

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

Nayoung Rim[†]

August 2018

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

*A prior version of this working paper circulated as "Title IX and Female Occupational Choice: Removing Barriers to Graduate Higher Education." I thank Thomas Coleman, Jennifer Ghandhi, Bob Michael, and seminar participants at the University of Chicago Harris School of Public Policy, the annual meeting of the Population Association for America, the annual meeting of the Association for Public Policy and Management, and the annual meeting of the Society of Labor Economists for their helpful comments and discussions. This material is based upon work supported by AccessLex Institute. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of AccessLex or the U.S. Naval Academy. All errors are my own.

[†]United States Naval Academy, Department of Economics. Email: rim@usna.edu

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.⁵ 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.

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.

⁵Although 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, in graduate education, applicants apply to specific programs of study 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.

Focusing on the distribution of fields of study, I estimate that Title IX led to a 30 percent 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 the 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.

My difference-in-differences (DID) analysis finds that master's degrees drive my results; white women were 7.2 percentage-points more likely than white men to pursue a traditionally male-dominated master's degree after Title IX, and 12.9 percentage-points less likely to pursue a traditionally female-dominated master's degree. 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 female preferences.

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 data, which reveal that female graduate enrollment increased sharply immediately after Title IX's passage. Further, I find that institutions that relied more on federal funds - the schools that would face harsher penalties if found to be in violation of Title IX - enrolled more female students in comparison to institutions that had less at stake.

The coincidence in timing does not, of course, prove causation; there were many other changes occurring between the late 1960s and early 1970s that may be responsible for the change in female educational choices. To begin, social norms were evolving: the birth control pill became widely available and abortion was legalized. Female attitudes towards traditionally male fields of study were changing along with their career aspirations. The Equal Employment Opportunity Act also passed in 1972, strengthening anti-discrimination labor laws which may have affected female educational decisions. Second, the Vietnam War Draft ended in 1973, meaning the rush of young men enrolling in graduate programs to avoid the 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.

I rule out alternative explanations by estimating the immediate impact of Title IX on the women who were able to apply to graduate school right when Title IX passed. This empirical strategy allows me to plausibly isolate Title IX from other confounding factors as this cohort of women were too old to be affected by sudden changes in state laws increasing minors' pill access and *Roe v. Wade*. It is possible that high school course-taking or career aspirations may have changed with this cohort, manifesting in a change in graduate fields of study. But I do not find any evidence of sudden changes.⁶

I begin the remainder of the paper by describing the status of women in education prior to Title IX. Section 3 discusses Title IX regulations and enforcement. I describe the data in Section 4 and my main results in Section 5. Section 6 discusses alternative explanations. I conclude with a discussion in Section 7.

2 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 but made no explicit mention of gender discrimination in educational institutions. Despite these advancements, gender discrimination in educational institutions persisted as it was technically not banned.

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).

Data on conferred degrees reveal a gender disparity, which is consistent with the U.S. News article. At the time the article was written, there were 524,008 conferred B.A. degrees of which 57.4 percent were to men.⁷ The most popular undergraduate major was Business for men and Education for women. Only one of 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.⁸ Once in graduate school, men

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

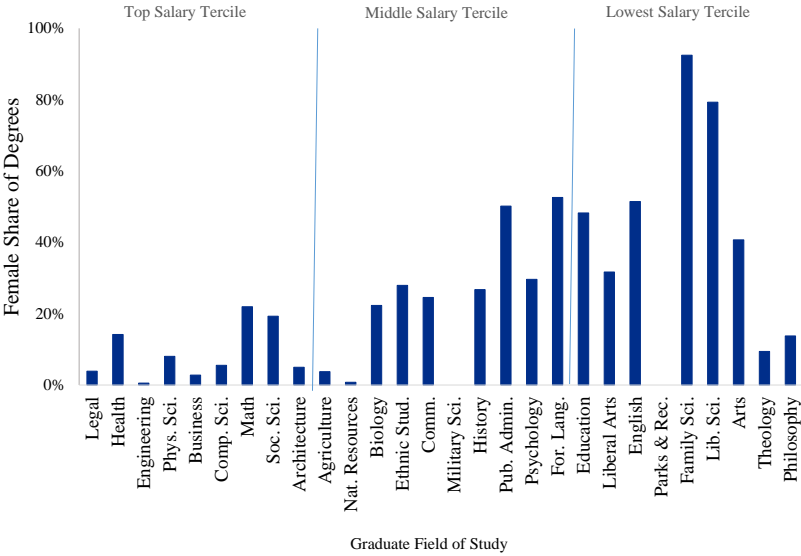
⁷These statistics are for the academic year 1965-66 and are from the Higher Education General Information Survey (HEGIS) 1965 Earned Degrees data.

⁸The number of conferred graduate degrees was 190,507. These statistics are from the 1965 Current Population Survey.

and women pursued different fields of study. Nearly half of the women in graduate school were pursuing a degree in Education in 1965, whereas men were more evenly distributed across the 28 major fields of study (see Figure A1). Further, if I classify fields of study by median salary, more than half of the men in graduate school were pursuing degrees in the top salary tercile, with 32 percent representing the top three: Law, Health, and Engineering.⁹ In contrast, I find that 12 percent of women were in fields in the top salary tercile.

The gender disparity in graduate education is starker when we examine the share of female graduates in each degree field. In Figure 1, the horizontal axis lists the 28 major fields of study in rank order of median salary between 1962 and 1991. 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.

Figure 1: Female Share of Graduate Degrees in 1965



Source: HEGIS 1965 Earned Degrees data.
 Notes: N = 190,507. 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.

The U.S. News and World Report 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

⁹Fields 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.

Hearings on June 17, 1970.¹⁰ 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:

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. 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

¹⁰The 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.

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).¹¹

Part of the problem was a widely-held belief by school administrators that women were not committed 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”.¹² 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.

Despite the qualitative evidence, it is difficult to ascertain the factual validity of the “less-committed female student” argument as there is a lack of accurate attrition data from that time. The Chicago Report, administered in October 1969, was the first of its kind to publish attrition statistics by department. It reports attrition data at the undergraduate level for three academic years: 1965-66, 1966-67, and 1967-68. Attrition data at the graduate level is even more sparse, owing to the difficulty of gathering data across different departments (Discrimination Against Women, 1970, p. 806). In the end, it was only able to collect data from doctoral students entering between 1962 and 1964 in just one department in each of the following four divisions: Biological Sciences, Physical Sciences, Social Sciences, and Humanities. It is important to stress that the Chicago Report contains small sample sizes and so the data are merely illustrative. The report finds that the difference in attrition at the undergraduate level is small, with women being 2 percentage-points more likely to drop out (Discrimination Against Women, 1970, p. 806). At the Ph.D. level, however, there are no consistent differences between men and women in regards to leaving before finishing a degree.¹³ Women stop at the master’s level more frequently than men but the reasons for doing so are widely varied, whereas men are more likely than women to stop due to poor performance (Discrimination Against Women, 1970, p. 806).

Although these numbers may suggest that attrition rates in graduate school are higher for women than for men, the Chicago Report argues that a clearer picture is revealed by analyzing financial aid information.

¹¹Whether any of these estimates are statistically significantly different is unknown.

¹²The 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.

¹³The Chicago Report classified Ph.D. students into four groups: Left before Degree; Master’s Degree Only; Ph.D. Completed; and Still Working.

When looking at gender-specific shares of aid applicants who were offered aid for graduate study, the overall pattern suggests that women were offered aid “somewhat less frequently than men” (Discrimination Against Women, p. 801).¹⁴ The Chicago Report also notes that female students had filed a number of complaints that departments were discriminating against women in regards to financial aid (Discrimination Against Women, p. 804). This complaint is echoed in the U.S. News article, which included testimony from a woman who graduated at the top of her undergraduate department and won a scholarship for graduate study at Harvard. However, she was unable to “pick up a fellowship in any other field [besides teaching]” (U.S. News & World Report, p. 54). Furthermore, the female student lost a prized teaching fellowship to “a guy who graduated at the bottom of the class” because the department head commented that “she [would] be married in a year” (U.S. News & World Report, p. 54). If women were less likely to receive financial aid offers, then that may explain higher attrition rates for women - rather than a lack of commitment. Indeed, the Chicago Report also found that women at the University of Chicago have high career commitment: 92 percent of women want to have a career compared to 81 percent of men (Discrimination Against Women, 1970, p. 867). Relatedly, 62 percent of women respondents would be “very disappointed” if they left school before completing their education compared to only 53 percent of men (Discrimination Against Women, 1970, p. 871).¹⁵

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 career aspirations between men and women, differing preferences between men and women for fields of study, or a lack of adequate preparation on the part of female applicants. To narrow down possible explanations, I exploit the passage of a new law (Title IX) that banned gender discrimination in admissions. This empirical methodology allows me to estimate the short-term impact of reducing barriers-to-entry on female educational choices.¹⁶ In the next section, I discuss Title IX regulations and whether schools complied.

¹⁴The Chicago Report collected the number of offers of fellowships and scholarships made at the time of admission to new graduate students in 1967, 1968, and 1969. The data were collected from only four divisions (Biological Sciences, Physical Sciences, Social Sciences, and Humanities) as financial aid was given mainly on the basis of need in the College, the M.B.A. program at the Graduate School of Business, and the Law School. The aid numbers do not control for quality of applicants, so definitive conclusions cannot be drawn.

¹⁵It is important to mention that the Chicago Report’s findings should be interpreted with caution. Not only were data sparse and reported without standard errors, but the Report was administered in 1969, when many young men were applying to and attending graduate school to avoid the Vietnam War draft. This is not the primary reason that young women were in graduate school. The differential selection into graduate school may have resulted in the gender differences observed in the Chicago Report’s findings.

¹⁶A 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 not sudden ones. An examination of the data confirms this assumption. Results are in the Online Appendix at <https://goo.gl/h4MEaw>.

3 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. As labor market inequities may be linked to sex inequities in the educational system, the senator believed a policy that fought “the continuation of corrosive and unjustified discrimination against women [in the American educational system]” was needed (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.

The law was broad in scope, covering many aspects of education discrimination, but in regards to admissions, Title IX 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 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).

Four months after its introduction, Title IX was signed into law by President Richard Nixon on June 23, 1972. Guidelines on how to implement Title IX, however, were not determined until June 1975.¹⁷ These 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.

¹⁷The 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.

Grove City College received no direct federal aid though 480 of its 2,200 students received federal grants and loans. Believing it was exempt from Title IX, Grove City refused to sign the Assurance of Compliance form. The Department of Education argued that student aid made Grove City a recipient of federal assistance and entered an order terminating assistance until Grove City “correct[ed] its noncompliance with Title IX and satisfie[d] the Department that it is in compliance” (Grove City College, 1984). Grove City College filed a lawsuit, and the case eventually went before the Supreme Court.¹⁸

Although Title IX implementation regulations were not signed until three years after its passage, the Department of Health, Education, and Welfare (HEW) actually began working on the regulations just a few months after its passage. Further, 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.

Perhaps for this reason, it is not surprising to learn that “many institutions [had] already begun to respond to the spirit of Title IX” as soon as one month after the implementation regulations were signed (Sex Discrimination Regulations, 1975, p. 416).¹⁹ For example, one year before the regulations were signed into law, the University of Michigan had 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).

3.1 Did Universities Comply with Title IX?

In this section, I examine the evidence on whether colleges and universities complied with Title IX. One hypothesis about Title IX’s impact on schools is that graduate schools would respond more than undergraduate schools as testimonials and data on enrollment and conferred degrees indicate a greater sex disparity at the graduate level. This means graduate programs had more room to respond in comparison to undergraduate programs. Second, implementation regulations stipulate that non-compliance will result in termination of federal funds. Therefore, we may expect to see a greater reaction among institutions that

¹⁸Grove City College v. Bell (1984) held that Title IX could be applied to a private school that refused direct federal funding but for which a large number of students had received federally funded scholarships. The Court also held that the federal government could require a statutorily mandated “assurance of compliance” with Title IX even though no evidence had been presented to suggest that Grove City College had discriminated. However, the Court also held that the regulation would apply only to the institution’s financial aid department, not to the school as a whole. The decision by the Supreme Court was effectively overturned when the United States Congress subsequently passed the Civil Rights Restoration Act of 1987, which specified that recipients of federal funds must comply with civil rights laws in all areas, not just in the particular program or activity that received federal funding.

¹⁹This statement was made by 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, 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).

receive more federal funds relative to institutions that rely less on federal money. Further, HEW’s process of finalizing compliance regulations was public and began immediately after Title IX’s passage in 1972. Therefore, we may expect to see an “anticipation effect”, especially among institutions that may be more affected by the penalty for non-compliance. I summarize these two predictions about female enrollment share below.

If schools complied with Title IX, we would expect to see:

1. A greater response by graduate schools relative to undergraduate schools
2. A greater response by institutions that rely more on federal funds relative to institutions that rely less on federal funds

I test these predictions using 1969-1980 Fall Enrollment data from the Higher Education General Information Survey (HEGIS).²⁰ The HEGIS series 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, conferred degrees, and financial statistics of institutions.

To test the first prediction, the following regression equation is estimated separately for graduate enrollment and undergraduate enrollment:

$$F_{it} = \beta_0 + \sum_{s=1970}^{1980} \tau_s \cdot \mathbb{1}\{t = s\} + X' \gamma + \varepsilon_{it} \quad (1)$$

where F_{it} is school i ’s growth in the share of enrolled female students in year t and X is a set of state dummies. The parameters of interest are τ_s , which tell us the average annual increase in female growth relative to 1969. For graduate student enrollment, the data start in 1970, so τ_s tells us the relative annual growth with respect to 1970. Estimates are weighted by the school’s total enrollment, and standard errors are clustered by state.

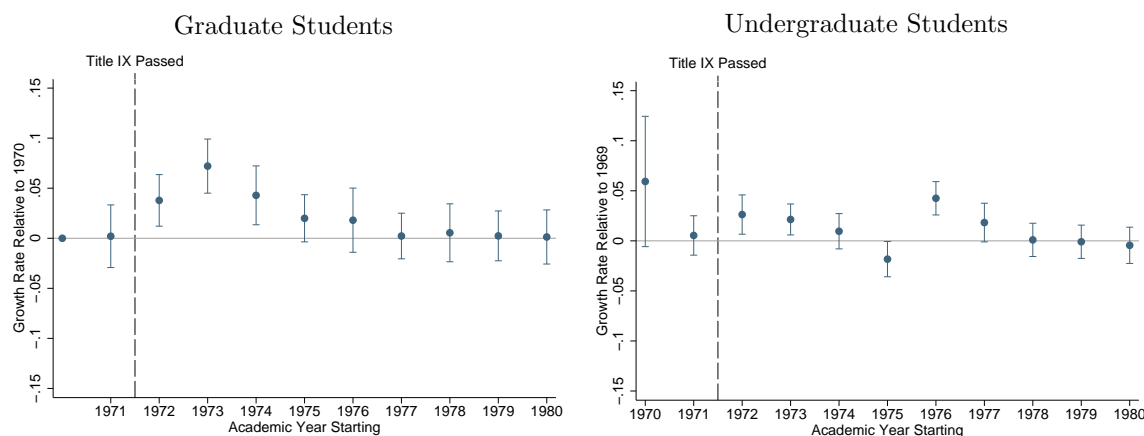
The two graphs in Figure 2 compare female growth rates in graduate enrollment (left) and undergraduate enrollment (right). We see positive growth in female share of graduate enrollment starting in academic year 1972-73, with the largest increase (0.072) occurring one academic year after Title IX’s passage. The one-year lag between Title IX’s passage in June 1972 and increased female enrollment in Fall 1973 is what one would expect if schools and female applicants responded immediately to Title IX. The effect on female undergraduate enrollment, by comparison, is smaller though also positive and statistically significant.²¹ I

²⁰Ideally, I would use first-year enrollment data for this analysis. Unfortunately these historical data do not differentiate first-year graduate student enrollment from total graduate student enrollment.

²¹We observe a large increase, though not statistically significant, in female undergraduate enrollment in 1970 relative to 1969. The reason for this increase is because several schools became co-educational that year. The 17 schools that became co-educational in 1970 experienced a 955 percent mean growth in female undergraduate enrollment that year, enrolling an additional 3,819 female students. The fact that several colleges and universities - and especially *elite* schools - were becoming

would like to highlight that the graphs depict growth rates; in terms of levels, female enrollment numbers are still increasing after 1973, but at a slower rate than they were immediately after Title IX's passage.

Figure 2: Growth in Female Share of Enrolled Students



Source: HEGIS 1969-1980 Fall Enrollment data.

Notes: $N = 11,179$ (graduate students) and $31,215$ (undergraduate students). Dots depict each year's increase in growth in female share of enrolled students relative to 1969 (undergraduate students) and 1970 (graduate students). The vertical dashed line indicates when Title IX was signed into law (June 1972). Estimates control for state fixed effects and are weighted by the school's total enrollment. Standard errors are clustered by state, and wings are 95% confidence intervals.

To test the second prediction, I examine enrollment trends by the university's funding source. I use 1968-1972 financial statistics data from HEGIS to calculate the portion of the university's educational revenue and student aid grants that come from the federal government. A school's educational revenue may come from student tuition and fees, governmental appropriations²², endowment income, private gifts, sponsored research and programs, and recovery of indirect costs. Student aid grants may come from federal, state, or local government, private gifts and grants, endowment income, or other sources. A school may receive federal funds for appropriations, research and programs, and student aid grants. I calculate each school's federal-funds share and categorize them 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 1972 is 7.3 percent with a standard deviation of 9.3 percent. The median share is 4.7 percent. The 10th and 90th percentiles are 0 percent and 17.4 percent, respectively. The mean shares of the three terciles are 0.9 percent (low), 4.8 percent (medium), and 16.3 percent (high). Public schools receive about \$960,000 more on average relative to private schools, but private schools also receive federal money. For example, Harvard

co-educational around this time may present a possible alternative explanation: a disproportionate share of women who attend elite colleges that just turned co-ed may be more likely to pursue non-traditionally female degrees in graduate school. An examination of the B.A. majors of females at newly-coed undergraduate institutions versus "always co-ed" institutions finds no significant differences between the two types of institutions. The full analysis and results are in the Online Appendix at <https://goo.gl/h4MEaw>.

²²This 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.

University, Yale University, Stanford University, and Princeton University are in the top tercile.

I examine 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. Because graduate enrollment data begin in 1970 even though undergraduate enrollment data begin in 1969, I use total enrollment data starting from 1970. The regression model is as follows:

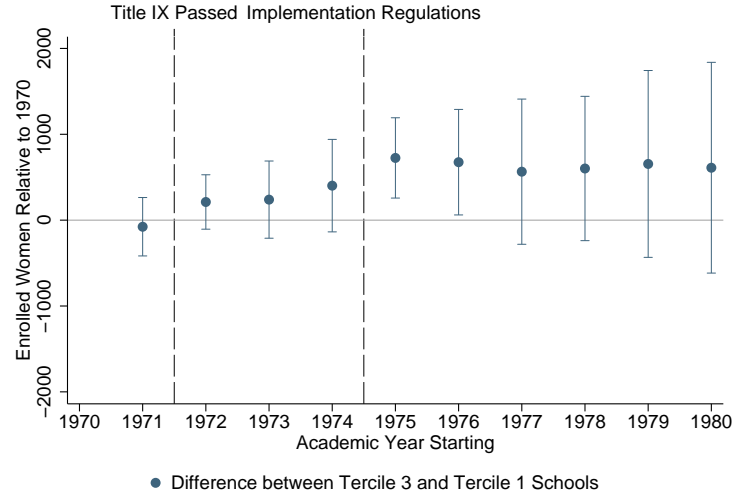
$$\begin{aligned}
F_{it} = & \beta_0 + \beta_1 Med_i + \beta_2 High_i + \sum_{s=1971}^{1980} \mathbb{1}\{t = s\} + X'\gamma + \sum_{s=1971}^{1980} \tau_s^L \cdot \mathbb{1}\{t = s\} \cdot Low_i \\
& + \sum_{s=1971}^{1980} \tau_s^M \cdot \mathbb{1}\{t = s\} \cdot Med_i + \sum_{s=1971}^{1980} \tau_s^H \cdot \mathbb{1}\{t = s\} \cdot High_i + \varepsilon_{it}
\end{aligned} \tag{2}$$

where F_{it} is school i 's female enrollment in year t , X includes school and state fixed effects, and Med_i and $High_i$ are indicator variables for whether school i is in Tercile 2 (Med) or in Tercile 3 ($High$) according to its federal-funds share. The reference group is Tercile 1 (Low) schools in 1970. Estimates are weighted by the school's total enrollment, and standard errors are clustered by state. The parameters of interest are τ_s^H , the coefficients on the year dummies for Tercile 3 schools. These tell us how the average female enrollment among Tercile 3 schools changes annually relative to the average Tercile 1 school's enrollment in 1970. These estimates and their corresponding 95% confidence intervals are graphed in Figure 3.

Vertical dashed lines in Figure 3 indicate when Title IX and its compliance regulations were signed into law (July 1972 and May 1975, respectively). Female enrollment in Tercile 3 schools is slightly greater than enrollment in Tercile 1 schools, but this difference is not statistically significant. The difference grows in academic year 1974-75 and becomes statistically significant in academic year 1975-76. This evidence of an anticipation effect is not surprising given the public process in which HEW drafted Title IX implementation regulations. These results are consistent with what we would expect to see if schools were complying with Title IX. Importantly, we see an immediate response by schools. Figure A2 depicts female enrollment trends for Tercile 1 (low) schools. Female enrollment increases statistically significantly starting with the academic year 1973-74. These three figures together suggest that female enrollment at all schools increased immediately after Title IX's passage, but that female enrollment at schools that had the largest incentive to comply (Tercile 3 schools) grew more significantly after Title IX's compliance regulations became law, in the 1975-76 academic year.

Who are the students affected by Title IX? 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. These relate to students born in 1950 or 1951 (see Table

Figure 3: Change in Female Enrollment by Federal-Funds Share



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

Notes: $N = 32,231$. Graduate school enrollment data begin in 1970 so dots depict each year's difference in female enrollment between Tercile 3 (high share) schools and Tercile 1 (low share) female enrollment in 1970. Terciles are based on the average share of a school's educational revenue that comes from the federal government between 1968 and 1972. Vertical dashed lines indicate when Title IX and its compliance regulations were signed into law (June 1972 and May 1975, respectively). Estimates control for school and state fixed effects and are weighted by the school's total enrollment. Standard errors are clustered by state, and wings are 95% confidence intervals.

1). Although it is certainly possible that women took some time off inbetween graduate and undergraduate studies, highlighting the age of these applicants is helpful when examining alternative explanations such as increased access to the birth control pill and abortion legalization.

If a female student applied to a master's program in Fall 1972 and matriculated in Fall 1973, she would expect to graduate in Spring 1975. Therefore, if Title IX were successful I would expect to see a discontinuity starting with graduate degrees conferred in Spring 1975.

4 Data and Convergence Measures

4.1 Data

The National Survey of College Graduates (NSCG) is a longitudinal, biennial survey of U.S. college graduates that began in the 1970s. I use data from 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, in this dataset. Most

Table 1: 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				

importantly, the 1993 survey asks respondents to report their field of study and year of degree for their (1) bachelor’s degree, (2) most-recent degree, and (3) second most-recent degree. I classify graduate degree as any degree other than a bachelor’s degree. This includes master’s degrees, professional degrees, and doctoral degrees. All results reported in this paper use data on the highest degree.²³ There are 255 reported fields of study in the NSCG data. I consolidate these into 28 main fields, as categorized by the 2010 Classification of Instructional Programs (CIP).²⁴ The main NSCG analysis sample considers all graduate degrees obtained before age 35 between 1964 and 1987; this results in 29,310 observations.²⁵ I combine two-year cells to increase power.

4.2 Convergence Measures

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

²³The highest degree very closely corresponds with most-recent degree. 99.6 percent of respondents in the NSCG 1993 survey have matching highest-degree and most-recent degree types. Of the 447 respondents whose highest degree type and most-recent degree type differ, 134 of them (30 percent) are in the same field-of-study.

²⁴CIP 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.

²⁵I choose age 35 as an arbitrary cutoff age as most graduate degrees are obtained by then. The average age of a graduate-degree graduate was 30 between 1960-1971 and 31 between 1973-1990.

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

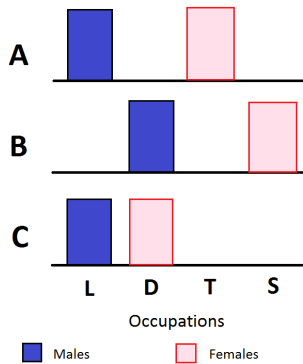
$$S_t = (0.5) \cdot \sum_i |m_{it} - f_{it}| \quad (3)$$

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 exact field-of-study 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 4 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 4: 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 4 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 4 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 .²⁶

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

²⁶Appendix 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 1991.²⁷ 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.

5 Results

In this section, I provide graphical evidence of gender convergence in graduate-field distribution after Title IX’s passage. The left graph in Figure 5 plots the segregation index between men and women from 1964 to 1986. In 1964, the segregation index is 47 percent. This means that 47 percent of the women (men) with graduate degrees would need to change their field of study in order to have the same overall graduate-field distribution as men (women). The level of gender segregation in graduate fields of study remains relatively stable until it drops suddenly starting with degrees earned in 1974/1975. The solid lines are fitted linear trends allowing for a break, which was found by looking for a structural break in the data.²⁸ I estimate the sudden convergence between the male and female distributions to be 11.4 percentage-points. As the Segregation Index level was 38.5 percent in 1972, this indicates a 30 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 measures. 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 sizes of segregated and integrated fields (Graduate Field Mix Effect).²⁹ 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 seg-

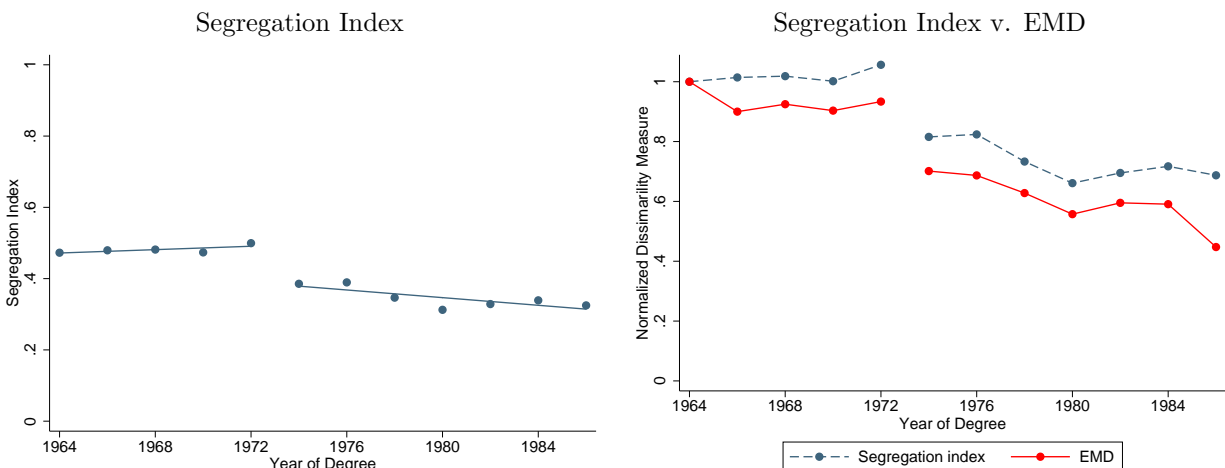
²⁷I use both male and female salary in order to capture a field’s ranking in the hypothetical case that men and women are paid the same salary within the same occupation. I conduct a robustness check using the median salary of women, and my results do not change.

²⁸The year of the break was found by maximizing the R^2 of the following regression: $Y(t) = \beta_0 + \beta_1 \cdot \mathbb{1}\{t > t^*\} + \tau \cdot t + \delta \cdot ((t - t^*) \times \mathbb{1}\{t > t^*\}) + \varepsilon_t$, where $Y(t)$ is the dissimilarity measure in year t and t^* is the year of the structural break in the time series. The parameter τ is a linear time trend before the structural break, β_1 is the size of the structural break, and δ is the linear time trend after the structural break. The range of the structural break excludes the first and last years of the time period.

²⁹This decomposition formula is taken from Blau, Brummond, and Liu (2013).

regation (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 88 percent of the -11.4 percentage-point change between 1972 and 1974 is due to changes in sex composition within occupations with the remaining 12 percent due to changes in the field mix.

Figure 5: Female-Male Convergence in Graduate-Field Distributions



Source: NSCG 1993 data.

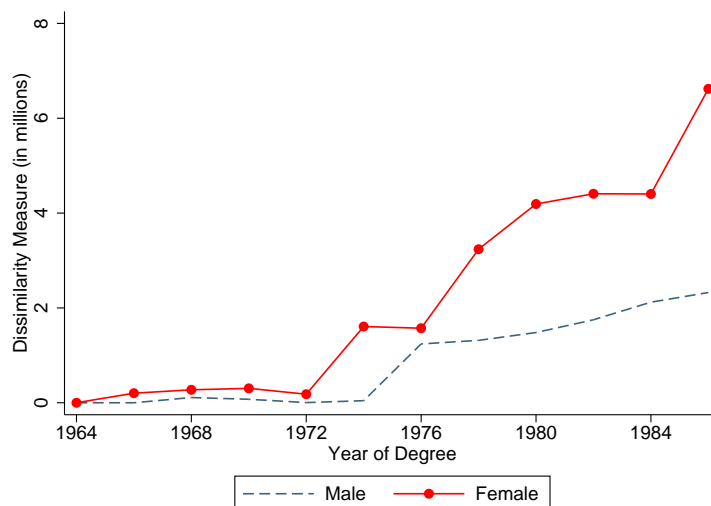
Notes: Dots depict the segregation index between female and male distributions of graduate field of study over time (left graph) and dissimilarity measures normalized to 1964, separately for Segregation Index and EMD (right graph). Lines are connected values allowing for a break between 1972 and 1974. The break year was determined by looking for a structural break in the data. Year of degree encompasses two-year cells.

The right graph in Figure 5 compares distributional change as measured by the Segregation Index and EMD. Both convergence measures are normalized to their respective 1964 values. The two measures show the same picture. I find a structural break between degrees earned in 1972/1973 and 1974/1975 whether I use the Segregation Index or EMD. Both measures estimate that distributional convergence increased around 20 percent after Title IX's passage, relative to its 1964 value. EMD, however, estimates greater convergence. Whereas the Segregation Index is relatively flat until the discontinuity in 1974, EMD finds convergence during this period. Because of how EMD is calculated, this implies that convergence was occurring in fields that were further apart. I find similar results using HEGIS Earned Degrees data (see Figure A3).

I now explore the underlying drivers of the observed distributional change. Is this change due to predominantly female movement, predominantly male movement, or both? I compare the female distribution of graduate fields to the female distribution from 1964, and do the same for the men. Figure 6 reveals that gender convergence in graduate fields was driven by female movement. Larger EMD values relate to greater distributional divergence whereas smaller EMD values relate to distributional convergence. Prior to 1972,

the female graduate-field distribution did not look very different from the distribution in 1964 and the same is true for males. After 1972, however, females and males begin entering different fields from their 1964-peers, but the change among females begins earlier and is larger.

Figure 6: Distributional Change in Graduate Fields by Sex



Source: NSCG 1993 data.

Notes: This figure plots distributional change in graduate-field distributions relative to the 1964 distribution, separately for each gender. Year of degree encompasses two-year cells.

The next analysis examines which degrees are driving the distributional change. From the timing of the observed discontinuity, I would expect that master's degrees, which generally require two years of coursework, are the main driver in comparison to doctoral degrees, which require five or six years (a lower bound in some disciplines). This also makes sense as around three-quarters of conferred graduate degrees are master's degrees.³⁰

I estimate a difference-in-differences regression model, comparing the female-male difference in conferred degrees each year, separately for master's degrees and doctoral degrees. Because my DID methodology compares female degrees to male degrees, there may be a relationship between the two especially when comparing gender differences within a particular degree field. Given a fixed class size, administrators may decide to increase female enrollment by limiting male enrollment. To bypass this issue, I restrict my analysis sample to whites. Whites make up 90 percent of the NSCG sample allowing the white-male share to vary independently of the white-female share. Second, I focus on degrees earned between 1970 and 1977 to hone in on the short-run impact of Title IX and mitigate any long-term effects from other gradual changes that

³⁰The average share of graduate degrees that are master's degrees is 75 percent between 1965 and 1981, with annual shares ranging from 74 percent to 77 percent.

were occurring around this time.

Within degree-type, I estimate the following regression model by gender parity tercile. I proxy for the level of gender parity in the degree field by using the field’s average female share of degrees between 1962 and 1970 and categorize fields into terciles based on female share.³¹

$$Y_{ict} = \beta_0 + \beta_1 \cdot F_i + \sum_{s=1971}^{1977} \tau_s^M \cdot \mathbb{1}\{t = s\} + \sum_{s=1971}^{1977} \tau_s^F \cdot (F_i \times \mathbb{1}\{t = s\}) + X' \gamma + \varepsilon_{ict} \quad (5)$$

where $Y_{ict} = 1$ if individual i obtained a graduate degree in tercile c in year t , F_i is a female dummy, and X is a set of fixed effects for school region and birth year. 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 7, and standard errors are clustered by school region.

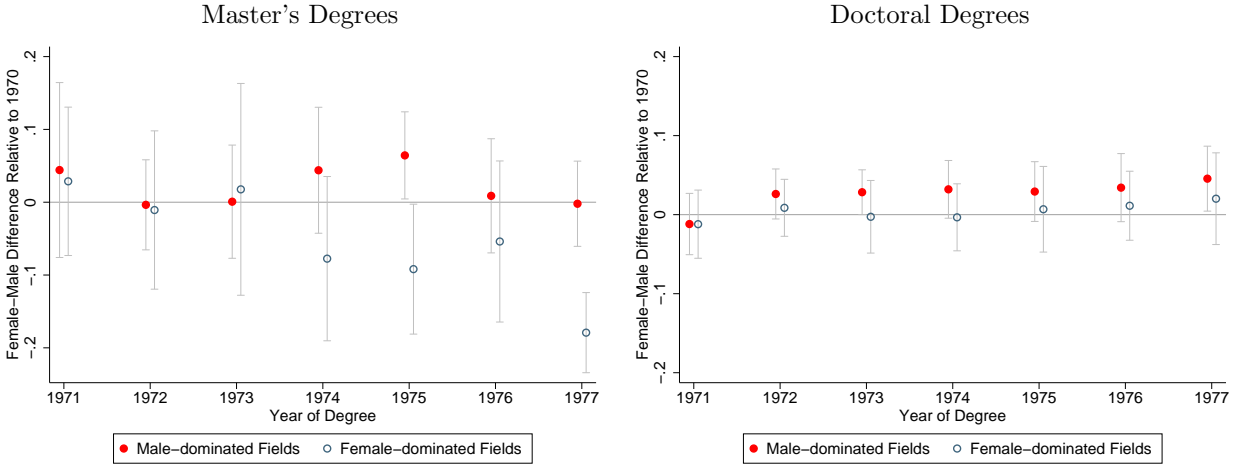
In terms of doctoral degrees, we do not see any significant increase in female degrees earned during this time period (Figure 7). In contrast, there is a 6.4 percentage-point increase in female master’s degrees in male-dominated fields of study in 1975, two academic years after Title IX was passed in June 1972. Given that 37 percent of master’s degrees were awarded to women, this represents an effect size of 17 percent. To provide a sense of the fields that are driving this result, the most popular master’s degrees in male-dominated fields between 1962 and 1970 were Business (47 percent) and Engineering (25 percent). The most popular field in female-dominated master’s degrees was Education (70 percent).

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 (graduate degrees) prior to the treatment (Title IX’s passage in 1972). This allows us 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. We see from Figure 7 that this assumption holds; the female-male difference in 1971 and 1972 are small in magnitude and statistically insignificant.

This analysis also provides an indirect test for the presence of gender discrimination in graduate education. One alternative explanation for low female representation in certain fields would be that female preferences differ from male preferences. That is, there may be few females in business 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 M.B.A. admissions quotas for women were removed, we would still see few women in business school, relative to men, because women have a distaste for business. Contrary

³¹Appendix Table A2 lists the fields that are in these three groups. This list is highly correlated with the grouping by expected salary, indicating that graduate fields that were male-dominated were also the most lucrative.

Figure 7: Gender Difference in Graduate Degrees by Degree-Type and Gender Parity



Source: NSCG 1993 data.

Notes: $N = 7,344$. The sample is restricted to whites who obtained a graduate degree before age 35 between 1970 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 1962-1970. Estimates control for birth year and school region. Standard errors are clustered by school region, and wings depict 95% confidence intervals.

to this hypothesis, I find that traditionally male-dominated fields experienced greater female growth after Title IX.

6 Alternative Explanations

This section explores other changes occurring between the late 1960s and early 1970s that may be responsible for the change in female educational choices. The two main alternative explanations I consider are the end of the Vietnam War Draft and technological changes to fertility like the birth control pill and abortion. A discussion of other confounding factors, including cohort-specific changes and changes in equal employment laws, can be found in the Online Appendix.³²

6.1 End of Vietnam War Draft Deferment Policy

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. According to Selective Service System records, 1,857,304 men entered military service through the draft between August 1964 and February 1973.³³

³²The Online Appendix can be found at <https://goo.gl/h4MEaw>.

³³Induction statistics are taken from the Selective Service System's online records at <https://www.sss.gov/About/History-And-Records/lottery1> and

Given the high draft numbers during the Vietnam War, it may not be surprising to learn that the number of deferments was high. Before 1967, Selective Service included Class II-S deferments, which 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 (e.g., J.D. or M.D.) were allowed to defer up to a maximum of four years (Samuelson, 1967). Deferments were granted as long as the student was enrolled full-time and remained in good standing. According to the Semi-Annual and Annual Reports of the Director of Selective Service, there were a total of 1.783 million Class II-S currently active deferments in 1966 (p. 15). Between 1967 and 1979, the number of Class II-S deferments continued to remain around 1.8 million each year, around 14-15 percent of all active deferments.

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.³⁴

The timing of the end of the Vietnam War and its graduate deferment policies presents a valid alternative explanation for the observed discontinuous increase in female graduate degrees conferred in Spring 1974/Spring 1975. As women were not eligible to be drafted, the Vietnam War did not affect women directly. However, the draft may have affected women indirectly through male enrollment. Although no one knew exactly how many graduate students had enrolled on account of the draft deferment policy³⁵, as men comprised a majority of graduate students the new policy was expected to have a significant impact on enrollment. For example, Harvard University President Nathan M. Pusey lamented that the only persons entering graduate school due to the more restrictive deferment policy would be “the lame, the halt, the blind, and the female” (“New Draft Policy to Cut Graduate School Enrollment”, 1969).

There are two potential mechanisms that I will be exploring. First, the end of blanket deferments

<https://www.sss.gov/About/History-And-Records/Induction-Statistics>.

³⁴These types of degrees made up around 10 percent of all conferred graduated degrees between 1958 and 1971.

³⁵The Selective Service reports do not distinguish between deferments for undergraduate study v. graduate study.

for graduate school in 1968, particularly for doctoral programs, may have subsequently increased female enrollment in Fall 1968 or Fall 1969 and manifested in an effect in Spring 1974 or Spring 1975 (assuming it takes six years to complete a Ph.D.). Second, when the draft ended in 1973³⁶, the rush of young men enrolling in health professional programs to avoid the Vietnam War also ended. The sudden ebb of male enrollment in health professional programs (defined as degrees in medicine, dentistry, veterinary medicine, osteopathy, and optometry) thus allowed women to fill the void, thereby resulting in a sudden increase in the number of women with health professional degrees. In this case, the observed discontinuity in convergence trend is not a result of the passage of Title IX, but a result of the end of draft deferment policies during the Vietnam War.

I will now discuss why I believe that these two explanations do not fully explain the observed discontinuity. The first is that the discontinuity in convergence trend appears to be driven by master's degrees rather than doctoral degrees, as evidenced in Figure 7. Because draft deferments for graduate study ended in 1968 (with the exception of health professional degrees) and master's programs are usually two years, it is unlikely that the end of draft deferments for graduate study in 1968 led to a sudden increase in female master's degrees *six years later*, in Spring 1975. Further, although the data reveal that men responded to deferment incentives by pursuing a doctoral degree, I do not see strong evidence that female enrollment rose to fill the void created by a lack of male enrollment when draft deferments for doctoral studies ended.³⁷

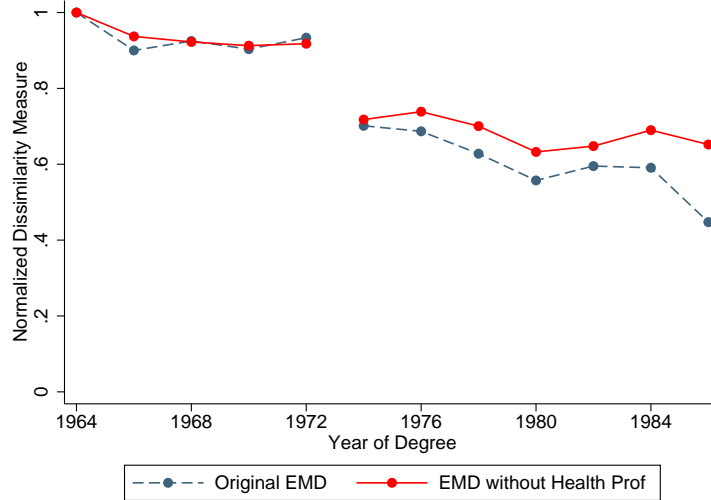
The second reason I do not believe the Vietnam War draft deferment policy is driving my results is that the discontinuity is not driven by health professional degrees, which are the degrees that qualified for the deferment throughout the Vietnam War. To examine this alternative explanation, I estimate distributional convergence without health professional degrees and see if there is still a discontinuity in convergence trend between female and male distributions. Figure 8 plots the new normalized EMD values, which compare female and male distributions of graduate degree-fields without health professional degrees, against the original normalized EMD values.

There is still a marked break in the convergence trend between degrees earned in 1972/1973 and 1974/1975. This figure suggests that health professional degrees, or the degrees that qualified for Class II-S postgraduate deferments during the Vietnam War, are not driving my convergence results. Further, the alternative explanation is not consistent with the timing of the event. If the male influx into health professional degrees stopped in 1972, when the draft ended, then we should see an effect in female conferred degrees starting in Spring 1977 (assuming female entry spiked in Fall 1972, and it takes four years to degree completion). However, the data show a break two to three years after 1972. As health professional degrees require four

³⁶The 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.

³⁷These results are presented in the Online Appendix at <https://goo.gl/h4MEaw>.

Figure 8: Female-Male Convergence with and without Health Professional Degrees



Source: NSCG 1993 data.

Notes: This figure plots normalized EMD values between female and male graduate-field distributions with and without health professional degrees. Health Professional degrees are defined as graduate degrees in medicine, dentistry, veterinary medicine, osteopathy, and optometry. Lines are connected values allowing for a break between 1972 and 1974. The break year was determined by looking for a structural break in the data. Year of degree encompasses two-year cells.

years of schooling, the timing does not line up.

6.2 Changes in Fertility Control

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.³⁸ 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.³⁹ 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

³⁸For 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.

³⁹These 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).

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 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. The 1950 and 1951 birth cohorts were already at the age of majority when most of these state laws changed, meaning they already had access to the pill (see Table 1). In fact, female students were able to obtain the pill on campus before the changes in 1971: 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).

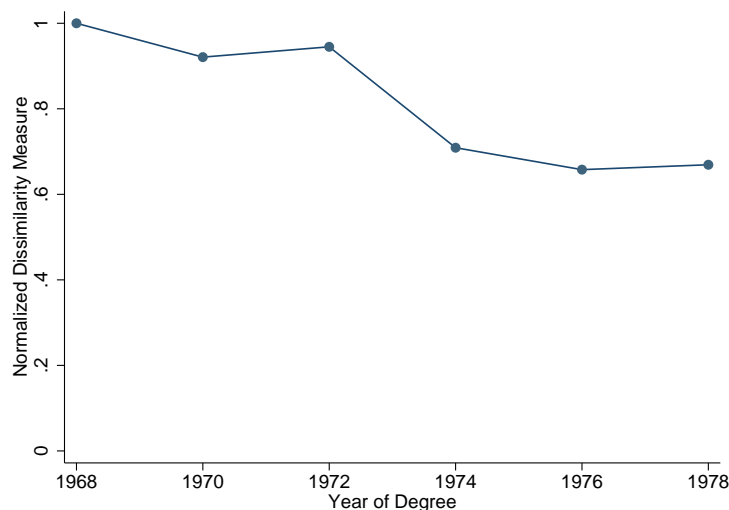
The second reason I do not think increased pill access is a major confounder is that I find differential effects by the field’s gender parity (see Figure 7). As the pill lowered the cost of making long-term career investments, pill access may have influenced a young woman’s decision to pursue a doctoral 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 business grew at a faster rate than female M.A. degrees in education. It is not clear why pill access would affect a woman’s decision to pursue a business 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.

I attempt to disentangle the impact of pill access from Title IX by focusing on individuals that 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 allowing 19 year olds to obtain the pill before 1967.⁴⁰ These states are: Alaska, Arkansas, Idaho, Illinois, Kentucky, Mississippi, Montana,

⁴⁰To 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

Nevada, North Dakota, Ohio, Oklahoma, and Utah. I focus on degrees conferred between 1968 and 1979 and plot the EMD values in Figure 9.

Figure 9: Gender Convergence in States with Teen Pill Access before 1967



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

Notes: This figure plots normalized EMD values between female and male graduate-field distributions among individuals born in states that passed laws granting 19 year olds pill access in 1968 or earlier. Year of degree encompasses two-year cells.

Consistent with the main results, a discontinuity exists in the convergence trend. Female and male graduate-field distributions become 24 percentage-points more similar between degrees conferred in 1972/1973 and 1974/1975, 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 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).⁴¹ 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.

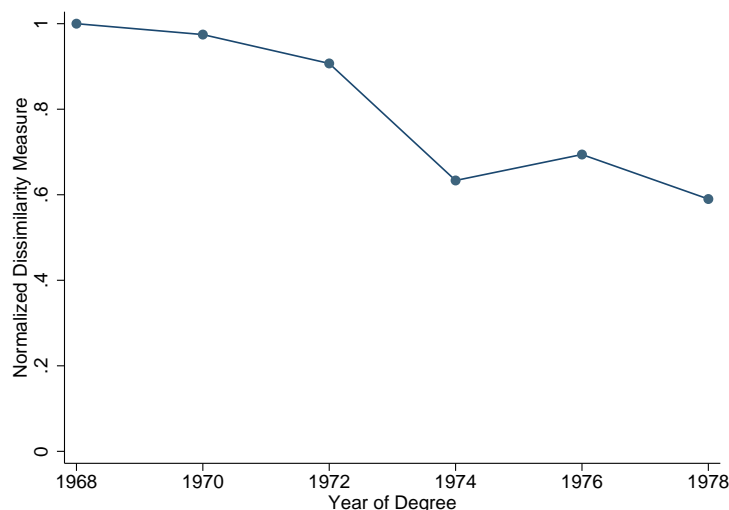
The last alternative explanation I will discuss is the 1973 landmark U.S. Supreme Court case *Roe v.*

and retrieved from <https://nces.ed.gov/programs/digest/d95/dtab197.asp>.

⁴¹After 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*.

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. However, the main reason I do not believe this Supreme Court ruling is driving my results is because of the discrepancy in timing. Looking at Table 1, the cohorts of interest needed to have applied for graduate school in Fall 1972 in order to explain the observed discrepancy. *Roe v. Wade*, however, was passed in January 1973, likely after most applications were in.

Figure 10: Gender Convergence in States that Legalized Abortion in 1970/1971



Source: NSCG 1993 data.

Notes: This figure plots normalized EMD values between female and male graduate-field distributions among individuals born in states that legalized abortion in 1970 and California, which legalized abortion in 1971. Year of degree encompasses two-year cells.

As a robustness check, I estimate gender convergence in the five Repeal States that legalized abortion in 1970. These states are Alaska, California, Hawaii, New York, and Washington.⁴² Similar to the pill analysis, I focus on graduate-degree fields earned between 1968 and 1978 by individuals born in these five states. Figure 10 plots the EMD values. As before, a discontinuity exists in the convergence trend between degrees conferred in 1972/1973 and 1974/1975, even in states where abortion was legal. Female and male graduate-field distributions become 27 percentage-points more similar, supporting the argument that legalized abortion is not driving my results.

⁴²California legalized abortion in 1971.

7 Discussion

During the 1960s, nearly 16 percent of working women were secretaries, administrative assistants, and office clerks.⁴³ By 2000, the occupational distribution for women looked very different. Thirty-six percent of U.S. lawyers and judges and 32 percent of U.S. physicians and surgeons were female.⁴⁴ 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 that 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 a natural experiment. 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.⁴⁵ 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

⁴³This number is based off women aged 35 to 45 in the 1960 Census IPUMS 5 percent sample and the 1965-1969 Current Population Survey.

⁴⁴These statistics are based off the 2000 Census IPUMS 5 percent samples for people aged 35 to 45.

⁴⁵Reardon 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.

data also support this explanation; institutions that relied more on federal funding experienced larger female enrollment growth rates. 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 largest increase in over fifty years between 1929 and 1983 (Cole, 1986, Table 1).⁴⁶ In terms of policy implications geared towards reducing gender disparity in education, this paper provides optimistic evidence for the role of legislation.

⁴⁶This 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). In the Online Appendix, I examine whether EEOA affected female educational choices. The Online Appendix can be found at <https://goo.gl/h4MEaw>. I do not find supportive evidence that EEOA directly impacted female decisions, 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.

References

- 118 Cong. Rec. 5803. (1972). *Title IX - Prohibition of Sex Discrimination*. Retrieved from <https://www.gpo.gov/fdsys/>
- 40 Fed. Reg. 24128. (1975). *Nondiscrimination on Basis of Sex*. Retrieved from <https://www.loc.gov/item/fr040108/>
- Acemoglu, D., & Angrist, J. D. (2001). Consequences of employment protection? The case of the Americans with Disabilities Act. *Journal of Political Economy*, 109(5), 915–957.
- Bailey, M. J. (2006). More power to the pill: the impact of contraceptive freedom on women’s life cycle labor supply. *Quarterly Journal of Economics*, 289–320.
- Bailey, M. J. (2010). “Mamma’s Got the Pill”: How Anthony Comstock and Griswold v. Connecticut Shaped US Childbearing. *American Economic Review*, 100(1), 98–129.
- Barbato, L. (1970). Study of the Prescription and Dispensing of Contraceptive Medications at Institutions of Higher Education. *Journal of the American College Health Association*, 19(1), 303–306.
- Beegle, K., & Stock, W. A. (2003). The Labor Market Effects of Disability Discrimination Laws. *Journal of Human Resources*, 38(4), 806–859.
- Beller, A. (1977). The Impact of Equal Employment Opportunity Laws on the Male/Female Earnings Differential. *University of Wisconsin-Madison Working Paper No. 436-77*.
- Beller, A. (1982a). The Impact of Equal Employment Opportunity Policy on Sex Differentials in Earnings and Occupations. *American Economic Review Papers and Proceedings*, 72(2), 171.
- Beller, A. (1982b). Occupational Segregation by Sex: Determinants and Change. *Journal of Human Resources*, 17(3), 371.
- Black, S. E., & Juhn, C. (2000). The Rise of Female Professionals: Are Women Responding to Skill Demand? *American Economic Review*, 90(2), 450–455.
- Blau, F. D., Brummund, P., & Liu, A. Y.-H. (2013). Trends in occupational segregation by gender 1970–2009: Adjusting for the impact of changes in the occupational coding system. *Demography*, 50(2), 471–492.
- Blau, F. D., & Kahn, L. M. (1997). Swimming upstream: Trends in the gender wage differential in the 1980s. *Journal of Labor Economics*, 15(1, Part 1), 1–42.
- Blau, F. D., & Kahn, L. M. (2006). The us gender pay gap in the 1990s: Slowing convergence. *ILR Review*, 60(1), 45–66.
- Blau, F. D., Kahn, L. M., & Waldfogel, J. (2000). Understanding young women’s marriage decisions: The role of labor and marriage market conditions. *ILR Review*, 53(4), 624–647.
- Buek, A. P., & Orleans, J. H. (1973). Sex discrimination: A bar to a democratic education: Overview of Title IX of the education amendments of 1972. *Conn. L. Rev.*, 6, 1.
- Chay, K. (1998). The Impact of Federal Civil Rights Policy on Black Economic Progress: Evidence from the Equal Employment Opportunity Act of 1972. *Industrial and Labor Relations Review*, 51(4), 608.
- Cole, S. (1986). Sex Discrimination and Admission to Medical School, 1929–1984. *American Journal of Sociology*, 92(3), 549–567.
- Comment. (1976). Implementing Title IX: The HEW Regulations. *University of Pennsylvania Law Review*, 124(3), 806–842. Retrieved from <http://scholarship.law.upenn.edu/penn-law-review/vol124/iss3/5/>
- Donohue III, J. J., & Heckman, J. (1991). Continuous versus episodic change: The impact of civil rights policy on the economic status of blacks. *Journal of Economics Literature*, 29(4), 1603–1643.
- Duncan, O. D., & Duncan, B. (1955). A Methodological Analysis of Segregation Indexes. *American sociological review*, 20(2), 210–217.
- Eisenstadt v. Baird*, 405 U.S. 438. (1972). Retrieved from <http://caselaw.findlaw.com/us-supreme-court/405/438.html>
- Flood, S., King, M., Ruggles, S., & Warren, J. R. (2017). *Integrated Public Use Microdata Series, Current Population Survey: Version 5.0 [dataset]*. Minneapolis, MN: University of Minnesota. Retrieved from

<https://doi.org/10.18128/D030.V5.0>

- Goldin, C. (1988). *Marriage bars: Discrimination against married women workers, 1920's to 1950's*. National Bureau of Economic Research Cambridge, Mass., USA.
- Goldin, C., & Katz, L. F. (2002). The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions. *Journal of Political Economy*, 110(4), 730-770.
- Green, E. (September 13, 1965). *To President Beadle*. Retrieved from the University of Chicago, Special Collections Research Center, Office of the President Records, Edward H. Beadle (1961-1968).
- Grove City College v. Bell*, 465 U.S. 555. (1984). Retrieved from <http://caselaw.findlaw.com/us-supreme-court/465/555.html>
- Heckman, J. J., & Payner, B. S. (1989). Determining the impact of federal antidiscrimination policy on the economic status of blacks: a study of south carolina. *American Economic Review*, 79(1), 138-177.
- Heckman, J. J., & Sedlacek, G. (1985). Heterogeneity, aggregation, and market wage functions: An empirical model of self-selection in the labor market. *Journal of Political Economy*, 93(6), 1077-1125.
- Hock, H. (2007). *The pill and the college attainment of American women and men*.
- Hsieh, C.-T., Hurst, E., Jones, C. I., & Klenow, P. J. (2016). The Allocation of Talent and U.S. Economic Growth.
- If Your Daughter Wants to Go to College. (May 24, 1965). *U.S. News & World Report*, 54-55.
- Mason, M. A., & Younger, J. (2014). Title IX and Pregnancy Discrimination in Higher Education: The New Frontier. *NYU Rev. L. & Soc. Change*, 38, 269.
- Massey, D. S., & Denton, N. A. (1988). The dimensions of residential segregation. *Social forces*, 67(2), 281-315.
- Mulligan, C. B., & Rubinstein, Y. (2008). Selection, Investment, and Women's Relative Wages over Time. *Quarterly Journal of Economics*, 1061-1110.
- Myers, C. K. (2007). A cure for discrimination? Affirmative action and the case of California's Proposition 209. *ILR Review*, 60(3), 379-396.
- Myers, C. K. (2016). *Young Women's Access to Abortion and Contraception, 1960-present* (Tech. Rep.).
- Myers, C. K. (2017). Power of the Pill or Power of Abortion? Re-examining the effects of young women's access to reproductive control. *Journal of Political Economy*, *Forthcoming*.
- Neumark, D., & Stock, W. A. (1999). Age Discrimination Laws and Labor Market Efficiency. *Journal of Political Economy*, 107(5), 1081-1125.
- Neumark, D., & Stock, W. A. (2006). The labor market effects of sex and race discrimination laws. *Economic Inquiry*, 44(3), 385-419.
- New Draft Policy to Cut Graduate School Enrollment. (1969). In J. Austin (Ed.), *CQ Almanac 1968 (24th ed.)*. Washington, DC: Congressional Quarterly. Retrieved from <https://library.cqpress.com/cqalmanac/document.php?id=cqal68-1282246>
- Paul, E. W., Pilpel, H. F., & Wechsler, N. F. (1974). Pregnancy, teenagers and the law, 1974. *Family Planning Perspectives*, 142-147.
- Reardon, S. F., & Owens, A. (2014). 60 Years After *Brown*: Trends and Consequences of School Segregation. *Annual Review of Sociology*, 40, 199-218.
- Rose, W. L., Graham, P. A., Grey, H., Schorske, C., & Smith, P. (November 9, 1970). Report of the American Historical Association Committee on the Status of Women (1970). Retrieved from <https://www.historians.org/about-aha-and-membership/aha-history-and-archives/historical-archives/report-of-the-aha-committee-on-the-status-of-women>
- Rubner, Y., Tomasi, C., & Guibas, L. J. (2000). The Earth Mover's Distance as a Metric for Image Retrieval. *International Journal of Computer Vision*, 40(2), 99-121.
- Samuelson, Robert J. (July 3, 1967). LBJ Signs Draft Law Cutting Graduate 2-S. *The Harvard Crimson*. Retrieved from <http://www.thecrimson.com/article/1967/7/3/lbj-signs-draft-law-cutting-graduate/>
- Smith, J. P., & Ward, M. (1985). Time-series growth in the female labor force. *Journal of Labor Economics*, 3(1, Part 2), S59-S90.

- Smith, J. P., & Ward, M. (1989). Women in the Labor Market and in the Family. *Journal of Economic Perspectives*, 3(1), 9–23.
- Steven Ruggles, R. G. J. G., Katie Genadek, & Sobek, M. (2017). *Integrated Public Use Microdata Series: Version 7.0 [dataset]*. Minneapolis, MN: University of Minnesota. Retrieved from <https://doi.org/10.18128/D010.V7.0>
- Stevenson, B. (2010). Beyond the classroom: Using Title IX to measure the return to high school sports. *Review of Economics and Statistics*, 92(2), 284–301.
- Stromquist, N. P. (1993). Sex-equity legislation in education: The state as promoter of womens rights. *Review of Educational Research*, 63(4), 379–407.
- United States. Congress. House. Committee on Education and Labor. Special Subcommittee on Education. (Discrimination Against Women). (1970). *Discrimination Against Women: Hearings before the Special Subcommittee on Education of the Committee on Education and Labor, House of Representatives, 91st Congress, 2d Session, on Section 805 of H.R. 16098*. Washington, DC: Government Printing Office.
- United States. Congress. House. Committee on Education and Labor. Subcommittee on Postsecondary Education. (Sex Discrimination Regulations). (1975). *Sex Discrimination Regulations: Hearings before the Subcommittee on Postsecondary Education of the Committee on Education and Labor, House of Representatives, 94th Congress, 1st Session: Review of regulations to implement Title IX of Public Law 920318 conducted pursuant to Sec. 431 of the General Education Provisions Act, Washington, D.C.* Washington, DC: Government Printing Office.
- United States Selective Service System (Selective Service Report 1966). (January 3, 1967). *Annual Report of the Director of Selective Service for the fiscal year 1966 to the Congress of the United States pursuant to the Universal Military Training and Service Act as amended*. Washington, DC: Government Printing Office.
- United States Selective Service System (Selective Service Report 1967). (January 15, 1968). *Semi-Annual Report of the Director of Selective Service for the Period July 1 to December 31, 1967 to the Congress of the United States pursuant to the Military Selective Service Act of 1967*. Washington, DC: Government Printing Office.
- United States Selective Service System (Selective Service Report 1968). (January 15, 1969). *Semi-Annual Report of the Director of Selective Service for the Period July 1 to December 31, 1968 to the Congress of the United States pursuant to the Military Selective Service Act of 1967*. Washington, DC: Government Printing Office.
- United States Selective Service System (Selective Service Report 1969). (January 15, 1970). *Semi-Annual Report of the Director of Selective Service for the Period July 1 to December 31, 1969 to the Congress of the United States pursuant to the Military Selective Service Act of 1967*. Washington, DC: Government Printing Office.
- United States Selective Service System (Selective Service Report 1970). (October 15, 1970). *Semi-Annual Report of the Director of Selective Service for the Period January 1 to June 30, 1970 to the Congress of the United States pursuant to the Military Selective Service Act of 1967, as amended*. Washington, DC: Government Printing Office.
- U.S. Department of Education, National Center for Education Statistics. (n.d.-a). *Classification of Instructional Programs - 2010 (CIP 2010)*. Retrieved from <https://nces.ed.gov/ipeds/cipcode/browse.aspx?y=55>
- U.S. Department of Education, National Center for Education Statistics. (n.d.-b). *Higher Education General Information Survey (HEGIS): Earned Degrees 1965-1981 [Computer file]*. ICPSR version. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor].
- U.S. Department of Education, National Center for Education Statistics. (n.d.-c). *Higher Education General Information Survey (HEGIS): Fall Enrollment 1967-1975 [Computer file]*. ICPSR version. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor].
- U.S. Department of Education, National Center for Education Statistics. (n.d.-d). *Higher Education General Information Survey (HEGIS): Financial Statistics 1968-1969 [Computer file]*. ICPSR version. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor].

- U.S. Department of Justice (DOJ). (2012). *Equal Access to Education: Forty Years of Title IX*. Washington, DC: Government Printing Office.
- Valentin, I. (1997). Title IX: A brief history. *Holy Cross JL & Pub. Pol'y*, 2, 123.

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:

$$f_{ij} \geq 0, \quad 1 \leq i \leq K, \quad 1 \leq j \leq K \quad (6)$$

$$\sum_{i=1}^K f_{ij} \leq s_i^m, \quad 1 \leq i \leq K \quad (7)$$

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

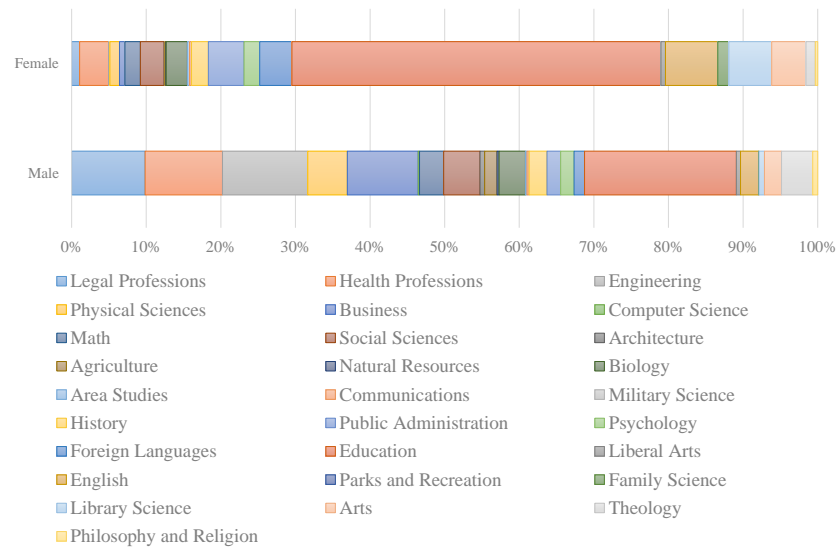
$$\sum_{i=1}^K \sum_{j=1}^K f_{ij} = \min \left(\sum_{i=1}^K s_i^m, \sum_{j=1}^K s_j^w \right) \quad (9)$$

Constraint (6) allows moving people from M to W and not vice versa. Constraint (7) 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 (8) is the analog for occupation categories in F ; and constraint (9) 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:

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

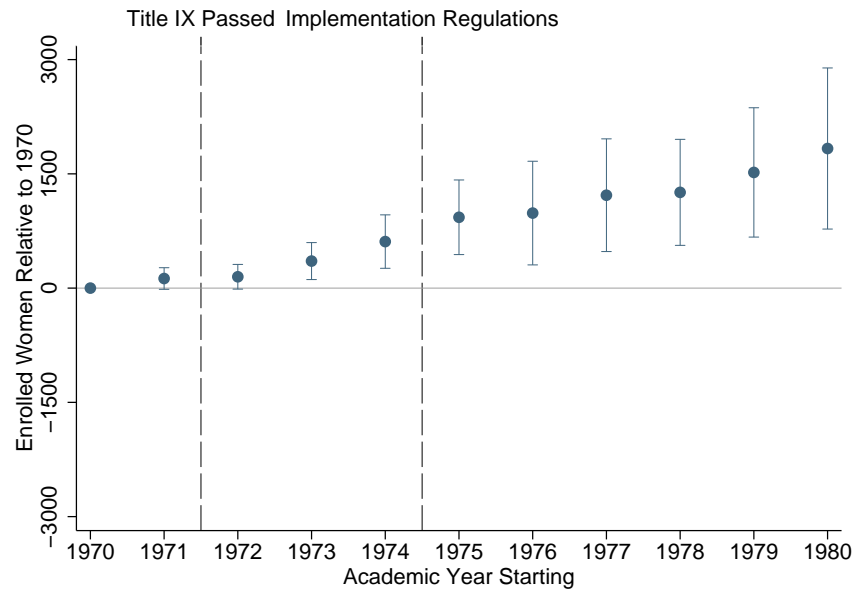
The normalization factor is the total weight of the smaller distribution, because of constraint (9). Thus, the EMD naturally extends the notion of the dissimilarity between two distributions.

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



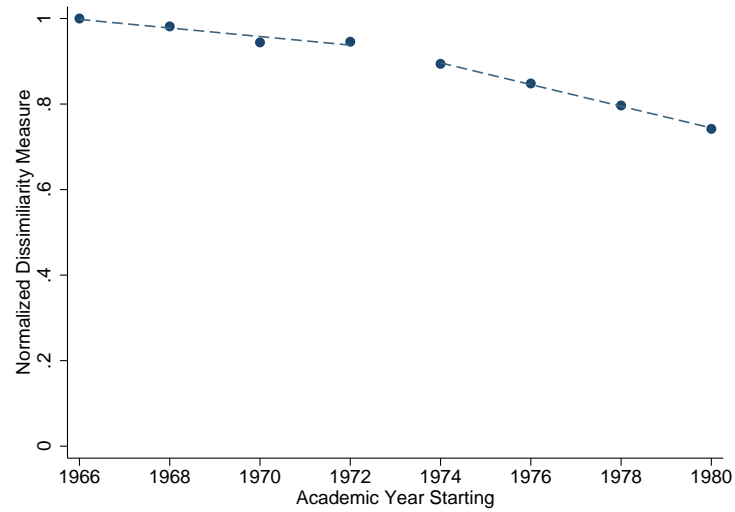
Source: HEGIS 1965 Earned Degrees data.
Notes: N = 190,507. This figure depicts the field's share of graduate degrees conferred in academic year 1965-1966, separately by sex. Fields are listed in decreasing order of median salary.

Figure A2: Change in Female Enrollment in Schools with Low Federal Funds Share



Source: HEGIS 1968-1980 Fall Enrollment data and 1968-1971 Financial Statistics data. Notes: $N = 32,231$. Graduate school enrollment data begin in 1970 so dots depict each year's difference in female enrollment relative to 1970 in Tercile 1 (low) schools. Terciles are based on the average share of a school's educational revenue that comes from the federal government between 1968 and 1972. Vertical dashed lines indicate when Title IX and its compliance regulations were signed into law (June 1972 and May 1975, respectively). Estimates control for school and state fixed effects and are weighted by the school's total enrollment. Standard errors are clustered by state, and wings are 95% confidence intervals.

Figure A3: Gender Convergence in Graduate Fields of Study using HEGIS data



Source: HEGIS 1965-1984 Earned Degrees data.

Notes: 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. The break year was determined by looking for a structural break in the data. Academic year encompasses two-year cells.

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

Fields in the Top Tercile

Architecture and Related Services
 Business, Management, Marketing, and Related Support Services
 Computer and Information Sciences and Support Services
 Engineering
 Engineering Technologies and Engineering-Related Fields
 Health Professions and Related Programs
 Legal Professions and Studies
 Mathematics and Statistics
 Physical Sciences
 Social Sciences

Fields in the Middle Tercile

Agriculture, Agriculture Operations, and Related Sciences
 Area, Ethnic, Cultural, Gender, and Group Studies
 Biological and Biomedical Sciences
 Communication, Journalism, and Related Programs
 History
 Homeland Security, Law Enforcement, Firefighting and Related Protective Services
 Natural Resources and Conservation
 Psychology
 Public Administration and Social Service Professions

Fields in the Bottom Tercile

Education
 English Language and Literature/Letters
 Family and Consumer Sciences/Human Sciences
 Foreign Languages, Literatures, and Linguistics
 Liberal Arts and Sciences, General Studies and Humanities
 Library Science
 Parks, Recreation, Leisure, and Fitness Studies
 Philosophy and Religious Studies; Theology and Religious Vocations
 Visual and Performing Arts

Source: NSCG 1993 data.

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

Fields in the Top Tercile (Lowest 1962-1970 Female Share)

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
 Engineering Technologies and Engineering-Related Fields
 Homeland Security, Law Enforcement, Firefighting and Related Protective Services
 Legal Professions and Studies
 Philosophy and Religious Studies; Theology and Religious Vocations
 Physical Sciences

Fields in the Middle Tercile

Biological and Biomedical Sciences
 Communication, Journalism, and Related Programs
 Health Professions and Related Programs
 History
 Mathematics and Statistics
 Natural Resources and Conservation
 Parks, Recreation, Leisure, and Fitness Studies
 Social Sciences
 Visual and Performing Arts

Fields in the Bottom Tercile (Highest 1962-1970 Female Share)

Area, Ethnic, Cultural, Gender, and Group Studies
 Education
 English Language and Literature/Letters
 Family and Consumer Sciences/Human Sciences
 Foreign Languages, Literatures, and Linguistics
 Liberal Arts and Sciences, General Studies and Humanities
 Library Science
 Psychology
 Public Administration and Social Service Professions

Source: NSCG 1993 data.