The Intersection of Immigration and Gender: Labor Force Outcomes of Immigrant Women Scientists*

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Objective. This paper is the first systematic study of the intersection of immigration and gender among scientists and engineers. *Methods.* We use data from the 5% Public Use Microsample (PUMS) of the 1990 census and the longitudinal 1982–1989 Survey of Natural and Social Scientists and Engineers (SSE) to compare the labor force outcomes of women immigrant scientists to immigrant men and native-born women scientists. *Results.* We find that immigrant women are less likely to be employed and promoted than immigrant men and native-born women. Although women immigrants appear to earn slightly less than native-born women, this gap is explained by such factors as field, employment sector, and family characteristics. We suggest that immigration paths may underlie some of the labor force disadvantages experienced by immigrant women scientists. *Conclusions.* The results of this paper highlight the importance of considering gender differences, particularly differences in migration path, when studying immigrant scientists. Consideration of gender leads to a fuller understanding of immigrant scientists' labor force outcomes.

Immigrants are an important source of the scientific workforce in the United States. According to an estimation from the 1990 census, 11.7% of all scientists in the United States are foreign born (Bouvier and Martin, 1995), compared to 8.5% foreign-born in the general population (Edmonston and Passel, 1994).[1] Our estimates from the 5% Public Use Microsample (PUMS) of the 1990 census indicate that the overrepresentation of immigrants is even higher among scientists with advanced degrees, at about 20%.

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[1] Scientists here are defined as all persons eighteen and over whose occupations fall into engineering, mathematics, computer science, or natural science categories on the 1990 U.S. Census.

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The large proportion of immigrants among scientists has led to heated discussions, among policy makers and academics alike, concerning their labor market experiences in the scientific workforce. Discussions of immigrant participation in the scientific labor force often conclude that immigrants on the whole are disadvantaged compared to native-born scientists. Immigrants may experience higher unemployment and lower salaries, as well as slower rates of promotion. Consideration of promotion is important, because although immigrants may earn approximately as much as native-born scientists due to the technical nature of their jobs, their promotion prospects are less favorable (Tang, 1993).

Any discussion of immigrant scientists' experiences is at best incomplete, however, if it does not explicitly consider the gender of the scientist. Studies of the labor force outcomes of immigrant scientists that do not directly address gender differences (e.g., Koch, 1987; Tang, 1993; Schlottmann et al., 1987) may provide an incomplete picture of immigrants' experiences, because, as Pedraza (1991) points out, immigrant women may be unlike their male peers. The labor force outcomes of immigrant women may be unique due to their varied family and migration experiences, as well as discrimination by gender and nativity.

The few studies that do look at immigrant women's experiences in the labor market (Cobb-Clark, 1993; Hughey, 1990; Stier, 1991) cite the important influence of human capital, job characteristics, and family responsibilities on immigrant women's labor force outcomes. In this research, we expand upon this literature by also considering the special disadvantages that immigrant women may experience due to the circumstances under which they migrate to the United States. Married women who migrate, for instance, often do so to benefit their husbands' careers and not their own (Lichter, 1983; Maxwell, 1988). As secondary immigrants, women scientists and engineers may have more difficulty finding jobs, particularly those with the potential for career advancement and promotion.

This article is the first systematic study of the intersection between immigration and gender in science and engineering. In this research, we compare three labor force outcomes—employment, earnings, and promotions—of scientists by immigration status, gender, and their interactions. Our empirical analysis proceeds in three stages. First, we present descriptive statistics on employment and earnings by gender and nativity using the 5% Public Use Microsample (PUMS) and then we present descriptive statistics on promotion using the Survey of Natural and Social Scientists and Engineers (SSE). Next, we examine the possible factors that account for the observed patterns in employment and earnings by gender and nativity, applying multivariate logit and linear models to the PUMS data. Finally,

we report findings from a multivariate logit Event History Analysis (EHA) examining the promotion rates of a cohort by both nativity and gender.

Data

In this research, we use data from both the 5% Public Use Microsample (PUMS) of the 1990 U.S. Census and from the longitudinal 1982–1989 Survey of Natural and Social Scientists and Engineers (SSE). As discussed by Citro and Kalton (1989) and Xie (1989), defining *scientists* is not self-evident in statistical studies using data from the census and other large surveys. Two alternatives are commonly used: occupation-based and education-based definitions. The occupation-based definition specifies that the incumbents of particular scientific occupations are scientists. The education-based definition considers individuals with certain educational credentials (usually scientific degrees) as scientists. Neither definition is free of potential problems. The education-based definition may be too broad, including many people who work in nonscientific occupations after graduation (Xie, 1989, 1996). Further, for the PUMS data, the education-based definition is not feasible because field of study was not measured in the U.S. Census. However, the occupation-based definition is also less than ideal, for those with no formal scientific education may be working in scientific fields. In addition, graduates with scientific degrees may be unable to find work as scientists and thus are excluded by the occupation-based definition.

Statistical studies conducted by the National Science Foundation and other research institutions typically combine the occupation-based and education-based definitions. Following a recent study by Shauman and Xie (1996) also using PUMS data, we conservatively define as a scientist anyone whose occupation falls within one of the scientific and engineering occupations (Shauman and Xie, 1996, Appendix A) and whose highest attained degree is at the postgraduate level.[2] This yields an extract file with 34,921 scientists and engineers. For the SSE data, we define as a scientist anyone who, at the time of the first wave of the survey, reported being employed in a scientific or engineering occupation and has a master's or doctoral degree.

We use the PUMS data to examine differences by gender and immigration status in employment and earnings. The nationally representative PUMS sample provides a rich cross-section of the scientific labor force. However, the results from the PUMS data are static and as such have no

[2] An occupation is reported only for those actively employed during the past five years and is either the current or last occupation held by the respondent. Using only 1990 census data, we cannot include scientists who have moved to nonscientific jobs or have been unemployed or out of the labor force for more than five years. Thus, we may capture only the most "successful" scientists.

bearing on dynamic processes that may give rise to other dimensions of inequality. We employ the SSE data to further examine longitudinal patterns of promotion to management by gender and immigrant status.

The SSE survey was based on a sampling frame drawn from the 1980 U.S. Census. The frame included those who completed four or more years of college and were currently incumbents of any of 52 science and engineering occupations, or who were not employed or in the labor force but reported a scientific occupation as the last occupation held in the past five years. The sampling frame was then stratified by 11 occupational fields, race/ethnicity, and gender. Minorities and women were oversampled. The study contains longitudinal data from four waves: 1982, 1984, 1986, and 1989. During the first wave, in 1982, about 88,000 out of 122,000 mailed questionnaires were returned, yielding a response rate of 72%. The response rates from panel to panel are high, ranging from 72 to 84%. However, in the final wave, in 1989, only 47% or approximately 41,000 of the original 88,000 respondents remained.

Differential attrition by nativity and gender in the SSE sample are potential problems for our study. However, it is likely that our estimates of differences in promotion rates by nativity are conservatively biased. It is reasonable to postulate that less successful immigrants may return to native countries if they are not satisfied in the U.S. labor market. Thus, immigrants present in the SSE follow-up surveys are likely to be more successful than those who were not retained. If this reasoning holds true, the differences between immigrant and native-born scientists in the observed follow-up surveys are smaller than they would be in follow-ups with no attrition.

Our analysis of the SSE data is restricted to a cohort of scientists and engineers who were twenty-five to thirty-four years old in 1982. We focus on their progress in attaining promotions to management over time until 1989. By examining one cohort, we control for differences in age and work experience and avoid potential biases associated with left-censoring.[3] Further, we look at a group of scientists who were generally educated and socialized at a similar point in time. Once a scientist or engineer was promoted to management, he or she was excluded from further analysis. The sample for statistical analysis contains a total of 6,657 cases.

Descriptive Results

The employment rate is defined as the number of workers employed divided by the number of workers in the labor force. The first row in Table 1 reports the employment rate by gender and immigration status calculated from the 1990 PUMS. The employment rate does not differ ap-

[3] Left-censoring, in this case, refers to the fact that older scientists are "survivors" who tend to be more successful than their peers who have left science.

TABLE 1

Sample Means for Employment Characteristics and Promotions, by Sex and Immigration Status

	Male Scientists/Engineers		Female Scientists/Engineers	
	Native-Born	Foreign-Born	Native-Born	Foreign-Born
Using 1990 Census PUMS				
Employment Characteristics				
Employed[a]	0.987	0.981	0.984	0.970
Earnings[b] (1989)	$52,359	$49,359	$36,754	$36,585
Log Earnings[b]	10.74	10.68	10.35	10.34
(*n*)	(20,672)	(5,723)	(7,295)	(1,231)
Using SSE, 1982–1989				
Promotion to Management	0.089	0.087	0.069	0.027
(*n*)	(4,453)	(745)	(1,313)	(146)

SOURCES: Data were obtained from the 1990 PUMS for employment status and earnings and 1982–1989 SSE for promotion to management.

[a]Based on those in the labor force.

[b]Based on those employed full-time with positive earnings.

preciably by immigration status for male scientists, hovering at 98 to 99%. However, for female scientists the employment rate is higher for native-born scientists than for their immigrant counterparts: 98.4% for the native-born compared to 97% for immigrants.

In the second row, we summarize earnings differences by gender and immigration status among employed workers. Immigrant men make about $3,000 less a year (in 1989 dollars) than native-born male scientists, representing a 6% disadvantage. Among women, the difference is not so large. Female scientists who are immigrants earn only $169 less than native-born female scientists, representing less than a 1% disadvantage.

Using pooled data from the 1982, 1984, 1986, and 1989 waves of the SSE, we report the raw promotion rate, that is, the occurrence-exposure rate, of scientists/engineers by gender and immigration status in the last row of Table 1. We find that immigrant women are promoted less than both immigrant men and native-born women. Approximately 9% of both native-born and immigrant male scientists in this cohort had been promoted to management by the end of seven years. However, while almost 7% of native-born females had been promoted at the end of seven years, only 2.7% of immigrant women were promoted.

Multivariate Analyses

To tease out the net effects associated with being an immigrant female scientist, it is necessary to control for other potentially confounding factors

and to assess the extent to which these confounding factors explain the descriptive statistics reported in Table 1. In our analyses, we consider the following groups of variables and interaction effects.[4]

Variables and Interaction Effects

Demographic Characteristics. Relative disadvantages experienced by women immigrant scientists compared to female native-born scientists could be due, in part, to their youth and their race. In our multivariate analyses, respondent's age is measured categorically in models using the PUMS data and continuously in the analyses using the SSE data restricted to one ten-year cohort.[5] Included as a baseline control in all models, race is recoded into the broad categories White (the reference category), Asian, and other.[6] A key independent variable of this research, sex, is measured with a dummy variable denoting female, in reference to male.

Human Capital. Our key measure of human capital is education. We differentiate between scientists and engineers with only master's and professional degrees versus those with doctoral degrees with a dummy variable denoting Ph.D. as 1 and master's or professional degree as 0. Another potential measure of human capital is work experience. For the PUMS data, a direct measure of experience is unavailable, but it is highly correlated with age, which is included. Given the cohort-based design for our SSE data, work experience is approximated by the length of the longitudinal study. Thus, the dummy variables denoting the years of the follow-up surveys (with 1984 as the reference) for the SSE data can be interpreted as capturing the effect of experience.

Field/Business Sector. Segregation of fields by gender and immigration status may confound our analyses on labor force outcomes. We group scientists into five major fields based on their reported occupation: biological science, physical science, social science, mathematical science, and engineering. For the SSE data, we have information about the field of a scientist's highest degree, which is included as an additional control.[7] We also take into account sector differences, since scientists employed in industrial positions may earn more money and experience a higher promotion rate than those working in academia or government (Peek, 1995). Employment sector is recoded into four categories: industry, academic, government, or other.

[4]Descriptive statistics for the variables are available upon request.

[5]Since cohort membership was determined by birth year, the scientists are in the same birth cohort but not necessarily in the same employment cohort.

[6]Hispanic and African Americans, and Hispanic, African, and Caribbean Black immigrants are aggregated in the "other" category because their numbers are small.

[7]The U.S. Census does not ask from which countries respondents received their degrees. Using the SSE, however, we found that whether a respondent received his or her bachelor's degree or highest degree from a foreign country did not significantly affect his or her rate of promotion.

Immigration Status. Women scientists may be more likely than men to be secondary migrants; that is, women scientists (perhaps married to other scientists) may be more likely to have migrated for their spouses' career advancement (Lichter, 1983; Maxwell, 1988; Shauman and Xie, 1996). If so, labor market prospects for women who are secondary immigrants may not be as good as for those who are primary, employer-sponsored immigrants (Pedraza, 1991). Since we do not have a good measure of immigration path, we test this hypothesis by two proxy indicators: marital status and immigration status. Marital status is discussed in the next paragraph. Immigration status is measured with two categories: native-born (the reference group) and foreign-born.

Family Responsibilities. Due to a greater proportion of secondary migrants among them, women immigrants may be more likely to be married than native-born and male immigrant scientists. Immigrant women may also have higher fertility than native-born women and thus more young children who need care. These family responsibilities may compete with a female scientist's career for her time (Hughey, 1990; Koch, 1987; Stier, 1991; Peek, 1995; Shauman and Xie, 1996). In our analyses, both marital status and presence of children are included as family characteristics and are measured with dummy variables (not married = 0, married = 1; no children = 0, one or more children present = 1).

English Proficiency. Lack of English skills may also inhibit one's chances in the labor market (Hughey, 1990; Koch, 1987; Portes and Rumbaut, 1990). In our multivariate analyses with PUMS data, English proficiency is measured with a dummy variable (does not speak English well = 1, speaks English well = 0). Unfortunately, English proficiency was not measured in the SSE survey.

Interaction Effects. In addition, we include two sets of interaction effects to specify the labor force outcomes experienced by immigrant women scientists: the interaction between gender and marital status, and the interaction between gender and immigration status. As argued earlier, both marital status and immigration status are intended to capture the effects of different immigration paths for men and women immigrant scientists. The interaction between gender and marital status tests the hypothesis that, due to within-family gender stratification, marriage hinders women's scientific careers but has either neutral or positive effects on men's careers. The interaction between gender and immigration status tests the hypothesis that immigrant women scientists are further disadvantaged in the labor market because they are more likely to be secondary immigrants. Note that we do not have direct measures to distinguish secondary immigrants from primary immigrants.

Results on Employment and Earnings from the PUMS. Using PUMS data, we first focus on employment and earnings. When employment is our dependent variable, we restrict our analysis of the PUMS subsample to scientists/engineers who are in the labor force and assign 1 if a scientist/engineer is employed and 0 otherwise. Two nested logit models are estimated via maximum likelihood, and the estimated coefficients from these models are reported in the first two columns of Table 2. We can easily convert the logit parameters to specific probabilities using the formula:

$$\Pr(y = 1) = \exp(x'b)/[1 + \exp(x'b)].$$

The key coefficients for Model 1, the baseline model reported in column 1, are those representing sex and immigration status. Women scientists are less likely to be employed than men, though this coefficient is only significant at the .10 level of confidence. However, nativity has a stronger effect on employment than does gender. Foreign-born scientists are significantly less likely than native-born scientists to be employed at the .001 level of confidence.

Model 2, reported in the second column of Table 1, includes two interaction terms representing married women scientists and women immigrant scientists. Model 2 is a significant improvement from Model 1($\chi^2 = 31.37$; df = 2). When interactions between sex and marital status and between sex and nativity are included in the logit model, the negative effects of both nativity and gender diminish. Foreign-born scientists are still significantly less likely to be employed, though this effect is weaker in Model 2 than in Model 1. In Model 2, gender has a significant and positive effect on employment. The positive main effect of sex (i.e., the effect when all other dummy variables take the value of 0) means that the employment probability is actually higher among unmarried, native-born female scientists and engineers than among their male counterparts.

Furthermore, in Model 2, we find the interaction between gender and marital status to be highly significant, lowering the employment of married women. This is in contrast to a positive effect of marriage for men. The interaction between nativity and gender is also significant at the .05 level of confidence, indicating that even controlling for variation in human capital, job characteristics, and family responsibilities, immigrant women have a significantly lower employment rate than immigrant men and native-born women. Taken together, the results are consistent with the conjecture that many women scientists who immigrated to the U.S. may experience lower employment because they come as married secondary migrants.

We apply two nested linear models estimated by ordinary least squares (OLS) for a multivariate analysis of earnings. The dependent variable for both models is the natural logarithm of annual earnings in 1989 (in 1989 dollars). The coefficients of the explanatory variables, then, reflect approximately the percentage change in earnings associated with a one-unit change in each of these variables. The subsample used for this analysis consists of full-time employed scientists with positive earnings, and the

model includes the logged weeks worked per year and logged hours worked last week in order to control for labor supply. The empirical results are presented in the last two columns of Table 2.

Similar to the logit models for employment, the model including the two interaction terms is a significant improvement over the model without them ($F = 28.41$; $df = 2, 31{,}707$). We find a negative and significant interaction effect between sex (being female) and marital status (being married) for earnings. This interaction effect means that married women suffer an additional 10% penalty beyond the main effects of marriage and gender. In contrast to the logit models for employment, though, the interaction between gender and immigration status is significant and positive. This suggests that immigrant women have about 5% *more* earnings than what may be inferred for immigrant men and native-born women.

Results on Promotions from the SSE. In order to examine differences by gender and nativity in the rate of promotion to management positions, we examine one young cohort of scientists and engineers from the longitudinal SSE data. The mean promotion rate by gender and immigration status reported in Table 1 shows that immigrant women scientists are much less likely to be promoted to managerial positions than native-born women scientists and men scientists. To ascertain whether or not these descriptive differences are statistically significant after other potential explanatory variables are controlled, we conduct a multivariate event history analysis. Given that the SSE panel was reinterviewed in 1984, 1986, and 1989, our analysis strategy is based on changes in the three discrete time intervals: 1982–1984, 1984–1986, and 1986–1989. A scientist contributes to the risk set until he or she is promoted or drops out of the study. The data are pooled across the different intervals for joint estimation. The statistical model is a binary logit model with whether or not promotion to management occurs within a time interval as the dependent variable (no = 0, yes = 1). We construct the model to closely resemble the two earlier models on employment and earnings reported in Table 2. Table 3 presents the maximum likelihood estimates of the logit model. Note that the variable labels for time-varying variables are marked by a superscript t.

Again, the focus here is on the interactions between gender and marital status, and between gender and immigration status. When comparing the two models, we see that the inclusion of the two interactions in Model 2 does not improve Model 1 ($\chi^2 = 4.38$; $df = 2$). The interaction between gender and marital status is clearly insignificant and should be treated as zero. The interaction between gender and immigration appears to be large and marginally significant (coeff. = -1.017; $p < .10$). When this interaction is included, the estimated coefficient of immigration status measures the nativity differences in the promotion rate for male scientists, and the positive but insignificant estimate rejects Tang's (1993) conclusion that the

TABLE 2

Estimated Coefficients from Nested Logistic Models of Employment and OLS Models of the Log of Earnings

	Employment[a]		Earnings[b]	
	Model 1	Model 2	Model 1	Model 2
Constant	4.424**	4.253**	5.247**	5.269**
Sex				
Female (dummy)	−0.193+	0.514**	−0.171**	−0.114**
Age				
25–29		(excluded)		
30–34	−0.453*	−0.475**	0.185**	0.184**
35–39	−0.353+	−0.392*	0.309**	0.307**
40–44	−0.692**	−0.727**	0.391**	0.388**
45–49	−0.758**	−0.820**	0.457**	0.453**
50–54	−0.743**	−0.820**	0.476**	0.470**
55–59	−0.929**	−1.022**	0.511**	0.502**
Race				
White		(excluded)		
Asian	0.216	0.175	−0.042**	−0.041**
Other	−0.140	−0.144	−0.037**	−0.037**
Immigration Status				
Native-born		(excluded)		
Foreign-born	−0.834**	−0.685**	−0.047**	−0.054**
Education				
Ph.D.	0.490**	0.483**	0.161**	0.161**
Occupational Field				
Biological science		(excluded)		
Physical science	−0.113	−0.116	0.124**	0.124**
Social science	−0.229	−0.261	0.062**	0.063**
Mathematical science	−0.186	−0.179	0.213**	0.213**
Engineering	−0.111	−0.148	0.289**	0.289**
Employment Sector				
Industry		(excluded)		
Academic	0.091	0.097	−0.205**	−0.204**
Government	0.522*	0.526*	−0.068**	−0.068**
Other	0.045	0.044	0.027**	0.027**
Work Duration				
Log of weeks worked in 1989		N/A	0.867**	0.863**
Log of hours worked last week		N/A	0.387**	0.380**
Family Status				
Married (dummy)	0.497**	0.835**	0.063**	0.095**
One or more children (dummy)	0.256*	0.207+	0.048**	0.043**
English Proficiency				
Does not speak English well (dummy)	−1.703	−1.567	−0.181	−0.160
Sex*Marital Status				
Married female (dummy)		−0.970**		−0.104**
Sex*Immigration Status				
Foreign-born female (dummy)		−0.462*		0.047*
Model χ^2	164.17	195.54		
DF	21	23		
R^2			0.329	0.330

[a]Based on those in the labor force.

[b]Based on those employed full-time with positive earnings.

SOURCE: Data were obtained from the 1990 PUMS. $^{+}p < 0.10$ $^{*}p < 0.05$ $^{**}p < 0.01$.

TABLE 3

Logistic Regression Results for Promotion—An Event History Analysis of Scientists and Engineers, 25 to 34 Years Old

	Model 1	Model 2
Constant	−3.331**	−3.336**
Year[t]		
1984	(excluded)	
1986	0.039	0.039
1989	0.277*	0.276+
Sex		
Female (dummy)	−0.195	−0.163
Age	0.022	0.022
Race		
White	(excluded)	
Asian	−0.340	−0.352+
Other	−0.254	−0.250
Immigration Status		
Native-born	(excluded)	
Foreign-born	0.086	0.193
Education[t]		
Ph.D. (dummy)	−0.135	−0.138
Field of Highest Degree[t]		
Biological science	(excluded)	
Physical science	0.315	0.331
Social science	1.949*	1.917*
Mathematical science	0.815*	0.820*
Engineering	0.899**	0.901**
Others	1.551**	1.555**
Occupation Field[t]		
Biological science	(excluded)	
Physical science	−0.652*	−0.661*
Social science	−0.682+	−0.679+
Mathematical science	−0.202	−0.210
Engineering	−0.908**	−0.915**
Employment Sector[t]		
Industry	(excluded)	
Academic	−1.822**	−1.828**
Government	−0.357**	−0.359**
Other	0.202	0.191
Family Status[t]		
Married (dummy)	0.147	0.131
One or more children (dummy)	0.110	0.124
Sex*Marital Status[t]		
Married female (dummy)		0.066
Sex*Immigration Status		
Foreign-born female (dummy)		−1.017+
Model χ^2	190.61	194.99
DF	22	24

SOURCE: Data were obtained from 1982–1989 SSE. $^{+}p < 0.10$ $^{*}p < 0.05$ $^{**}p < 0.010$.

[t]Variables are time variant.

net effect of immigration on promotion for men is negative. Our results show that only women immigrant scientists are less likely to be promoted than their native-born counterparts. We suggest that women immigrants may be entering less desirable and competitive positions because they are secondary immigrants.

Conclusion

The preceding results unambiguously highlight the importance of considering gender in studies of immigrant scientists. The results from the PUMS data reveal that immigrant women scientists are less likely to be employed than immigrant men and native-born women, though immigrant women do not appear to earn less once they are employed full-time. Using the SSE data, we focus on a relatively homogeneous group—one young cohort of scientists and engineers—over a period of seven years. Our analysis indicates that, while immigrant men are promoted at rates equal to native-born men, immigrant women are promoted at lower rates than both native-born women and immigrant men. For both these sets of analyses, ignoring gender would have led to erroneous conclusions.

Our results point to special disadvantages experienced by immigrant women scientists and engineers. We speculate that their labor force outcomes may be influenced by the immigration path taken by many female immigrants—as spouses of immigrant men. In light of our findings, we echo Pedraza's call (1991) for considering both the "public" and "private" spheres when studying women immigrants. More research attention should be devoted to the special circumstances experienced by immigrant women scientists, particularly those who did not immigrate to advance their careers but to join husbands in the United States.

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