

**Organizations and Effectively Maintained Inequality in U.S. Graduate Education
: Racial Sorting by Graduate Degree Program Quality Measures**

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Abstract. An extensive sociological literature documents horizontal educational stratification at the baccalaureate level. We extend this line of work to the leading edge of educational expansion by examining racially-stratified sorting of post-collegiate graduate degree seekers during a period of rapid expansion in graduate enrollments and graduate student borrowing. Building on theories of effectively maintained inequality, we conceptualize graduate education as an engine of horizontal organizational stratification that differentially sorts degree seekers into programs of varying quality at the institutional- and degree-type levels. Nationally, we find substantial racial disparities in the income premiums and additional student loan debt associated with graduate degree attainment. Analysis of administrative data on graduate program-level average earnings and debt, along with the racial composition of subsequent student cohorts, finds substantial racial sorting occurring both at the institution and degree-type levels, such that programs with lower earnings and higher debt graduate significantly higher proportions of Black students.

Graduate programs have been the fastest growing educational sub-sector in the U.S. over the past three decades, expanding from around 1.2 million full-time equivalent students in 1990 to around 2.3 million today. This expansion has been financed primarily by an expansion of federal student loans (Black, Turner, and Denning 2023). In line with a presumption that graduate degree holders accrue substantial economic returns, Congress eliminated caps on how much graduate students can borrow in federal loans in 2006. Total federal lending to graduate students nearly eclipsed lending to undergraduates in recent years, even though US colleges and universities enroll around five times as many undergraduates as graduate students. Despite the centrality of graduate student loans to both graduate education and the larger student loan policy landscape, graduate student debt has still received little attention from education scholars. Scholarship has primarily focused on returns and inequities from undergraduate student loan borrowing (Looney and Yannelis 2015).

The limited existing scholarship on graduate student debt has yielded inconsistent findings as to whether the graduate student loan system produces similar inequalities as those observed in undergraduate student borrowing (Minaya, Scott-Clayton, and Zhou 2024; Pyne and Grodsky 2020). We first examine this at the population-level by analyzing household data from the Survey of Consumer Finance (SCF) data. Mirroring inequalities observed in undergraduate student borrowing, we find that Black households with graduate degrees tend to have much higher student debt than other racial groups with graduate degrees. Additionally, Black post-BA households(s) have a larger excess of debt over Black households with only undergraduate degrees compared to debt gaps by highest degree within other racial groups. Finally, among Black households, graduate degree households have *lower average* net worth than households in which the highest degree attained is a Bachelors. The opposite is true for other racial groups.

To begin explaining these population-level disparities in the outcomes of debt-funded graduate education, we next use College Scorecard data to analyze the racially disparate sorting of graduate enrollees across horizontally-differentiated graduate degree programs. Here we build on the insight of Lucas (2001)' theory of effectively maintained inequality (EMI) with propositions for why debt-financed graduate education will be characterized by racial and organizational sorting across graduate schools and degree types of varying quality and expected average payoff. The EMI theory posits that socio-economically advantaged families are likely to seek advantages in the *quality* of education, rather than just the *quantity* of education, as a level of schooling increases towards universality. Advantaged families are expected to do so because of the economic and status rewards that are conferred to those with "better education." As graduate degree attainment increases, we should thus expect those with family advantages to maintain their advantages by obtaining access to qualitatively superior graduate degrees to those attained by less advantaged students. In other words, widening expansion of access to graduate degree programs will be accompanied by intensified horizontal stratification in the sorting of students across graduate programs of varying "quality" or economic value relative to cost.

While the EMI theory was originally developed to explain the persistence of socio-economic stratification in educational attainment amid widening access to higher education, we focus instead on racial stratification. To a greater extent than parents' income or education, advantages and disadvantages from racial status follow students into the labor market even as they accrue more education. Additionally, parents are now known to provide financial support to children well into adulthood (Fingerman et al. 2015; Rauscher 2016). This contributes to the intergenerational reproduction of disparate opportunities, as Black parents more often lack

financial assets to help subsidize adult children's educational investments and career cultivation (Smith, Hamilton, and Eaton 2025).

We thus expect horizontal stratification in the sorting of Black students in graduate education to resemble the disproportionate sorting of Black students into under-resourced and high student-debt institutions that has been documented at the undergraduate level (Addo, Houle, and Simon 2016a). Instructional support and student loan burdens are closely associated with the status rankings of educational institutions which commonly use merit scholarships (Eaton et al. 2019) or endowments (Clotfelter 2017) to subsidize lower tuition and student debt. Students thus also commonly earn lower incomes after graduating from colleges that enroll students with large loan packages. Such racial sorting into under-resourced and high debt institutions, moreover, has been compounded by financialized predatory recruitment of Black students by investor-owned for-profit colleges with low spending on instructional support (Cottom 2017; Eaton et al. 2016; Goldstein and Eaton 2021). While for-profit institutions have played less of a role in graduate education expansion, less-resourced or opportunistic non-profit institutions may seek revenue by offering high debt graduate programs, including through outsourcing to for-profit firms like online program managers (Hamilton, Daniels, et al. 2024; Smith et al. 2023). Such initiatives could employ marketing that effectively targets Black students who may be more lacking in geographic mobility or in the household resources needed to differentiate between programs according to cost and quality. Accordingly, we expect racial sorting in graduate education to also occur across institutions with varied prestige, funding, and organizational forms.

We also expect racial sorting to occur within institutions across different degree types. Graduate fields of study are highly specialized and are more tied to professional career trajectories than undergraduate majors (Fealing, Lai, and Samuel L. Myers 2015). Racial segregation by college major (Ferrare and Lee 2014, 2014; Monarrez and Washington 2020) and subsequent occupational pathways (Stainback and Tomaskovic-Devey 2012) may funnel Black students into certain graduate degree types. Prior research has shown large disparities in after school income between these varied graduate degree types, with higher incomes for those gaining professional degrees in law, medicine, and business than for graduate degrees associated with lower income professions like teaching, nursing, and social work (Altonji and Zhong 2021; Minaya et al. 2024). Institutions facing resource scarcity (Danziger, Barr, and Turner 2013) may seek to expand debt-financed graduate programs that appeal to Black college graduates who are crowded out of other graduate degree programs (Black et al. 2023). Inversely, more intense rankings competition may lead professional degree programs in law and medicine to limit their enrollments and debt packages more than other graduate programs (Sauder and Espeland 2009).

We assess horizontal stratification in graduate program attendance using College Scorecard data for 3,568 graduate degree programs across 742 institutions. We measure program quality using several outcome-based metrics, which are based on Scorecard's consumer dashboard for the 2014-2016 graduation cohort's outcomes. These include median earnings four years after degree completion, median cumulative debt for graduate education at the time of degree completion, and debt-to-earnings ratio. We then correlate those program-level quality metrics with the racial composition of *subsequent* 2018-20 cohorts.

Most variance in programs' median earnings, debt, and debt-to-income ratios across programs is observed between degree types. We also find, however, that 15 percent of programs' median earnings variance and 24 percent of programs' median student borrowing variance occurs between institutions. We find racial segregation of advanced degree holders between both institutions and degree types according to these Scorecard measures for quality. More of the

white-Black sorting in graduate education by these program quality measures, however, is explained by sorting across institutions. Specifically, we find that a 10-percent higher median debt among the earlier (2014-16) graduation cohort of a program is associated with a 3.7 percent higher share of Black students in the later (2018-20) cohort, after controlling for the effects of the program's degree type, our other quality indicators, and the share of Black students in the earlier cohort. By contrast, 10-percent higher median earnings for a program is associated with a 2.9 percent smaller share of Black students. This institution-level sorting is partially driven by Black students' disproportionate enrollment in for-profit institutions, as evidenced by the attenuation of debt- and earnings-based sorting by 9 and 23 percent, respectively, after accounting for differences between for-profit and other institutions. This suggests racial inequality in graduate student debt outcomes will persist despite recent policy measures to limit borrowing more strictly for particular graduate degree types. Policy attention is also needed for disparities between institutions.

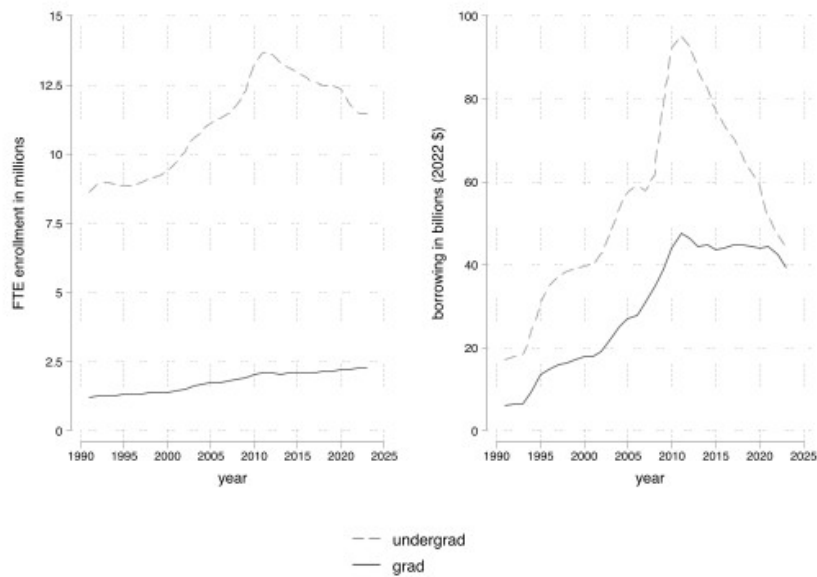
THE EXPANSION OF GRADUATE EDUCATION AND GRADUATE STUDENT DEBT

US graduate education has expanded steadily over time, but its growth was accompanied by a much faster accumulation of student loan debt than observed in undergraduate education. Between 1990 and 2022, total graduate enrollment increased by more than 90 percent, from around 1.2 million to nearly 2.3 million full-time equivalent (FTE) students (see Figure 1, left panel). However, federal borrowing for graduate education grew much faster during the same period, rising from about \$6 billion to just under \$40 billion in constant 2022 dollars (Figure 1, right panel). By 2022, graduate students made up about one-fifth of all student loan borrowers, yet they received nearly half of all federal student loan disbursements.

The disproportionate growth of graduate student loan debt suggests a shift in how students finance graduate education amid enrollment expansion. Although the share of both undergraduate and graduate students who borrow federal loans has declined since the early 2010s, the decline has been much slower among graduate students. In 2022, about 43 percent of graduate students borrowed federal loans, compared to 32 percent of undergraduates (Figure 2, left panel). In addition, while average undergraduate borrowing has plateaued and declined in recent years, average graduate borrowing has continued to rise.

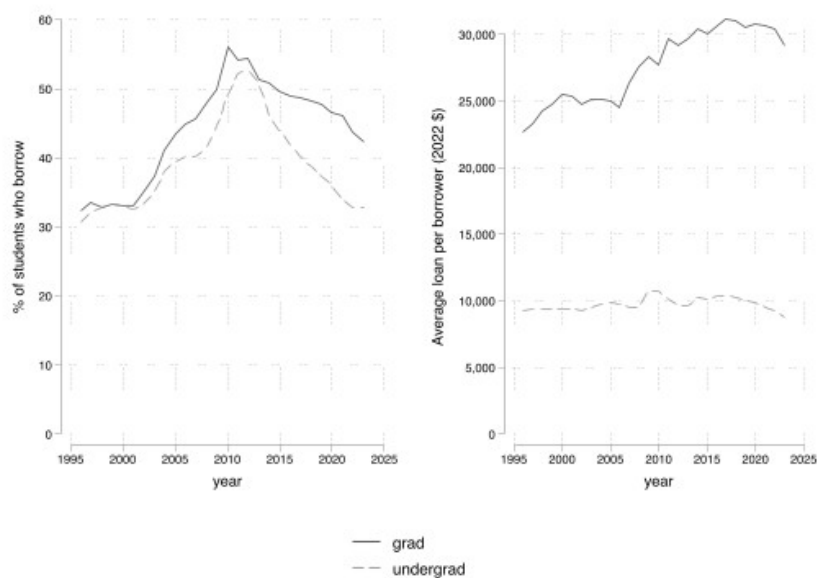
Research suggests that the expansion of graduate education is a result of both shifting labor-market demands and institutional responses to financial uncertainties. Graduate level credentials have become increasingly important for labor-market success, as returns to advanced degrees have grown more rapidly than returns to bachelor's degrees (Acemoglu and Autor 2012; Valletta 2015). In many professional and managerial occupations, graduate credentials are now expected as essential requirements for promotion and salary increase (Grinstead 2024). At the same time, the labor market for bachelor's degree holders has become saturated (Ashworth and Ransom 2019), pushing some portion of young adults to pursue further education as a way to adapt to the increasingly competitive labor market (Vedder, Denhart, and Robe 2013; Wendler et al. 2010).

Figure 1: Total enrollment and federal borrowing by undergraduate and graduate students



Note: Data published in The College Board 2023 Trends in Student Aid using source data from IPEDS, unpublished data provided by US Department of Education staff, and Title IV Program Volume reports. See College Board Table 3.

Figure 2: Percent of students borrowing and average loan per borrower for federal student loans



Note: Data published in The College Board 2023 Trends in Student Aid using unpublished data provided by US Department of Education staff and Title IV Program Volume reports. See College Board Table 6.

Institutions have also experienced enhanced financial uncertainty over the last three decades. State budget cuts (Danziger et al. 2013; Johnson, Oliff, and Williams 2011) and continued decline in college enrollment (Belkin 2022) increased financial volatility, especially after the Great Recession (Brown and Hoxby 2015). At the same time, for public and non-elite

private institutions, there was a mounting pressure to keep pace with well-financed private universities that utilized large endowments and investment returns to increase per-student spending and institutional prestige (Stevens and Gebre-Medhin 2016). While federal student aid and loan programs have expanded, for-profit institutions exploited these programs to capture public subsidies (Eaton et al. 2016; Goldstein and Eaton 2021), and non-profit and public institutions also increasingly adopted aspects of this revenue-oriented model (Hamilton, Daniels, et al. 2024; Smith et al. 2023).

This shift was partially driven by the introduction of the federal Graduate PLUS loan program in 2006. Unlike traditional Stafford loans, which impose borrowing limits, Graduate PLUS loans allow students to borrow up to the full cost of attendance as set by education institutions. A modest increase in undergraduate student loan caps in 2006 was followed by higher student loan debt at investor-owned for-profits (Eaton, Howell, and Yannelis 2020). Similarly, Grad PLUS loans changed the cost-demand schedule of graduate education. For institutions, especially those that needed additional revenue opportunities, Graduate PLUS made it possible to raise the cost of attendance without a corresponding decline in enrollment (Black et al. 2023; Mitchell, Leachman, and Masterson 2017). For students, it allowed some who might have been priced out to enroll, but only by taking on substantially higher levels of student debt (Black et al. 2023). Graduate PLUS loans thus helped stabilize a model of graduate education where institutional revenue growth is accelerated by both enrollment expansion and increased student debt borrowing.

Together, these trends suggest that the expansion of graduate education has been financed primarily through the expansion of student loans. As demands for graduate credentials increased, institutions under enhanced financial uncertainties turned to graduate education programs as a means to stabilize revenues. The introduction of Graduate PLUS loans alleviated the downward pressure on tuition for graduate education while lowering the initial financial hurdle for graduate education (Witteveen 2023), resulting in the expansion of graduate enrollment accompanied by a much more rapid increase in graduate student loan debt.

RACIAL STRATIFICATION AMONG GRADUATE DEGREE HOLDERS

The growing centrality of graduate education and graduate student borrowing warrants a closer examination of their impacts on education-based stratification. However, graduate education and graduate student debt have received little attention from education scholars (see Posselt and Grodsky 2017 for review). Scholarship has been largely focused on inequities in returns to college education and college student loan borrowing, and findings on the return to graduate education have been inconsistent (Minaya et al. 2024; Pyne and Grodsky 2020). We therefore draw on a broader scholarship on social stratification in postsecondary education.

A rich body of literature documents that the expansion of college education over the twentieth century did not eliminate education-based inequality but transformed its primary mechanisms. During the post-World War II period, increased access to college education initially produced broader gains in occupational status (Hauser and Featherman 1976), narrowing racial disparities and increasing social mobility (Hout 1984; Wilson 1978). However, as college access further widened, socio-economic and racial disparities became more salient within the college-educated population (see Gerber and Cheung 2008 and Hamilton, Dawson, et al. 2024 for review).

This new form of stratification aligns with the effectively maintained inequality (EMI) theory. Lucas (2001) posits that, as access to a given level of education expands, inequality

increases among those who receive it. This transition from vertical to horizontal stratification occurs through the qualitative differentiation of education experiences, or “curriculum strata.” In secondary education, Lucas (2001) finds a strong association between parental socio-economic status and students’ curricular (college vs. non-college) tracks. Research finds parallel trends in college education: conditional on student performance, there is a strong correlation between students’ family backgrounds and the colleges they apply (Dynarski et al. 2021). This gap is driven by multiple factors including geographical restrictions (Hillman 2016), information gaps (Dynarski et al. 2021), and risk-avoiding tendency (Shapiro 2004:7) associated with lower family backgrounds. For similar reasons, the choice of college majors (e.g., STEM vs. non-STEM) is influenced by family backgrounds net of mathematical readiness (Niu 2017), shaping future career outcomes and earnings (Kim, Tamborini, and Sakamoto 2015).

Extending EMI, we conceptualize graduate education as an emergent domain of horizontal stratification where qualitative differentiation across graduate degree programs shapes unequal economic outcomes among advanced degree holders. In this view, we define graduate degree programs as units of curricular stratification such that, as access to graduate education expands, the distribution of students across graduate institutions and degree types functions as key mechanisms through which socio-economic inequality is reproduced and potentially exacerbated among those who earn advanced degrees.

While EMI was originally developed to uncover the persistence of socio-economic stratification in the quality of educational attainment across degree transitions, we instead focus on racial stratification. Family resources and access to information differ not only across parental education and occupational status, but also by race. Although earlier studies theorized that family resources will matter less for later educational transitions (Müller and Karle 1993), parents now provide support to children well into adulthood (Fingerman et al. 2015; Rauscher 2016). This may extend gaps between Black and white students into graduate education, because Black parents more often lack financial and social capital to help subsidize adult children’s educational investments (Buchmann, Condron, and Roscigno 2010; Shapiro 2004; Smith et al. 2025). Furthermore, access to graduate programs has been polarized as status competition among elite institutions (Chu 2021) and professional degree programs (Espeland and Sauder 2016) drive credential inflation while less-selective institutions and degree programs prioritize enrollment growth and tuition revenues (Seamster and Charron-Chénier 2017). These racial gaps in resources and information set the stage for racial sorting of advanced degree holders amid widening access to graduate education.

While racial stratification among college degree holders is well-documented (Emmons and Noeth 2015; Gaddis 2015; Hamilton, Dawson, et al. 2024), less is known about the racial stratification among advanced degree holders. Most existing studies do not fully engage the concept of horizontal stratification. Studies often focus on a single degree type, such as law (Campos 2012), medicine (Greysen, Chen, and Mullan 2011), or MBA (Arcidiacono, Cooley, and Hussey 2008). Emerging studies that encompass multiple degree types find conflicting patterns concerning racial differences in earnings premiums. Using the 2013 data of National Survey of College Graduates (NSCG), Pyne and Grodsky (2020) find that the earnings premium associated with a graduate degree is higher for Black individuals than for white individuals. In contrast, using administrative data on master’s degree completers in Ohio, Minaya and colleagues (2024) find lower returns to graduate education for Black individuals relative to white individuals.

To address these theoretical gaps and empirical inconsistencies, we adopt a broader conceptualization of racial stratification among graduate degree holders. First, we incorporate wealth accumulation as a distinct dimension of education-based stratification (Pfeffer 2018:1035). Scholars argue that, while earnings inequality is substantial, wealth plays a distinct and more significant role in producing inequality because it generates additional wealth at a faster rate than earnings (Piketty 2014). Wealth is closely tied to education-based stratification (Pfeffer 2018). Family wealth shapes access to higher-quality schools and “shadow education” such as private tutoring (Buchmann et al. 2010; Pfeffer 2018), and racial gaps in college-level student loan borrowing (Addo, Houle, and Simon 2016b; Smith et al. 2025). In turn, education is associated with faster growth of wealth, net of income (Conley 2001; Killewald, Pfeffer, and Schachner 2017:394). Considering the significance of wealth both as a driver and outcome of education-based stratification, we assess whether the earnings premium and additional student debt associated with graduate education compound into higher household net worth.

Second, we directly assess horizontal stratification within graduate education by focusing on differentiation across degree programs. While Lucas (2001) emphasized differentiation between curricular tracks as a mechanism of horizontal stratification in near-universal secondary education, we extend this logic to graduate education by focusing on differentiation across graduate degree programs. Considering the growing popularity of graduate education, we expect to find substantial heterogeneities in program-level measures of economic prospect between institutions and across degree types. Such variations would provide direct evidence of horizontal stratification within graduate education. Moreover, comparing the magnitude of variations across institutions and degree types would allow us to assess where stratification is most pronounced, i.e., whether differentiation is primarily occurring across fields of study, graduate education institutions, or at the intersection of the two.

The EMI theory further implies that inequality is maintained because advantaged groups enroll in higher-quality curricular tracks while disadvantaged groups are sorted into lower-quality ones. Extending this, we expect to find Black students disproportionately concentrated in institutions and degree types with lower economic prospects. Furthermore, as graduate education continues to expand and to draw in more Black students, we expect that racial sorting across institutions and fields of study intensifies over time rather than remaining static. In other words, we expect program quality measures, drawn from the post-graduation earnings and debt of prior cohorts, to be independently associated with the share of Black students in subsequent cohorts.

DATA AND METHODS

We conduct two sets of analysis. We employ the Survey of Consumer Finances (SCF) to compare family wealth, earnings, and student loan debt across racial groups and education levels. We then use a harmonized data set between College Scorecard and program-level components of the Integrated Postsecondary Education Data System (IPEDS) to examine horizontal stratification across graduate degree programs. We conclude our analysis by examining the relationship between program quality measures and the racial composition of future student cohorts.

Analysis 1. Racial Variations in Economic Premiums Associated with Graduate Education

Administered by the Federal Reserve Board (FRB), the Survey of Consumer Finances (SCF) is widely acknowledged as the most comprehensive survey of U.S. household finance (Board of Governors of the Federal Reserve System 2024), providing fine-grained information

on assets, liabilities, income, and demographic characteristics of a nationally representative sample of households. SCF has been widely used in both academic research and policy analysis on wealth and income inequality (Kuhn, Schularick, and Steins 2020; Yellen 2016).

We pool the two most recent (2019 and 2022) waves of SCF to estimate population-level, age-adjusted means of student debt, household income, and net worth by race and education level. We restrict the analytic sample to households in which the highest degree is either a bachelor's or a graduate degree. The resulting sample includes 24,638 households, including 12,795 households that reported a bachelor's degree as the highest level of education and 11,843 that reported a graduate degree as the highest level of education.

Using this data set, we estimate a set of linear models predicting log income, log education debt, and net worth. Income and education debt are logged so that the outcome distribution is closer to normal, making model estimates less prone to outlier bias. Each model includes indicators for race, degree level, and a quadratic function of age. Race is measured using a categorical variable indicating non-Hispanic white, Black, Hispanic/Latine, and other race-ethnic groups, which include Asians, Native Americans and Alaska Natives, Native Hawaiians, and other Pacific Islanders, among others. Race and degree level are interacted to estimate race-specific differences in the outcomes by education level. Survey weights are applied throughout the analysis.

Analysis 2. Racialized Horizontal Stratification of Graduate Degree Programs

To examine horizontal stratification, we construct a degree-program-level data set by harmonizing data from College Scorecard and IPEDS. College Scorecard is a repeated cross-sectional dataset covering higher education institutions and degree programs. The program-level Scorecard data include median earnings and median debt for graduate cohorts within each degree program. To reduce privacy concerns while minimizing data suppression, the public-use Scorecard data set aggregates two adjacent graduation cohorts. For the earliest cohorts, who graduated in academic years (AY) 2014-2015 and 2015-2016, earnings have been updated one, four, and five years after graduation, while the total amount of graduate student loan debt is measured at the time of graduation. For later cohorts, economic outcomes are measured one year after graduation and are not subsequently updated. IPEDS completions (C) component is annually updated and provides the demographic composition of degree completers for each academic year and degree program.

We integrate Scorecard and IPEDS at the program level, which is defined by the unique combination of institution ID, degree level (master's or professional), and four-digit CIP code. Academic doctorate programs are not included in our analyses because they typically require longer years of study and often require post-doctoral training before entry into stable career positions. The current Scorecard data set does not provide a sufficiently long observation window to follow academic doctorates' early career outcomes, much less to examine their relationship with subsequent graduation cohorts. Building on the structure of the Scorecard data set, we construct a longitudinal data set in which each time spell represents two adjacent academic years. The resulting data set begins with records for AY 2014-2016 and ends with records for AY 2018-2020. The data set is updated each year, and each time spell (e.g., AY 2015-2017) partially overlaps with the two adjacent spells (e.g., AY 2014-2016 and AY 2017-2019).

Both the Scorecard and IPEDS data are based on population surveys and administrative records. The response rate for IPEDS surveys is greater than 99 percent because all post-secondary institutions are legally mandated to complete IPEDS surveys to remain eligible for

federal aids. While the public-use Scorecard data set does not include records for graduate programs that yield too few degree completers, the data set covers about 90 percent of all master's degree completers and about 99 percent of all professional degree completers (Fu 2021:Exhibit 2). The resulting analytic sample covers 3257 program-year observations representing 128 degree types and 681 graduate institutions.

Variable Measurement

To measure the racial composition of graduate programs, we use the logged percentage of Black graduates within a given graduation cohort. IPEDS does not collect the race and ethnicity of non-U.S. residents, so only U.S. citizens and permanent residents are included in the calculation.

We also use three program quality measures from the Scorecard data: median earnings, median student loan debt, and debt-to-earnings ratio. Median post-graduation earnings of the AY 2014-2016 graduation cohort is measured about four years after their graduation, in calendar years 2018 and 2019, respectively. The earnings data come from federal tax reports (W-2 and Form 1040) and are inflation-adjusted to constant 2020 dollars.

Median cumulative student loan debt includes Stafford (Direct Subsidized and Unsubsidized) and Grad PLUS loans disbursed for the focal graduate program. The data come from National Student Loan Data System (NSLDS) and represent raw borrowing amounts before interest. Because NSLDS collects data only for student loan borrowers, our program-level median debt also reflects debt among borrowers rather than among all graduates.

Debt to income ratio is calculated as the ratio of median cumulative student loan debt to median post-graduation earnings four years after degree completion, both adjusted to 2020 dollars. All three variables are logged to minimize outlier bias and to estimate coefficients in terms of percentage differences rather than absolute, percentage-point differences (Wooldridge 2010).

Lastly, to examine attenuation of institution-level racial sorting, we flag private, for-profit institutions using data from the Institutional Characteristics (IC) component of IPEDS.

Model Specification

Our program-level analysis begins by estimating unconditional linear mixed effects models each predicting a program quality measure. The models use random intercepts at both the institution and degree-type levels but do not include any fixed covariate, allowing for a decomposition of total variance in the outcome. We use a cross-classified structure because each degree program type is offered at multiple institutions rather than being housed in a single institution. The unconditional mixed-effects model can be expressed as follows:

where the log of median earnings (Y) of graduates from program i of institution j and degree type k is a function of the constant (μ), a random effect of institution (α_j), a random effect of degree type (β_k), and a program-level error term (ϵ_{ijk}). The two random effect terms are assumed to be normally distributed as follows:

where σ^2_{inst} and σ^2_{deg} represent variances at the institution- and degree-type level, respectively.

After decomposing the variances of program quality measures into the institution and degree-type levels, which are measured based on the financial records of the graduates in AY 2014-2016, we estimate how these measures are associated with the demographic composition of the AY2018-2020 graduation cohort. We use models with degree-type and institution fixed effects to capture institutional and degree-type-level sorting, respectively.

The institutional sorting model can be formally described as follows:

where $\text{share}_{G,i}$ denotes the percentage of demographic group G among the 2018-20 graduation cohort. All quality measures (log median earnings ($\ln\text{EARN}$), log median debt ($\ln\text{DEBT}$), log debt-to-earnings ratio ($\ln\text{RATIO}$)) are measured for the 2014-16 cohort. The model also controls for the log percentage of focal group among the 2014-16 cohort ($\text{share}_{G,i}$) to account for baseline demographic differences. Degree type fixed effects (γ_{deg}) absorb average differences across degree types, such that the coefficients on financial variables capture within-degree-type, between-institution-level associations between program quality measures and the racial composition of the future cohort.

Similarly, the second model includes institution fixed effects to estimate degree type-level associations:

All variables measuring program quality and group share are logged. Therefore, we transform each coefficient b to $\exp(b)$, which yields estimated relative (percentage) difference in the outcome associated with a 10 percent higher value in the corresponding independent variable.

RESULTS

How do household finances of graduate degree holders compare to those of college degree holders, and how do education-based economic premiums or penalties vary across race-ethnic groups? Before analyzing stratification across graduate degree programs, we estimate race-specific economic differences associated with graduate education.

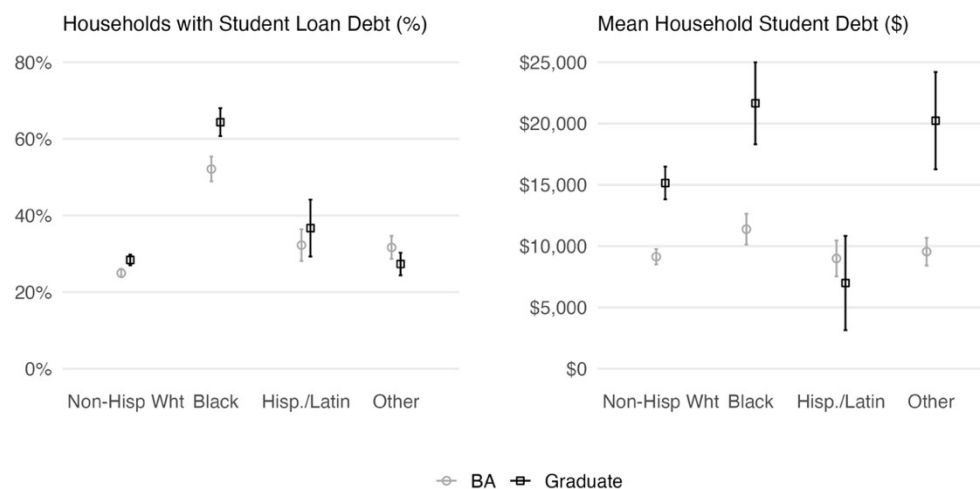
Analysis 1. Racial Variations in Debt and Net-Worth Associations with Graduate Education

Compared to white households headed by a bachelor's degree holder (hereafter, BA households), white households headed by a graduate degree holder (hereafter, post-BA households) are estimated to earn \$17,583 more annually (see Figure 3). This premium is about 38 percent higher than the corresponding premium for Black families, among which post-BA households earn about \$12,173 additional income than BA households. Hispanic and other race-ethnic groups' estimated income premiums did not significantly differ from those of white households. These results are consistent with Minaya and colleagues (2024)' finding that Black people in Ohio see higher percentage increase in income after finishing master's education than white people.

Figure 3. Age-adjusted household income gap between graduate and college degree holders

In addition to income premiums, graduate student loan debt is unequally distributed across racial groups. Although graduate education is associated with a higher likelihood of owing student loan debt for both white and Black families, the magnitude of this association varies substantially (Figure 4, left panel). Black post-BA households are 12 percentage points more likely to owe student loan debt than Black BA households (64% vs. 52%), which is a four times wider gap in absolute terms than the estimated 3 percentage-point difference among white households (28% vs. 25%). For Hispanic families and families of other race-ethnic backgrounds, graduate education is not associated with a significant increase in the likelihood to owe student loan debt.

Figure 4. Age-adjusted likelihood to owe student loan debt and average loan debt by race and education level



Among households that owe student loan debt, there is an additional Black-white gap in age-adjusted loan debt amounts (Figure 4, right panel). White post-BA households owe about

\$15,146 in student loan debt on average, which is about \$6,014 or 66% more than white BA households owe (\$9,132). Black post-BA households owe about \$21,651 in student loans, which is about \$10,271 or 90.3% more than \$11,380 owed by Black BA households. Put differently, as the household's highest education level changes from a college to a graduate degree, the estimated Black-White gap in net student loan debt more than doubles from \$2,248 to \$6,505.

Similar with the case for income, Hispanic families' student debt does not significantly vary by education level. However, other race/ethnic groups, which include Asians, Native Americans, Alaska Natives, and Pacific Islanders, among others, show a wide gap in the age-adjusted amount of student loan debt (\$10,682 or 112%) between BA- and post-BA households.

So far, we present results indicating that households headed by a graduate degree holder tend to earn more income while owing more student loan debt, net of age. We also find that income premiums and additional debt burdens associated with graduate education are not equally distributed across racial groups. White households tend to experience larger income premiums than Black households, while Black households owe more additional student debt for graduate education.

Considering the substantial additional debt and relatively modest income premium associated with graduate education, we ask whether Black households with an advanced degree holder accumulate more wealth than those headed by a bachelor's degree holder. We address this question in Figure 5, which presents race-specific differences in household net worth by education attainment.

Figure 5. Age-adjusted net worth of households with graduate degree holders, compared to households with college degree holders

The results show substantial heterogeneity across race-ethnic groups. Among white households, graduate education is associated with about \$786,185 of additional wealth, net of differences by age. Households in the other race-ethnic category also show a positive wealth premium associated with graduate education. By contrast, we find no evidence of positive wealth premium among Black and Hispanic households. Most strikingly, for Black households, graduate education is associated with a significant *net worth deficit* of \$127,145, which suggests that

unlike for white families and families of other race-ethnic backgrounds (the majority of whom are Asian), graduate education is not translating into a positive economic sum for Black and Hispanic families.

Analysis 2. Racialized Horizontal Stratification of Graduate Degree Programs

The household-level analysis finds substantial racial gaps in economic premiums associated with graduate education. Black households experience the lowest income premium and the highest level of additional debt associated with graduate education. Consequently, Black graduate degree holders are estimated to own lower household net worth than Black college graduates.

Why are Black individuals experiencing poorer economic premiums associated with graduate education than other groups? To understand this, we examine the racial segregation of graduate degree holders across graduate education institutions and degree types.

Table 1 presents summary statistics of the program-level data set, drawn from the Scorecard and IPEDS. Graduates from master's and professional degree programs became more racially diverse during our observation period, between academic years (AY) 2014-2016 and 2018-2020. On average, Black graduates comprised about 12.9 percent of the 2014-2016 graduation cohorts, which increased to 13.8 percent in AY 2018-2020. In contrast, white men's share declined from about 22.5 percent of the AY 2014-2016 graduation cohort to 20.6 percent of the AY 2018-2020 cohort.

Table 1. Descriptive statistics of the variables used in the program-level analysis
(N: 135 fields of study, 742 institutions, and 3,538 programs)

Variable	Mean	SD	Min	Max	Source	
Group share, 2014-16 cohort (%)						
Black	12.92	18.92	0	100	IPEDS	
White men	22.48	17.10	0	100		
Group share, 2018-20 cohort (%)						
Black	13.80	19.38	0	100	College Scorecard	
White men	20.61	16.16	0	100		
Program quality measures						
Median earnings (constant 2020 dollars)	73,639	29,396	21,786	287,792		
Median student debt (constant 2020 dollars)	55,134	48,670	5,639	439,325		
Debt-to-earnings ratio	0.77	0.56	0.09	5.81		

We measure program quality using three variables indicating the economic prospects of “median” graduates. On average, a program's median graduate in AY 2014-2016 owed 55,000 dollars of graduate student loans (Stafford + Grad PLUS) upon graduation and earned approximately 74,000 dollars four years after graduation (in constant 2020 dollars). The average

program's ratio of median student debt (before interest) to median earnings was 0.77, which means that, the average program is designed such that the median student owes student loan debt that amounts to about 77% of their expected annual earnings four years after degree completion.

However, all three quality measures show large variations across degree programs. The standard deviation of median earnings was \$29,396, with values ranging from \$21,786 to \$287,792. Median student debt shows even greater variation with the standard deviation of \$48,670 and a range from \$5,639 to \$439,325. These wide variations indicate that graduate degree programs are highly stratified in terms of their student economic outcomes.

Figure 6 visualizes this dispersion by plotting average median earnings and graduate student loan debt by degree type (upper panel) and institution (lower panel). The diagonal lines denote the average debt-to-earnings ratio. Degree types and institutions located above the diagonal line tend to entail higher debt burdens relative to earnings, whereas those below the line tend to yield higher earnings relative to debt.

Arts and humanities stand out as low-earning, high-debt programs, whereas STEM fields are largely characterized by lower debt compared to expected earnings. Health-related degree programs vary widely in earnings, but they generally entail higher amount of student loan debt borrowing relative to expected annual earnings after degree completion. Social sciences and education are concentrated near the diagonal line, which represents the average ratio between debt and earnings. Comparing across institutions, public institutions are relatively homogeneous, characterized by lower debt relative to earnings, whereas private institutions vary widely in both earnings and debt. Notably, the majority of for-profit institutions are characterized by high-debt and low earnings, which is consistent with prior studies emphasizing their distinct role in lowering college students' financial well-being (Cottom 2017; Goldstein and Eaton 2021).

Figure 6. Earnings and graduate student debt, averaged by degree type (upper panel) and institution (lower panel)

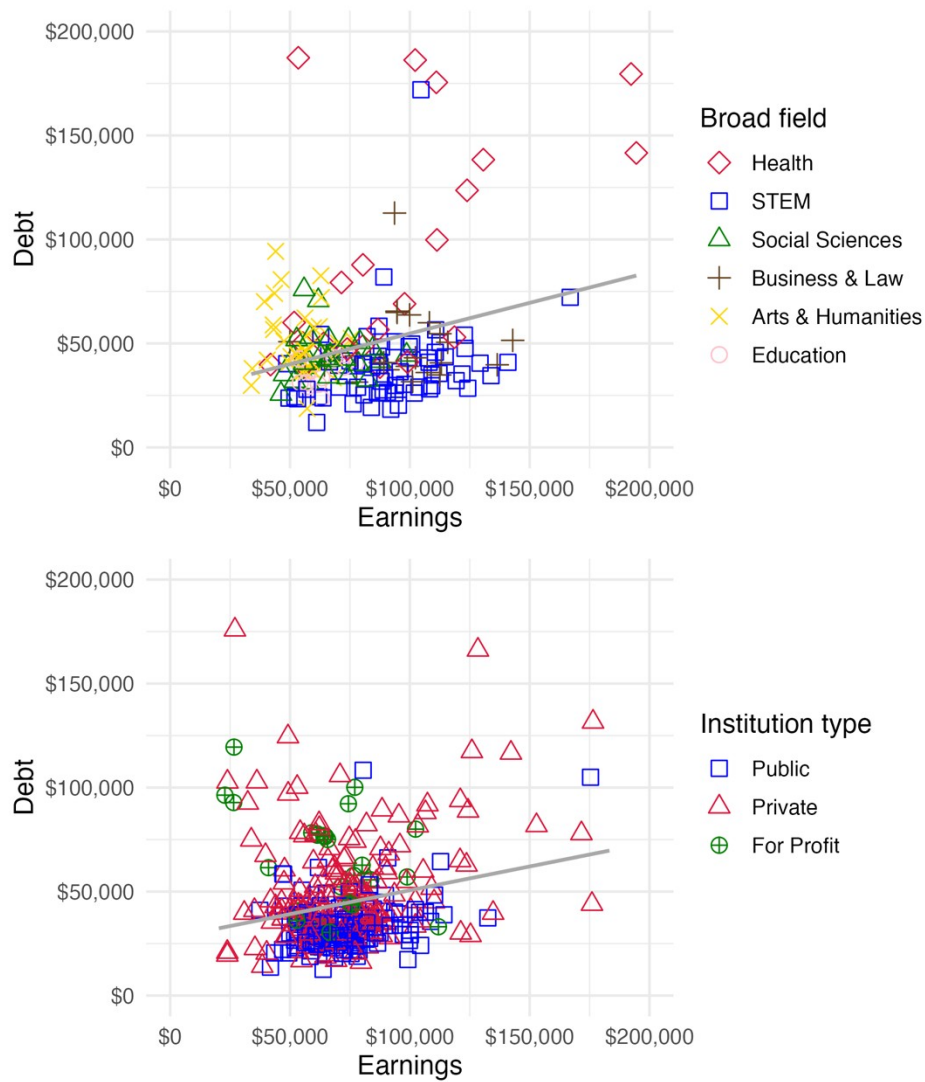


Table 2. Variance decomposition of program quality measures by institution and degree type

Outcome variable	Percentage of Variance		
	Degree Type	Institution	Residual
Median earnings, 4 years after graduation	65.0%	14.6%	20.3%
Cumulative debt	60.6%	24.4%	15.0%
Debt-to-earnings ratio, 4 years after graduation	64.0%	20.5%	15.5%

The descriptive analysis of graduate degree programs finds substantial heterogeneities in all three quality measures -- earnings, student loan debt, and debt-to-earnings ratio --, providing clear evidence that graduate education is horizontally stratified across both degree types and graduate education institutions. To understand the relative importance between the two, we decompose the total program-level variance in three program quality measures into the institution and degree-type levels. The result in Table 2 suggests that quality measures vary more widely between degree types than between graduate institutions. About 65% of the total variance in median earnings is estimated to come from the differences between degree types, whereas only 14.6% comes from differences across institutions. The remaining 20.3% is attributable to program-level characters independent of both dimensions. Similarly, about 60.6% of the total variance in median graduate student loan debt comes from the variation in borrowing amounts across degree types whereas about 24.4% is due to institutional heterogeneities. Lastly, the ratio of median student loan debt to median earnings also estimated to vary more greatly across degree types (64%) than across institutions (21%).

How does the horizontal stratification of graduate degree programs across institutions and degree types intersect with the racial composition of graduate cohorts? Figure 7 shows the cross-sectional associations between programs' economic outcomes and the share of Black graduates within the same cohorts. The panels on the left, labeled "institutional sorting," plot deviations from the degree-type average. Therefore, the left panels describe how graduate programs' economic (dis)advantages relative to the same degree types at other institutions are associated with differences in the racial composition of degree completers. Similarly, the panels on the right, labeled "degree type sorting," plot the relationship between economic (dis)advantages and Black students' representation relative to other degree programs in the same institution.

Figure 7. Relationship between program quality measures and the share of Black graduates, centered around degree-type mean (left column) and institution mean (right column)

The panels on the left show negative associations between program quality measures and Black representation, indicating that Black students tend to be underrepresented at degree programs with better economic outcomes compared to programs conferring the same degree at other institutions. Specifically, the linear fixed-effects models estimate that \$10,000 higher median earnings than the degree-type average is associated with 2.5 percentage-point fewer Black graduates, but \$10,000 higher debt relative to degree-type average is associated with 1.4 percentage-point more Black graduates. A 10-percentage-point higher debt-to-earnings ratio is associated with 0.64 percentage-point more Black graduates.

The panels on the right show that Black students are concentrated in degree programs characterized by lower median earnings and lower student loan debt compared to the institutional

average. Specifically, \$10,000 higher median earnings is associated with 0.46 percentage-point smaller share of Black graduates relative to other degree types, and \$10,000 higher debt is associated with 0.4 percentage-point smaller share of Black graduates. Debt-to-earnings ratio is not significantly associated with within-institutional variations in the share of Black graduates.

Overall, the cross-sectional analysis reveals that Black graduate students are concentrated at institutions characterized by lower earnings and higher student loan debt, and degree program types associated with lower earnings and lower student loan debt. However, this analysis does not tell us about whether and how this racial segregation by program quality has changed over time. To examine this, in Table 3, we estimate the relationship between program quality measures and the share of Black graduates in AY 2018-2020, net of the share of Black graduates in AY 2014-2016. The model includes degree-type fixed effects to estimate variations across institutions within the same degree type. Coefficients on program quality measures are transformed to represent a percentage difference in the outcome associated with a 10 percent increase in the focal quality measure. The coefficient on the for-profit indicator represents an estimated difference in the outcome between for-profit and other institution types.

Table 3. Analysis of institutional heterogeneity in Black representation among AY 2018-2020 graduate cohorts

Variable	Model 1	Model 2	Model 3	Model 4	Attenuation (Model 3 to Model 4)
Black share in 2014-16	6.168*** (0.182)	5.905*** (0.192)	5.885*** (0.192)	5.825*** (0.202)	1.03%
Median earnings	-2.327*** (0.652)	-3.355*** (0.755)	-4.317*** (1.058)	-3.851*** (1.063)	10.80%
Median debt		3.235*** (0.482)	4.213*** (0.785)	3.965*** (0.793)	5.89%
Debt-to-earnings ratio			-1.222 (0.659)	-1.184 (0.631)	
For-profit				17.586* (8.819)	
Degree-type FE	Included	Included	Included	Included	
Adjusted R-Squared	0.551	0.560	0.560	0.561	
Degree types	128	128	128	128	
Observations	3,257	3,257	3,257	3,257	

Note: *p<0.05 **p<0.01 ***p<0.001. Errors are clustered by degree type. Coefficients on program quality measures represent estimated percentage difference in the share of Black graduates in AY 2018-2020 associated with a 10 percent higher value in the corresponding variable. Coefficient on the for-profit indicator represents an estimated percentage difference in the share of Black graduates between for-profit and other types of institutions.

The results indicate that Black students have been increasingly concentrated in graduate programs with weaker economic prospects than comparable programs at other institutions awarding the same degree. The median earnings of program graduates are negatively associated with future Black enrollment, such that a 10 percent higher level of earnings in the AY 2014-16 graduation cohort (hereafter, the earlier cohort) is associated with about a 2.3 to 4.3 percent smaller share of Black students in the AY 2018-20 graduation cohort (hereafter, the later cohort).

Table 4. Analysis of degree-type heterogeneity in Black representation among AY 2018-2020 graduate cohorts

Variable	Model 5	Model 6	Model 7	Model 8
Share of Black in 2014-16 cohort	4.631*** (0.249)	4.611*** (0.249)	4.601*** (0.249)	4.372*** (0.259)
Median earnings	-0.892 (0.501)	-0.343 (0.541)	-1.100 (0.745)	-1.607 (0.910)
Median debt		-1.015** (0.311)	-0.143 (0.657)	0.392 (0.689)
Debt-to-earnings ratio			-1.071 (0.632)	-0.958 (0.632)
Broad field: STEM				22.998 (13.407)
Social Sciences				31.259*** (8.663)
Business & Law				23.244*** (6.655)
Arts & Humanities				3.562 (10.253)
Education				6.184 (6.265)
Other				6.184 (10.725)
Institution FE	Included	Included	Included	Included
Adj. R-Sq.	0.605	0.607	0.607	0.612
Institutions	681	681	681	681
Observations	3,257	3,257	3,257	3,257

Note: *p<0.05 **p<0.01 ***p<0.001. Errors are clustered by institution. Coefficients on program quality measures represent estimated percentage difference in the share of Black graduates in AY 2018-2020 associated with a 10 percent higher value in the corresponding variable. Coefficients on broad field indicators represent an estimated percentage difference in the share of Black graduates between health-related fields and the focal field of study.

Conversely, programs where the earlier cohort owed larger amounts of graduate student debt tend to graduate more Black students in the future. According to model estimates, a 10

percent higher median graduate loan debt of the earlier cohort is associated with about a 3.2 to 4.2 percent larger share of Black students in the later cohort. Model 3 shows that, after accounting for median debt and median earnings, debt-to-earnings ratio is not significantly associated with the share of Black students in the later cohort.

Notably, Model 4 indicates that for-profit institutions are graduating an increasing proportion of Black students, net of program quality measures and the share of Black students in the past. Compared to public and non-profit institutions, Model 4 estimates that for-profit institutions graduate a 17.6 percent higher share of Black students in AY 2018-2020, net of program quality measures. The associations between program quality measures and future Black representation are substantially attenuated after accounting for differences between for-profit and other institution types, suggesting that racialized horizontal stratification across graduate programs is partially driven by Black students' disproportionate enrollment in for-profit institutions.

Models 5-8 examine racial sorting across degree types using linear models with institution fixed effects. Across all models, the estimated effect of the share of Black graduates in the earlier cohort remains significant and consistent, indicating the persistence racial stratification across degree types. By contrast, all models estimate that differences in median earnings between degree types are not significantly associated with the future representation of Black graduates. Likewise, although median debt is negatively associated with Black representation in Model 6, this association is attenuated after debt-to-income ratio is added to the model. These results suggest that, unlike institutional stratification, racial sorting by the economic prospects of degree type has not weakened or intensified over the observation period.

In Model 8, we introduce indicators of broad fields. Relative to health-related fields, degree programs in the social sciences have about 31.2 percent higher Black representation in the later cohort. Similarly, programs in law and management have about 23.2 percent higher Black representation. These patterns indicate that racial segregation between broad fields of study is exacerbating over time.

CONCLUSION

This study examines racial stratification among advanced degree holders during a period of rapid growth in graduate education and graduate student borrowing. Drawing on nationally representative household data from the Survey of Consumer Finances (SCF), we document racial disparities in the associations between student debt, income, household net-worth, and graduate degree holding. Using program-level administrative data from the College Scorecard and IPEDS, we map the contours of racialized horizontal stratification across graduate degree programs.

At the household level, we find that graduate education is associated with distinct economic outcomes depending on the family's race-ethnic background. While graduate degrees are associated with higher incomes for both white and Black households, Black households have smaller income premium and substantially higher net student loan burdens over those with only undergraduate degrees. Consistent with this and previously documented disparities in parental assistance with debt and wealth building, , graduate education does not yield a net worth premium for Black households. The economic returns to graduate education are unevenly distributed across racial groups in a way that penalizes Black households headed by advanced degree holders.

At the graduate program level, we reveal substantial heterogeneity in post-graduation earnings and graduate student debt across institutions and degree types. While about two-thirds

of variation in program quality exists between degree types, racial sorting is more salient between institutions. Cross-sectionally, fewer Black students tend to matriculate at programs with higher incomes, lower debt burdens, and lower debt-to-earnings ratio for past graduates. This pattern remains consistent after netting out average differences across institutions and degree types, which means that racial stratification is active on both dimensions.

Longitudinally, program-level shares of Black students tend to be persistent over time. However, after accounting for internal consistency, we observe independent associations between the post-graduation economic outcomes of the earlier cohort and the share of Black students in the later cohort. We test these associations at both degree-type and institutional levels. Racial sorting across degree types remained stable during the observation window, between AY 2014-2016 and AY 2018-2020. However, within each degree type, we find that Black students have been increasingly concentrated in programs characterized by lower relative earnings and higher debt. This provides evidence that racialized horizontal stratification among graduate degree holders has exacerbated over time rather than reproducing the status quo.

These results provide empirical grounds for extending the theory of effectively maintained inequality to graduate education. Amid the expansion of access to graduate education, it appears that inequality among those who hold advanced degrees is substantial. While Lucas reasons that horizontal stratification is corollary to near-universal access to an education level, we find clear signs of stratification at a much earlier phase of educational expansion. Similar with how high school graduates were sorted into college- and non-college tracks, graduate degree holders are sorted into different graduate programs. Unlike how Lucas focused on a unidimensional hierarchy of curriculum strata, we conceptualize the stratification of graduate education as multidimensional. Our program-level analysis largely supports the idea that institutions and degree program types are the two primary dimensions (or “curricular strata”) of horizontal stratification in graduate education.

Lastly, while Lucas focused on stratification by family’s socio-economic status, we focus on racial stratification on the grounds that the higher education sector has experienced the bifurcation of institutional priorities between the elite institutions and lower-tier institutions. Elite institutions have increasingly prioritized rankings and prestige, which generate extra revenues and financial certainty for them. Lower-tier institutions, by contrast, have focused on a different strategy characterized by the expansion of student pools into racially marginalized students while exploiting the uncapped student loans, such as Grad PLUS loans, and minimizing investment in education quality. Our analysis demonstrates institutional sorting patterns that support this theoretical extension. While sorting across degree types has stabilized, institutional sorting is intensifying over time. For-profit institutions are playing a distinct role in this, as they do attenuate more than 10 percent of earnings-based racial sorting, and about six percent of debt-based racial sorting.

The findings also offer policy implications. Our findings suggest that College Scorecard quality disclosures have at least failed to help Black graduate students to avoid schools and programs with higher earnings and lower debt burdens than their predecessors. In fact, they have tended to enroll in such lower quality schools and programs at higher rates than past cohorts. Some of this sorting occurs through increased enrollment in for-profit graduate programs, but also selection of lower quality non-profit institutions. Rather than relying on disclosures, policy makers could consider that schools meet standards for their graduates’ average income and debt burdens to maintain the schools’ eligibility to enroll students with federal loan aid. Such “gainful

employment” regulations have to date only been applied to undergraduate programs with exemptions for non-profits.

Program quality requirements for federal loan aid has the advantage of addressing disparities in student loan related outcomes both within and between schools. This approach differs from recent measures by US lawmakers to restore limits on borrowing per student from federal graduate student loan programs. The new limits are fixed across schools regardless of average earnings and loan repayment rates for the schools’ graduates, obviating incentives for schools to maximize earnings and earnings to debt ratios. At the same time, the Department of Education is imposing lower limits on borrowing for professional degree programs for professions that are thought to yield lower returns like teaching, nursing, and social work. These measures may deter schools from offering such graduate programs for professions even where there is substantial workforce demand. The limits, moreover, do nothing to address the disparities in quality across graduate programs through which we have shown sorting towards effectively maintained inequality.

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