Sex Segregation in Fields of Doctoral Degrees in the United States, 1971-1998: A Methodological and Empirical Analysis Using Segregation Indices Describing Evenness

Abstract

This paper uses the NECS data on doctoral degree recipients' gender distribution in over 200 detailed academic fields in the United States from 1971 to 1998. The author addresses the following questions: 1) does the overall gender-based segregation mostly come from within or between broad areas; 2) are fields getting more integrated or segregated by gender in the last 28 years; 3) of all fields, which ones contribute the most to the changing trend. In order to answer the above questions, the author used multiple segregation indices that measure evenness, including Theil's H, the index of dissimilarity (D), size-standardized D (SSD), and Charles and Grusky's A (A). The decomposition of H showed that six broad areas, Engineering, Social and Behavioral Science, Humanities, Science/Mathematics, Business and Health/Applied Social Science, got increasingly integrated within themselves. The between-area segregation gradually accounted for a higher percentage in the overall segregation. From 1971 to 1980, the gender-based segregation of American doctoral degree recipients decreased. From 1980 to 1990, some large fields such as Clinical Psychology grew segregated and some segregated fields such as Mechanical Engineering and Nursing grew larger; however, due to the offsetting effects, the trend was sensitive to which index is used. From 1990 until now, the gender segregation level decreased negligibly. Overall, America's educational elite is feminizing, but the large declines in field segregation of the 1970s had largely stalled by the end of the century.

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Introduction

The gender distribution of American higher education has received extensive attention from researchers because of the inseparable relation between the segregation in labor force and in higher education. Studies have discovered the vertical and horizontal relation between gender and occupations, i.e. women concentrate in lower pay jobs or some certain categories of occupations. Over time, especially after the 1972 Title IX provisions of the Higher Education Acts, women's enrollment in higher education, from associate degree programs to Master's and doctoral degree programs, has increased tremendously (Jacobs 1985). Various research on the non-doctoral degree sector of higher education emerged as people with degrees lower than doctorates are the main supply to the labor force for nearly all occupations. Some scholars even focused narrowly on one discipline, such as Medicine. Moreover, cross-country studies are also available, exploring gender segregation in Australian, British and some other European countries' higher education.

At the same time, the segregation of male and female faculty by fields has not been entirely ignored and become increasingly interesting, as American doctoral programs have seen a dramatic increase of female faces. Unfortunately, the doctoral degrees recipients are the under-investigated group comparing to the degrees recipients at other levels of the higher education. Only Jacobs (1985) and Ransom (1990) have explored the gender distribution and its changing trend among American doctoral degree recipients. Jacob's data cover 1948 to 1980 and Ransom's data spanned from the mid-1970s to the mid-1980s. Studies focusing on years after 1985 are not available.

Moreover, most of the previous research on higher education has two features. First, the crude classification of fields: degrees are only categorized into several fields of study for the sake of simplicity or due to the limitation of available data.[1] Second, the focus on explanation rather than describing the trend accurately: researchers usually put less effort in finding the most convincing way of measuring segregation than explaining why gender segregation increases or decreases based on the results they received by measures of segregation selected because they are the most widely used.

The author uses a dataset constructed on the basis of the NECS annual data. The dataset divides all fields into more than two hundred categories that grant doctoral degrees from 1971 to 1998. During the period, the overall percentage of doctoral degree recipients who were female increased from 14% to 42%. Most of the increase came from the increment of the number of females because the absolute number of male doctorates remains nearly unchanged during the time. With the help of the data that have more refined categories than other research, the author will answer the following questions: 1) putting the approximately two hundred fields into six larger areas, does the gender

[1] For example, Watts (1997) classified all degrees into only ten disciplines.

segregation mostly come from the segregation within areas (such as engineering or social and behavioral science), or does it mostly come from the between-area segregations; 2) did American doctoral programs get more integrated or segregated by gender in the last 28 years; 3) of all fields, which ones contribute the most to the changing trend. The paper uses multiple indices while attempting answering the above questions. Methodologically, the author tries to choose different indices for different tasks.

Past research on gender segregation in doctorate degree recipients and higher education in general

Ransom (1990) uses data from nationwide surveys of college and university faculties as well as the data on doctorate degrees granted from the 1970s and 1980s. He found a slight decrease of gender-based segregation among faculty members during the early 1970s but an increase of segregation among doctoral degree recipients from mid 1970s to 1980s. This research used a rough classification of fields (only four of them: Nursing, Humanities, Social Sciences, Engineering), looking only at the segregation between the large fields.

In his large-scale research on American higher education, Jacobs (1985: 211) found that from 1948 to 1980 “sex segregation by specialty declined among Associate, Bachelor’s and Master’s and professional degree recipients.” He also surprisingly found that among doctoral degree recipients, the sex segregation was stable across years. He used a rough classification of fields (20 fields) in the analysis. D is used as the measurement of segregation in his research. Jacobs tried to explain the phenomenon by reasons such as gender differences in educational background, and career choices between men and women before and after they entered college.

Wilson and Boldizar (1990) tried to explain the gender-based segregation among college students in different majors from the perspective of the students' mathematics achievement. They found that from 1973 to 1983, college women still concentrated in fields with lower mathematics achievements. Boulis, Jacobs and Veloski (2001) found that in medical schools, women became increasingly concentrated in certain specialties such as pediatrics and family practice. The change within schools reflects a larger national change in the physician workforce in terms of gender distribution.

Cross-national or international studies on gender-based segregation among fields in the higher education cover Australia, Britain, other European countries and even the whole globe. Watts (1997) used the Karmel and Maclachlan[2] index to measure the gender segregation of course completions across fields of study in Australian higher education from 1978 to 1994. He found that "although women continued to raise their share of completions over the period, there was little change in the extent of gender segregation in aggregated and segregation increased in Masters and Bachelors courses." (Watts 1997:45) Watts only used 10

[2] The Karmel and Maclachlan index is the one that Watts (1995) claimed that was more advantageous than Charles and Grusky's A. This paper does not go deep into the debate of Watts vs. Charles and Grusky.

fields of studies in his research.[3] Rich (1999) studied the gender segregation in the academic staff of universities in Great Britain and the U.S. from 1980 to 1993. He also used the Karmel and Maclachlan index and found that all levels of academic employment have seen a decrease of gender-based segregation in Britain over the 12 years. The decline at each level is six times higher in US institutes of higher education. Rich used 9 categories of fields in the research.[4] Ramirez and Wotipka's (2001) study showed that, from 1972 to 1992, women's enrollments in science and engineering fields in higher education increased globally.

Generally, scholars discover a trend of reduced gender-based segregation in higher education both in the U.S. and other countries. Science and Engineering fields, which are traditionally regarded as "male fields," have seen more female students' enrollment relative to male students across time. That is to say, there is less and less gender segregation within the Science and Engineering fields. Are those statements true for American doctoral degree recipients? This is what this research wants to find out.

Segregation Indices and Measurements of Evenness

The central idea of segregation indices is to quantify the distribution of a social feature, such as race, gender, or social economic status within a certain

[3] The ten fields are: Agriculture; Architecture Building; Art, Humanities & Social Sciences; Business, Administration & Economics; Education; Engineering surveying; Health Medicine; Law, Legal Studies; Science; Veterinary.

[4] The categories of fields are: Education; Medicine; Engineering; Agriculture; Biological; Administrative; Architecture; Language; Other arts.

group of entities[5] that have such features, so that the patterns of the distributions can be condensed into one number that is unique to the group under inspection. Therefore, people can compare the segregation level among groups (e.g., cities, or countries) according to the numeric values of the segregation indices. The most common application of segregation indices is to compare the residential segregation of racial groups across cities consisting of geographical tracts, but can also be used for non-residential data such as the data for this research. Here the interest is in sex segregation of doctoral degrees recipients across years in which there are hundreds of fields that grant such degrees in each year.

In 1988, Massey and Denton successfully classified spatial residential segregation into five dimensions by factor analysis: evenness, exposure, centralization, clustering and concentration. However, the last three dimensions have no analogy in non-spatial data. This paper only focuses on the measurement of evenness. According to Massey et al. (1988: 283-284), evenness "refers to the differential distribution of two social groups among areal units in a city." For the non-residential sex segregation data, the definition is the differential distribution of women versus men among different fields in a year. But evenness is not measured in an absolute sense, i.e., measured against 50%.[6] Rather, it is measured

[5] Entities here refer to occupations or census tracts, etc. A group of entities can be a country which has different occupations, or a city that is composed of census tracts

[6] Although the component of H, E, is measured again 50 percent, H is nonetheless about the distribution of female in one field relative to the overall percent female of all fields because it

relative to the overall representation of women among those getting doctorates, i.e., the percentage of female in the whole country across all academic fields together. That is to say, a field or occupation is considered integrated only if the percentage of female in this field is the same as the percent female in the population of all fields in the country in one year. Therefore, if as in year 1971, 12% of the people who received doctorates are female, then the sex distribution of doctorates in this year is considered completely integrated if every single field has 12% female, and, in this case, the sex segregation indices have the minimum value 0. Conversely, if each field contains only males or females in one year, the index should show complete segregation and be maximized at 1.[7]

Scholars have designed quite a few indices to measure evenness. The most famous ones include the index of dissimilarity (Duncan and Duncan 1995), the Gini index (Taeuber and Taeuber 1965), Atkinson's A (Atkinson 1970), Theil's H (Theil 1972; Theil and Finizza 1971), Size-Standardized D (Gibbs 1965; Gross 1968), Karmel and Maclachlan index (Karmel and Maclachlan 1988), and Charles and Grusky's A (Charles and Grsuky 1995). The history of the development of segregation measurements is full of debate, disagreement and overrule. Scholars have used data simulation, formula derivation and many other ways to assess the advantages of one or some indices over others.

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compares fields' difference from 50% to the difference between 50% and the overall percent of female.

[7] The maximum value of segregation will be 1 for most indices, but Charles and Grusky's A is an exception because it does not have upper ceiling.

Little by little, the debate of segregation indices started to focus on the index of dissimilarity (D), the most popular and easy to understand index. The modifications of and alternatives to the D are discussed extensively, mainly on two issues, which are also the two important standards assessing the segregation indices. In the present application, these can be called field invariance and sex invariance. Field invariance means that a change in the relative size of each field does not affect the index value if the sex ratio of each field does not change. The sex invariance means that a change in the sex ratio does not change the index value if the relative size of fields does not change (James and Taeuber 1985; Massey et al. 1988; Charles and Grusky 1995).

The most valuable feature of D is "sex invariance" (James et al. 1985), or as Charles et al. (1995: 935) said, "the value of D is unaffected by simple multiplicative transformations of the sex ratio and consequently it can safely be used to compare countries, cities, or time periods with differing rates of female labor force participation." However, the biggest problem of D is that it is dependent on field composition (the "occupational composition" in Charles and Grusky's 1995 application), which is the size of each field relative to the total population in each year. Size-standardized D solves the "field variance" problem but is not "sex invariant."

There are two ways to solve this problem: decomposing D (Watts 1998a) or creating a brand new index that is invariant to both the change of relative field size and the sex ratio. Charles et al. (1995) thought that building a real margin-free index was the best way out. However, Watts (1998b) argued that Charles and Grusky's invention is problematic[8] and suggested going back to the Karmel-Maclachlan decomposition[9] (Watts 1998b) to solve the field and sex variance problem.

While the debate between D, SSD and A has not ceased, H has started to receive more attention in recent years. Reardon and Firebaugh (2002) reintroduced Theil's entropy index of segregation (H) (Theil 1972) with four other multiple-group indices. Since H is not yet very commonly used (several examples of the usage of H are in Kulis 1997; Miller and Quigley 1990; White 1987), Reardon and Firebaugh explained it in detail in their article in 2000 and emphasized its decomposition features. H can be decomposed in two ways, one of which is relevant to the problem here. It allows decomposition of the overall segregation score based on all academic fields into between-area and within-area segregation, when all fields are divided into a smaller number of broad areas.

H, D, SSD, and A (by Charles and Grusky) will be used in this research. Table 1 shows the characteristics of the four indices in terms of field and sex

[8] Watts stated that due to the nature of log odd ratio, Charles and Grusky's A is undefined if there are 0s in the data. Moreover, Charles et al. used broad category of occupations in their examples of designing the index, which may also cause problem according to Watts.
[9] Karmel and Maclachlan decomposition is based on the IP index designed by Karmel and Maclachlan. Watts and Rich proposed that the K and M decomposition method could help the researchers "identify the source of change in the overall pattern of segregation." (See Watts 1992, 1995; Rich 1993)

invariance, together with the formulas of each index. H assesses the sum of the deviation of diversity extent (E_i) in each field from the overall diversity (E). The entropy (E_i and E) measures the diversity of a field. Entropy reaches the maximum when there are 50% female and 50% male in the field. However, H is nonetheless about the distribution of female in one field relative to the overall percent female of all fields because it compares fields' difference from 50% to the difference between 50% and the overall percent of female. The index of dissimilarity (D) is the maximum vertical distance between the Lorenz's curve and the diagonal line of evenness. It measures the proportion of females that needs to change the field they are in to achieve an even distribution or total integration[10] (Duncan and Duncan, 1955). This number of women who would have to move to achieve integration is expressed as a proportion of the number that would have to move in the situation of maximum segregation (Jakubs 1977, 1981). Size-standardized D is a modification of D, and it ensures that two fields of the same percent female will contribute the same to the magnitude of SSD regardless of the size of the two fields. Therefore, if fields do not change their sex composition, a change in the relative size of field will not lead to a change in the index over time. However, if one wants the index to capture the degree of segregation experienced by the average person, this may be seen as a

[10] Integration means in any field the proportion of females over the population in the field is the same as the overall proportion of females in the total population.

disadvantage, and one may want bigger fields to count more, as they do in D. The A is established on the basis of log linear models. The log odds ratio of percent female in each field [$\ln(p_i/(1-p_i)) = \ln(F_i/M_i)$][11] is the major component of the index's formula. Compared to all previous indices, A uses a different approach to measure segregation because it totally abandons the "scalar summary" method but turns to the log multiplicative approach.

<insert Table 1 here>

Data

The dataset used in this paper is drawn from data published annually by the National Center of Education Statistics (NCES) on the number of men and women who received doctorates in all fields of study from academic year 1970-1971 to 1997-1998. In this paper, the author uses 1971 to refer to the academic year 1970-1971. Therefore, the dataset includes data of 28 years from 1971 to 1998.

NCES has changed their classification of fields several times during the twenty-eight year period, especially in 1983, when the number of fields greatly increased. Therefore, some field names disappear with time, and some new field names appear in later years. For the variation of the number of fields, several ways are used to deal with the problem, including using newly emerged fields' names to replace old fields' names if there are only minor changes from the old

[11] To transform from the left side of the equation to the right side, multiply a Ti/Ti, which is the total number of people in field i inside the natural log.

field to the new field, putting the newly emerged fields into the "other" category of an old field, or dropping the new fields.

To begin with, there are 263 fields in the dataset; therefore, the number of observations is 7,364, (263 times 28). After dropping very small fields whose total number of doctorates is less than 100 across the twenty-eight years, there are 202 fields left for the study, which means 5,656 observations (202 times 28). The dataset has 0s in some fields, when the number of females or males one field/year is 0. While calculating H, the author arbitrarily set E_i equal to 0 if in field i, there are only females or males in a certain year. For calculating A, if the denominator of the log odds ratio of one field equals (e.g., there are no male doctorates in that field/year), the log odds ratio of this field/year is arbitrarily set as 0 for the convenience of calculation.[12]

More than one million (1,008,424 for the 202 fields) people have received doctoral degrees in the U.S. from 1971 to 1998. The number of doctorates dropped is approximately 2000 since only the fields that granted less than 100 doctorate degrees in 28 years are excluded. Obviously, the cases dropped are a trivial population for the total population. The largest 18 fields (size ranging from

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[12] This is not an ideal way to deal with the 0 problem. But in my dataset, the fields that have 0 males or females in some years are very few and small in size. Setting the odds ratios of those several field/years do not hurt the accuracy of A badly. I also use another way, which is substituting 1 for the 0s in the data. A based on the data with 1 substitution is nearly the same as the A based on the data that assuming undefined log as 0 (Correlation> .99). Grusky and Charles (1998) suggested using the method of ransacking incomplete or sparse arrays if zero cells convey useful information.

15627 in Sociology to 49896 in Chemistry) take 48 percent of the total population across twenty-eight years. Table 2 has details about the 18 largest fields.

The numbers of doctorates, female, male and total, have changed over the years as well. Figure 1 shows that that the total annual number of female doctorates increased from approximately 5,000 to 20,000. However, the changing magnitude of males is not as dramatic. From 1973 to 1985, the total number of male doctorates even decreased slightly. Although after 1985, male doctorates also saw an increase of 5,000, the changing magnitude is only half that of females increase during this time period.

<insert Figure 1, Table 2 here>

Research Design

Use multiple indices of evenness at the same time

In order to answer the three questions raised earlier, the author needs to measure, analyze and compare gender segregation across years. In this case, a methodological question is inevitable: which index to use to serve which function. Before Duncan et al. (1955) demonstrated that the index of dissimilarity consisted of most of the information that other indices carried, there was a chaotic debate over the nature of segregation and how to measure it (Wright 1937; Jahn Schmid and Schrag 1947; Williams 1948; Cowgwell and Cowgwell 1951; Bell 1952). After Taeuber and Taeuber (1965) confirmed Duncan et al.'s conclusion, most of the debate centered on challenging the leading role of D. The major criticism against D is that D is not field invariant. Regarding the criticisms, variations of D emerged later, making up for some disadvantages of D, such as size-standardized D (SSD) (Charles et al. 1995). But as mentioned above, SSD is field invariant but not sex invariant. Charles et al. (1995) designed a new index, A, claiming that it has the advantages of both D and SSD and does not have their deficiencies. However, not everyone is convinced by using A to replace D and SSD. Moreover, the field invariance of both SSD and A is achieved by, in effect, weighting fields equally regardless of their size. This means they may not give us an accurate picture of the segregation experienced by the average person. In order to get a complete picture of what happened among the doctoral degree recipients in terms of gender-based segregation, the author calculates all three indices, puts the trend of each into one graph and observes the similarities and differences of the three results.[13] The author will also calculate the correlations between the indices using years as units of analysis.

While the indices give largely the same picture to the 1970s and 1990s, the author will point out a conflict: from 1980 to 1990, the trend of D and SSD conflicts while that of SSD and A harmonize. The author focuses on the middle decade to find out which fields are the main causes to the contradiction in the middle decade. The sensitivity analysis below is the method that the author applies to locate the fields responsible.

[13] See the Table 1 for formulas of the three indices.

Sensitivity Analysis

The logic of the sensitivity analysis is to see what happens to the segregation indices when the sex compositions of a few large fields are changed. The procedure entails firstly keeping the total number of doctorates in each year for one field unchanged, secondly assuming this field is perfectly integrated[14] across the 28 years (i.e., the percent female of this field in each year is equal to the average percent female of this year), and lastly recalculating D and SSD, using the data containing this hypothetical value of this field. The effect of the decrease in segregation in this field on the correlation of D and SSD across years from 1980 to 1992 demonstrates how important this field is in creating the differing trend in D and SSD.

The author chooses six fields (Educational administration, Psychology, Education general, Clinical Psychology, other Education and Sociology) that may affect the correlation between D and SSD. In the simulation, the author will assume these six fields integrated cumulatively, with one more fields each time. The six fields are selected out of the largest 18 fields based on whether there is difference between their percent female and the percent female of all fields combined, taken as a ratio of the overall percent female. Therefore, the value of

[14] The integration level used here is the average female percentage of all fields of each year. Rigorously speaking, the simulated data of each field's female percentage should follow a trend that is parallel to the average percent female trend but start at the original number of female percentage of the field in the first year. That is to say, the simulated line that is used in this paper is shifted up by a constant, which is the distance between the field's female percentage and the average female percentage in the first year. The author has double-checked the simulation using the more rigorous method and finds that the correlation between D and SSD is very close to the correlation obtained in the current simulation.

|(Pi-P)|/P is calculated, where Pi is the percent female of a field in one year, and P is the overall percent female in the year. For instance, in year 1971, the percent female of Sociology is .2 when the average percent female is .15. The distance between them is .05. In 1998, the percent female of Sociology increased to .56 and the average ratio changed to .42, so the distance between them grew to .14. Although .14>.05, .14 is around one third of the average percent female of 1998, and .05 is also one third of the average ratio of 1971. In this case, it is not fair to say that from 1971 to 1998, Sociology grow more female relative to the whole academia. Although, from 20 percent female PhD recipients to 56 percent, Sociology becomes more female across time, Sociology is not more segregated today than 28 years ago because the whole of academia is getting more female as well. Therefore, the author needs to consider each distance proportional to the average percent female in order to figure out whether a field is more segregated or not from one year to the next year. For the selection out of the 18 largest fields (consisting 48% of all doctorates over all years) of the simulation, all fields for which |(Pi-P)|/P increased between 1980 and 1992.

Decomposition of H

In our data, the index H and D show similar trends across time (see Figure 2). They decrease during the first decade, increase in the second decade, and are almost constant during the third decade. However, H is the only index that can be used to decompose segregation unambiguously (Reardon, Yun, and Eitle 2000).

The author utilizes the decomposition feature of H to answer the question: does the overall gender segregation mostly come from between-area segregation or within-are segregation? To make this assessment, the author decides all fields into broad areas.[15]

<insert Figure 2 here>

The overall H equals the sum of the between-area H and a within-area component that is a weighted average of the k within-area segregation levels: $H = H_D + \sum_{d=1}^{k} \frac{T_d E_d}{TE} H_d$. In this formula, H_D is between area segregation index, H_d is the within area d, E , E_d and T are respectively the diversities and the total population of area d and the total population of all areas. The within-area component here is a weighted average of the within-area values of H, where areas are weighted by both their relative sizes (T_d / T) and their relative diversities (E_d / E) (Reardon et al. 2000).

We have three levels in ohur data: field/year is the smallest unit of analysis, area/year is the medium level and all fields/year is the highest level. Each area/year consists of a number of field/years and there are overall six areas in each year. Based on this data, we can get three types of Theil's H: the H within each area, the H between the six areas and the overall H of each year based on the

[15] Please see the appendix for which fields belong to which area.

fields of each year.[16] With the help of the decomposition of H, the author can discover whether the American academia is a combination of several discipline groups, which are homogenous within but different between them, or vice versa.

Findings

The segregation by gender in 6 areas: decomposition of H

As mentioned earlier, the author classified the 202 fields into six areas: Engineering, Natural science/Mathematics, Social and behavioral science, Humanities, Business, Health/applied social science. The first question to answer here is whether the unbalanced (disproportional) gender distribution mainly occurs within each broad area or between areas. For instance, if the gender distribution within each area is even, that is, all fields within the engineering area have the same percentage of women, and so do those of the Social and Behavioral science area, but the average percent female of the two areas are very different, in this case, most of the gender segregation comes from between-area segregation rather than within. In this situation, it would be as if the whole of academia consists of several discipline groups within which women and men are distributed proportionally, but between which there are quite different sex compositions. It is also interesting to discover the trend of this within versus between segregation.

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[16] The formula for calculating H: $H = \sum_{i=1}^{n}[t_i(E - E_i)/ET]$. For the first H, E is the entropy for the area in one year, Ei is the entropy for each field within the area in that year, ti is the population of each field and T is the total population of the area of the year. For the second H, E is the entropy for all areas of one year, Ei is the entropy for each area of the year, ti is the population of each area and T is the total population of all areas of that year. For the third H, E is the entropy for all fields of one year, Ei is the entropy for each field of the year, ti is the population of each field and T is the total population of all fields of the year.

Figure 3 shows that most areas are evenly distributed in terms of gender (H<.1) except for the Health/Applied Social Science area and the Humanities area. In addition, the Health/Applied Social Science area and the Humanities areas are the two that experience the most change of H values, decreasing from around .3 to .1 for the former and from around .2 to .1 for the latter, indicating declines within-area segregation over time. For the remaining four areas, apart from the first three or four years, the within-area H stays almost constant. (According to Fischer, Stockmayer, Stiles and Hout [2002], a movement > .02 on H can be considered as a significant change.)

<insert Figure 3 here>

According to Table 3, the between-area and within-area segregation magnitudes are very close; each consists of 40 to 60 percent of the overall segregation. Figure 4 demonstrates the change over time in the proportional of the overall segregation that is between-area and within-area. From 1971 to 1998, the between-area segregation saw a constant increase from 40 percent of the overall segregation to 60 percent. Conversely, the within-are segregation has decreased, from 60 to 40 percent. Overall, American doctoral programs are growing to be more and more similar within these areas in terms of gender distribution. However, the within-are segregation is still a significant proportion of the overall segregation.

<insert Figure 4, Table 3 here>

The changing trend of American doctoral degree recipients' gender segregation: D, SSD and A

Figure 5 shows the changing trend of D, size-standardized D (SSD) and A across the 28 years. In this figure, the behaviors of SSD and A are similar: both show that sex segregation decreased from 1971 to 1998. Although from 1980 to 1988, A sees quite a few zigzags, the overall trend is still descending. Since the range of A is from 0 to infinity, it is impossible to compare the magnitude of segregation showed by A and that by D and SSD. D and SSD are, both in the 0 to 1 metric.

<insert Figure 5 here>

The trend in D and SSD is most inconsistent in the decade from 1980 to 1990. According to Figure 5, in the first decade (from 1971 to 1980), both D and SSD decrease but the starting point of SSD is higher than D; in the middle decade from (1980 to 1992), D ascends and SSD descends; in the last decade (from 1992 to 1998) both of them descend only slightly. The correlation between D and SSD across years for the first period is .889, for the second period, -.876, and for the third period .736. SSD is bigger than D in all 28 years but the difference between them is the biggest in 1971 then gets smaller and smaller.

The fact that SSD is always larger than D implies that small fields are usually more segregated than larger fields, since the SSD weights small and large fields equally. The reduction of the distance between SSD and D shows that very small fields got more and more integrated relative to large fields. The negative correlation between D and SSD from 1980 to 1992 is the biggest mystery showed by Figure 5. There are two possible explanations for this phenomenon: during this period, big fields got more segregated or always quite segregated fields got larger.

Therefore the author needs to answer two questions. First, from 1980 to 1992, are there any big fields that become more segregated? If so, what is the impact of them on D and SSD? Second, from 1980 to 1992, are there any segregated fields that become larger? If so, what is the impact of them on D and SSD?

Fields' differential influence on D and SSD

<u>Large fields grow segregated</u>

For the first question, the author needs to find out the changing trend of gender distributions of the largest fields. She ranks fields by the total number of doctorates granted in each field across 28 years. Figures 6-8 demonstrate the changing trend the percent female of individual fields relative to the overall percent female. The numbers presented on the figures are not directly the percent female of each field, but the value (pi-P)/P for each one of the large fields. Since the change of the distance between one field and the average percent female across years does not mean much because the average percent female itself changes across time, the main purpose of making figures 6 to 8 is to demonstrate the changing trend of the segregation level for each large field more effectively.

As mentioned earlier, if one field in figures 6-8 shows a departure from the horizontal line in the middle, this field is getting segregated. Figure 6[17] is for the six largest fields (Chemistry, Educational Administration, Psychology, Education general, Physics and Theology). These six fields have more that 30,000 doctorate degrees across the 28 years (nearly 30 percent of the total population). Figure 7 is for seven large fields that are smaller than the first group (Electrical Engineering, English, Economics, History, Clinical Psychology and other Education.[18]) Figure 8 is for Curriculum and Instruction, Mathematics, Biology, Political Science, Biochemistry, and Sociology.

<insert Figure 6, 7, 8 here>

The percent female of all 18 fields (see table 3 for the absolute and relative size of the 18 fields) increased nearly monotonically from 1971 to 1998. Most of them keep being either femalely under-representative or over-representative[19] across 28 years. For instance, Chemistry has less than ten percent female in 1971 when average percent female is 12%. In 1998 the percent female of Chemistry grows to 31% but the overall percent female grows to 42%; therefore, Chemistry is still female under-representative. Among these 18 fields, educational administration is the only field that crossed the average female ratio line (i.e.,

[17] Fields in each figures mentioned here are arranged by the size of the fields.
[18] Other Education is a residual category of education including fields that do not exist since the first year.
[19] "Under-representative" means that the female ratio of a field is lower than the average female ration of all fields. "Over-representative" means the opposite. Both over and under representation of females contribute to segregation.

changes from female under-representative to over-representative). History, Biology and Biochemistry are the three special fields whose female percentage keeps being very close to the average female ratio, i.e., they are three relatively integrated fields.

Figure 6-8 shows that during 1980-1992, among the largest 18 fields, only the following fields get more segregated, i.e., the distance between whose percent female and the average percent female relative to the average percent female increases across years. Those fields are: Educational administration, Psychology, Education general, Clinical Psychology, other Education and Sociology. In order to test whether those fields have affected the value of D and SSD different and made them negatively correlated, the author did a sensitivity analysis using simulation. The logic of the simulation has been explained in detail above.

Table 4 shows the result of the simulation. Big fields' tendency of getting more and more segregated does cause the negative high correlation between D and SSD. In the original data, the correlation between D and SSD from 1981 to 1992 is -.876. From model 2 to model 7, as more and more large fields are assumed integrated, the correlation between D and SSD moves from -.813 to -.212. The trend of D has changed quite significantly after assuming the large fields integrated.

<insert Table 4 here>

Figure 9 illustrated the simulated change of the correlation between D and SSD. After assuming four fields integrated, especially after assuming Clinical Psychology being integrated, the correlation between D and SSD has changed from -.876 to -.443. After accumulatively assuming the integration of one larger field, other Education, the correlation made another big change to -.241.

Figure 10 shows that the trace of D gets flatter and flatter as more and more large fields are assumed integrated. However, as expected, the simulation does not change SSD much because each field is considered equally no matter what its size is while calculating SSD. Seven fields is a very small number compared to the overall 202 fields. The SSD in model 1 and that in the rest of the models have very high correlations (>.99).

<insert Figure 9, 10 here>

As to the magnitude of the impact, the author finds that the flattening effect on D is the largest from model 4 to model 5, which means that clinical psychology is the field that makes the biggest change on the changing trend of D. From model 1 to model 4, the correlation between old D (D1) and the new D (D calculated based on simulated data) decreases slightly and very slowly from .979 to .906. However, adding clinical psychology into the fields that are assumed integrated in model 5 makes the correlation between the old D and the new D drop from .906 in model 4 to .644. Besides Clinical Psychology, other Education also made a relatively large change on D. After adding other education into the fields that are assumed integrated in model 6, the correlation between the old D and the new D drops from .644 to .513.

Therefore, the author concludes that the increasing segregation of large fields, especially Clinical Psychology and other Education, is one of the reasons for the conflict between the changing trend of D and SSD from 1981 to 1992. In this case, it is the increasing feminization of the fields that drives the divergence between D and SSD.

<u>The most segregated fields grow larger</u>

To ascertain if the most segregated fields grew faster, the author needs to locate the most segregated fields. She calculates the average percent female of each field across 10 year (from 1981 to 1992) and then calculates the average percent female of all fields. After finding the distance between the average percent female of each field and the average percent female of all fields, the author ranks those fields by the distance, through which the most segregated fields are located.[20] For example, the overall percent female of all fields grows from 31% to 37% from 1981 to 1992. The mean of the overall percent female is .34. The mean of the percent female in Chemistry across this decade is .21. The distance between them is .13. This distance is smaller than the distance between the percent female of psychology and all fields, which is .17. Therefore,

[20] The author also compared the average of |(Pi-P)|/P of each field across years to find out the most segregated fields. The results are the same as using the current method. The current method explained here is more intuitive.

Chemistry is less segregated than Psychology from 1981 to 1992. In order to locate the most segregated fields, it seems more reasonable to use the mean of the percent female of each field across all 28 years. But one problem with this is that if a field crosses the average percent female line, that is to say, it changes from female under-representative to female over-representative, the average percent female may not accurately describe the segregation level of a field. For instance, the average percent female of Educational Administration is very close to the average percent female of all fields but it is actually quite segregated on both sides: female over-representation and under-representation. In this particular case, the mean cannot represent the segregation level of this field, especially during certain period of time. From 1981 to 1992, educational administration is always female over-represented and the average percent female during this time is .46, which is much larger than .38, the average percent female of this field across all 28 years.

Table 5 shows the most segregated 22 fields from 1981 to 1992. However, most of them have very small sizes. Nursing and Mechanical engineering are the two largest fields among these 22 fields. Figure 11 shows the growth trend of mechanical engineering and nursing from 1981 to 1992. Both of them grow rapidly during the period. However, due to the large number of fields (202 all together), an individual field only contributes a very small percentage of the overall population. Also most of the population concentrates in the largest 18 fields. The growth of the size of one field, which does not belong to the largest fields, though highly segregated, such as nursing, can have only a limited impact on the overall trend in D significantly. Therefore, it would be difficult to locate several fields whose size growth impacts the correlation between D and SSD from 1981 to 1992 using simulation. The simulation would be assuming that the size of those segregated fields does not change across year and calculate D and SSD based on the simulated percent female value of these fields. It is more likely that if the growth of always-segregated fields did contribute to the increase in D in the middle period, it was a large group of very small fields. Technically, it is almost impossible to single out those small fields whose collective behavior makes the difference.

Therefore, the author can only say that there is a large group of very small fields that are always very segregated. Although the size increase of segregated fields impacts D and SSD differently by definition, the author cannot locate those fields that make differences. Nursing and Mechanical Engineering are the largest two fields among them, however.

<insert Figure 11, Table 5 here>

Conclusion

The main purpose of this paper is to understand what happened in gender segregation of doctoral degree recipients from the 202 fields in the U.S. The author classifies the 202 fields into 6 areas and used the decomposition of H to find that from 1971 to 1998, the within-area segregation reduced across time and between-area segregation increased as a proportion of the overall segregation. Therefore, generally speaking, the American doctoral program started to turn into a combination of several areas, which differ from each other but are coherent within each one on the dimension of sex composition.

This paper also compares trends in segregation using several indices of evenness, D, SSD and A together in one graph. From 1970 to 1980, D, SSD and A unanimously demonstrate a decrease of gender-based segregation among American doctoral degree recipients. From 1980 to 1992, D and SSD move in opposite directions, when D indicates an increase of gender-based segregation in fields but SSD shows a decrease. A also shows a decrease from 1980 to 1992. After 1992, all three indices show that the gender-based segregation decreases only slightly. Further investigation on the middle decade shows that the conflict between D and SSD during the period is due to: some large fields that grew more segregated and some segregated fields that grew larger. Data simulation shows that Clinical Psychology and Other Education (the residual category within education's many specific fields) are the two fields that impact D the most from 1981 to 1992 and makes D strongly negatively correlate with SSD during this time. Both of these fields have always been disproportionately female, but they became increasingly so. Given their large size, they contributed importantly to increasing segregation using D, but their effect is less in the indices, SSD and A, that do not weight fields by size.

This research is meaningful in two ways. Firstly, rather than using aggregated data with large categories, the author used refined categories of fields; i.e. rather than using social sciences or engineering as the units of analysis, this research uses more than two hundred fields as the units of analysis and is then examine segregation across all detailed fields as well as how much of it is within and between sex broad areas.

Secondly, this research uses three indices together to describe the changing trend of gender segregation. The fact that SSD and A, on the one hand, and D(along with H), on the other, show very different trends for the period from 1980 to 1992, is evidence that using multiple indices is necessary for certain datasets. Certainly, given different features of all kinds of datasets, it is not easy to make a general diagnostic remark about when to apply single or multiple indices. However, the sensitivity analysis that the paper applied is an example of how one can analyze complicated situations when both the field and the sex composition of a dataset change and indices disagree on the trends.

Who enters doctoral programs and finally receives the degrees is an important issue to study as the features of doctoral degree recipients are closely related to that of the faculty member of the United States. Moreover, doctoral degree recipients supply some important segments of the non-academic labor force such as clinical Psychologists and school district administrator. In the long run, the “educational elites” impacts the whole country tremendously. These educational elites are becoming more feminized, but this analysis suggests that the declines in segregation by fields of the 1970s have now stalled.

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Figure1: Number of doctorates granted in the U.S. 1971-1998

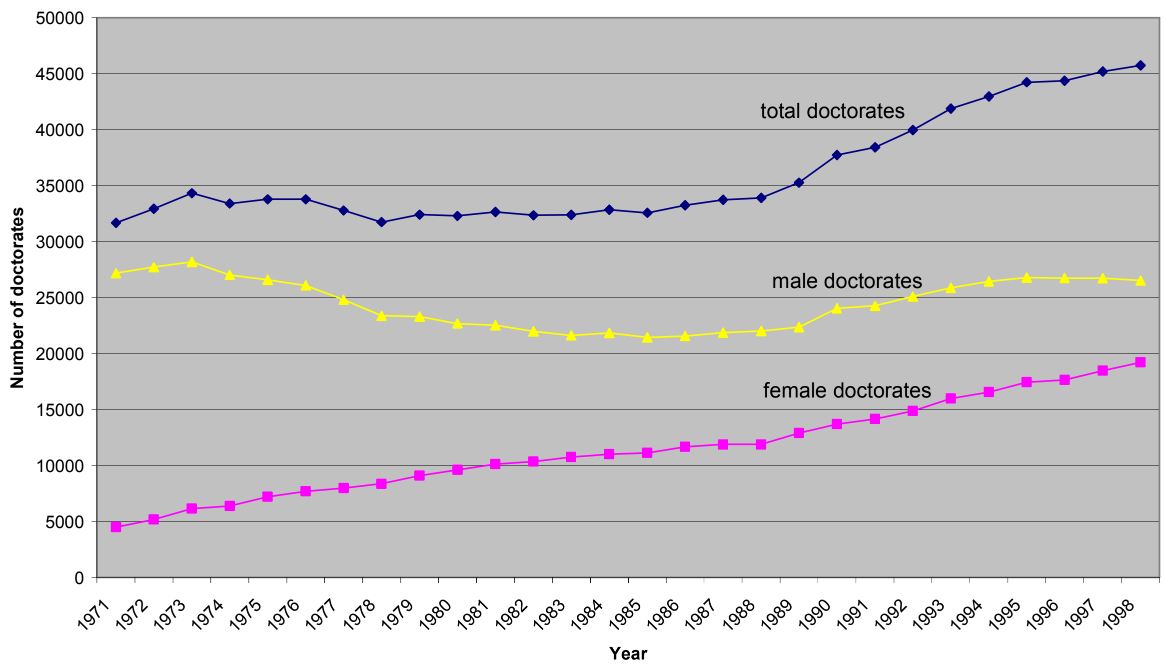


Figure 2: D and H

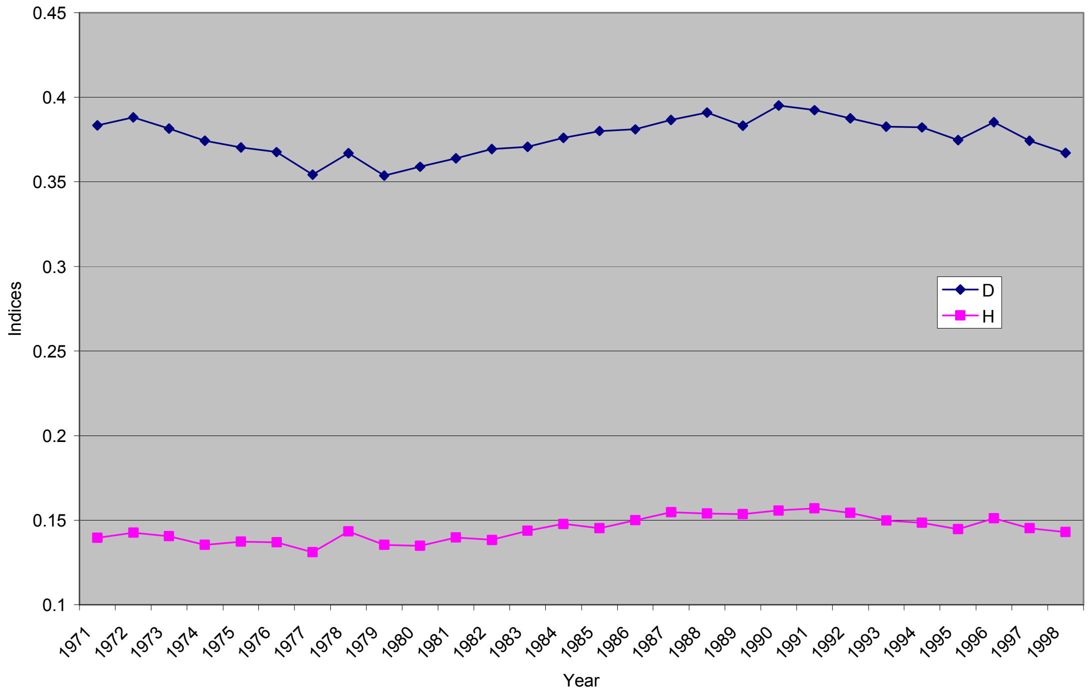


Figure 3: Within-area segregation

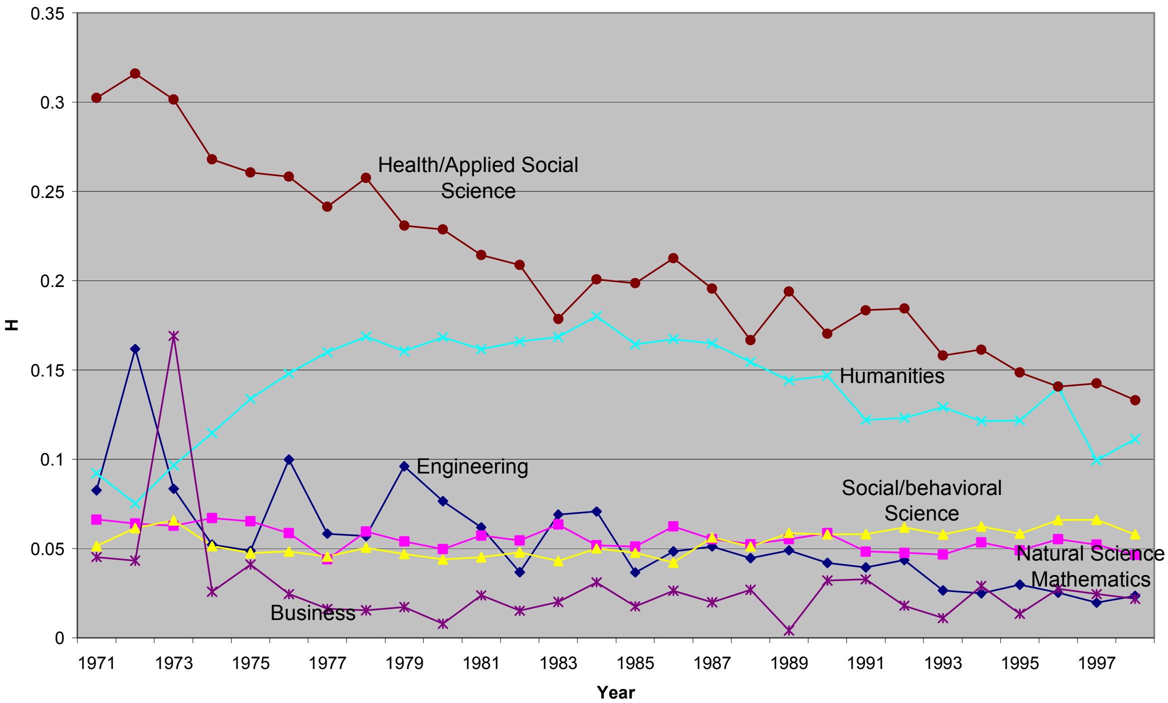


Figure4: Within and between area segregation (the Change of Proportion)

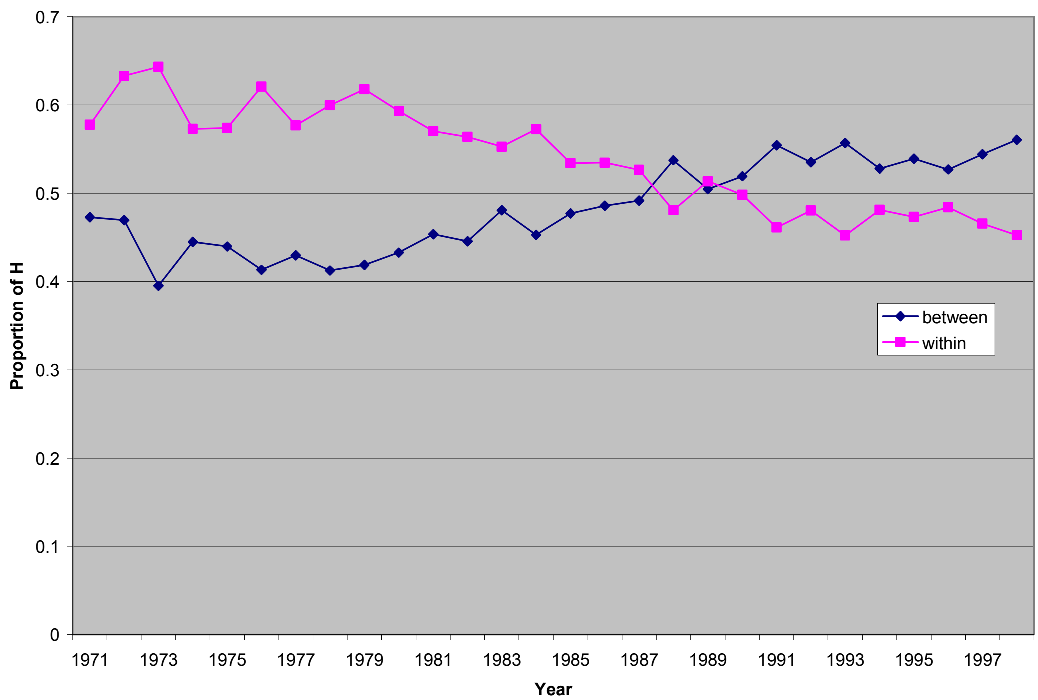


Figure 5: D,SSD and A of doctorates 1971-1998

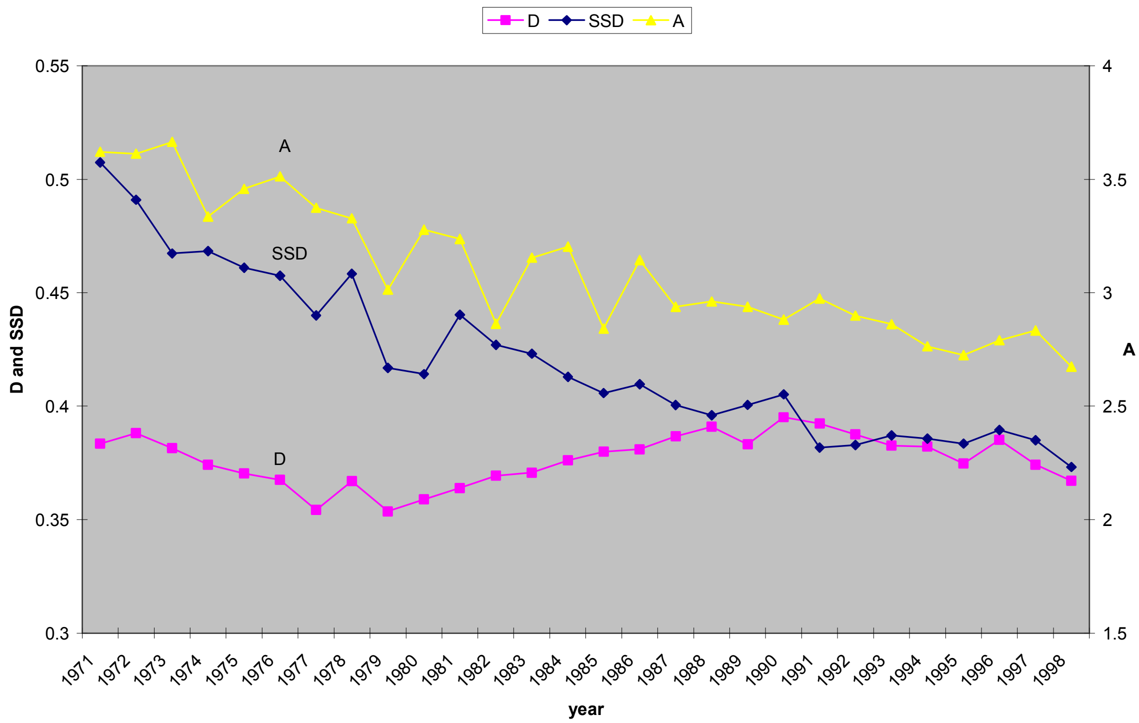


Figure 6: Changing trend of the percent female in individual large fields relative to overall percent female (1)

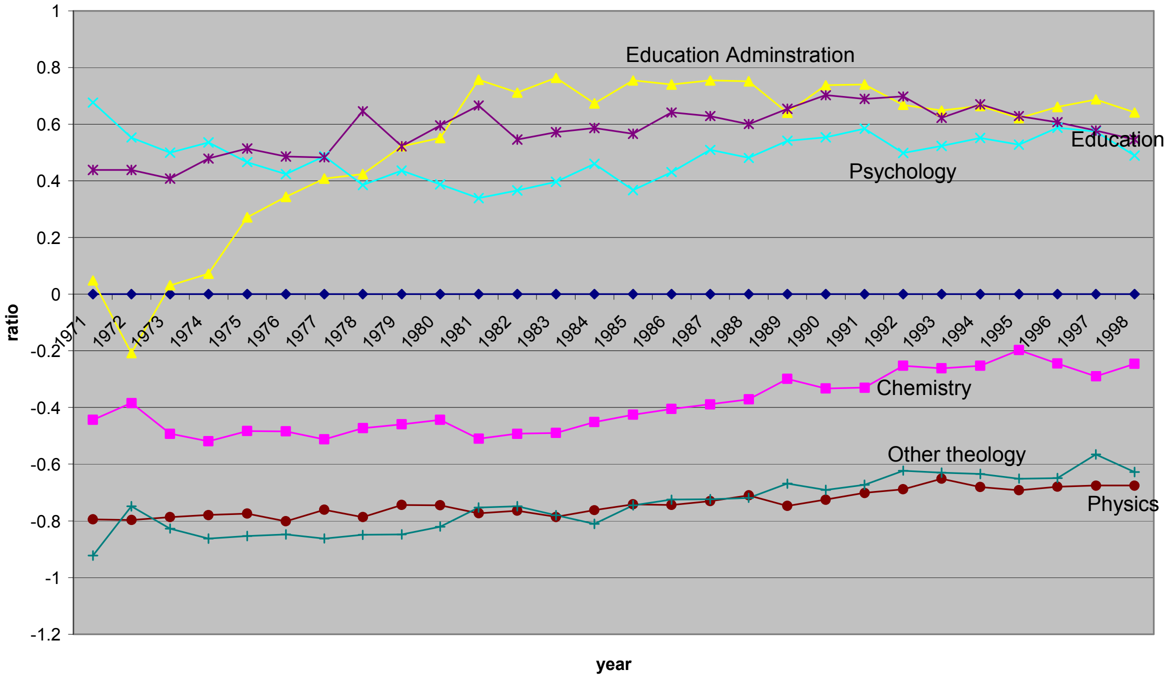


Figure 7: Changing trend of the percent female in individual large fields relative to overall percent female (2)

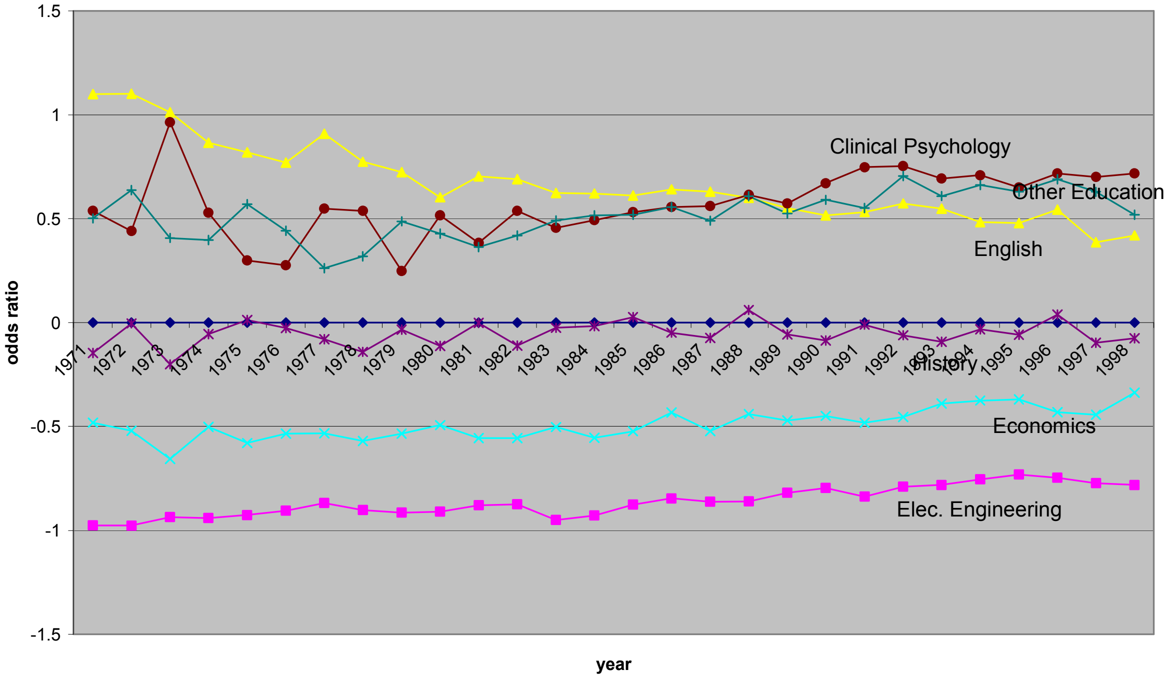


Figure 8: Changing trend of the percent female in individual large fields relative to the overall percent female (3)

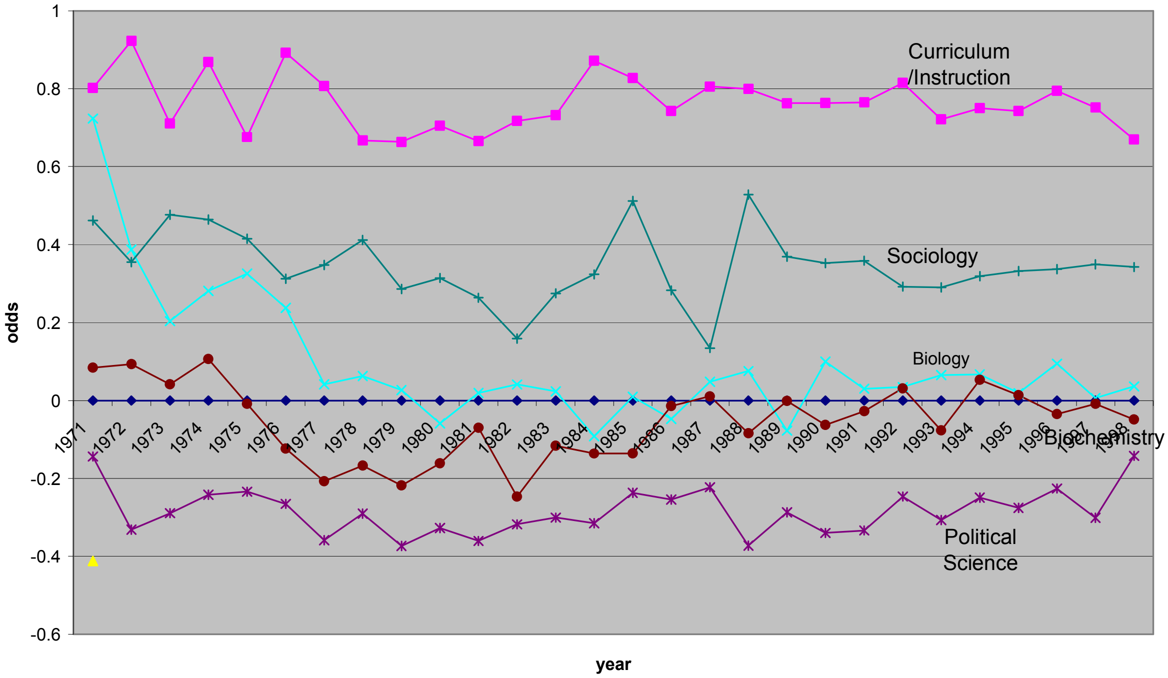


Figure 9: The simulated change in the correlation between D and SSD after assuming several large fields integrated accumulatively

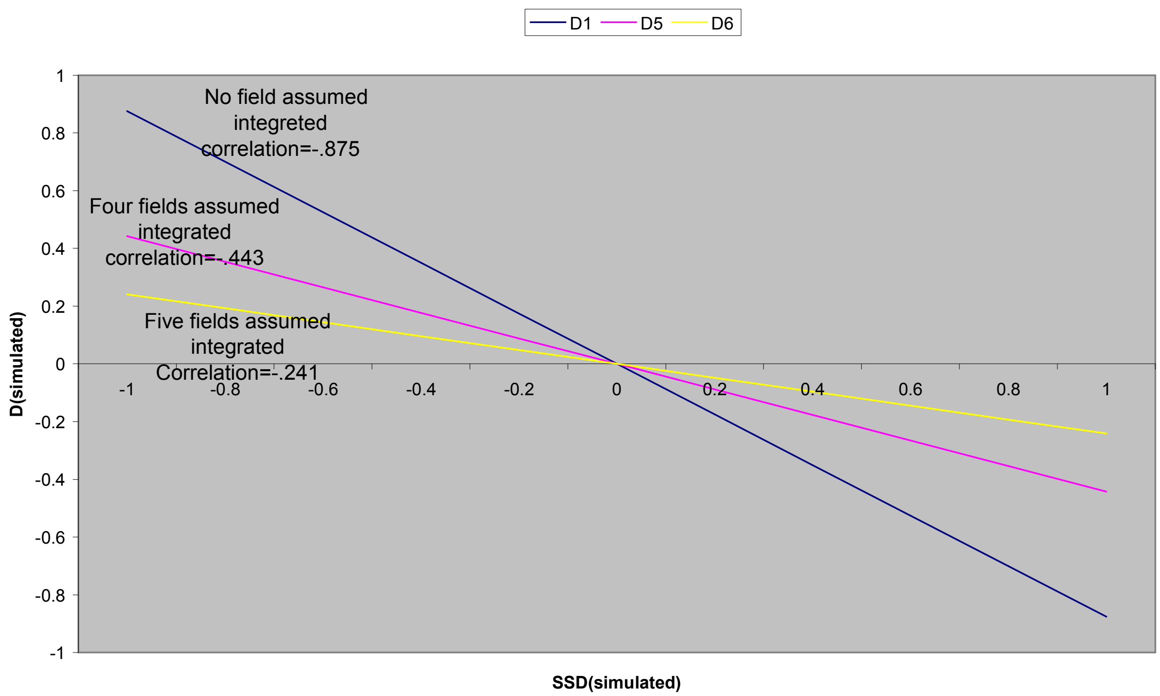


Figure 10: The simulation of D when assuming more and more fields integrated, when D1 is the real D

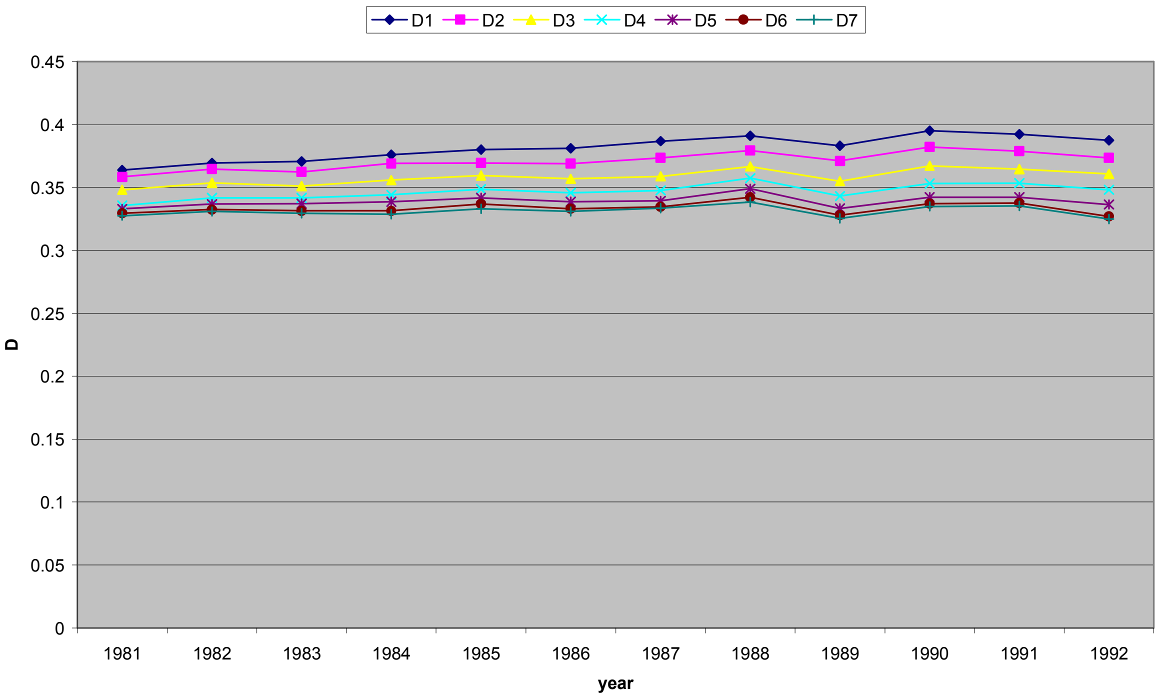
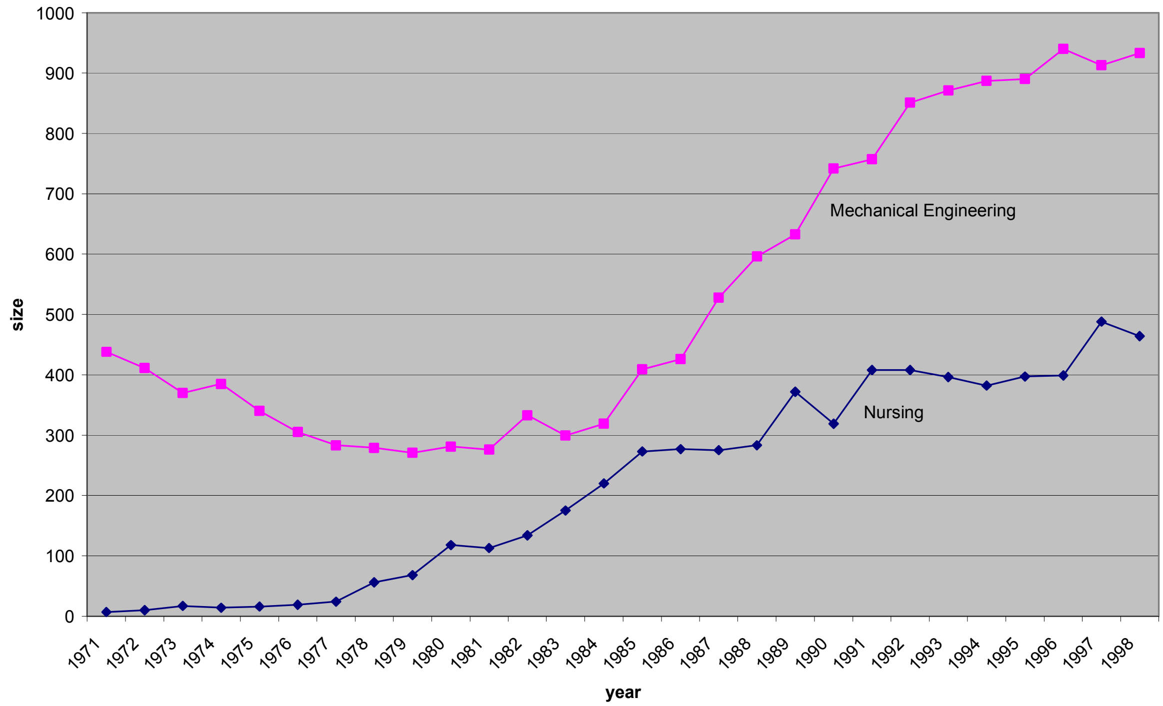


Figure 11: Size growth of the two of the most segregated fields



Appendix: List of fields and the classification of areas in our data.

The author roughly classifies the 202 fields into 6 areas. The fields are classified into six areas.

Engineering	Mathematics/Science	Social/ Behavioral Science
Computer engineering	Biology, general	African studies
Information science	Biochemistry/biology	American studies
Computer science	Botany, general	Asian studies
Engineering, general	Plant Pathology	Middle east studies
Aerospace	Cell Biology	Other area studies
Agricultural engineering	Molecular Biology	Educational, general
Bioengineering	Microbiology	Curriculum/Instruction
Ceramic engineering	Anatomy	Administration of special education
Chemical engineering	Biometrics/biostatistics	Educational supervision
Electrical/Electronic engineering	Ecology	Educational administration
Engineering Mechanics	Marine biology	Educational statistics
Engineering Physics	Neurosciences	Educational testing
Environmental Health engineering	Nutrition Sciences	Social foundations of education
Material engineering	Toxicology	Special education
Mechanical engineering	Zoology, general	Education of emotionally handicapped
Metal engineering	Entomology	Education of mentally handicapped
Mining and Mineral engineering	Genetics, human and animal	School psychology
Naval Architecture and Marine engineering	Pathology, human and animal	Special learning
Nuclear engineering	Pharmacology, human and animal	Student personnel
Ocean engineering	Physiology, human and animal	Adult and continuing education
Petroleum engineering	Other Life Sciences	Elementary education
Civil engineering	Mathematics, General	Pre-elementary education
Industrial engineering	Applied Mathematics	Secondary education
Other engineering	Statistics	Agriculture education
Engineering Related Technologies	Other Mathematics	Art education
Engineering and Related Disciplines	Biological and Physical sciences	Business education
	Astronomy	Health Education

	Astrophysics	Home Economics Education
	Atmospheric sciences and meteorology	Industrial arts, vocational and technical education
	Chemistry, general	Mathematics education
	Analytical chemistry	Music education
	Inorganic chemistry	Physics education
	Organic chemistry	Reading education
	Pharmaceutical chemistry	Science education
	Geology	Other education
	Geochemistry	Other interdisciplinary studies
	Geophysics	Psychology, general
	Metallurgy	Clinical psychology
	Oceanography	Counsel psychology
	Earth science	Developmental psychology
	Physics	Experimental psychology
	Other physics	Industrial psychology
		Physiological psychology
		Social psychology
		Other psychology
		Social sciences, general
		Anthropology
		Archeology
		Demography
		Economics
		Geography
		History
		International relations
		Political science
		Sociology
		Urban studies
		Other social sciences

Humanities	**Business**	**Health care/ Applied Social Science**
Foreign Language, general	Business and commerce	Agriculture economics
Chinese	Accounting	Animal science
Russian	Bank and Finance	Dairy science
Slavic languages (other than Russian)	Business Management	Poultry science
German	Business Economics	Food science and technology
French	Insurance	Agronomy
Italian	International Business	Horticulture
Spanish	Labor and industrial relations	Range management
Hebrew	Operational research	Soil science
Other Foreign languages	Marketing	Other agriculture
English, general	Personnel	Architecture
Classics	Other business and management	City and community planning
Contemporary literature		Communication
Linguistics		Journalism
Literature, English		Radio and Television
Speech, debate and forensic science		Other communication fields
Other letters		Medical laboratories technologies
Philosophy/religious studies		Physical therapy
Liberal Arts		Speech-language pathology
Humanities and social sciences		Health services
Religious education		Nursing
Religious music		Pharmacy
Other theology		Public health
Fine and visual arts		Other health related fields
Drama art		Home economics general
Art history		Textiles and clothing
Music, general		Food science and nutrition
Music history		Other home economics
Music performance		Law
Other fine and visual arts		Library and archival sciences

		Community services
		Parks and recreation management
		Protective services
		Social work
		Other public affairs

Table 1: Indices of Evenness[21] and their properties

Index	Formula	Min	Max[22]
Dissimilarity (D)	$D=\sum_{i=1}^{n}[t_i \mid p_i - P \mid / 2TP(1-P)]$	0	1
Theil's H (H)	$H=\sum_{i=1}^{n}[t_i(E-E_i)/ET]$[23]	0	1
Size Standardized D (SSD)	$SSD=\frac{1}{2}\sum_{i=}^{n}\mid[(F_i/t_i)/\sum_{i=1}^{n}(F_i/t_i)]-[(M_i/T_i)/\sum_{i=1}^{n}(M_i/T_i)]\mid$	0	1
Grusky' A (A)	$A=\exp\{\frac{1}{n}\sum_{i=1}^{n}[\ln(\frac{F_i}{M_i})-[\frac{1}{n}\sum_{i=1}^{n}\ln(\frac{F_i}{M_i})]^2\}^{\frac{1}{2}}$	0	Infinity

Properties

	Dissimilarity (D)	Information Theory (H)	Size Standardized D (SSD)
Scale invariance	Y	Y	N
Field invariance	N	N	Y

Y=yes; N=no.

[21] t_i: total # of PhDs in field i; pi: proportion of PhDs in field i who are female; F_i: # of female PhDs in field i; M_i: # of male PhDs in field i; F: # of female PhDs in all fields; M: # of male PhDs in all fields; T: total # of PhD in all fields; P: proportion of female PhD in all fields; All above symbols represent data in one single year.

[22] Maximum value refers to total segregation

[23] $E=P\log[1/P]+(1-p)\log[1/(1-p)]; E_i=(p_i)\log[1/p_i]+(1-p_i)\log[1/(1-p_i)]$

Table 2: The 18 Largest fields[24]

Field	Number of Doctorates[25]	Proportional size of each field relative to all fields
Chemistry, General	49896	0.049
Educational Administration	48688	0.048
Psychology, General	48045	0.048
Education, General	36154	0.036
Physics	31908	0.032
Theology/Divinity	30826	0.031
Elec. Engineering	25542	0.025
English, General	25241	0.025
Economics	22275	0.022
History	21322	0.021
Clinical Psychology	20982	0.021
Other Education	20076	0.02
Curriculum and Instruction	19660	0.019
Mathematics, General	18905	0.019
Biology, General	17911	0.018
Political Science	16086	0.016
Biochemistry	16026	0.016
Sociology	15627	0.015

[24] The total number of doctorates in the 18 fields is 48% of the overall population of doctorates in 28 years.
[25] This number is the total number of doctorates granted in this field from 1971 to 1998

Table 3: Decomposition of Theil's H

	Total H and additive decomposition			**Proportional decomposition**	
Year	Total	Between	Within	Between	Within
1971	0.14	0.066	0.081	0.473	0.578
1972	0.143	0.067	0.09	0.47	0.633
1973	0.141	0.056	0.09	0.395	0.643
1974	0.135	0.06	0.078	0.445	0.573
1975	0.137	0.06	0.079	0.44	0.574
1976	0.137	0.057	0.085	0.413	0.621
1977	0.131	0.056	0.076	0.43	0.577
1978	0.143	0.059	0.086	0.413	0.6
1979	0.135	0.057	0.084	0.419	0.618
1980	0.135	0.058	0.08	0.433	0.593
1981	0.14	0.063	0.08	0.454	0.57
1982	0.138	0.062	0.078	0.446	0.564
1983	0.144	0.069	0.079	0.481	0.553
1984	0.148	0.067	0.085	0.453	0.573
1985	0.145	0.069	0.078	0.477	0.534
1986	0.15	0.073	0.08	0.486	0.535
1987	0.155	0.076	0.081	0.492	0.527
1988	0.154	0.083	0.074	0.537	0.481
1989	0.154	0.078	0.079	0.505	0.514
1990	0.156	0.081	0.078	0.519	0.498
1991	0.157	0.087	0.072	0.554	0.461
1992	0.154	0.083	0.074	0.535	0.48
1993	0.15	0.083	0.068	0.557	0.452
1994	0.149	0.078	0.071	0.528	0.481
1995	0.145	0.078	0.068	0.539	0.473
1996	0.151	0.08	0.073	0.527	0.484
1997	0.145	0.079	0.068	0.544	0.466
1998	0.143	0.08	0.065	0.561	0.453

Table 4: Demonstration: the impact of large fields or fields that get more segregated on the changing trend of D and SSD

Models[26]	Model1		model2		Model 3		Model4		Model 5		Model 6		Model7	
year	D1	SSD1	D2	SSD2	D3	SSD3	D4	SSD4	D5	SSD5	D6	SSD6	D7	SSD7
1981	0.364	0.44	0.358	0.441	0.348	0.44	0.336	0.438	0.333	0.437	0.33	0.436	0.328	0.435
1982	0.369	0.427	0.365	0.428	0.354	0.427	0.342	0.426	0.337	0.424	0.332	0.423	0.331	0.423
1983	0.371	0.423	0.362	0.424	0.351	0.423	0.342	0.421	0.337	0.42	0.331	0.418	0.329	0.417
1984	0.376	0.413	0.369	0.411	0.356	0.41	0.344	0.408	0.339	0.407	0.331	0.405	0.329	0.404
1985	0.38	0.406	0.369	0.406	0.359	0.405	0.349	0.403	0.342	0.401	0.337	0.4	0.333	0.398
1986	0.381	0.41	0.369	0.408	0.357	0.407	0.346	0.405	0.339	0.403	0.333	0.401	0.331	0.4
1987	0.387	0.4	0.373	0.4	0.359	0.399	0.348	0.397	0.339	0.395	0.335	0.394	0.334	0.394
1988	0.391	0.396	0.379	0.395	0.367	0.394	0.357	0.392	0.349	0.39	0.342	0.389	0.338	0.387
1989	0.383	0.401	0.371	0.397	0.355	0.396	0.343	0.394	0.333	0.392	0.328	0.39	0.325	0.389
1990	0.395	0.405	0.382	0.404	0.367	0.403	0.353	0.401	0.342	0.399	0.337	0.397	0.335	0.397
1991	0.392	0.382	0.379	0.381	0.364	0.379	0.354	0.377	0.342	0.374	0.338	0.373	0.335	0.372
1992	0.388	0.383	0.373	0.382	0.361	0.38	0.348	0.378	0.336	0.376	0.327	0.373	0.325	0.373
correlation(D,SSD)[27]		-0.88		-0.81		-0.76		-0.76		-0.44		-0.24		-0.21
correlation D[28]			0.979		0.938		0.906		0.644		0.513		0.506	
correlation SSD[29]				0.998		0.998		0.998		0.998		0.998		0.997

[26] Model 1 is based on the original data. In model 2, education is assumed integrated. In model 3, educational administration and psychology are assumed integrated. In model 4, educational administration, psychology and education general are assumed integrated. In model 5, educational administration, psychology, educational general and clinical psychology are assumed integrated. In model 6, all the previous fields and other education are considered integrated. In model 7, all previous fields and sociology are assumed integrated.

[27] The correlation between D and SSD in different models.

[28] The correlation between D1 and each one of the Ds in models 2 to 7. It shows the change of D.

[29] The correlation between SSD1 and each one of the SSDs in models 2 to 7. It shows the change of SSD.

Table 5: The most segregated fields

Field	Total doctorates[30]	Mean pfd in each field [31]	Average pfd of all fields[32]	Difference between pfds[33]	Absolute value of difference between pfds[34]
Mining and Mineral Engine.	580	0.018	0.149	-0.131	0.131
Food Science	1376	0.279	0.149	0.131	0.131
Middle East Studies	150	0.018	0.149	-0.131	0.131
Metallurgy	324	0.017	0.149	-0.132	0.132
Mechanical Engineering	14966	0.017	0.149	-0.132	0.132
Atmosphere	654	0.016	0.149	-0.132	0.132
Computer Science	901	0.014	0.149	-0.135	0.135
Aerospace	4519	0.014	0.149	-0.135	0.135
Speech-Language	2631	0.284	0.149	0.135	0.135
Other Mathematics	133	0.012	0.149	-0.137	0.137
Petroleum	848	0.012	0.149	-0.137	0.137
French	3591	0.296	0.149	0.147	0.147
Other Home Engineering	4134	0.298	0.149	0.149	0.149
Spec Education	5500	0.299	0.149	0.15	0.15
Art History	2922	0.303	0.149	0.155	0.155
Elementary Education	4189	0.32	0.149	0.171	0.171
special Learning	329	0.33	0.149	0.181	0.181
Reading English	2495	0.346	0.149	0.197	0.197
Home ec g	1378	0.361	0.149	0.212	0.212
Pre-Elementary Education	853	0.365	0.149	0.216	0.216
Textiles/	400	0.392	0.149	0.244	0.244
Nursing	6132	0.394	0.149	0.245	0.245
Home economics	363	0.406	0.149	0.257	0.257

[30] Total number of doctorates in this field across 28 years.
[31] Average percent female of this field from 1981 to 1992.
[32] The average percent female of all fields from 1981 to 1992.
[33] Diffpfd=meanfieldpfd-averagepfd.
[34] Absolute value of diffpfd.