



Heterogeneity in Labor Market Returns to Master's Degrees: Evidence from Ohio

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Abstract

Graduate education is among the fastest growing segments of the U.S. higher educational system. This paper estimates the returns to Master's degrees and examines heterogeneity in the returns by field area, student demographics and initial labor market conditions. We use rich administrative data from Ohio and an individual fixed effects model that compares students' earnings trajectories before and after earning a Master's degree. Findings show that obtaining a Master's degree increased quarterly earnings by about 14% on average, but the returns vary largely across graduate fields. We also find gender and racial disparities in the returns, with higher average returns for women than for men, and for White than for Black graduates. In addition, by comparing returns among students who graduated before and under the Great Recession, we show that economic downturns appear to reduce but not eliminate the positive returns to Master's degrees. There are important variations in the returns to Master's degrees during the recession across field area and race/ethnicity.

Keywords Economic impact · Educational economics · Returns to education · Graduate education · The Great Recession

Introduction

Graduate education is among the fastest growing segments of the U.S. higher educational system. While total undergraduate enrollment in degree-granting postsecondary institutions increased by 26% between 2000 and 2018, total post-baccalaureate enrollment increased by 41% over the same period (Hussar et al., 2020). This rapid growth in enrollment has been accompanied by an even faster increase in graduate school debt, which rose by 51% between 2000 and 2018. While the increase in graduate student debt has attracted policy concern (Douglas-Gabriel, 2020; Miller, 2020), less attention has been given to the other side of the equation: what returns students earn from a

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graduate degree. Most of the existing studies on this question use outdated sources of data, self-reported measures of labor market outcomes, and/or empirical strategies that can control only for selection on observable characteristics (e.g., Arcidiacono et al., 2008; Song et al., 2008; Stevenson, 2016; Tamborini et al., 2015; Titus, 2007). Two recent papers (Altonji & Zhong, 2021; Altonji & Zhu, 2021) provide more rigorous causal evidence on labor market returns to a wide range of graduate programs. These recent studies find substantial differences in returns to Master's degrees across fields, but still leave important open questions about the heterogeneity in labor market returns to graduate degrees across demographic groups and labor market contexts.

This paper estimates the labor market returns associated with Master's degrees and explores their variations across different field areas, student demographics, and initial labor market conditions. We estimate returns over a 10-year period following degree completion, which extends beyond the timeframe examined in most prior studies. We use administrative data tracking graduate students enrolled in Ohio from 2000 to 2009, with quarterly earnings spanning historically for 20 years through the fourth quarter of 2019.

Our study will contribute in two primary ways. First, we examine labor market returns to Master's degrees using an individual fixed effects strategy similar to Altonji and Zhu (2021), but with a sample from a different state (Ohio) spanning over a long-time frame including the Great Recession and the steady recovery of the 2010s. Second, we examine heterogeneity in the returns by the labor market conditions at graduation. Increasing evidence has shown that initial macroeconomic conditions matter for both the quality of first job and long-term career development (Altonji et al., 2016; Kahn, 2010; Schwandt & von Wachter, 2019). Our study not only advances the literature to highly-skilled entrants with graduate degrees, it also informs more rational educational choices under a recession, with possible implications during the current pandemic for policymakers and students. To the best of our knowledge, we are the first to compare labor market outcomes under different economic conditions at graduation for highly skilled graduates.

On average, we find that obtaining a Master's degree increased quarterly earnings by about 14%. Consistent with past empirical evidence, the returns varied across fields. Our results suggest that while Master's degrees in Health increased earnings by approximately 33%, students could have nearly zero earnings gains from completing a Master's degree in Arts and Humanities. The magnitudes of the returns to obtaining a Master's degree in other fields are around 12%. We also find gender and racial disparities in the returns to Master's degrees, with higher average returns for women than for men, and for White graduates relative to their Black peers. In addition, we compare returns among cohorts who graduated with the Master's degree before versus during the Great Recession. The returns remained strongly positive among cohorts who graduated during the recession (10%), but were about 6 percentage points lower than for those who graduated before the recession (16%). While obtaining a Master's degree on average can boost up earnings, it is important for individuals and policymakers to take into consideration the heterogeneity in returns to Master's degrees depending on field area and labor market conditions.

The paper proceeds as follows. The next section reviews literature on labor market returns to graduate degrees and interactions between graduating under recessions and labor market outcomes. Section “[Data and Sample](#)” describes the data and the analysis sample used in the study. Section “[Empirical Methodology](#)” discusses the empirical framework to analyze labor market returns to graduate degrees. Section “[Results](#)” presents empirical results, and the paper concludes with a discussion of the findings and future research in Sect. “[Discussion and Conclusion](#)”.

Previous Literature

The economic theory of human capital investment suggests that individuals invest in schooling until the marginal benefits in terms of future earnings and other non-monetary benefits are equal to its marginal costs. While costs of graduate education are relatively more straightforward, students have incomplete information about its payoffs. Moreover, Lindley and Machin (2016) warned against examining college graduates as a single group of workers in the labor market due to its increasingly heterogeneous nature between advanced degree holders and college-only workers. Therefore, providing information about returns to graduate degrees is critical to guide students and policymakers about investments in graduate schools.

There is a small but growing literature examining labor market returns to graduate degrees. For example, Titus (2007) employed a propensity score matching model among students who completed a Bachelor's degree in 1993, and found no significant returns to Master's degrees in fields other than Education and Business. Arcidiacono et al. (2008) used an individual fixed effects approach and found positive wage returns to an MBA program among students who registered to take the GMAT in 1990 and were followed up with surveys through 1998. Song et al. (2008) applied a two-stage regression model among Bachelor's degree recipients between 1963 and 1986, and found an estimated annualized return of 7.3% for Master's degrees, 16.6% for professional degrees, and 12.8% for doctoral degrees. Stevenson (2016) examined returns to quality in graduate education among students who received a Bachelor's degree in 1993, and found no returns to either degree completion or program quality in most graduate programs. Important exceptions include Master's programs in health, where completion substantially increased earnings, as well as MBA and professional degree programs, where program quality had a positive influence on earnings. While these studies shed light on returns to graduate degrees, they all used data from more than two decades ago. As both graduate education and the labor market have been developing and changing, the results may not generalize well to current conditions.

One important recent paper by Altonji and Zhong (2021) used fixed effects for combinations of college major and graduate field with more recent data from the National Survey of College Graduates (NSCG, 1993–2015) and the National Survey of Recent College Graduates (NSRCG, 1993–2010). The paper found differences across fields of graduate degrees in returns on earnings. One limitation of the study is that the analyses are based on self-reported earnings and oversampled individuals in Science and Engineering fields.

The most similar study to ours is Altonji and Zhu (2021) examining labor market returns to various graduate degrees applying alternative fixed effects models with administrative data from Texas. Results also show variations across fields, with particularly high returns to graduate degrees in health-related fields. In addition, this paper found substantial differences across racial and gender groups, and studied how the returns differ by college GPA and major, and across graduate institutions. Our paper examines labor market returns to Master's degrees with administrative data from a different state (Ohio) using an individual fixed effects model. We show similar patterns in the returns under a different state context to findings from Altonji and Zhu (2021). In addition, our data span over a long-time frame and allow us to compare labor market returns to Master's degrees among students who graduated before and during the Great Recession.

Our paper also relates to the literature on the effects of entering the labor market during a recession. Prior literature has documented that initial labor market experiences have large and persistent impacts on long-term career progression and success (Oreopoulos et al.,

2012; Kahn, 2010; Liu et al., 2016; van den Berge, 2018). For example, both the quality of the first employer and the first job match have been shown to have lasting impacts on students' future employment and earnings. Therefore, how graduates fare during labor market shocks can have critical implications for their earnings trajectories.

Indeed, there is increasing evidence showing that labor market entrants under a bad economic condition suffer adverse consequences on labor market outcomes. Kahn (2010) showed that graduating under the recession in the early 1980s led to earnings losses persisting up to 15 years among college graduates. Schwandt and von Wachter (2019) studied young workers who entered the labor market in the U.S. from 1976 to 2015, and found that entrants under times of high unemployment experienced substantial and long-lasting employment and wage reductions. These effects were particularly large among nonwhite student groups, partly driven by greater losses in employment. Altonji et al. (2016) examined labor market outcomes of U.S. college graduates from the classes of 1974 to 2011, and also concluded that a large recession at graduation substantially reduced initial earnings. Furthermore, the effects differed by field of study: the losses were smaller among students in fields predicted with higher earnings.

Yet, less is known about how entering the labor market during a recession interacts with labor market outcomes among highly-educated workers with graduate degrees. Human resources with graduate-level training are scarcer in the labor market. Thus, workers with graduate degrees are potentially less vulnerable to adverse conditions in the labor market than their less educated counterparts. Our study aims to present empirical insights into the relationship between graduate degrees and labor market outcomes by leveraging administrative data from Ohio. Additionally, we examine changes in returns to Master's degrees during the Great Recession to better understand the transition from graduate schools to the labor market amidst economic downturns.

Data and Sample

For our empirical analysis, we use two administrative data sources from the state of Ohio. De-identified data were provided by the Ohio Education Research Center (OERC) under a limited-use, restricted data agreement. The OERC assembles data from multiple state agencies, including the Ohio Board of Regents (OBR) and the Ohio Department of Job and Family Services (ODFJS), into a repository known as the Ohio Longitudinal Data Archive (OLDA).¹

The first dataset includes demographic and term-level academic information for all the students attending any public institutions of higher education in Ohio between the years of 2000 and 2011. We can identify students' demographic characteristics, school enrollment

¹ The following acknowledgement is required to be stated on any materials produced using workforce or higher education data accessed from the OLDA: This workforce solution was funded by a grant awarded to the U.S. Department of Labor's Employment and Training Administration. The solution was created by the Center for Human Resource Research on behalf of the Ohio Department of Job and Family Services and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any formation on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership. This solution is copyrighted by the institution that created it. Internal use, by an organization and/or personal use by an individual for non-commercial purposes, is permissible. All other uses require the prior authorization of the copyright owner.

and degree outcomes from the dataset. The second dataset includes quarterly earnings records of all the employees subject to Unemployment Insurance (UI) contributions in Ohio between the years of 1999 and 2019. The earnings records can be linked to the education data through an individual identifier. Thus, we can identify students' quarterly earnings before enrollment at graduate school as well as after the completion of a graduate degree. The data also include the county of the employer, which allows us to link county-level unemployment rates from the Bureau of Labor Statistics (BLS) to each quarter and every worker in the data, serving as a proxy for the labor market conditions that the individual worked under.

For this study, we restrict the analysis sample to Master's degree holders who first enrolled and obtained a Master's degree in Ohio's public college system from Fall 2000 to Fall 2009. This restriction allows us to track and compare each individual's quarterly earnings from six quarters before graduate school enrollment to 10 years after completion. Individuals who obtained Master's degrees older than 50 are excluded.

Since our fixed effects approach compares an individual's earnings before and after obtaining the graduate degree, one would ideally like to focus on Bachelor's degree holders who actively participated in the labor market before graduate school enrollment. Yet, a limitation of the data is that we cannot observe Bachelor's degree completion for all individuals in our sample. To address this, we limit the sample to individuals who had at least four quarters of earnings higher than the state minimum wage at an age older than 22 within six quarters before their first graduate enrollment.² Furthermore, we limit the sample to individuals who have at least one quarter of earnings higher than the minimum wage within 10 years after completion. This ensures that individuals who did not work actively for UI-covered employers in the state after Master's completion are excluded as we are not able to identify their post-Master's degree earnings.

Table 1 displays descriptive statistics of our analysis sample. Approximately 65% are women and 84% are White students.³ The average student in our sample first enrolled in graduate school at the age of 30 and earned a Master's degree at the age of 32. Degrees in the fields of Education, Business, Social and Behavioral Sciences and Health are the most common. And we can track approximately an average of six quarters of earnings before graduate enrollment and 33 quarters of earnings post Master's degree completion for individuals in the sample.

Appendix Table 3 compares our analysis sample with national samples of Master's students in the National Postsecondary Student Aid Study (NPSAS): GR 2004 and NPSAS: GR 2008 who have earned a Bachelor's degree, had a job prior to graduate enrollment and completed the Master's degree program in 2003–2004 and 2007–2008, respectively. Compared to Master's degree holders in the nation, our analysis sample has a slightly higher proportion of women and White students. Master's degree holders in Ohio are more

² We cannot capture Bachelor's degree completion for everyone, since some may have earned it prior to our data window, or may have done so at an out-of-state or private institution not covered in our data. All individuals in our sample adhere to this exclusion restriction. Earnings above the minimum wage are approximated using information from U.S. Department of Labor, State Minimum Wage Rate for Ohio [STTMIN-WGOH], retrieved from FRED, Federal Reserve Bank of St. Louis: <https://fred.stlouisfed.org/series/STTMIN-WGOH>. The minimum wages are converted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers, U.S. City Average (CPI-U), in the same way as the earnings data. 17.3% of master's degree holders (6288 individuals) were excluded from our sample because they lacked four quarters of earnings exceeding the minimum wage before enrolling in graduate school.

³ The racial distribution of our sample corresponds to Ohio's overall demographics—approximately 76% of the state's population are White based on census estimates in 2019.

Table 1 Descriptive statistics

	Main analysis sample		Recession analysis samples	
	Master's degree holders in Ohio (2000–2009)		Master's Degree Holders in Ohio before recession (2004–2007)	Master's degree holders in Ohio under recession (2008–2009)
<i>Gender</i>				
Male	34.6%		34.8%	34.3%
Female	65.3%		65.2%	65.6%
<i>Race</i>				
White non-Hispanic	84.1%		84.3%	83.9%
Black non-Hispanic	8.0%		7.8%	7.5%
Hispanic	1.2%		1.2%	1.3%
Asian or Pacific Islander	1.5%		1.5%	2.2%
Other	5.2%		5.2%	5.2%
<i>Age</i>				
Graduate school enrollment	30		30	30
Master's degree completion	32		32	32
<i>Master's degree field</i>				
Arts and Humanities	3.9%		3.9%	3.7%
Business	20.2%		21.8%	20.8%
Education	46.8%		46.7%	42.5%
Engineering	3.3%		2.8%	3.8%
Health	9.4%		9.5%	11.3%
Natural Science and Mathematics	2.8%		2.6%	2.6%
Services	1.9%		1.9%	2.3%
Social and Behavioral Sciences	11.6%		10.9%	13.0%

Table 1 (continued)

	Main analysis sample	Recession analysis samples
	Master's degree holders in Ohio (2000–2009)	Master's Degree Holders in Ohio before recession (2004–2007)
<i>No. of quarters with earnings higher than minimum wage and older than 22</i>	5.7	5.6
Pre-graduate enrollment	32.6	32.3
Post-master's degree	29,247	5911
Sample size (N)		

Note: Our primary analysis involves individuals who enrolled in and completed a Master's degree between Fall 2000 and Fall 2009 in Ohio. Exclusions apply to those obtaining the master's degree after age 50 and individuals with at least four quarters of earnings exceeding the state minimum wage after turning 22 within six quarters before graduate enrollment, plus at least one quarter above the minimum wage within 10 years after completing the master's degree. The recession analysis focuses on individuals who complete a master's degree from 2004 to 2009, within 3 years of their initial graduate school enrollment in the main analysis sample. Those obtaining the degree from 2004 to 2007 represent pre-Great Recession master's degree holders, while those from 2008 to 2009 are master's degree holders during the Great Recession

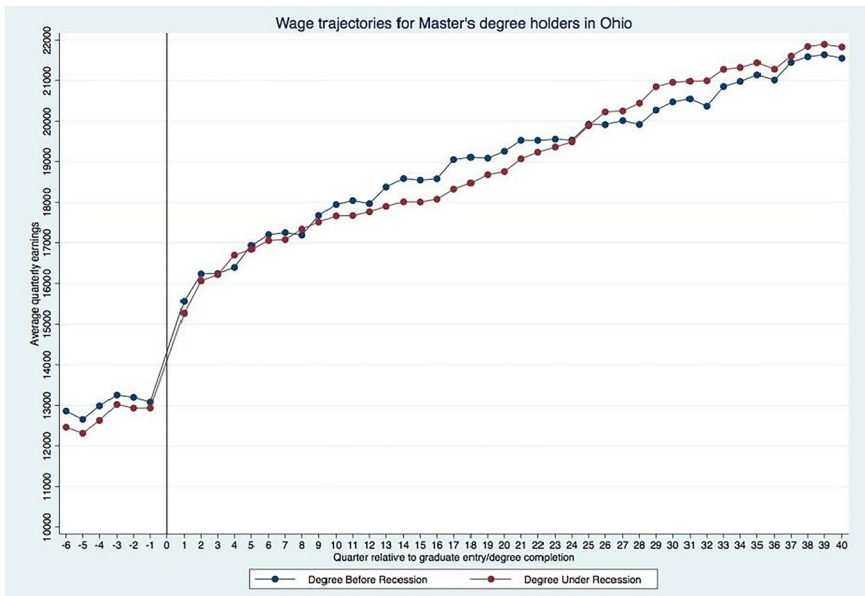


Fig. 1 Wage trajectories for master's degree holders in Ohio, by graduation cohort. Note: This figure illustrates the unadjusted average quarterly earnings six quarters before graduate enrollment (depicted as negative relative quarters) and 10 years after attaining a graduate degree (represented as positive relative quarters) for individuals graduating before and during the Great Recession. The analysis sample involves Master's degree holders in Ohio who first enrolled in graduate school and obtained a Master's degree from Fall 2000 to Fall 2009. Exclusions include individuals over 50 upon obtaining their master's degree. The sample further requires at least four quarters of earnings above the state minimum wage after turning 22 within six quarters before graduate enrollment and at least one quarter of earnings surpassing the minimum wage within 10 years after earning the master's degree. We define a recession comparison sample by examining wage trajectories of individuals graduating between 2004 and 2009 within 3 years of initial graduate school enrollment, comparing those from 2004 to 2007 (pre-recession) with those from 2008 to 2009 (during the recession). Earnings are adjusted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers, U.S. City Average (CPI-U), and top-coding applies to the highest 1% wages. Wages below the minimum wage or earned before age 22 are excluded from the analysis

likely to complete a Master's degree in Education and at a relatively younger age. Overall, descriptive statistics of our analysis sample are similar to the rest of the country.

An important limitation of our earnings data is that we are unable to distinguish between quarters when an individual was unemployed, not in the labor force, worked in another state or under non-UI-covered employers in Ohio. We therefore exclude quarters of missing earnings from the analysis. All the earnings are converted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers, U.S. City Average (CPI-U), and the highest 1% are top-coded. Figure 1 shows unadjusted average quarterly earnings six quarters before graduate enrollment (shown as negative relative quarters) and 10 years after graduate degree completion (depicted as positive relative quarters) for individuals graduating prior to and during the Great Recession. The figure displays a sharp earning jump right after the completion of the Master's degree, and the earnings continued to rise gradually over the next 10 years. Also, the figure shows a slight earning dip one and two quarters before the first enrollment term at graduate school, indicating possible existence of the Ashenfelter dip before graduate entry.

Empirical Methodology

To estimate the labor market returns to Master's degrees, we employ an individual fixed effects approach comparing pre- and post-graduate education earnings within the same individual among Master's degree holders in our analysis sample. For each individual, we use quarters of earnings within six quarters before the first graduate enrollment as pre-earnings, and quarters of earnings within 10 years after the completion of the Master's degree as post-earnings. Only earnings higher than state's minimum wage earned at an age older than 22 are used in the estimation. Specifically, we estimate:

$$\begin{aligned} L\text{earn}_{it} = & \alpha + \beta \text{Madeg}_{it} + \theta_1 \text{Age}_{it} + \theta_2 \text{Age}_{it}^2 + \gamma \text{Prern}_{it} + \sigma \text{Postern}_{it} + \delta \text{Demog}_i * YQ_t \\ & + \lambda \text{Field}_i * YQ_t + \pi \text{Cohort}_i * YQ_t + \varphi \text{Unempr}_{it} + \eta_i + \varepsilon_{it} \end{aligned} \quad (1)$$

The dependent variable $L\text{earn}_{it}$ is the log-transformed real quarterly earning for individual i at quarter t . Madeg_{it} is a dummy variable indicating if individual i has obtained a Master's degree in quarter t . That is, quarters of pre-earnings have a value of zero for this variable and quarters of post-earnings have a value of one.

The underlying age (experience)—earnings profile is accounted for by Age_{it} and Age_{it}^2 . Prern_{it} is a set of two dichotomous variables, which equal to one for the time period one and two quarters before first graduate enrollment, respectively. These two variables control for possible pre-enrollment dips in earnings (Ashenfelter's dip) that we observed shortly before first graduate enrollment in Fig. 1.⁴ Postern_{it} is a post-degree dummy that controls for potential work start delays after obtaining a Master's degree. $\text{Demog}_i * YQ_t$ is a vector of time-variant person-specific demographics including a time trend interacted with race/ethnicity, gender and age at first enrollment in graduate school. We also control for $\text{Field}_i * YQ_t$, a time trend interacted with fields of study declared at first graduate school enrollment, and $\text{Cohort}_i * YQ_t$, a time trend interacted with cohorts of entry at graduate school. These interaction terms control for linear time trends specific to individual characteristics, and accounts for the fact that underlying earnings trajectories may be different by these characteristics. Uempr_{it} is the county-quarter level employment rate to capture ongoing local economic shifts for individual i . η_i controls for individual fixed effects, and thus eliminates the risk of a bias due to any omitted factors that stay constant across time for each individual. Our estimation includes data from post-Master's degree quarters to account for time-variant factors and underlying earnings trajectories by individual characteristics. However, the time trends may pick up some effect of the Master's degree on earnings growth, especially when returns change with post-graduate school experience.

The coefficient of interest measures the change to earnings within an individual from before graduate school to after graduate degree receipt, compared to the trends we would expect for similar students. Since the analysis sample includes individuals who eventually obtained a Master's degree and quarters of earnings higher than the minimum wage only, the estimated return is the treatment on the treated effect conditional on active employment.

The interpretation of the point estimates as causal relies on certain assumptions within the empirical methodology. First, since the degree data do not track students beyond the year of 2011 but the earnings data expand to 2019, we could not consistently identify a control group of individuals who never obtained a Master's degree over the entire time

⁴ Our main results remain consistent up to two decimal points for most variables when these two dummies are excluded. These results will be made available per request.

frame of the earnings data. As a result, our sample does not include a “pure” control group but includes only those who earned a Master’s degree at some point by 2011. We compare earnings trajectories of graduates before and after completing their degrees, assuming that the timing of graduation is as good as random, allowing those completing a master’s degree earlier or later to serve as controls for one another. Our model accounts for individual-specific variations in outcomes that remain constant over time, alongside important time-variant factors such as age, county-level unemployment, and time trends in earnings based on race/ethnicity, gender, field of study, age, and cohort of entry into graduate school. In our dataset, quarters from 2011 to 2019 exclusively represent post-graduation earnings. We therefore do not control for time fixed effects because it will absorb some of the returns to Master’s degrees. Instead, we include controls for flexible time trends, which we allow to vary by age at entry, race/ethnicity, gender, and field area.⁵

Due to the absence of undergraduate records for students outside Ohio’s public college system or beyond our education data’s time coverage, we don’t include individual undergraduate variables like college major in the model. This is not a concern for our estimation, as any time-invariant effects of college-related variables are controlled by the individual fixed effects, and our specification also already includes graduate-field-area-specific time trends.

Finally, subgroup analyses were conducted based on gender, race/ethnicity, and fields of study categorized into eight areas using CIP codes. Additionally, to explore the heterogeneity in Master’s degree returns concerning graduation labor market conditions, we compared individuals graduating before and during the Great Recession. We created a recession comparison sample by focusing on individuals graduating between 2004 and 2009 within 3 years of initial graduate school enrollment, comparing those from 2004 to 2007 (pre-recession) with those from 2008 to 2009 (during the recession).⁶

Results

Labor Market Returns to Master’s Degrees

Table 2 reports estimates of the effects of obtaining a Master’s degree on log earnings. Column 1 shows the average return to any Master’s degree. Since Master’s degree holders in different fields of study enter different labor markets, we categorize Master’s degrees into eight areas based on CIP codes: Arts and Humanities, Business, Education, Engineering, Health, Natural Sciences and Math, Services, and Social and Behavioral Sciences.⁷ We conduct subgroup analyses by field area and show estimates in Column 2–9.

⁵ Our main results remain the same to the second decimal place when excluding demographics and field area, both interacted with time, and the quarter-specific unemployment rate. These results will be made available upon request.

⁶ The National Bureau of Economic Research (NBER) defines a recession as “a period of falling economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales,” and estimates that the Great Recession began in December 2007 and ended in June 2009. Since our study focuses on labor market outcomes, and unemployment rates continued to increase through the end of 2009, we include all of 2009 in the recession. Table 1 compares summary statistics between students who graduated with a Master’s degree before and under the Great Recession in the recession comparison sample. There is no significant difference in student compositions across the two cohorts.

⁷ Top majors (CIP codes) within each field area are listed in Appendix Table 1.

The coefficient for the estimated return (in logs) to any Master's degree is 0.139. This indicates that on average a Master's degree increased quarterly earnings by about 14%. That is, obtaining a Master's degree increased earnings by approximately \$1600 per quarter from an average baseline quarterly earnings of \$11,433.

Although the average return to a Master's degree is positive and statistically significant, Table 2 shows a large variation in returns by graduate fields. Ranked from the highest to the lowest, the estimated returns to a Master's degree are approximately 33% for Health, 15% for Education, 14% for Natural Sciences and Math, 13% for Engineering, 11% for Services, 9% for Business, 10% for Social and Behavioral Sciences, and essentially zero for Arts and Humanities.⁸ To allow for comparison across graduate fields, the returns are shown in percentages as baseline earnings also vary across fields. Also, the returns do not take into account direct and indirect costs of completing the Master's degree. These results thus suggest that the net value of a Master's degree in Arts and Humanities could be negative.

Table 3 illustrates heterogeneity in returns to Master's degrees by gender and race/ethnicity. Results for gender disparities indicate that the returns are higher for women than for men. On average, a Master's degree increased quarterly earnings by about 9% for men and 16% for women. Before graduate enrollment, men in our sample had an average baseline earning of \$13,380 while women had only \$10,511. Obtaining a Master's degree increased quarterly earnings for men by \$1204 and \$1713 for women. Results demonstrate that women benefit more from obtaining a Master's degree than men, suggesting that the gender wage gap would be narrower but still not fully closed among these highly skilled graduates.

In terms of racial disparities, Table 3 shows that returns are the highest among White degree holders, and relatively lower among Black degree holders. Specifically, obtaining a Master's degree increased quarterly earnings by about 15% for White students and 11% for Black students. In addition, the estimated returns are about 13% for Hispanic degree holders, and 10% for Asian degree holders. However, results for Hispanic and Asian students are estimated on a small sample and thus should be interpreted with caution.

Heterogeneity in returns by field area may help explain the gender differences in the overall magnitude of estimates returns, because men are substantially underrepresented in health and education fields despite their high returns. As shown in Appendix Table 2, men are relatively more likely to graduate in Business and Engineering, while women are more likely to graduate in Education and Health. Similarly, compared to White degree holders, Blacks are relatively more likely to graduate in fields that have low returns like Social and Behavioral Sciences. Although field choices alone cannot fully explain the heterogeneity in returns across demographic groups, results suggest that graduate fields serve as a contributing factor to the gender and racial disparities in returns to Master's degrees.

Labor Market Returns to Master's Degrees and the Great Recession

In order to examine heterogeneity in returns to Master's degrees by the labor market conditions at graduation, we compare individuals who graduated with a Master's degree before

⁸ Our estimate for Master's degrees in education closely mirrors Ohio's minimum salary schedule for teachers with 2 years of experience and a BA degree, indicating a consistent salary increase for those who complete a master's degree.

Table 2 Individual fixed effects estimates of labor market returns to master's degrees

Variables	Outcome: log real quarterly earnings								
	Any master's degree			Master's degree area					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Master's degree	0.139 (0.004)***	0.018 (0.022)	0.089 (0.009)***	0.146 (0.004)***	0.125 (0.021)***	0.329 (0.017)***	0.139 (0.025)***	0.107 (0.032)***	0.099 (0.012)***
Number of observations	1,058,874	36,811	198,369	533,655	31,387	99,245	28,102	18,923	112,376
Number of students	29,144	1,148	5884	13,656	952	2745	827	553	3378
Baseline quarterly earning	\$11,433	\$9463	\$15,535	\$10,364	\$13,566	\$12,199	\$11,068	\$10,133	\$9797

Note: Each column represents a distinct regression, displaying individual fixed effects estimates. Our analysis encompasses Master's degree holders in Ohio who enrolled in graduate school and obtained their degree between Fall 2000 and Fall 2009. Exclusions apply to individuals obtaining the master's degree older than 50 and those lacking at least four quarters of earnings exceeding the state minimum wage after the age of 22 within six quarters before graduate enrollment, and at least one quarter above the minimum wage within 10 years after obtaining the master's degree. Earnings are adjusted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers (CPI-U), with the top 1% of wages top-coded. Exclusions include wages below minimum wage, missing data, or earnings before age 22. All regressions include controls for: (1) individual age per quarter; (2) dummies for one quarter before and after graduate school enrollment, and two quarters before graduate school entry; (3) demographics such as race, gender, age at first graduate school enrollment, entry cohort, and declared major at first graduate school enrollment, all interacting with time trends; (4) county unemployment rate. Baseline quarterly earnings denote the geometric mean of earnings pre-graduate enrollment

Robust standard errors clustered at individual level in parentheses

***p < 0.01, **p < 0.05, *p < 0.1

Table 3 Gender and racial disparities in return to master’s degrees

Outcome: log real quarterly earnings	Gender		Race			
	Male	Female	White	Black	Hispanic	Asian
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Master’s degree	0.09 (0.006)***	0.163 (0.005)***	0.147 (0.004)***	0.105 (0.013)***	0.132 (0.032)***	0.097 (0.033)***
Number of observations	359,065	698,744	905,289	79,331	12,622	13,917
Number of students	10,082	19,034	24,518	2331	360	443
Baseline quarterly earning	\$13,380	\$10,511	\$11,260	\$11,246	\$11,775	\$15,778

Note: Each column represents a distinct regression, displaying individual fixed effects estimates. Our analysis encompasses Master’s degree holders in Ohio who enrolled in graduate school and obtained their degree between Fall 2000 and Fall 2009. Exclusions apply to individuals obtaining the master’s degree older than 50 and those lacking at least four quarters of earnings exceeding the state minimum wage after the age of 22 within six quarters before graduate enrollment, and at least one quarter above the minimum wage within 10 years after obtaining the master’s degree. Earnings are adjusted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers (CPI-U), with the top 1% of wages top-coded. Exclusions include wages below minimum wage, missing data, or earnings before age 22. All regressions include controls for: (1) individual age per quarter; (2) dummies for one quarter before and after graduate school enrollment, and two quarters before graduate school entry; (3) demographics such as race, gender, age at first graduate school enrollment, entry cohort, and declared major at first graduate school enrollment, all interacting with time trends; (4) county unemployment rate. Baseline quarterly earnings denote the geometric mean of earnings pre-graduate enrollment

Robust standard errors clustered at individual level in parentheses

***p < 0.01, **p < 0.05, *p < 0.1

and under the Great Recession.⁹ The majority (84%) of the sample who graduated under the recession started graduate school before the recession (before 2008). Figure 1 shows unadjusted wage trajectories of the two graduation cohorts. There is a noticeable increase in students’ earnings immediately after the completion of a Master’s degree, followed by a gradual increase over the subsequent 10 years for both groups. Focusing on the recession comparison sample, we examined and compared returns to Master’s degrees among students who graduated before and during the Great Recession using the same individual fixed effects model. In particular, we add to the estimation an interaction term of a flag for graduating with the Master’s degree under the recession and the dummy variable for post-Master’s degree quarters. Individuals who graduated in 2008 or 2009 get a value of one for the recession flag, and individuals who graduated before 2008 get a value of zero. The coefficient on the interaction term would estimate the variation in the return to a Master’s degree completed under the Great Recession from the return to the degree completed before the recession.

Table 4 shows estimated coefficients on the dummy variable for post-Master’s degree quarters and the interaction term of the dummy and the recession flag. The coefficient

⁹ Note that our only interest here is to examine heterogeneity in returns to credentials depending on initial labor market conditions. We are neither estimating the effect of the Great Recession on earnings per se, nor can we examine how returns to Master’s degrees may change after the recession. Furthermore, we note that we cannot causally identify whether the estimated heterogeneity in returns is directly due to the difference in labor market conditions or whether it may reflect heterogeneity in returns along other dimensions (e.g., field areas, gender).

on the dummy variable indicates returns to Master's degrees completed before the Great Recession, and the sum of the coefficients on the dummy variable and the interaction term indicates returns to degrees completed under the recession. Overall, a Master's degree completed under the recession had a lower return than before the recession. Specifically, a Master's degree increased quarterly earnings by about 16% for students who graduated before the recession, and by only about 10% for those who graduated under the recession. While returns to Master's degrees under the Great Recession were still positive, returns for those graduating during the recession were about 6 percentage points lower.¹⁰

Table 4 also shows returns to Master's degrees among graduates before and under the Great Recession by graduate field area. This specification breaks the estimations down to smaller samples, resulting in weaker statistical power. None of the coefficients of interaction terms appear positive, indicating that returns to Master's degrees completed under the Great Recession were lower than degrees completed before the recession across fields. Returns completed under the recession were lower than returns completed before the recession by about 12 percentage points for Master's degrees in Services, and 6–7 percentage points for a degree in Business, Social and Behavioral Sciences, and Education. The coefficients of interaction terms are not statistically significant for Arts and Humanities, Engineering, Health, and Natural Sciences and Math. Except for Engineering, the coefficients also have a small magnitude, suggesting that returns to Master's degrees in these fields did not vary significantly with the recession.

Table 5 examines interaction terms between returns to Master's degrees and the Great Recession by gender and race/ethnicity. These interaction terms are mostly negative and significant, suggesting that the relative payoff to Master's degrees decreased during the recession across all gender and racial groups. Returns to Master's degrees decreased by a similar magnitude for both genders in recession years versus prerecession years (6 percentage points). For Whites and Hispanics, these estimates are larger and significant than for Black and Asian degree holders. The distribution of graduate fields by gender and race/ethnicity in recession years versus prerecession years are shown in Appendix Table 4. While the distribution of field areas by gender did not significantly change during the Great Recession, Black degree holders were notably less likely to graduate in Education than their White peers.

Robustness Checks

Appendix Table 5 displays results for a robustness check regarding how we treat missing earnings, which could reflect non-employment but could also indicate migration out of state, self-employment, or employment in a non-UI covered position. As discussed, our primary specification excludes quarters with missing earnings as we could not identify the reason for the missing data. However, our results would overestimate returns to Master's degrees if missing earnings are mostly due to unemployment. To check if the exclusion of missing earnings biases the findings, we conduct a robustness check limiting the analysis

¹⁰ It's important to note that Fig. 1 displays unadjusted earnings data, not our regression estimates. While the initial 2 years post-graduation show less dramatic differences in raw earnings, only two quarters during this period exhibit higher earnings for the recession cohorts, whereas quarters 10–24 post-graduation show significantly lower earnings. Our regression models account for these nuances by including controls for the unemployment rate in each quarter, which helps mitigate the temporary impact of economic conditions. The pre-recession cohorts experience tougher economic conditions in the later post-graduation quarters, potentially explaining why the apparent shift seen in the raw data is attenuated in the regression estimates.

Table 4 Interactions between return to master’s degrees and the great recession

Variables	Master’s degree area								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome: log real quarterly earnings									
Any master’s degree		Arts and Humanities	Business	Education	Engineering	Health	Natural Sciences and Math	Services	Social and Behavioral Sciences
Master’s degree	0.163 (0.005)***	0.039 (0.030)	0.124 (0.012)***	0.176 (0.006)***	0.114 (0.031)***	0.334 (0.022)***	0.169 (0.036)***	0.132 (0.046)***	0.12 (0.016)***
Master’s degree * degree under the great recession	-0.058 (0.006)***	-0.014 (0.035)	-0.066 (0.014)***	-0.059 (0.008)***	-0.061 (0.039)	-0.021 (0.027)	-0.009 (0.043)	-0.117 (0.057)**	-0.061 (0.021)***
Number of observations	673,238	22,952	134,863	328,952	19,123	66,949	16,053	12,512	71,834
Number of students	18,371	711	3935	8340	570	1846	478	366	2125
Baseline quarterly earning	\$11,239	\$8991	\$15,376	\$10,152	\$12,870	\$11,951	\$10,285	\$10,004	\$9505

Note: Each column represents a distinct regression, displaying individual fixed effects estimates. Our analysis encompasses Master’s degree holders in Ohio who enrolled in graduate school and obtained their degree between Fall 2000 and Fall 2009. Exclusions apply to individuals obtaining the master’s degree older than 50 and those lacking at least four quarters of earnings exceeding the state minimum wage after the age of 22 within six quarters before graduate enrollment, and at least one quarter above the minimum wage within 10 years after obtaining the master’s degree. Individuals who obtained the master’s degree from 2004 to 2007 are master’s degree holders before the Great Recession, and individuals who obtained the master’s degree from 2008 to 2009 are master’s degree holders under the Great Recession. Earnings are adjusted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers (CPI-U), with the top 1% of wages top-coded. Exclusions include wages below minimum wage, missing data, or earnings before age 22. All regressions include controls for: (1) individual age per quarter; (2) dummies for one quarter before and after graduate school enrollment, and two quarters before graduate school entry; (3) demographics such as race, gender, age at first graduate school enrollment, entry cohort, and declared major at first graduate school enrollment, all interacting with time trends; (4) county unemployment rate. Baseline quarterly earnings denote the geometric mean of earnings pre-graduate enrollment

Robust standard errors clustered at individual level in parentheses

***p < 0.01, **p < 0.05, *p < 0.1

Table 5 Interactions between return to master's degrees and the great recession by gender and race/ethnicity

Outcome: log real quarterly earnings	Gender		Race			
	Male	Female	White	Black	Hispanic	Asian
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Master's degree	0.114 (0.009)***	0.186 (0.006)***	0.172 (0.005)***	0.121 (0.017)***	0.175 (0.047)***	0.131 (0.049)***
Master's degree * degree under the great recession	-0.056 (0.011)***	-0.055 (0.008)***	-0.057 (0.007)***	-0.034 (0.023)	-0.093 (0.051)*	-0.023 (0.050)
Number of observations	227,666	444,859	576,765	48,804	7925	9930
Number of students	6355	11,998	15,471	1420	220	313
Baseline quarterly earning	\$13,210	\$10,312	\$11,036	\$11,076	\$11,931	\$16,112

Note: Each column represents a distinct regression, displaying individual fixed effects estimates. Our analysis encompasses Master's degree holders in Ohio who enrolled in graduate school and obtained their degree between Fall 2000 and Fall 2009. Exclusions apply to individuals obtaining the master's degree older than 50 and those lacking at least four quarters of earnings exceeding the state minimum wage after the age of 22 within six quarters before graduate enrollment, and at least one quarter above the minimum wage within 10 years after obtaining the master's degree. Individuals who obtained the master's degree from 2004 to 2007 are master's degree holders before the Great Recession, and individuals who obtained the master's degree from 2008 to 2009 are master's degree holders under the Great Recession. Earnings are adjusted to 2019Q4 dollars using the Consumer Price Index for All Urban Consumers (CPI-U), with the top 1% of wages top-coded. Exclusions include wages below minimum wage, missing data, or earnings before age 22. All regressions include controls for: (1) individual age per quarter; (2) dummies for one quarter before and after graduate school enrollment, and two quarters before graduate school entry; (3) demographics such as race, gender, age at first graduate school enrollment, entry cohort, and declared major at first graduate school enrollment, all interacting with time trends; (4) county unemployment rate. Baseline quarterly earnings denote the geometric mean of earnings pre-graduate enrollment

Robust standard errors clustered at individual level in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

sample to individuals with no employment gaps. We estimate returns for individuals who have earnings data that could be used in the analysis for all the six quarters before graduate enrollment and every quarter throughout the 10 years after completion of a Master's degree.

Overall, our findings are robust to missing earnings data. Column 1 of Appendix Table 5 shows that the average labor market return to a Master's degree among individuals with no employment gaps (12%) was slightly lower than but close to the findings using the full analysis sample (14%). Results of how the returns varied with the Great Recession shown in Column 2 are also consistent with our main results.

As discussed above, 16% of the recession comparison sample who graduated with the Master's degree under the recession also entered graduate school under the recession. Their enrollment decisions, such as major choice, may be influenced by the recession, which have implications for their returns to Master's degrees. We therefore test whether the results are sensitive to dropping students who entered graduate school after 2008. Among students who entered graduate school before the recession, we compare students who completed a Master's degree before and under the recession. Appendix Table 6 shows results of this test. These results are consistent with our main results, which reassures that our estimation

results on how returns to Master's degrees varied with the Great Recession were not driven by selection bias.

Because we may be concerned about potential differences in pre-existing earnings trends, we've introduced an additional robustness check to account for individual-specific trends. Appendix Table 7 show that coefficients remain positively significant, with larger point estimates compared to our primary specification. It remains unclear, however, whether these trends will persist indefinitely or if they might represent temporary patterns similar to an extended Ashenfelter's dip. In fact, upon retesting individual trends excluding the two quarters before entry, we found no notable differences.

Discussion and Conclusion

In recent years, the U.S. has seen a surge in advanced degree attainment despite declining college enrollments. The number of individuals holding master's degrees has doubled since 2000. This trend coincides with a rise in graduate students seeking loans, driven by changing job demands and efforts to address pay disparities. However, empirical insights into the economic returns of obtaining a master's degree remain limited. This trend intersects with ongoing debates about the value of higher education, as more bachelor's degree holders pursue graduate degrees to stand out in a competitive job market. Our findings, viewed in the context of rising educational costs and credential inflation, shed light on the evolving landscape of education and its link to labor market outcomes.

This paper exploits state administrative data with an individual fixed effects model and provides estimates of the labor market returns to Master's degrees. On average, obtaining a Master's degree increased earnings by about 14% or \$1600 per quarter. According to data from NPSAS: GR 2008, the average cumulative amount borrowed for graduate school is \$26,263 at Ohio's public institutions.¹¹ This suggests that graduate debt would be paid off in about 5 years with the estimated average quarterly return to Master's degrees. Although attending graduate school also entails indirect costs such as "forgone earnings," graduate education still seems like a good investment in the long term on average. However, the returns vary largely across graduate fields. While obtaining a Master's degree could be a great investment for students in certain graduate fields (e.g., Health), it may not be for other fields (e.g., Arts and Humanities). These results highlight that students' decisions about attending graduate school and choosing a graduate field are likely to be important in determining labor market outcomes.

Although we use a different approach to categorize Master's degree fields than Altonji and Zhu (2021)'s study, our results are largely similar across several graduate fields such as Engineering, Health and Social and Behavioral Sciences. Yet, our estimates are lower for Master's degrees in Business and higher for Education than Altonji and Zhu (2021)'s estimates.¹² The difference in returns to Business could be due to different labor market

¹¹ Calculated by authors using NCES PowerStats among borrowers who enrolled in and completed a Master's degree in 2007–2008 at a public institution in Ohio.

¹² Given our study's approach of organizing majors into broader degree fields and Altonji and Zhu's (2021) focus on specific majors, direct comparisons are challenging. For instance, while we grouped multiple Engineering majors for adequate sample sizes, Altonji and Zhu examined Computer Engineering, Mechanical Engineering, and Electrical Engineering separately, lacking findings for the broader Engineering degree field. This discrepancy made a direct comparison between our studies challenging. To address this discrep-

conditions at graduation or different quality of MBA programs offered in the two states. And the difference in Education may be explained by differences in teacher's salary schedule between the two states.¹³ Therefore, returns to graduate degrees could be sensitive to state conditions and regulations, which should be taken into consideration when generalizing our results to a different state.

Our paper also shows that the average labor market return to a Master's degree is higher for women and Black students relative to men and White students. We find that differences in graduate fields may contribute to the gender and the Black-White gaps in returns to Master's degrees. Determining what drives these gaps is beyond the scope of this paper, but should be an important priority for future research.

Finally, we further compare returns to Master's degrees among students who graduated before versus during the Great Recession to examine heterogeneity in the returns by labor market conditions at graduation. Our findings suggest that economic downturns largely reduce but not eliminate the positive returns to Master's degrees. While prior research showed that entering the labor market in times of high unemployment leads to smaller earnings losses for Whites (Schwandt & von Wachter, 2019), we find that the returns for Whites who complete a Master's degree are significantly lower when the economy is in a recession.

Our findings are subject to challenges that limit their generalizability. Our sample is limited to individuals who work both before and after graduate school. Another limitation of the data is that Master's degree completion and labor market outcomes can only be observed for individuals who attend public institutions and work a UI-covered position in Ohio. Thus, the findings may have limited generalizability to individuals who enroll in graduate school directly after college, completed Master's degrees at private/for-profit colleges, and worked non UI-covered positions or in another state with different labor market conditions. Our study could be extended with different samples/contexts in order to provide a more thorough understanding about returns to graduate school investments.

Despite these limitations, we believe that our paper has important implications for policies and future research on returns to graduate education. Our paper highlights important variation in the returns to Master's degrees across demographic groups, field areas and initial labor market conditions. This contributes to the body of evidence of differential returns and has implications not only for students' making choices, but also for policymakers evaluating changes aimed at affordability and accountability of graduate school. Costs of graduate education and non-monetary returns to graduate degrees are also critical factors in

Footnote 12 (Continued)

ancy, we selected comparable results between our study and theirs, considering majors they reported that constitute a significant portion of the degree fields we cover. Specifically, our estimate for a Master's degree in Engineering is 0.125, among which 22% are in Mechanical Engineering; and Altonji and Zhu's individual fixed effects estimate for a graduate degree in Mechanical Engineering is 0.125. We estimate that a Master's degree in Health, mostly in Nursing, has a return of 0.329; and their estimate for a degree in Nursing is 0.26. Also, our estimate for a degree in Social and Behavioral Sciences, represented largely by Social Work, is 0.099; and their estimate for a degree in Social Work is 0.097. While Altonji and Zhu show that an MBA degree has a return of 0.194, our estimate for a Master's degree in Business, among which 66% are in Business Administration and Management, is only 0.089. A Master's degree in Education has a return estimated at 0.146 in our study, represented by 24% in Curriculum and Instruction and 15% in Education Administration and Leadership, but is low for both majors in Altonji and Zhu's results (0.033 for a degree in Education Administration, and -0.005 for a degree in Curriculum and Instruction).

¹³ In Ohio, the minimum teacher salary increases with the highest degree level of the teacher. In Texas, the minimum salary only depends on years of experience, and teachers with an advanced degree may be compensated with a stipend by districts.

determining optimal investment decisions in graduate education. While our study focuses on examining returns to Master's degrees on earnings, it has important implications for future research with access to data on costs, debt and non-monetary outcomes associated with graduate education.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11162-024-09777-8>.

Data availability The data used in this study are not publicly available due to restrictions imposed by the data agreement.

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