed without noise. Estimates of $\hat{M}_{im}$ are unavailable for majors other than these 20 because either gender and ethnicity data was unavailable or the majors were created too soon before the restriction.

declare restricted majors rose in the years leading up to those restrictions and then slightly declined after their imposition, by a noisily-estimated 10 percentage points. However, the change in intentions does not exhibit a URM gap, suggesting that the disproportionate decline in URM enrollment does not arise from differential discouragement from departments' introductory courses.[38]

Having characterized students' revealed intentions to declare restricted majors, we use $\hat{M}_{im}$ to identify changes in the major choices of students who intend restricted majors in the years before and after the restrictions are implemented. We estimate the following staggered difference-in-difference models over a stacked student-campus-major dataset by weighted least squares:

$$Y_{im} = \zeta_{my_i} + \gamma\hat{M}_{im} + \sum_{t=-6}^{6} \beta_{it}\mathbb{1}\{y_i + t = R_m\} \times \hat{M}_{im} + \epsilon_{im} \tag{8}$$

These regressions include major-cohort indicators ζ_{my_i} to flexibly absorb within-campus major choice trends, leaving β_{it} to be identified by variation between students with stronger and weaker intentions of declaring the restricted major m relative to the baseline year. We estimate either a single $\hat{\beta}_{it}$ for each t (over all i) or two coefficients by ethnicity, setting $\beta_{-3} = 0$ for all i, and cluster standard errors by major and by student as if $\hat{M}_{im}$ were observed without noise.[39]

5.2 Results

Panel A of Figure 8 shows that the imposition of major restrictions does not cause a measurable overall shift in the average academic performance of the students who intend the restricted majors, as measured by students' two-way GPA fixed effect. However, major restrictions decrease the likelihood with which students who intended the restricted major are able to successfully declare it by about 15 percentage points, though the average effect between one and four years after the policy's implementation is only marginally statistically significant.

As above, we summarize stratification-relevant changes in students' major attainment by the

[38]Appendix D examines the stratifying effects of major restrictions among intended majors by *gender*, showing that the decline in major intentions was wholly driven by female students, in line with other studies that have shown relatively larger discouragement effects of low grades (Ahn et al., 2019; Li and Zafar, 2021) and test scores (Azmat, Calsamiglia, and Iriberri, 2020) among female students.

[39]When estimating β_{it} by gender or ethnicity, we also condition on the interaction between $\hat{M}_{im}$ and the characteristic as well as characteristic-by-t fixed effects.

average wage premium associated with that major.[40] Interestingly, Panel (c) shows that the decline in restricted major declaration does not translate into any overall change in the average premium of declared majors; on average, students who intend a restricted major but are pushed into other fields by the restriction appear to declare similar-premium majors instead.

However, the major choices of URM and non-URM students who intend restricted majors diverge after the restriction's implementation. Panel B presents estimates of $(\hat{\beta}_{URM,t} - \hat{\beta}_{NonURM,t})$ for the same three outcomes, characterizing the major choices of high-$\hat{M}_{im}$ URM students relative to non-URM students.[41] URM students did not exhibit differential selection into major intention by average academic performance, though there is (relatively-weak) evidence that high-$\hat{M}_{im}$ URM students were less likely to declare the major than high-$\hat{M}_{im}$ non-URM students. However, high-$\hat{M}_{im}$ URM students' average major premium precipitously declined in the years following major restrictions; compared to the average non-URM student with $\hat{M}_{im} = 0.2$, major restrictions led similar-$\hat{M}_{im}$ URM students to declare majors with lower premiums by about 1.2 percentage points on average.[42]

These findings suggest that major restrictions tend to lead URM students to declare relatively lower-premium majors, not because they are discouraged from attempting to declare restricted majors but because they are *unable* to declare the major despite their intentions. Appendix C provides additional case-study evidence that major restrictions disproportionately prohibit URM students from declaring restricted majors (as opposed to URM students being discouraged from attempting restricted majors), showing that this can be fully explained by URM students' poorer average pre-college academic opportunity and preparation.

The presented difference-in-difference estimates average over *all* estimable major restriction policies, even though some impose restrictions on lower-premium majors. While we do not have sufficient power to restrict our analysis to the high-premium majors that are increasingly restricted at many U.S. colleges and universities, it would not be surprising to observe sharper increases in

[40] A crosswalk between ACS majors and UC majors is available from the authors.

[41] See Figure A-17 for separate β estimates by URM status.

[42] The major premium gap appears to abruptly close again 4 years after the restriction is imposed, though Panel (d) shows a sharp rise in URM students' relative academic performance that year as well. We interpret this as the result of growing mismeasurement of $\hat{M}_{im}$, which at that point is estimating major intentions using the course-taking behavior of students at least eight years prior.

stratification across majors in those cases.

6 Discussion: Major Restrictions and Ethnic Stratification

College major stratification by ethnicity has been rising since the late 1990s, and increasingly ubiquitous college major restriction policies tend to increase stratification. We estimate the potential contribution of new major restriction policies to college major stratification by comparing the observed growth in our four UC campuses' major premium gap with a simulated gap that our estimates suggest would be generated by the campuses' new major restrictions.

Let U_t and N_t be the sets of URM and non-URM UC students who matriculate at one of the four UC campuses in year t, and let W_i be the (unobserved) wage premium of the major that *would be* earned by student i absent any major restrictions. Then aggregate stratification at those four campuses (as defined in Equation 1) absent any restrictions can be written as

$$\frac{1}{|N_t|}\sum_{i\in N_t} W_i - \frac{1}{|U_t|}\sum_{i\in U_t} W_i \tag{9}$$

Now let Γ be the set of campus-major pairs that have been restricted since some base year, and let P_r be the set of years in which major $r \in \Gamma$ was restricted. Let $\beta^U_{P_r t}$ and $\beta^N_{P_r t}$ denote the effects of major restriction policies on the major premiums earned by URM and non-URM students who intended those majors in t. Given student i's predicted degree of intention to major in r ($\hat{M}_{ir}$), observed aggregate stratification is

$$\frac{1}{|N_t|}\sum_{i\in N_t}\Big(W_i + \sum_{r\in\Gamma}\beta^N_{P_r t}\hat{M}_{ir}\Big) - \frac{1}{|U_t|}\sum_{i\in U_t}\Big(W_i + \sum_{r\in\Gamma}\beta^U_{P_r t}\hat{M}_{ir}\Big) \tag{10}$$

We estimate the difference between Equations 9 and 10 – the contribution of new major restrictions to aggregate stratification – by imposing a series of simplifying assumptions. We abstract away from major restrictions' small differential impact on students' major intentions by replacing the non-URM average $\hat{M}_{ir}$ with the URM average. This permits us to estimate and employ a single causal coefficient between restrictions and ethnicity differences in major choice,

$\widehat{(\beta^N_{P_rt} - \beta^U_{P_rt})}$, which we estimate to be about -0.06 – the average of the $\hat{\beta}_t$ coefficients 1-3 years following restriction implementation (from Figure 8) – when the restriction is in place. Because we are unable to estimate major intentions many years after restrictions' implementation (due to changes in introductory curricula that decrease the reliability of our predicted major attainment), we also fix $\sum_{i \in U_t} \hat{M}_{ir}$ at its average value 1-3 years following restrictions' implementation scaled by the URM population at that campus. This means we can simulate the contribution of newly-implemented major restrictions to the growth in UC college major stratification since 1995 as

$$SimGap_t \approx \widehat{(\beta^N - \beta^U)} \sum_{r \in \Gamma} \left(\mathbb{1}\{t \in P_r\} \frac{1}{|U_{\min(P_r)}|} \sum_{i \in U_{\min(P_r)}} \hat{M}_{ir} \right). \tag{11}$$

This sums the estimated contribution of each post-1995 restriction to the ethnicity premium gap.[43]

Figure 9 shows that newly-implemented major restrictions alone effectively explain UC's growth in ethnic stratification between the 1995 and 2011 graduating classes, but that growth in stratification after 2011 – the first year whose graduating class largely chose majors after the '07-08 financial crisis – outstripped the effects of new restrictions. One important contributor to post-2011 stratification not captured by the simulation is the recent tightening of many high-premium UC departments' restrictions, likely in response to a post-crisis surge in student demand for lucrative majors.[44] Some economics departments, for example, substantially sharpened the enforcement of their GPA restrictions immediately following the financial crisis (see Figures A-18 and A-19), and computer science departments similarly tightened their restrictions in the late 2010s; for example, Berkeley increased its computer science GPA threshold from 3.0 to 3.3 in 2015. Our findings suggest that the compounding restrictions in these fields – which are also among the five largest majors at all four UC campuses – likely explain an appreciable share of UC's post-2011 stratification growth. We conclude that major restriction policies alone can largely explain the recent growth in college major stratification at the observed University of California campuses, providing further evidence that major restrictions are a first-order contributor to the recent growth

[43]For restricted majors that had no observable students either three years before or three years after the restriction's implementation – prohibiting estimation of the mean $\hat{M}_{ir}$ in Equation 11 – we replace $\hat{M}_{ir}$ with M_{ri}, observed major attainment, scaled by 1.26, the average ratio between predicted and actual URM majors 1-3 years following restrictions' implementation.

[44]While the presence of major restrictions precludes clear observation of major demand on our study campuses, recessions increase national demand for lucrative fields of study (Blom, Cadena, and Keys, 2021).

in ethnic stratification across college majors in the United States.

7 Conclusion

The gap in the economic value of college majors earned by underrepresented minority (URM) and non-URM graduates has increased more than three-fold since the mid-1990s, with Black and Hispanic graduates earning degrees that have 3 percent lower average earnings than those received by their white and Asian peers. About two-thirds of this rise in ethnic stratification can be explained by the rise of within-institution stratification, which in turn has been particularly increasing at the large public research universities that enroll about a quarter of American college students. Those universities' increasingly prevalent major restriction policies appear to have played an important role in stratifying their lucrative majors by ethnicity: implementing a new major restriction policy tends to decrease the restricted department's URM enrollment by 20 percent and disproportionately push URM students who intended the major into less-lucrative fields instead. In the same way that test-based meritocratic admissions policies inefficiently limit selective university access among applicants with poorer academic qualifications, the stratification generated by major restriction policies exacerbates equity gaps between high- and low-SES families, with negative implications for efficiency, economic mobility, and the ethnicity wage gap.[45]

References

Abowd, John M., Francis Kramarz, and Davis N. Margolis. 1999. "High Wage Workers and High Wage Firms." Econometrica 67 (2):251–333.

Ahn, Thomas, Peter Arcidiacono, Amy Hopson, and James R. Thomas. 2019. "Equilibrium Grade Inflation with Implications for Female Interest in STEM Majors." NBER Working Paper 26556.

Altonji, Joseph, Peter Arcidiacono, and Arnaud Maurel. 2016. "The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects." Handbook of the Economics of Education 5:305–396.

Altonji, Joseph, Erica Blom, and Costas Meghir. 2012. "Heterogeneity in Human Capital Investments: High School Curriculum, College Major, and Careers." Annual Review of Economics 4 (1):185–223.

Altonji, Joseph G. and Rebecca M. Blank. 1999. "Race and Gender in the Labor Market." Handbook of Labor Economics 3:3143–3259.

Andrews, Rodney and Kevin Stange. 2019. "Price Regulation, Price Discrimination, and Equality of Opportunity in Higher Education: Evidence from Texas." American Economic Journal: Economic Policy 11 (4):31–65.

Arcidiacono, Peter. 2004. "Ability Sorting and the Returns to College Major." Journal of Econometrics 121 (1-2):343–375.

[45]See Bleemer (2021) and Bleemer and Mehta (2021) for evidence on the efficiency of test-based admissions policies and major restriction policies, respectively.

Arcidiacono, Peter, Esteban Aucejo, and V. Joseph Hotz. 2016. "University Differences in the Graduation of Minorities in STEM Fields: Evidence from California." American Economic Review 106 (3):525–562.

Arcidiacono, Peter, Esteban Aucejo, and Ken Spenner. 2012. "What happens after enrollment? An analysis of the time path of racial differences in GPA and major choice." IZA Journal of Labor Economics 1 (5).

Arcidiacono, Peter, Josh Kinsler, and Tyler Ransom. 2019. "Legacy and Athlete Preferences at Harvard." Journal of Labor Economics .

Arcidiacono, Peter and Cory Koedel. 2014. "Race and College Success: Evidence from Missouri." American Economic Journal: Applied Economics 6 (3):20–57.

Armstrong, Elizabeth A and Laura T Hamilton. 2013. Paying for the Party. Harvard University Press.

Azmat, Ghazala, Caterina Calsamiglia, and Nagore Iriberri. 2020. "Gender Differences in Response to Big Stakes." Journal of the European Economic Association 14 (6):1372–1400.

Bayer, Patrick and Kerwin Kofi Charles. 2018. "Divergent Paths: A New Perspective on Earnings Differences Between Black and White Men Since 1940." Quarterly Journal of Economics 133 (3):1459–1501.

Bertrand, Marianne and Sendhil Mullainathan. 2004. "Are Emily and Greg More Employable than Lakisha and Jamal? A Field Experiment on Labor market Discrimination." American Economic Review 94 (4):991–1013.

Bettinger, Eric P. and Bridget Terry Long. 2017. "Mass Instruction or Higher Learning? The Impact of College Class Size on Student Retention and Graduation." Education Finance and Policy 13 (1):97–118.

Black, Dan, Amelia Haviland, Seth Sanders, and Lowell Taylor. 2006. "Why Do Minority Men Earn Less? A Study of Wage Differentials Among the Highly Educated." Review of Economics and Statistics 88 (1):300–313.

Black, Dan A., Amelia M. Haviland, Seth G. Sanders, and Lowell J. Taylor. 2008. "Gender Wage Disparities among the Highly Educated." Journal of Human Resources 43 (3):630–659.

Bleemer, Zachary. 2018. "The UC ClioMetric History Project and Formatted Optical Character Recognition." Center for Studies in Higher Education Research Paper Series 18 (3).

———. 2020. "Mismatch at the University of California before Proposition 209." UC-CHP Policy Brief 2020 (5).

———. 2021. "Top Percent Policies and the Return to Postsecondary Selectivity." Manuscript .

———. 2022. "Affirmative Action, Mismatch, and Economic Mobility after California's Proposition 209." Quarterly Journal of Economics .

Bleemer, Zachary and Aashish Mehta. 2020. Major Restrictions, Socioeconomic Stratification, and Student Outcomes. Oakland, CA: UCOP Institutional Research and Academic Planning.

———. 2021. "Will Economics Make You Rich? A Regression Discontinuity Analysis of the Return to College Major." American Economic Journal: Applied Economics .

Blom, Erica, Brian C Cadena, and Benjamin J Keys. 2021. "Investment over the business cycle: Insights from college major choice." Journal of Labor Economics 39 (4):1043–1082.

Bound, John, Michael Lovenheim, and Sarah Turner. 2010. "Why Have American College Completion Rates Declined? An Analysis of Changing Student Preparation and Collegiate Resources." American Economic Journal: Applied Economics 2:129–157.

Bound, John and Sarah Turner. 2007. "Cohort Crowding: How Resources Affect Collegiate Attainment." Journal of Public Economics 91:877–899.

Brenoe, Anne Ardila and Ulf Zolitz. 2020. "Exposure to More Female Peers Widens the Gender Gap in STEM Participation." Journal of Labor Economics 38 (4):1009–1054.

Brown, Charles and Mary Corcoran. 1997. "Sex-Based Differences in School Content and the Male-Female Wage Gap." Journal of Labor Economics 15 (3):431–465.

Butcher, Kristin F., Patrick J. McEwan, and Akila Weerapana. 2014. "The Effects of an Anti-Grade-Inflation Policy at Wellesley College." Journal of Economic Perspectives 28 (3):189–204.

Canaan, Serena and Pierre Mouganie. 2021. "The Impact of Advisor Gender on Female Students' STEM Enrollment and Persistence." The Journal of Human Resources .

Card, David. 1999. "The Causal Effect of Education on Earnings." Handbook of Labor Economics 3:1801–1863.

Card, David and Laura Giuliano. 2016. "Universal Screening Increases the Representation of Low-Income and Minority Students in Gifted Education." Proceedings of the National Academy of Sciences 113 (48):13678–13683.

Card, David and Alan B. Krueger. 1992. "School Quality and Black-White Relative Earnings: A Direct Assessment." Quarterly Journal of Economics 107 (1):151–200.

Card, David and A. Abigail Payne. 2021. "High School Choices and the Gender Gap in STEM." Economic Inquiry 59 (1):9–28.

Carrell, Scott E., Marianne E. Page, and James E. West. 2010. "Sex and Science: How Professor Gender Perpetuates the Gender Gap." Quarterly Journal of Economics 125 (3):1101–1144.

Caulkins, Johnathan P., Patrick D. Larkey, and Jifa Wei. 1995. "Adjusting GPA to Reflect Course Difficulty." Manuscript .

Chetty, Raj, John Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan. 2020. "Income Segregation and Intergenerational Mobility Across Colleges in the United States." Quarterly Journal of Economics 135 (3):1567–1633.

Colwell, Rita, Ashley Bear, and Alex Helman. 2020. Promising Practices for Addressing the Underrepresentation of Women in Science, Engineering, and Medicine. Washington, D.C.: The National Academies Press.

Darity, William. 2005. "Stratification economics: The role of intergroup inequality." Journal of Economics and Finance 29 (2):144–153.

Darity, William A. and Patrick L. Mason. 1998. "Evidence on Discrimination in Employment: Codes of Color, Codes of Gender." Journal of Economic Perspectives 12 (2):63–90.

Deming, David J., Claudia Goldin, and Lawrence F. Katz. 2012. "The For-Profit Postsecondary School Sector: Nimble Critters or Agile Predators?" Journal of Economic Perspectives 26 (1):139–164.

Denning, Jeffrey and Patrick Turley. 2017. "Was that SMART? Institutional Financial Incentives and Field of Study." Journal of Human Resources 52 (1):152–186.

Gerard, Francois, Lorenzo Lagos, Edson Severnini, and David Card. 2021. "Assortative Matching or Exclusionary Hiring? The Impact of Employment and Pay Policies on Racial Wage Differences in Brazil." American Economic Review 111 (10):3418–3457.

Ho, Tin Kam. 1995. "Random decision forests." In Proceedings of 3rd international conference on document analysis and recognition, vol. 1. IEEE, 278–282.

Ioannides, Yannis M. and Linda Datcher Loury. 2004. "Job Information Networks, Neighborhood Effects, and Inequality." Journal of Economic Literature 42 (4):1056–1093.

Kirkeboen, Lars, Edwin Leuven, and Magne Mogstad. 2016. "Field of Study, Earnings, and Self-Selection." Quarterly Journal of Economics 131 (3):1057–1111.

Lang, Kevin and Jee-Yeon K. Lehmann. 2012. "Racial Discrimination in the Labor Market: Theory and Empirics." Journal of Economic Literature 50 (4):959–1006.

Li, Cher Hsuehhsiang and Basit Zafar. 2021. "Ask and You Shall Receive? Gender Differences in Regrades in College." American Economic Journal: Economic Policy .

MacLeod, W. Bentley and Miguel Urquiola. 2015. "Reputation and School Competition." American Economic Review 105 (11):3471–3488.

Mountjoy, Jack and Brent R. Hickman. 2020. "The Returns to College(s): Estimating Value-Added and Match Effects in Higher Education." Manuscript .

Mourifie, Ismael, Marc Henry, and Romuald Meango. 2020. "Sharp Bounds and Testability of a Roy Model of STEM Major Choices." Journal of Political Economy 128 (8):3220–3283.

National Academies. 2007. Rising Above the Gathering Storm. Washington, D.C.: The National Academies Press.

Neal, Derek A. and William R. Johnson. 1996. "The Role of Premarket Factors in Black-White Wage Differences." Journal of Political Economy 104 (5):869–895.

Novgorodsky, David and Bradley Setzler. 2019. "Practical Guide to Event Studies." Manuscript .

Page, Lindsay C. and Judith Scott-Clayton. 2016. "Improving College Access in the United States: Barriers and Policy Responses." Economics of Education Review 51:4–22.

Ruggles, Steven, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek. 2018. IPUMS USA: Version 8.0. Minneapolis, MN: IPUMS.

———. 2020. Integrated Public Use Microdata Series USA: Version 10.0 [dataset]. Minneapolis, MN: Minnesota Population Center, IPUMS. Https://doi.org/10.18128/D010.V10.0. Accessed March 2020.

Schmidt, Stephen J. 2021. "Minimum Grade Requirements for Economics Majors: Effects on Enrollments and Student Learning." AEA Papers and Proceedings 111:107–111.

Sloane, Carolyn M., Erik G. Hurst, and Dan A. Black. 2021. "College Majors, Occupations, and the Gender Wage Gap." Journal of Economic Perspectives 35 (4):223–248.

Stange, Kevin. 2015. "Differential Pricing in Undergraduate Education: Effects on Degree Production by Field." Journal of Policy Analysis and Management 34 (1):107–135.

Stinebrickner, Ralph and Todd R. Stinebrickner. 2014. "A Major in Science? Initial Beliefs and Final Outcomes for College Major and Dropout." The Review of Economic Studies 81 (1):426–472.

Sun, Liyang and Sarah Abraham. 2021. "Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects." Journal of Econometrics .

Turner, Sarah E. and William G. Bowen. 1999. "Choice of Major: The Changing (Unchanging) Gender Gap." Industrial and Labor Relations Review 52 (2):289–313.

Vars, Frederick and William Bowen. 1998. "Scholastic

Aptitude Test scores, race, and academic performance in selective colleges and universities." In The Black–White test score gap, edited by C. Jencks and M. Phillips. Washington, D.C.: Brookings Institution Press, 457–479.

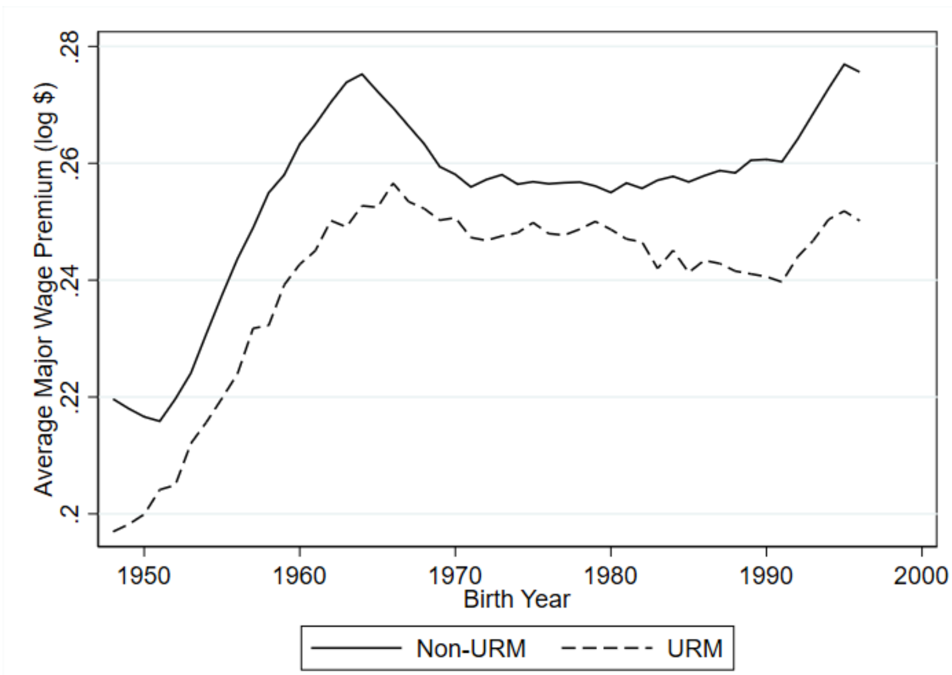
Wiswall, Matthew and Basit Zafar. 2015. "Determinants of College Major Choice: Identification Using an Information Experiment." Review of Economic Studies 82:791–824.

———. 2018. "Preference for the Workplace, Investment in Human Capital, and Gender." Quarterly Journal of Economics 133 (1):457–507.

———. 2021. "Human Capital Investments and Expectations about Career and Family." Journal of Political Economy 129 (5):1361–1424.

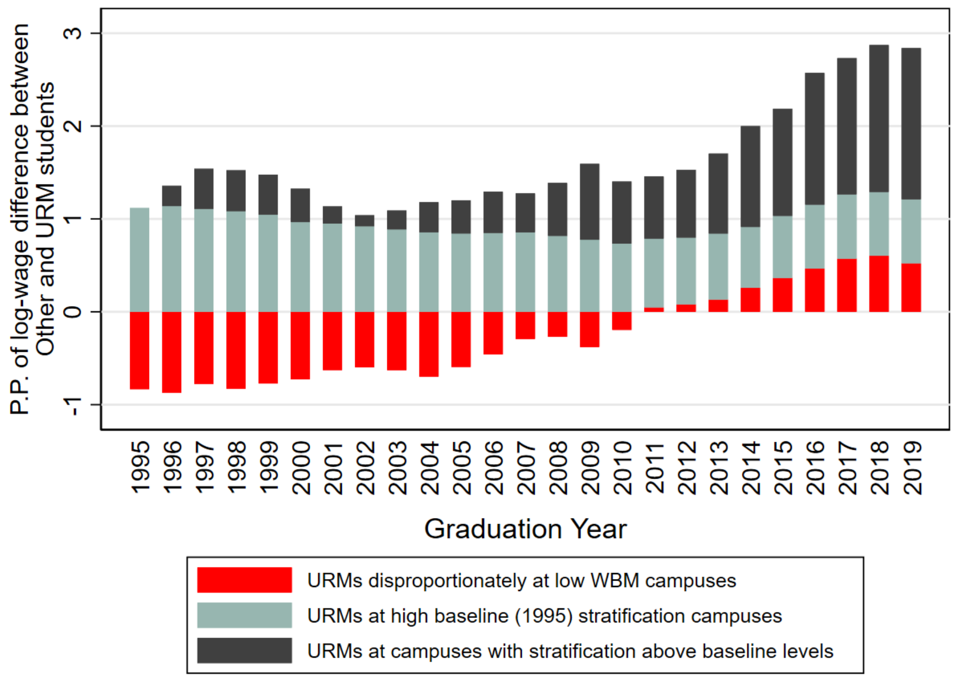
Wittman, Donald. 2020. "GPA is a Terrible Measure of College Success: There are Much Better Grade-Based Alternatives." Manuscript .

Figure 1: Average College Major Premium by Birth Cohort and Ethnicity



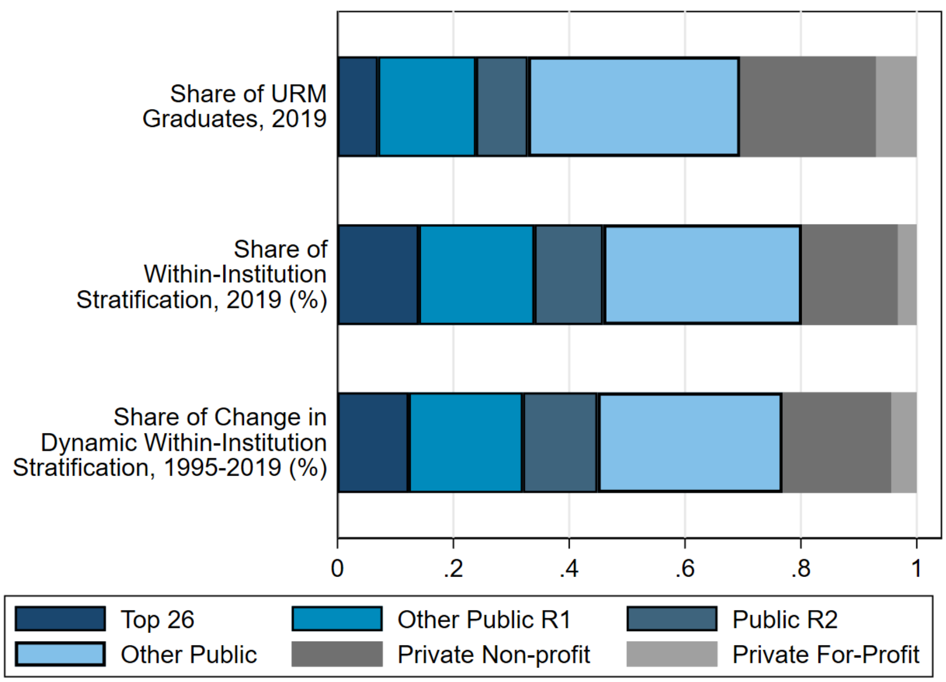
Note: Average college major wage premium of college graduates by birth cohort and ethnicity among 2009-2019 ACS respondents. Major premiums are estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, and year covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS; see Appendix A for details. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018).

Figure 2: Annual Between- and Within-Institution Ethnic Stratification by Major



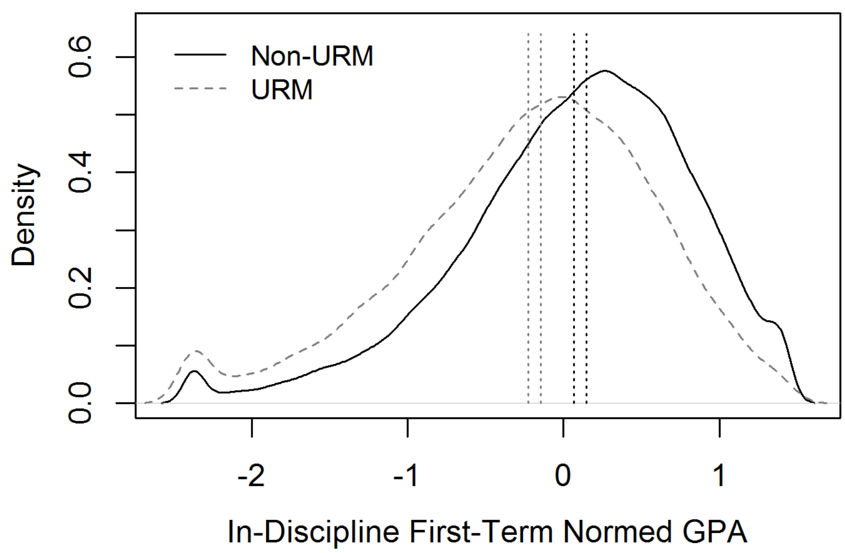
Note: Annual estimates of the three terms of Equation 5 for the 1995-2019 cohorts of college graduates, presenting average between-institution, static within-institution, and dynamic within-institution components of ethnic stratification across college majors in the U.S. higher education system. The static within-institution component fixes universities' level of stratification in 1995, while the dynamic component weights universities by their differential stratification (relative to 1995) in that year; otherwise the decomposition follows the traditional between-within pattern. The sample is limited to four-year degree-granting institutions in the 50 U.S. states. Average college major premiums are assumed to be equal across ethnicities in institution $\times$ year cells in which no graduates of one ethnicity are observed. Major premiums are estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, and year covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS; see Appendix A for details. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018) and IPEDS.

Figure 3: Within-Institution Ethnic Stratification: Contributions of Sectors



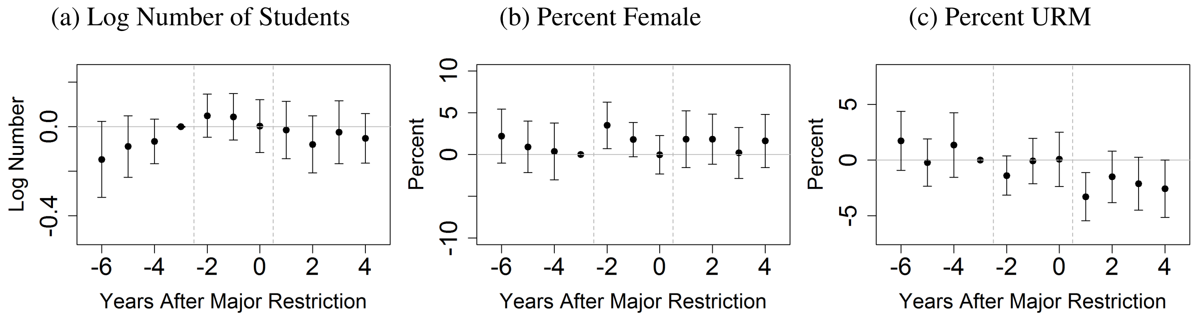
Note: The 2019 share of URM graduates, the 2019 contribution to within-institution stratification, and the contribution to the 1995-2019 change in dynamic within-institution stratification by higher education sector. For each sector T, its share of URM graduates is $P_t(T|U) = \Sigma_{i \in T} P_t(i|U)$. Sector contributions to within-institution stratification are sector subtotals of the second summation in Equation 4, and sector contributions to the change in dynamic within-institution stratification are sector subtotals of the third summation in Equation 5. The sample is limited to four-year degree-granting institutions in the 50 U.S. states. Average college major premiums are assumed to be equal across ethnicities in institution $\times$ year cells in which no graduates of one ethnicity are observed. Major premiums are estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, and year covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS; see Appendix A for details. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018) and IPEDS.

Figure 4: Distribution of Introductory Course GPAs by Ethnicity



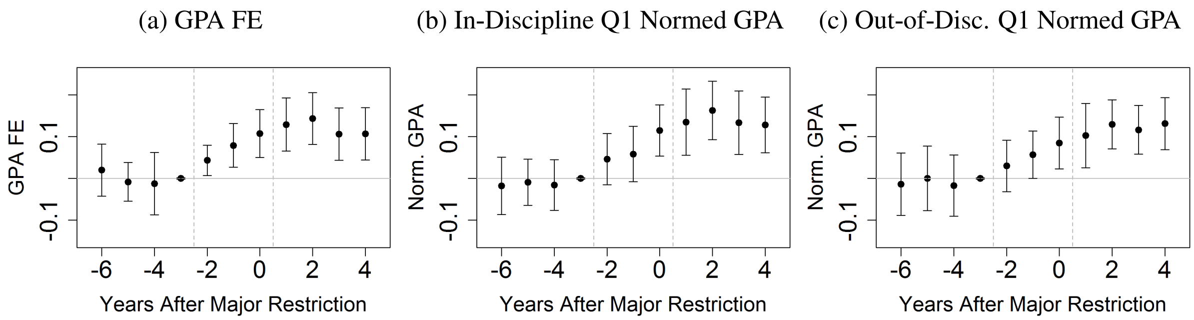
Note: Kernel density plots of winsorized normed first-term in-discipline grades among students who declared restricted majors three cohorts before that major was restricted, by ethnicity. Dotted lines show the median (right) and mean (left) values by ethnicity. Normed GPA is defined within-course following Equation 6; in-discipline courses include those in the major's discipline (Humanities, Social Sciences, Natural Sciences, Engineering, or Professional) along with all math and statistics courses. Source: UC ClioMetric History Project Student Database.

Figure 5: Department-Level Event Study: Student Demographics



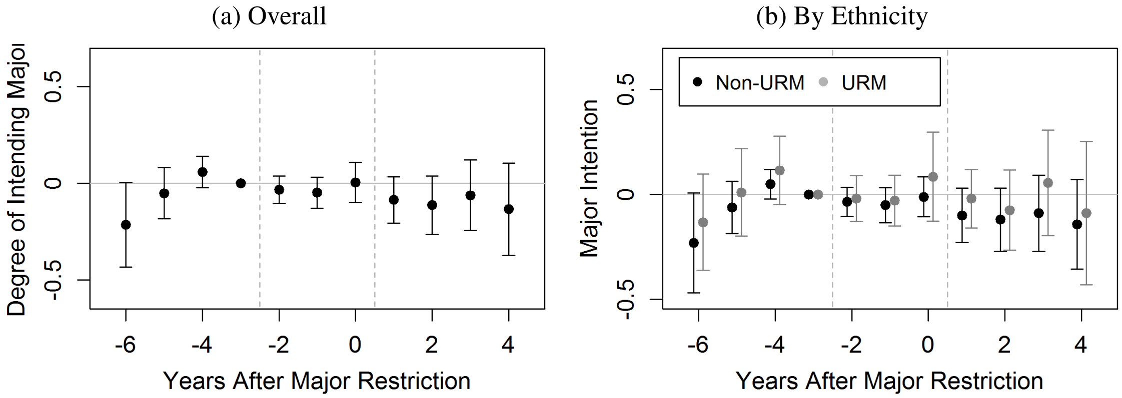
Note: Event study β estimates of demographic characteristics of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year. Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). Source: UC ClioMetric History Project Student Database.

Figure 6: Department-Level Event Study: Student Academic Characteristics



Note: Event study β estimates of the measured academic performance of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year. Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). GPA fixed effect is the student effect from a two-way fixed effect model of grades on students and course-terms. Normed GPA is defined within-course following Equation 6; out-of-discipline courses include those taken outside the major's discipline (Humanities, Social Sciences, Natural Sciences, Engineering, and Professional) and excluding Mathematics and Statistics courses, while in-discipline courses include those in the major's discipline. Source: UC ClioMetric History Project Student Database.

Figure 7: Estimated Changes in Students' Intentions for Restricted Majors

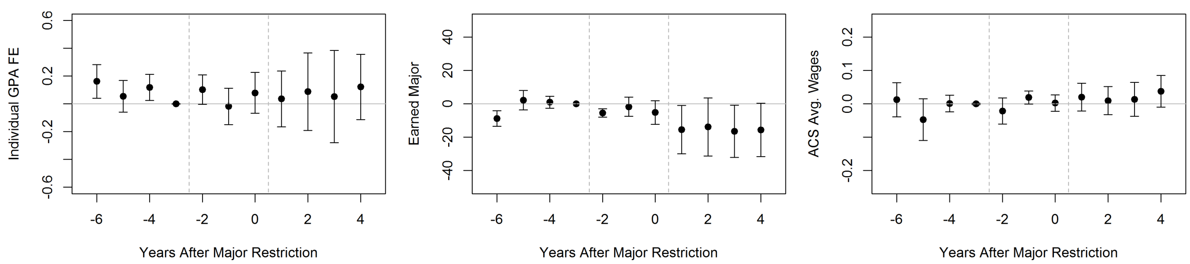


Note: Event study β_{it} estimates – overall and by URM ethnicity – of the average degree to which students exhibit their intention to earn newly-restricted majors ($\hat{M}_{im}$) before and after the implementation of the restriction, following Equation 37 and estimated over a stacked dataset of students i's major intentions in field m. $\beta_{i,-3}$ is omitted, and standard errors are two-way clustered by campus-majors m and by students i. Models include m fixed effects. Asterisks reflect p-values from hypothesis tests of equality in each period by gender or ethnicity: $*$ ten percent, $**$ five percent, and $***$ one percent. Source: UC ClioMetric History Project Student Database.

Figure 8: Changes in Major Choice and Composition of Students Who Intend Restricted Majors

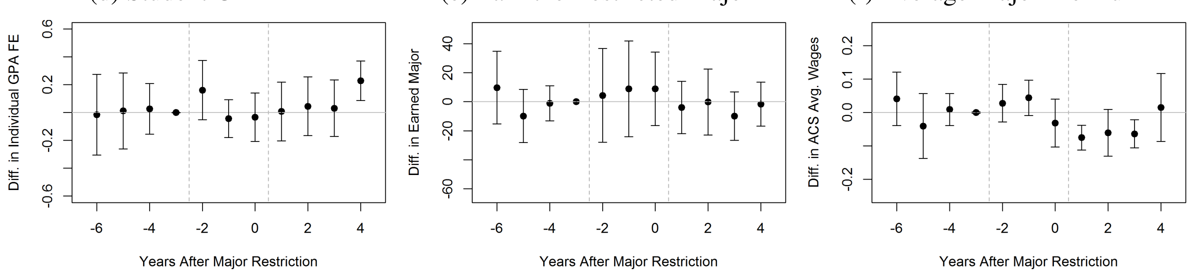
Panel A: Overall Average Change After Major Restriction

(a) Student GPA FE (b) Earn the Restricted Major (c) Average Major Premium



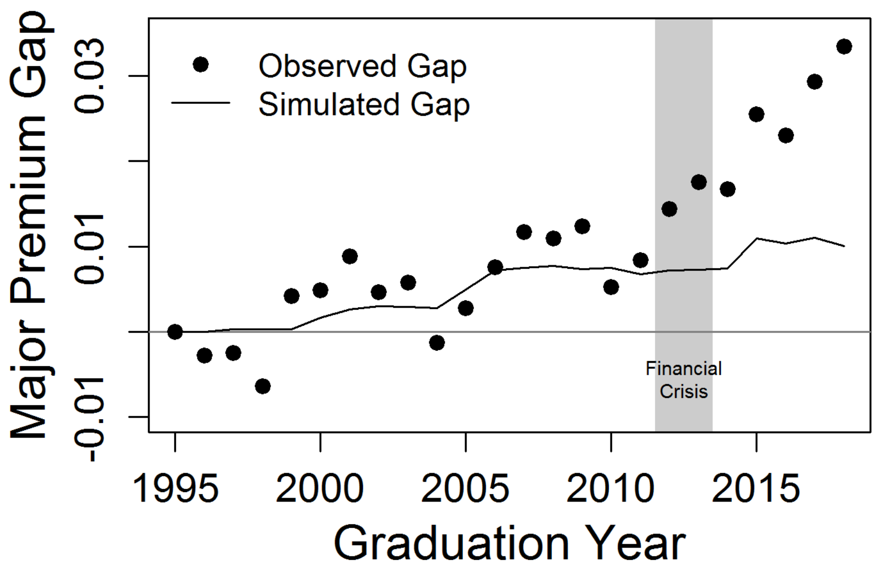
Panel B: Relative Change Among URM Students Compared to Non-URM Students

(d) Student GPA FE (e) Earn the Restricted Major (f) Average Major Premium



Note: Difference-in-difference event study β_{it} estimates of the relationship between students' intending the restricted major ($\hat{M}_{im}$) and their major choice or student characteristic before and after the implementation of the restriction, following Equation 8 and estimated over a stacked dataset of students i's major intentions in field m. Panel B shows the differences between estimates changes for non-URM and URM students. Outcomes are defined as the student's GPA fixed effect (their individual fixed effect from a two-way fixed effect model of GPA on student and course effects), whether the student declares the restricted major, and the premium of the student's major (as defined in Appendix A). β_{-3} is omitted, and standard errors are two-way clustered by campus-majors m and by students i. Models include campus-major-cohort fixed effects. Source: UC ClioMetric History Project Student Database and the American Community Survey (Ruggles et al., 2020).

Figure 9: Growth in UC Major Premium Gap, Actual and Simulated from New Restrictions



Note: The difference in the average major wage premium earned by URM and non-URM graduates of UC Berkeley, Davis, Santa Barbara, and Santa Cruz (relative to 1995) and the simulated difference that would be expected given the major restrictions imposed by those campuses since 1995 following Equation 11. See text for details. Shaded region indicates the two cohorts of students who experienced the '07-08 financial crisis in their first year (assuming graduation after four years). URM includes Black, Hispanic, and Native American students. Source: UC ClioMetric History Project Student Database and the American Community Survey (Ruggles et al., 2020).

Table 1: Binding Major Restrictions at the Top 25 US&WR Ranked Public Universities, Fall 2019

Univ.	Undergrad. Students	Computer Science	Economics	Finance	Mechanical Engineering	Nursing
Cornell†	14,907	2.5	2.7	3.3; A	2.5; A	*
UCLA	31,002	3.5; A	2.5	3.3	3.5; A	HS
UC Berkeley	30,853	3.3	3.0	A	3.0; A	*
Virginia	16,655	-	-	A	2.5	A
Michigan	29,821	-	-	A	A	A
UC Santa Barbara	22,186	3.2	2.85	2.85	A	*
UNC – Chapel Hill	18,862	-	-	3.0; A	*	A
UC Irvine	29,307	3.0	2.5	3.0; A	3	A
Georgia Tech	15,573	-	-	-	-	*
Florida	35,247	-	3.0	3.0	2.8	3.3
William and Mary	6,285	-	-	2.5; A	*	*
UC Davis	30,145	3	-	*	2.8	*
UC San Diego	28,587	3.3; A	2.5	*	A	*
Georgia	28,848	-	A	A	A	*
UI – Urbana-Champaign	33,955	3.75; A	-	A	3.75; A	*
UT – Austin	40,492	A	-	3.25; A	3.0; A	3.0; A
UW – Madison	32,196	-	-	2.75; A	A	2.75; A
Ohio State	45,946	3.2	-	3.0; A	3.4	A
Purdue	31,006	-	2.75	-	3.2; A	2.75
Rutgers	35,641	-	-	A	A	HS
Penn. State – Univ. Park	40,835	HS	-	3.2	HS	HS
Washington	31,331	A	A	2.5; A	A	2.8; A
Connecticut	19,241	3.0; A	-	A	3.0; A	3.0; A
UMD – College Park	29,868	-	-	A	2.7	3.0; A
Clemson	19,402	-	-	-	HS	A
Texas A&M	53,065	2.75; A	3.0	3.5; A	3.5; A	A

Note: The Fall 2019 minimum major admissions requirements for enrolled students at the top 25 public universities as ranked by US News and World Report in 2019, in addition to Cornell University (which is †part-public). A number indicates the minimum GPA required in department-specified courses for current students to declare the major, omitting restrictions of C+ or lower. Chosen majors are the top-earning majors reported in Altonji, Blom, and Meghir (2012) averaged between male and female students, Table 3, omitting Electrical Engineering due to its similarity with Computer Science. Finance includes Business Administration, Business Economics, and Economics and Accounting majors when otherwise unavailable.

HS: Students must be directly admitted from high school to the major (with elevated admissions standards). **A**: Students must submit a successful internal application after initial enrollment in order to earn the major. *****: Major is unavailable.

Source: University and department websites and US News & World Report, August 2019

Table 2: Annual Within-Institution Stratification by Sector

Year	Top 26 Publics	Other Public R1	Public R2	All Other Publics	Non-Profit Schools	For-Profit Schools	All Institutions
1995	2.0	1.0	1.1	1.2	1.0	0.2	1.2
2019	4.6	2.7	3.0	2.2	1.7	1.1	2.3

Note: The URM-weighted average of within-institution stratification $\left(S_t(i) = \sum_m W_m \Delta_R[P_t(m|i,R)]\right)$, measured in log dollars, overall and by university sector. Years indicate college graduation cohort years. The higher education sectors partition four-year U.S. institutions; R1 and R2 research universities follow the Carnegie Classification.

Source: 2009-2019 American Community Survey (Ruggles et al., 2018) and IPEDS.

Table 3: Observational Relationship between Major Restrictions and URM Stratification

	URM Share in Major	
Any Restriction	-3.0 (1.3)	
Mechanical Restriction		-3.1 (1.1)
Discretionary Restriction		0.1 (1.6)
Institution FE	X	X
Field of Study FE	X	X
$\bar{Y}$	11.1	
Observations	98	

Note: Estimates from an OLS linear regression of a major's 2019 URM (Black or Hispanic) graduate share on whether the major is restricted, over the 26 institutions and four of the five majors presented in Table 1. Nursing is excluded because it is restricted on every campus at which is offered. Mechanical restrictions limit access to students with below-threshold introductory grades; discretionary restrictions limit access to students based on detailed applications, generally including both measured academic preparation along with essays and other materials. Each model includes institution and major fixed effects. Standard errors clustered by institution in parentheses.

Source: Integrated Postsecondary Education Data System.

Table 4: Fifty Years of Major Restrictions at Four Universities

Major	Years First	Years Last	Rule	Major	Years First	Years Last	Rule
			UC Berkeley				
Business°	1970	-	A	Art	1993	-	A/3.3
Economics	1976	-	3.0	Psychology	2003	-	3.2
Computer Science	1979	2007	3.0	Public Health	2004	-	A/2.7
Political Economy	1980	2004	3.0-3.2	Oper. Research†	2005	-	3.2
Media Studies†	1980	-	A/3.2	Env. Econ. & Pol.	2009	-	2.7
Biochemistry*	1988	1989	2.7	Computer Science*	2013	-	3.0-3.3
			UC Davis				
Statistics	1982	2004	3.0	Communication	2001	2013	2.5
Land. Architecture	1986	-	A	Human Dev.	2001	-	2.5
Psychology	1989	-	2.5	Managerial Econ.	2001	2011	2.8
Int. Relations	1992	2013	2.5	Biotechnology	2007	-	2.5
Computer Science	1997	2004	2.75	Design*	2011	2013	2.6
Exercise Science*	1997	2000	2.5	Mechanical Eng.*	2011	2014	2.8
Vit. and Enology	1998	-	2.5	Computer Science*	2016	-	3.0
Ferment. Science*	1998	2000	2.5				
			UC Santa Barbara				
Computer Science°	<1983	2014	A/3.2	Political Science	1988	-	2.6
Communication°†	1983	-	2.5-3.0	Biology	1996	-	‡
Economics°	1984	-	2.7-2.85	Law and Society	1997	2006	2.5
Psychology°	1985	-	2.5-2.75	Biopsychology	2001	-	2.7-2.75
Mathematics°	1985	-	2.5	Computer Eng.	2003	2013	3
Electrical Eng.	1986	1996	3	Fin. Math. and Stat.	2005	-	2.5
			UC Santa Cruz				
Economics	2002	-	2.8	Chemistry	2011	-	2.5
Physics	2008	-	2.7	Cognitive Science†	2011	-	2.5
Psychology	2011	-	2.7	Applied Linguistics*	2016	-	2.7

Note: Eligible major restrictions include GPA requirements for specified courses exceeding a C+ (2.3) or an internal competitive application. Does not include majors that are open to admits to a specific college but closed to admits to different colleges, like most Engineering majors; in any case, those policies have little changed in this period. † indicates that the major has had restrictions since within two years of its creation; * indicates that the restriction only lasted (or has only lasted) for a small number of years, either of which lead the major to be omitted from analysis below; and ° indicates that the major was implemented prior to the beginning of our data. The reported years are one year before the first or last year in which the restriction is mentioned in the campus's course catalog. **A**: Students must submit a successful internal application after initial enrollment in order to earn the major. ‡ UCSB Biology implements a complex and highly-stratified major restriction that requires several course-catalog pages to explain (with dozens of alternative paths leading to different major specialties), though ultimately never requires GPA performance over 2.0 in any course.

Source: University of California course catalogs.

Table 5: Descriptive Statistics of UC Campus Majors

	All	Berkeley	Davis	Santa Barbara	Santa Cruz	3 Years Before Major Restriction
Number of Majors	216 [73]	77 [5]	91 [13]	54 [3]	40 [5]	
# Students	83 [110]	92 [111]	60 [91]	107 [138]	94 [101]	187 [161]
% Female	53 [22]	52 [21]	55 [23]	54 [23]	53 [22]	51 [21]
% URM	19 [17]	18 [17]	18 [17]	22 [20]	20 [15]	13 [7]
Sample Size, Overall						
Events	29	7	10	7	5	
Major-Years[1]	6,237	2,222	1,855	1,113	1,047	
Sample Size, Observe Demographics						
Events	25	7	7	6	5	
Major-Years[1]	5,763	2,222	1,455	1,039	1,047	

Note: Descriptive statistics of the average number of departments at each covered university, average number of students per department, and average percent of female and URM students across departments, for all departments and for departments three years before instituting major restrictions. Standard deviations in brackets. Events indicate number of new observable major restrictions (see Table 4) and major-year observations, in the full sample and in the sample where student demographic characteristics (like ethnicity) are observed. [1] Only includes major-years with at least 20 observations; smaller departments are omitted from analysis.

Source: UC ClioMetric History Project Student Database.

Table 6: Summary of Department Difference-in-Difference Estimates around Major Restriction Implementation

	Log Num. of Students	Percent Female	Percent URM	SAT Score	GPA FE	First Term GPA[1] In Disc.	Out of Disc.
4-7 Yrs. Before Restriction	-0.10	1.12	0.96	-3.61	-0.00	-0.01	-0.01
	(0.06)	(1.34)	(0.94)	(11.74)	(0.03)	(0.02)	(0.03)
Transition Years	0.03	1.66	-0.41	11.90	0.08	0.07	0.06
	(0.05)	(0.94)	(0.94)	(11.35)	(0.02)	(0.03)	(0.03)
1-5 Yrs. After Restriction	-0.04	1.39	-2.35	30.24	0.12	0.14	0.12
	(0.06)	(1.40)	(1.09)	(13.82)	(0.03)	(0.04)	(0.03)
Campus-Major FE	X	X	X	X	X	X	X
Campus-Year FE	X	X	X	X	X	X	X
Observations	6,354	5,867	5,867	4,200	6,174	5,835	5,753
$\bar{Y}$	4.3	52.8	18.7	1819		0	0
Δ (Post-Pre)[2]	0.06	0.28	-3.31	33.85	0.12	0.13	0.13
	(0.08)	(1.22)	(0.84)	(13.27)	(0.03)	(0.03)	(0.03)
Placebo p-value[3]	[0.626]	[0.872]	[0.037]	[0.058]	[0.000]	[0.000]	[0.004]

Note: Event study β estimates of the measured characteristics of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year. Standard errors clustered by campus-major in parentheses. Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. "Before" indicates 3-7 years before initial restriction implementation; "Transition" includes the year of implementation and two years earlier; and "After" includes 1-5 years following implementation. β_{-3} is omitted. Students can be included in more than one major estimate (e.g. as double-majors). [1]First-term normed GPA is defined within-course following Equation 6; out-of-discipline courses include those taken outside the major's discipline (Humanities, Social Sciences, Natural Sciences, Engineering, and Professional) and excluding Mathematics and Statistics courses, while in-discipline courses include those in the major's discipline. [2] The difference between "After" and "Before" Major Restriction β coefficients, with standard error in parentheses. [3]An exact p-value on Δ (Post-Pre) from 1,000 draws of placebo major restrictions, to account for mechanical correlations as students move between departments in general equilibrium.

Source: UC ClioMetric History Project Student Database and UC Corporate Student System.

Online Appendix

College Major Restrictions and Student Stratification

Zachary Bleemer and Aashish Mehta

December, 2021

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Appendix A: Baseline and Alternative Estimates of College Major Premiums

College major choice has important causal consequences for subsequent labor market outcomes, generating wage differences which may exhibit even higher variance than the distribution of value-added across more- and less-selective American universities (Kirkeboen, Leuven, and Mogstad, 2016). While the interpretation of observational wage differences between majors is complicated by selection bias (Arcidiacono, 2004), college major premium statistics adjusted for simple demographic characteristics have been shown to provide reasonable proxies for the field-specific returns experienced by students on the GPA-restriction margin of college major access in at least one context (Figure A-1). As a result, we index the 'economic quality' of college majors by estimating the following model over 2009-2019 college-educated and employed ACS respondents between age 35 and 45 by OLS:

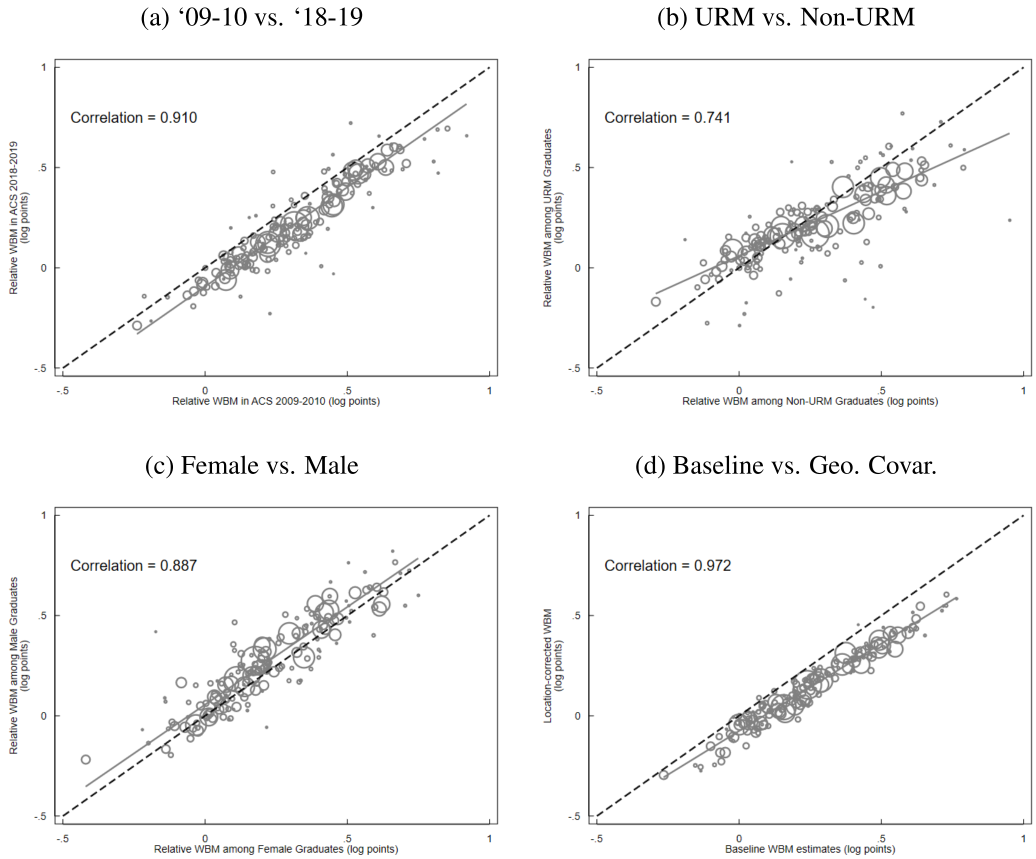
$$Wage_{it} = P_{m_i} + \alpha_{g_i e_i a_i d_i t} + \epsilon_{it} \tag{AA-1}$$

where log wage income $Wage_{it}$ is projected onto an additive function of the major earned by i and the full set of interactions between indicators for i's gender (g_i), six ethnicity categories (e_i), age (a_i), whether i earned more than one college major (d_i), and the survey year t. Respondents who report more than one major are randomly assigned to one of their majors. Our baseline estimates of P_{m_i} are presented for each ACS major category in Table A-1.

We test the sensitivity of these P_{m_i} coefficients and the resulting cohort trends in major choice by estimating a series of alternative specifications. First, we test for changes over time in the relative estimated return to each college major by separately estimating Equation AA-1 over the 2009-2010 and 2018-2019 ACS cohorts. Panel (a) of Figure AA-1 shows that the two sets of college major premium estimates are strongly correlated (0.90) parallel to the 45-degree line. Panel (b) shows a somewhat weaker and flatter relationship when Equation AA-1 is estimated separately among URM and non-URM workers, with a greater wage spread among non-URM workers, though the correlation (0.73) remains very strong. Panel (c) shows little evidence of differences in relative major-specific wage returns by gender (0.87), while Panel (d) shows that adding local region (PUMA) indicators to Equation AA-1 – to absorb, for example, cost-of-living differences across localities – yields near-identical estimates of P_{m_i} (0.97). Correlations between our baseline estimates and each set of alternate premium statistics exceed 0.95, except for the correlation with the attenuated estimates from the URM subsample (roughly 1/6 of graduates), which is 0.80.

Figure AA-2 shows that replacing our baseline estimates of P_{m_i} with the unconditional median wage of employed college graduates by major yields a highly-similar economic quality index across majors (0.96), suggesting that the wage differences across majors are generally unrelated

Figure AA-1: Stability of Alternative College Major Premium Specifications



Note: This figure shows that alternative definitions of average college major premium – either using different samples of ACS students or absorbing local geographic wage variation – yield qualitatively-similar major premium coefficients. This figure correlates major premium coefficients estimated using a sequence of different subsamples and estimation strategies. In this study's baseline specification (Equation AA-1), premiums are estimated by regressing log wages on major indicators and covariates over employees aged 35-45 in the 2009-2019 ACS. Panels (a) to (c) compare premium estimates across 2009-2010 and 2018-2019 ACS respondent subsamples, URM and non-URM subsamples, and female and male subsamples. Panels (d) and (e) respectively compare the baseline premium estimates to coefficients estimated in the presence of PUMA geographic fixed effects, and to coefficients from the baseline specification reestimated after dropping all workers whose majors were imputed from their occupation, age and sex in the ACS data. Source: The American Community Survey (Ruggles et al., 2018).

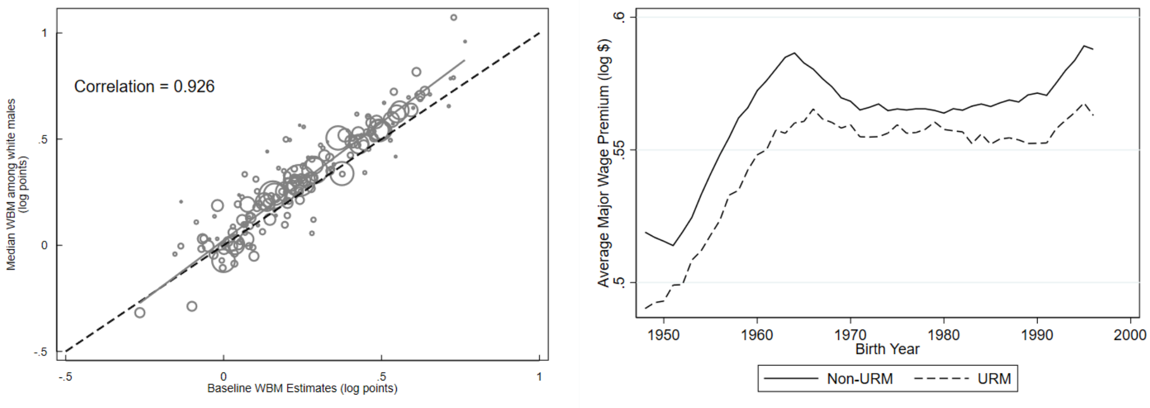
to the fixed characteristics included in Equation AA-1 as covariates.[46] We restrict the median-wage sample to (1) native (2) white (3) male workers who (4) worked at least 27 weeks in the previous year for 30 hours per week and (5) excluding ACS respondents whose college majors are imputed as a result of non-response, following Sloane, Hurst, and Black (2021) (who estimate gender-specific major premium statistics and focus on trends in the gender college major gap by cohort.[47]

[46]Median wage statistics are adjusted for inflation by partialing out year effects using OLS.

[47]Excluding imputed respondents from our main major premium specification results in a nearly-identical set of coefficients (correlation 0.994).

Figure AA-2: Comparison between Major Premium Estimates and Median Wages by Major

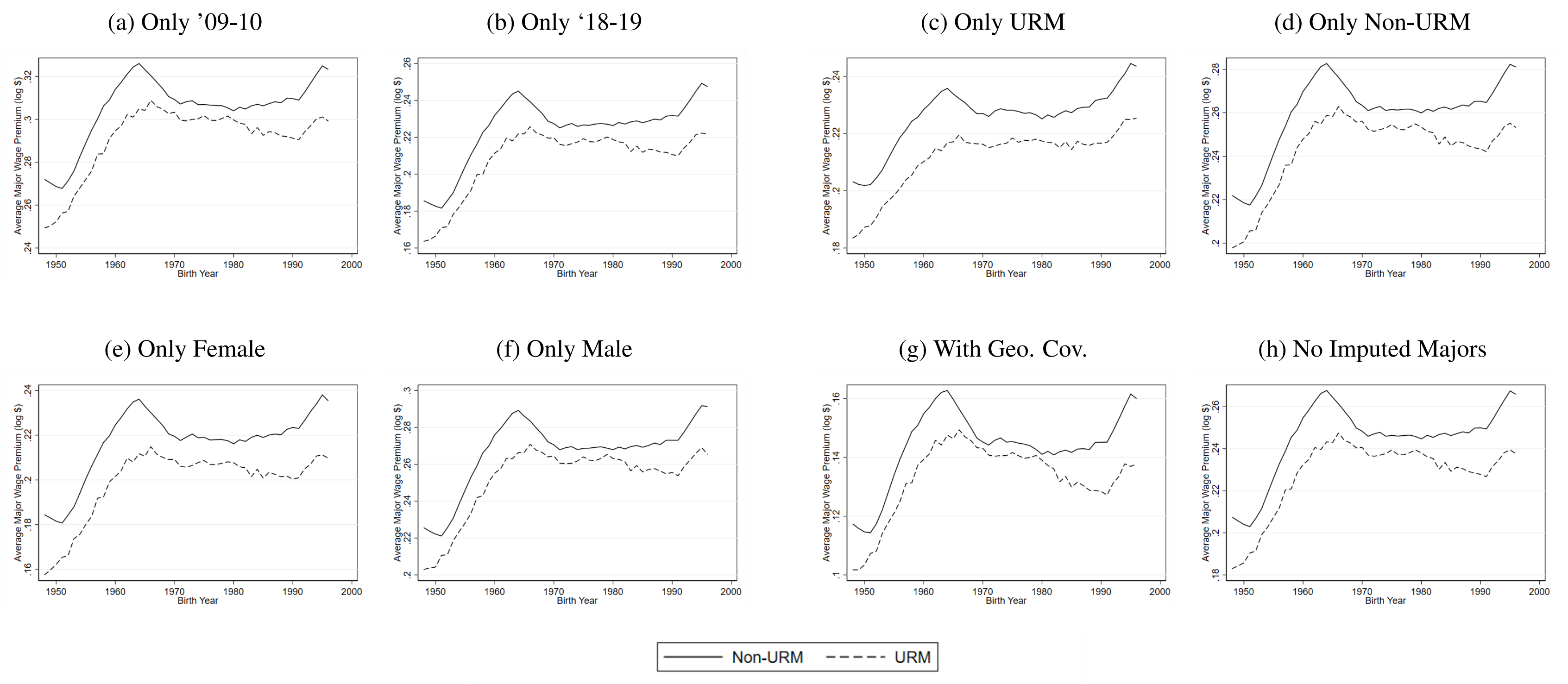
(a) Median vs. Baseline | (b) Log Median Wages



Note: This figure shows that replacing P_m with median wages by major yields qualitatively-similar major premium coefficients and stratification trends. Along the x-axis of Panel (a), the baseline P_m coefficients are estimated by regressing log wages on major indicators and covariates over employees aged 35-45 in the 2009-2019 ACS. Along the y-axis of Panel (a) and in Panel (b), each major is characterized by within-major median wages estimated on a sample of males aged 45-55 who have worked at least 27 weeks in the last year, following Sloane, Hurst, and Black (2021). Source: The American Community Survey (Ruggles et al., 2018).

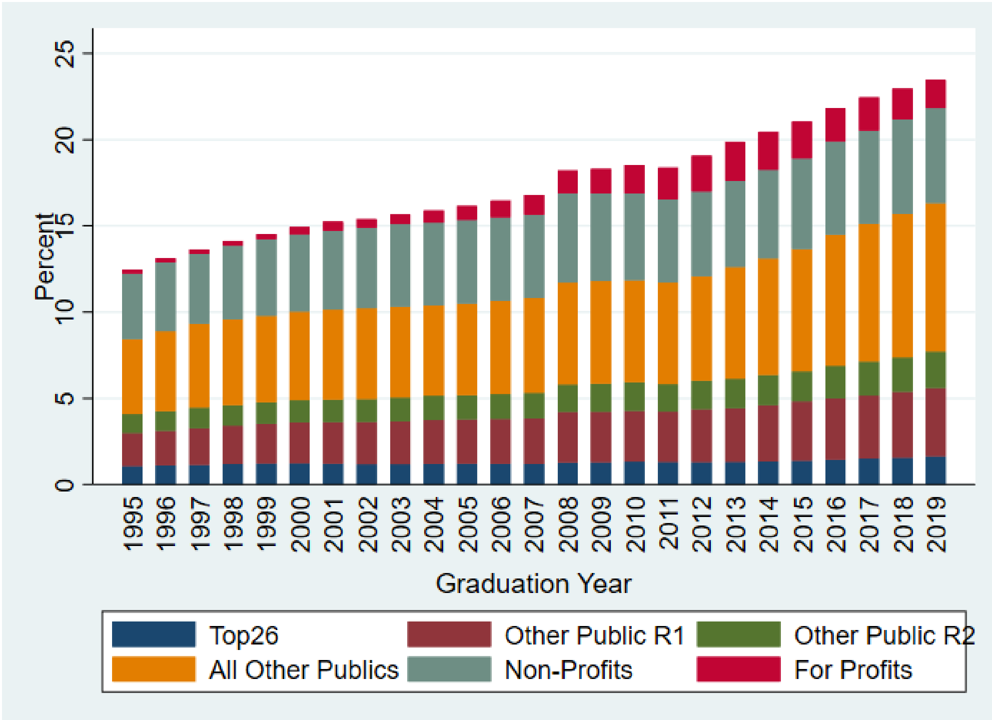
Figure AA-3 replicates the average premium-by-cohort-by-ethnicity trends shown in Figure 1 using each of these alternative specifications. Though the relative levels of URM and non-URM college graduates' average major premiums over time vary by specification, all eight figures exhibit the same pattern described in the present study's introduction: the college major gap between URM and non-URM students had narrowed and was largely unchanging in the years leading up to the 1980 birth cohort, but has been steadily widening in the years since. This finding appears qualitatively robust to each alternative major premium specification.

Figure AA-3: Stratification trends using Alternative College Major Premium Estimates



Note: This figure shows that alternative definitions of average college major premiums – either using different samples of ACS students or different estimation strategies – yields qualitatively similar stratification patterns since the 1950s birth cohorts. This figure depicts average college major premiums by birth cohort and ethnicity among all college graduates (as in Figure 1) using a sequence of different subsamples and estimation strategies. Solid (dashed) lines estimate expected major premiums for non-URM (URM) workers. In the baseline specification, premiums are estimated by regressions of log wages on major indicators and control variables as explained in Appendix A over wage employees aged 35-45 in the 2009-2019 American Community Survey. Panels (a) to (f) restrict the premium estimation sample to 2009-2010 and 2018-2019 ACS respondents, URM and non-URM respondents, and female and male respondents. Premiums in Panel (g) are estimated in the presence of PUMA geographic fixed effects. Panel (h) estimates premiums after dropping the roughly 12% of the sample whose college majors were imputed from their occupation, age and sex. Source: The American Community Survey (Ruggles et al., 2018).

Figure BB-1: Contributions to URM Representation, by Sector and Graduation Year



Note: This figure shows that the URM share of college students has been steadily increasing since the 1990s, with particular growth among non-research public universities and for-profit universities. This figure depicts the fraction of all four-year college degree completers who belong to under-represented minority groups (Black, Hispanic or Native American), by university sector and year of graduation. Source: IPEDS.

Appendix B: Growth in Between-Institution College Major Stratification

While this study primarily focuses on the growth of within-institution ethnic stratification since the late 1990s, Figure 2 shows that over 40 percent of the increase in overall stratification has been driven by *between*-institution changes in where URM students enroll. One reason for these between-institution shifts in URM enrollment was the dramatic rise in URM college enrollment in the period (mirroring URM students' growing proportion of U.S. high school graduates); URM representation among recipients of 4-year degrees grew 80% between 1995 and 2019, but by differing proportions in each institution type (Figure BB-1). This appendix provides evidence showing that between-institution stratification increased because low-premium institutions – that is, institutions whose graduates tended to earn below-average-premium majors – absorbed a disproportionately large share of this influx of URM college students. It also confirms that institutions' expected major wages are strongly positively correlated with their selectivity: as additional URM students flowed into less-selective universities, those schools' low average major premiums drove

Table BB-1: Stratification Between and Within Sectors of Institutions

	Top 26 Publics	Other Public R1	Public R2	All Other Publics	Non-Profit Schools	For-Profit Schools	All Institutions
Panel A: Probability of graduating from each sector by URM status							
URM							
1995	0.086	0.154	0.088	0.350	0.306	0.017	1.000
2019	0.070	0.169	0.089	0.367	0.234	0.070	1.000
Other							
1995	0.105	0.204	0.084	0.275	0.322	0.009	1.000
2019	0.103	0.201	0.080	0.274	0.300	0.042	1.000
Panel B: Average college major premium by sector and URM status (100s of log dollars)							
URM							
1995	25.88	22.62	22.11	21.01	23.29	27.89	22.59
2019	27.60	24.29	22.03	20.77	22.51	21.67	22.42
Other							
1995	27.36	23.72	22.49	20.22	23.43	25.96	22.97
2019	32.48	27.39	24.90	22.49	24.59	22.67	25.33
Panel C: Between-within *sectoral* decomposition of aggregate stratification (100s of log dollars)							
Between sectors							
1995	0.53	1.20	-0.09	-1.51	0.37	-0.20	0.31
2019	1.07	0.87	-0.23	-2.09	1.62	-0.64	0.60
Within sectors							
1995	0.13	0.17	0.03	-0.28	0.04	-0.03	0.07
2019	0.34	0.52	0.26	0.63	0.49	0.07	2.31
Total							
1995	0.66	1.37	-0.05	-1.79	0.42	-0.23	0.38
2019	1.41	1.40	0.02	-1.45	2.10	-0.57	2.91
Panel D: Ethnic stratification within sector (100s of log dollars)							
1995	1.48	1.11	0.37	-0.79	0.14	-1.93	0.38
2019	4.88	3.10	2.87	1.72	2.08	1.00	2.91
Change	3.41	2.00	2.50	2.51	1.94	2.93	2.53

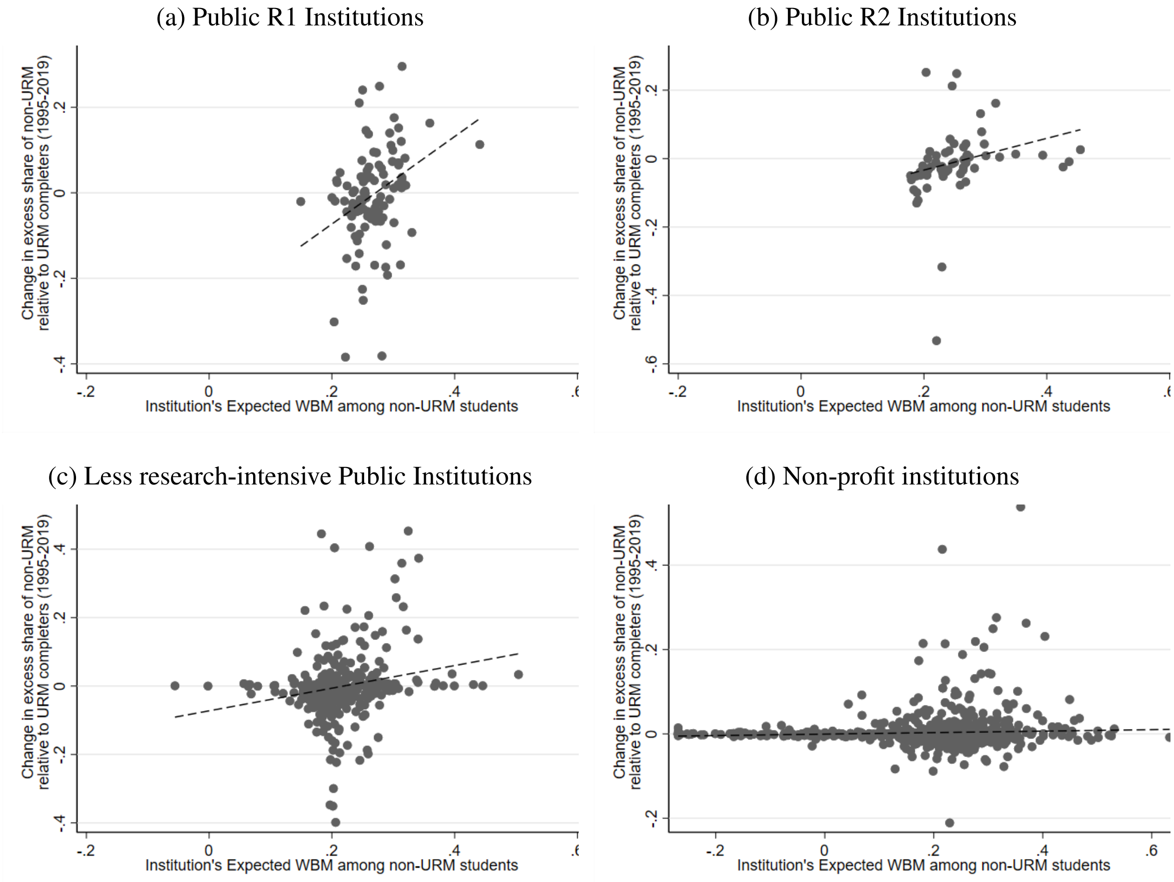
Note: This table shows several average probabilities used to calculate the decomposition presented in Figure 2 as well as a sectoral decomposition showing that most between-institution stratification increased within sector. Statistics in Panel A are $P_t(T|R) \equiv \Sigma_{i \in T} P_t(i|R)$. Panels B and C are $E_t[W_M|R,T]$ (relative to General Agriculture) and $S_T \equiv \Delta_R[E_t(W_M|T)]$ respectively. Panel D adapts Equation 4 to sum across sectors rather than institutions.

Source: 2009-2019 American Community Survey (Ruggles et al., 2018) and IPEDS.

part of the observed growth in ethnic stratification across majors over the past 25 years.

We measure the degree to which URM students' enrollment shifted across university sectors by recalculating the two-way decomposition presented in Equation 4 across six university sectors (T) instead of across the full set of 3,600 higher education institutions. Panel A of Table BB-1 shows that URM students became much more likely to graduate from private for-profit colleges and much less likely to graduate from private non-profit institutions between the mid-1990s and

Figure BB-2: Stratification between institutions, by Sector



Note: This figure shows that that share of non-URM students graduating from more prestigious public institutions grew faster than the share of URM students graduating from them. The vertical axis is the difference between non-URM and URM students, in the 1995-2019 change in an institution's share of graduates of each ethnic group (i.e., $\Delta_R[P_{2019}(i|R) - P_{1995}(i|R)]$). The horizontal axis depicts the average college wage premium awarded by those institutions, averaged between 1995 and 2019. Source: IPEDS and ACS (Ruggles et al., 2020).

2019. This shift from more- to less-prestigious private institutions was much less pronounced among non-URM students. Panel A also shows that public institutions' combined share of URM graduates rose only slightly, while the top 26 public institutions' share declined.

Panel B shows that in 2019, the least-prestigious (for-profit and other public) institutions that absorbed most of the influx of URM students tended to specialize in low-wage majors. The average premium of college majors awarded by for-profit universities fell from among the highest among the university sectors in 1995 to the lowest by 2019. This wage drop is particularly pronounced among URM students, indicating that the influx of URM students into the for-profit sector was overwhelmingly accommodated by the expansion of low-premium majors. Panel B also confirms that the average premium of majors awarded at public universities are positively associated with

Table BB-2: Correlation between University Selectivity and Average Major Premium

Selectivity Measure	Correlation	N
6-year Graduation rate	0.310	1,925
6-year Non-URM Graduation rate	0.319	1,906
Rejection Rate	0.198	1,722
SAT Verbal Score	0.446	1,199
SAT Math Score	0.509	1,199
ACT Combined Score	0.470	1,237
ACT English Score	0.420	1,155
ACT Math Score	0.494	1,155

Note: This table shows that the ranking of universities by their average major premium is strongly positively correlated with their ranking by several traditional measures of university selectivity. Spearman correlations between 2019 measures of institutional selectivity and the average premium of their 2019 graduates' college majors. Test score statistics are institutions' reported 75th percentile of scores.

Source: The 2009-2019 American Community Survey (Ruggles et al., 2018) and IPEDS.

their research prestige.

These trends suggest that the growing accommodation of URM students at less prestigious private and public institutions lifted between-institution stratification. However, Panel C of Table BB-1 shows that between-*sector* stratification increased by only about 0.32 percentage points, though Figure 2 shows that between-*institution* stratification increased by 1.34 percentage points. This indicates that most of the shift of URM students toward lower-premium institutions between 1995 and 2019 occurred within university sectors. Accordingly, Panel D shows large increases in within-sector stratification.

Figure BB-2 reconfirms that between-institution stratification was overwhelmingly driven by within-sector reallocation, especially among the most research intensive public institutions. Institutions with higher average major premiums graduated an increasing share of non-URM students (relative to URM students) over time. This relationship is particularly weak among non-profit institutions, and its strength tracks public institutions' research intensity. As in the main text, this again emphasizes the importance of public research universities as loci of ethnic stratification in higher education, here in the case of URM students switching from higher- to lower-premium public research universities in the 2000s and 2010s.

Finally, Table BB-2 confirms that the average premium of majors awarded to an institution's graduates is strongly positively correlated with measures of its selectivity, including 6-year graduation rates (among URM, non-URM and all students), SAT and ACT scores (at the 75th percentile), and freshman applicant rejection rates (one minus the admission rate).

In summary: between-institution college major stratification increased because of two patterns in the absorption of a dramatic influx of URM students, each of which has been studied elsewhere. First, the public sector took on more URM students but tended to absorb them in less prestigious institutions – in part as a result of the declining prevalence of affirmative action (Bleemer, 2022), the persistent use of legacy admissions policies (Arcidiacono, Kinsler, and Ransom, 2019), and other university admissions policies that disadvantage URM applicants on average – that focused on lower-premium majors. Second, private non-profit universities did not expand their URM populations proportionally, so many of them earned degrees from for-profits that in turn expanded their offerings of lower-premium majors, especially for URM students (Deming, Goldin, and Katz, 2012).

Appendix C: The Mechanisms of Major Restrictions – A Case Study of Economics

To further illuminate how major restrictions influence the majors that students enter, we compare entry into the high-return economics majors at UC Santa Barbara (UCSB) and UC Davis between 2010 and 2016.[48] These majors provide a useful case study for several reasons:[49]

1. UC Davis and UC Santa Barbara were similarly-selective institutions; both were ranked between 38 and 42 in every annual US News & World Report national university ranking in the period.

2. Each campus had a similarly-structured progression of introductory courses that students were required to take prior to major declaration: two quarters of calculus, introductory micro- and macroeconomics (Economics 1 and 2), and one or two additional courses depending upon students' chosen track.

3. All economics tracks at Santa Barbara had a 2.85 grade point average restriction (over 3-5 introductory economics courses), while the Davis economics major was unrestricted.[50]

[48]Economics is among the highest-premium majors offered by UC campuses; see Table A-1. UC Berkeley's economics major is omitted because Berkeley's semester schedule (as opposed to UCSB and Davis's quarter schedules) yields a different lower-division economics curriculum, with introductory micro- and macroeconomics combined into a single course. This prohibits direct comparison with the other campuses. UCSC economics also provides a limited test case, since its restriction was non-binding in its early years of implementation Bleemer and Mehta (2021).

[49]While a surge in international student enrollments during this period could have crowded students out of the economics majors at both schools, the surge was larger at UC Davis.

[50]UC Davis's Managerial Economics track, like many business-oriented economics majors, had a 2.8 GPA major restriction before 2013. That track catered to almost half of the students in economics-based majors at UC Davis. Similarly, UCSB offered an alternative means of qualifying for its Business Economics major until Summer 2011. While Davis's 'partial' major restriction and the early exception to Santa Barbara's restriction could attenuate the comparative results discussed below, the coefficient estimates are similar (but less-precise) if the sample is split before 2014 and models are re-estimated separately in both periods (available from the authors).

4. The Santa Barbara restrictions (and Davis's non-restriction) did not change in the sample period.

5. Despite UCSB's restriction, the economics majors at each school graduated more students than any other major in the period, suggesting substantial demand.

As a result, we investigate the mechanisms driving major restrictions' effect on campus stratification by examining differences in students' economics course grades, course enrollment, and major declaration at each campus $u \in \{D, SB\}$ using a series of linear regression models:

$$Y_{iyct} = \alpha_{ct} + \gamma_y + \beta_c X_i + \epsilon_{iyct} \tag{CC-1}$$

$$Y_{iyct} = \alpha_{ct} + \gamma_{y,UCSB_i} + \beta_c X_i + \beta'_c X_i \times UCSB_i + \epsilon_{iyct} \tag{CC-2}$$

where each outcome Y_{iyctu} for student i in cohort y who completed course c in term t is modeled as a function of students' demographic, socioeconomic, high school opportunity, and academic preparedness characteristics.[51] Cohort and course-term fixed effects are included for each campus, and standard errors are clustered by high school. Propensity weights ensure that the Davis and Santa Barbara student samples are balanced on observed covariates, including the full set of covariates described above as well as county fixed effects for Californians.[52] Our preferred interpretation of these models is that between-campus differences in students' propensity to declare the major mainly reflect the effect of UCSB's economics major restriction.

The first two regression models presented in Table CC-1 examine which of the students who enrolled in ECON 1 eventually declared economics majors, where ECON 1 enrollment is a signal of students' potential interest in majoring in economics.[53] The first model includes only demographic and socioeconomic characteristics as covariates, directly testing whether UCSB's major restriction induces social stratification. The baseline Davis estimates, where any student is permitted to declare an economics major after passing the introductory courses, reveal how "preferences" for the major differ by ethnicity and income.[54] They reveal a significant relative preference for the subject among Asian students, but not among URM students. There is some

[51]These characteristics include gender, ethnicity, log parental income, SAT score, high school GPA, California residency, California public school enrollment, and the presence of AP and IB economics for students from public CA high schools. An indicator for missing income marks students who omitted their family income on their college application, usually connoting above-average income or wealth (Bleemer, 2022).

[52]In particular, each observation is weighted by the student's inverse likelihood of enrolling at that campus (from a first-stage regression on the full X_i as well as high school county fixed effects), recovering the average treatment effect for students at both campuses.

[53]Economics major declaration includes both Economics and Economics & Accounting at UCSB and both Economics and Managerial Economics at UC Davis.

[54]By "preference" here, we mean simply students' relative desire to complete different majors given their aptitudes, inclinations, and personal circumstances.

Table CC-1: 2010-2016 Economics Major Enrollment Propensities at UC Davis and UCSB

Dep. Var:	Earn Economics Major, Conditional on ECON 1						Enroll in ECON 1	
	Davis	UCSB	Diff.	Davis	UCSB	Diff.	Davis	Diff.
Female	-8.68	-5.84	2.85	-8.57	-5.94	2.63	-9.09	-4.49
	(1.25)	(1.30)	(1.55)	(1.24)	(1.27)	(1.54)	(0.56)	(0.88)
Asian	6.06	3.07	-2.99	5.69	4.11	-1.58	6.90	-0.18
	(1.22)	(1.47)	(1.92)	(1.21)	(1.37)	(1.80)	(0.79)	(1.02)
URM	0.60	-10.07	-10.68	-0.84	-3.92	-3.08	-7.00	3.56
	(1.40)	(1.40)	(1.93)	(1.45)	(1.41)	(1.96)	(0.72)	(0.97)
Log Fam. Inc.	0.64	1.96	1.32	0.86	0.28	-0.58	0.83	-0.29
	(0.45)	(0.43)	(0.61)	(0.49)	(0.40)	(0.62)	(0.24)	(0.34)
Miss. Income	4.40	6.55	2.15	4.76	2.26	-2.50	3.06	-1.21
	(1.83)	(1.92)	(2.62)	(1.87)	(1.90)	(2.64)	(1.07)	(1.47)
Out-of-State	-4.50	-4.30	0.20	-4.74	0.69	5.43	4.34	-2.45
	(2.30)	(2.58)	(3.41)	(2.43)	(2.63)	(3.52)	(1.52)	(2.06)
International	0.96	-0.23	-1.19	0.26	5.64	5.38	17.02	14.09
	(1.79)	(2.22)	(2.62)	(2.06)	(2.22)	(2.78)	(5.45)	(3.15)
CA Private HS				4.07	-0.59	-4.66	1.35	1.66
				(1.85)	(1.83)	(2.44)	(1.13)	(1.42)
High School Offered[1]:								
AP Macro				0.34	4.76	4.42	-1.23	-0.27
				(1.96)	(2.04)	(2.82)	(1.18)	(1.51)
AP Micro				1.49	4.25	2.76	-5.25	4.18
				(2.81)	(2.95)	(4.16)	(1.26)	(2.06)
IB Economics				-4.37	2.96	7.34	0.27	-0.75
				(3.07)	(4.04)	(5.24)	(2.07)	(3.74)
SAT Score[2]				-1.78	6.96	9.55	-1.12	1.45
				(0.55)	(0.56)	(0.83)	(0.37)	(0.49)
HS GPA[2]				-1.44	5.47	7.42	-2.59	0.85
				(0.66)	(0.53)	(0.86)	(0.41)	(0.50)
Course-Term FEs		X			X		X	
Campus-Cohort FEs		X			X		X	
R^2		0.02			0.04		0.06	
Observations		16,974			16,974		62,512	
Mean of Y	32.2	26.4	-	32.2	26.4	-	29.0	

Note: This table shows that URM and otherwise-disadvantaged students who took Economics 1 at UC Santa Barbara – which implemented a major restriction – were much less likely to ultimately declare the major than such students at UC Davis, which had no such restriction, though these differences are fully absorbed by those students' poorer measured pre-college academic opportunity and preparation. Propensity-score-weighted WLS regression models among 2010-2016 freshman-applicant Santa Barbara and Davis students of economics major declaration and ECON 1 enrollment on student characteristics. Major declaration models conditional on having earned a grade in ECON 1. Main effects estimated for Davis and Santa Barbara; 'Diff' is estimated as the difference between Santa Barbara and Davis. Standard errors clustered by high school in parentheses. Inverse propensity score weights estimated using the full set of listed covariates as well as California county indicators. Family income is missing for the $\sim$ 13 percent of students who did not report family income on their application; estimates relative to the mean observed log income. [1]High school course offerings are only observed for public CA high schools. [2]Normalized to mean 0, s.d. 1.

Source: UC ClioMetric History Project Student Database, UC Corporate Student System, and California Department of Education.

evidence that preference for economics increases with income; the (presumably) higher-income students who do not report family income statistics are much more likely than average to declare the major.[55]

At Santa Barbara, by comparison, Asian students who took ECON 1 are not significantly more likely to declare an Economics major, while URM students are 10 percentage points less likely to declare an economics major than white students. The magnitude of this URM difference is appreciable relative to an average declaration propensity of 26.4 percent at UCSB.[56] The difference between the campuses in URM students' relative propensity to declare an economics major is similarly large and statistically significant. Income also appears to have stronger effects on enrollment at Santa Barbara. This is consistent with the major restriction muting student preferences, and doing so in a way that stratifies students on ethnicity and income, as students who exit the economics major are very likely to instead earn lower-return majors (Bleemer and Mehta, 2021).

The second regression model in Table CC-1 includes academic opportunity and preparation covariates. Ethnic differences between similarly-prepared students are much smaller than the unconditional gaps estimated in the previous model, though URM students remain somewhat less likely to declare an economics major at UCSB than at Davis, by 3.1 (s.e. 2.0) percentage points.[57] This suggests that the primary stratifying effect of the major restriction is to induce selection based on prior preparation.

The other coefficients in this regression confirm that impression. At Davis, ECON 1 students with higher SAT scores and high school GPAs are less likely to select an economics major, while the opposite is true at UCSB. This suggests that economics tends not to be the top choice of the most-prepared (ECON 1) students, but that the major restriction systematically prevents less-prepared students from declaring the major at UCSB.[58] Second, while exposure to economics in high school does not predict major declaration at Davis, it does at UCSB. This suggests that the restriction induces selection on prior general preparation and on prior exposure to economics.

The final model in Table CC-1 examines selection (conditional on prior opportunity and preparation) along a different margin: enrollment in a student's first economics course. The UCSB

[55]The coefficient on missing income has been adjusted to reflect the difference in outcome propensity between missing-income students and a student with average log family income. See Bleemer (2022) for the predicted family income distribution of income non-reporters.

[56]Major declaration propensity among plausibly-interested students is significantly lower at UCSB (26.4%) than it is at Davis (32.2%). This difference is similar in magnitude to the effects of major restrictions on major size reported in Section 4.

[57]In fact, only SAT score (not HS GPA or courses) partially absorbs URM students' lower likelihood of major declaration at UCSB. If SAT scores are poorer predictors of URM students' academic performance than they are for non-URM students (Vars and Bowen, 1998), then the URM student effect would be over-absorbed in this context. Indeed, interacting SAT score with URM status estimates a sharply negative coefficient for URM students at UCSB and yields a baseline URM coefficient (at mean SAT) of -4.5 (s.e. 2.2) percentage points.

[58]The major restriction may also make the economics major more appealing to highly-prepared students for other reasons, e.g. by improving the major's signal quality (MacLeod and Urquiola, 2015).

outcomes differ significantly from those at Davis in three respects. First, female students are less likely to take ECON 1 at UCSB, in line with the student-level event study estimates from Section 5, and again suggesting that the major restriction mutes preferences. Second, students with *lower* SAT scores and high-school GPAs are more likely take ECON 1 at Davis, while those who attended private school are not. In contrast, high SATs and high school GPAs are not associated with taking ECON 1 at UCSB, and private high-school attendance is. Each of these results is consistent with the major restriction inducing significant positive self-selection into the first course in the major based on prior preparation, perhaps because students who feel they are less likely to qualify for the major do not attempt it. Finally, students who have taken AP Micro and are therefore eligible to opt out of ECON 1 tend to do so at Davis, but not at UCSB, where the major restriction only considers ECON 1 grades from courses taken at UCSB.

The results presented in Table CC-1 reveal that there is more positive selection and self-selection into the economics majors at UCSB than at Davis, that selection is on prior academic preparation and exposure to economics in high school, and that this selection results in stratification on ethnicity and income. Our preferred interpretation is that the greater observed positive selection at UCSB arises from that campus's major restriction. The following subsection investigates alternative interpretations of the presented statistics.

C.1 Explaining Stratification by Pre-College Preparation

One alternative explanation for the patterns described above is that quantitative aptitude covaries with prior preparation to a greater degree among UCSB students. If this were the case, and students' course and major choices responded to it, this could explain the higher degree of selection on prior preparation and economics experience at UCSB. However, the first two models presented in Table CC-2 – which model ECON 1 students' performance in the first two calculus courses – show that this is not the case for quantitative skills. The baseline (Davis) coefficients confirm significant variation in math preparation by observables, including prior preparation: higher SAT scores, high school GPAs, and family incomes predict better mathematical performance, as do being Asian and female, while URM students had worse math grades. However, there is almost no evidence of a stronger relationship between student characteristics and math performance at UCSB than at Davis in either of the first two calculus courses.

Another alternative explanation for the observed patterns is that UCSB might provide lower grades to less-prepared students in its introductory courses, discouraging those students using 'soft' restrictions rather than relying on its mechanical restriction policy. The next two columns in Table CC-2 show that in fact, the opposite is the case: higher SAT scores are more *weakly* associated with ECON 1 grade gains at UCSB than at Davis, and the URM grade penalty is smaller at UCSB

Table CC-2: Economics Students' Course Performance at Davis and Santa Barbara

	Grade in Calc. I		Grade in Calc. II		Difference in:		UCSB-only determinants of:		
	UCD	Diff.	UCD	Diff.	ECON 1 Grade	ECON 2 Grade	ECON 1 Grade	ECON 2 Grade	ECON 10A Grade
Female	0.06	-0.05	0.12	-0.03	0.09	-0.01	-0.14	-0.13	-0.03
	(0.03)	(0.04)	(0.03)	(0.05)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)
Asian	0.17	-0.07	0.21	-0.14	-0.06	-0.15	0.02	-0.04	0.01
	(0.03)	(0.05)	(0.03)	(0.05)	(0.03)	(0.04)	(0.02)	(0.02)	(0.04)
URM	-0.11	-0.05	-0.17	-0.05	0.09	0.06	-0.11	-0.12	-0.12
	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)	(0.04)	(0.02)	(0.02)	(0.04)
Log Fam. Inc.	0.02	-0.01	0.00	0.02	-0.02	0.00	0.01	0.02	0.01
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Miss. Income	-0.09	0.08	-0.07	0.09	-0.01	0.04	-0.02	0.01	-0.01
	(0.05)	(0.07)	(0.06)	(0.07)	(0.05)	(0.05)	(0.02)	(0.03)	(0.05)
Out-of-State	-0.08	0.33	0.02	0.17	-0.00	-0.10	0.10	0.11	0.25
	(0.07)	(0.09)	(0.07)	(0.09)	(0.07)	(0.07)	(0.04)	(0.05)	(0.07)
International	0.42	0.32	0.46	0.07	0.02	-0.12	0.48	0.40	0.41
	(0.05)	(0.06)	(0.07)	(0.08)	(0.06)	(0.06)	(0.06)	(0.04)	(0.08)
CA Private HS	-0.07	0.13	-0.02	0.02	-0.01	-0.08	0.02	0.01	0.01
	(0.04)	(0.06)	(0.06)	(0.06)	(0.04)	(0.05)	(0.03)	(0.03)	(0.05)
High School Offered[1]:									
AP Macro	0.02	0.04	0.03	0.06	0.06	0.13	0.07	0.13	0.06
	(0.05)	(0.07)	(0.05)	(0.07)	(0.05)	(0.05)	(0.03)	(0.04)	(0.05)
AP Micro	-0.00	0.06	-0.08	0.12	0.19	0.08	0.06	0.04	0.02
	(0.07)	(0.10)	(0.08)	(0.09)	(0.07)	(0.07)	(0.04)	(0.05)	(0.07)
IB Economics	-0.08	-0.07	0.03	0.09	0.03	0.09	0.09	0.15	0.13
	(0.13)	(0.18)	(0.14)	(0.13)	(0.08)	(0.12)	(0.05)	(0.08)	(0.12)
SAT Score[2]	0.24	0.03	0.21	-0.04	-0.08	-0.01	0.23	0.27	0.19
	(0.01)	(0.03)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
HS GPA[2]	0.16	0.01	0.17	0.04	-0.03	-0.03	0.14	0.15	0.16
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Course-Term	X	X	X	X	X	X	X	X	X
Campus-Cohort	X	X	X	X	X	X	X	X	X
R^2	0.16		0.11		0.21	0.18	0.18	0.18	0.08
Observations	10,168		11,554		16,974	13,884	7,829	6,216	3,565
Mean of Y	2.89		2.75		2.61	2.58	2.56	2.55	2.76

Note: This table shows that disadvantaged UCSB students' exiting the economics major appears likely to be explained by the binding GPA restriction, despite those students earning slightly higher relative grades at UCSB (where grades' stakes are much higher). Propensity-score-weighted WLS regression models among 2010-2016 freshman-applicant Santa Barbara and Davis students of grades earned in first and second quarters of calculus, ECON 1 and 2, and the subsequent ECON 10A course at Santa Barbara on student characteristics. Mathematics grades are conditional on ECON 1 enrollment. Main effects estimated for Davis and Santa Barbara; 'Diff' estimated as the difference between Santa Barbara and Davis. Standard errors clustered by high school in parentheses. Inverse propensity score weights estimated using the full set of listed covariates as well as California county indicators. Family income is missing for the $\sim$ 13 percent of students who did not report family income on their application; estimates relative to the mean observed log income. Calculus I and II courses are MATH 2A/B, 3A/B, or 34A/B at UCSB and 16A/B and 21A/B at Davis. [1]High school course offerings are only observed for public CA high schools. [2]Normalized to mean 0, s.d. 1.

Source: UC ClioMetric History Project Student Database, UC Corporate Student System, and California Department of Education.

than at Davis. This implies that UCSB provides somewhat more-lenient grades in its introductory courses, but its major restriction nevertheless deters disadvantaged and lower-preparation students from earning the major.

The final three columns of Table CC-2 illuminate how UCSB's major restriction – which selects on socioeconomic status, prior academic opportunity, and measured academic preparation – generates larger ethnic and income gaps in major declaration. While ethnicity grade gaps are less pronounced at UCSB than at Davis, the restriction makes grade gaps more consequential at UCSB. UCSB students with higher high school GPAs and SAT scores obtain much higher grades in ECON 1, 2, and 10A, and those who had access to IB or AP economics perform much better in ECON 1 and 2. URM students also obtain lower grades in these threshold courses than their equally prepared counterparts, clarifying why prior preparation does not fully explain URM students' lower likelihood of economics major declaration.

These results confirm major restriction filtering as the most likely interpretation for differences in the role of ethnicity, exposure to economics, and prior preparation in major completion between Davis and Santa Barbara.

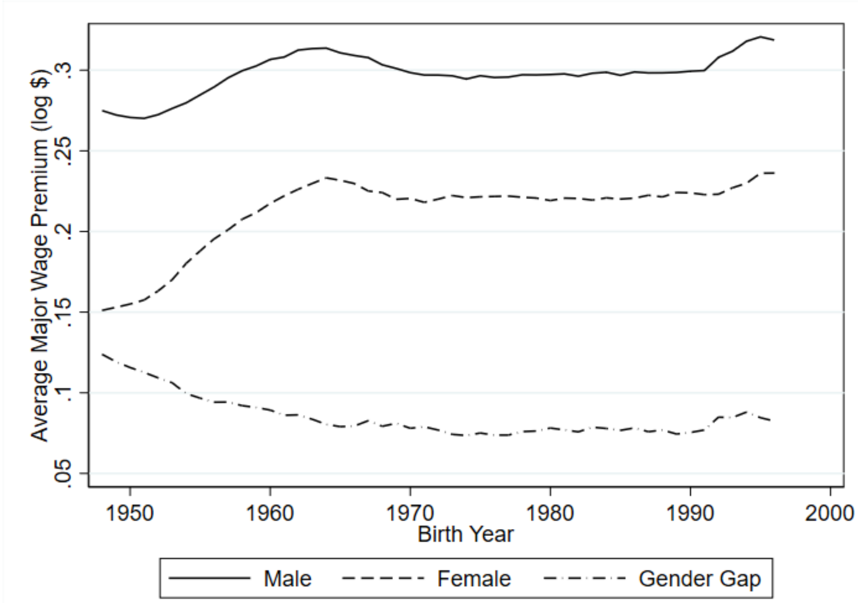
Appendix D: Gender Gaps and Major Restrictions

While the present study focuses on differences in college major attainment by ethnicity, prior studies have more commonly analyzed major attainment gaps by gender. In addition to Sloane, Hurst, and Black (2021)'s recent review of trends in college major choice by gender, many studies have documented differences in student preferences and preparation that contribute to the gap (Wiswall and Zafar, 2018; Mourifie, Henry, and Meango, 2020; Card and Payne, 2021), and others have evaluated a series of policies intended to narrow the gender gap in STEM major attainment (e.g. Canaan and Mouganie, 2021). This appendix compares trends in the economic value of students' college major choices by gender and ethnicity over time and then characterizes the differential effects of major restrictions on male and female students' major choice.

Figure DD-1 recapitulates the college major premium trends shown in Figure 1 by gender. It shows that the gap between the average premium of majors earned by men and women closed between the 1950 and 1965 birth cohorts from about 0.12 log points to 0.08 log points, but that the gap has remained largely unchanged in the subsequent 30 years, with some slight growth in recent years.[59] As a result, there is no trend in aggregate gender stratification to decompose; despite

[59]Evidence presented by Black et al. (2008) (and evidence presented by Brown and Corcoran, 1997) suggest that college majors explained 9-13 (8) percentage points of the male-female wage gap among 1993 (1984) workers, who were mostly members of the 1930-1970 (1920-1960) birth cohorts. Turner and Bowen (1999) note that gender convergence of major choice had ceased by the early 1960s birth cohorts.

Figure DD-1: Average College Major Premium by Birth Cohort and Gender



Note: This figure shows that the college major premium gap between male and female college graduates closed in the 1950s birth cohorts but has stagnated around 0.08 log points since. Average college major premium of college graduates by birth cohort and gender among 2009-2019 ACS respondents, and the difference between those averages. Major premiums are estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, year, and double-major covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS; see Appendix A for details. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018).

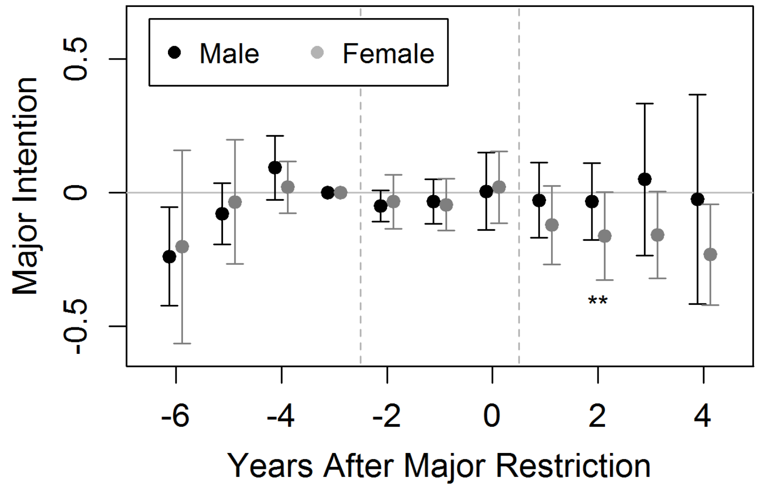
substantial policy innovation in recent years (e.g Colwell, Bear, and Helman, 2020), female college graduates consistently earn less-lucrative degrees than their male peers.[60]

Figure 5 shows that the implementation of major restriction policies has no average effect on the share of female students earning the restricted major. However, this average effect appears to be the result of two offsetting effects observable using the student-intention estimates from Section 5. Figure DD-2 plots estimates from a version of the staggered difference-in-difference model described in Footnote 37 that replaces URM status with gender. It shows some evidence of a decline in female students' revealed *intention* to earn restricted majors after the imposition of the restriction: when a major restriction is implemented, female students are discouraged (on average) from the first-term courses most commonly selected by students who earn that major.

However, this decline in major intention appears to be offset by an increased likelihood of major completion conditional on intention. Panel (b) of Figure DD-3 – which presents estimates of Equation 8 replacing URM status with gender – provides only weak evidence of this; if anything,

[60]Sloane, Hurst, and Black (2021) implement an alternative measure of the economic value of majors – indexing majors by the median hourly wage of native white men between ages 43 and 57 – but arrive at highly similar conclusions, though they emphasize the gap's narrowing in the 1950s birth cohorts rather than the stagnation over the subsequent decades. See Figure A-20.

Figure DD-2: Estimated Changes in Students' Intentions for Restricted Majors by Gender



Note: This figure shows that major restrictions have no observable differential effect on the composition or major choices of student who intend restricted majors by gender. Difference-in-difference event study β_{it} estimates of the relationship between students' intending the restricted major ($\hat{M}_{im}$) and their major choice or student characteristic before and after the implementation of the restriction, following Equation 8 and estimated *by gender* over a stacked dataset of students i's major intentions in field m. Outcomes are defined as the student's GPA fixed effect (their individual fixed effect from a two-way fixed effect model of GPA on student and course effects), whether the student declares the restricted major, and the premium of the student's major (as defined in Appendix A). β_{-3} is omitted, and standard errors are two-way clustered by campus-majors m and by students i. Models include campus-major-cohort fixed effects. Source: UC ClioMetric History Project Student Database and the American Community Survey (Ruggles et al., 2020).

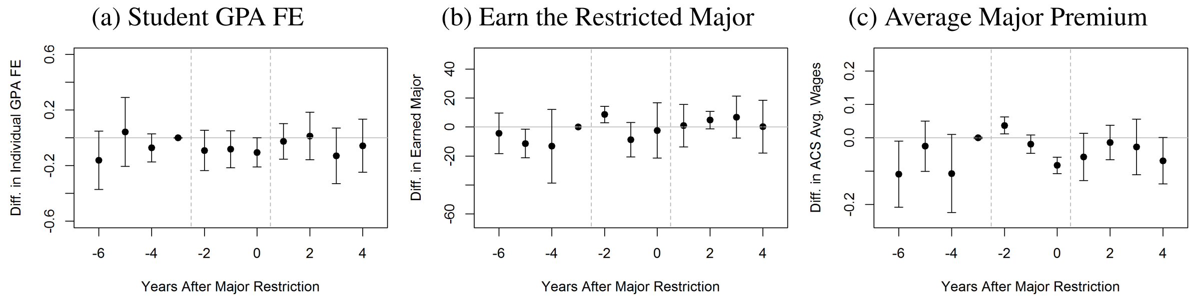
female students who intend the restricted major become slightly *more* likely on average to earn that major. This evidence is clarified by the case study presented in Appendix C: female students are less likely to enroll in Economics 1 when the economics major is restricted, but those who do earn higher grades in the course, resulting in a higher likelihood of attaining the economics major conditional on taking Economics 1 among female students.

Appendix E: Asian, Black, and Hispanic Major Attainment

The main specifications in the presented study compare the college major choices of underrepresented minority (URM) and non-URM students nationally and in the University of California system. In this appendix, we further disaggregate our presented findings into four ethnic groups – Black and Hispanic (URM) and white and Asian (non-URM) – to discuss ethnicity-specific trends and provide justification for our presented baseline aggregates.

Figure EE-1 replicates Figure 1 by ethnicity, showing the average college major premium

Figure DD-3: Estimated Changes Among Intended Majors by Gender

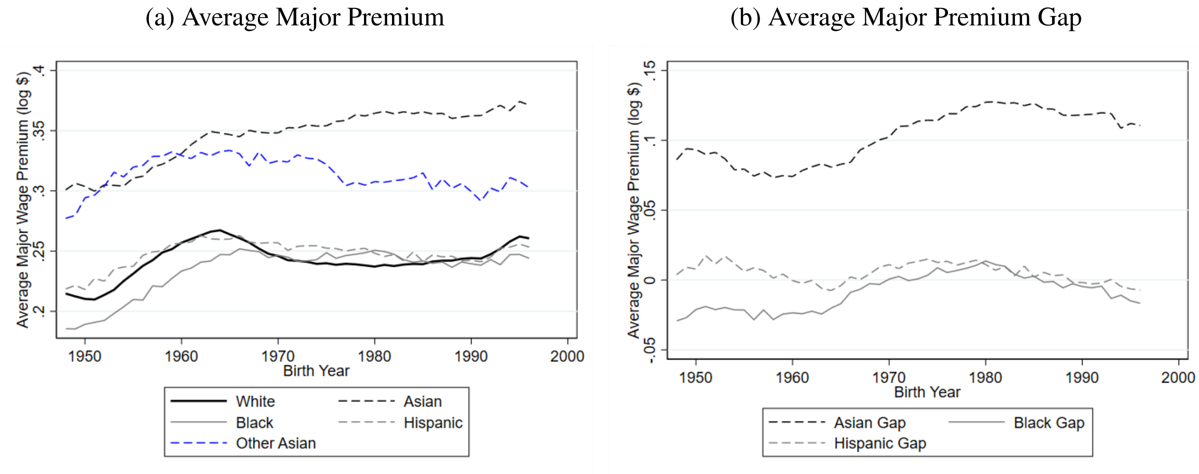


Note: This figure shows that newly-implemented major restrictions did not systematically impact selection into intending the restricted major or the premiums of majors earned by intended majors by gender. Triple-difference event study β_{it} estimates of the difference between male and female students' relationships between students' intending the restricted major ($\hat{M}_{im}$) and their major choice or student characteristic before and after the implementation of the restriction, following Equation 8 and estimated over a stacked dataset of students i's major intentions in field m by gender. Outcomes are defined as the student's GPA fixed effect (their individual fixed effect from a two-way fixed effect model of GPA on student and course effects), whether the student declares the restricted major, and the premium of the student's major (as defined in Appendix A). β_{-3} is omitted, and standard errors are two-way clustered by campus-majors m and by students i. Models include campus-major-cohort fixed effects. Source: UC ClioMetric History Project Student Database and the American Community Survey (Ruggles et al., 2020).

earned by graduates in each birth cohort since the 1950s. While Black college graduates earned lower-premium majors than Hispanic graduates in the '50s and '60s birth cohorts, since the mid-1970s the two groups have earned similar-premium majors. Between the 1979 and 1996 birth cohorts, the college major premium gap between white and Black (Hispanic) college graduates grew by 0.021 (0.027) log dollars, similar trends that could plausibly be explained by similar mechanisms. Asian graduates, on the other hand, make up only a small share of college graduates but tend to earn much higher-premium degrees than white graduates, though the trend in premiums has been roughly similar to that of white graduates in recent years. The white-Asian gap declined during the relevant period by 0.016 log dollars (to about 0.1 log dollars). See Black et al. (2006) for further discussion of differences in college major choice between white and Asian college graduates.

How are these trends differentially explained by the impact of college major restrictions on students' major attainment? Figure EE-2 presents difference-in-difference estimates of the impact of implementing a new major restriction on the share of students in each major by ethnic group. Of the 3.3 percentage point decline in restricted majors' URM enrollment between the pre-and post periods (Table 6), 1.2 percentage points of the decline was among Black students and 2.1 percentage points among Hispanic students. This suggests that Black students were the more impacted by the policy; their decline was twice what would have been expected if the effects were evenly proportional (using the full sample's enrollment shares). However, the declines faced by both groups (more noisily estimated for Black students) suggest that major restrictions tend to lead

Figure EE-1: Average College Major Premium by Birth Cohort and Specific Ethnicity



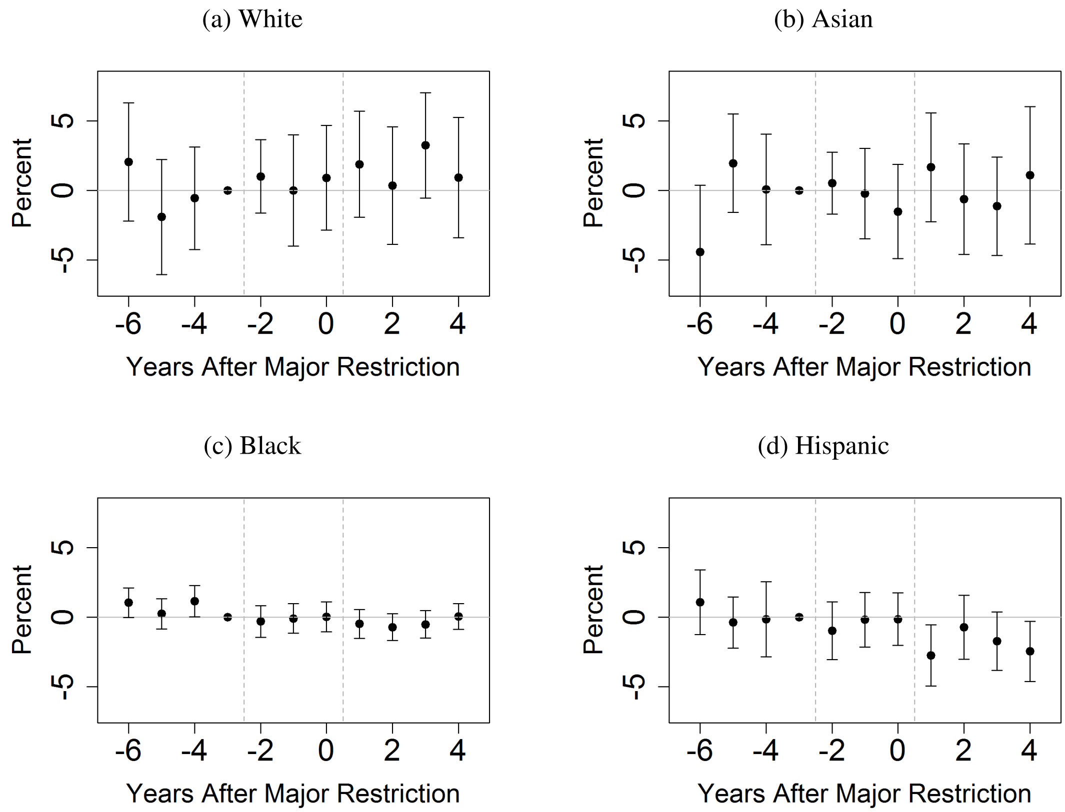
Note: This figure shows that Black and Hispanic college graduates have followed similar college-major-premium trends since the mid-1960s – with a flat and slightly positive major-premium gap (relative to white graduates) steadily declining by over 0.02 log points since 1980 – but that Asian graduates earn far higher-premium majors than any other ethnic group on average. Average college major premium by birth cohort and specific ethnicity – white, Asian, Black, and Hispanic – among 2009-2019 ACS respondents, and the difference between each ethnicity-cohort's average major premium and white graduates' average major premium in that cohort. College major premiums are estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, and year covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS; see Appendix A for details. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018).

both groups to exit restricted majors.[61]

Both white and Asian enrollment increased in restricted majors following the restrictions' implementation, though the dynamics presented in Figure EE-2 are noisily estimated. Enrollment increased by 0.9 percentage points among Asian students – whereas 1.1 percentage points would have been expected given Asian students' enrollment share – and 1.8 percentage points among white students (as expected). The remaining increase was among students of other or unreported ethnicities. This suggests that each group of non-URM students was similarly impacted by major restriction policies, which justifies grouping them in the baseline analysis in the main text.

[61]UC majors in the sample were 15 percent Hispanic and 3 percent Black on average.

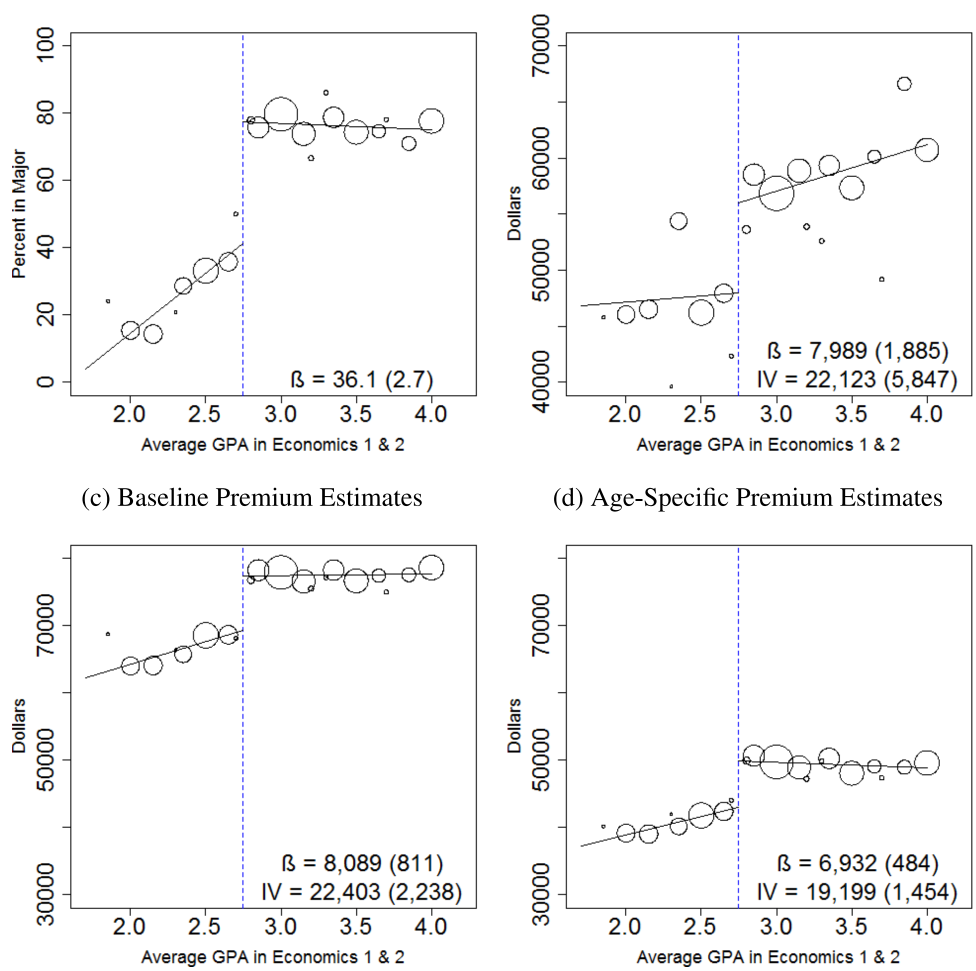
Figure EE-2: Department-Level Difference-in-Difference Estimates by Specific Ethnicity



Note: This figure disaggregates the effects of major restrictions by ethnicity and shows clear evidence of a decline in Hispanic attainment in restricted majors and noisier evidence of increases among white and Asian students and a decrease in Black students. Event study β estimates of the ethnicity shares of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year. Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). Source: UC ClioMetric History Project Student Database.

Other Appendix Figures and Tables

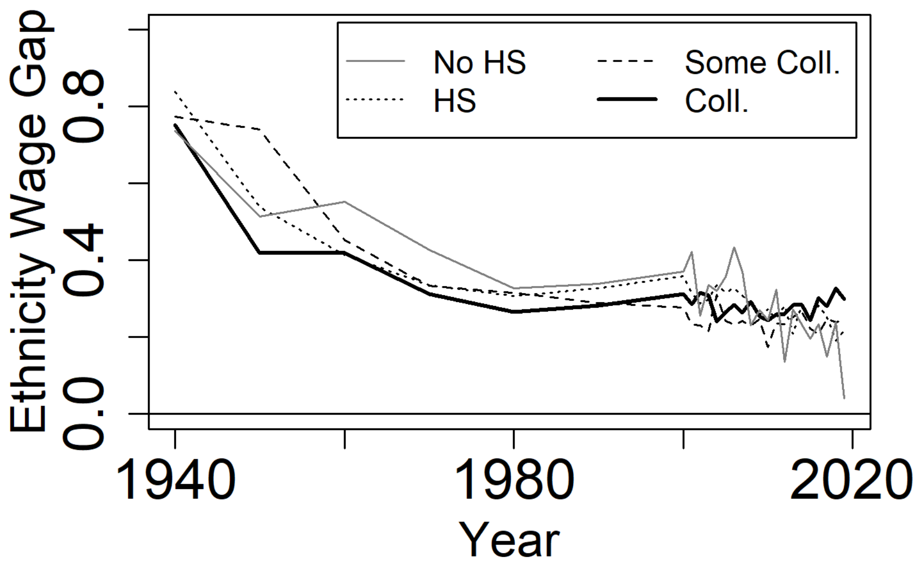
Figure A-1: Quasi-Experimental Validation of College Major Premium Estimates



(a) First Stage: Major in Economics
(b) Observed 2017-2018 Wages
(c) Baseline Premium Estimates
(d) Age-Specific Premium Estimates

Note: This figure shows that the college major premium ($\hat{W}_m$) estimates accurately predict the change in students' observed annual earnings resulting from a quasi-experimental shift in the college majors of 2008-2012 UC Santa Cruz compliers (who preferred to major in economics), whether using the baseline major premium estimates or replacing the estimation sample with same-age ACS respondents. Panels (a) and (b) replicate Figures 1 and 2 from Bleemer and Mehta (2021), showing a sharp discontinuity in access to the economics major at UC Santa Cruz between 2008 and 2012 as a result of the department's 2.8 major restriction policy, visualizing both the (first-stage) decline in economics major attainment and the change in average annual California wages earned by students. Panels (c) and (d) show the economic value of majors earned by the UCSC students, measuring economic value by the baseline major premium estimates (Table A-1) and using a comparable set of statistics (also following Equation AA-1) estimated over a population of workers of similar age as those in the UCSC wage estimation sample (ages 24-29). College major premium estimates are additively inflated by the average log wage of the hold-out major (general agriculture) in each sample and exponentiated for comparability with the UCSC wage estimates. Source: UC ClioMetric History Project Student Database, the American Community Survey (Ruggles et al., 2018), and (Bleemer and Mehta, 2021).

Figure A-2: Average Mid-Career Ethnicity Wage Gap Over Time by Education Level

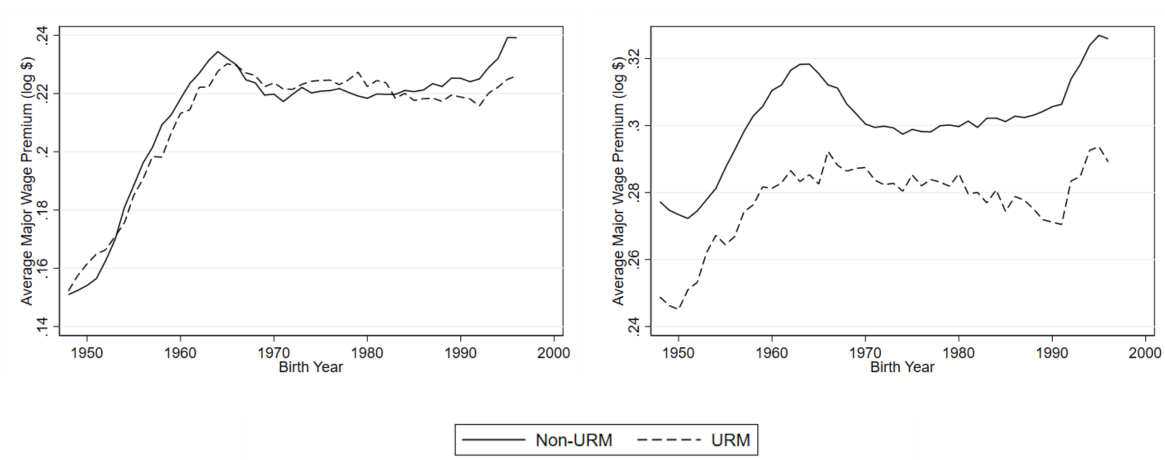


Note: This figure shows that URM workers have historically earned substantially lower wages than similarly-educated non-URM workers, but that while that gap has closed across education groups since the 1940s, that convergence has slowed – and even reversed – among college-educated (but not less-educated) workers in recent years. This figure shows the difference in mean log wages earned by male native-born non-URM and URM workers between ages 38 and 42 by year and education level: no high school degree, high school degree but no college, some college but no four-year college degree, and (at least) a four-year college degree. The sample is restricted to individuals with positive observed wages. URM includes Black, Hispanic, and Native American workers; non-URM includes all other workers. Samples include 1% samples of the 1940, 1950, and 1970 U.S. censuses, 5% samples of the 1960, 1980, 1990, and 2000 censuses, and all subsequent ACS respondents (as available from Ruggles et al., 2018); averages are weighted by sample weights. Source: The 1940-2000 U.S. Decennial Census and the 2001-2019 American Community Survey (Ruggles et al., 2018).

Figure A-3: Aggregate College Major Ethnic Stratification Separately by Gender

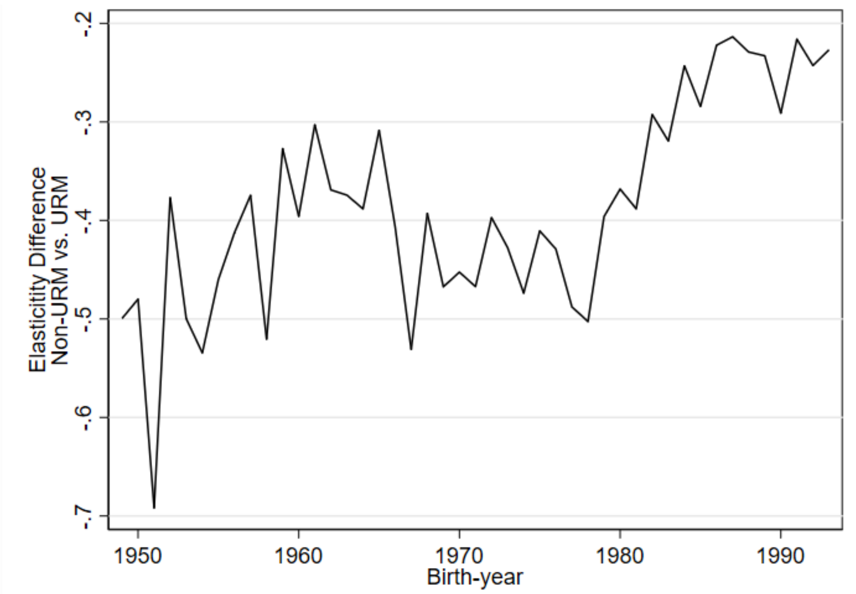
(a) Female

(b) Male



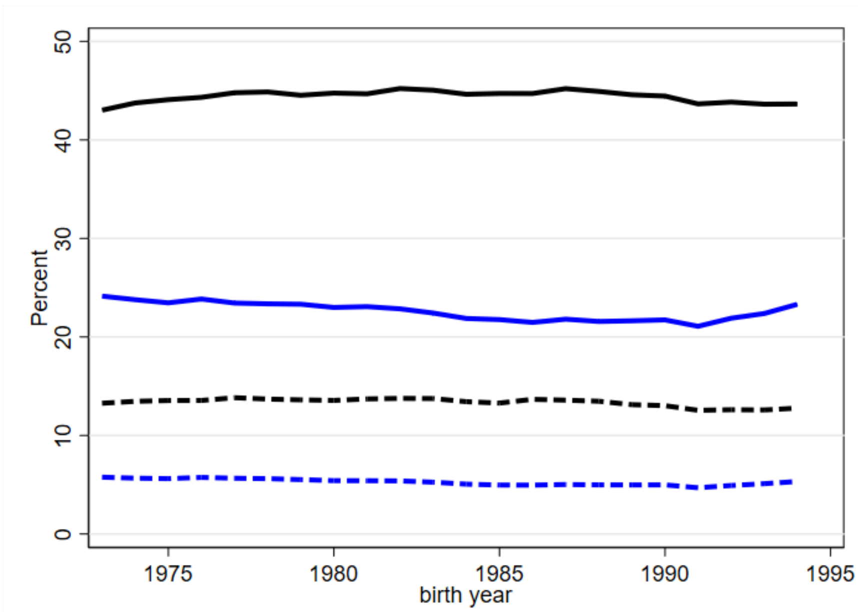
Note: This figure shows that college major stratification has long been smaller among women than among men, the qualitative trend has been the same among both groups, with a narrowed gap in the 1970-1980 birth cohorts that has slowly widened since that time. This figure depicts the average college major premium attained by birth cohort and ethnicity among all female (a) and male (b) college graduates, as in Figure 1. College major premiums are estimated by regressions of log wages on major indicators and control variables as explained in Appendix A over wage employees aged 35-45 in the 2009-2019 American Community Survey. Source: The American Community Survey (Ruggles et al., 2018).

Figure A-4: Racial Difference in Elasticity of Wages to College Major Premiums



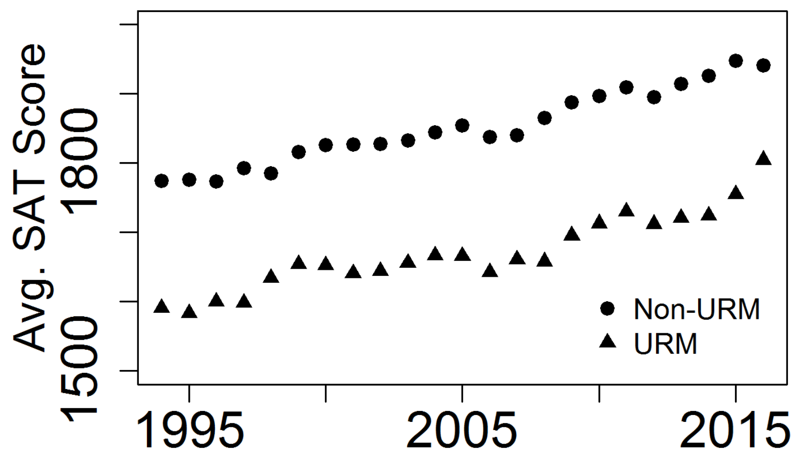
Note: This figure shows that URM students' wage-benefits of completing higher wage majors have grown relative to those of non-URM students, with the URM elasticity rising from about 0.5 to about 0.8. Ethnic differences in elasticities are birth-year-specific coefficients on the interaction between a students' major wage and a URM dummy, in a log-wage regression that includes dummies for birth-year x URM, and for birth-year x ACS-year x major x sex. Sample is restricted to employees holding at least a 4-year degree, aged 25-60 Source: The American Community Survey (Ruggles et al., 2018).

Figure A-5: Probability of High School Graduates' College and R1 Completion by Ethnicity



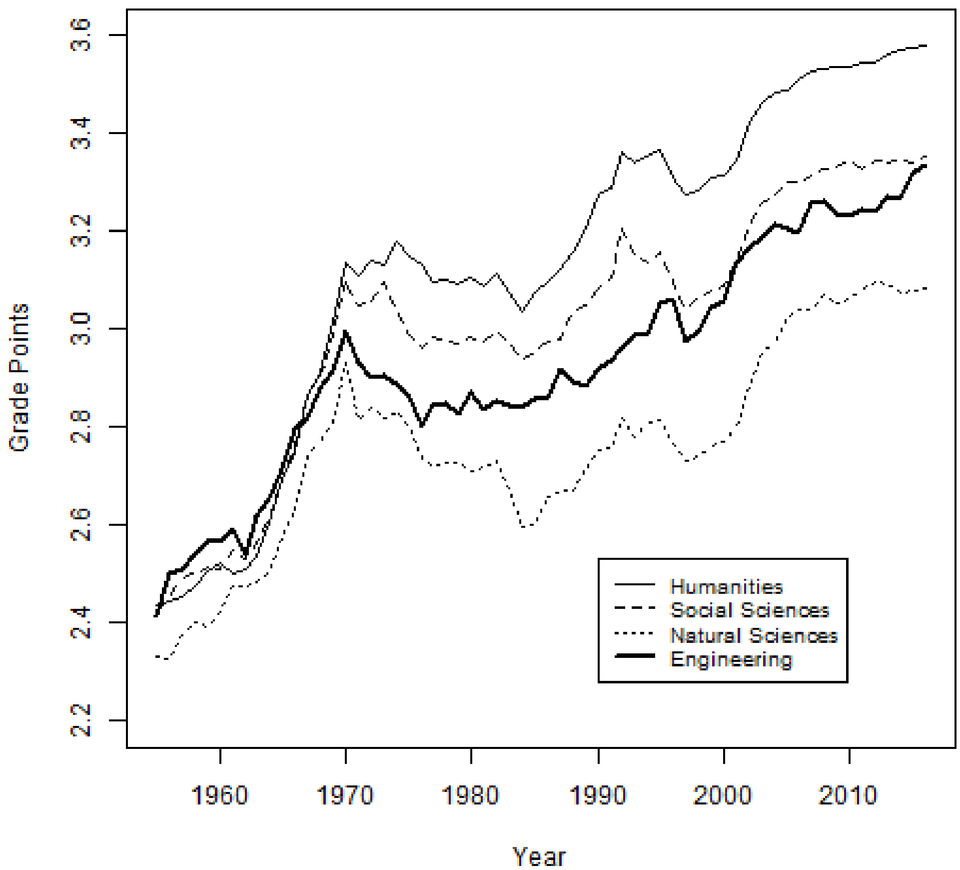
Note: This figure shows that the chances of URM high school graduates earning a college degree, or a college degree from an R1 university, have not grown significantly faster than those of non-URM graduates. Solid lines are the fraction of high-school graduates in each ethnic group and birth cohort who have completed at least a four-year degree. Dashed lines are the fraction who have completed a 4 year degree from an R1 institution. Blue (black) lines reflect probabilities for URM (non-URM) students. Source: The American Community Survey (Ruggles et al., 2018) and IPEDS.

Figure A-6: Average SAT Score of UC Students by URM Status and Cohort



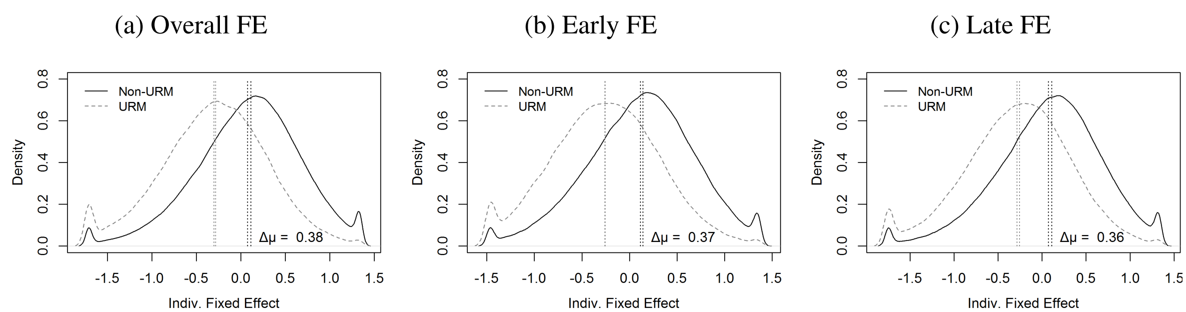
Note: This figure shows that R1 URM students' SAT scores have not declined over the past 30 years, suggesting that the increasing stratification within these institutions is not driven by negative selection among URM students. Average SAT score at UC Berkeley, UC Davis, UC Santa Cruz, and UC Santa Barbara by freshman cohort and URM status. Each campus is equally weighted in each series. Source: UC ClioMetric History Project Student Database.

Figure A-7: Average UC Berkeley Grades by Discipline over Time



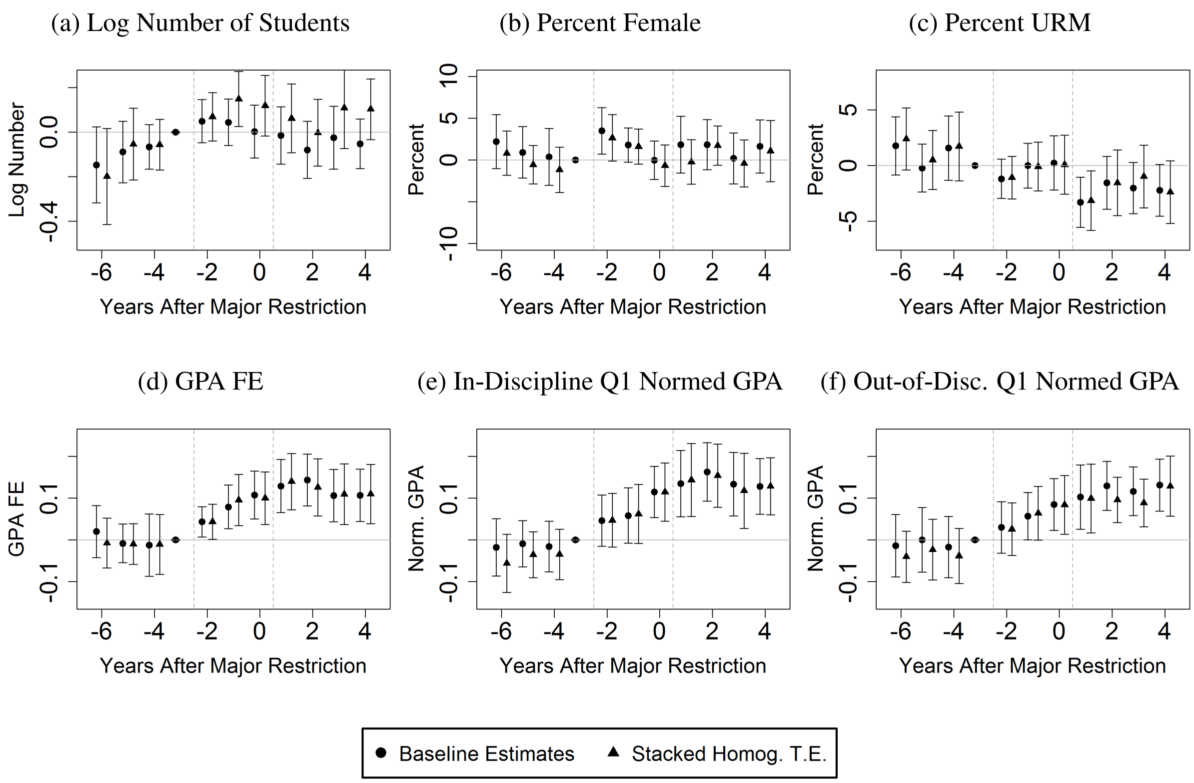
Note: This figure shows stark evidence of differential grade inflation by discipline at one public university, justifying the need for normalized GPAs over time and course. Average grade points earned by undergraduate students in Humanities, Social Science, Natural Science, and Engineering courses at UC Berkeley annually from 1955 to 2016. Departments categorized by the authors. Source: UC ClioMetric History Project Student Database.

Figure A-8: Distribution and Non-Convergence of GPA Fixed Effects



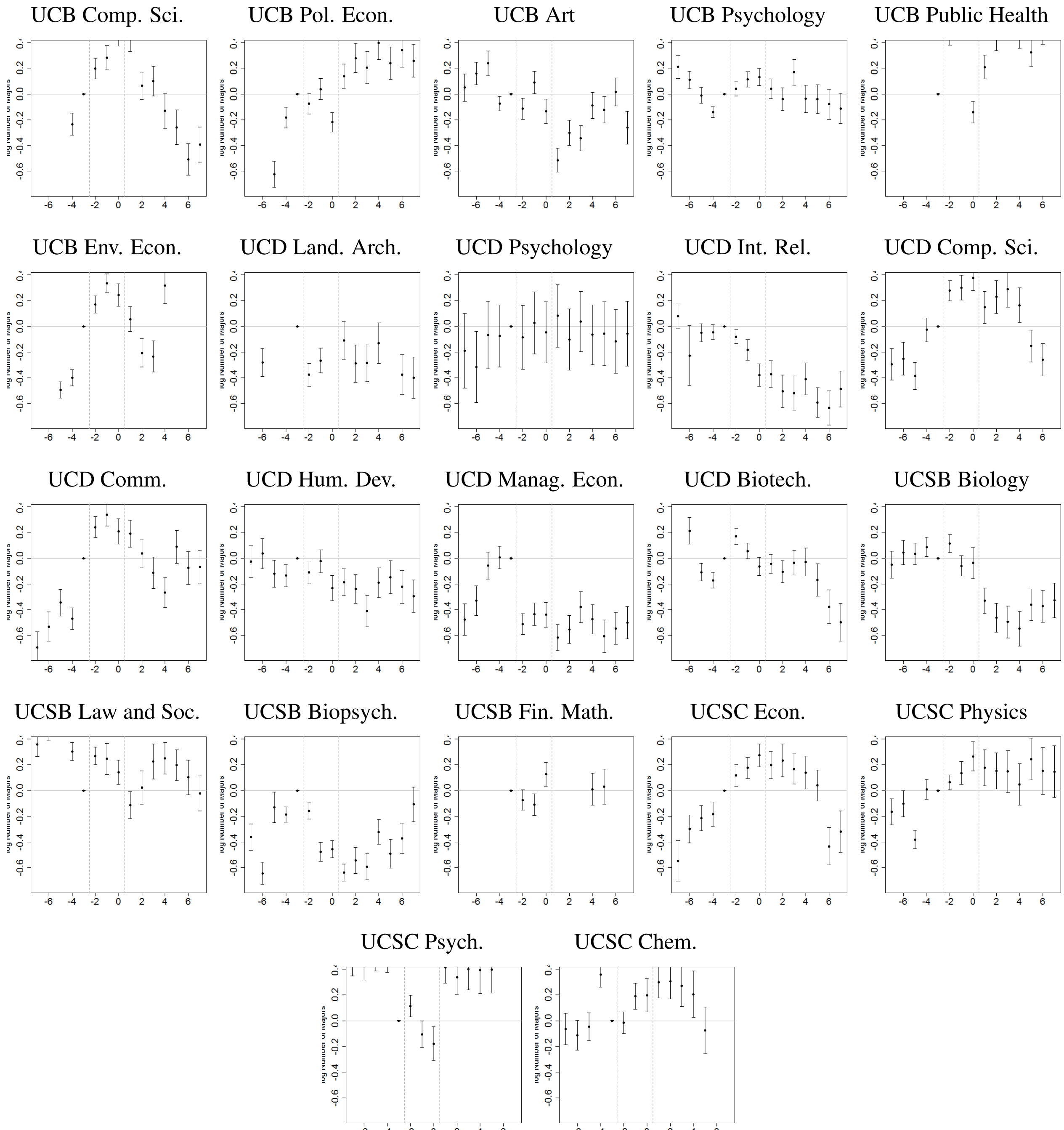
Note: This figure shows that URM UC students have consistently poorer average academic performance (as measured by grades) that does not converge over time, suggesting that educational allocation on the basis of even later-year academic performance would likely generate stratification. Distribution of observed students' GPA fixed effects by ethnicity overall and when estimated with separate individual effects for courses taken in the first two academic years ("Early") and courses taken in subsequent years ("Late"). Coefficients from two-way fixed effect regressions of GPA on student and course-term fixed effects estimated separately by UC campus; fixed effects are de-meaned by campus and are presented without shrinkage, though students with fewer than five courses in either relevant period are omitted. Dotted lines show the median and mean by URM status, and the reported coefficient is the difference between the non-URM and URM means. Source: UC ClioMetric History Project Student Database.

Figure A-9: Robustness of Department-Level Event Studies



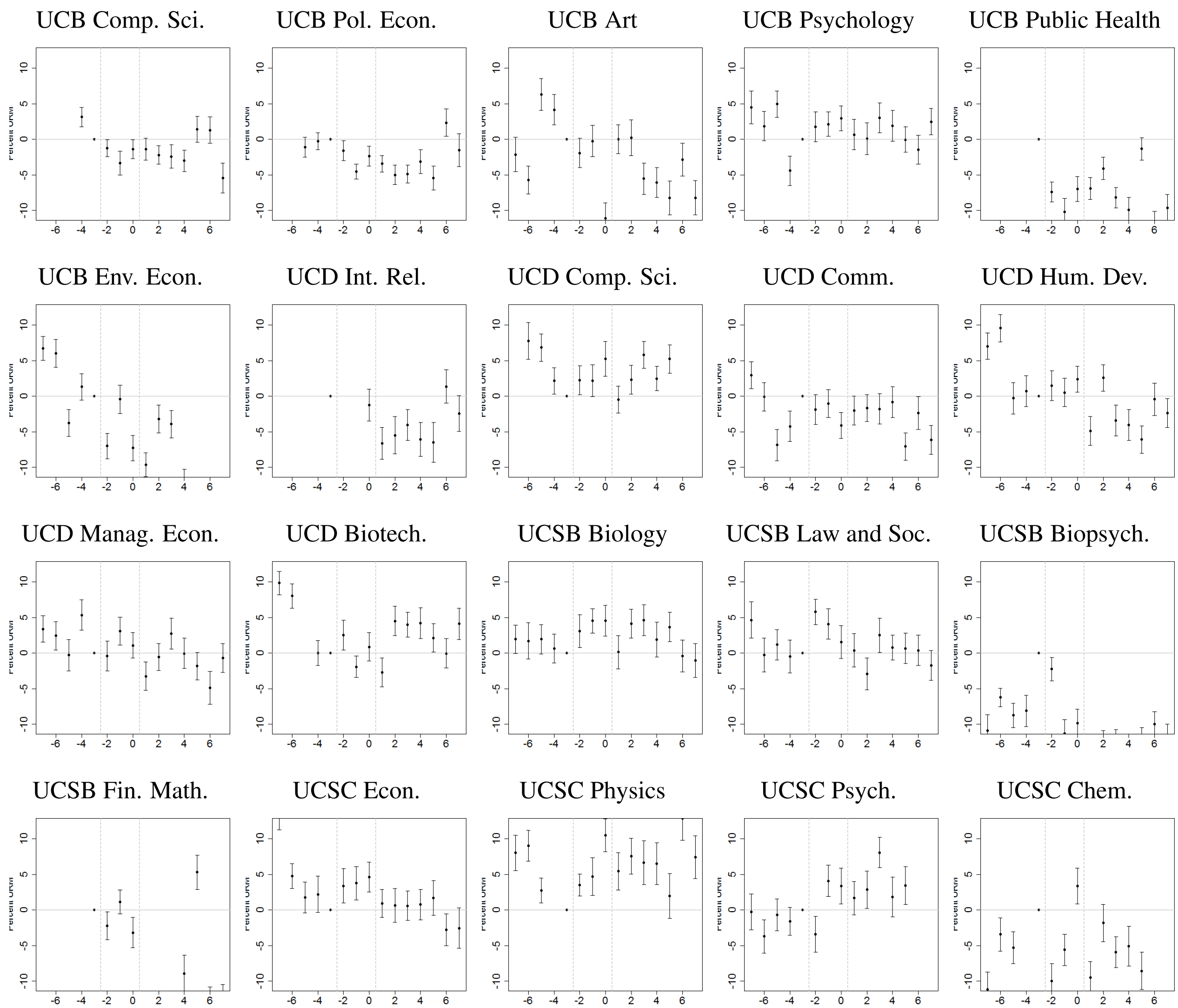
Note: This figure shows that the event study coefficients shown in Figures 5 and 6 are robust to stacked event study estimation with homogeneous treatment effects. Event study β estimates of demographic and academic characteristics of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year, estimated using the baseline specification and following Novgorodsky and Setzler (2019)'s implementation of Sun and Abraham (2021). Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). Normed GPA is defined within-course following Equation 6; out-of-discipline courses include those taken outside the major's discipline (Humanities, Social Sciences, Natural Sciences, Engineering, and Professional) and excluding Mathematics and Statistics courses, while in-discipline courses include those in the major's discipline. Source: UC ClioMetric History Project Student Database.

Figure A-10: Individual Department Event Studies: Log Number of Students



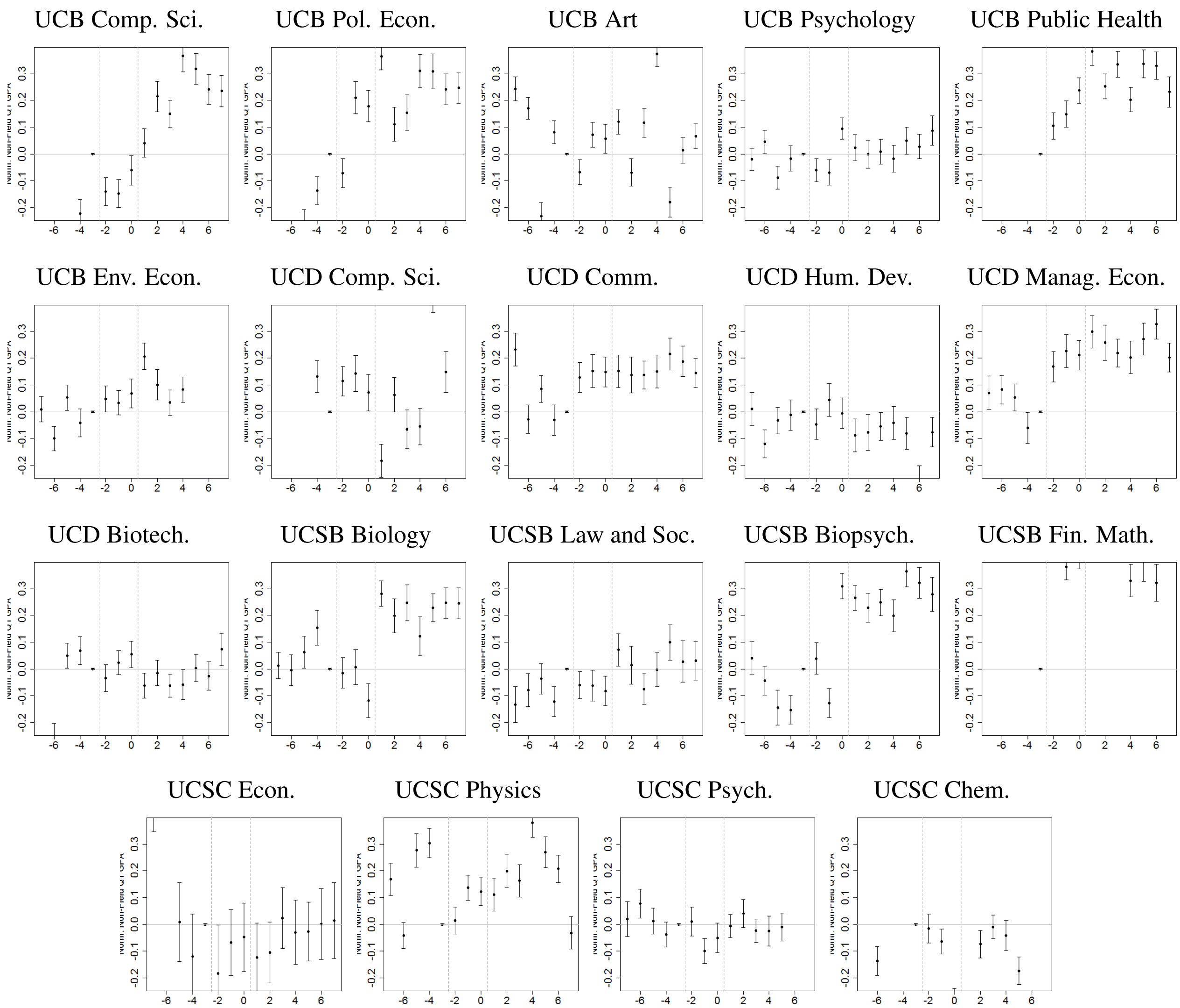
Note: Event study β estimates of the log number of students in each respective major before and after the implementation of its restriction, relative to other majors in that campus-year. Estimated over the full sample of campus-major-cohorts, but only including one 'event' per figure. β_{-1} is omitted and standard errors are clustered by campus-major. Coefficients are missing in the earliest years during which the major did not exist and in the latest years when the restriction was lifted. Source: UC ClioMetric History Project Student Database.

Figure A-11: Individual Department Event Studies: Percent of Majors URM



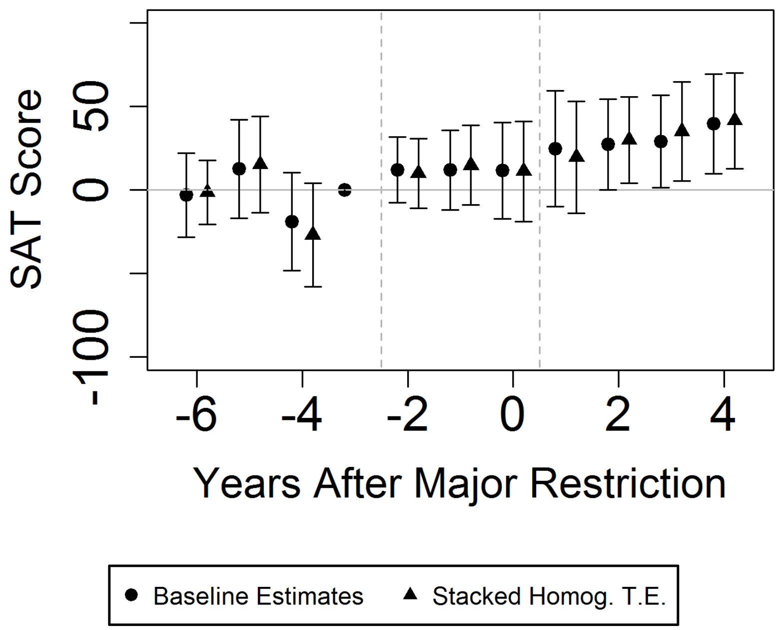
Note: Event study β estimates of the percent of declared students in each respective major who are underrepresented minorities (URM) before and after the implementation of the major's restriction, relative to other majors in that campus-year. Estimated over the full sample of campus-major-cohorts, but only including one 'event' per figure. β_{-1} is omitted and standard errors are clustered by campus-major. Coefficients are missing in the earliest years during which the major did not exist and in the latest years when the restriction was lifted. Source: UC ClioMetric History Project Student Database.

Figure A-12: Individual Department Event Studies: Outside-Discipline Normed GPA



Note: Event study β estimates of each major's declared students' first-term normed GPA in courses taken outside of the major's division (and excluding Mathematics and Statistics courses) before and after the implementation of its restriction, relative to other majors in that campus-year. Estimated over the full sample of campus-major-cohorts, but only including one 'event' per figure. β_{-1} is omitted and standard errors are clustered by campus-major. Coefficients are missing in the earliest years during which the major did not exist and in the latest years when the restriction was lifted. Source: UC ClioMetric History Project Student Database.

Figure A-13: Effect of Major Restriction on Average SAT Score

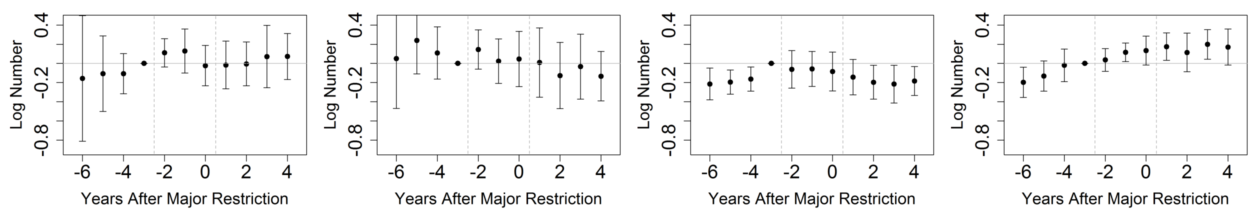


Note: This figure shows that implementing a new major restriction increased the average SAT score of students declaring the major, in line with the increases in other measures of academic preparation and performance shown in Figure 6. Event study β estimates of the average observed SAT score of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year, estimated using the baseline specification and following Novgorodsky and Setzler (2019)'s implementation of Sun and Abraham (2021). SAT scores are averages by declared major and cohort-year, defined by students' first year of enrollment, and are only observed after 1994 for students who entered UC as freshmen. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). Source: UC ClioMetric History Project Student Database and Bleemer and Mehta (2020).

Figure A-14: Campus-Specific Department-Level Difference-in-Difference Estimates

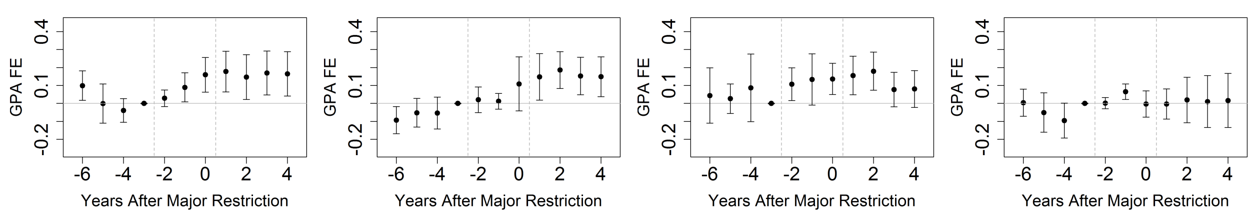
Panel A: Log Number of Students

(a) Berkeley (b) Santa Barbara (c) Davis (d) Santa Cruz



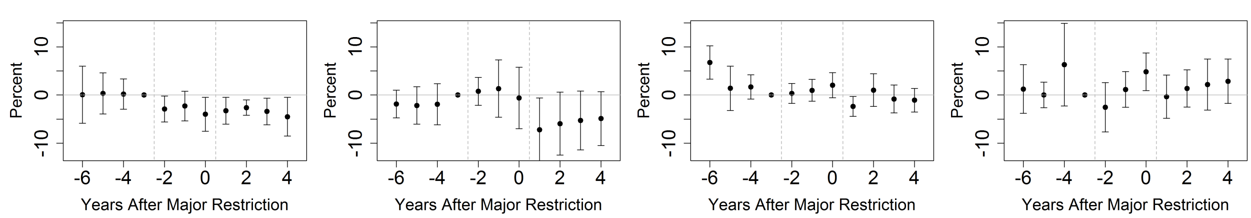
Panel B: GPA Fixed Effect

(e) Berkeley (f) Santa Barbara (g) Davis (h) Santa Cruz



Panel C: Percent of Students URM

(i) Berkeley (j) Santa Barbara (k) Davis (l) Santa Cruz

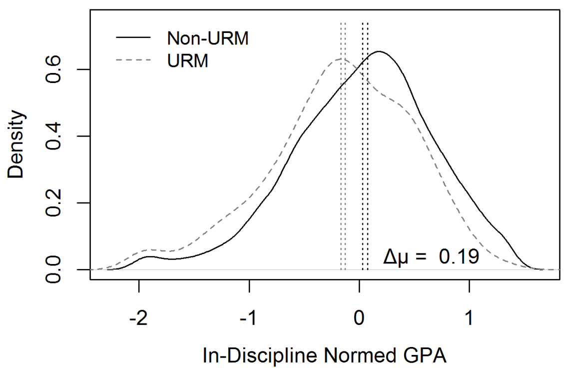


Note: This figure shows that the main effect of implementing new major restriction policies is replicable at Berkeley, Davis, and Santa Barbara, but that major restrictions have no immediate estimable effect at the Santa Cruz campus, which apparently did not enforce its restrictions.Event study β estimates of demographic and academic characteristics of students who declare restricted majors before and after the implementation of the restriction, relative to other majors in that campus-year and estimated separately by campus. GPA fixed effect is the student effect from a two-way fixed effect model of grades on students and course-terms. Outcomes are averages by declared major and cohort-year, defined by students' first year of enrollment. β_{-3} is omitted, and standard errors are clustered by campus-major. Students can be included in more than one major estimate (e.g. as double-majors). Source: UC ClioMetric History Project Student Database.

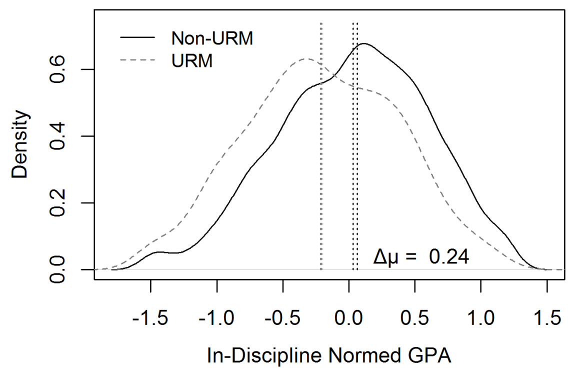
Figure A-15: Distribution of Restricted-Major Academic Performance by Ethnicity

Panel A: Grade Distribution in $t = -3$, Before Restrictions' Implementation

(a) Introductory GPA

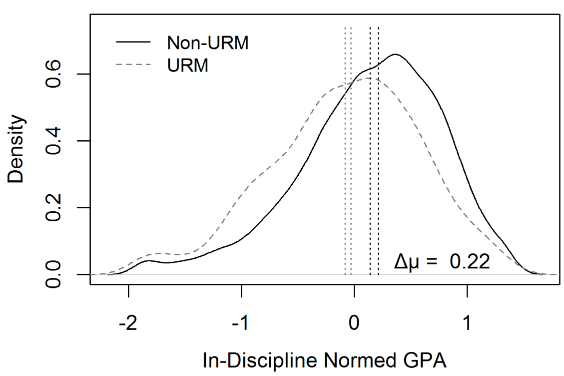


(b) Upper-Division GPA

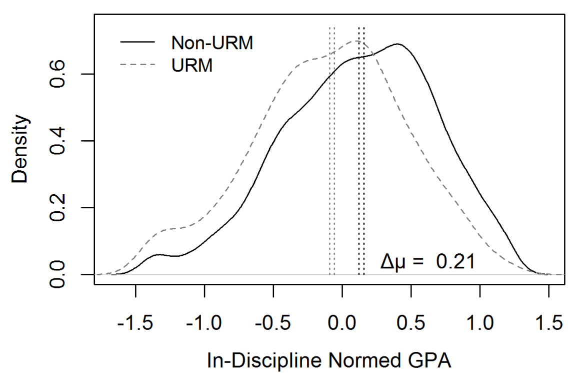


Panel B: Grade Distribution in $t = 3$, After Restrictions' Implementation

(c) Introductory GPA

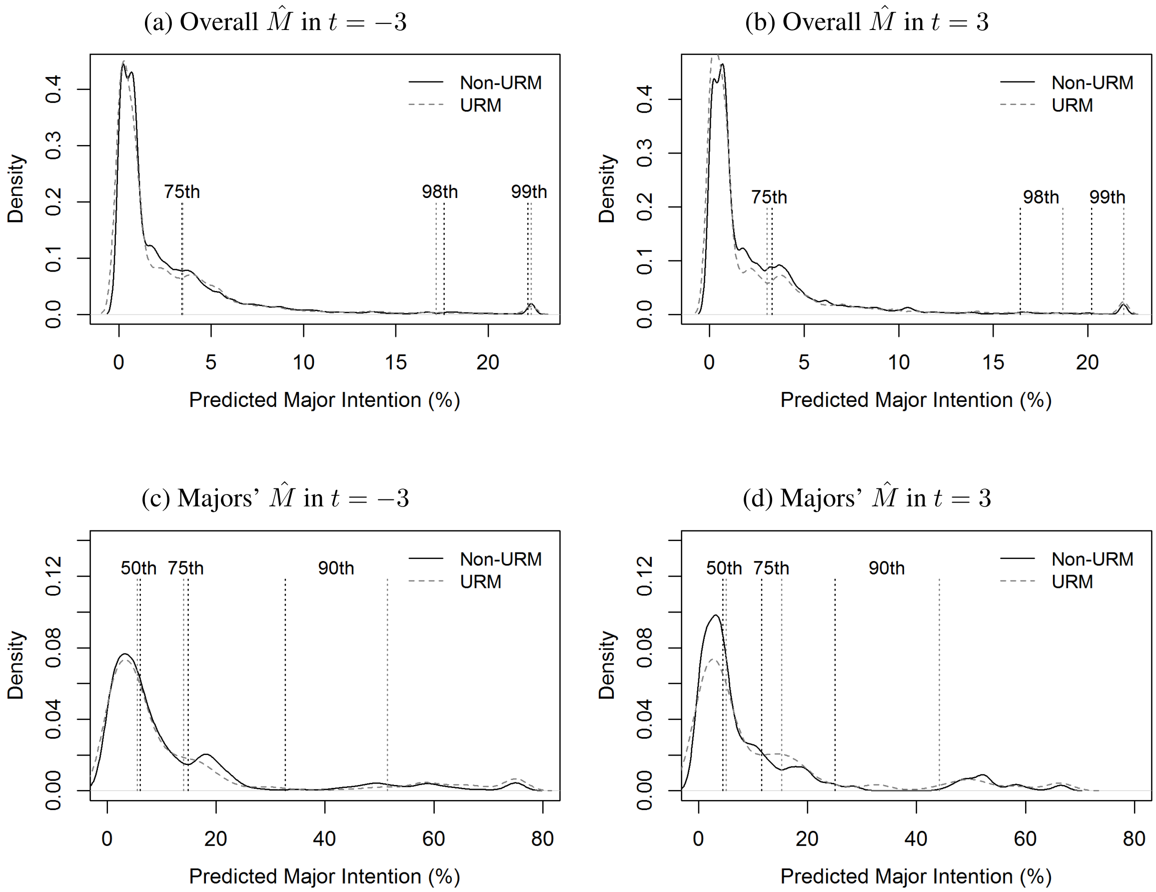


(d) Upper-Division GPA



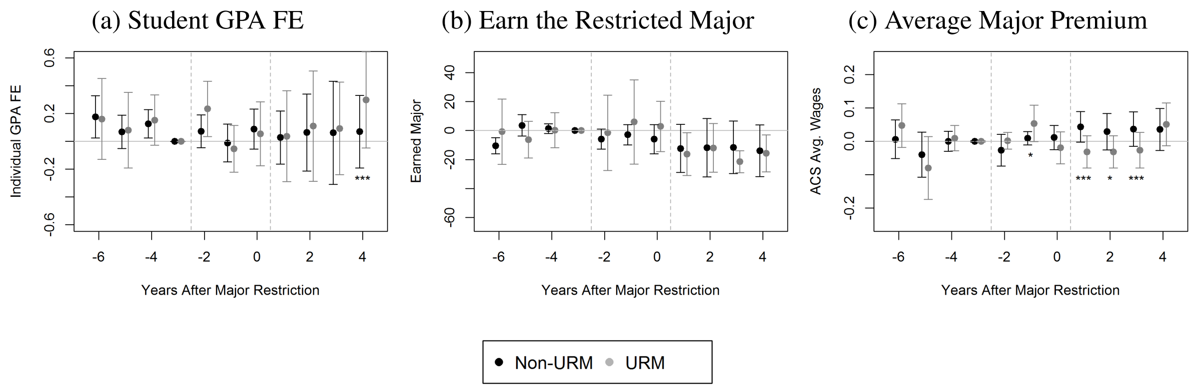
Note: This figure shows that URM students consistently earned lower grades in both introductory and upper-division courses in soon-to-be-restricted majors, and major restrictions did not lead to any measurable ethnic convergence in students' academic performance. Distribution of observed students' in-discipline normed GPA for courses taken in the first two academic years ("Introductory") and courses taken in subsequent years ("Upper-Division") by ethnicity, among students who earned either soon-to-be-restricted majors (three years before implementation) or recently-restricted majors (three years after implementation). Normed GPA is defined within-course following Equation 6; in-discipline courses include those taken in the major's discipline (Humanities, Social Sciences, Natural Sciences, Engineering, and Professional) as well as Mathematics and Statistics courses. Dotted lines show the median and mean by URM status, and the reported coefficient is the difference between the non-URM and URM means. Source: UC ClioMetric History Project Student Database.

Figure A-16: Distribution of Estimated Major Intentions by Ethnicity



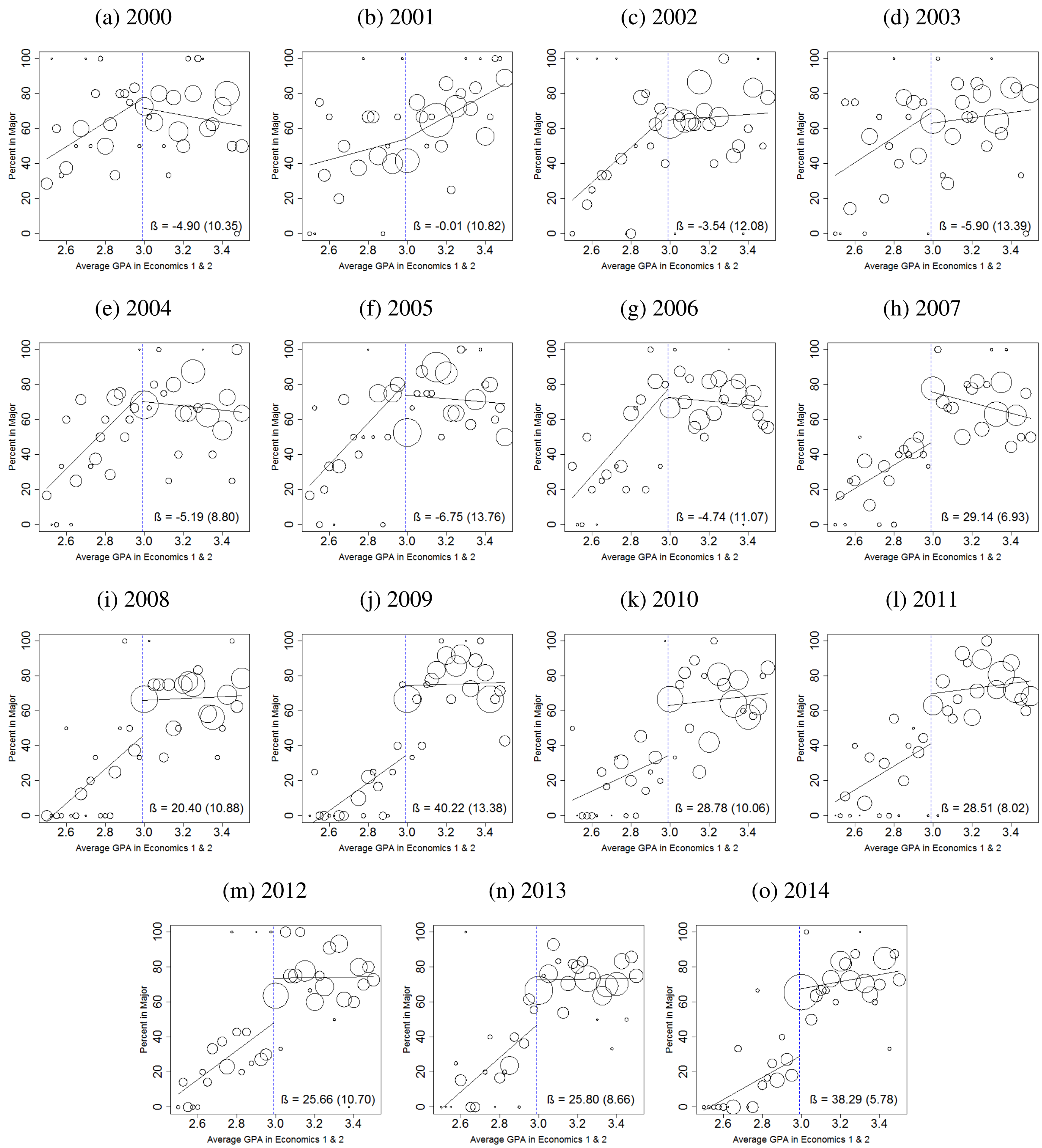
Note: This figure shows that over one percent of both URM and non-URM students in the non-training sample were predicted to earn restricted majors using their first-term Fall courses with a probability of at least 20 percent, though the distribution is very sharply skewed toward 0. Kernel density plots of winsorized $\hat{M}$, students' predicted likelihood of earning each restricted major (as estimated by random forest as described in Section 5), overall and among students who earned the restricted major, by ethnicity and number of years before or after the major's restriction was imposed. Percentiles are indicated by ethnicity. Source: UC ClioMetric History Project Student Database.

Figure A-17: Estimated Changes in Major Choice of Intended Majors by Ethnicity



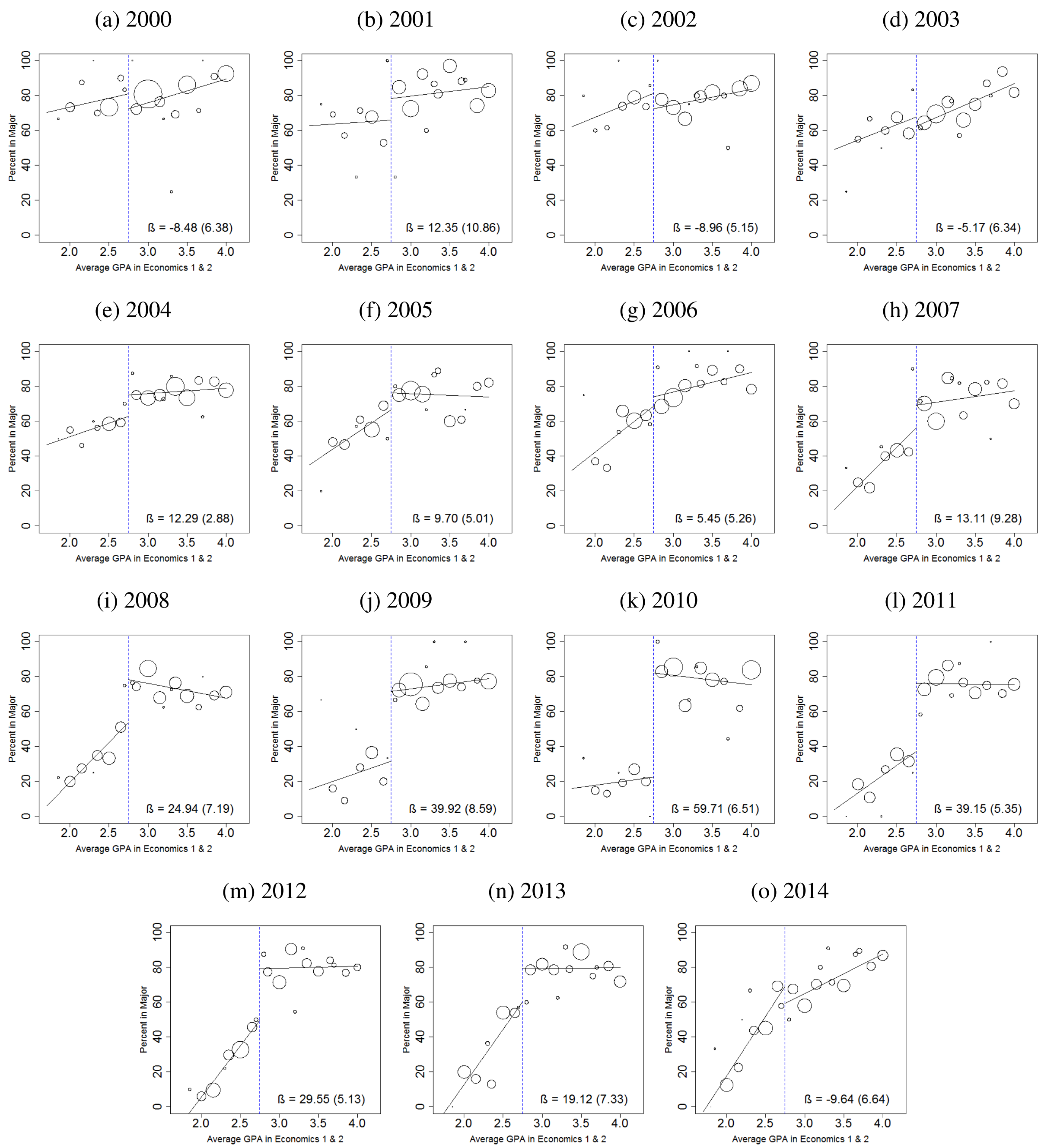
This figure shows the ethnicity-disaggregated coefficients used to produce Panel B of Figure 8, showing that the average premiums of majors earned by restricted-major-intending students diverge by ethnicity after restrictions' imposition despite only small relative declines in those URM students' likelihood of restricted major declaration. Note: Difference-in-difference event study β_{it} estimates of the relationship between students' intending the restricted major ($\hat{M}_{im}$) and their major choice or student characteristic before and after the implementation of the restriction, following Equation 8 (allowing separate β coefficients by URM status) and estimated over a stacked dataset of students i's major intentions in field m. Outcomes are defined as the student's GPA fixed effect (their individual fixed effect from a two-way fixed effect model of GPA on student and course effects), whether the student declares the restricted major, and the premium of the student's major (as defined in Appendix A). β_{-3} is omitted, and standard errors are two-way clustered by campus-majors m and by students i. Models include campus-major-cohort fixed effects. Source: UC ClioMetric History Project Student Database and the American Community Survey (Ruggles et al., 2020).

Figure A-18: Berkeley Economics Major Declaration at the Admission Threshold by Year



Note: This figure shows that UC Berkeley's economics major restriction policy was hardly binding until the 2007 cohort but was somewhat binding thereafter. Each circle represents the percent of economics majors (y axis) among each start cohort of UC Berkeley students who earned a given introductory economics GPA (x axis). The size of each circle corresponds to the proportion of students who earned that GPA. Cohort years are defined by year of entry. Majoring in economics indicates declaring (and never rescinding) the economics major. Fit lines and beta estimate (at the 3.0 GPA threshold) from linear regression discontinuity specification; standard error (clustered by GPA) in parentheses. The economics GPA is the mean of intro economics, two semesters of calculus, the first-taken of intermediate micro- or macroeconomics, and intro statistics; calculus could be omitted if "Advanced Placement" credit is observed. Source: UC-CHP Student Database.

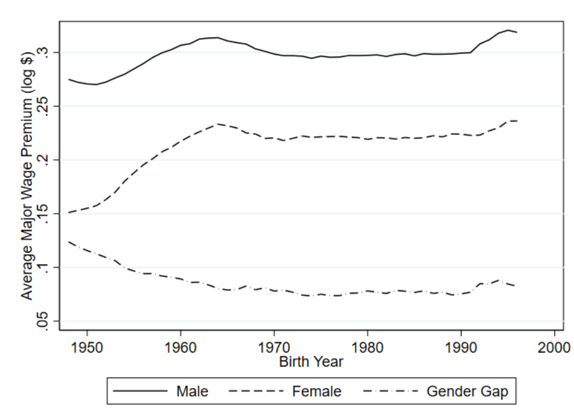
Figure A-19: UCSC Economics Major Declaration at the Admission Threshold by Year



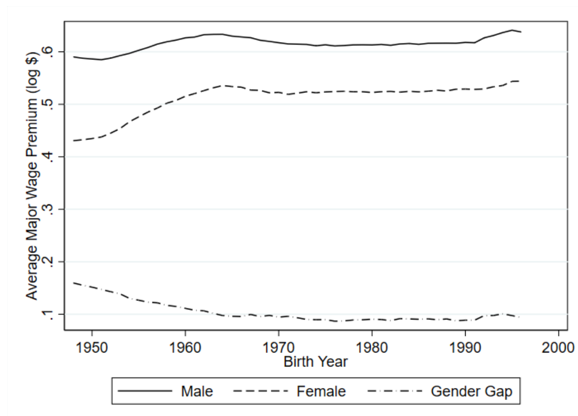
Note: This figure shows that UCSC's economics major restriction policy was hardly binding until the 2008 cohort, most binding in 2010, and became less binding after 2013 (in part because the introductory GPA rule changed). Each circle represents the percent of economics majors (y axis) among each cohort year of UCSC students who earned a given GPA in Economics 1 and 2 (x axis). The size of each circle corresponds to the proportion of students who earned that introductory GPA. Cohort years are defined by year of entry. Majoring in economics indicates declaring any of UCSC's three economics major tracks: economics, global economics, or business management economics. Fit lines and beta estimate (at the 2.8 GPA threshold) from linear regression discontinuity specification; standard error (clustered by GPA) in parentheses. This figure replicates Figure A-1 of Bleemer and Mehta (2021). Source: UC ClioMetric History Project Student Database.

Figure A-20: Average College Major Premium by Birth Cohort and Gender

(a) Baseline Major Premium Statistics



(b) Sloane, Hurst, and Black (2021) Medians



Note: This figure shows that the trends in average economic value of college majors earned by male and female college-graduate cohorts in the U.S. are highly similar when economic value is alternatively estimated using this study's baseline college major premium statistics or using the median wage statistics preferred by Sloane, Hurst, and Black (2021). College graduates' average major premium by birth cohort and gender among ACS respondents and the difference between those averages. The left panel presents estimating using the baseline major premium statistics estimated by OLS regression of log wages on major indicators and gender, ethnicity, age, year, and double-major covariates over wage employees aged 35-45 appearing in the 2009-2019 ACS (replicating Figure DD-1); see Appendix A for details. The right panel follows Sloane, Hurst, and Black (2021) by assigning each major to the median CPI-adjusted hourly wage earned by native white men with "strong labor market attachment" (that is, who worked at least 30 hours per week for at least 27 weeks in the prior year) between ages 43 and 57 appearing in the 2014-2017 ACS. The specification remains slightly different from that of Sloane, Hurst, and Black (2021): we do not drop ACS respondents with missing (imputed) responses. Source: The 2009-2019 American Community Survey (Ruggles et al., 2018).

Table A-1: Estimated College Major Premiums

Major Code and Name		β	s.e.	Major Code and Name		β	s.e.
6202	Actuarial Science	0.7640	0.0494	1401	Architecture	0.2297	0.0228
6106	Health and Medical Preparatory Programs	0.7280	0.0377	6402	History	0.2270	0.0218
2404	Biomedical Engineering	0.7271	0.0389	5004	Geology and Earth Science	0.2237	0.0259
2419	Petroleum Engineering	0.7176	0.0851	6100	General Medical and Health Services	0.2236	0.0278
3611	Neuroscience	0.7123	0.0490	3202	Pre-Law and Legal Studies	0.2232	0.0286
4006	Cognitive Science and Biopsychology	0.6525	0.0524	2602	Common Foreign Language Studies	0.2144	0.0239
6108	Pharmacy, Pharm. Sciences, and Admin.	0.6363	0.0240	5006	Oceanography	0.2087	0.0427
3603	Molecular Biology	0.6218	0.0306	6006	Art History and Criticism	0.2063	0.0295
2405	Chemical Engineering	0.6215	0.0232	5401	Public Administration	0.2026	0.0315
3601	Biochemical Sciences	0.6098	0.0257	1902	Journalism	0.2018	0.0232
2418	Nuclear Engineering	0.6097	0.0562	2107	Computer Networking and Telecommunications	0.2010	0.0302
4005	Mathematics and Computer Science	0.5996	0.0614	6103	Health and Medical Administrative Services	0.2004	0.0254
2407	Computer Engineering	0.5931	0.0227	6104	Medical Assisting Services	0.1966	0.0310
5008	Materials Science	0.5849	0.0381	2106	Computer Information Management and Security	0.1958	0.0282
2408	Electrical Engineering	0.5571	0.0213	1901	Communications	0.1951	0.0215
5501	Economics	0.5476	0.0219	2500	Engineering Technologies	0.1942	0.0352
3607	Pharmacology	0.5441	0.0632	1103	Animal Sciences	0.1933	0.0275
2401	Aerospace Engineering	0.5383	0.0270	5299	Miscellaneous Psychology	0.1902	0.0365
2415	Metallurgical Engineering	0.5354	0.0490	6110	Community and Public Health	0.1847	0.0313
2414	Mechanical Engineering	0.5305	0.0214	2101	Computer Programming	0.1732	0.0389
5402	Public Policy	0.5274	0.0480	1301	Environmental Science	0.1652	0.0244
3701	Applied Mathematics	0.5243	0.0355	5206	Social Psychology	0.1649	0.0606
3605	Genetics	0.5074	0.0432	3301	English Language and Literature	0.1609	0.0214
2416	Mining and Mineral Engineering	0.5060	0.0655	3201	Court Reporting	0.1601	0.0723
6207	Finance	0.5029	0.0215	2303	School Student Counseling	0.1575	0.0380
3600	Biology	0.4916	0.0213	5200	Psychology	0.1555	0.0211
2102	Computer Science	0.4901	0.0212	4002	Nutrition Sciences	0.1499	0.0324
5003	Chemistry	0.4837	0.0225	4801	Philosophy and Religious Studies	0.1458	0.0240
2412	Industrial and Manufacturing Engineering	0.4749	0.0246	5502	Anthropology and Archeology	0.1381	0.0247
6205	Business Economics	0.4726	0.0312	5000	Physical Sciences	0.1374	0.0531
5007	Physics	0.4658	0.0235	5507	Sociology	0.1364	0.0219
5505	International Relations	0.4626	0.0272	5301	Criminal Justice and Fire Protection	0.1280	0.0213
2410	Environmental Engineering	0.4583	0.0325	5503	Criminology	0.1248	0.0288
3702	Statistics	0.4571	0.0344	1101	Agriculture Production and Management	0.1225	0.0287
2417	Naval Architecture and Marine Engineering	0.4570	0.0510	4007	Interdisciplinary Social Sciences	0.1119	0.0303
3606	Microbiology	0.4523	0.0277	5201	Educational Psychology	0.1079	0.0411
2501	Engineering and Industrial Management	0.4463	0.0414	3604	Ecology	0.1057	0.0296
6212	Management Information Systems and Statistics	0.4428	0.0228	5504	Geography	0.1050	0.0253
2403	Architectural Engineering	0.4363	0.0445	2601	Linguistics and Comparative Language and Lit.	0.1016	0.0311
5506	Political Science and Government	0.4282	0.0215	2310	Special Needs Education	0.0955	0.0236
2406	Civil Engineering	0.4258	0.0223	2308	Science Teacher Education	0.0919	0.0270
2413	Materials Engineering and Materials Science	0.4245	0.0342	1903	Mass Media	0.0852	0.0245
2105	Information Sciences	0.4232	0.0254	1303	Natural Resources Management	0.0816	0.0257
2409	Engineering Mechanics, Physics, and Science	0.4211	0.0440	2399	Miscellaneous Education	0.0815	0.0246
5801	Precision Production	0.4180	0.1611	5202	Clinical Psychology	0.0800	0.0571
3608	Physiology	0.4075	0.0303	2305	Mathematics Teacher Education	0.0800	0.0276
3609	Zoology	0.4053	0.0306	3401	Liberal Arts	0.0749	0.0224
2400	General Engineering	0.4045	0.0222	4101	Physical Fitness, Parks, Recreation, and Leisure	0.0726	0.0225
5599	Miscellaneous Social Sciences	0.4011	0.0474	1302	Forestry	0.0691	0.0315
2499	Miscellaneous Engineering	0.4009	0.0298	4000	Interdisciplinary & Multidisciplinary Studies	0.0673	0.0289
5001	Astronomy and Astrophysics	0.3916	0.0642	2603	Other Foreign Languages	0.0662	0.0347
3700	Mathematics	0.3831	0.0226	3302	Composition and Speech	0.0639	0.0306
6204	Operations, Logistics and E-Commerce	0.3752	0.0271	6004	Commercial Art and Graphic Design	0.0580	0.0229
6107	Nursing	0.3739	0.0210	3402	Humanities	0.0579	0.0335
6201	Accounting	0.3617	0.0212	2001	Communication Technologies	0.0514	0.0309
5005	Geosciences	0.3484	0.0448	1106	Soil science	0.0481	0.0543
5601	Construction Services	0.3419	0.0266	2313	Language and Drama Education	0.0464	0.0239
6210	International Business	0.3363	0.0272	5500	General Social Sciences	0.0443	0.0290
5901	Transportation Sciences and Technologies	0.3354	0.0249	2311	Social Science or History Teacher Education	0.0340	0.0254
3801	Military Technologies	0.3282	0.0900	2300	General Education	0.0339	0.0212
2100	Computer and Information Systems-General	0.3184	0.0221	6199	Miscellaneous Health Medical Professions	0.0334	0.0301
2402	Biological Engineering	0.3138	0.0384	1105	Plant Science and Agronomy	0.0289	0.0302
1104	Food Science	0.3064	0.0404	2309	Secondary Teacher Education	0.0281	0.0235
6200	General Business	0.2880	0.0212	6211	Hospitality Management	0.0281	0.0252
6206	Marketing	0.2867	0.0216	6005	Film, Video and Photographic Arts	0.0238	0.0280
2502	Electrical Engineering Technology	0.2857	0.0273	2306	Physical and Health Education Teaching	0.0133	0.0233
2301	Educational Administration and Supervision	0.2838	0.0299	5404	Social Work	0.0005	0.0224
3699	Miscellaneous Biology	0.2790	0.0315	1100	General Agriculture	0.0000	0.0000
4001	Intercultural and International Studies	0.2790	0.0298	2304	Elementary Education	-0.0009	0.0212
5098	Multidisciplinary or general science	0.2788	0.0228	2312	Teacher Education: Multiple Levels	-0.0034	0.0257
6105	Medical Technologies Technicians	0.2763	0.0253	5203	Counseling Psychology	-0.0065	0.0339
5102	Nuclear and Industrial Radiology Technologies	0.2670	0.0503	2901	Family and Consumer Sciences	-0.0200	0.0236
5205	Industrial and Organizational Psychology	0.2655	0.0475	1199	Miscellaneous Agriculture	-0.0207	0.0768
1102	Agricultural Economics	0.2616	0.0373	3501	Library Science	-0.0209	0.0510
6109	Treatment Therapy Professions	0.2558	0.0227	3602	Botany	-0.0296	0.0482
2599	Miscellaneous Engineering Technologies	0.2531	0.0276	2314	Art and Music Education	-0.0325	0.0239
5002	Atmospheric Sciences and Meteorology	0.2528	0.0385	5701	Electrical and Mechanic Repairs and Technologies	-0.0454	0.0479
6299	Miscellaneous Business	0.2514	0.0283	6000	Fine Arts	-0.0496	0.0232
1904	Advertising and Public Relations	0.2509	0.0251	6001	Drama and Theater Arts	-0.0633	0.0256
1501	Area, Ethnic, and Civilization Studies	0.2449	0.0260	6002	Music	-0.0673	0.0240
6403	United States History	0.2418	0.0539	5403	Human Services and Community Organization	-0.0707	0.0273
6209	Human Resources and Personnel Management	0.2408	0.0242	6003	Visual and Performing Arts	-0.0872	0.0351
2411	Geological and Geophysical Engineering	0.2401	0.1390	2307	Early Childhood Education	-0.1010	0.0247
6102	Communication Disorders Sciences and Services	0.2391	0.0245	6099	Miscellaneous Fine Arts	-0.1353	0.0840
6203	Business Management and Administration	0.2390	0.0209	6007	Studio Arts	-0.1361	0.0301
2504	Mechanical Engineering Related Technologies	0.2340	0.0364	2201	Cosmetology Services and Culinary Arts	-0.1548	0.0381
2503	Industrial Production Technologies	0.2303	0.0294	4901	Theology and Religious Vocations	-0.2659	0.0240

Note: Estimates from an OLS regression of annual log income on major indicators across all employed college-educated respondents to the 2009-2019 ACS between ages 35 and 45, conditioning on an indicator for earning more than one college major and the interactions between gender, ethnicity (six categories), age, and survey year. Individuals with at least two majors are randomly assigned to one of their reported majors. Standard errors are robust.

Source: The 2009-2019 American Community Survey (Ruggles et al., 2018)