Are There Sex Differences in the Utilization of Educational Capital Among College-Educated Workers?

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Introduction

Despite increasing postsecondary participation rates of women (Bae et al. 2000; Jacobs 1996; Spain and Bianchi 1996; Statistics 2005; Xie and Shauman 2003) and the increasing integration of college majors (Xie and Shauman 2003), occupational segregation by sex persists in the U.S. labor force. The fact that occupational integration lags behind educational integration indicates that sex differences in occupational sorting occurs even among individuals with educational investments that are equal in both quantity, e.g. attainment of a college degree, and quality, e.g. the major field in which the degree was earned. For occupational segregation to persist, in other words, men and women who have made equal educational investments must differ in how they utilize their educational capital in the labor force. Identifying the extent, character and causes of population variation in the utilization of educational capital is therefore essential to our understanding of the processes by which segregation is perpetuated in the labor market.

In this paper I introduce the concept of educational utilization as an overlooked part of the education-to-work transition. I use data from the O*NET and the *National Surveys of College Graduates*, to develop multiple operationalizations of the links between college majors and occupations that are used to measure educational utilization. I then assess the comparability of the multiple measures and assess the relative explanatory power of the operationalizations using conditional logit models of occupational choice. Finally, I use individual-level data for representative samples of U.S. college graduates from the 1993 and 2003 *National Surveys of College Graduates* to measure sex differences in the utilization of educational capital and to test if the observed gap varies across the multiple operationalizations.

Sex segregation in education and the labor force

The close correlation between the sex segregation of college majors and the sex segregation of occupations is well known (Davis 1965; Jacobs 1989; Jacobs 1995; Peng and Jaffe 1979; Polachek 1978), as is the power of controlling for college major to explain sex differences in occupational attainment and earnings (Brown and Corcoran 1997; Daymont and Andrisani 1984; Gerhart 1990; Shauman 2006). Given the linkages between educational fields and occupational placement (Shauman 2006), sex differences in educational specialization impose upper bounds on the degree of occupational integration that can be expected. But controlling for college major falls far short of explaining occupational segregation: labor force integration lags behind the integration of college majors to a significant degree. For example, although women earned 57.3 percent of all bachelor's degrees in the biological sciences in 2000, they accounted for only 40.7 percent of employees in biological science occupations. An integration gap of similar magnitude exists for the physical sciences, where 41.7 percent of 2000 bachelor's degrees went to women but 31.3 percent of employees were women, and in engineering, where the contrast was 20.1 percent versus 10.8 percent. Although the slow pace of social change through the cohort replacement process may explain some of this inertia in occupational segregation, the gap between the representation of women among degree-holders and the representation of women in related labor force sectors is significant even among the newest entrants to the labor force.

The lag between the integration of educational fields and the integration of occupational categories indicates that there may be significant sex differences in whether and how educational capital is utilized in the labor force. The differential between educational and occupational segregation is not a definitive symptom, however, since occupational sex segregation exists if male and female college graduates are equally likely to utilize their education by gaining employment in occupations that are related to their education, but they enter separate sets of related occupations. The extent to which occupational segregation is affected by the differential educational utilization of men and women is not yet know since there are few studies that investigate sex

differences in individual education-to-work transitions. I begin to address this gap in the literature with the research presented in this paper.

The utilization of educational capital

Educational utilization can be conceptualized as a process that requires at least two steps. The first step to utilizing one's educational capital is employment in the labor force. For those who are employed in the labor force, the second step to educational utilization is gaining employment in an occupational setting that uses the substantive skills developed in during the pursuit of the college or post-graduate degree. Sex differences in labor force participation have been well-documented (Bianchi 1995; Spain and Bianchi 1996), so I bracket that aspect of sex differences in educational utilization by focusing this analysis only on the members of recent cohorts of college graduates who are employed full-time in the labor market. Thus, the focal concept of this analysis is employment in an occupation that is related to the major field in which each respondent attained his/her bachelor's degree, i.e., employment in an occupation where one's education is utilized.

Qualitative linkages between college majors and occupations are expected, given that college majors represent a type of self-selected treatment, involving the development of specialized knowledge and skills that may be recognized and valued in the labor market. This connection is the product of (1) the relative homogeneity of the population selecting a given major, (2) the homogenizing effect of the educational track, and (3) the demand for specific skills in particular occupations. Majoring in a particular field represents an affinity for the content of that field, the possession of prerequisite education, and aspirations for employment in a related field. The homogeneity of the students who select into majors is likely to intensify with the completion of the established sequence of coursework that usually comprises the core requirements of a major. Although the structure of most majors in postsecondary institutions in the U.S. allow students to tailor their coursework to their particular interests as they fulfill requirements, the courses that satisfy these requirements usually are predetermined, leading to significant commonality in the experience of students within a major. It is reasonable to assume, therefore, that the individuals attaining a degree in a given field are likely to have similar interests, occupational aspirations, and stocks of skills and specific content knowledge. On the demand-side, productivity in particular occupational settings requires specific skills, some of which may be associated with education in a particular field of study. So employers may use degrees in particular fields as a qualification for employment. Attaining a degree in a particular major should thus qualify an individual for, and facilitate entry into, a particular set of occupations. Conversely, without a degree in a select set of college majors entry into the related occupations may be difficult or impossible.

The qualitative major-occupation connections are therefore a product of the substantive similarity of the education and the work: the degree to which the specialized education imparted by a major is utilized on the job. The strength and narrowness of the connections between college major and occupations will vary across fields according to the amount of variation in the three components specified above. That is, the majors with the strongest labor market linkages will be those with the most homogeneous entering populations (e.g., in terms of occupational aspirations), the most standardized educational requirements (e.g., little variation across students in the courses taken), and consistent demand in specific occupational categories for the skills associated with the major. Relative heterogeneity in any of these three determinants will produce weaker or more diffuse links between majors and occupations in the labor market. The engineering fields are commonly assumed to set the standard for majors with strong occupational linkages, i.e., it is assumed that those majoring in engineering are very likely to utilize their education in the labor force. The humanities and social sciences are often pointed to as examples of majors with relatively weak links to the labor force, i.e., those majoring in these fields may be significantly less likely to utilize their education in the labor force. It is reasonable, therefore, to expect a significant amount of variation across major fields in the likelihood of educational utilization.

Operationalizing educational utilization

If the utilization of educational capital entails entering an occupation that requires the use of the specialized knowledge and skills one developed through educational experiences, how should this concept be operationalized? Ideally, a researcher would simply compare measures of both the skills individuals developed through their course of study in college to the skills required in their job. Given the absence of such detailed measures, educational utilization can be operationalized as employment in an occupation that is substantively

related to one's education. Such an operationalization thus requires the identification of major-occupation linkages. There are four available strategies for identifying the set of occupations that are substantively linked to a given major.

Prior research on the utilization of educational capital has focused almost exclusively on the utilization of education in science and engineering fields, and, more specifically, on sex differences in the utilization of such specialized educational investments. These studies exclusively rely on a researcher-imposed operationalization of educational utilization. In this approach, researchers classify a set of occupations as those that comprise the science/engineering labor market, based on independent judgment and/or the conventions of prior research, and employment in one of these occupations is defined as the utilization of science/engineering education. This approach may work well when the occupational classification scheme parallels the organization of college majors, when occupational categories are internally homogenous, and when college majors have clearly defined occupational destinations. The researcher-defined operationalization relies on the judgment of the researcher, rather than on the assessment of the individuals whose education-work transition is being observed or on an empirical method of assessing the substantive consistency of a major-occupation pair. The limits of this approach become obvious when it is applied to major fields such as English or sociology, which appear to have more diffused occupational linkages than do science and engineering.

Alternatively, empirical methods may be employed to identify major-occupation linkages. One empirical approach would be to conceptualize the transition from college to the labor market as a migration process where the size of the flow of "migrants" from college majors to occupations is the key indicator of the major-occupation linkages. I used this approach in previous work to identify the normative pathways college graduates follow in the labor force (Shauman 2006). It can be applied equally well to all college majors to yield a measure of the strength of the "link" between each major-occupation dyad. But, while this approach identifies the frequently traveled pathways from specific college majors to specific occupational categories (Kerckhoff 1996), it is flawed as a method for identifying the substantively consistent major-occupation dyads. The substantive similarity of major-occupation dyads should be measured directly; it cannot be inferred from the size of major-occupation flows since these flows are dependent on the idiosyncrasies of the occupational classification scheme. For example, very large occupational categories, such as "managers and administrators, not elsewhere classified," may receive substantial flows of college graduates from many majors, regardless of the substantive connectedness of the majors with the occupation.

A second empirical approach would utilize descriptions of the degree, educational and training requirements in specific subject areas for detailed job categories. Data on the demands of occupations would satisfying the occupational side of the ideal measure of educational utilization described above and could be used to identify the set of occupations that have a substantive relationship to a degree field.

A third empirical approach would rely on individual survey respondent's subjective assessment of the degree to which their work is related to their education. This approach would yield high content validity at the individual-level but may introduce a great deal of random noise and low levels of reliability across cases. A more reliable identification of education-work linkages may be obtained by aggregating the individual assessments of education-work comparability within major-occupation pairings. The aggregate measure would provide for each major field a continuous measure of the "relatedness" of each occupation. The reliability of this measure would be limited by the size of the sample populating each major-occupation dyad. The scope of the measure is limited by the occurrence of major-occupation "migration", for this measure of the substantive linkage between a particular major and a particular occupation requires that the occupation be entered by some minimal number of individuals who share that college major.

I use these four operationalization approaches to generate six measures of major-occupation linkages that can be used to asses educational utilization:

1. *Researcher-imposed* – For major fields that have clear occupational outlets, I create a dichotomous indicator variable that identifies the occupations that are assumed to be “linked” with the major depending on the category titles used in an occupational classification scheme.

2. *Flow* – For all majors, I use the size of the flow of graduates into occupations from each major field as a continuous measure of the popularity of major-occupation linkages.

3. *Subjective* – I use the aggregation of the individual assessments of education-work relatedness as a continuous measure of the "link" between majors and occupations.
4. *Substantive* – I use information about the degree, subject and training requirements of jobs within occupational categories to generate a continuous measure of the substantive connection between occupations and major fields.
5. *Weighted Subjective* – I weight the subjective by the rate measure to yield a quantitative measure of the strength of the subjective relationship between each college major and occupational category.
6. *Weighted Substantive* – I weight substantive measure by the rate to yield a quantitative measure of the strength of the substantive relationship between each college major and occupational category.

Data and Methods

The analysis presented in this paper proceeds in two parts. The first part involves the comparison of the six operationalizations of educational utilization and the second part employs these operationalizations to test for sex differences in the experience of educational utilization at the transition to the labor market upon degree completion.

Data for the operationalization of major-occupation links

There are three data requirements of the empirical measures of major-occupation linkage that I use to assess educational utilization: (1) a measure of the size of the flow of individuals to specific occupations from specific majors, (2) individual-level assessments of major-occupation relatedness by incumbents within all possible parings of detailed classifications of college majors and occupations, and (3) information on the degree-level and subject area requirements for all occupations. The first two of these data demands are satisfied by the 1993 and 2003 waves of the *National Surveys of College Graduates* (NSCG93 and NSCG03). The NSCG93 and NSCG03 are surveys of representative samples of college-educated individuals identified in the 1990 (for the NSCG93) and 2000 (for the NSCG03) Censuses. The NSCG93 sample included 215,000 individuals under age 75 working in all occupational fields and holding a bachelor's degree or higher in all fields of study, although those working in science and engineering fields were oversampled. The NSCG03 sample consists of 170,797 individuals under age 75 drawn from the 2000 Decennial Census long form respondents who indicated they had a baccalaureate degree or higher in any field of study, again with an oversample of those working in science and engineering fields. Two important aspects of the NSCG surveys recommend it for this study. First, these studies provide large, nationally representative samples that include detailed information about the employment characteristics, degree attainment, and field of postsecondary study of college graduates. Second, both data sets include a self-report measure of the relatedness of the respondents' occupations to the major field of their most recent degree.

For the operationalization of major-occupation linkages, I extracted samples from the NSCG93 and NSCG03 that include all respondents who are U.S. citizens, aged 25 to 50 years, who had attained a degree 10 to 24 years prior to the survey date, who reported being employed at the time of the survey and who provided valid information about their college major, their occupation, a valid response to a survey item soliciting their subjective assessment of the degree to which their major and job are related. The sample drawn from the NSCG93 using these selection criteria consists of 30,078 individuals who earned their degrees in the years 1970 to 1984. Applying these conditions to the NSCG03 data yields a sample of 26,024 individuals who earned their degrees in the years 1980 to 1994.

The third data requirement for the multiple operationalizations of major-occupation linkages is satisfied by the *O*NET Occupational Information Network 11.0 Database* (O*NET). The 11.0 release of the O*NET is the most current version of the online successor to the *Dictionary of Occupational Titles*. It is a source of updated and detailed information about the characteristics, requirements and activities of a broad range of jobs (Boese et al. 2001). The O*NET Database provides ratings of occupational and worker attributes for jobs classified according to the 2000 Standard Occupational Classification (SOC) system. The O*NET information on job and worker attributes are gathered from both professional job analysts and from representative surveys of job incumbents. The O*NET provides a measure of the required level of education for each job that

distinguishes 12 levels of degree attainment or certification. It also includes two measures of occupational demand for expertise in particular areas. The first is a measure of the demand for knowledge of the principles and facts related to 31 subject areas. The second is a measure of the required level of education in 15 general subject areas.

Data for the assessment of multiple measures and analysis of sex differences in educational utilization

The NSCG93 and NSCG03 also provide the analytical sample I use to both assess the explanatory power of the multiple measures of major-occupation linkages and to measure sex differences in the utilization of educational capital at the transition to the labor market. The analytical samples include individuals aged 23 to 35 who were working full time in the civilian labor force at the time of the1993 or 2003 survey, and who had attained a degree within the 9 years preceding the survey – i.e., between 1985 and 1993 for the NSCG93 and between 1995 and 2003 for the NSCG03. All analyses are estimated using an analytical data file that pools the two cohorts. After the excluding respondents with incomplete information on occupation, sex, and bachelor's degree major, the NSCG93 sample includes 13,388 individuals, of which 5,506 (41.13 percent) are female and the NSCG03 sample includes 8,494 individuals, of which 3,809 (44.84 percent) are female. I note that these NSCG93 and NSCG03 analytical samples are exclusive of the samples of degree-holders used for the operationalization, so the subjective assessments of major-occupation connections provided by the respondents included in the operationalization samples are exogenous to the behavior of the survey respondents included in the analytic sample.

While the selection criteria I impose limit the generalizability of the findings, they are justified on empirical grounds. The exclusion of part time workers is necessary because occupational placement may be endogenous to this dimension of labor force attachment since the possibility of working part time is not evenly distributed across all occupations. Furthermore, since part time work is associated with sex, this selection criterion removes an influence that may confound the measurement of sex differences in occupational placement. Focusing on the experiences of new entrants to the labor force, i.e., young people who had recently earned a bachelor's degree (within 9 years of the survey), controls the influence of two factors that confound the measurement of sex differences in educational utilization: (1) cohort differences in characteristics such as human capital investments, labor market experiences and orientations toward work, and (2) the sorting influences of the labor market. Excluding older cohorts of degree recipients therefore limits the potential for upwardly biased estimates of sex differences in educational utilization since men and women in younger cohorts are likely to be more homogeneous than those in older cohorts with respect in their educational investments and work orientations. In addition, assessing sex differences among young workers parses the influence of labor market sorting mechanisms that intensify sex segregation over the life course (Jacobs 1989) and allows a focused investigation of the sex differences that occur as young people make the transition from postsecondary education to the labor force.

Multivariate method for estimating educational utilization

Since I conceptualize educational utilization as gaining employment in an occupational setting that uses the substantive skills developed in during the pursuit of the college or post-graduate degree, I analyze educational utilization by estimating the degree to which the occupational placement is associated with each of the measures of major-occupation connections using a conditional logit model (Hoffman and Duncan 1988; Long 1997; McFadden 1974; Powers and Xie 2000). Let P_{ik} denote the probability that the ith individual enters the kth occupation, with i =1, 2, N, and k = 1, 2,…J, where N is the sample size, and J is the set of 67 available occupations. Let x_{ij} denote a vector of explanatory variables that are specific to each individual and each occupational outcome. The choice probability is specified as:

$$P_{ik} = \frac{\exp(x'_{ik}\,\beta)}{\sum_{j=1}^{J}\exp(x'_{ij}\,\beta)} \quad . \qquad (1)$$

For this analysis, the explanatory variables are limited to the measures of major-occupation connection. These measures vary by both i and k since I link the information on major-occupation connections to the individual-level records in the analytical sample by college major and separately for each cohort. This data link provides,

for each individual in the analytic sample, a value of 6 measures of major-occupation linkage that is dependent on the individual's major and that is specific to each of the 67 occupational categories in the choice set.

I estimate reduced-form models that include each of the measures of major-occupation connection separately, as well as series of hierarchical models that incorporate all possible combinations of the 6 measures. Models are estimated with controls for degree-level, cohort, and major. I use model goodness-of-fit statistics to assess the relative explanatory power of each model specification.

I test for the hypothesized sex differences in educational utilization by estimating models that include both two-way interactions between each the measures of major-occupational connection and sex. In the estimated models, a significant SEX-interaction coefficient represents a significant sex disparity in the association between a covariate and the odds of employment net of the marginal occupational distribution. By allowing the estimated influence of each of the six measures of major-occupation linkage to vary by sex in the model of occupational attainment I entertain the idea that educational utilization at the transition to the labor market may operate differentially by sex on each of the dimensions I am able to measure.

Expected Results

I expect to find strong empirical evidence of "pathways" or linkages between college majors and occupations and that multiple measures of those linkages are necessary to adequately operationalize the concept of educational utilization. I also expect to find significant sex differences in educational utilization, but that these sex differences vary across the measures of major-occupation linkages, by major field and by degree level.

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