

The Effect of Title IX on Gender Disparity in Graduate Education*

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Abstract

This paper examines whether Title IX of the Education Amendments of 1972, which banned sex discrimination in admissions, was successful in reducing gender disparity in graduate education. I find a sharp convergence of female and male graduate-degree fields coincident with Title IX's passage. This distributional change occurred as women moved into male-dominated fields and does not seem to be driven by gender-specific preferences. Alternative explanations including the end of the Vietnam War Draft, increased access to the pill, abortion legalization, changing female attitudes, and the strengthening of anti-discrimination labor laws are also considered but do not explain the discontinuity.

Keywords: Title IX, gender inequality, education

JEL Codes: I24, J16, J18

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1 Introduction

One of the most striking changes in American society, and indeed almost all developed nations, is convergence in labor market outcomes between men and women. In 1960, less than 4 of 10 women were participating in the labor force. In 2000, the female labor force participation rate was 60 percent.¹ Not only did women enter the workforce in large numbers, but they entered high-skilled, male-dominated occupations. For example, the share of female lawyers and judges increased from 4 percent to 34 percent between 1960 and 2000.² It has been a goal of public policy for decades to reduce these gender disparities. The best available research in terms of what has contributed to this convergence seems to focus on demand factors, such as a rise in skill demand, and technological changes, particularly around fertility, rather than more direct legal attempts to legislate away sex discrimination in education.³ Given that high-skill occupations often require graduate degrees (for example, law and medicine), examining the female-male convergence in graduate education is relevant and important. The goal of this paper is to empirically assess whether policy is effective in reducing sex discrimination in graduate education.⁴

In examining sex discrimination laws, this paper is similar to Beller (1982a), which looks at the effect of equal opportunity (EO) policy on female occupational choices. The author finds that women exposed to EO laws in schooling and the labor market are more likely to be employed in traditionally male occupations, but does not focus on schooling outcomes. In contrast, this paper directly examines whether Title IX of the Education Amendments of 1972, which banned sex discrimination in admissions, was successful in reducing gender disparity in graduate education.

Although Title IX applied to both graduate institutions and public undergraduate institutions, this paper focuses on graduate education because of the direct relationship between admissions to a graduate program and the field of study. For example, prospective students apply to specific graduate programs such as a Master's degree in Education or a Ph.D. in Economics. Admission to a program, therefore, directly correlates to a degree in that field of study. In contrast, admission to an undergraduate institution does not necessarily determine one's choice of major. For example, a female college student may just as likely major in Education at Wellesley College or at Yale University. Therefore, I use Title IX as a plausibly

¹These statistics are from the U.S. Bureau of Labor Statistics and were retrieved from FRED at <https://fred.stlouisfed.org/series/LNS11300002>.

²These statistics are based off the 1960 and 2000 Census IPUMS 5 percent samples for people aged 18 to 55.

³See, for example, Heckman and Sedlacek (1985), Smith and Ward (1985, 1989), Blau and Kahn (1997, 2006), Blau, Kahn, and Waldfogel (2000), Black and Juhn (2000), and Mulligan and Rubinstein (2008) for research on demand factors. For research on the role of fertility, see Goldin (1988), Goldin and Katz (2002), Bailey (2006, 2010), and Myers (2017).

⁴The literature on the effectiveness of anti-discrimination laws is quite extensive, covering racial discrimination laws (e.g., Heckman and Payner, 1989; Donohue and Heckman, 1991; Chay, 1998; Neumark and Stock, 2006), sex discrimination laws (e.g., Beller, 1977, 1982a, 1982b; Myers, 2005; Neumark and Stock, 2006), disability discrimination laws (e.g., Angrist and Acemoglu, 2001; Beegle and Stock, 2003), and age discrimination laws (e.g., Neumark and Stock, 1999). This paper focuses on the effectiveness of anti-discrimination laws on educational outcomes, which has been less studied.

exogenous reduction in barriers to entry for women applying to graduate programs and examine its impact across different degree fields.

Focusing on the distribution of fields of study, I estimate that Title IX led to a 12 percentage-point reduction in sex disparity in graduate education. I use two different methods to measure gender convergence: the Segregation Index, also known as the Index of Dissimilarity, and the Earth Mover’s Distance algorithm (EMD). Although both measure distributional change, only EMD takes into account which categories in the distribution are changing. For example, in measuring the dissimilarity between female and male distributions of graduate fields of study, EMD takes into account which fields people move out of and into, and, more importantly, the distance between fields (using a rank ordering of the field’s expected salary as a measure of distance). This is an important detail as more lucrative fields of study had greater sex disparities before Title IX. My results hold for either convergence measure, though EMD estimates greater convergence. Further, I find that more federally dependent schools—ones that would face harsher penalties if found to be in violation of Title IX—experienced more convergence relative to less federally dependent schools.

My difference-in-differences (DID) analysis finds that white, female graduate students were 5 percentage-points more likely than white men to pursue a traditionally male field after Title IX, an effect size of about 73 percent. In contrast, white, female graduate students were 6.3 percentage-points less likely to pursue a traditionally female degree field. Both my distributional analysis and DID results find that after Title IX, women entered male-dominated fields suggesting that barriers to entry were the reason for pre-existing sex disparities in graduate education rather than differing preferences between men and women. This is further supported by my findings when I compare schools that are more federally dependent to schools that are less federally dependent. That I find stronger effects among more federally dependent schools would not necessarily be predicted by gender-specific preferences, but is consistent with a barriers to entry story.

Title IX is largely associated with high school and college athletics; one of the seminal papers on Title IX finds that it increased female college attendance and labor market participation by increasing female participation in high school athletic programs (Stevenson, 2010). Other researchers have examined its effect on educational outcomes, but most are historical accounts or qualitative studies (Buek and Orleans, 1973; Stromquist, 1993; Valentin, 1997; DOJ, 2012; Mason and Younger, 2014). To my knowledge, this is the first study that seeks to estimate causal effects of Title IX on graduate education.

There is one important identification concern that warrants discussion. As Title IX is a national policy, there is no natural comparison group against which to measure the impact of the law. This is an issue if the law were anticipated or if it were passed in response to changing social attitudes at the time, especially regarding admissions policies. In these cases, a simple event-study may result in a biased OLS estimate as I would be unable to disentangle the trend from the law’s impact. These concerns are mitigated when

examining the history behind Title IX’s passage. The law came at a time when women’s rights were expanding, but the main impetus for its passage was persistent gender discrimination in educational institutions. That women faced greater obstacles than men is supported by administrative data, which reveal that female graduate enrollment increased immediately following Title IX’s passage. Further, I find that institutions that relied more on federal funds enrolled more female students in comparison to institutions that had less at stake. Again, this is consistent with a “barriers-to-entry” story.

Although Title IX may be seen as an exogenous reduction in barriers to entry for women, other events may have occurred around the same time that prevent me from making a causal claim. For example, the draft ended in 1973, meaning the rush of young men enrolling in graduate programs to avoid the Vietnam War also ended. The sudden ebb of male enrollment may have allowed women to fill the void, thereby resulting in a sudden increase in the number of women with graduate degrees. To bypass this problem, I focus my analysis on non-doctorate, non-health professional graduate degrees, which constitute 86 percent of graduate degrees.⁵ Draft deferments to these graduate programs ended in 1968, thereby allowing me to separate the effect of Title IX from the Vietnam War draft.

Second, I consider law changes regarding fertility control: abortion legalization with *Roe v. Wade* and changes in state laws increasing minors’ access to the birth control pill. A literature finds that technological changes in fertility control affected female educational and occupational decisions (e.g., Goldin, 1988; Goldin and Katz, 2002; Bailey, 2006, 2010; Myers, 2017). I find a similar discontinuous break in the convergence trend starting with degrees earned in spring 1975 when focusing on Repeal states, where abortion was legal before *Roe v. Wade*. I also find that minors who gained pill access due to changing state laws were too young to apply to graduate school when Title IX was passed. These findings suggest that fertility-related law changes do not explain my findings. Further, fertility-related explanations may explain an increase in female educational attainment overall, but they do not necessarily predict a reduction in gender disparity *across* different fields—particularly of the kind I find where women moved into traditionally male fields.

Last, the Equal Employment Opportunity Act (EEOA), which also passed in 1972, strengthened anti-discrimination labor laws. The concern is that stronger anti-discrimination labor laws may have affected female educational decisions. It is certainly possible for EEOA to have an indirect effect that would manifest over the long run, but it is less clear that the EEOA, which applied to the labor market, would have an *immediate* impact on women’s educational decisions. As a check, I leverage state-level variation in the existence of fair employment practice laws, and find that in states where EEOA strengthened anti-discrimination labor laws, women entered traditionally female graduate programs beginning in spring 1975.

⁵Health professional degrees are graduate degrees in medicine, dentistry, veterinary medicine, osteopathy, or optometry. This statistic is calculated using earned degrees data from the Higher Education General Information Survey between 1965 and 1981.

This does not explain my finding, which is that women moved into traditionally *male* fields.

Because I find a discontinuous increase in female enrollment and earned degrees, I do not believe more gradual changes can explain my results, such as evolving social norms. Nevertheless, I examine whether female high school course-taking or career aspirations may have changed, manifesting in a change in graduate fields of study. I do not find evidence of sudden changes.⁶

I begin the remainder of the paper with background on the status of women in education and Title IX regulations. Section 3 describes the data and presents summary statistics. I examine whether Title IX affected graduate enrollment in Section 4 and whether it reduced gender disparity in earned degrees in Section 5. Section 6 discusses alternative explanations. I conclude with a discussion in Section 7.

2 Background

2.1 The Status of Women in Education

The 1960s saw a colossal expansion of women’s rights. President John F. Kennedy was elected into office on the promise of a New Frontier, ready to confront previously unconquered problems of social and civil injustice. As such, he signed the Equal Pay Act of 1963 into law, banning wage disparity based on sex. One year later, the Civil Rights Act of 1964 was passed — a landmark piece of civil rights legislation that prohibited racial segregation in schools. However, it made no explicit mention of gender discrimination in educational institutions.

On May 24, 1965, U.S. News and World Report published a story on gender discrimination in university admissions policies. The writers surveyed 1,619 co-educational U.S. colleges and found that though few have official quotas for female enrollment, the majority acknowledge an unofficial practice to maintain the level of boys to girls. The policy differs by school, but “almost always it calls for more boys than girls” (U.S. News & World Report, 1965, p. 54).

The article caught the attention of Representative Edith Green, who was Chairman of the Special Subcommittee on Education in the House at the time (Green, 1965). Representative Green, seeking to pass a higher education bill that addressed gender bias in education, held Congressional Hearings on June 17, 1970.⁷ For seven days, hearing after hearing, statement after statement revealed the dire status of a woman’s place in education (Discrimination Against Women, 1970). The statement of Professor Ann Sutherland Harris, Assistant Professor of Art History at Columbia University, summarized it best:

⁶This analysis can be found in the Online Appendix at <https://goo.gl/h4MEaw>.

⁷The higher education bill was Section 805 of H.R. 16098 or the Omnibus Post-Secondary Education Act of 1970. The 1970 Congressional Hearings are considered to be the impetus for the development of Title IX.

The rule is a simple one: the higher, the fewer. Although more women than men finish high school (and this has been true since 1920), fewer women than men go on to college, largely because it is harder for a woman to gain entrance to college with the necessary financial support. Fewer women than men go on to get higher degrees, again largely because graduate departments discriminate against women in admissions policies and in the distribution of fellowships. Once they qualify, the higher-the-fewer rule continues to apply: the higher in terms of rank, salary, prestige or responsibility, the fewer the number of women to be found. (*Discrimination Against Women*, 1970, pp. 244-245).

Two clear facts about admissions policies emerged from the 1970 Congressional Hearings. First, sex bias existed in both undergraduate and graduate admissions and was prevalent across all disciplines. For example, undergraduate admission to University of North Carolina was restricted to females “who are especially well-qualified”, but no such restriction for male applicants existed (*Discrimination Against Women*, 1970, p. 739). In the State of Virginia, 21,000 women were rejected for college entrance over a 3-year period while not one male student was rejected (*Discrimination Against Women*, 1970, p. 739). At Cornell University, studies on the status of women found that “there were quotas on women applicants operating at all the schools” (*Discrimination Against Women*, 1970, p. 1077). According to one testimony, when the Dean of Admissions at New York University Law School was approached with the idea of actively recruiting female law students, he responded that there were already too many women and that NYU did not need classes composed of 50 percent women (*Discrimination Against Women*, 1970, p. 587). According to another testimony, the Dean at Harvard Law School stated that female enrollment at Harvard Law would probably stay at 5 percent of the class as “that was Yale Law School’s percentage; and that, after all, there could never be a great influx of women into the school...because the policy was never to give any man’s place to a woman” (*Discrimination Against Women*, 1970, p. 587).

Second, school administrators and applicants both knew that women faced barriers in pursuing graduate programs that men may not have faced. The U.S. News and World Report article publicized this fact, which was supported by testimonies from the 1970 Congressional Hearings. For example, Professor Ann Sutherland Harris recounted stories of her colleagues complaining that women undergraduates needed A or A- grades for graduate school admission while their male counterparts were admitted with B averages (*Discrimination Against Women*, 1970, p. 248). A University of Chicago Report (hereafter Chicago Report) on the status of its women found that 34 percent of graduate women had grade point averages of A or A-, while the corresponding fraction for graduate men was 27 percent (*Discrimination Against Women*, p. 798). In the State School of Agriculture at Cornell, “the mean SAT scores of entering women freshmen are higher than those of men by 30-40 points” (*Discrimination Against Women*, 1970, p. 1077).⁸

Part of the problem was a widely-held belief by school administrators that women were not committed

⁸Whether any of these estimates are statistically significantly different is unknown.

students. This was often used as an explanation by school officials when asked why women were discriminated against in admissions (Discrimination Against Women, 1970, p. 248). For example, a 1970 report by the American Historical Association (AHA) on the status of women in the profession states that one prohibitive reason for women obtaining Ph.D.s is the notion that women “prefer to marry and devote themselves to domestic life”.⁹ The AHA report’s final recommendations included objectives to “remove existing disabilities and to establish a genuine parity for women historians”, including the adoption of a formal position of disapproval of gender discrimination in graduate school admissions, grants, and awarding of degrees.

2.2 Title IX Regulations and Enforcement

After an unsuccessful attempt by Representative Green to add a sex discrimination prohibition to the Education Amendments of 1971, Senator Birch Bayh of Indiana introduced an amendment that would eventually become Title IX of the Education Amendments of 1972. Current legislation, such as the Equal Pay Act, dealt mostly with sex inequities in the labor market. The senator believed that a policy that fought sex discrimination in the educational system was necessary, since labor market inequities may be linked to sex inequities in the educational system (118 Cong. Rec. 5803, 1972).

The new law mandated that:

No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance.

Title IX was broad in scope, covering many aspects of education discrimination, but in regards to admissions, it applied specifically to “institutions of vocational education, professional education, and graduate higher education, and to public institutions of undergraduate higher education.”

The initial bill included language on enforcement:

Compliance with any requirement adopted pursuant to this section may be effected (1) by the termination of or refusal to grant or to continue assistance under such program or activity to any recipient as to whom there has been an express finding on the record, after opportunity for hearing, of a failure to comply with such requirement, but such termination or refusal shall be limited to the particular political entity, or part thereof, or other recipient as to whom such a finding has been made, and shall be limited in its effect to the particular program, or part thereof, in which such noncompliance has been so found, or (2) by any other means authorized by law.

The consequences for non-compliance were severe: any program, department, or school that was found to be practicing gender discrimination after it was notified of the violation would no longer receive federal

⁹The American Historical Association established an ad hoc committee on February 21, 1970 to study the status of women. The committee was instructed to collect statistics on women at all levels of the profession (student admissions, degrees awarded, faculty employment, salary, promotion, etc.) and to make recommendations for action by the AHA. The report was based on a survey of thirty representative institutions and a questionnaire of all Ph.D. recipients in 1970.

assistance. This enforcement policy was similar to that of Title VI of the 1964 Civil Rights Act (118 Cong. Rec. 5803, 1972; University of Pennsylvania Law Review, 1976).

Title IX was signed into law by President Richard Nixon on June 23, 1972, four months after its introduction. The Department of Health, Education, and Welfare (HEW) began working on regulations five weeks later. The process was very much public. Between August 2-4, 1972, HEW held national hearings to discuss Title IX regulations. In June 1974, an initial draft of the regulations was published in the Federal Register. After reviewing nearly 10,000 comments, HEW edited the regulations, and they were signed into law by President Gerald Ford in May 1975.¹⁰

Implementation regulations required schools to sign “Assurance of Compliance” forms promising the federal government to comply with the law (40 Fed. Reg. 24128, 1975). The onus was on schools to prove they complied with the federal regulations, but the federal government also enforced the regulations. For example, it began enforcement proceedings against Grove City College in 1976 after the school refused to sign an Assurance of Compliance form.

3 Data

In this section, I describe the datasets used for my analysis. Then, I present summary statistics on the gender disparity in graduate education.

Earned Degrees data. I use two different data sources for earned degrees. The first is called the National Survey of College Graduates (NSCG), a longitudinal, biennial survey of U.S. college graduates that began in the 1970s. I use the 1993 survey, which surveyed all non-institutionalized, U.S. individuals under the age of 73 with at least a bachelor’s degree as of 1993. The individuals who lived through Title IX would have been roughly 40-50 years old in 1993 and, therefore, are in this dataset. Most importantly, the survey asks respondents to report their fields of study and degree years. There are four types of degrees: bachelor’s, master’s (includes MBA), professional (e.g., JD, ThD, MD, DDS, etc.), and doctorate. I classify master’s, professional, and doctoral degrees as “graduate degrees”. If an individual has more than one graduate degree, I use the highest degree. I focus on graduate degrees obtained before age 35 between 1961 and 1988, resulting in 25,841 observations and 20,590 observations for non-doctorate, non-health professional graduate degrees.¹¹ I combine two-year cells to increase power and to reduce measurement error from recall bias.¹²

The second data source for earned degrees is from the Higher Education General Information Survey

¹⁰The Department of Health, Education, and Welfare published Title IX implementation guidelines on June 4, 1975, and the regulation went into effect on July 21, 1975.

¹¹I choose age 35 as most graduate degrees are obtained by then. The average age of a graduate-degree graduate was 30 years old between 1960-1971 and 31 years old between 1973-1990.

¹²A plot of reported degree-year reveals a cyclical trend from year to year. I combine degree-years into two-year cells to smooth the distribution.

(HEGIS). HEGIS is a set of surveys that began in the 1960s and is administered by the U.S. Department of Education to all public and private two-year and four-year institutions. The purpose of the survey is to provide comprehensive information on various aspects of post-secondary education, such as enrollment, earned degrees, and financial statistics of institutions. Earned degrees data are from academic year 1965-66 to academic year 1981-82. I restrict my sample to non government-military universities with graduate programs that appear in all 16 years of data and for which I have financial statistics data. This leaves me with 608 universities representing around 3.7 million graduate degrees and 3.2 non-doctorate, non-health professional graduate degrees over this time period.

I aggregate reported fields of study in both the NSCG and HEGIS Earned Degrees data to 26 main fields, as categorized by the 2010 Classification of Instructional Programs (CIP).¹³

Fall Enrollment data Graduate enrollment data are from HEGIS and span from Fall 1969 to Fall 1980.¹⁴ I restrict my enrollment sample to non government-military schools that appear in all years between 1969 and 1980 and for which I have financial statistics data. This leaves me with 808 universities representing 13.7 million graduate enrollments over 12 years.

Financial Statistics data. I use school financial statistics data from HEGIS to classify schools into terciles based on the school’s “federal-funds share”, or the share of a school’s total revenue that comes from federal funds. Financial statistics data are from academic year 1968-69, the earliest for which there are data, to academic year 1971-72. I use these baseline years before Title IX’s June 1972 passage to avoid endogeneity between enrollment and federal assistance. Total revenue is composed of educational revenue and student aid grants. Educational revenue may come from student tuition and fees, governmental appropriations¹⁵, endowment income, private gifts, sponsored research and programs, and recovery of indirect costs. Likewise, student aid grants may come from federal, state, or local government, private gifts and grants, endowment income, or other sources. In general, a school may receive federal funds for appropriations, research and programs, and student aid grants. I calculate each school’s total federal dollars as a fraction of their total revenue, and categorize schools into terciles based on their share. There is quite some variation in federal-funds share across schools. The average federal share of total educational revenue between 1968 and 1971 is 6.8 percent with a standard deviation of 9.7 percent. The median share is 3.9 percent. The 10th and 90th percentiles are 0 percent and 17 percent, respectively. The mean shares of the three terciles are 0.7 percent (low), 4.3 percent (medium), and 15.8 percent (high). Public schools receive around \$960,000 more federal

¹³CIP was originally developed in 1980 by the U.S. Department of Education’s National Center for Education Statistics for the purpose of accurate tracking, assessment, and reporting of fields of study.

¹⁴Total and BA enrollment data begin in Fall 1968 whereas graduate enrollment data begin in Fall 1969.

¹⁵This pertains to federal, state, or local government money set aside for the school. As an example, the top three schools in terms of federal appropriations between 1968 and 1972 are the U.S. Air Force Academy, the U.S. Military Academy, and the U.S. Naval Academy.

money on average than private schools, but private schools also receive federal money. For example, Harvard University and Yale University are in the top tercile.

3.1 Summary statistics

Next, I present summary statistics on earned degrees before Title IX. At the time the U.S. News article was written (May 1965), there were 524,008 conferred B.A. degrees of which 57.4 percent were to men.¹⁶ The most popular undergraduate major was Business for men and Education for women. Only one in five college graduates went on to graduate school, but men were twice more likely to go than women. In academic year 1965-66, 73 percent of graduate degrees were awarded to men.¹⁷ Furthermore, men and women pursued different fields of study in graduate school. Nearly half of the women in graduate school were pursuing a degree in Education in 1965, whereas men were more evenly distributed across the 26 major fields of study (see Figure A1). Moreover, if fields of study are classified by median salary, 55 percent of male graduate students were pursuing degrees in the top salary tercile, with 31 percent representing the top three: Law, Health, and Engineering.¹⁸ In contrast, 12.4 percent of women were in fields in the top salary tercile.

The disparity is starker when we examine the share of female graduates in each degree field. In Figure 1, the horizontal axis lists the 26 major fields of study in rank order of median salary. For example, law degrees have the highest median salary and graduate degrees in Philosophy have the lowest median salary. This ordering highlights the fact that women are disproportionately concentrated in graduate fields in the bottom salary tercile, while men are concentrated in the top salary tercile. Red, horizontal, dashed lines depict tercile averages, which are 8.7 percent (high), 27 percent (middle), and 45.4 percent (low).

At the end of the day, it is difficult to ascertain whether discrimination actually existed because we do not have school-level data on applications and acceptances separated by sex. The data on earned degrees reveal a large gender disparity, and it may be due to discrimination. However, it may also reflect differing preferences between men and women for fields of study, a lack of adequate preparation on the part of female applicants, or differing career aspirations between men and women. To narrow down possible explanations, I exploit the passage of a new law (Title IX) that banned gender discrimination in admissions. If the observed gender disparity were due to differing tastes between men and women and not because of barriers to entry, then Title IX, which banned sex discrimination in graduate admissions, would have little impact on the gender disparity in graduate fields of study.¹⁹ I test this hypothesis in Sections 4 and 5.

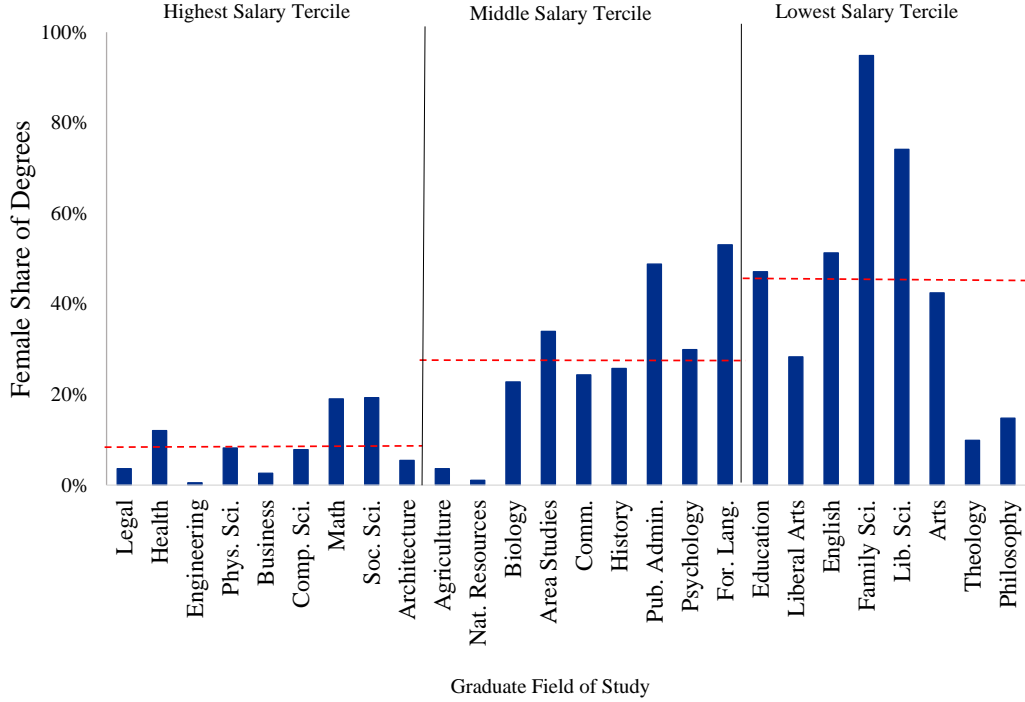
¹⁶These statistics are for the academic year 1965-66 and are from the Higher Education General Information Survey (HEGIS) 1965 Earned Degrees data.

¹⁷The number of conferred graduate degrees was 190,507. These statistics are from the 1965 Current Population Survey.

¹⁸Fields of study were categorized into terciles based on its median salary between 1962 and 1991. See Table A1 for the list of fields in each salary tercile.

¹⁹A key assumption is that any changes in female preferences for high-school subjects or college majors or in female career aspirations were gradual changes and did not change suddenly between 1972 and 1973. An examination of the data confirms

Figure 1: Female Share of Graduate Degrees in 1965



Source: HEGIS 1965 Earned Degrees data.

Notes: N = 30,174. This figure depicts the female share of graduate degrees conferred in academic year 1965-66, separately by field of study. Fields are listed in decreasing order of median salary. Red, horizontal, dashed lines depict tertile averages, which are 8.7 percent (high), 27 percent (middle), and 45.4 percent (low).

4 Did Title IX Affect Female Graduate Enrollment?

This section examines whether universities complied with Title IX. First, I examine whether female graduate enrollment changed discontinuously after Title IX's passage. Then, I examine whether universities with a higher federal-funds share differentially increased their female enrollment. As the punishment for non-compliance is termination of federal funds, we may expect to see a greater reaction by institutions that receive more federal funds relative to institutions that rely less on federal money.

To examine whether female graduate enrollment changed discontinuously after Title IX's passage, I estimate the following regression model:

$$F_{it} = \beta_0 + \sum_{s=1969, s \neq 1971}^{1980} \tau_s \cdot \mathbb{1}\{t = s\} + X' \gamma + \beta_1 total_{it} + \varepsilon_{it} \quad (1)$$

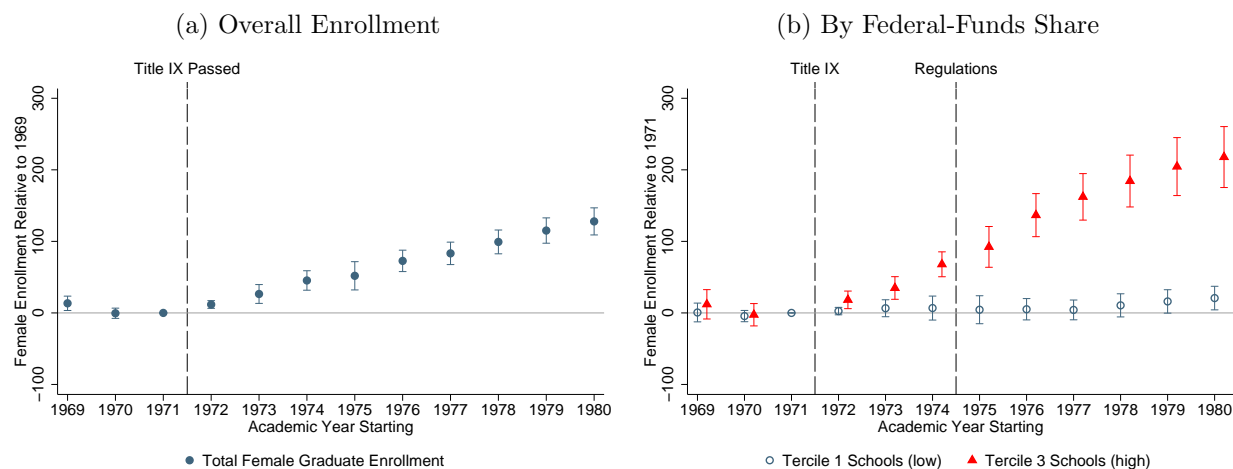
this assumption. Results are in the Online Appendix at <https://goo.gl/h4MEaw>.

where F_{it} is school i 's female graduate enrollment in academic year starting t and X is a vector of school fixed effects and state fixed effects. I also include the school's total graduate enrollment in each year ($total_{it}$) to the extent that school size may be correlated with female admissions, and thus enrollment. The parameters of interest are τ_s , which tell us the average annual increase in female enrollment relative to 1971. Standard errors are clustered by state.

Panel A of Figure 2 graphs the values of τ_s between Fall 1969 and Fall 1980 for all 820 graduate schools. The vertical dashed line depicts when Title IX was signed into law (June 1972). At the earliest, Title IX's passage would affect Fall 1972 applicants looking to enroll in Fall 1973. Average graduate female enrollment at a university increased by 26 students in Fall 1973, relative to Fall 1971 enrollment.²⁰ Female graduate enrollment at an average university in Fall 1971 is 415, so this estimate represents an effect size of 6 percent. Importantly, female enrollment continued to increase steadily throughout the 1970s.

A look at total graduate enrollment finds that enrollment increased over time, suggesting that schools increased class sizes rather than giving men's places to women. Mean graduate enrollment increased by 200 students between Fall 1972 and Fall 1973, whereas median graduate enrollment increased by 120 students. The increase between 1972 and 1973 is the largest annual change between 1969 and 1980. Additionally, the change appears to be driven by larger schools.

Figure 2: Change in Female Graduate Enrollment



Source: HEGIS 1969-1980 Fall Enrollment data and 1968-1971 Financial Statistics data.

Notes: $N = 9,696$. Vertical dashed lines indicate when Title IX and its compliance regulations were signed into law (June 1972 and May 1975, respectively). In Panel A, dots depict each year's change in female enrollment relative to 1971. Panel B depicts each year's difference in female enrollment between Tercile 3 (high share) schools and Tercile 1 (low share) female enrollment, relative to Tercile 1 schools' average enrollment in 1971. Terciles are based on the average share between 1968 and 1971 of a school's revenue that comes from the federal government. For both panels, estimates control for school and state fixed effects and school's total enrollment by year. Standard errors are clustered by state, and wings are 95% confidence intervals.

Next, I examine female graduate enrollment trends by the university's funding source. Specifically, I test

²⁰There is a positive increase in Fall 1972 enrollment as well, but this increase is small—about 12 students.

whether schools with a larger federal-funds share are also more likely to experience greater female enrollment. The argument is that these schools face harsher penalties for non-compliance relative to schools that rely less on federal funds, and so have a greater incentive to reduce barriers to entry for women. The regression model is as follows:

$$\begin{aligned}
F_{it} = & \beta_0 + \beta_1 Mid_i + \beta_2 High_i + \sum_{\substack{s=1969, \\ s \neq 1971}}^{1980} \mathbb{1}\{t = s\} + \sum_{\substack{s=1969, \\ s \neq 1971}}^{1980} \tau_s^L \cdot (\mathbb{1}\{t = s\} \times Low_i) \\
& + \sum_{\substack{s=1969, \\ s \neq 1971}}^{1980} \tau_s^M \cdot (\mathbb{1}\{t = s\} \times Mid_i) + \sum_{\substack{s=1969, \\ s \neq 1971}}^{1980} \tau_s^H \cdot (\mathbb{1}\{t = s\} \times High_i) + \beta_3 total_{it} + X'\gamma + \varepsilon_{it}
\end{aligned} \tag{2}$$

where F_{it} is school i 's female graduate enrollment in academic year starting t , X is a vector of school and state fixed effects, $total_{it}$ is school i 's total graduate enrollment in year t , and Mid_i and $High_i$ are indicator variables for whether school i is in Tercile 2 (“*Mid*”) or in Tercile 3 (“*High*”) according to its federal-funds share. The reference group is Tercile 1 (“*Low*”) schools in 1971. Standard errors are clustered by state.

The parameters of interest are τ_s^H , the coefficients on the year dummies for most federally dependent (Tercile 3) schools. These tell us how female enrollment at an average Tercile 3 school changed annually relative to an average Tercile 1 school's female enrollment in 1971. These estimates and their corresponding 95% confidence intervals are graphed in Panel B of Figure 2.

Vertical dashed lines indicate when Title IX and its compliance regulations were signed into law (July 1972 and May 1975, respectively). Prior to Title IX, female graduate enrollment in Tercile 3 schools and Tercile 1 schools are similar. In Fall 1972, female enrollment at Tercile 3 schools increases by an average of 18 students. Enrollment nearly doubles the following fall (35 additional women relative to an average Tercile 1 school) and grows to an additional 137 students in Fall 1976, after compliance regulations are in effect. To be clear, these estimates are school-level increases in female enrollment. The average number of graduate women in a Tercile 3 school was 642 in 1971. An increase of 137 female students, therefore, represents an effect size of 21 percent.

In contrast, female enrollment at Tercile 1 schools is relatively stable throughout this time period and not statistically significant until Fall 1979. Female graduate enrollment at Tercile 2 schools (not pictured) follows the same pattern as Tercile 3 schools but at smaller magnitudes.

The observed increase in female graduate enrollment immediately following Title IX's passage is consistent with testimony from the 1975 Congressional Hearings on Title IX regulations. For example, Nellie M. Varner, spokesperson for the National Association of State Universities and Land-Grant Colleges, the American

Council on Education, and the Association of American Universities, said that “many institutions [had] already begun to respond to the spirit of Title IX” (Sex Discrimination Regulations, 1975, p. 416).²¹ This is not surprising as the initial bill in 1972 stated that the penalty for non-compliance would be termination of federal funds. Compliance regulations later clarified the process through which compliance would be determined and enforced. Therefore, it is not surprising to see federally-dependent schools increase their enrollment beginning in fall 1972. As an example, the University of Michigan asked its schools and colleges to review their recruitment, admissions, and financial aid policies “in light of the proposed Title IX regulations” (Sex Discrimination Regulations, 1975, p. 416). Michigan is a Tercile-3 school.

5 Did Title IX Reduce Gender Disparity in Graduate Education?

In the previous section, I presented evidence of a discontinuous increase in female enrollment in graduate programs following Title IX’s passage. Further, there was a larger increase among more federally dependent schools, which is consistent with the theory that Title IX reduced barriers to entry, rather than a change in female preferences. In this section, I examine whether Title IX reduced gender disparity in graduate education. I first present a distributional analysis, which examines how the distributions of fields of study between men and women converged after Title IX’s passage. Then, I conduct a difference-in-differences analysis to estimate how the likelihood of pursuing a traditionally male graduate degree changed for women relative to men after Title IX’s passage. For both analyses, I focus on non-doctorate, non-health professional²² graduate degrees. This is for two reasons. First, as I am examining earned degrees instead of enrollment, this simplifies the analysis by considering programs of similar length (2-3 years of study). Second, this avoids problems raised by the Vietnam War draft, which allowed men pursuing health professional degrees to defer the draft.²³

5.1 Distributional Analysis

Convergence Methods

I use two different methods to measure gender convergence. The first is the Segregation Index, also known as the Index of Dissimilarity, developed by Duncan and Duncan (1955). The segregation index is used to measure change in the distribution of an unordered, categorical variable and has been used in a variety of applications, from measuring racial segregation in neighborhoods (Massey and Denton, 1988) to

²¹This statement was made by Nellie M. Varner at the June 1975 Congressional Hearings before the Subcommittee on Postsecondary Education. The purpose of these Hearings was to review Title IX regulations and hear any contestations. The main opposition was on Title IX’s coverage of athletic programs (Sex Discrimination Regulations, 1975, pp. 69, 285, 385).

²²Health professional degrees are graduate degrees in medicine, dentistry, veterinary medicine, osteopathy, and optometry.

²³See Section 6.1 for more information.

gender segregation in occupations (Blau, Brummund, and Liu, 2013). It is calculated as follows:

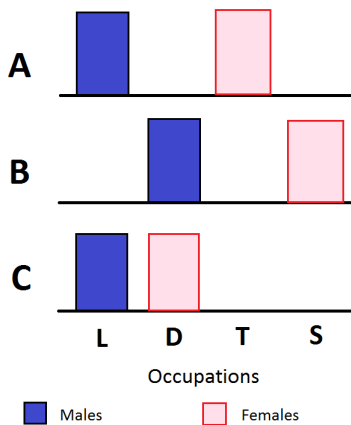
$$S_t = (0.5) \cdot \sum_i |m_{it} - f_{it}| \quad (3)$$

where m_{it} is the share of all male graduate students in degree-field i in year t and f_{it} is the share of all female graduate students in field i in year t . This measure indicates the percentage of women (or men) who would have to change graduate fields for the overall distributions of men and women to be identical. For example, if the share of women in all fields is the same as their share of total graduate degrees, then the segregation index is 0. Therefore, larger values indicate greater segregation (divergence) and smaller values indicate greater integration (convergence).

As is clear from the formula, the segregation index does not consider the ordering of the fields of study. For example, a segregation index of 30 means that 30 percent of women need to change their degree-field but there is little constraint on specifically which field these women move to or where they moved from. In some cases, however, this is an important detail. I illustrate this point with a simple example below.

Say we would like to measure gender segregation in the occupation distribution. For simplicity, assume there are four occupation categories: L, D, T, and S. Figure 3 presents three different examples of occupation distributions by gender: A, B, and C. The segregation index for all three scenarios is equal to 100 ($= 0.5 \cdot (|100 - 0| + |0 - 100|)$). According to the segregation index, these three distributions have the same level of gender segregation.

Figure 3: Convergence Measure Example



Let us add some structure and assume that L is Lawyers, D is Doctors, T is Teachers, and S is Secretaries. Lawyers and Doctors are highly-paid occupations while Teachers and Secretaries are lower-paid. Now it

matters which occupations men and women are segregated into, and it is less clear that segregation is the same for these three distributions. Distributions A and B seem similar in that men are in high-paid occupations and women in low-paid occupations. In contrast distribution C is different, with both men and women in high-paid occupations (men are lawyers and women are doctors); somehow distribution C is less unequal or segregated than A or B because in C men and women are in similarly paid occupations.

The distinction between A and B on the one hand and C on the other arises because, when assessing the level of gender segregation, we inherently assign values to occupations. The value induces an ordering and distance (metric) for the occupations, and how *far* we move matters. Figure 3 is drawn to reflect this ordering, with the occupations ordered along the x-axis according to wage: Doctors earn more than Lawyers, Lawyers more than Teachers, and Teachers more than Secretaries. The ordering in Figure 3 has meaning.

Consider again distributions A and B versus C. Distribution A is a society where all women are teachers and all men are lawyers. Lawyers and teachers are far apart, as measured by wage. For distribution B, men and women are also far apart. Distribution C, however, represents a world where men and women are closer. This is the sense in which distributions A and B are more segregated or divergent than distribution C; if we want to move men and women to be in the same occupation, for distribution C we do not have to move people very far (in terms of wages). To relate this to the segregation index, for gender inequality we care about *where* we move that 30 percent of women relative to where they came from. A woman moving from a low-wage, female-dominated occupation to a high-wage, male-dominated occupation would indicate more convergence (decreasing segregation) compared to moving her to a low-wage, male-dominated occupation.

The Earth Mover’s Distance is a metric that incorporates the idea that we care about the distance moved. It measures the difference between two distributions by asking how we move one distribution (the women) to the other distribution (the men) and keeping track of *how far* the women have to be moved. In other words, the EMD is the minimal cost that must be paid to transform one distribution into the other. For example, say we have a male distribution of K graduate fields, $M = [m_1, \dots, m_i, \dots, m_K]$, and a female distribution of K graduate fields, $W = [w_1, \dots, w_i, \dots, w_K]$. To transform distribution M to distribution W , the EMD is defined as follows:

$$\text{EMD}(M, W) = \frac{\sum_{i=1}^K \sum_{j=1}^K d_{ij} f_{ij}}{\sum_{i=1}^K \sum_{j=1}^K f_{ij}} \quad (4)$$

where i, j denote graduate-field category for distributions M and W , respectively, d_{ij} is the distance between graduate-field categories m_i and w_j , and f_{ij} is the total number of people who are being moved between m_i and w_j .²⁴

EMD measures where and how far probability mass must be moved when transforming the female into

²⁴Appendix A describes EMD in more detail.

the male distribution, and so the ordering of categories is non-trivial. In my application, I order graduate fields by expected salary. I define a field’s expected salary as the median salary for everyone who obtained a graduate degree in that field between 1962 and 1991.²⁵ Because EMD considers categories that are further away from each other to have a higher “moving cost”, the ordering by expected salary is a logical one. One issue with using salary is that there are substantial within-occupation income differences between men and women. Further, there may be non-pecuniary benefits a person may consider when valuing a specific occupation. To mitigate this problem, I use a rank ordering and define the distance between fields as one-unit of Euclidean distance rather than using the difference in expected salary as the distance measure.

Results

Figure 4 provides graphical evidence of gender convergence in graduate-field distributions after Title IX’s passage. I use NSCG data, and degree year is aggregated into 2-year cells to reduce recall bias.²⁶ The analogous figure using HEGIS Earned Degrees data is in Figure A2.²⁷ Panel A plots the segregation index between men and women from 1960 to 1986. In academic years 1960-61 and 1961-62, the segregation index is 48.3 percent. This means that almost half of the women with graduate degrees would need to change their field of study in order to have the same overall graduate-field distribution as men. The level of gender segregation in graduate fields of study remains relatively stable, hovering in the low-to-mid 50s, until it drops suddenly to 42.7 percent with degrees earned in spring 1975 and spring 1976. This timing is consistent with the June 1972 passage of Title IX. After Title IX, women would apply in fall 1972 to enroll in two-year master’s programs in fall 1973 and graduate in spring 1975. The solid lines are fitted linear trends aligned to these relevant years. I estimate the increased convergence between male and female distributions to be about 6.1 percentage-points. As the segregation index was 48.8 percent in spring 1973/spring 1974, this equates to a 12.5 percent reduction in gender disparity in graduate fields of study.

One important consideration is how increased entry of women into graduate programs affects the distributional convergence measure. This is important as more women may be more likely to attend graduate school during this time, irrespective of Title IX and just due to gradually changing forces. To answer this question, I decompose the segregation index to see whether distributional convergence occurred because of a change in sex composition within degree fields (“sex-composition effect”) or because of a change in relative

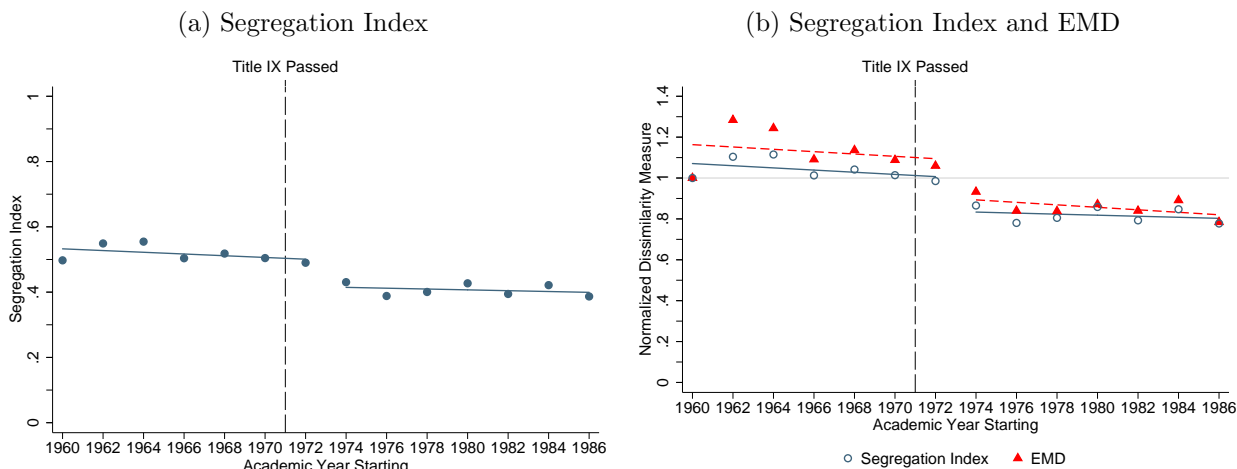
²⁵I use both male and female salary in order to capture a field’s ranking in the hypothetical case that men and women are paid the same salary within the same occupation. I conduct a robustness check using the median salary of women, and my results are similar.

²⁶See Section 3 for more information.

²⁷The HEGIS Earned Degrees data begin in academic year 1965-66 and follow a similar pattern as the NSCG results in that both the segregation index and EMD are pretty stable until academic year 1972-73. Then both measures drop by around 3 percentage-points and steadily decline until the end of the sample period. The initial drop is smaller than the one estimated using NSCG data; one possible reason is that the HEGIS data consist of schools that appeared in all 16 years of earned degrees data whereas the NSCG data are the universe of all college graduates.

sizes of segregated and integrated fields (“graduate field mix effect”).²⁸ An example of a sex-composition effect is when women predominantly enter male-dominated fields or vice versa. An example of a field mix effect is a secular decline in male-dominated graduate fields of study. This would result in greater distributional integration even if the within-field segregation (sex composition) remained unchanged. Under the assumption that new women entering graduate programs entered traditionally female programs rather than traditionally male programs, we can equate the field mix effect to one where there was a universal increase in female graduate students. I find that nearly 74 percent of the -6.1 percentage-point change between 1972 and 1974 is due to changes in sex composition within occupations with the remaining 26 percent due to changes in the field mix.

Figure 4: Female-Male Convergence in Graduate-Field Distributions



Source: NSCG 1993 data.

Notes: $N = 20,590$. Dots depict the segregation index between female and male distributions of graduate field of study over time (panel a) and dissimilarity measures indexed to 1960, separately for Segregation Index and EMD (panel b). The vertical dashed line indicates when Title IX was signed into law (June 1972). Lines are linear fits of earned degrees not affected by (before) and affected by (after) Title IX’s passage. Year of degree encompasses two-year cells.

Panel B of Figure 4 compares distributional change as measured by the segregation index and EMD. Both convergence measures are indexed to their respective 1960 values, and show the same general picture. There is a discontinuous break starting with degrees earned in spring 1975 and spring 1976. Both measures estimate that distributional convergence increased around 12 percentage-points after Title IX’s passage, relative to its 1972 value. The lines are fitted linear trends for years before and after the new law. They highlight that EMD estimates greater segregation (relative to 1960) compared to the segregation index in the years before Title IX’s passage. After Title IX, segregation appears to have lessened as the distance between the two convergence measures has decreased. This implies that the increased convergence is because women moved

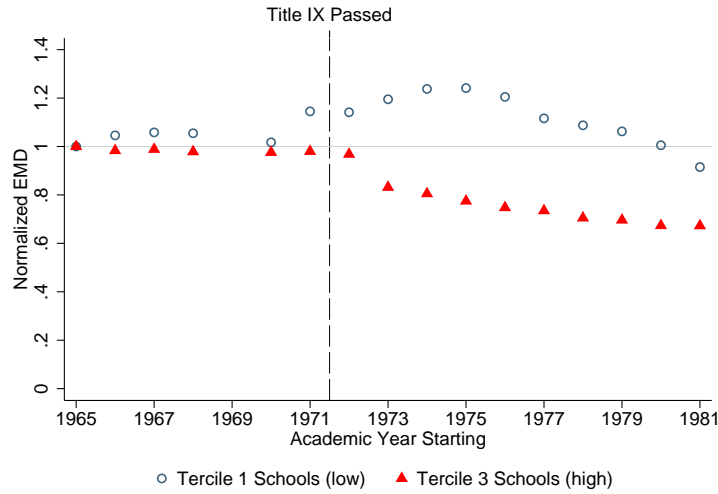
²⁸This decomposition formula is taken from Blau, Brummond, and Liu (2013).

into more lucrative, male-dominated fields.

One observation about the graph in Panel B is the inflated index numbers in the early 1960s. This is true for both convergence measures, but the EMD index increased a lot more relative to the segregation index in the early 1960s (28 percentage-points vs. 14 percentage-points). That both measures increased indicates that men were pursuing different fields of study than women during this time. Because of how EMD is calculated, a larger relative increase in the EMD index indicates that these different degree fields were further apart in their salary rankings. That is, not only were men pursuing different degree-fields than women, but these fields were also more lucrative. By the late 1960s, the indices drop back down close to their 1960 levels. One potential explanation for this pattern is the draft deferment policy during the Vietnam War. I discuss this in more detail in Section 6.1.

Next, I examine whether fields of study between men and women converged more in federally dependent schools, or schools with a federal-funds share in the highest (third) tercile, relative to federally independent schools, or schools with a federal-funds share in the lowest (first) tercile. I calculate EMD separately for the two groups and plot normalized values in Figure 5.

Figure 5: Distributional Change by Federal Funds Share



Source: HEGIS 1965-1981 Earned Degrees data and 1968-1971 Financial Statistics data.

Notes: $N = 116,294$. Dots depict EMD values between female and male distributions of graduate field of study indexed to 1960, separately for more federally dependent schools (Tercile 1) and less federally dependent schools (Tercile 3). Terciles are based on the average share between 1968 and 1971 of a school's revenue that comes from the federal government. The vertical dashed line indicates when Title IX was signed into law (June 1972).

Before Title IX (AY1972), the degree-field distributions of men and women pursuing non-doctorate, non-health professional graduate degrees do not vary much from year to year. Then starting with degrees earned

in spring 1974, there is an increase in convergence by 13.7 percentage-points for students at more federally dependent schools (Tercile 3). Gender convergence increases by an additional 6.7 percentage-points in spring 1976 and 11 percentage-points in spring 1977. These are both about two years after which we saw increases in female enrollment after Title IX and its regulations were signed into law (see Figure 2). In contrast, distributions in federally independent schools (Tercile 1) *diverged* over this time period.

5.2 Difference-in-differences Analysis

The previous section focused on a distributional analysis of gender disparity, wherein I estimated the convergence of degree-field distributions between men and women over time. This section uses another identification strategy to answer whether Title IX reduced gender disparity in graduate education. It asks, “Amongst all graduate-degree holders, what is the likelihood of a woman pursuing a traditionally male-dominated field of study, relative to a man?” Again, I focus on non-doctorate, non-health professional graduate degrees.

I estimate a difference-in-differences regression model, comparing the female-male difference in conferred degrees each year. Because the DID methodology compares female degrees to male degrees, I restrict my analysis sample to whites to avoid the mechanical relationship between female share of degrees and male share of degrees. For example, if the number of female students in a cohort of a fixed size increases by two, then the number of male students automatically decreases by two. Focusing on whites allows the female and male shares to vary independently; a increase in white female students by two does not automatically translate to a decrease in white male students by two.

The ability to cut by race is one reason I use NSCG data for this analysis. HEGIS data do not distinguish by race until academic year 1976-77. Another reason I use NSCG data for this analysis is because it allows me to estimate the conditional likelihood of a graduate degree in a particular field. This is not possible with HEGIS data, which are administrative data and do not contain any information about the student.

The sample consists of all white graduate-degree holders, and degree year is aggregated into 2-year cells to reduce measurement error from recall bias.²⁹ The following regression model is estimated separately for male-dominated fields (Tercile 1) and female-dominated fields (Tercile 3):

$$Y_{ict} = \beta_0 + \beta_1 \cdot F_i + \sum_{\substack{s=1960, \\ \neq 1970}}^{1986} \tau_s^M \cdot \mathbb{1}\{t = s\} + \sum_{\substack{s=1960, \\ \neq 1970}}^{1986} \tau_s^F \cdot (F_i \times \mathbb{1}\{t = s\}) + X' \gamma + \varepsilon_{ict} \quad (5)$$

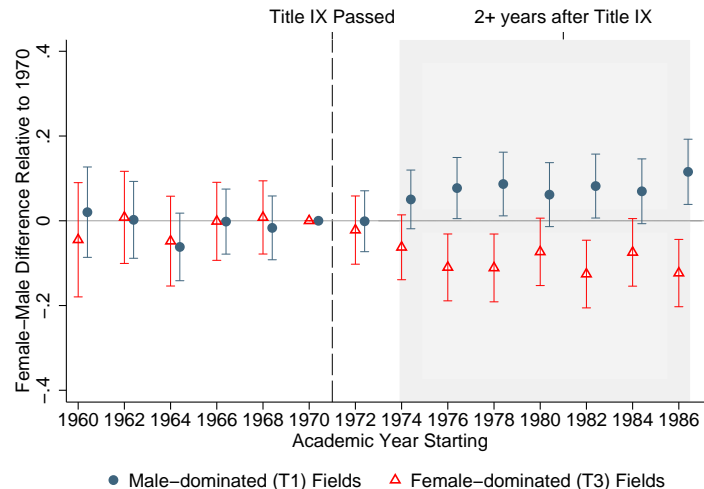
where $Y_{ict} = 1$ if individual i obtained a graduate degree in tercile c in year t and 0 otherwise, F_i is a female

²⁹See Section 3.

dummy, and X is a vector of controls including school region, birth year, and number of college graduates in each year. Terciles are based on the degree field's female share of degrees between 1960 and 1971.³⁰ Standard errors are clustered by school region.

The parameters τ_s^M depict a time trend for males relative to 1970 (the reference group). The parameters of interest are τ_s^F , which tell us how the female-male difference in graduate degrees in tercile c changes annually relative to the reference group. These estimates are reported in Figure 6.

Figure 6: Gender Difference in Non-Doctorate, Non-Health Professional Graduate Degrees



Source: NSCG 1993 data.

Notes: $N = 17,107$. The sample is restricted to whites who obtained a graduate degree before age 35 between 1960 and 1977. Dots depict the female-male difference in degrees in each year, separately for degrees in male-dominated fields of study and in female-dominated fields of study. Fields of study are categorized by their mean share of females between 1960 and 1971. Estimates control for birth year, school region, and the number of college graduates each year. Robust standard errors are reported in parentheses, and wings depict 95% confidence intervals. The vertical dashed line depicts when Title IX was passed (June 1972). The gray shaded area depicts years at least two academic years after Title IX's passage.

The female-male difference in graduate degrees is not statistically significantly different from zero until four years after Title IX's passage. This is true for both male-dominated and female-dominated degree fields. Starting in spring 1975 and spring 1976, women are 5 percentage-points more likely to earn a graduate degree in a male-dominated field relative to men in spring 1970 and spring 1971. This timing is consistent with what we would expect for two-year master's degrees, and with the increase in female graduate enrollment observed in Section 4. Further, the gender gap increases to 7.7 percentage-points for degrees earned in spring 1977 and spring 1978, and to 8.7 percentage-points for degrees earned in spring 1979 and spring 1980. These larger increases in female earned degrees are consistent with the increase in female enrollment after Title IX's regulations were signed in 1975. For female-dominated degrees, the gender gap decreases by 6.3

³⁰Appendix Table A2 lists the fields that are in these three groups.

percentage-points in spring 1975 and spring 1976, and by 11 percentage-points in spring 1977 and spring 1978.

To provide a sense of the effect size, nearly 7 percent of female graduate students earned a non-doctorate, non-health professional graduate degree in a traditionally male field in spring 1971 and spring 1972. My estimate of 5 percentage points, therefore, represents an effect size of 72.5 percent. Conversely, my estimate of 6.3 percentage-points is an effect size of nearly 8 percent, as 81 percent of female graduate students earned a traditionally female degree in spring 1971 and spring 1972.

The identifying assumption for DID is that the treatment group (white women) and the comparison group (white men) were exhibiting similar trends in the outcome variable (traditionally male field or traditionally female field) prior to the treatment (Title IX’s passage in 1972). This parallel trends assumption allows me to obtain counterfactual estimates of the treatment group’s outcome in the absence of treatment. For the purposes of this study, this means that the female share of graduate degrees should be on a similar trend as male graduate degrees before Title IX’s passage. Pre-treatment leads in Figure 6 show that female-male differences are zero or very close to zero and not statistically significant.³¹

To provide a sense of the fields that are driving this result, I estimate equation (5) separately by degree field. The estimates for τ_{1974}^F are graphed in Figure A3. Amongst traditionally male fields, women disproportionately entered Legal, Computer Science, and Engineering fields relative to men. For traditionally female fields, Education and Library Science saw declines in female degrees, while Health³² experienced an increase, relative to men.

This analysis also provides an indirect test for the presence of gender discrimination in graduate education. One alternative explanation for low female representation in male-dominated fields would be that female preferences differ from male preferences. That is, there may be few females in law or engineering because males differentially prefer these fields. If this were true, a removal of barriers-to-entry would have no effect on female share in these fields. That is, even if JD admissions quotas for women were removed, we would still see few women in law school, relative to men, because women have a distaste for law. Contrary to this hypothesis, I find that traditionally male-dominated fields experienced greater female growth after Title IX. I discuss additional alternative explanations in the next section.

³¹Although pre-treatment leads are not the same as parallel trends, they are a necessary condition for the validity of a difference-in-differences strategy.

³²These degrees are graduate degrees in health outside of “health professional degrees”, which are graduate degrees in medicine, dentistry, veterinary medicine, osteopathy, or optometry. Examples of these degrees are graduate degrees in Nursing, Occupational and Physical Therapy, Dental Hygiene, and Public Health.

6 Alternative Explanations

This section explores other changes occurring between the late 1960s and early 1970s that may also have affected women’s educational decisions. The three main alternative explanations I consider are the end of the Vietnam War draft, state law changes related to pill access and abortion, and the Equal Employment Opportunity Act of 1972. My discussion of cohort-specific changes can be found in the Online Appendix.³³

6.1 Vietnam War and the End of Draft Deferments for Graduate School

U.S. military involvement in the Vietnam War began to escalate in the early 1960s, under President Kennedy, and escalated even further between 1963 and 1969 under President Johnson. There were 112,386 inductions in 1964, more than doubling to 230,991 the following year.³⁴ Given the high draft numbers during the Vietnam War, it may not be surprising to learn that the number of deferments was high.³⁵

Class II-S deferments allowed a male individual pursuing undergraduate or graduate studies to defer his induction. Those pursuing undergraduate studies were allowed to defer until they graduated or until they reached their 26th birthday, whichever came first (Selective Service Report 1966). Those pursuing a master’s degree were allowed to defer for one year, while those pursuing a Ph.D. or a professional degree were allowed to defer up to five years (Samuelson, 1967; Executive Order 11360). Deferments were granted as long as the student was enrolled full-time and remained in good standing.

On June 30, 1967, President Johnson signed Executive Order 11360, eliminating graduate school deferments except for those “satisfactorily pursuing a course of graduate study in medicine, dentistry, veterinary medicine, osteopathy or optometry, or in such other subjects necessary to the maintenance of the national health, safety, or interest as are identified by the Director of Selective Service upon the advice of the National Security Council.” Although mathematics, engineering, and natural sciences were included in initial discussions of exempted fields of study, they are excluded from the final list of graduate fields (Samuelson, 1967; Selective Service Report 1967; “New Draft Policy to Cut Graduate School Enrollment”, 1969). The July-December 1968 Semi-Annual Report of the Director of Selective Service specifies that Class II-S post-graduate deferments may be extended only to students pursuing medicine, dentistry, veterinary medicine, osteopathy, or optometry (hereafter referred to as “health professional degrees”).

The amendment to the Selective Service Regulations did not affect those who were in their second or subsequent year of graduate studies as of October 1, 1967. Those students were grandfathered into the

³³The Online Appendix can be found at <https://goo.gl/h4MEaw>.

³⁴Induction statistics are taken from the Selective Service System’s online records at <https://www.sss.gov/About/History-And-Records/lotter1>.

³⁵According to Selective Service System records, 1,857,304 men entered military service through the draft between August 1964 and February 1973. Statistics are taken from <https://www.sss.gov/About/History-And-Records/Induction-Statistics>.

original deferment policy. However, students who were accepted or enrolled in their first year of graduate study as of October 1, 1967 were only able to defer for one academic year.

As women were not eligible to be drafted, the Vietnam War did not affect female enrollment directly. However, the draft may have affected women indirectly through male enrollment. Although it is unknown exactly how many graduate students had enrolled on account of the draft deferment policy³⁶, as men comprised a majority of graduate students the new policy was expected to have a significant impact on enrollment. Therefore, the Vietnam War draft may have affected female graduate enrollment twice: first in 1968, with the end of graduate school deferments except for health professional degrees, and second in 1973, with the end of the draft.³⁷ The concern is that these events coincide with Title IX's passage, preventing me from disentangling the two effects.

A careful examination of the timing reveals that the Vietnam War draft does not contaminate my analysis of non-doctorate, non-health professional graduate degrees. For example, deferments for graduate study ended in 1968 (with the exception of health professional degrees) so we may expect to see an impact on two-year graduate degrees in spring 1970 at the earliest. This is before Title IX's passage. Therefore, the analysis in Section 5 is not contested by changes in the draft deferment policy.

In contrast, the timing presents a challenge for doctorates and health professional degrees. Due to the new draft policy, we may expect to see an impact on female doctoral degrees beginning with fall 1969 enrollment. However, the timing of earned degrees is complicated by the fact that time to degree differs significantly by field. For example, Physics PhDs take, on average, six years to complete while History takes ten. Students pursuing health professional degrees were not affected by the new draft deferment policy in 1968 since those degrees were still exempt from the draft. Instead, they were affected by the end of the draft altogether in January 1973. However, the close timing with Title IX's passage in June 1972 makes it difficult to parse the two impacts. These are the reasons I focus on non-doctorate, non-health professional graduate degrees in my analysis (Sections 4 and 5).

To provide a clearer picture of the potential impacts of the Vietnam War and Title IX, I examine medical school applications from academic year 1955-56 to academic year 1983-84 (see Table 1). Although data are missing between years 1956 and 1959, the Vietnam War and draft inductions began escalating in 1960 so we are still able to see any impacts the draft may have had on male applications.

First, we see that from the start of the Vietnam War in 1955 until its escalation in the early 1960s, male applications were stable. There is a large increase in male applications in Fall 1962 (an 11 percent increase from the previous academic year), which may have coincided with the escalation of the war under

³⁶The Selective Service reports do not distinguish between deferments for undergraduate study v. graduate study.

³⁷The Selective Service announced on January 27, 1973 that there would be no more draft calls. The last draft call had occurred on December 7, 1972.

Table 1: Applicants to Medical Schools by Sex and Year

Academic Year	Number of Applicants		Growth Rate	
	Male	Female	Male	Female
1955-56	13,935	1,002		
1960-61	13,353	1,044	-4%	4%
1961-62	13,215	1,166	-1%	12%
1962-63	14,646	1,201	11%	3%
1963-64	16,236	1,432	11%	19%
1964-65	17,437	1,731	7%	21%
1965-66	17,027	1,676	-2%	-3%
1966-67	16,554	1,696	-3%	1%
1967-68	16,773	1,951	1%	15%
1968-69	19,021	2,097	13%	7%
1969-70	22,176	2,289	17%	9%
1970-71	22,253	2,734	0%	19%
1971-72	25,435	3,737	14%	37%
1972-73	30,655	5,480	21%	47%
1973-74	33,304	7,202	9%	31%
1974-75	33,912	8,712	2%	21%
1975-76	32,515	9,575	-4%	10%
1976-77	31,911	10,244	-2%	7%
1977-78	30,374	10,195	-5%	0%
1978-79	27,075	9,561	-11%	-6%
1979-80	25,919	10,222	-4%	7%
1980-81	25,436	10,664	-2%	4%
1981-82	25,054	11,673	-2%	9%
1982-83	24,045	11,685	-4%	0%
1983-84	23,239	11,961	-3%	2%

Source: Cole (1986), Table 1.

President Kennedy.³⁸ My conjecture for why male applications stagnated between 1964 and 1967—when draft inductions drastically increased—is that men were applying to other graduate programs to defer the draft. Men in Ph.D. programs also were able to defer for five years, and studies have found an increase in male doctoral degrees during the Vietnam War (e.g., Singer, 1989; Chiswick, Larsen, and Pieper, 2010). This also explains why male applications for medical school spiked again in Fall 1968, after the new draft policy eliminated deferments for all graduate programs except health professional degrees. Further, we would expect that male numbers should drop starting in academic year 1973-74, immediately after the draft ended in January 1973. This is what we see. Between academic year 1968-69 and academic year 1972-73, the years under the new deferment policy, male applications grew by 61 percent. The following fall, male applications grew by only 9 percent. And thereafter, applications stagnated and even fell.

In contrast, female applications exhibited strong growth—double-digit growth rates—until well after the

³⁸The Vietnam War began in 1955 under President Nixon. Then Kennedy defeated Nixon in the 1960 Presidential elections.

draft ended. There is no reason that female *applications* would be affected by the draft, as opposed to female admissions and thus enrollments. However, it is plausible that Title IX may have affected female applications. It was well-known by female applicants at the time that they faced barriers in pursuing graduate programs, such as unofficial gender quotas (see Section 2). The public nature of the Title IX bill may have influenced women to apply to medical school and other traditionally male programs, under the assumption that these unfair practices would be corrected. Consistent with this theory, the largest increase in female medical school applications occurred in academic year 1972-73 (47 percent), the fall immediately following Title IX's passage, and continued to grow.

At the end of the day, it is difficult to draw definitive conclusions since we have limited data. But medical school applications data, at least, reveal that men appeared to be reacting to changing draft policies. Patterns in female applications, on the other hand, appear to be consistent with a “barriers to entry” story.

6.2 Fertility-Related Law Changes

In this section, I discuss various law changes regarding fertility control and their potential impact on female educational decisions. First, I consider changes in state laws that increased minors' access to the birth control pill. Then, I discuss the 1973 Supreme Court ruling *Roe v. Wade*, which legalized abortion.

Minors' increased access to the birth control pill

The introduction of *Enovid* in 1960 as an oral contraceptive was an important milestone in advancing female rights and civil liberties. It not only gave women sexual freedom, but it also lowered the cost of making long-term career investments. With greater certainty over the pregnancy consequences of sex, women no longer needed to worry about an unintended pregnancy interrupting their education or career.³⁹ When *Enovid* became publicly available, it was first available only to married women or to those above the age of majority. In other words, an unmarried woman above the age of majority (i.e., a woman older than 21 in most states) was legally able to obtain the pill. During the late 1960s, several states lowered their age of majority thereby granting a large set of single college-aged women access to the pill.⁴⁰ Aside from changes in the age of majority, there were other legal ways that unmarried minors could obtain the pill. Under common law, informed consent is necessary for a physician to provide medical services (including contraception), and minors are generally considered incapable of providing informed consent. One legal way around this issue is state-specific medical consent statutes that give minors the ability to consent to medical care. Another

³⁹For example, Hock (2007) finds that pill access increased college attainment for women. Goldin and Katz (2002) find evidence that pill availability lowered the costs of long-duration professional education for women.

⁴⁰These legal changes came about mainly in response to the discrepancy in minor's rights highlighted by the ongoing Vietnam War. In particular, 18-year old men were being drafted but were not allowed to vote until they were 21 (Paul, Pilpel, and Wechsler, 1974).

legal way around this issue is if the state has judicial or legislative recognition of a mature minor doctrine, which allowed a minor to consent to medical care if “she is judged capable of understanding the nature and potential consequences of treatment” (Myers, 2016).

One concern is that changes in state laws, doctrines, and medical consent statutes resulted in sudden increased legal access to the pill for college-aged women, which may have influenced their educational decisions. Although states changed their laws in different years, in half of all U.S. states, 18 year olds gained legal access to the pill between 1971 and 1972 (Myers, 2016). Therefore, the observed discontinuity in graduate-field convergence may have been driven by increased access to the pill due to state-law changes rather than Title IX.

There are two reasons that I do not believe increased pill access among 18-20 year old women is driving my results. The first is that these state-law changes did not affect the cohorts of interest. Considering that the law was signed in June 1972, the earliest we would expect to see an impact is on Fall 1972 applications. The youngest applicants would either be a rising senior in college or a recent college graduate.⁴¹ These relate to students born in 1950 or 1951, who were already at the age of majority when most of these state laws changed ((see Table 2). This means they already had access to the pill. In fact, female students were able to obtain the pill on campus prior to these law changes: a 1970 study that surveyed prescription and dispensing practices of contraception on college campuses found that 63 percent of college physicians prescribed hormonal contraceptive medications and 77 percent of colleges that did so prescribed them to unmarried women (Barbato, 1970).

The second reason I do not think increased pill access is a major confounder is that I find differential effects by the field’s gender parity (see Figure 6). As the pill lowered the cost of making long-term career investments, pill access may have influenced a young woman’s decision to pursue a doctoral degree or a medical degree, both of which require a long training period. But conditional on the type of degree, it is hard to imagine how pill access would have a differential effect by field-of-study. For example, after Title IX, female M.A. degrees in engineering grew at a faster rate than female M.A. degrees in education. It is unclear why pill access would affect a woman’s decision to pursue an engineering degree rather than an education degree. This result would not necessarily be predicted by a “pill access” story, but is consistent with a “barriers-to-entry” story.

As a robustness check, I attempt to disentangle the impact of pill access from Title IX by focusing on individuals who had pill access when they began college. As the 1950 and 1951 birth cohorts are the populations of interest, I restrict the NSCG data to graduate-degree holders born in states that passed laws

⁴¹Although it is certainly possible for women to take time off in-between graduate and undergraduate studies, highlighting the age of the youngest possible applicants is helpful when examining this alternative explanation.

Table 2: Example Schooling Histories by Birth Cohort

		Person born in 1950		Person born in 1951	
Year	Term	Age	Schooling History	Age	Schooling History
1968	Fall	18	Start BA	17	
1969	Fall	19		18	Start BA
1970	Fall	20		19	
1971	Fall	21		20	
1972	Spr	22	Graduate BA	21	
	Fall		Apply to grad school		Apply to grad school
1973	Spr	23		22	Graduate BA
	Fall		Start MA		Start MA
1974	Spr	24		23	
	Fall				
1975	Spr	25	Graduate MA	24	Graduate MA
	Fall				

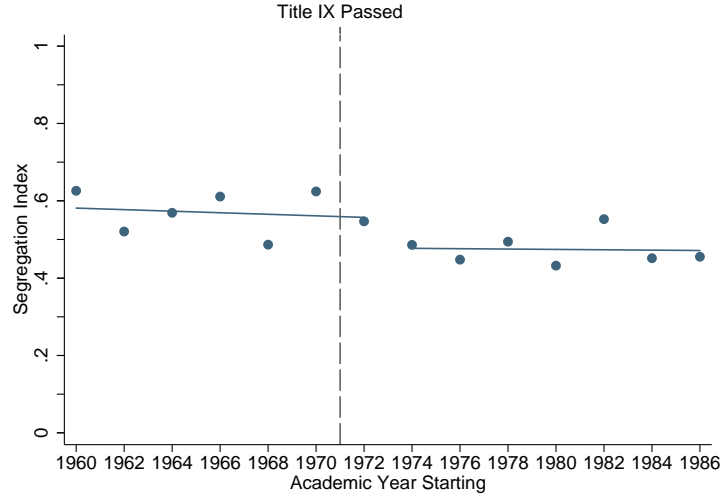
allowing 19 year olds to obtain the pill before 1967.⁴² These states are: Alaska, Arkansas, Idaho, Illinois, Kentucky, Mississippi, Montana, Nevada, North Dakota, Ohio, Oklahoma, and Utah. As before, I focus on non-doctorate, non-health professional graduate degrees conferred between spring 1961 and spring 1987 and plot the segregation index in Figure 7. Consistent with the main results, a discontinuity appears with degrees earned two to three years after Title IX’s passage, even in states where young college-aged women had access to the pill. This supports the argument that pill access is not driving my finding.

Related to this alternative explanation is the 1972 U.S. Supreme Court ruling *Eisenstadt v. Baird*, which granted unmarried persons legal access to the pill. *Eisenstadt v. Baird* was a challenge of a specific state law (Massachusetts) that prohibited the sale of contraceptives to unmarried people (Eisenstadt v. Baird, 1972).⁴³ I do not believe that this Supreme Court ruling is driving my results because: (1) this court case was a challenge to one specific state’s law, and many other states were already allowing unmarried women to obtain the pill legally; and (2) the ruling would not have affected my birth cohorts of interest, as discussed above.

⁴²To the extent that students may attend college out-of-state, this analysis does not fully control against pill access. However, the percentage of students that attend college in-state is pretty high. For example, in Fall 1992 more than 80 percent of new undergraduate students attended college in their home state. This statistic is from the National Center for Educational Statistics and retrieved from <https://nces.ed.gov/programs/digest/d95/dtab197.asp>.

⁴³After the 1965 Supreme Court ruling in *Griswold v. Connecticut* established the right of married persons to use birth control without governmental inference, many states repealed or substantially liberalized their anti-contraception laws. Massachusetts, on the other hand, amended its Comstock law to prohibit the sale of contraceptives to unmarried people (Myers, 2016). This is the law that was challenged and struck down in *Eisenstadt v. Baird*.

Figure 7: Gender Convergence in States with Teen Pill Access before 1967



Source: NSCG 1993 data; Myers (2017), Appendix Table A-1.

Notes: $N = 3,777$. This figure graphs the segregation index between female and male graduate-field distributions among individuals born in states that passed laws granting 19 year olds pill access in 1967 or earlier (Alaska, Arkansas, Idaho, Illinois, Kentucky, Mississippi, Montana, Nevada, North Dakota, Ohio, Oklahoma, and Utah). Lines are linear fits of earned degrees not affected by (before) and affected by (after) Title IX's passage. Year of degree encompasses two-year cells.

Abortion Legalization with *Roe v. Wade* (1973)

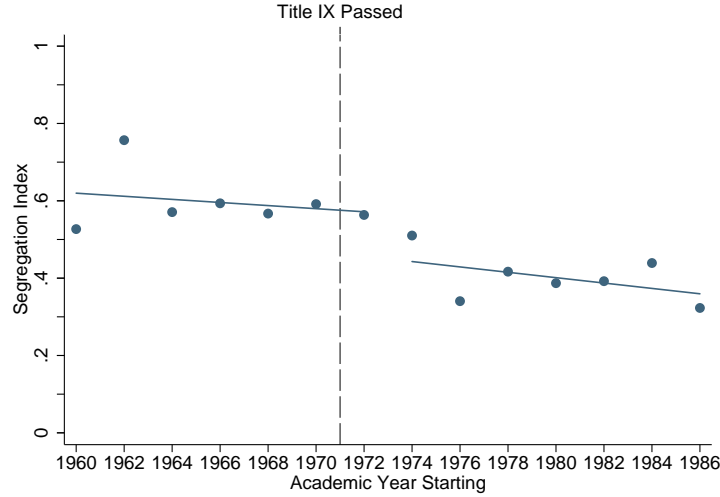
The second fertility-related alternative explanation I consider is the 1973 landmark U.S. Supreme Court case *Roe v. Wade* that legalized abortion. Just as the birth control pill lowered the cost of long-term investments for women, abortions gave women more choice and control over their lives. Similar to my analysis on pill access, I estimate gender convergence in the five Repeal States that legalized abortion in 1970. These states are Alaska, California, Hawaii, New York, and Washington.⁴⁴ Figure 8 plots the segregation index between men and women. There is more gender convergence in the distribution of degrees earned in spring 1974 and spring 1975 relative to previous years, but a larger change occurs with degrees earned subsequently. Further, female and male degree distributions appear to be converging at a faster pace in these Repeal states relative to the rest of the country. This may be due to the large number of schools in California and New York and may also reflect the progressive environment of these states.

6.3 Equal Employment Opportunity Act of 1972

This section explores the possibility that the Equal Employment Opportunity Act of 1972 (EEOA) affected women's educational choices. Although anti-discrimination laws in the labor market existed since

⁴⁴California legalized abortion in 1971.

Figure 8: Gender Convergence in States that Legalized Abortion in 1970/1971



Source: NSCG 1993 data.

Notes: $N = 4,813$. This figure graphs the segregation index between female and male graduate-field distributions among individuals born in states that legalized abortion in 1970 (New York, Washington, Hawaii, and Alaska) and California, which legalized abortion in 1971. Lines are linear fits of earned degrees not affected by (before) and affected by (after) Title IX's passage. Year of degree encompasses two-year cells.

the early 1960s⁴⁵, enforcement powers were relatively weak. For example, the Civil Rights Act of 1964 created the U.S. Equal Employment Opportunity Commission (EEOC) but it “possessed no authority to force recalcitrant employers and unions to comply with the law” (Equal Employment Opportunity Commission, 1973, p. 1). This changed with the Equal Employment Opportunity Act of 1972, which gave the EEOC the power to bring civil actions against private employers. The Act also expanded the jurisdictional coverage of Title VII to employers with 15 or more employees, as well as to local and state governments and educational institutions (Equal Employment Opportunity Act, 1972).

To examine the impact of the Equal Employment Opportunity Act, I follow a similar methodology to Chay (1998), which exploits the fact that some states already had fair employment practice (FEP) laws prior to EEOA. According to Chay (1995), state FEP laws were very similar to Title VII and also established commissions that had enforcement powers. In fact, under Title VII, the EEOC was to defer the processing of discrimination charges to states with FEP laws. However, not all states had FEP laws. Most of the states with weak or no FEP laws were in the south (Chay, 1995, Appendix Table 1). For example, eight of the nine states with no FEP laws were in the South: Alabama, Arkansas, Georgia, Louisiana, Mississippi, South

⁴⁵The Equal Pay Act, which prohibited wage discrimination in sex, passed in 1963. Title VII of the Civil Rights Act of 1964 prohibited job discrimination because of sex in addition to race, color, religion, and national origin. In 1965, President Johnson signed Executive Order 11246, banning federal contractors from discrimination in employment based on sex as well as race, color, religion, and national origin.

Carolina, Tennessee, and Virginia. Florida, North Carolina, and Texas had laws for public enforcement only. In contrast, “almost all of the states outside the South had FEP laws with more extensive coverage than that required by the 1972 EEOA” (Chay, 1998, p. 610). Following the classification in Appendix Table 1 in Chay (1995), I separate states into those with weak or no FEP laws (“Weak”) or not (“Strong”) and estimate a triple difference regression comparing the number of female degrees by gender-parity tercile. Terciles are based on the degree field’s average female share of degrees between 1960 and 1971. The model is as follows:

$$\begin{aligned}
Y_{ift} = & \beta_0 + \beta_1 Weak_i + \beta_2 Post_t + \beta_3 (Weak_i \times Post_t) + \beta_4 Mid_f + \beta_5 High_f \\
& + \beta_6 (Mid_f \times Weak_i) + \beta_7 (High_f \times Weak_i) + \beta_8 (Mid_f \times Post_t) + \beta_9 (High_f \times Post_t) \\
& + \beta_{10} (Mid_f \times Post_t \times Weak_i) + \beta_{11} (High_f \times Post_t \times Weak_i) + X'\gamma + u_{ift}
\end{aligned} \tag{6}$$

where Y_{ift} is the number of female graduate degrees in field tercile f conferred by school i and year t ; $Weak_i$ is an indicator variable for whether school i had weak or no FEP laws prior to the 1972 EEOA; $Post_t$ is equal to 1 if the degree year is in spring 1975 or later and 0 otherwise; Mid_f and $High_f$ are indicator variables for whether degree field f is in Tercile 2 (“Mid”) or in Tercile 3 (“High”) according to its mean share of female degrees; and X is a vector including school i ’s total graduate degrees conferred in year i , year fixed effects, and school fixed effects. The reference group is female degrees in fields with a female share in the lowest tercile (Tercile 1) conferred between spring 1965 and spring 1974. Standard errors are clustered by state.

The parameter of interest is β_{10} , which tells us how female degrees in traditionally female fields (Tercile 3 or “High”) between years 1975 and 1982 from schools in “Weak” states, where the EEOA definitively strengthened current labor laws, changed relative to the reference group. Again, I focus on non-doctorate, non-health professional graduate degrees, and I use HEGIS Earned Degrees data because I need the state of the degree-granting school.⁴⁶

Each column in Table 3 presents estimated coefficients from equation (6) as I add in controls. The estimates do not change much across the different specifications. My preferred specification in column 3 finds that, in states where EEOA had the strongest impact on labor laws, the average school increased conferred female degrees in female-dominated fields by 13 students, relative to male-dominated degree fields in states that were less affected by EEOA. This is the opposite of my main results, which found that women entered traditionally male fields of study after 1972. Thus, even if EEOA had an immediate impact on women’s educational decisions, it does not explain my finding. Perhaps a more fitting interpretation is that states with weak anti-discrimination labor laws were predominantly in the south, which has strong gender norms. Therefore, Title IX, potentially combined with EEOA, may have had a larger impact on increasing

⁴⁶NSCG data only report the region of the graduate degree-granting school.

women's educational attainment overall as opposed to increasing female representation in traditionally male degrees. This is also consistent with my results in Figure 8, which found greater reduction of gender disparity in more progressive states.

Table 3: Effect of Equal Employment Opportunity Act of 1972

Outcome Variable: Female Non-Doctorate, Non-Health Professional Graduate Degrees	(1)	(2)	(3)
Post 1975	8.129*** (2.526)	14.60*** (3.144)	4.915 (3.851)
Weak State	7.154 (5.710)	7.216 (5.693)	
Post 1975 x Weak State	-4.159 (3.689)	-4.219 (3.691)	-3.366 (3.847)
Tercile 2 Field	22.97*** (3.088)	23.08*** (3.098)	28.57*** (4.425)
Tercile 3 (F-dom.) Field	59.58*** (6.481)	59.73*** (6.479)	54.44*** (7.490)
Post 1975 x Tercile 2 Field	-2.487 (2.594)	-2.637 (2.614)	3.897 (3.290)
Post 1975 x Tercile 3 (F-dom.) Field	15.61*** (3.419)	15.53*** (3.431)	16.31*** (3.501)
Weak State x Tercile 2 Field	-2.920 (4.630)	-2.986 (4.619)	-1.807 (6.773)
Weak State x Tercile 3 (F-dom.) Field	-5.775 (9.922)	-5.836 (9.919)	-5.894 (10.45)
Post 1975 x Weak State x Tercile 2 Field	2.736 (3.036)	2.795 (3.042)	1.605 (3.316)
Post 1975 x Weak State x Tercile 3 (F-dom.) Field	17.24*** (6.177)	17.30*** (6.179)	12.90** (5.806)
Observations	24,653	24,653	24,653
R-squared	0.758	0.759	0.846
Controls for:			
Year		Yes	Yes
School			Yes

Source: HEGIS 1968-1975 Earned Degrees data; Chay (1995), Appendix Table 1.

Notes: Sample is school- and field-level degrees earned by women between spring 1966 and spring 1982, where degrees are non-doctorate, non-health professional graduate degrees. Terciles are based on a degree field's gender parity. Reference group is "Strong States", which had FEP laws prior to EEOA, between 1966 and 1974. "Weak States" are Alabama, Arkansas, D.C., Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Standard errors are clustered by state and reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1

7 Discussion

During the 1960s, nearly 16 percent of working women were secretaries, administrative assistants, and office clerks.⁴⁷ By 2000, the occupational distribution for women looked very different. Thirty-six percent

⁴⁷This number is based off women aged 35 to 45 in the 1960 Census IPUMS 5 percent sample and the 1965-1969 Current Population Survey.

of U.S. lawyers and judges and 32 percent of U.S. physicians and surgeons were female.⁴⁸ The female-male occupational convergence has important implications; the reallocation of female talent between 1960 and 2000 is estimated to explain 25 percent of the growth in U.S. GDP per capita (Hsieh et. al, 2016). Hsieh and coauthors also find that declining obstacles to accumulating human capital were more important than declining labor market discrimination in explaining the convergence. A contribution of my paper is the examination of the removal of a specific human capital barrier (Title IX) and its resulting impact. I find that Title IX sped up the gradual change that was occurring in graduate education in the late 1960s. Further, the distributional change was driven by a reduction in gender disparity among the most lucrative fields, which were also male-dominated.

Because Title IX is a national policy, it is difficult to find useful variation to measure the impact of the law. This is a concern if the law were anticipated or if it were passed in response to the changing social attitude at the time. However, data reveal that enrollment patterns changed after sex discrimination in admissions became illegal. This is in line with historical accounts, which state that the main impetus for Title IX’s passage was gender discrimination in educational institutions. To the extent that Title IX was unexpected, its passage can be viewed as an exogenous reduction in barriers to entry to graduate programs for women. In the absence of confounders, a before-after analysis may provide a causal estimate. I examine the possibility of potential confounders, such as sudden changes in policy or in female preferences, but do not find any substantive evidence that these can explain my findings.

One interesting question is why Title IX was successful in reducing inequality in schools while past laws were not. A possible reason is the existence of an enforcement mechanism. For example, *Brown v. Board of Education* ruled that segregated schools are unconstitutional, but it offered no guidelines on how to comply with the ruling.⁴⁹ In contrast, compliance regulations for Title IX were clearly stated and communicated to schools. For example, the HEGIS Fall Enrollment Survey, which had been administered to all U.S. post-secondary institutions since 1968, included a page post-Title IX that clearly states that completion of the survey is mandatory for “all institutions of higher education which receive, are applicants for, or expect to be applicants for Federal financial assistance” (Codebook for HEGIS 1976 Fall Enrollment Survey). The data also support this explanation; institutions that relied more on federal funding experienced larger female enrollment growth rates and saw greater convergence in the distribution of fields of study. It is also possible that in addition to affecting schools’ behavior, Title IX inspired women to apply to graduate programs. For example, female applications to medical school grew 47 percent in the fall following Title IX’s passage, the

⁴⁸These statistics are based off the 2000 Census IPUMS 5 percent samples for people aged 35 to 45.

⁴⁹Reardon and Owens (2014) document that schools did little to reduce racial segregation immediately following the *Brown v. Board of Education* in 1954. Rather, most of the segregation decline occurred after 1968.

largest increase in over fifty years between 1929 and 1983 (see Table 1).⁵⁰ In terms of policy geared towards reducing gender disparity in education, this paper provides optimistic evidence for the role of legislation.

⁵⁰This behavior may have been further heightened by similar laws that were also passed in 1972. For example, in March 1972, the Senate passed the Equal Rights Amendment and Congress passed the Equal Employment Opportunity Act (EEOA). I do not find strong evidence that EEOA directly impacted female decisions to pursue traditionally male degrees, but it is possible that the spirit of the law may have had an impact. In this case, the scope of anti-sex discrimination laws considered must be broadened and this paper presents an upper-bound estimate of Title IX.

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Appendix

A The Earth Mover’s Distance (EMD) Algorithm

The Earth Mover’s Distance is a metric that measures the difference between two distributions that considers both within-bin and cross-bin differences. In a nutshell, it is the minimal cost that must be paid to transform one distribution into the other. Computation of EMD is borne from the transportation problem. Suppose that several suppliers, each with a given amount of goods, are required to supply several consumers, each with a given limited capacity. For each supplier-consumer pair, the cost of transporting a single unit of goods is given. The transportation problem is then to find a least-expensive flow of goods from the suppliers to the consumers that satisfies the consumers’ demand. The following formalization of EMD is reproduced from Rubner, Tomasi, and Guibas (2000) for the reader’s convenience. The notation has been adapted to apply to the context of occupational convergence.

The computation of EMD can be formalized by the following linear programming problem:

Let

$$M = \{(m_1, s_1^m), \dots, (m_K, s_K^m)\}$$

be the male occupation distribution with K occupation categories, where m_i is occupation i and s_i^m is the share of males in occupation i .

Analogously, let

$$W = \{(w_1, s_1^w), \dots, (w_K, s_K^w)\}$$

be the female occupation distribution with K occupation categories; and let $\mathbf{D} = [d_{ij}]$ be the difference matrix where d_{ij} is the difference between occupations m_i and w_j , that minimizes the overall cost

$$WORK(M, W, \mathbf{F}) = \sum_{i=1}^K \sum_{j=1}^K d_{ij} f_{ij},$$

subject to the following constraints:

$$f_{ij} \geq 0, \quad 1 \leq i \leq K, \quad 1 \leq j \leq K \quad (7)$$

$$\sum_{i=1}^K f_{ij} \leq s_i^m, \quad 1 \leq i \leq K \quad (8)$$

$$\sum_{j=1}^K f_{ij} \leq s_i^w, \quad 1 \leq j \leq K \quad (9)$$

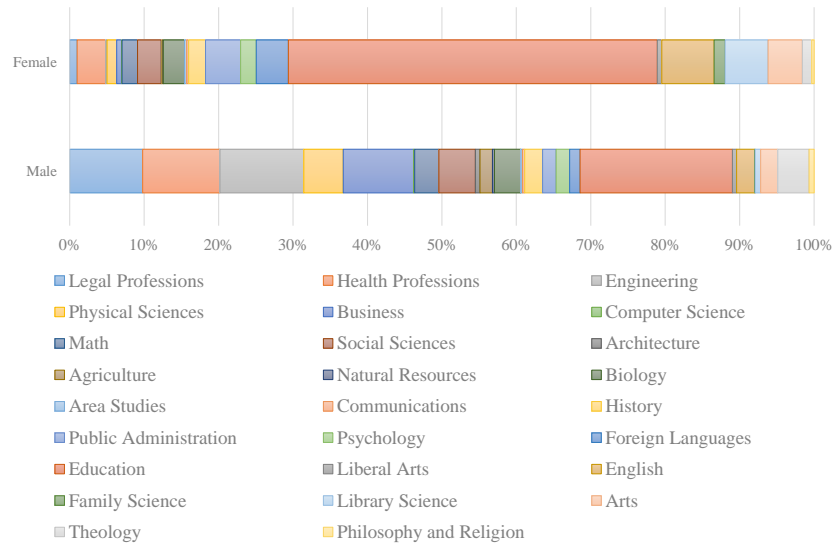
$$\sum_{i=1}^K \sum_{j=1}^K f_{ij} = \min \left(\sum_{i=1}^K s_i^m, \sum_{j=1}^K s_j^w \right) \quad (10)$$

Constraint (7) allows moving people from M to W and not vice versa. Constraint (8) limits the number of males who can be moved in an occupation to their share (i.e., if 30 percent of males are doctors, the number of male doctors who can be moved to another occupation is limited to that 30 percent). Constraint (9) is the analog for occupation categories in F ; and constraint (10) forces to move the maximum number of people possible. This maximum number is called the total flow. Once the transportation problem is solved, and the optimal flow F is found, the earth mover's distance is defined as the resulting work normalized by the total flow:

$$EMD(M, F) = \frac{\sum_{i=1}^K \sum_{j=1}^K d_{ij} f_{ij}}{\sum_{i=1}^K \sum_{j=1}^K f_{ij}}$$

The normalization factor is the total weight of the smaller distribution, because of constraint (10). Thus, the EMD naturally extends the notion of the dissimilarity between two distributions.

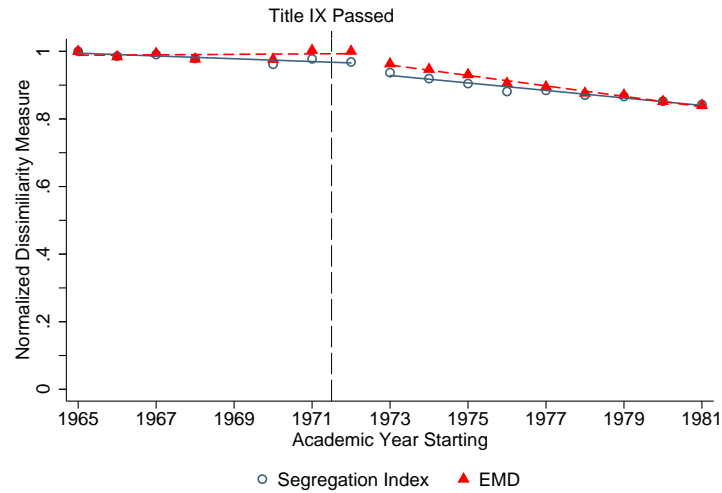
Figure A1: Distribution of Graduate Fields of Study in Academic Year 1965-1966 by Sex



Source: HEGIS 1965 Earned Degrees data.

Notes: N = 190,507. This figure depicts the field's share of graduate degrees conferred in academic year 1965-1966, separately by sex. Fields are listed in decreasing order of median salary.

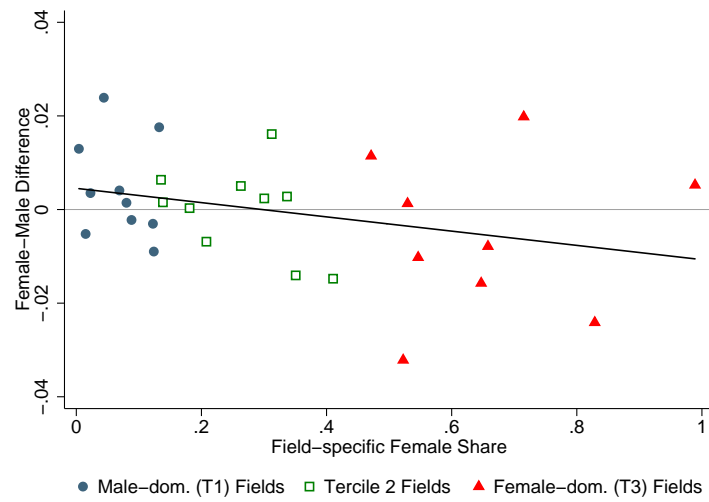
Figure A2: Gender Convergence in Graduate Fields of Study using HEGIS data



Source: HEGIS 1965-1981 Earned Degrees data.

Notes: N = 116,294. This figure plots normalized EMD values between female and male distributions of graduate fields of study using HEGIS data. Lines are fitted linear trends allowing for a break between 1972 and 1974.

Figure A3: Gender Difference by Field of Study



Source: NSCG 1993 data.

Notes: Dots depict the female-male difference in non-doctorate, non-health professional graduate degrees in each year, separately for each degree field. Fields of study are categorized into terciles by their mean share of females between 1960 and 1971. Estimates control for birth year and school region. Estimates control for birth year, school region, and the number of college graduates each year.

Table A1: List of Major Fields of Study by Salary Tercile

<i>Fields in the Top Salary Tercile</i>
Architecture and Related Services
Business, Management, Marketing, and Related Support Services
Computer and Information Sciences and Support Services
Engineering
Legal Professions and Studies
Mathematics and Statistics
Natural Resources and Conservation
Physical Sciences
Social Sciences
<i>Fields in the Middle Salary Tercile</i>
Agriculture, Agriculture Operations, and Related Sciences
Area, Ethnic, Cultural, Gender, and Group Studies
Biological and Biomedical Sciences
Communication, Journalism, and Related Programs
Foreign Languages, Literatures, and Linguistics
Health Professions and Related Programs
History
Liberal Arts and Sciences, General Studies and Humanities
Public Administration and Social Service Professions
<i>Fields in the Bottom Salary Tercile</i>
Education
English Language and Literature/Letters
Family and Consumer Sciences/Human Sciences
Library Science
Philosophy and Religious Studies
Psychology
Theology and Religious Vocations
Visual and Performing Arts

Source: NSCG 1993 data.

Notes: Ranking for non-doctorate, non-health professional graduate degrees earned between 1960 and 1990, inclusive.

Table A2: List of Major Fields of Study by Gender Parity

<i>Fields in the Top Tercile (Male-dominated)</i>
Agriculture, Agriculture Operations, and Related Sciences
Architecture and Related Services
Business, Management, Marketing, and Related Support Services
Computer and Information Sciences and Support Services
Engineering
Legal Professions and Studies
Philosophy and Religious Studies
Physical Sciences
Theology and Religious Vocations
<i>Fields in the Middle Tercile</i>
Area, Ethnic, Cultural, Gender, and Group Studies
Biological and Biomedical Sciences
Communication, Journalism, and Related Programs
History
Mathematics and Statistics
Natural Resources and Conservation
Psychology
Social Sciences
Visual and Performing Arts
<i>Fields in the Bottom Tercile (Female-dominated)</i>
Education
English Language and Literature/Letters
Family and Consumer Sciences/Human Sciences
Foreign Languages, Literatures, and Linguistics
Health Professions and Related Programs
Liberal Arts and Sciences, General Studies and Humanities
Library Science
Public Administration and Social Service Professions

Source: NSCG 1993 data.

Notes: Ranking for non-doctorate, non-health professional graduate degrees earned between 1960 and 1971, inclusive.