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WHY DO WOMEN LEAVE SCIENCE AND ENGINEERING?

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ABSTRACT

I use the 1993 and 2003 National Surveys of College Graduates to examine the higher exit rate of women compared to men from science and engineering relative to other fields. I find that the higher relative exit rate is driven by engineering rather than science, and show that 60% of the gap can be explained by the relatively greater exit rate from engineering of women dissatisfied with pay and promotion opportunities. Contrary to the existing literature, I find that family–related constraints and dissatisfaction with working conditions are only secondary factors. My results differ due to my use of non–science and engineering fields as a comparison group. The relative exit rate by gender from engineering does not differ from that of other fields once women's relatively high exit rates from male fields generally is taken into account.

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American policy analysts are concerned at the declining U.S. share in world patenting and scientific publishing, which many trace to the perceived failure of the United States to educate as many scientists and engineers as "competitor" countries. Possible solutions to this problem are to increase skilled immigration, since skilled immigrants are disproportionately in science and engineering fields, or to increase the number of natives in science and engineering, with the under–represented groups of women and minorities obvious targets. The National Academy of Sciences (2007) and the Institute of Electrical and Electronics Engineers – USA (2007) recommend both immigration–based solutions and domestic solutions such as better K–12 education, more public research funding and special scholarships to encourage natives to study science and engineering.[1] Hewlett et al. (2008) emphasize another strategy: increased retention of women in science and engineering. They identify reasons why women leave science and engineering at a higher rate than men, and propose ways to make science and engineering more friendly to women.

Some of the factual claims made in public discourse may not be reliable (concerning the claim that China trains more engineers than the United States, for example, Gereffi et al. 2008 argue that many "engineers" in China have education corresponding to technician education in the United States), and some of the underlying assumptions questionable (a service–based economy would not optimally have the same share of engineers as a manufacturing–based economy). Even so, disproportionate exits of women from science and engineering could be an indicator of inefficiency. Certain practices in science and engineering firms may prevent women from reaching their full potential, or there may be outright discrimination against women in such firms. The existence of such practices or discrimination could in turn discourage women from entering science and engineering.

In this paper, I investigate why women whose highest degree is in science or engineering cease doing science and engineering–related work at higher rates than similarly trained men. Unlike earlier work, I use non–science and engineering fields as a comparison group, and contrast science and engineering. The results shed light on whether interventions to

[1]Hunt (2009) and Hunt and Gauthier–Loiselle (2010) examine the effect of immigration on patenting and publishing.

reduce the female exit rate from science and engineering are warranted, and if so, which.

The higher exit rate from science and engineering of women compared to men has been best documented by Preston (1994, 2004, 2006). Women's higher exit rate to non–employment is not surprising, but Preston shows that female scientists and engineers are also more likely than their male counterparts to move to a job outside science and engineering. The considerable literature on women leaving science and engineering highlights the difficulty of balancing long work hours and family in science and engineering, the isolation of being a minority and the associated lack of mentoring and networks, the risk-taking environment, the "hostile macho culture" and discrimination.[2] However, with the exception of Morgan (2000), the research of which I am aware uses samples of current or former scientists and engineers only, without any comparison with other skilled occupations. To see the limitations of such a focus, consider a common explanation for women quitting science and engineering: long work hours. Long work hours may indeed disproportionately lead women rather than men to leave science and engineering, but long work hours may also disproportionately lead skilled women to leave other fields. Women may simply churn more than men in search of a job with optimal work hours. Thus, while it may be worthwhile for science and engineering employers to implement Hewlett et al. (2008)'s prescription of more flexible working time, if other employers implement and benefit from similar policies, any science and engineering–specific disadvantage in retaining women will persist.

I use the 1993 and 2003 National Surveys of College Graduates (NSCG) to investigate retention of women in science and engineering compared to other fields, defining a worker as having left his or her field if he or she reports doing work unrelated to the field of study of the highest degree. I also analyze the wages of leavers and stayers. I demonstrate that the exit rate for women compared to men is indeed higher from science and engineering than from other fields. I show that the excess exits are concentrated in engineering rather

[2]Hall (2007), Hewlett et al. (2008), Preston (1994, 2004, 2006), Sonnert and Holton (1995), Stephan and Levin (2005); see also Rosser and Taylor (2009).

than science, and in exits to other fields rather than to non–employment[3]. Furthermore, I show that the problems are not those emphasized by the previous literature. Rather, I find that the most important driver of excess female exits from engineering is dissatisfaction over pay and promotion opportunities, a factor explaining about 60% of the differential gender gap in exit rates. Concerns about pay and promotion have gone unnoticed by the literature studying only science and engineering fields, because women are slightly less likely to leave engineering for this reason than men: however, women are much less likely than men to leave non–science and engineering fields for this reason. Family–related constraints are not a factor: while many more women than men cite family issues as the reason for leaving engineering, the gender gap is as large in non–science and engineering fields. I find that working conditions, the unavailability of a job in the field, changes in professional interests and job location play statistically significant but minor roles. I do find slight excess exits of women from science for family–related reasons: these are offset by relatively lower female exits for all other reasons.

In seeking explanations for why women engineers may be particularly disgruntled about pay and promotion, it is helpful to know that their relatively high exit rates, both in total and for pay and promotion reasons, are no higher than would be expected given the high share of engineers that is male: compared to men, women have relatively higher total and pay and promotion–motivated exit rates from more male fields of study. Excess female exits from a field are not influenced by the field's working hours, wages, or share of workers in management, though these are all positively correlated with the male share. The implication is that a lack of mentoring and networks, or discrimination by managers and co–workers are the more promising of the existing explanations for excess female exits, and that explanations hinging on the precise nature of engineering work should be discarded. The slight excess female exits from science for family–related reasons are not accounted for by the share of trained scientists that is male.

[3]My analysis goes beyond that of Morgan (2000), who uses the 1993 NSCG to compare exits from full–time employment of women from different fields.

1 Data and descriptive statistics

I use the 1993 and 2003 waves of the National Survey of College Graduates, data collected under the auspices of the National Science Foundation. The surveys are a stratified random sample of respondents to the 1990 and 2000 census long forms who reported having a bachelor's degree or higher. I define someone as having left a field if they state that their current work is not related to the field of study of their highest degree. The surveys ask: "Thinking about the relationship between your work and your education, to what extent was your work on your principal job held during the week of [...] related to your HIGHEST degree field? Was it... closely related/somewhat related/not related?" If the respondent answered "not related", he or she was asked "Did these factors influence your decision to work in an area outside of your HIGHEST degree field?" and given a list of possible factors to check: family–related reasons; working conditions; pay, promotion opportunities; job in highest degree field not available; change in career or professional interests; job location; other reason. He or she was then asked "Which factor in [the list] represents your MOST important reason for working in an area outside of your HIGHEST degree field?".

In addition to conventional variables on salary and demographics, I also take advantage of the question asked of all workers in 2003: "When thinking about a job, how important is each of the following factors to you . . .", a question followed by a list of job attributes: salary, benefits, job security, job location, opportunities for advancement, intellectual challenge, level of responsibility, degree of independence, contribution to society. Workers must indicate whether each factor is very important, somewhat important, somewhat unimportant or not important at all.

The advantage of the data is that they allow identification of who has left their field and why, for all fields. The disadvantage is that the date of the exit is not known, which precludes hazard rate analysis of the type carried out by Preston (1994). Preston (1994, 2004, 2006) uses the 1980s and 1990s longitudinal files associated with the NSCG (in addition to her own survey), but these cover only those working in science and engineering occupations. The cross–sectional nature of my data also imposes the use of field of study of highest degree to determine initial field. Unlike in occupation–based samples, exits thus include exits after the completion of studies and before the first job. I discuss the relation between the two types of exit in the Data Appendix.

I use three samples in my analysis, from all of which I exclude respondents 65 or older. The main sample used to analyze working in the field of study consists of all workers, except those working part–time because they are students, and 197,686 observations. When I analyze earnings I am obliged to exclude all part–time workers, leaving me with 179,155 observations. I measure earnings as annual salaries adjusted to represent full–time full–year work, a constraint imposed upon me by the 1993 data. Finally, I include all respondents, except those who say they are working part–time or not working because they are students, to analyze the probability of working, yielding a sample of 222,853 observations. The Data Appendix describes the samples and the measure of earnings in more detail.

In the top panel of Table 1, I show that about 20% of both men and women report that the work in their current job is unrelated to their field of study of their highest degree. Men and women differ in their distribution between the other two categories, with more women than men saying their work is closely related to their field of study. For those reporting that their work is unrelated to their field of study, I show in the middle panel the distribution of the main reason for this. The main gender differences are the much higher share of women who are working in a different field for family–related reasons (4.1% of women compared to only 1.2% of men), and the smaller share of women who are working in a different field due to pay and promotion opportunities (4.1% of women compared to 6.5% of men). Women are somewhat more likely work in a different field due to dissatisfaction with working conditions. The bottom panel shows the shares of workers citing the various factors behind working in a different field as either the main reason or a secondary reason.

In my data, 9.7% of men and 6.0% of women have a highest degree in science, and

14.2% of men and only 2.9% of women have a highest degree in engineering.[4] More detail on field of study by gender is given in Appendix Table 1, while Appendix Tables 2 and 3 show the means of the other covariates used in the regressions below.

2 Method

I begin by establishing whether women do indeed disproportionately leave science and engineering for non–employment, part–time employment, or an unrelated job. The approach is a difference–in–differences analysis: to compare the gender gap for science and engineering with the gender gap for other fields of study. I then investigate whether any excess exits I find can be explained with worker characteristics. I allow separate difference–in–differences for science and engineering, estimating a basic specification using linear probability regressions, weighted with survey weights, for the pooled years 1993 and 2003:

$$Y_{it} = \beta_0 + \beta_1 S_{it} + \beta_2 E_{it} + \beta_3 F_{it} + \beta_4 S_{it} \times F_{it} + \beta_5 E_{it} \times F_{it} + \beta_6 X_{it} + \beta_7 F_{it} \times \gamma_t + \gamma_t + \epsilon_{it}, \quad (1)$$

where i indexes individuals and t the year, S is a dummy for the field of study of highest degree being in science, E the equivalent for engineering, and F is a dummy for female. Excess female exits from science and engineering would be reflected in β_4 and β_5. In a more general specification, I replace the dummies for science and engineering with a set of 35 field of study dummies. I calculate robust standard errors. I pool 1993 and 2003 because the effects of interest do not in general differ statistically significantly across the years, though I allow the coefficient on the female dummy to vary by year.

The first outcome Y of interest is the probability of being employed, an outcome I study with the sample of all respondents. The second and third are the probability of working full–time and the probability of the current job being unrelated to the field of study of the highest degree, outcomes I study with the sample of workers. Excess female

[4] By "science" I mean natural sciences, excluding social sciences and health fields. I include computer science with engineering and mathematics with science. The statistics are weighted with the survey weights.

exits would be reflected in positive β_4 and β_5 for holding an unrelated job, and negative β_4 and β_5 for being employed or full–time employed. With the sample of workers, I also examine the probability of the current job being unrelated to the field of study for a specific reason. For example, I estimate a linear probability model for the probability of a worker having left his or her field and cited family as the main reason, and a second for the probability of a worker having his or her field and cited family as either the main reason or a secondary reason. Only one of the seven possible reasons can be given as the main reason, but for ease of interpretation I do not use a multinomial or nested logit to examine the choice.

The covariates X comprise dummies for a master's degree (including MBA), doctoral degree or professional degree, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic and Asian, and dummies for foreign born. If I restrict the sample to 2003, I can also control for three dummies each for the importance the respondent attaches to the nine job attributes listed in the data section. I do this in regressions for outcomes other than employment. In this way I can control for initial selection into different fields (though ideally the job preferences would be measured before the respondent began working). The results are robust to controlling for the interaction of education and field, though I do not report these results.

I do not control for fertility (or marriage) in these regressions, since the fertility choice is made jointly with the decision of whether to remain in the field of study (or to remain employed). However, the correlation between fertility and remaining in the field of study may be informative, so I examine it in additional regressions. I do not know the timing of leaving the field of study, so I would ideally use information on lifetime fertility to date. However, I know only the number and ages of children of the respondent living in the household at the time of the survey, so I proxy lifetime fertility with a dummy C_{it} for whether any child of the respondent (of any age) is living in the household. I explore gender and field differentials in the relation between fertility and how closely related the respondent's job is to his or her field of study, by adding C_{it}, $C_{it} \times F_{it}$, $C_{it} \times S_{it}$, $C_{it} \times E_{it}$, $C_{it} \times S_{it} \times F_{it}$ and $C_{it} \times E_{it} \times F_{it}$ to equation (1). A positive coefficient on the triple interactions in a regression for working in an unrelated job would suggest that women have more difficulty combining work and children in science and engineering than in other fields, relative to men.

In equation (1), science and engineering are being compared to a set of fields of study as disparate as business, teaching and technology (i.e. technical training below the level of engineering). While science and engineering may seem naturally distinct, due to their mathematical nature and use of equipment and laboratories, it is possible that what in fact distinguishes them is their high share of male workers. Female exits may increase relative to male exits as the share of male workers increases, and any apparent specificities of science and engineering may simply reflect this.

To test this, I allow for excess female exits from male–dominated fields by adding to the covariates of equation (1) m_j and $m_j \times F_{ijt}$, where m_j is the share of men in field of study j. For this purpose, I use the most detailed field of study categories (143 categories). If β_4 and β_5 were statistically significant and change little with the addition of these covariates, the share of males in a field of study is not relevant for gender differences between science and engineering and other fields. If β_4 and β_5 become statistically insignificant, science and engineering exit rates merely reflect their male–dominated work force. I cluster the standard errors by detailed field of study.

To judge the pecuniary and hence productivity implications of a person not working in the field of study of the highest degree, I use the sample of full–time workers to estimate weighted least squares salary regressions, calculating robust standard errors:

$$log\, w_{it} = \alpha_0 + \alpha_1 SR_{it} + \alpha_2 NR_{it} + \alpha_3 F_{it} + \alpha_4 SR_{it} \times F_{it} + \alpha_5 NR_{it} \times F_{it} + \alpha_6 X_{it} + \alpha_7 F_{it} \times \delta_t + \delta_t + \nu_{it}, \quad (2)$$

where SR_{it} is a dummy for the respondent's job being somewhat related to the field of study of the highest degree, and NR_{it} is a dummy for the job being unrelated. The coefficients α_4 and α_5 indicate whether the salary penalties indicated by α_1 and α_2 are different for women. I also replace the dummy for unrelated, NR_{it}, with the main reasons the respondent could give for the job being unrelated to the field of study, to judge how the salary penalty varies with the main reason for leaving the field. Naturally, there is a selection issue here: people prepared to leave their field of study for family reasons, say, may have unobserved attributes that affect their earning power, probably negatively. These regressions should be taken as merely suggestive of possible consequences of leaving one's field of study, although the selection problem should be mitigated by my ability to control for the job attributes to which the worker attaches importance. For the earnings regressions, the X covariates include, in addition to the covariates used for the earlier regressions, a dummy for tenure of five years or more (continuous tenure is not available for 1993, see Data Appendix), a dummy for self–employment and eight census region dummies.[5]

3 Results

3.1 Are there excess female exits from science and engineering?

I begin by establishing whether science and engineering do have excess female exits compared to other fields employing workers with a college education or more. In Table 2, I consider exits to non–employment, using the sample of all respondents. The first three rows indicate, as expected, that for those trained in science, engineering and other fields, the share of women who are employed is lower than the share of men who are employed. What is potentially interesting is how the gender gap differs across the fields. The fourth row shows that if science is compared with other fields, there is no statistically significant difference in the gender employment gap. The fifth row shows that women as trained engineers have a statistically significant 2.5 percentage point employment advantage relative to other fields: the opposite of what would be expected if women were driven from employment for engineering–specific reasons. The unreported results for the probability of working part–time rather than full–time are very similar: the gender gap in science is the same as in other fields, while the gender gap in engineering relative to other fields

[5] I extend the 1993 NSCG analysis of Robst (2007a,b) by examining wages by reason and field of study jointly, rather than separately, and by using 2003 data.

indicates that female engineers are relatively unlikely to work part–time (the difference–in–differences is 4.1 percentage points).

Next, I compare the gender gap in how closely job and field of study are related for workers trained as scientists and engineers compared to workers trained in other fields. In the upper panel of Table 3, I consider the share of workers whose job is not related to their field of study of highest degree. 23–24% of both men and women who studied science have an unrelated job, larger shares than the 21% of both men and women who studied something other than science and engineering who are working in a job not related to their field of study. The difference in the gender gap is not large: a statistically insignificant 1.1 percentage points excess exit rate of women from science. This is not necessarily at odds with the existing literature, which typically does not separate science and engineering. The panel shows that the exit rate from engineering is very low for men: only 9.8% of men trained as engineers are doing unrelated work. While the exit rate is also low for women, at 12.9% it is considerably higher than for men. The comparison of the gender gap in engineering with non–science and engineering fields therefore shows a statistically significant 3.2 percentage point excess exit rate of women from engineering. This excess exit rate is small compared to the female shortfall in entry to engineering, but its elimination could encourage female inflows.

In the lower panel, I check the robustness of these results by examining shares of workers reporting a job closely related to their field of study. The difference–in–differences measures are statistically significant for both science (-4.7 percentage points) and engineering (-6.7 percentage points). Stated differently, if leaving the field is measured by having a job either not related or only somewhat related to the field of study, there are excess female exits from both science and engineering. However, by this measure of leaving the field, women are less likely to leave science and engineering than men.

3.2 Consequences of leaving the field of study of highest degree

I next assess attempt to assess whether there are negative consequences for full–time workers who leave the field of study of their highest degree. Because the results differ considerably by field of study, I estimate the log earnings regressions (equation 2) separately for science, engineering and other fields. I present the basic results in columns 1–3 of Table 4, in specifications where I control for all variables except job preferences. Column 1 indicates that male holders of a science degree who perform somewhat related work earn 3.2% more than those who do closely related work (while there is little difference for women), and columns 2–3 show that for non–scientists, performing somewhat related work has a statistically significant but small wage penalty: 4.0–4.2% for holders of non–science and engineering degrees and for men trained as engineers, and 8.2% for women trained as engineers. The wage penalty for leavers should be interpreted as a combination of wage changes from leaving the field and an overrepresentation among leavers of less motivated workers or workers whose career is progressing unexpectedly poorly.

The more serious penalties are associated with doing work unrelated to the highest degree. These are particularly high for workers leaving engineering (column 2), who earn 31 log points (36%) less than stayers if male and 41 log points (51%) less if female. The penalties for science are smaller, at 9.8% for men and 15.2% for women, while the penalties for those trained in neither science nor engineering lie between the engineering and science values. These results suggest that the main policy concern should be trained scientists and engineers whose job is unrelated to their field of study, and that those with somewhat related jobs are less of a concern.

In columns 4–6, I replace the single dummy for unrelated work with seven dummies for the main reason the work is unrelated. Doing unrelated work is associated with a large wage penalty for most reasons, though the wage outcomes are always worst for engineering and usually best for science. The exceptional exit reason is pay and promotion opportunities: leaving science and non–science and engineering for these reasons is associated with wage premia of 10.6% and 2.2% respectively. By contrast, workers who leave engineering for these reasons suffer a 11.6% wage penalty.[6] This apparent penalty casts doubt on the ability of cross–section data to yield information on the wage changes leavers experience.

Columns 4–6 also show that, after controlling for the reason for exiting a field, the wage penalty for unrelated work for women leaving engineering is statistically significantly greater than for men (by 8.5%), smaller for women compared to men leaving non–science and engineering (by 3.8%), and similar for women and men leaving science. In unreported regressions I have allowed the regression coefficients on reason to vary by gender. The coefficient on the interaction term is statistically insignificant for both science and engineering women for the pay and promotions reason which will be of particular interest below. This is important, as it suggests that it is not the case that women who say they left science or engineering for pay and promotion reasons had unsatisfactory pay and promotion outcomes due to family constraints, else their wage penalty would be closer to that of women leaving for family reasons.[7]

The results are similar to those in Table 4 when the sample is restricted to 2003 or to workers whose highest degree was received in 1980 or later (not reported). So far I have not controlled for the importance workers attach to various job attributes, which are available for 2003 only. When I add these dummies to the specification of columns 4–6 using the 2003 sample, the coefficients on exiting for the various reasons change only by a few percentage points, despite the fact that the job attribute coefficients are very significant (these results are not reported).[8] The coefficients on the pay and promotion dummies become less favorable to leavers, since workers for whom pay is important earn more in general and are more likely to quit for pay and promotion reasons: the coefficient falls from 0.12 to 0.08 for science, from -0.12 to -0.14 for engineering, and from -0.004 to

[6] There is either more negative selection among workers leaving engineering for pay and promotion reasons, or the wage gains to leaving engineering for these reasons are lower.

[7] Women have statistically significantly greater penalties for exits from engineering for family reasons and because no job is available in the field of study, and for exits from science for working conditions reasons.

[8] The unreported coefficients indicate that workers valuing independence, intellectual challenge and especially pay earn more, while those valuing job security and especially societal contribution earn less. This is consistent with Fortin (2008).

-0.030 for non–science and engineering.

3.3 Why do women leave science and engineering?

I now turn to attempting to explain the existence of excess female exits from engineering. I first estimate equation (1) with employment as the dependent variable. The first column of Table 5 presents a specification almost equivalent to the simple difference–in–differences in the Table 2, except that a year dummy and its interaction with female are also controlled for. The coefficients on the two interaction terms represent the difference–in–differences effects. In column 2, I add 35 field of study dummies, and in column 3 the remaining covariates. In column 3, the gender gaps between science and engineering and other fields are small and insignificant: the high employment rate of women trained as engineers in column 1 is explained by field of study (column 2) and age and years since highest degree. Restricting the sample to 2003 (column 4) or to respondents who received their highest degree in 1980 or later (column 5) also yields small and insignificant coefficients on the interaction terms.

It is possible that the lack of differential employment patterns by gender and field masks informative differences in the reasons for non–employment. I therefore repeat the regressions seven times, each time using as the dependent variable the probability of not working for one of seven possible reasons respondents can give.[9] Appendix Table 4 shows that, conditional on covariates, the only statistically significant effect is that women trained as engineers are less likely to be non–employed because they have no need to work or do not want to work.[10]

I have also estimated the regressions for workers, with full–time work as the outcome, to see if science and engineering women are pushed to work part–time. The unreported results indicate no difference in the gender gap between science and other fields, and a

[9]As I have dropped people not working because they are students, I do not examine the eighth possible reason, being a student.

[10]The results for 2003 and for recipients of highest degrees in 1980 or later suggest female engineers are more likely not to be working because no suitable job is available.

wrongly–signed positive difference–in–differences effect of 2.5 percentage points for engineering, in the specification with the full covariates. I conclude that excess female exits from science and engineering are present only in exits to another job, and therefore turn to explaining the differences in how closely related a worker's job is to his or her field of study.

In Table 6, I analyze the probability of having a job not related to the field of study of the highest degree. The specification of column 1 is nearly equivalent to the difference–in–differences analysis of Table 3 Panel A, except that a year dummy and its interaction with female are controlled for. In column 2, I replace the science and engineering dummies with 35 field of study dummies; in column 3 I add the other covariates (other than job preferences). The addition of the covariates makes little difference to the insignificant coefficient for women in science, but increases the difference–in–differences coefficient on women in engineering to 5.8 percentage points in column 3, indicating excess female exits from engineering.

In column 4, I restrict the sample to 2003 (which increases the difference–in–differences coefficient for engineering to 7.7 percentage points), in order to add the dummies for the importance of job attributes in column 5: possibly the initial selection of men and women into fields of study leads to differences in job preferences across fields of study, which then influence field exit rates. A comparison of columns 4 and 5 shows this is not the case, despite the joint significance of the job preferences coefficients: the excess exits of women from engineering are not explained by any of the available covariates.[11] In column 6, I show that the results for workers who received their degrees in 1980 or later are similar to the results for the full sample.

In Table 7, I consider whether correlations between children and job relatedness by gender and field of study hint at differences in the difficulty of combining family and career

[11]The addition of the job preferences dummies cuts in half the negative coefficient on the main female effect: women's generally lower tendency to leave their field of study conditional on their characteristics is in part explained by their different valuations of job attributes. For example, workers valuing societal contribution are much less likely to leave their field and are much more likely to be female.

for women trained in engineering. Column 1 reproduces the full–sample results of Table 6 column 3. Column 2 shows that, while having a child in the household is associated with a 2.7 percentage point lower probability of a job unrelated to field of study, the interactions with female, science and engineering have insignificant coefficients, and the addition of the child covariates has not changed the difference–in–differences coefficients compared to column 1. Column 3 shows that women trained as engineers have a 3.7 percentage point more positive association between having a child and having an unrelated job than other workers, suggesting that combining children and career may indeed be more difficult in engineering than other fields. The coefficient on the interaction of female and engineering now represents the effect for childless women: although the coefficient of 3.8 percentage points is one third smaller than the column 1 value for all women, it remains sizeable, indicating that most of the excess female exits from engineering are not attributable to children.

The results for the 2003 sample in column 4, and in column 5 where I control for job preferences, show no additional effect of children for women trained as engineers, nor do the column 6 results for respondents who received their degree in 1980 or later. The 2003 coefficient on the triple interaction of child, engineering and female is statistically significantly smaller than the 1993 coefficient, suggesting women's child responsibilities are no longer an engineering–specific problem. Consistent with this, the addition of the triple interaction to the 2003 regression has no effect on the estimated excess exits of women from engineering (as shown by comparing the table's results with unreported results).

I pursue the analysis of the causes of women leaving science and engineering by using the reasons given by respondents whose job is not related to their field of study. In Panel A of Table 8, I consider the probability of leaving the field of study and giving as the main reason family, pay and promotion, or working conditions. In the odd columns I control only for a year dummy and its interaction with female, while in the even columns I also control for worker characteristics (except job preferences). Column 1 shows that there are statistically significant excess female exits from science for family–related reasons, of 1.6 percentage points, but no such excess exits for engineering. The unreported gender difference in family–related exit rates from science fields (the single difference, rather than the difference–in–differences) is a sizeable 4.5 percentage points, which is the gender gap the previous literature has focused on. But because the gender difference in non–science and engineering fields is 2.8 percentage points, the excess female exits from science are only 1.6 percentage points. The addition of covariates reduces the excess exits from science to 1.3 percentage points (column 2).

Column 3 shows that pay and promotion opportunities play an important role in excess female exits from engineering: the coefficient on the engineering interaction term indicates a 2.8 percentage point effect, accounting for most of the total engineering excess female exits of 3.3 percentage points (in Table 6 column 1). The role of pay and promotion has been overlooked in the previous literature, because the exit rate from engineering for pay and promotion reasons is similar for men and women (the unreported single difference is an insignificant 0.3 percentage points). However, in non–science and engineering fields, women are 3.1 percentage points less likely than men to leave for pay and promotion reasons. The estimated excess exits from engineering increase to 3.6 percentage points when covariates are added in column 4, accounting for 62% of the total conditional excess exits of 5.8 percentage points (in Table 6, column 3). There are no excess exits of women from science for pay and promotion reasons. Columns 5 and 6 suggest that working conditions play no role in excess female exits from either science or engineering.

In Panel A of Table 9, I examine the probability of leaving the field of study and giving one of the other four possible main reasons. For conciseness, I report only the estimates using full covariates (other than job preferences). The difference–in–differences effects are small and statistically insignificant for science and engineering for all four reasons: unavailability of a job in the field of study (column 1), change in professional interests (column 2), job location (column 3) and other reason (column 4), with the exception of excess female exits from engineering of 0.6 percentage points for "other" reasons. I conclude from Panel A of Tables 8 and 9 that the most important reason for women leaving engineering at higher rates than men is pay and promotion opportunities. Women trained in science are affected to a smaller extent by family–related reasons, which are offset by all the other reasons collectively, though none is individually statistically significant.

In Panel B of Tables 8 and 9 I search for more minor causes, by estimating the probability of a reason being mentioned at all, whether it is the most important reason or not. Where the full covariates are included, the difference–in–differences effect for engineering is positive and statistically significant for every reason except family reasons. This points to there being many reasons that lead women to leave engineering at higher rates than men, but the conclusion based on Panel A that the most important reason is pay and promotion is reinforced by the fact that the largest coefficient in Panel B is for pay and promotion (Table 8, column 4). For science, the difference–in–differences effect for family–related reasons is statistically significant (Table 8 column 2). Of the remaining reasons, only working conditions (Table 8, columns 5 and 6) matter, and the effect is statistically insignificant once covariates are added.

I have repeated the regressions for the year 2003 only, and for recipients of highest degrees in 1980 or later. The only noteworthy differences are that in both these samples, compared to men, the women trained as engineers are statistically significantly more likely than women trained in other fields to give a change in career interests as their main reason for leaving their field, and that for the recent degree recipients, women scientists are statistically significantly less likely to to name field job unavailability as the main reason. Pay and promotion remains the most important factor for engineering. For the regressions using the 2003 sample I can add controls for job preferences, and the results are robust to this addition.

It is possible that women report dissatisfaction with pay and promotion opportunities in engineering because they are more likely to be sidelined upon returning from a career break than in other fields, due to the rapid advancement of technology. Preston (2004) shows that among former scientists and engineers who re–enter science and engineering, those re–entering the fastest–evolving fields have the lowest wages compared to those who never left science and engineering. If this explanation were correct, pay and promotion dissatisfaction should be equally salient in science, which is not the case. Nevertheless, I investigate this possibility further, using the 1993 data which include actual experience. I define a dummy to represent a career break of more than five years, using actual experience and year of highest degree. Naturally, a career break could be the outcome of leaving a field rather than the cause, but as for children, the correlations could prove informative. I take the pay and promotion specification of Table 8 Panel A, column 4, and add a quadratic in actual experience, the career break dummy, and its interaction with science and with engineering. The addition of the controls does not affect the difference–in–differences coefficients, although the coefficient on the career break dummy is positive and significant, as is the coefficient on its interaction with science (these results are not reported). This casts doubt on the career break explanation for female pay and promotion concerns in engineering.

3.4 Do science and engineering differ due to their male work force?

Rather than posing unique problems for women, science (in terms of compatibility with family) and engineering (in terms of pay and promotion causing difficulties) may reflect problems that grow as the male share of the work force increases. Figure 1 gives a sense of the potential importance of the male share in the field of study of the highest degree. For each of the 143 detailed fields, I plot the gender gap in the exit rate against the share male. The relation is strongly positive, and the R^2 of the regression line, weighted by the number of workers trained in the field, is fully 0.26. The slope of 0.12 indicates that a 10 percentage point increase in the male share increases the gender gap in the exit rate by 1.2 percentage points. The positive relation holds within both science and non–science and engineering, though not within engineering. Few non–science and engineering fields are as male–dominated as the engineering fields, and most exceptions are technology fields.

I investigate this in a regression context by adding to equation (1) the male share in the worker's detailed field of study and its interaction with female. I provide the baseline in column 1 of Table 10: there is a 5.1 percentage point excess female exit rate from engineering with full covariates except for field of study (I include only dummies for science and engineering). In column 2, I add the male share covariates: this causes the coefficients on the interaction of female with both science and engineering to flip from positive to statistically significantly negative: engineering loses 4.9 percentage points fewer women than one would expect. Men are much less likely to leave male–dominated fields (a 10 percentage point increase in the male share reduces the male exit rate by 1.9 percentage points), while women's exit rates are positively affected by the male share, which means that there are excess female exits from male–dominated fields generally. Once this is controlled for, the relative female exit rates from science and engineering look favorable compared to other fields.

In columns 3 and 4, I exclude from the sample workers whose field of highest degree is education, to assess the influence of the field of study which accounts for 26% of women. Excess female exits from engineering are lower (column 3) than when education was in the comparison group, but adding the male share covariates in column 4 again flips the sign to negative and significant for both science and engineering. In columns 5 and 6, I restrict the sample to 2003, allowing me to control for job preferences. The patterns are qualitatively similar, though the difference–in–differences effects are closer to zero after the male share covariates are added. Unreported regressions show the results for recipients of degrees in 1980 or later are similar to those for the full sample.

I investigate whether the share of male workers in a field may be proxying for other underlying characteristics of jobs in the field, though a full treatment is beyond the scope of the paper, and I do not report the results. The Table 10 results are not affected by the addition of average weekly work hours (or share of workers with hours over 45 or 50) of stayers in the field and its interaction with a female dummy (both coefficients are insignificant), nor by the addition of average wages of stayers and its interaction with female (the interaction with female is insignificant). Controlling for hierarchy in the career path with the share of stayers who are supervisors and who are supervisors of supervisors (and their interactions with a female dummy) explains why men tend to stay in male fields (male fields have many supervisors of supervisors, and men and women tend equally to stay in fields with many supervisors of supervisors), but leaves the coefficient on the female interaction with male share little changed (and therefore does not explain excess female exits from engineering). Adding controls for stayers' average preferences over job attributes and their interaction with a female dummy does explain half the coefficient on the female interaction with male share in the 2003 sample, and correspondingly about half the excess female exits from engineering, but it is unclear whether these covariates capture attributes of jobs or co–workers.

In Table 11, I relate the male share covariates to the main reason for leaving the field. Columns 1 and 2 show that the male share covariates have small effects on leaving the field for family–related reasons, and that the excess female exit rate from science for this reason is little affected by their inclusion (1.2 percentage points rather than 1.5 percentage points). However, in columns 3–4, I show that due to the large effect of the male share covariates on leaving a field for pay and promotion reasons, their inclusion fully explains the 3.1 percentage point excess exit rate from engineering for this reason. Women's concerns about pay and promotion are therefore not an engineering–specific issue, but an issue general to male–dominated fields. The unreported results for 2003 and for recipients of degrees in 1980 or later are similar.

Columns 5 and 6, where I examine leaving the field due to working conditions, are representative of the results for the remaining unreported reasons: there are no excess exit rates before male shares are included, and the signs flip to negative and significant, though small, after their inclusion. The results suggest that one should not look for explanations connected with the nature of scientific and engineering work (with the exception of science and family compatibility), but for explanations of female retention difficulties that become more severe as the share of men in the work force increases, and affect women's pay and promotion.

4 Conclusion

The large existing literature on retention of women in science and engineering focuses almost exclusively on comparisons of male and female scientists and engineers. In this paper, I compare gender differences across fields in order to establish the whether science and engineering are unique. This reveals that there are indeed excess female exits from engineering, though not from science, and that the excess exits are to jobs in another field, rather than to non–employment. Neither worker characteristics nor worker preferences over job attributes, including salary and opportunities for advancement, contribute to explaining the excess female exits from engineering, and I find no differential impact of career breaks for engineers, nor a differential impact of children for women trained as engineers. However, 60% of the excess exits are attributable to concerns of women engineers regarding pay and promotion opportunities. The factors stressed in the literature, such as family considerations and work conditions, play little or no role. Family considerations are a negative factor for women trained as scientists, however, even though they are counterbalanced by positive factors.

The analysis of wages suggests that men and women leaving their field tend to be negatively selected. This negative selection renders difficult an assessment of the wage and productivity change associated with leaving.

The results would appear to point to problems for women specific to the engineering profession. However, I show that the excess exits of women trained as engineers, as well as their excess exits for pay and promotion reasons, are no larger than would be expected given the share of men in the field: the higher the male share, the greater the excess female exits from the field, both in total and for pay and promotion reasons. This suggests that the most useful remedies would tackle women's lack of mentoring and networks as well as possible discrimination by managers and co–workers, and would be applied to all fields with a high share of male workers. The slight excess female exits from science for family–related reasons are not accounted for by the share of trained scientists that are male.

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Data Appendix

I use individual–level data from the 1993 and 2003 National Surveys of College Graduates (NSCG). The data may be downloaded at sestat.nsf.gov/datadownload/. The surveys are stratified random samples of respondents to the 1993 and 2000 census long forms who reported having a bachelor's degree or higher. I drop respondents who live outside the United States or in U.S. territories, or who are aged 65 or older. I include in all samples those who are self–employed on their principal job. I would like to exclude full–time students, but I cannot identify students in 1993, except those who say they are either working part–time or not working because they are students. I therefore exclude in both years all these students from the analysis of the probability of employment, and the part–time worker students from the analysis of working in the field of study of highest degree. As I explain below, I exclude all part–time workers from the earnings analysis. I scale the weights from the 1993 and 2003 surveys so the sum of weights is equal for each year.

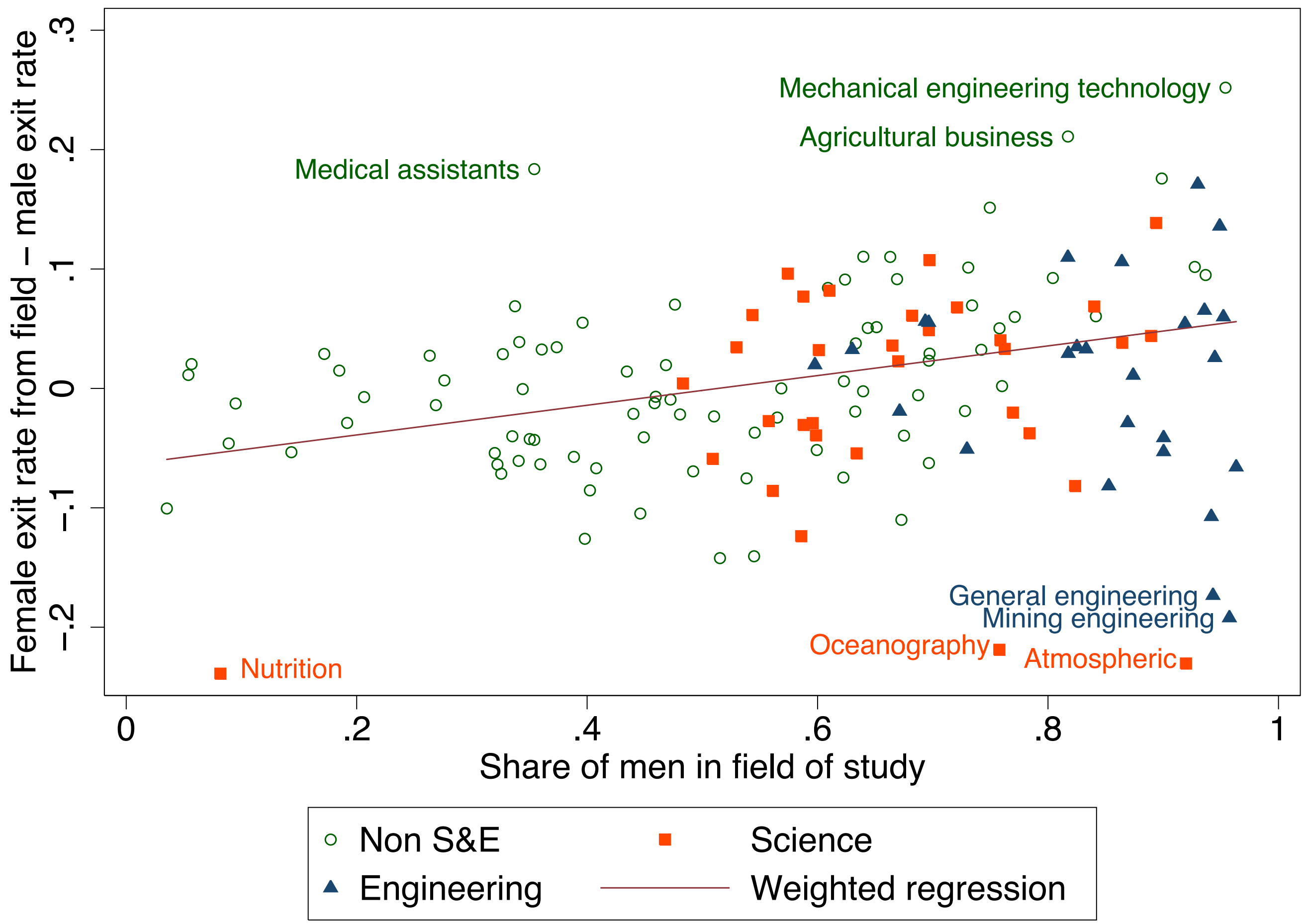
I define science as natural science, including mathematics, and excluding social science and health fields. I define engineering to include computer science. Field of study is provided in 30 or 143 categories. To use 142 field dummies as controls seems excessively detailed, but the more aggregate categorization is rather coarse for fields outside science, engineering and social science. For these fields, I therefore examine the finer categorization for my sample of workers, and select the six finer fields studied by more than 2% of workers. I use these and the 30 aggregate categories to create 36 field of study categories, listed in Appendix Table 1.

The surveys ask for "basic annual salary" on the principal job, and instruct "Do not include bonuses, overtime or additional compensation for summertime teaching or research". The self–employed are directed to "estimate earned income, excluding business expenses". There are no negative salary values. The raw data gathered in response to the earnings questions from the 1993 survey are not available. The only variable provided is "annualized" salary on the principal job (no further explanation is given), and a full–time worker variable. The salary is missing for part–time workers. I attempt to replicate this variable for 2003 by computing hourly wages and multiplying them by 40 hours and 52 weeks, and by excluding those who say they work part–time. I compute 2003 hourly wages by dividing the annual salary by the number of weeks it was based on and by the usual weekly hours on this job. I drop 1636 observations with missing or zero wage values and 1457 observations with hourly wage values below $5.15, the federal minimum wage in 2003. I also drop observations with a high hourly wage for respondents who looked likely to have confused annual weeks and months, or weekly and daily hours (the heaping patterns suggest such confusion exists): I drop observations with hourly wages of more than $100 if weekly hours are nine or less or annual weeks are twelve or less (739 observations). I cannot drop observations with imputed values, as these are not flagged. However, I drop from the wage sample the 379 remaining observations with an annual salary of $565,172, a value I strongly suspect is imputed (the next largest annual salary is $360,000). I can make none of these adjustments for the 1993 salary variable.

The 1993 survey does not ask for tenure on the current job. However, the respondent is asked if he or she was working at the same job five years previously, and this question was also asked in 2003, so I can define a consistent dummy for five or more years job tenure.

I could follow the existing literature by basing exit from a field on occupation rather than job relatedness to highest degree, though I cannot then associate a reason with the field change, and there is not an obvious equivalent to leaving science and engineering for workers trained in other fields. Of workers with a highest degree in science and engineering, who said their current job was unrelated to their field of study, 89% and 82% respectively were not working in a science or engineering occupation.

Figure 1: Excess female exits from fields of study by share of men in field



Notes: The exit rate from a field is the share of workers reporting their work is unrelated to the field of study of highest degree. The regression line is weighted by the number of workers trained in the field.

Table 1: Relation Between Job and Highest Degree (%)

	Male workers	Female workers	All workers
Closely related	52.5	58.3	55.1
Somewhat related	28.1	21.1	25.0
Not related	19.4	20.6	19.9
	100%	100%	100%
Not related; main reason is:			
Family related	1.2	4.1	2.5
Work conditions	1.8	2.4	2.1
Pay, promotion	6.5	4.1	5.4
No job in field	3.1	3.2	3.1
Change in career interests	3.7	3.8	3.8
Job location	1.0	0.9	0.9
Other reason	2.1	2.1	2.1
	19.4%	20.6%	19.9%
Not related; one reason is:			
Family related	4.1	8.2	5.9
Work conditions	8.3	10.9	9.5
Pay, promotion	11.8	9.4	10.7
No job in field	6.3	6.7	6.5
Change in career interests	9.3	9.3	9.3
Job location	8.0	9.3	8.6
Other reason	2.7	2.7	2.7

Notes: Shares are weighted with survey weights. The sample size is 197,686. Respondents were asked "… to what extent was your work on your principal job related to your highest degree? Was it…". Respondents who answered "not related", were asked "Did these factors influence your decision to work in an area outside of your HIGHEST degree field?". In 2003, the working conditions option specifies "e.g. hours, equipment, working environment" and the family-related option specifies "e.g. children, spouse's job moved".

Table 2: Employment Rate by Gender and Field of Highest Degree (%)

	Men	Women	Difference
Science	92.4	81.5	-10.9**
Engineering	92.6	84.0	-8.7**
Other field of study	92.6	81.4	-11.2**
Difference: science versus other	--	--	0.3 (0.7)
Difference: engineering versus other	--	--	2.5** (0.8)

Note: Weighted mean of dummy for whether working in survey week. Computer science is included in engineering, mathematics in science. Fields refer to the field of study of the highest degree. The sample size is 222,853. Standard errors in parentheses. ** indicates significance at the 5% level, * at the 10% level.

Table 3: How Job is Related to Highest Degree, by Gender and Field of Highest Degree (%)

	Male workers	Female workers	Difference
A. Job is unrelated			
Science	23.4	24.4	1.0
Engineering	9.8	12.9	3.1**
Other field of study	20.7	20.6	-0.1
Difference: science versus other	--	--	1.1 (1.0)
Difference: engineering versus other	--	--	3.2** (0.8)
B. Job is closely related			
Science	46.9	49.3	2.4
Engineering	60.3	60.7	0.4
Other field of study	51.7	58.8	7.1
Difference: science versus other	--	--	-4.7** (1.0)
Difference: engineering versus other	--	--	-6.7** (1.1)

Note: Weighted mean of dummy for whether job is unrelated to highest degree. Computer science is included in engineering, mathematics in science. Fields refer to the field of study of the highest degree. The sample size is 197,686. Standard errors in parentheses. ** indicates significance at the 5% level, * at the 10% level.

Table 4: Annual Salary Penalty for Having a Job Unrelated to Highest Degree

	(1) Science	(2) Engineering	(3) Other	(4) Science	(5) Engineering	(6) Other
Somewhat related	0.032**	-0.042**	-0.040**	0.031**	-0.042**	-0.040**
	(0.013)	(0.008)	(0.006)	(0.013)	(0.008)	(0.006)
Not related	-0.098**	-0.306**	-0.162**	--	--	--
	(0.017)	(0.019)	(0.007)			
Female* Somewhat related	-0.025	-0.040*	-0.012	-0.025	-0.040*	-0.012
	(0.023)	(0.021)	(0.008)	(0.023)	(0.021)	(0.008)
Female* Not related	-0.054*	-0.103**	0.001	-0.021	-0.085**	0.038**
	(0.029)	(0.042)	(0.010)	(0.028)	(0.039)	(0.010)
Not related; main reason is:						
Family related	--	--	--	-0.271**	-0.381**	-0.312**
				(0.042)	(0.070)	(0.016)
Work conditions	--	--	--	-0.169**	-0.385**	-0.261**
				(0.048)	(0.067)	(0.016)
Pay, promotion	--	--	--	0.106**	-0.116**	0.022**
				(0.025)	(0.029)	(0.009)
No job in field	--	--	--	-0.254**	-0.504**	-0.332**
				(0.028)	(0.033)	(0.012)
Change in career interests	--	--	--	-0.082**	-0.221**	-0.162**
				(0.030)	(0.038)	(0.012)
Job location	--	--	--	-0.230**	-0.360**	-0.345**
				(0.056)	(0.069)	(0.020)
Other reason	--	--	--	-0.252**	-0.386**	-0.302**
				(0.040)	(0.052)	(0.015)
R^2	0.25	0.27	0.31	0.27	0.28	0.32
Other covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,929	34,571	123,655	20,929	34,571	123,655

Note: Dependent variable is log annual salary. Full-time workers only. Weighted least squares coefficients with robust standard errors in parentheses. Science, engineering and other refer to the field of study of the highest degree. All regressions include a year dummy and a female*1993 dummy, dummies for a master's degree or a doctoral degree, a dummy for female, five dummies for years since highest degree, six dummies for age, a dummy for at least 5 years tenure, a dummy for self employed, dummies for black, Hispanic, Asian, dummies for foreign born, and 8 census region dummies. Columns 3 and 6 include a dummy for a professional degree. Columns 1 and 4 include 8 field of study dummies, columns 2 and 5 include 7 field dummies, columns 3 and 6 include 19 dummies. ** indicates significance at the 5% level, * at the 10% level.

Table 5: Effect of Field of Study and Gender on Probability of Working

	(1)	(2) Full sample	(3)	(4) 2003 only	(5) Highest degree 1980 or later
Female*science	0.003	-0.005	-0.001	-0.000	-0.007
	(0.007)	(0.007)	(0.007)	(0.012)	(0.009)
Female*engineering	0.027**	0.013**	0.006	0.004	-0.002
	(0.008)	(0.008)	(0.008)	(0.012)	(0.008)
Female	-0.112**	-0.107**	-0.122**	-0.120**	-0.127**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)
Science degree	-0.002	--	--	--	--
	(0.003)				
Engineering degree	0.000	--	--	--	--
	(0.002)				
R^2	0.03	0.03	0.08	0.08	0.06
Field of study	--	Yes	Yes	Yes	Yes
Other covariates	--	--	Yes	Yes	Yes
Observations		222,853		90,204	128,193

Note: Dependent variable is a dummy for working in the survey week. Weighted linear probability coefficients with robust standard errors in parentheses. All regressions except that in column 5 include a year dummy and a female*1993 dummy. Field of study controls are 35 dummies. Other covariates are dummies for a master's degree, a doctoral degree or a professional degree, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. The sample in column 5 contains respondents whose highest degree was received in 1980 or later. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 6: Effect of Field of Study and Gender on Having a Job Unrelated to Highest Degree

	(1)	(2)	(3)	(4)	(5)	(6)
		Full sample		2003 only		Highest degree 1980 or later
Female*science	0.011	0.016*	0.005	0.004	0.007	-0.014
	(0.010)	(0.010)	(0.010)	(0.016)	(0.016)	(0.013)
Female*engineering	0.033**	0.057**	0.058**	0.077**	0.071**	0.046**
	(0.008)	(0.009)	(0.009)	(0.014)	(0.014)	(0.009)
Female	-0.015**	-0.022**	-0.020**	-0.019**	-0.009**	-0.015**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Science degree	0.028**	--	--	--	--	--
	(0.006)					
Engineering degree	-0.109**	--	--	--	--	--
	(0.003)					
R^2	0.01	0.07	0.10	0.10	0.12	0.10
Field of study	--	Yes	Yes	Yes	Yes	Yes
Other covariates	--	--	Yes	Yes	Yes	Yes
Job preferences	--	--	--	--	Yes	--
Observations		197,686		79,213		117,016

Note: Dependent variable is a dummy for working in a job unrelated to the highest degree. Weighted linear probability coefficients with robust standard errors in parentheses. Regressions in columns 1-3 and 6 include a year dummy and a female*1993 dummy. Field of study controls are 35 dummies. Other covariates are three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. The job preferences controls are three dummies each (very important, somewhat important, somewhat unimportant) for how important the following attributes are "when thinking about a job": salary, benefits, job security, job location, opportunities for advancement, intellectual challenge, level of responsibility, degree of independence, contribution to society. The sample in column 6 contains workers whose highest degree was received in 1980 or later. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 7: Effect of Children on Having a Job Unrelated to the Highest Degree

	(1)	(2) Full sample	(3)	(4) 2003 only	(5)	(6) Highest degree 1980 or later
Female*science	0.005	0.006	-0.004	0.005	0.008	-0.018
	(0.010)	(0.010)	(0.014)	(0.024)	(0.023)	(0.018)
Female* engineering	0.058**	0.058**	0.038**	0.076**	0.073**	0.039**
	(0.009)	(0.009)	(0.012)	(0.021)	(0.021)	(0.013)
Female	-0.020**	-0.024**	-0.023**	-0.030**	-0.016**	-0.022**
	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)
Child in household	--	-0.027**	-0.025**	-0.027**	-0.024**	-0.024**
		(0.004)	(0.004)	(0.007)	(0.007)	(0.005)
Child*female	--	0.006	0.003	0.018*	0.013	0.011
		(0.005)	(0.005)	(0.009)	(0.009)	(0.007)
Child*science	--	0.013	0.007	0.005	0.007	0.002
		(0.009)	(0.011)	(0.020)	(0.019)	(0.016)
Child*engineering	--	0.004	-0.003	0.001	0.001	0.002
		(0.006)	(0.007)	(0.012)	(0.012)	(0.008)
Child*science*female	--	--	0.018	-0.001	-0.000	0.009
			(0.019)	(0.032)	(0.031)	(0.024)
Child*engineering*female	--	--	0.037**	-0.000	-0.008	0.015
			(0.017)	(0.027)	(0.028)	(0.018)
R^2	0.10	0.10	0.10	0.10	0.12	0.10
Job preferences	--	--	--	--	Yes	--
Observations		197,686		79,213		117,016

Notes: Dependent variable is a dummy for working in a job unrelated to the highest degree (columns 1-3) and for working in a job closely related to the highest degree (columns 4-6). Weighted linear probability coefficients with robust standard errors in parentheses. Columns 1-3 and 6 include a year dummy and a female*1993 dummy. All regressions include 35 field of study dummies, three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 8: Effect of Field of Study and Gender on Job Unrelated to Highest Degree for Various Reasons

	(1)	(2)	(3)	(4)	(5)	(6)
	Family-related reasons		Pay, promotion opportunities		Working conditions	
A. Main reason						
Female*science	0.016**	0.013**	0.003	0.002	-0.002	-0.003
	(0.005)	(0.005)	(0.005)	(0.006)	(0.003)	(0.003)
Female* engineering	0.001	0.003	0.028**	0.036**	-0.000	0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Female	0.029**	0.030**	-0.032**	-0.038**	0.005**	0.006**
	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)
Science degree	0.003	--	-0.002	--	-0.001	--
	(0.002)		(0.004)		(0.002)	
Engineering degree	-0.008**	--	-0.049**	--	-0.012**	--
	(0.001)		(0.002)		(0.001)	
R^2	0.01	0.02	0.01	0.04	0.00	0.01
B. Any reason						
Female*science	0.020**	0.018**	-0.005	-0.007	0.019**	0.012
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Female* engineering	0.001	0.008	0.027**	0.043**	0.003	0.013**
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
R^2	0.01	0.04	0.01	0.07	0.01	0.05
Other covariates	--	Yes	--	Yes	--	Yes

Note: Dependent variable is a dummy for working in a job unrelated to the highest degree. Weighted linear probability coefficients with robust standard errors in parentheses. The sample size is 197,686. All regressions include a year dummy and a female*1993 dummy. Panel B also includes dummies for female, science and engineering. Other covariates are 35 field of highest degree dummies, three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 9: Effect of Field of Study and Gender on Job Unrelated to Highest Degree for Various Reasons

	(1) Job in field not available	(2) Change in career interests	(3) Job location	(4) Some other reason
A. Main reason				
Female*science	-0.006	-0.002	0.000	0.001
	(0.005)	(0.005)	(0.003)	(0.003)
Female* engineering	0.004	0.006	0.000	0.006**
	(0.004)	(0.004)	(0.002)	(0.003)
Female	-0.004**	-0.007**	-0.003**	-0.004**
	(0.002)	(0.002)	(0.001)	(0.002)
R^2	0.01	0.02	0.01	0.01
B. Any reason				
Female*science	-0.004	-0.003	0.000	0.001
	(0.007)	(0.007)	(0.008)	(0.004)
Female* engineering	0.014**	0.028**	0.015**	0.008**
	(0.006)	(0.006)	(0.006)	(0.004)
R^2	0.03	0.04	0.05	0.01
Other covariates	Yes	Yes	Yes	Yes

Note: Dependent variable is a dummy for working in a job unrelated to the highest degree. Weighted linear probability coefficients with robust standard errors in parentheses. The sample size is 197,686. All regressions include a year dummy and a female*1993 dummy. Panel B also includes dummies for female, science and engineering. Other covariates are 35 field of highest degree dummies, three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 10: Effect of Male Share in Field of Study on Having a Job Unrelated to Highest Degree

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample		No teachers		2003 only	
Female*science	0.009	-0.031**	-0.008	-0.034**	0.011	-0.028
	(0.022)	(0.013)	(0.024)	(0.014)	(0.026)	(0.019)
Female*engineering	0.051**	-0.049**	0.033	-0.056**	0.079**	-0.015
	(0.021)	(0.019)	(0.023)	(0.023)	(0.022)	(0.022)
Female	-0.018	-0.181**	-0.002	-0.188**	-0.020	-0.177**
	(0.019)	(0.030)	(0.021)	(0.050)	(0.019)	(0.028)
Science degree	0.015	0.030	0.021	0.033	0.008	0.020
	(0.027)	(0.027)	(0.029)	(0.028)	(0.029)	(0.029)
Engineering degree	-0.136**	-0.085	-0.131**	-0.076**	-0.142**	-0.098**
	(0.025)	(0.035)	(0.027)	(0.036)	(0.025)	(0.035)
Share male in study field	--	-0.187**	--	-0.221**	--	-0.170*
		(0.062)		(0.068)		(0.065)
Share male in study field * female	--	0.319**	--	0.330**	--	0.310**
		(0.055)		(0.089)		(0.052)
R^2	0.06	0.06	0.05	0.06	0.06	0.06
Share male in field + share male*female	--	0.132*	--	0.109	--	0.141*
		(0.079)		(0.121)		(0.077)
Non-field covariates	Yes	Yes	Yes	Yes	Yes	Yes
Job preferences	--	--	--	--	Yes	Yes
Observations	197,686		172,420		79,213	

Note: Dependent variable is a dummy for working in a job unrelated to the highest degree. Weighted linear probability coefficients with in parentheses standard errors clustered by detailed field of study (143). Regressions in columns 1-4 include a year dummy and a female*1993 dummy. Non-field covariates are three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. The job preferences controls are three dummies each (very important, somewhat important, somewhat unimportant) for how important the following attributes are "when thinking about a job": salary, benefits, job security, job location, opportunities for advancement, intellectual challenge, level of responsibility, degree of independence, contribution to society. The sample in columns 3-4 contains workers whose field of highest degree is not in education. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Table 11: Effect of Male Share in Field of Study on Having a Job Unrelated to Highest Degree for Various Main Reasons

	(1)	(2)	(3)	(4)	(5)	(6)
	Family-related reasons		Pay, promotion		Working conditions	
Female*science	0.015**	0.012**	0.003	-0.010	-0.002	-0.007**
	(0.005)	(0.005)	(0.011)	(0.008)	(0.003)	(0.003)
Female*engineering	0.003	-0.004	0.031**	-0.006	0.003	-0.008**
	(0.005)	(0.006)	(0.008)	(0.007)	(0.003)	(0.004)
Share male in study field	--	-0.012**	--	-0.093**	--	-0.016**
		(0.006)		(0.024)		(0.005)
Share male in study field * female	--	0.022*	--	0.123**	--	0.034**
		(0.012)		(0.016)		(0.008)
R^2	0.02	0.02	0.02	0.02	0.01	0.01
Share male in field + share male*female	--	0.009	--	0.031	--	0.018**
		(0.013)		(0.022)		(0.009)
Non-field covariates	Yes	Yes	Yes	Yes	Yes	Yes

Note: Dependent variable is a dummy for working in a job unrelated to the highest degree for the main reason given in the column heading. Weighted linear probability coefficients with in parentheses standard errors clustered by detailed field of study (143). The sample size is 197,686. All regressions include controls for female, highest degree in science and highest degree in engineering, a year dummy and a female*1993 dummy. Non-field covariates are three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.

Appendix Table 1: Fields of Study of Highest Degree, by Gender (%)

	Male workers	Female workers	All workers	Job not related	Job closely related
A. Science					
Computer and information sciences	2.8	1.5	2.3	7.6	72.2
Mathematics and statistics	1.9	1.3	1.6	20.9	40.7
Agricultural and food sciences	1.0	0.5	0.8	23.8	46.2
Biological sciences	3.1	3.0	3.1	26.2	50.3
Environmental life sciences	0.5	0.2	0.4	29.5	44.0
Chemistry, except biochemistry	1.3	0.6	1.0	19.6	54.8
Earth, atmospheric and ocean sciences	0.8	0.2	0.5	26.9	47.5
Physics and astronomy	0.8	0.1	0.5	20.0	43.3
Other physical sciences	0.2	0.2	0.2	24.0	45.0
B. Engineering					
Aerospace, aeronautical, astronautical	0.5	0.0	0.3	16.5	51.8
Chemical	0.7	0.2	0.5	11.5	50.8
Civil and architectural	1.9	0.2	1.2	8.7	67.2
Electrical and computer	3.6	0.4	2.1	9.3	60.4
Industrial	0.6	0.1	0.4	17.7	40.7
Mechanical	2.4	0.2	1.4	10.8	51.3
Other engineering	1.7	0.2	1.0	13.9	53.1
C. Non-science and engineering					
Economics	2.1	0.7	1.5	30.5	28.2
Political and related sciences	2.1	1.3	1.8	46.6	21.6
Psychology	2.7	5.1	3.8	26.1	45.7
Sociology and anthropology	1.4	2.4	1.9	37.3	29.8
Other social sciences	1.1	1.1	1.1	40.5	31.4
Medicine	4.5	1.9	3.3	2.4	95.0
Other health	2.3	11.0	6.2	9.1	79.4
Technology and technical fields	1.9	0.3	1.2	13.9	51.2
Other science and engineering-related	0.6	0.2	0.4	15.4	65.1
Social service and related	2.9	3.4	3.1	20.1	64.1
Sales and marketing	3.3	2.1	2.8	17.0	38.6
Art and humanities	7.5	11.4	9.2	39.1	37.8
Accounting	5.3	3.7	4.6	10.9	67.2
Business administration, management	10.7	5.6	8.4	15.5	41.6
Other management and administration	8.0	4.0	6.2	17.9	42.7
Elementary teacher education	1.0	11.0	5.4	18.0	72.5
Other (specified) education	5.7	10.5	7.9	18.5	65.0
Other (unspecified) education	1.9	4.7	3.1	18.8	64.3
Law, pre-law, legal studies	4.7	2.5	3.7	7.6	83.0
Other non-science and engineering	6.6	8.1	7.3	25.8	47.2
D. All	100.0	100.0	100.0	19.9	55.1
Observations	118,192	79,494		197,686	

Notes: Shares weighted with survey weights. Column 4 contains the share in the field reporting that their work in the current job is not related to their highest degree of study, column 5 the share reporting their work is closely related to their highest degree of study.

Appendix Table 2: Means of Covariates by Gender

	Male workers or men	Female workers or women	All workers or all	All workers or all	
				2003	Highest degree 1980 or later
A. Workers					
Female	--	--	0.45	0.47	0.49
Bachelor's degree	0.62	0.65	0.63	0.63	0.60
Master's degree (incl. MBA)	0.24	0.28	0.26	0.26	0.29
Doctoral degree	0.05	0.02	0.04	0.04	0.04
Professional degree	0.09	0.04	0.07	0.07	0.07
Age	43.5	42.0	42.8	43.8	38.0
	(9.5)	(9.4)	(9.4)	(9.7)	(8.0)
Years since highest degree	16.7	14.8	15.9	16.6	9.8
	(9.4)	(9.2)	(9.4)	(9.9)	(5.5)
Black	0.05	0.08	0.06	0.07	0.07
Hispanic	0.04	0.04	0.04	0.05	0.05
Asian	0.06	0.06	0.06	0.07	0.06
Foreign-born	0.10	0.09	0.10	0.12	0.11
Born abroad U.S. citizen	0.01	0.01	0.01	0.01	0.01
Born in U.S. territory	0.00	0.01	0.01	0.01	0.01
Year 2003	0.38	0.42	0.40	1	0
Child in household	0.57	0.53	0.56	0.55	0.54
Share men in study field	0.64	0.41	0.54	0.54	0.55
Observations	118,192	79,494	197,686	79,213	117,016
B. Workers and non-workers					
Working	0.93	0.81	0.87	0.86	0.90
Observations	127,986	94,867	222,853	90,204	128,193
C. Full-time workers					
Log annual salary -nominal $	10.84	10.57	10.73	10.88	10.70
	(0.56)	(0.51)	(0.55)	(0.54)	(0.53)
Tenure at least 5 years	0.55	0.50	0.53	0.52	0.42
Self employed	0.16	0.09	0.13	0.15	0.10
Observations	112,829	66,326	179,155	70,298	106,850

Note: Shares and means weighted with survey weights. Standard deviations in parentheses.

Appendix Table 3: Workers Attaching Very High Importance to Particular Job Attribute 2003 (%)

	Male workers	Female workers	All workers
Salary	58.4	56.5	57.5
Benefits	63.5	66.3	64.8
Job security	61.9	67.1	64.3
Job location	48.8	57.3	52.8
Opportunities for advancement	45.0	38.9	42.2
Intellectual challenge	60.5	65.4	62.8
Level of responsibility	47.2	47.8	47.5
Degree of independence	62.5	65.6	63.9
Contribution to society	43.0	58.6	50.3
Observations	46,364	32,849	79,213

Note: Shares weighted with survey weights. The question asked is "When thinking about a job, how important is each of the following factors to you…". The possible answers are very important, somewhat important, somewhat unimportant, not important at all. In the regression, the full set of dummies is controlled for.

Appendix Table 4: Effect of Field of Study and Gender on Probability of Not Working for Various Reasons

	(1) Retired	(2) On layoff from a job	(3) Family responsibilities	(4) Chronic illness, disability	(5) No suitable job available	(6) No need, do not want to work	(7) Other
Female*science	-0.003	0.003	0.009	0.004*	0.002	-0.005	-0.004*
	(0.003)	(0.002)	(0.005)	(0.002)	(0.002)	(0.004)	(0.002)
Female* engineering	-0.001	-0.002	0.003	0.002	0.004	-0.010**	-0.002
	(0.002)	(0.003)	(0.006)	(0.002)	(0.003)	(0.004)	(0.002)
Female	0.006**	-0.002**	0.091**	0.002	0.002*	0.054**	0.005**
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
R^2	0.14	0.01	0.06	0.01	0.00	0.04	0.01

Note: Dependent variable is a dummy for not working in the survey week for the reason given in the column heading. 222,853 observations. Weighted linear probability coefficients with robust standard errors in parentheses. All regressions include a year dummy and a female*1993 dummy, 35 field of study dummies, three education dummies, five dummies for years since highest degree, six dummies for age, dummies for black, Hispanic, Asian, and dummies for foreign born. Science and engineering refer to the field of study of the highest degree. ** indicates significance at the 5% level, * at the 10% level.