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Women and Men Go to University: Mathematical Background and Gender Differences in Choice of Field in Higher Education[1]

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Gender segregation in higher education is well documented. Female students major in mathematics, technology, and sciences less often than men, and they concentrate in humanities and social sciences. Using multinomial logit on the 6,139 applicants to Tel Aviv University in Israel in 1994, I examined the claim that one of the roots of gender segregation in higher education lies in course-taking patterns in high school. The main findings are as follows: Women are underrepresented among the applicants to the mathematics-related fields of study; mathematical background in high school is particularly effective in narrowing the gender gap in applying to selective and attractive, but not mathematically related, fields of study at the university; women rely on high qualifications more than men when applying to selective and male-dominated fields of study. Several explanations of the findings will be discussed.

KEY WORDS: gender gap; higher education; field of study; Israel; high school history; gender composition; selectivity.

Researchers on inequality in higher education usually refer to ethnic origin, socioeconomic status, and gender as the three major sources of inequality. However, gender inequality in higher education is different from the other two types. The disadvantage of underprivileged ethnic or socioeconomic groups stems primarily from lower participation in postsecondary education. Female students are not disadvantaged in this respect; in most Western societies women participate in postsecondary education as much as men do (Baker & Velez, 1996; Bradley, 2000). Women's disadvantage stems from a different source—their choice of fields of study. Female students major in mathematics, technology, and sciences less often than male students, and they tend to concentrate in humanities and social sciences, two fields of study that do not attract many men (American Association of University Women [AAUW], 1999; Beyer, 1999; Bradley, 2000; Jacobs, Finken, Griffin, & Wright, 1998; Oakes, 1990; Sonnert, 1995; Strenta, Elliot, Adair, Matier, & Scott, 1994).

Although it seems evident that the lower participation rates of ethnic minorities and members of lower socioeconomic strata in higher education are a disadvantage, the treatment of women's preferences of areas of specialization as a disadvantage is less obvious. Such an approach implies the existence of a hierarchy among the various fields of study, that is, that mathematics, technology, and sciences are better choices than humanities and social sciences. The differential treatment of the different fields of study probably stems from their implications for the labor market. The concentration in humanities and social sciences prevents women from entering science-oriented careers. Because of the value of technology and science in a modern economy, the inability to pursue careers in such fields places women in marginal and less economically rewarding positions in the labor market (AAUW, 1999; Hearn & Olzak,

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1981; Ma & Willms, 1999; Pedro, Wolleat, Fennema, & Baker, 1981). Consequently, educators, policymakers, and the public believe that encouraging women to change their pattern of fields of study in higher education is a useful strategy for reducing the gender income gap in the labor market (Ma & Willms, 1999; Oakes, 1990).

The assumed implications of the gender differences in fields of study for the gender gaps in the labor market have motivated the research on this issue. To date, attention has been focused on women, in an attempt to capture the reasons for their reluctance to major in science and technology. The researchers seem less interested in the reluctance of male students to major in humanities and social Sciences, the "feminine" fields of study, perhaps because this seems rational from the economic point of view, and hence, less critical. The "feminine" fields of study have their own merits in terms of personal expression, informed citizenship, and the acquisition of cultural capital (AAUW, 1999), but these are by no means perceived as equal to the economic benefits attached to mathematics and sciences. Thus, the concentration of women in tertiary education in humanities and social sciences is analyzed as a disadvantage, whereas men's reluctance to major in these fields of study is perceived as an advantage.

One prevalent claim found in the research done in this area is that the roots of the gender segregation in higher education lie in the earlier stages of students' educational careers, mainly in high school (Boli, Allen, & Payne, 1985; Ma & Willms, 1999; Oakes, 1990; Pedro et al., 1981; Wilson & Boldizar, 1990). The participation of female students in advanced mathematics and science courses in high school is relatively low for a number of reasons: some related to girls' attitude toward this field of study, and others to school influence. Research on the attitudes of female students has concentrated on their lack of interest in mathematics and sciences (Jacobs et al., 1999), on their belief that these fields of study are irrelevant to their careers (Tamir, 1988), on their general negative attitude toward mathematics (Ma, 1999), and on their mathematics anxiety (Guzzetti & Williams, 1996; Kahle & Rennie, 1993; Ma and Willms, 1999). Researchers who focus on school influence refer to negative messages from teachers and counselors (Maple & Stage, 1991), the masculine orientation of the curriculum in mathematics and sciences (Tamir, 1988), the small number of female teachers who can serve as role models (Oakes, 1990), and differential school policy in assigning students of the two genders to advanced courses in these fields (Burkam, Lee, & Smerdon, 1997). The low participation of female students in mathematics and sciences is true for many educational systems, and for various ethnic groups and social classes within systems.[3]

The low rate of participation of female students in advanced courses in mathematics and sciences in high school disqualifies them from majoring in mathematics, technology, and sciences for several reasons. Many university departments of mathematics, sciences, and technology demand, as a prerequisite for admission, courses in mathematics and sciences beyond the minimum necessary for high school graduation (Oakes, 1990). This policy disqualifies a priori many female high school graduates. Because of their high school background, the performance of female students in introductory mathematics courses in college, which serve as a basis for selection to advanced courses, is much lower than that of male students (Boli, Allen, & Payne, 1985; Moreno & Muller, 1999; Strenta et al., 1994). Moreover, exposure to advanced mathematics and sciences in high school may help to reduce the math anxiety that many female students experience (Levine, 1995). Conversely, failure to take these courses intensifies math anxiety and reduces the probability of choosing to major in this field of study in the future (Ma &Willms, 1999).

This line of reasoning implies that the narrowing of the gender gap in career patterns should start in high school. If female students would take more "masculine" courses in high school, they would major in "masculine" fields of study at university and eventually join "masculine" occupations in the labor market. In other words, changes in patterns of course taking in high school can moderate the concentration of women in lower-paid areas. This hypothesis, which may be of substantial value, has not been examined in labor market research nor in research done on higher education. Education is a central factor in the research on gender segregation in the labor market and on the gender-based income gap, but it usually refers to years of schooling or credentials and not to the courses taken in high school. Course taking is a common issue in educational research, whereas analyses of the effect of high school experience on higher education curricula usually refer to achievements and

[3]See, for example, Adenika-Morrow (1996) and Catsambis (1994) for the Unite States, Croxford (1994) for Scotland, Lamb (1996) for Australia, Ten Dam and Volman (1991) for the Netherlands, Heller and Ziegler (1996) for Germany, Engstrom and Noonan (1990) for Sweden, Tabar (1992) for England, and Tamir (1988) for Israel.

aspirations (e.g., Wilson & Boldizar, 1990). Although patterns of course taking may be implied in achievements, they have not been examined directly in the research on choosing majors in higher education.

The purpose of this study was to test the effect of taking mathematics and sciences courses in high school on gender differences in fields of study in the university. Israel provides a particularly suitable arena for this analysis, because of the special status of mathematics and sciences in the high school curriculum.

Mathematics and Sciences in the Israeli High School Curriculum

The high school curriculum in Israel is composed of compulsory and optional subjects. The lowest level (3 units of study) of mathematics is compulsory, and the higher levels (4 or 5 units) are optional. Sciences are optional at the higher level and are usually offered at the 5-unit level. The units of study[4] correspond to the subject level and degree of difficulty.

Mathematics and sciences have a particularly high status in the curriculum of most Israeli high schools (Ayalon & Yogev, 1997). They are considered difficult and demanding subjects, and most schools are selective in assigning students to the advanced courses. The advanced mathematics and sciences courses are taken more often by more able students and by students who belong to privileged social groups (Ayalon & Yogev, 1997).

The universities contribute to the high status of mathematics by their policy of bonuses. Students are accepted to the university on the basis of a combination of their grades in the matriculation diploma and their score on the psychometric test. The matriculation exams are standardized tests for the compulsory and optional subjects, most of which are taken at the end of high school. The psychometric test is an aptitude test that is required by all universities. In calculating the applicant's combined grade, the universities add bonuses for each subject taken at the advanced level. Mathematics (like English) earns higher bonuses. In light of the high status of mathematics and sciences, most students and some teachers believe, though in fact it is a near-myth, that taking higher-level courses in mathematics and sciences enhances the probability of being accepted to university, even in nonscientific majors (Ayalon & Yogev, 1997).

[4]One unit equals 1 hr a week for 3 years or 3 hr a week for 1 year.

The special status of mathematics and sciences in the curriculum and the near-myth attached to their value for higher education enhances their appeal to students of both genders. The literature on the gender gap in taking mathematics courses reports that one of the reasons for the reluctance of female students to take advanced courses in this subject is the view that it is not useful for their careers (Baker & Jones, 1993; Ma & Willms, 1999; Pedro et al., 1981). In Israel, the special status of mathematics and sciences makes them relevant and useful (or at least perceived as such) for all students who wish to enroll in higher education. Consequently, a significant proportion of female students take advanced mathematics and science courses.[5] However, we do not know whether the exposure of female students to higher-level mathematics and sciences affected their later choice of field of study. The purpose of this study is to examine this question.

METHOD

Sample

The fields of study chosen by 6,139 Jewish applicants to Tel Aviv University in 1994 were analyzed. Because of the small number of Arab applicants (251), I could not control for nationality in the multivariate analyses. Because the Arab applicants constitute a unique group, which could affect the findings, I preferred not to include them in the analysis.

Tel Aviv University is now the largest in Israel. Yogev (2000) defined it as one of the four elite universities, which are characterized by a richer curriculum, emphasis on graduate studies, and a lower proportion of students who belong to disadvantaged groups. Higher status and Ashkenazi origin (the privileged Jewish ethnic groups) characterize the population of students at Tel Aviv University more so than those at other institutions of higher education. Clearly, Tel Aviv is not representative, academically or socially, of all the universities in Israel. However, because the gender typing of fields of study is universal, we can assume that processes that occur in this university resemble in many respects those that occur in the other universities.

[5]For example, according to the files of the Ministry of Education for 1992, 45% of the female students took advanced mathematics compared with 59% of male students. The respective figures for physics and chemistry, the mathematics-based sciences, are 20 and 37%.

Variables

The dependent variable is the field of study chosen by the applicant. In their application to the university, applicants may list up to three choices, in order of preference. The analysis refers only to the first preference.[6] The different fields of study are divided into eight categories, which vary in selectivity, gender composition, and mathematics-related requirements: (a) engineering; (b) sciences; (c) life sciences; (d) medicine; (e) law; (f) business and economics; (g) psychology; (h) humanities and social sciences.

A good indicator of the selectivity of a field of study is the admission criteria. Admission is based on the mean of the matriculation grades and the psychometric score, transformed into an 800-point scale. As noted, the matriculation certificate and the psychometric test are prerequisites in all Israeli universities. The degree of selectivity depends on the demand for the field and not on the assumed difficulty of the subject matter. Thus, Law, which is very popular among Israeli youngsters, is more selective than are sciences, although the latter are considered more demanding intellectually. Based on demand and supply, admission cutoff points also serve as indicators of the attractiveness of the field. Because the attractiveness of a field is usually connected to its prestige, the admission cutoff points may be viewed, to some degree, as indirect indicators of prestige. The admission cutoff points of the major fields, and the mathematics-related requirements of each field, which were officially published by Tel Aviv University in 1993 as information for applicants (Tel Aviv University, 1993), are presented in Table I.

Table I. Characteristics of Fields of Study

	Requirement for advanced courses[a]			
Field of study	Mathematics	Physics or chemistry	Cutoff point[a]	Women[b] (%)
Engineering	Yes	Yes	620	20
Sciences	Yes	Yes	560	40
Life sciences	No	No	533	65
Medicine	No	No	666	48
Law	No	No	634	47
Psychology	No	No	596	73
Business and economics	Yes	No	601	40
Social sciences	No	No	523	68
Humanities	No	No	500	73

[a]Source: Tel Aviv University, 1993.
[b]Percentage is out of undergraduate students in 1995–96. Source: Israel Central Bureau of Statistics, 1995–96, Table 4.

To illustrate the gender composition of the various fields, the last column of Table I presents the gender composition of undergraduate students in Israeli universities in 1995–96, based on official statistics published by the Israeli Central Bureau of Statistics (ICBS, 1997). I used these data because of their detailed information. Although the data describe gender composition after 1994, the application year of the current sample, they provide a reliable picture of the gender composition of the fields of study at that time.

Table I shows that the first two fields of study, sciences and engineering, are mathematics-based. Both departments demand advanced mathematics and advanced courses in physics or chemistry as prerequisites. As we can see in the table, engineering is more selective and more "masculine" than are sciences. Life sciences are a less mathematically oriented field of study. The department has no special demands regarding background in either mathematics or sciences. Its admission cutoff-point is relatively low, which indicates low selectivity and low attractiveness. The gender composition of life sciences shows that in Israel, as in other countries, it is a "feminine" field (e.g., Croxford, 1994; Jacobs et al., 1998; Smerdon, Burkam, & Lee, 1999; Wilson & Boldizar, 1990). The next four fields of study (medicine, law, psychology, and business and economics) are similar in their high selectivity, as shown by the admission cutoff points, but differ in mathematical orientation and gender composition. The first three are not mathematically oriented, whereas the last are as follows: the departments of business and economics require at least 4-unit mathematics of their applicants, whereas the departments of law, medicine, and psychology have no particular mathematics requirements. Business and economics are relatively "masculine" fields, psychology, as in other countries, is "feminine" (see, for example, Steinpreis et al., 1999), whereas medicine and law have almost gender-balanced composition. The eighth category (hereafter, humanities) is composed of humanities, sociology, and political sciences. These areas were combined into one category because they share several characteristics relevant to this study: lower selectivity, nonmathematical orientation, and a high percentage of female students.

[6]Although the study focuses on the decision making of students upon applying to a university, and not on their actual studies, it is interesting to note that about 65% of the applicants actually enrolled in Tel Aviv University and 86% of them studied the subject of their first choice.

Procedure

The effect of the courses taken in mathematics and sciences in high school on the gender gap in fields of study at university was analyzed by multinomial logit (Maddala, 1983). This method enables the estimation of the effect of explanatory variables on the odds of belonging to each of the categories of the dependent variable compared with a reference category. The dependent variable included seven categories, which represented the different fields of study. Humanities, the most "feminine" field of study, served as the reference category. The analysis included three models. In the first, restricted, model, gender (coded 1 for females) served as the only explanatory variable. In the second model, the number of units of study in mathematics and the number of advanced science courses taken in high school were added to the equation. In the third model, matriculation score in mathematics, score in the psychometric test, parental academic education (coded 1 if at least one parent had academic education), and ethnic origin (coded 1 for applicants of Middle Eastern or North African origin, the Jewish disadvantaged ethnic groups) were added to the equation. The last two variables served mainly as controls. The first model estimated the gender gap in choice of fields of study at university. The comparison between the first and the second models enabled the estimation of the effect of high-school-mathematics-related experience on the gender gap. The comparison between the second and the third models evaluated the residual effect of mathematics-related achievements, and the two sociodemographic characteristics, parental education and ethnic origin, on the gender gap.

RESULTS

Characteristics of the Applicants to the Different Fields of Study

I begin with a description of the characteristics of the applicants to the various fields of study in terms of gender composition, average level of the courses they have taken in mathematics, average number of advanced science courses, average psychometric score, and average score in mathematics. The information is presented in Table II.

The table shows that women are underrepresented among the applicants to engineering, and, to a lesser degree, to sciences and business and economics, three mathematically oriented fields of study. Women are overrepresented in the least mathematically oriented scientific field—life sciences. This finding is in accordance with the previously mentioned findings that show that life sciences constitute the "feminine" scientific field of study. Women are slightly underrepresented in medicine and law. These fields, both highly selective but not mathematically oriented, have undergone a notable change in the last decades: originally "masculine" fields of study, they have become almost gender-balanced.[7] Women are significantly overrepresented among the applicants to psychology, a selective but not mathematically oriented field of study, and humanities.

The mean number of units taken in mathematics demonstrates the value of this subject in the Israeli education system. The high average number of units among applicants to engineering and sciences and, to a certain degree, business and economics, is straightforward. However, we can see that the applicants to the selective but not mathematically oriented fields of law and medicine are also characterized by taking many units of study in mathematics. Advanced courses in mathematics are not a prerequisite for these fields, but it is common for students with high aspirations to take such courses in high school even when they do not need them for their careers. The higher bonuses that the universities give to higher-level mathematics, mathematics' value on the psychometric test, and the myths attached to it probably enhance the appeal of advanced mathematics courses to all ambitious students. The findings regarding sciences are similar and demonstrate that many students who take advanced courses in sciences in high school apply to fields that do not demand this background.

The mean psychometric score of the applicants mirrors the selectivity of the different fields of study, which is presented in Table I. Israeli youngsters are aware of the selectivity of the various fields and usually do not apply to the selective fields unless they are close to meeting the demands (Guri-Rosenblit, 1996).

Table II shows that applicants to life sciences, the "feminine" scientific field of study, are less mathematically oriented than applicants to all other fields except humanities. Applicants to life sciences are second to applicants of humanities also in their relatively

[7] To illustrate, according to the Israeli Central Bureau of Statistics, in 1969–70 women constituted 30% of all graduates of law in Israel. In 1994–95 the rate of women among law graduates increased to almost 50%. The parallel information on medicine is even more impressive (45 and 70%, respectively), but in this statistic medicine and health sciences were classified into the same category, which makes the information less relevant (ICBS, 1998).

Table II. Characteristics of the Applicants to Different Fields of Study

Field of study	% Women	Units in math Mean SD	Advanced science courses Mean SD	Psychometric score Mean SD	Math score Mean SD	*N*
Engineering	0.13	4.75 (0.49)	0.94 (0.49)	653.31 (56.48)	86.68 (9.77)	442
Science	0.34	4.70 (0.52)	0.87 (0.60)	657.47 (62.47)	87.47 (9.98)	568
Life sciences	0.69	4.06 (0.70)	0.41 (0.54)	609.67 (61.23)	82.75 (10.14)	241
Medicine	0.48	4.63 (0.59)	0.79 (0.63)	679.51 (51.11)	88.12 (9.70)	377
Law	0.50	4.42 (0.83)	0.67 (0.62)	675.03 (57.11)	88.87 (9.45)	862
Psychology	0.76	4.07 (0.82)	0.45 (0.58)	655.48 (63.31)	86.25 (10.70)	297
Business & economics	0.41	4.48 (0.72)	0.67 (0.60)	645.96 (64.27)	85.82 (10.08)	638
Humanities	0.78	3.58 (0.77)	0.18 (0.40)	568.73 (76.72)	81.68 (11.84)	2,741
Total	0.59	4.09 (0.87)	0.48 (0.59)	618.58 (82.00)	84.67 (11.18)	6,139
Women		3.89 (0.85)	0.36 (0.54)	596.90 (81.90)	84.23 (11.23)	3,642
Men		4.37 (0.81)	0.66 (0.61)	651.95 (70.55)	85.33 (11.08)	2,497

low academic ability. Applicants to the humanities exhibit the lowest number of units in mathematics and the lowest psychometric scores. Psychology, another "feminine" field of study, attracts candidates with high psychometric scores and less mathematics background.

The last two rows of Table II demonstrate the gender differences in courses taken in mathematics and sciences and in the scores in mathematics and the psychometric test. As expected, among the applicants to Tel Aviv University, as among all high school graduates in Israel, men have taken more units of study in mathematics than have women (4.37 compared with 3.89) and more advanced science courses (0.66 compared with 0.36), and they have higher scores on the psychometric test (652 compared with 596) and in mathematics (85.33 vs. 84.23).

Gender and Fields of Study

The multinomial logit analyses are presented in Table III. As noted, the first model consists of one independent variable—gender. The gender coefficient is the ratio of the odds of women, compared to men, applying for each field of study, divided by the parallel odds of applying to the humanities. Thus, the coefficient expresses the gender gap in applying to each field of study compared with the gender gap in applying to humanities. The odds ratios are presented in logarithmic form. Thus, a coefficient that exceeds zero indicates a field that is more "feminine" than humanities, a coefficient that is smaller than zero indicates that the field is less "feminine" than humanities, and a coefficient that is close to zero indicates a gender gap that is not different than that in humanities.

Table III. Multinomial Logit for Explaining Choice of Field of Study

Field of study	Engineering	Sciences	Life sciences	Medicine	Law	Psychology	Business & economics
1st equation							
Gender: female	−3.15*	−1.92*	−0.46*	−1.34*	−1.29*	−0.10	−1.66*
Constant, pseudo $R^2 = .06$	−0.43	−0.46	−2.07	−1.11	−0.31	−2.13	−0.22
2nd equation							
Gender: female	−2.85*	−1.64*	−0.36*	−1.09*	−1.08*	0.01	−1.44*
Units in math	1.50*	1.50*	0.59*	1.34*	0.95*	0.56*	1.10*
Advanced science courses	1.32*	1.17*	0.45*	1.01*	0.93*	0.62*	0.79*
Constant	−7.63	−7.52	−4.55	−7.24	−4.62	−4.55	−5.34
pseudo $R^2 = .15$							
3rd equation							
Gender: female	−2.87*	−1.55*	−0.17	−0.76*	−0.66*	0.41*	−1.27*
Units in math	1.45*	1.40*	0.45*	0.83*	0.43*	−0.05	0.97*
Advanced science courses	1.19*	0.96*	0.40*	0.69*	0.57*	0.35*	0.62*
Psychometric score (*100)	0.13	0.40*	0.37*	1.59*	1.81*	1.74*	0.58*
Math score (*100)	3.20*	3.66*	−0.14	3.15*	3.84*	0.98	2.30*
Mizrachi origin	0.36*	0.33*	0.03	0.48*	0.61*	−0.24	0.38*
Parental education	−0.25	0.02	−0.14	0.11	−0.19	−0.16	−0.26*
Constant	−10.75	−12.71	−6.10	−18.08	−17.37	−13.90	−10.24
pseudo $R^2 = .19$							

$^*p < 0.05$.

The first model (row 1 of Table III) shows that the gender coefficient is negative in all seven categories. This means that all fields of study, except psychology (for which the coefficient is small and statistically insignificant), are less "feminine" than humanities, the reference category. The gender gap in favor of male students is greatest in engineering. Sciences follow engineering, but the coefficient is much lower (−1.92 compared to −3.15). The insignificant coefficient of psychology indicates that the gender gap in choosing this field of study is similar to that of humanities.

In the second model the number of units in mathematics and the number of advanced science courses are added to the equation. The comparison between the first two models enables the estimation of the effect of high school history on the gender gap in fields of study. We can see that after controlling for courses taken in mathematics and sciences, the gender coefficient is smaller in six of the seven fields of study. However, the changes in most coefficients are small.

The lowest rate of reduction (10%) is found in engineering. Clearly, this field of study is less attractive to women than to men, and, despite its strong mathematical orientation, the mathematical background of the applicants does not have a significant effect on the gender gap. The reduction of the coefficients for the other fields of study is somewhat larger, but still marginal (between 13 and 22%). Paradoxically, the reduction in the mathematically oriented fields of study—engineering, sciences, and business and economics—does not exceed the reduction in the fields of study that lack mathematical orientation. Thus, high school experience is only marginally responsible for the relative reluctance of women, compared with men, to apply for the mathematically oriented fields of study.

The control for number of units in mathematics and number of advanced courses in sciences does not produce any notable change in the gender coefficient for one field of study—psychology. The coefficient remains low and insignificant, which suggests that high school curricular history is irrelevant to the gender differences in choosing this field of study.

After the inclusion of the psychometric score, the matriculation score in mathematics, parental education, and ethnic origin in the analysis (third model), most coefficients retain their statistical significance, but the rates of reduction vary. The control has no effect on the gender gap in engineering, and it only slightly affects the coefficients of sciences and business and economics. The reduction for medicine and law is much more impressive: the two coefficients are reduced by 43% compared with the first equation, which included only one explanatory variable—gender.

The most interesting change appears in two "feminine" fields of study: life sciences and psychology. The coefficient of life science gets smaller and loses its statistical significance. In the first equation we saw that women's relative tendency to apply for life sciences is smaller than the parallel tendency to apply for humanities. The third equation shows that this gender gap is related to gender differences in high school experience and the psychometric score. In other words, the lower exposure of women to higher-level mathematics and their lower scores on the psychometric test seem to be preventing them from applying to life sciences in higher proportions.

For psychology, the selective "feminine" field of study, the psychometric score operates as a suppressor (the coefficients of the other variables introduced in the third equation are low and insignificant). The control causes the gender coefficient, which is close to zero in the first two equations, to become positive and statistically significant. The positive coefficient implies that psychology attracts women, relative to men, even more than humanities do, but their inferiority in the psychometric score prevents female applicants from choosing this field of study more often than they do.

Returning to the gender composition of the various fields of study (Table I), we can see that the effect of mathematical background and psychometric score on the gender gap in choice of fields of study varies according to the relative "masculinity" of the field in question. The gender gap is the least affected in the most "masculine" field of study—engineering. It is somewhat affected in sciences and business and economics, which are also "masculine" areas. The effect of number of units in mathematics, number of advanced science courses, and the psychometric score is stronger for the nearly gender-balanced fields, medicine and law, and it is particularly significant for the "feminine" areas life sciences and psychology. In other words, the direct effect of patterns of taking courses in mathematics and sciences in high school, and their indirect effect via the psychometric score are most significant for the "feminine" fields of study.

The direct effects of number of units in mathematics, number of advanced science courses, and the scores in the psychometric test and in mathematics on the choice of fields of study, which are presented in the third equation, are in the expected direction. The effect of number of units in mathematics is particularly significant for engineering and sciences, the mathematics-based fields. It is lower, but still significant, for medicine, economics and business, and law, and lowest for life sciences and psychology. It is not surprising to find that number of units in mathematics is influential for the mathematically oriented fields of study, engineering and sciences. However, the effect of the number of units in mathematics is greatest with respect to the nonmathematically oriented law, which indicates that only high achievers apply to this selective field. The effect of number of advanced science courses follows a similar pattern to that of number of units in mathematics. The relatively high values of the number of advanced science courses for law and for economics and business, two fields that are not particularly science-oriented, demonstrates that taking advanced science courses in high school reflects students' ambition and motivation, and not necessarily their interest in the subject matter.

The effect of the psychometric score is statistically significant for the seven fields of study. It is most impressive in the selective fields of study—psychology, law, and medicine; it is much lower for sciences, business and economics, and engineering, and lowest for life sciences.

Although parental education and ethnic origin are included in the analysis mainly for control, the effects of the two variables are of interest. It appears that parental education has no significant effect on the choice of fields of study, and that, after control for the explanatory variables, students of Middle Eastern or North African origin are less interested in humanities than their ethnically more privileged counterparts.

Educational Background and Preferences of Women and Men

Up to this point, the gender gap in choosing fields of study in higher education, and the effect of different factors on this gap, were analyzed. We have seen that, paradoxically, mathematical background in high school affects the gender gap in choice of fields of study that are not mathematically oriented more than the mathematically oriented ones. In this section the pattern that underlies this finding will be described. As discussed, control for mathematical background does not change the gender gap in the "masculine" fields of study. However, this finding does not necessarily imply that this background has no effect on women's preferences. If mathematical background had a significant effect on the choices of women, and a similar effect on the choices of men, the gender gap would have remained unchanged. Changes in the preferences of women, regardless of their effect on the gender gap, have their own value for this study because they indicate that even if high school history does not affect the gender gap, it encourages women to apply for "masculine" fields of study.

The reduction of the gender gap after control for the explanatory variables can also follow different patterns. High school curricular history may affect both genders in a similar direction but in different magnitudes. If the effect for women were stronger than for men, we would have found a reduction of the gender gap. High school history can also affect the two genders in different directions; for example, mathematical background may enhance the tendency of women to apply to a field of study, and, at the same time, reduce the tendency of men to do so. In that case, the outcome would again be a reduction in the gender gap. To trace the patterns that underlie the findings on the gender gap, I conducted separate analyses for men and for women. Table IV presents the effect of the explanatory variables on the odds of applying to the different fields of study for each gender, separately. On the basis of the equation presented in the table, I calculated the expected probabilities of average male and female applicants and the probabilities of male and female applicants who took 5-unit mathematics and 5-unit physics, chemistry, or both (hereafter, applicants with mathematical background) applying for each field of study. The analysis of the expected probabilities for applicants with a strong mathematics background enables a clearer evaluation of the effect of high school curricular history on the preferences of both genders. If we find gender differences among these applicants, we can assume that factors other than high school history shape the preferences of men and women. Because the analyses were separate for the two genders, I conducted an additional analysis to test whether the differences between women and men with mathematical background were statistically significant. The results showed that gender differences in the likelihood to apply to the various fields among applicants with mathematical background were statistically significant for all fields of study except life sciences.[8]

[8] I performed multinomial logit for the whole sample that included, in addition to the explanatory variables used in this study, three dummy variables representing combinations of gender and mathematical background (women with mathematical background, women without mathematical background, and men without mathematical background). The fourth combination, men with mathematical background, served as the reference category. Thus, women with mathematical background were contrasted with men with mathematical background.

Table IV. Multinomial Logit for Explaining Choice of Field of Study, According to Gender

Field of study	Engineering	Sciences	Life sciences	Medicine	Law	Psychology	Business & economics
Women							
Units in math	2.28*	1.66*	0.60*	0.96*	0.56*	0.01	1.04*
Advanced science courses	1.53*	0.86*	0.44*	0.58*	0.46*	0.44*	0.72*
Psychometric score (*100)	1.38*	0.25	0.38*	2.15*	1.97*	1.69*	0.57*
Math Score (*100)	6.09*	4.09*	0.33	2.94*	4.44*	1.01	3.43*
Mizrachi origin	0.16	0.43*	0.12	0.41	0.59*	−0.32	0.47*
Parental education	−0.55	0.16	−0.04	0.15	−0.04	−0.14	−0.15
Constant	−28.33	−14.80	−7.39	−22.82	−20.88	−13.36	−12.88
pseudo $R^2 = .19$							
Men							
Units in math	1.31*	1.17*	0.16	0.65*	0.24*	−0.15	0.85*
Advanced sciences courses	1.12*	1.01*	0.27	0.82*	0.69*	0.10	0.54*
Psychometric score (*100)	−0.12	0.43*	0.33	1.06*	1.61*	2.12*	0.53*
Math score (*100)	2.56*	3.13*	−0.89	3.15*	3.16*	1.12	1.43*
Mizrachi origin	0.37	0.31	−0.14	0.56*	0.66*	0.00	0.35
Parental education	−0.32*	−0.15	−0.36	−0.02	−0.40*	−0.19	−0.42*
Constant	−7.94	−11.50	−3.96	−13.86	−14.71	−16.18	−8.63
pseudo $R^2 = .11$							

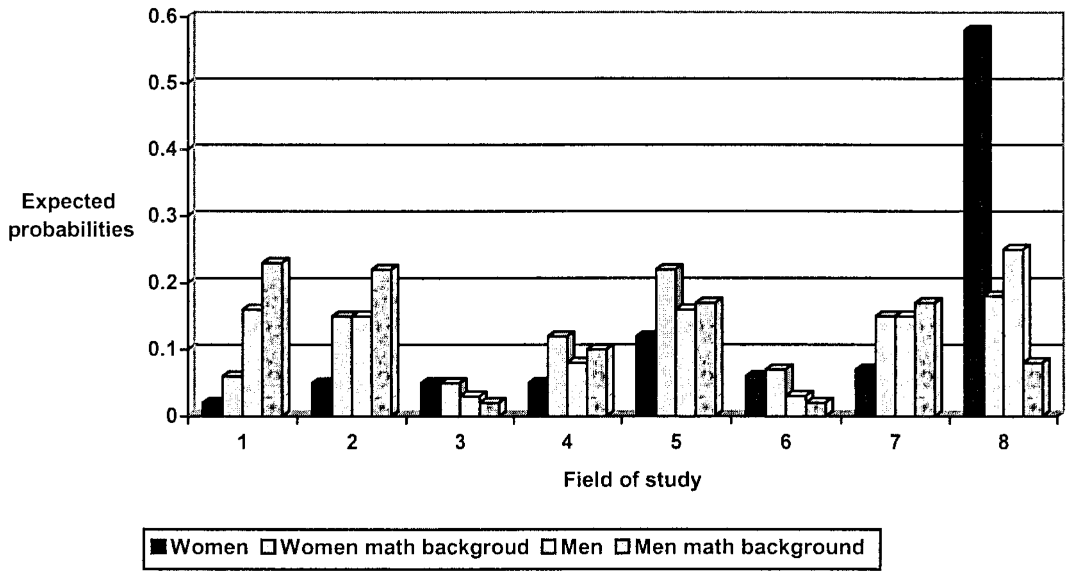
$^*p < 0.05$.

The probabilities are illustrated in Fig. 1, which shows that among applicants with mathematical background there is a sharp reduction in choosing humanities, for both men and women. It also shows that among these applicants, as among all applicants, the gender gap is greatest in engineering and humanities. The proportion of women with mathematical background who apply for engineering is slightly higher, and the proportion of women with this background who apply for humanities is much lower, than the parallel proportions for the entire sample of women. However, humanities is one of the most popular fields of study, and engineering one of the least popular fields of study, among women with mathematical background. Male applicants with mathematical background retain their advantage in sciences and business and economics, but there is an impressive increase in the proportion of female applicants to these fields of study. Clearly, mathematical background increases the tendency of women to choose sciences and business and economics, but it has a similar effect on men. Consequently, even among the applicants with mathematical background, men are more likely to choose these fields of study.

The effect of mathematical background on the choice of life sciences, the "feminine" science subject, reveals an interesting picture. Mathematical background has no effect on women's tendency to choose this area, whereas it reduces the parallel tendency among men. We saw that control for the explanatory variables eliminated the relative advantage of men in applying to life sciences (Table III). Now we can trace the pattern behind this finding: mathematical background reduces men's tendency to apply for life sciences, whereas it has no effect on the parallel tendency of women. Consequently, after the control for the applicants' educational history, men lose their relative advantage in the probability of applying for this field of study.

In psychology, another "feminine" field of study, mathematical background has opposite effects for the two genders. Mathematical background slightly increases women's tendency and slightly decreases men's tendency to apply for this field of study.

The most interesting change was found in medicine and law. In these two fields of study, which are attractive and selective but not mathematically oriented, the gender gap for applicants with mathematical background is opposite in direction from the gap for the sample as a whole. Men are more likely to apply to these fields of study in the sample as a whole, whereas women are more likely among the applicants with mathematical background. The change in the direction of the gap is a consequence of the different effect of mathematical background on men's and women's tendencies to choose these fields of study. Mathematical background causes only a slight increase in the proportion of applicants for these fields of study among men, whereas the parallel increase among women is large and impressive.



1. Engineering
2. Exact Sciences
3. Life Sciences
4. Medicine
5. Law
6. Psychology
7. Business and Economics
8. Humanities

Fig. 1. Expected probabilities applying to fields of study according to gender and mathematical background.

Figure 1 illustrates the different implications of mathematical background on the choices of the two genders. Mathematical background increases men's tendency to choose the mathematically based fields of study: engineering and sciences. The most significant increase in application rates among women with mathematical background is in four fields of study: medicine, law, sciences, and business and economics. Among these four fields of study, two (medicine and law) are not mathematically oriented.

The predicted probabilities indicate the value of educational history in shaping the choices of both genders. For a more accurate evaluation of the differential effect of the various explanatory factors for the two genders, we turn to the coefficients presented in Table IV, which show that in choosing fields of study, women rely on their qualifications more than men do. The coefficients of number of units in mathematics, number of advanced science courses, and the scores in mathematics and in the psychometric test are higher for women than for men in most fields of study, although an additional analysis showed that this gender difference does not reach statistical significance in all fields.[9]

The gender gap in the effect of the number of units in mathematics is particularly salient in life sciences. Other things being equal, every increase in the number of units in mathematics almost doubles ($e^{.60}$) the odds of applying for life sciences rather than humanities for women, whereas it has no effect on the parallel odds for men. This again demonstrates the differences between the two genders regarding

[9]To test whether these gender differences are statistically significant, I conducted a model for the whole sample that included all explanatory variables and four interaction terms: gender and units in mathematics, gender and advanced science courses, gender and the psychometric score, and gender and matriculation score in mathematics. The interaction between gender and number of units in mathematics was statistically significant for sciences, life sciences, engineering, and law; the interaction between gender and the psychometric score was significant for engineering, medicine, and law; the interaction between gender and the matriculation score in mathematics was significant for all fields of study; and the interaction between gender and number of advanced science courses was insignificant for all fields of study.

life sciences. Taking advanced mathematics increases the likelihood of women to apply for life sciences rather than humanities, whereas mathematical background does not distinguish between applicants for life sciences and humanities among men.

Women tend to apply for the selective fields of study when they have particularly high qualifications. This is demonstrated by the effect of the psychometric score. In the most selective fields of study, medicine, engineering, and law, where this score is of particular value, women's coefficients are significantly higher than men's. The only selective field of study that deviates from this pattern is psychology, where gender difference does not reach statistical significance, and the coefficient for men is even a little higher than that for women. The uniqueness of psychology suggests that the tendency of women to apply to selective fields only when they have particularly high qualifications is less relevant when the selective field has a "feminine" image.

DISCUSSION

Do patterns of courses taken in mathematics and sciences in high school affect women's choice of fields of study in higher education? The findings show that indeed they do, but not necessarily in the expected direction. Taking advanced mathematics and science courses in high school is very important in encouraging women to apply to medicine and law. It also substantially narrows the gender gap applying for these fields of study, which are selective, but not mathematically oriented. In fact, among the applicants with mathematical backgrounds, women choose these fields more often than men do. Mathematical background also enhances the advantage of women in two female-dominated fields of study: life sciences and psychology. The effect of courses taken in high school on the gender gap in choice of the mathematically oriented fields of study is much lower. Mathematical background increases women's applications to engineering, but because this field of study is very popular among men, it does not produce any notable changes in the gender gap. Mathematical background has an impressive effect on the percentage of women who apply for sciences and business and economics, but here again, because of its effect on men's choices, it does not change the direction of the gender gap.

Previous studies have shown that women avoid advanced mathematics courses in high school because they perceive this field of study to be irrelevant for their careers (Baker & Jones, 1993; Ma & Willms, 1999; Pedro et al., 1981). In Israel, because of the special status of mathematics and sciences, the advanced courses are relevant for all ambitious students, and indeed are taken by a significant proportion of female students. However, exposure to mathematics and sciences does not seem to encourage women to pursue mathematics or science careers as much as men do.

The findings do not imply that high school history has no effect on the choices of women. As a matter of fact, mathematical background affects women more than men. Mathematical background produces a very significant reduction in women's applications to humanities, on the one hand, and it increases, again very significantly, their choice of medicine and law, on the other. Thus, the findings do not refute the belief that changes in the courses taken by women in high school would produce changes in their choice of fields of study in the university. However, these changes are clearest in selective, but not mathematics-related, fields. It is possible, of course, that some of the female applicants took advanced mathematics and science courses in high school to improve their chances of being accepted to medicine and law, and eventually applied to these departments.

The findings suggest that male and female applicants to university operate in different realities regarding the demands of the various fields of study. These gender differences exist despite the clear specification of requirements by the different departments in brochures that each applicant has to purchase. Several phenomena produce the impression of different realities. The first is the different use by the two genders of mathematical background. Men's use of this background seems more instrumental: it encourages them to apply to the mathematically oriented fields of study for which this background is a prerequisite. In contrast, for women, a mathematical background serves mainly to deviate from the traditional "feminine" choice of humanities in favor of selective, but not mathematically oriented, fields of study.

The different realities are also expressed in the differences between male and female applicants to life sciences. For men, mathematical background does not distinguish applicants to life sciences from applicants to humanities, whereas for women mathematical background increases the likelihood of applying to life sciences rather than humanities. Here again, the application patterns of men seem more instrumental, because the department of life sciences does not actually require previous mathematical or scientific knowledge. However, previous findings (Ayalon, 1995) showed gender differences in the association between taking advanced courses in biology and in mathematics in high school. In high school, advanced courses in biology are linked to advanced courses in mathematics for female, but not for male, students. Accordingly, advanced courses in biology are a popular option for girls who study advanced mathematics, whereas boys who study advanced mathematics take advanced courses in biology only when they are not accepted to advanced courses in physics and chemistry (Ayalon, 1995). In this sense, the applications of women to life sciences continue the pattern established in high school and may be viewed as equally instrumental from their point of view.

The gender gap in the perception of university demands is also manifested in the effect of mathematical background on the choice of selective "masculine" fields of study. We have seen that for these fields of study, particularly the mathematically oriented ones, high school history and the psychometric score are more significant for women. This suggests that men apply to the various fields when they meet the demands of the university whereas women choose selective fields mainly when they possess qualifications that are higher than the official requirements.

How can we explain these findings? We know from previous research that women refrain from choosing fields of study that are known as discriminating (Beyer, 1999; Hearn & Olzak, 1991). Steele (1997) referred, in this context, to "stereotype threat" that discourages women from studying mathematics and sciences. According to this approach, individuals' choices of fields of study are influenced by their social categories. The stereotype threat may explain female applicants' perceived need for particularly high qualifications to apply for "masculine" fields of study in general and for the mathematically oriented ones in particular. Women may believe that outstanding qualifications will induce their classmates and professors to treat them as exceptional cases, and this way they may escape the stereotypic perception that women are unable to perform well in mathematics, sciences, technology, and other male-dominated fields of study. The findings on psychology provide some support for this explanation. The qualifications of women who apply to this selective and demanding, but female-dominated, field of study, do not surpass those of the male applicants. In other words, the encouragement provided by outstanding qualifications does not seem necessary for a female-typed and not mathematically oriented field of study.

An alternative explanation of the findings is based on the traditional view that female students refrain from studying mathematically oriented fields of study because of math anxiety. This line of explanation hardly holds for women with mathematical background who took advanced courses in mathematics, physics, and chemistry in high school. The advanced courses in these subjects are very demanding, and it is hard to imagine that students who completed them successfully (as did all the applicants to the university) suffer from mathematics anxiety. One can argue, of course, that women are not interested in mathematics and sciences and that taking advanced courses in these fields of study in high school is merely a strategy to improve their chances of being accepted to the departments of medicine and law. This may be true, but it can hardly be the whole truth. We have seen that women with mathematical background do apply to the mathematically oriented fields of study when equipped with high qualifications. This pattern indicates insecurity more than lack of interest. Obviously, further research is needed to examine the various explanations directly.

The gender gap in choosing mathematically oriented fields of study in higher education is widespread (Bradley, 2000). This may produce the impression that changes in this area are impossible. The current findings partly support this view by showing that despite the increase in the proportion of female students who take advanced courses in these subjects in high school the gender gap in choosing the mathematically oriented fields of study at university continues to exist. However, we must keep in mind that the gender composition of occupations is not static, and it does change over time. The best examples of this are medicine, law, and psychology. These prestigious occupations were male-dominated for a long time and often perceived as discriminatory. In spite of this, women have made an impressive entry into these occupations, which today are gender-balanced or female-dominated (Randour, Strasburg, & Lipman-Blumen, 1981; Steinpreis et al., 1999). We cannot dismiss the possibility that in the proper circumstances, we may witness a similar change in the gender composition of the mathematically oriented occupations.

However, even if this change occurs, will it bring the expected social consequences? The case of medicine and law shows that the assumption that the entry of women into male-dominated occupations is a good strategy for closing the gender income gap is somewhat problematic, at least in the Israeli case. In Israel, there is a remarkable inner differentiation in both law and medicine. In both occupations, women are concentrated in the public and lower-paid sector, whereas men are found more often in private practice, which is often very rewarding economically. The same is true for mathematics and sciences, where women are concentrated, more than men, in teaching, which is poorly paid. This leads us to the notion that the assumed social consequences of changes in women's choice of fields of study in higher education may be overestimated.

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