EQUAL BUT SEPARATE? A CROSS-NATIONAL STUDY OF SEX SEGREGATION IN HIGHER EDUCATION

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The contours and correlates of sex segregation in higher education are explored using data from twelve advanced industrialized countries. Tertiary sex segregation is examined across two dimensions: field of study (horizontal segregation) and tertiary level (vertical segregation). The authors argue that the different aspects of female status in higher education (e.g., overall enrollments, representation at the post-graduate level, and representation in traditionally male-dominated fields of study) do not covary because each variable is affected in distinct ways by structural and cultural features commonly associated with "modernity." In particular, (1) ideals of universalism do more to undermine vertical segregation than horizontal segregation, and (2) some modern structural features may actually exacerbate specific forms of sex segregation. Consistent with these arguments, results suggest strongly integrative effects of gender-egalitarian cultural attitudes on distributions across tertiary levels, and weaker, less uniform cultural effects on distributions across fields of study (one notable exception being a strong positive effect on women's representation in engineering programs). Two modern structural features—diversified tertiary systems and high rates of female employment—show segregative effects in some fields and institutional sectors. Overall, few across-the-board integrative or segregative effects can be discerned that would lend support to evolutionary conceptualizations of gender stratification. Modern cultural and structural pressures are manifested unevenly and in contextually contingent ways.

WOMEN NOW MAKE UP about half of all tertiary students in the industrialized world. This gender parity in enrollment rates represents the culmination of a remarkable global trend, which began in the 1960s, toward democratization of higher education. This trend has been applauded by social scientists, national governments, and international organizations as a positive step toward realizing modern universalistic ideals and more fully developing women's human capital potential.

While few systems of higher education can be described as male bastions today, it is well known that the distributions of men and

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women *within* these systems are extremely uneven (e.g., see Bradley 2000; Jacobs 1996; Kelly and Slaughter 1991; Persell et al. 1999). Understanding the contours and causes of this sex segregation is important because the economic impact of female tertiary incorporation depends in large part upon women's access to elite institutions and specialties (e.g., see Davies and Guppy 1997; Fuller and Schoenberger 1991; Jacobs 1995; Kingston and Smart 1990). Our objective is to describe patterns of cross-national variability in tertiary sex segregation in a sample of 12 advanced industrial countries and to explore the structural and cultural factors that may underlie this variability.

Sex segregation in higher education occurs along two main axes: *tertiary level* (two-year colleges and vocationally-oriented institutions, four-year universities, and post-baccalaureate institutions), and *field of study*. These axes may be roughly construed as representing "vertical" and "horizontal" dimensions of sex segregation, respectively (also see Jonsson 1999). Tertiary levels can be clearly ranked with respect to their social status, rigor, and duration, while fields of study represent distinctions more of kind than of grade.[1]

Past research suggests that educational systems differ considerably across countries with respect to sex distributions and that the various dimensions of women's tertiary status (i.e., overall enrollments, representation at elite tertiary levels, representation in male-dominated fields of study) do not covary cross-nationally or historically (e.g., Bradley and Charles 2002; Persell et al. 1999; Windolf 1997). We argue that these dimensions vary independently because each is affected in distinct ways by structural and cultural features associated with "modernity." In particular, we suggest that (1) ideals of universalism do more to undermine vertical segregation than horizontal segregation, and (2) some modern structural features may actually exacerbate particular forms of sex segregation.

In posing these arguments, we seek to extend and elaborate upon what we term "evolutionary" conceptualizations of gender inequality, which tend to treat "women's status" as a quantity that rises or falls uniformly depending upon the level of economic or cultural modernization characterizing a given historical or national context. Our more nuanced understanding of sex segregation requires measurement tools that preserve information on the gender-typing of individual educational fields and levels. A log-linear modeling framework is perfectly suited for this task.[2] Our data are for the mid- to late-1990s and are drawn from published sources. We restrict our attention to advanced industrialized countries because we wish to consider effects of some structural features common to postindustrial labor markets and established systems of higher education. The 12 industrial countries considered nonetheless exhibit significant variability with regard to their regional locations, levels of prosperity, educational structures, and other relevant cultural and social characteristics. Issues of country selection and representativeness are discussed below.

THE MACRO-LEVEL DETERMINANTS OF SEX SEGREGATION IN HIGHER EDUCATION

There is a strong tendency among scholars to conceptualize "women's status" as a unidimensional property that changes in accordance with shifts on a single causal variable, such as the level of industrialism (e.g., Goode 1963), female economic independence (e.g., Blumberg 1984), or ideological egalitarianism (e.g., Ramirez 1987; see Jackson 1998 for a less deterministic version). Such an "evolutionary" conceptualization is

[1] Although definitions of the various tertiary levels may vary somewhat cross-nationally, a postgraduate degree is always of higher status than a degree from a two-year vocational college and provides access to higher-status, better-rewarded occupations. Fields of study might arguably be arranged in a hierarchy as well, corresponding to the social status and economic opportunities associated with different programs (e.g., engineering versus sociology). We keep such distinctions in mind in interpreting our results.

[2] On the advantages of this approach for cross-national comparisons of sex segregation, see Charles and Grusky (1995) and Grusky and Charles (1998).

in line with functionalist theories, which treat all forms of ascriptive stratification as preindustrial remnants that are gradually eliminated as modern values and institutions replace traditional ones (Inkeles and Smith 1974). It is also in line with neoinstitutionalist accounts, which posit steady delegitimation of particularism as universalistic values and principles diffuse globally (Meyer 2001; Ramirez forthcoming).[3] Some feminist accounts have a unidimensional character as well, namely those that portray women's social position as a function of the entrenchment of patriarchal relations and/or female economic dependency (e.g., Hartmann 1987; Huber 1988).

The existing empirical literature on sex segregation in higher education provides little empirical support for unidimensional, evolutionary accounts. First, patterns of cross-national variability in tertiary sex segregation are at most weakly related to measures of women's status in other social spheres. Bradley (2000), for example, reports that levels of segregation across fields of study are higher in the United States than in Turkey. Moreover, historical and cross-national covariation among common indicators of female tertiary status (i.e., overall enrollments, relative representation at elite tertiary levels, relative representation in historically male-dominated fields of study) is quite weak. Dramatic gender differences in distributions across fields of study have been found even in countries where women are well represented in the most elite sectors of higher education (Bradley and Charles 2002), and even where massive growth in overall female enrollment rates has occurred (e.g., see Jacobs [1995] on the United States, Jonsson [1999] on Sweden, and Bradley [2000] on cross-national trends).[4]

We attribute the absence of "expected" patterns of covariation to two factors. First, we argue that the vertical and horizontal dimensions of sex segregation are affected in distinct ways by modern universalistic norms. We agree with evolutionary arguments insofar as these apply to the delegitimation of overt gender hierarchies (i.e., vertical inequalities) in more culturally egalitarian contexts. We argue, however, that *horizontal inequalities are likely to be more resistant than vertical inequalities to gender-egalitarian cultural pressures.* Sex segregation by field of study is generated and maintained by extremely resilient, taken-for-granted beliefs about gender differences that are not necessarily incompatible with mandates for gender equality. Essentialist stereotypes are, in fact, easily reconciled with the "equal but different" cultural principle that is at the heart of some feminists' visions of improved women's status (e.g., see Scott [1988] on the "equality-versus-difference" debate in feminist theory). We thus suspect that deeply embedded and widely shared cultural beliefs about gender differences continue to influence students' schooling choices and preferences, and educational counselors' placement decisions in subtle ways—even in liberal egalitarian cultural contexts. Neoinstitutionalist and feminist

[3] Although neoinstitutionalists and functionalists posit different underlying mechanisms (e.g., diffusion of world cultural ideals versus economic exigencies), both seem to imply uniformly integrative effects as normative mandates for gender equality intensify and proliferate.

[4] This is not to say that the *absolute* numbers of women in male-dominated fields have not increased along with overall female enrollments. Ramirez and Wotipka (2001), for example, find modest growth in women's share of science and engineering majors cross-nationally between 1972 and 1992. Nonetheless, the rate of feminization in engineering has lagged far behind that in other fields—especially education, humanities, and the social sciences. The stability in segregation index scores and in women's *relative* representation in scientific and technical fields that has been observed recently (e.g., see Bradley 2000; Jacobs 1995) can be attributed to these uneven female flows. Although we do regard absolute increases as indicative of improved female access to traditionally male-dominated domains, we focus here on relative sex ratios because we aim to examine women's representation independent of international differences in (1) overall female participation rates, and (2) overall tertiary system sizes. Both these factors are likely to vary in accordance with their own causal logics, and both have been cited as key explanatory variables in the generation of sex segregation. If compositional factors are confounded with "female representation," we cannot possibly ascertain the causal relationships among tertiary sex segregation, overall female enrollments, and growth of higher education.

theories of gender stratification make important contributions by calling attention to the importance of cultural norms and attitudes, but they generally do not consider the possibility that the integrative effects of egalitarian norms are not uniform across occupational or educational domains (also see Charles and Grusky forthcoming).

Next, we argue that some modern structural characteristics exacerbate specific forms of tertiary segregation. In particular, structural differentiation of higher education may effect increased concentration of women in lower tertiary levels and in traditionally female-labeled fields of study, thereby partially offsetting integrative cultural pressures. This argument is derived in part from previous studies of sex segregation in the economy, which have linked postindustrial structural features to increased female labor force participation *and* increased sex segregation (Oppenheimer 1973; also see Jackson 1998). Charles (1992, 1998) has documented *both* structural and cultural effects on occupational gender distributions: gender-egalitarianism is associated with increased female access to elite male-dominated occupations, and postindustrial structural characteristics are associated with greater concentration of women in sales, service, and clerical work. We suspect that similar countervailing processes are at work within systems of higher education.

Educational credentials and labor market outcomes in modern societies are tightly linked, both symbolically and functionally. Given this relationship, economic structures and opportunities—in particular, rates of female labor force participation—are likely to affect women's educational choices and placements as well.

In contrast to "evolutionary" conceptualizations of sex segregation, which imply across-the-board shifts in the overall *amount* of sex segregation, our arguments suggest that neither horizontal nor vertical sex segregation can be described in purely quantitative terms because the actual contours of sex segregation often vary across contexts.[5] Accordingly, we adopt a novel approach to measuring and comparing sex segregation. Rather than relying on comparisons of summary index scores, we employ a modeling framework that allows us to retain all information on the field- and level-specific contours of segregation.

[5] For example, horizontal segregation may occur through female concentration in education programs in one context and through female concentration in medical programs in another.

GENDER EGALITARIANISM

We conceptualize *gender egalitarianism* as the propensity for individuals in any given national or historical context to reject ascribed gender roles and to apply normative standards of "equal opportunity" in evaluating the fairness of gender distinctions in the public and private spheres. We seek to compare countries with respect to the overall salience and pervasiveness of gender-egalitarian principles and do not mean to imply the existence of a homogeneous "national character." We use data from the 1994 International Social Survey Program (ISSP) on the percentage of national respondents "disagreeing" or "strongly disagreeing" with a statement affirming the "naturalness" of a sexual division of labor: "A man's job is to earn money; a woman's job is to look after the home and family" (see Appendix A for details on the ISSP). This survey item provides an excellent indicator of individuals' adherence to liberal egalitarian ideals, because such ascribed role assignments are strongly at odds with modern norms of universalism, equal opportunity, and free choice. We have verified the validity of this measure by conducting a variety of tests (described below).

Recent research suggests that international variation in the salience of gender (and other categorical distinctions) in everyday life reflects variability in both symbolic resources and structural conditions (e.g., see Lamont and Thévenot 2000 on the dynamic relationship between ideology and social environment; also see Wuthnow 1989). This observation implies that the relationship between sex segregation and gender egalitarianism is ultimately a *reciprocal* one, and that estimates of cultural effects may be somewhat inflated. This is not a cause for great concern here, however, because tertiary gender distributions alone are unlikely to strongly affect prevailing definitions of men's and

women's roles and competencies. Norms and ideologies concerning gender distinctions are deeply rooted, reflecting the historical interaction of a broad array of attitudinal, institutional, and structural factors. Once institutionalized, they take on lives of their own and are quite stable.[6] At any given point in time, nation-specific cultural understandings of gender represent durable, systemic properties, forming the context in which curricular choices and allocative processes unfold (e.g., see Correll [2001] on the role of biased self-assessments in mathematics persistence).

As discussed above, we expect gender-egalitarian cultural norms to be associated with a more pronounced decrease in vertical segregation than horizontal sex segregation. Moreover, past research on sex segregation in the labor market suggests that integrative trends are unlikely to occur in an across-the-board fashion, but will be *uneven across economic sectors and occupations* (see Charles and Grusky forthcoming; Jackson 1998; Reskin and Roos 1990). Idiosyncratic social, economic, and historical conditions undoubtedly interact with cultural shifts to affect gender distributions across tertiary fields and levels.

Educational Structure

We consider three structural features of education that may affect gender distributions across tertiary levels, fields of study, or both: structural diversification, tertiary system size, and female tertiary participation.

Structural diversification. Based upon UNESCO's classification, we distinguish among three levels of higher education: tertiary education leading to an award not equivalent to a first university degree (level 5); education leading to a first university degree (level 6); and education leading to a postgraduate university degree (level 7) (see Appendix A).

In recent decades, higher education has undergone significant structural diversification, most notably through the proliferation and growth of nonuniversity institutions, such as vocational schools and two-year colleges (e.g., see Meek and Goedegebuure 1996). Expansion of nonelite tertiary opportunities has occurred worldwide (although to varying extents) as part of concerted national and international efforts to democratize and modernize higher education (Bradley and Charles 2002; Sirowy and Benavot 1986). Since this expansion has been achieved primarily through growth in the size and number of *non*university institutions, we operationalize this variable with regard to the relative size of this sector: nonuniversity graduates as percentage of all tertiary graduates (see Appendix A).

The gender-specific consequences of tertiary diversification have not been adequately theorized or explored. For the following reasons, we suggest that the net effect of tertiary diversification is to increase both vertical and horizontal gender inequalities.

Female representation in the more elite tertiary levels (i.e., in universities and graduate schools) is likely to be weaker in countries with larger nonuniversity sectors due to the disproportionate diversion of women into these institutions. Where nonuniversity institutions enroll a large share of tertiary students, this form of higher education will more often be considered as a viable option by secondary students, their parents, and their guidance counselors. As a result, university-qualified (or potentially university-qualified) students may be diverted from a more elite path into shorter, vocationally oriented tertiary programs (see Clark 1960; Finley 1992 on "cooling-out effects" of two-year institutions). Women will be overrepresented among diverted students to the extent that they more often factor in actual or anticipated work-family conflicts as they make their initial educa-

[6] Intertemporal correlations of available attitudinal measures are indeed very high. Among countries with ISSP data available in both 1988 and 1994, national scores on our indicator correlate at .96 across the two time points. Data from the World Values Survey, collected in 1980, 1990, and 1995 for many of our 12 countries also show high intertemporal correlations. In addition, our measure correlates strongly with various other indicators of gender egalitarian attitudes. For example, the correlation is .99 with an item pertaining to perceived gender differences in occupational aptitudes (1983 Eurobarometer study), and .90 with an item asserting that "men have more right to jobs" (1990 World Values Survey).

tional choices and as they consider the costs and benefits of university transfer (i.e., tertiary "persistence"). Fiorentine (1987) suggests that gender differences in educational investment reflect in part the availability to women of "normative alternatives" to a primary market role (e.g., a less demanding job or full-time domesticity). In addition to these individual-level processes, high levels of female participation in nonuniversity tertiary education may reduce public pressure on government and educational officials to take policy steps to promote gender parity in elite tertiary institutions.[7]

Structural diversification may also exacerbate some forms of "horizontal" sex segregation. As the relative size of the nonuniversity sector increases, the image of tertiary education as a whole will lose its elite luster, affecting identities and dispositions of students at all tertiary levels.[8] This is relevant to the question at hand, given evidence that individuals who understand themselves to be members of an intellectual or social elite more often possess a sense of self-efficacy and high self esteem (Della Fave 1980; Gecas 1991). These traits could facilitate transgression of cultural gender norms as students select fields for study. Moreover, gender identities may be less salient (and thus less likely to affect students' behavioral choices) in contexts where the identity of "college student" is imbued with elite status.[9]

The above arguments suggest that effects of structural diversification on field-specific gender distributions extend beyond the nonuniversity level. We conduct supplemental analyses to investigate the generalizability of these effects across levels.

TERTIARY SYSTEM SIZE. The absolute size of the tertiary system may affect gender distributions across both levels of study and fields of study. Whereas participation in small, selective tertiary systems is restricted to an educational elite, students are necessarily drawn from a broader cross-section of the population in countries with large tertiary systems. The latter group may include men and women with less intrinsic interest in intellectual pursuits, less stellar academic records, and/or less well-developed educational and occupational aspirations. Female participants in these "mass" systems may be more willing to settle for lower status institutions and "gender appropriate" fields of study (see Hakim 1996 for similar arguments with respect to occupational choice).

FEMALE TERTIARY PARTICIPATION. Tertiary gender distributions also may be influenced by the overall rate of female participation in higher education. Regarding the nature of this relationship, two very different predictions can be derived from the existing literature. Both modernization and neoinstitutionalist theories suggest that large-scale tertiary incorporation will lead to collective changes in female identity that spill over into other public- and private-sphere domains, including traditionally male-dominated institutions and fields of study (e.g., see Bradley and Ramirez 1996; Davis 1984; Goode 1963; Ramirez and Weiss 1979). These "empowerment" arguments suggest a *negative* relationship between women's overall tertiary participation rate and sex segregation across levels and fields.

Interestingly, the results of some historical case studies point to a *positive* relationship, however. Increasing female enrollments have, for example, been associated

[7] The segregative effect of tertiary diversification may be intensified over time by shifts in the mix of fields represented at specific levels (e.g., by expansion of nursing and teaching programs, or by their upgrading from the secondary to the tertiary educational level). We refer here to the *net* effect of structural diversification. Further on, we consider compositional effects, as well as possible interactions between vertical and horizontal sex segregation.

[8] We are not suggesting that structural diversification attenuates inter-level status differentials—simply that it contributes to an across-the-board reduction in the status associated with tertiary education. See Collier (2000) on the multidimensionality of the college student identity.

[9] Identity theorists conceptualize "the self" as composed of multiple identities, which are determined by social roles, traits, and category memberships, and which also are imbued with shared expectations for social action. The relative salience of different identities determines the likelihood of behavioral choices that are in line with them (e.g., see Serpe 1991; Stryker 1991).

with the creation of the field of home economics, short-cycle educational programs, and vocational institutions designed to prepare young women for marriage (Fujimura-Fanselow 1985; Rosenberg 1988). This argument suggests a tipping point: When women's relative presence in tertiary education becomes sufficiently large, it becomes normalized and a new constituency—the "female student"—emerges in the minds of families, students, and educational professionals. There may then be increasing efforts to accommodate women as a group, based on prevailing conceptions of gender (e.g., see Bourque and Conway 1993). When women's presence in higher education is rare, female students may be viewed as "exceptions," and they may more often be accommodated as such within existing programs in colleges and universities.

Women's Economic Role

Anticipated market roles and opportunities are likely to affect women's educational choices. Rational choice and neoinstitutionalist arguments suggest a relationship between *female labor force participation* rates and gender distributions across tertiary levels and fields of study. According to neoclassical economic theory, women's willingness to invest in human capital will be greater in contexts where they foresee more opportunities to apply their abilities in the marketplace (Becker 1991; Polachek 1978; also see Baker and Jones 1993; Waite and Berryman 1985). Neoinstitutionalist arguments suggest that large-scale incorporation of women into one male-dominated sphere may work to "demystify" others and legitimize their opening to women (e.g., Weiss, Ramirez, and Tracy 1976; Ramirez 1987). Both suggest *reciprocal* relationships between female employment opportunities and tertiary integration. Debates about whether educational segregation *causes* labor market gender inequality or vice versa are unlikely to be empirically resolved. Diffuse processes are undoubtedly at work that simultaneously affect expectations concerning women and men in the educational and occupational spheres (also see Hanson, Schaub, and Baker 1996).

DESCRIPTIVE RESULTS: THE CONTOURS OF SEX SEGREGATION ACROSS LEVELS AND FIELDS OF STUDY

We begin our empirical analysis by describing patterns of sex segregation across three tertiary educational levels and seven fields of study. Data on distributions across levels are for 1997; data on fields are for 1995 (or as close thereto as possible).[10] Our 12 countries were selected based on the availability of reliable, internationally comparable data on education. The results reported here and throughout are for *unweighted* national samples. General patterns do not change when data are weighted so that each country contributes an equal number of cases. Details on data and classification schemes can be found in Appendix A; Appendix B provides information on country selection, representativeness, and generalizability of results.

Sex Segregation by Tertiary Level

We first examine the contours of sex segregation by *tertiary educational level* ("vertical" segregation) by fitting a series of log-linear models to a three-way (72-cell) table that cross-classifies graduates by level, sex, and country. The descriptive results obtained are not influenced by cross-national differences in either the tertiary participation rate of women or the vertical structure of higher education (i.e., the relative sizes of the various levels). Such "compositional invariance" is crucial in the present context, since both tertiary structure and female participation rates are central explanatory variables. For example, we cannot hope to assess how gender distributions across tertiary levels and fields of study are affected by women's participation in higher education if these distributions are not measured independently of overall female enrollment rates (e.g., see Charles and Grusky 1995; Grusky and Charles 1998).

[10] Breakdowns by field of study are not available for 1997. We elected to use the 1997 data on tertiary levels because of improved cross-national standardization of "level" definitions between 1995 and 1997.

First we compute a "constant sex segregation" model (Model L1), which specifies a common pattern of vertical sex segregation across nations. It can be expressed as follows:

$$m_{ijk} = \alpha_k \beta_{ik} \gamma_{jk} \delta_{ij}, \quad (1)$$

where i indexes sex, j indexes tertiary levels, k indexes country, m_{ijk} is the expected frequency in cell ijk, and α_k is the grand mean for the k^{th} country.[11] To identify this model, we constrain the three *sex* × *level* interaction terms (δ_{ij}) to sum to zero.

Results are presented in the first panel of Table 1. The three *sex* × *level* association terms provide a pooled profile of gender distributions across tertiary levels in these 12 nations. Positive values indicate an international tendency for female overrepresentation at the respective level (relative to the other two levels); negative values indicate a tendency for female underrepresentation. Exponents give the factor by which women are over- or underrepresented at each level. Consistent with previous national and international studies (e.g., Fujimura-Fanselow 1985; Kelly 1989; Windolf 1997), these figures indicate decreasing female representation as tertiary level increases. Women are overrepresented by a factor of 1.4 (exp[.36] = 1.43) at the nonuniversity level in the average country, and underrepresented by a factor of 0.8 (exp[–.24] = .79) at the postgraduate level; relative gender parity prevails at the level equivalent to an American Bachelor's degree.

Fit statistics from Model L1 suggest substantial cross-national differences in the degree and/or pattern of vertical sex segregation, however. These differences can be described with reference to country-specific segregation terms (δ_{ijk}) from a saturated model:

$$m_{ijk} = \alpha_k \beta_{ik} \gamma_{jk} \delta_{ijk}, \quad (2)$$

where the δ_{ijk} terms are constrained to sum to zero within each country.

The segregation parameters, shown in the second panel of Table 1, essentially contrast the female-to-male sex ratio in the respective level and country to the average level-specific sex ratio in that country (see the closed-form equation in the note to Table 1). International differences are striking. For example, Japanese women are overrepresented by a factor of 3.4 (exp[1.23] = 3.42) at the nonuniversity level, whereas this level is characterized by gender parity in Spain. At the university and postgraduate levels, female representation also ranges widely across these 12 countries.

SEX SEGREGATION BY FIELD OF STUDY

Our analysis of gender distributions across fields of study ("horizontal" segregation) is based on a three-way (168-cell) table that cross-classifies 1995 graduates by field, sex, and country. Again, we establish a baseline level of cross-national variability by computing a "constant sex segregation" model (F1), represented by equation 1, with j in this case indexing fields rather than levels. Results are displayed in the first panel of Table 2.

Summary *sex* × *field* terms (δ_{ij}) from this model reveal a familiar pattern: female underrepresentation in engineering, math/computer science (and to a lesser degree, natural science); female overrepresentation in education, humanities, and health fields; and approximate gender parity in the social sciences. Taking the exponents of parameters tell us, for example, that women are overrepresented in education fields by a factor of three on average (exp[1.16] = 3.18), and that men are overrepresented in engineering by a factor of seven (exp[1.97] = 7.17). Similar distributional patterns have been uncovered in case studies of educational systems (e.g., Kelly 1989; Stolte-Heiskanen 1991) and in comparative analyses of occupational sex segregation (e.g., Charles 1992, 1998). These patterns are consistent with culture-centered and human-capital accounts, both of which predict fe-

[11] This model fits the three main effects of sex, level, and country, plus three two-way interactions—*sex* × *level*, *level* × *country*, and *sex* × *country*. The *sex* × *country* interaction permits the overall sex ratio in higher education to vary across countries. The *level* × *country* interaction permits the relative sizes of tertiary levels to vary across countries, and the *sex* × *level* interaction permits the "international" gender composition to vary across levels. See Charles and Grusky (1995) for a similar model of occupational sex segregation.

Table 1. Female Representation in Tertiary Education Levels across 12 Industrial Countries: Parameter Estimates from the Constant Segregation Model (L1) and the Saturated Model

Model	Nonuniversity Level	University Level		Index of Vertical Sex Segregation (*A*)
		First Degree	Postgraduate	
Model L1: Constant Sex Segregation Model[a]				
Pooled parameter estimates (sex × *level*)	.36	−.12	−.24	—
Saturated Model[b]				
Country:				
Austria	1.02	−.26	−.76	2.11
Canada	−.12	.27	−.15	1.21
Germany	.58	−.06	−.52	1.57
Ireland	−.09	.19	−.10	1.14
Italy	.37	−.04	−.33	1.34
Japan	1.23	−.25	−.98	2.51
New Zealand	.27	.04	−.31	1.27
Norway	.05	.36	−.41	1.37
Spain	.00	.37	−.38	1.36
Sweden	−.15	.40	−.24	1.33
United Kingdom	.19	−.04	−.14	1.15
United States	.14	−.01	−.13	1.12

[a] Cross-national invariance in sex segregation by tertiary education level: (*sex* × *country*) + (*sex* × *level*) + (*level* × *country*) (L^2 = 113,940; d.f. = 22).

[b] Cross-national variability in sex segregation by level (*level* × *sex* × *country*) (L^2 = 0; d.f. = 0). Values from the saturated model can be expressed in closed-form as: $\ln(F_j/M_j) - [1/J \times \Sigma\ln(F_j/M_j)]$, where F_j gives the number of women in level j, and M_j gives the number of men in level j. The summary segregation index, A, can be computed as $\exp(1/J \times \{\Sigma\ln(F_j/M_j) - [1/J \times \Sigma\ln(F_j/M_j)]\}^2)^{1/2}$, with terms defined as above. See Appendix A for data and sources.

male overrepresentation in fields characterized by functional or symbolic proximity to the traditional female domestic role (e.g., Becker 1991; Reskin 1993).

Results of a saturated model (equation 2 above, but with j indexing fields instead of levels) again suggest substantial international variability in these patterns (see the second panel of Table 2). For example, men are overrepresented among computer science and math graduates by a factor of four (exp[1.38] = 3.97) in Sweden, while near gender parity prevails in this field in Italy. Even in the overwhelmingly female-typed medical field, we find strong variability, with the United States, United Kingdom, New Zealand, and some Scandinavian countries showing a tremendous overrepresentation of women, and Italy showing female underrepresentation. The latter results are reminiscent of typical findings from studies of labor market sex segregation, which suggest that the greatest concentration of women in white-collar service positions occurs in the most advanced postindustrial societies (e.g., Charles 1998; Oppenheimer 1973).

In the final columns of Tables 1 and 2 we list country scores on summary indices (A) of vertical (Table 1) and horizontal (Table 2) sex segregation. Values of A give the factor by which women are over- or underrepresented at the average level (or field) in each nation (e.g., see Charles and Grusky 1995). A score of 1.00 would indicate gender parity in all levels (fields). Substantial sex segregation is evident in all countries and on both dimensions. Comparing index values across tables suggests greater horizontal than vertical segregation overall. This would appear to be consistent with our argument that essentialist ideologies of gender difference are more deeply institutionalized in modern so-

Table 2. Female Representation in Fields of Study across 12 Industrial Countries: Parameter Estimates from the Constant Segregation Model (F1) and the Saturated Model

Model	Education	Humanities, Arts	Social Science, Law, Business	Natural Science	Math, Computer Science	Medicine and Health	Engineering	Index of Horizontal Sex Segregation (*A*)
Model F1: Constant Segregation Model [a]								
Pooled parameter estimates (*sex* × *field*)	1.16	0.62	.13	–0.27	–0.69	1.01	–1.97	—
Saturated Model [b]								
Country:								
Austria	1.40	.60	.12	–.42	–1.09	.88	–1.49	2.66
Canada	1.11	.31	.47	–.19	–.82	.70	–1.58	2.37
Germany	1.43	.93	.07	–.51	–.68	.89	–2.13	3.10
Ireland	1.02	.50	.34	.11	–.41	.53	–2.08	2.56
Italy	1.77	1.21	–.17	.05	–.25	–.26	–2.34	3.34
Japan	1.91	1.89	.08	–1.19	–.74	.46	–2.42	4.37
New Zealand	1.36	.53	–.03	–.20	–1.14	1.32	–1.85	3.04
Norway	1.02	.44	.02	–.31	–1.01	1.40	–1.57	2.67
Spain	1.02	.47	.23	–.18	–.80	.78	–1.52	2.31
Sweden	1.35	.31	.21	–.18	–1.38	1.15	–1.47	2.79
United Kingdom	.87	.45	.10	–.17	–1.01	1.49	–1.73	2.76
United States	1.06	.30	.16	–.24	–.60	1.17	–1.84	2.60

Note: Data are pooled across all three tertiary education levels.

[a] Cross-national invariance in sex segregation by field of study (*sex* × *country*) + (*sex* × *field*) + (*field* × *country*) ($L^2 = 84{,}845$; d.f. = 66).

[b] Cross-national variability in sex segregation by field of study (*field* × *sex* × *country*) ($L^2 = 0$; d.f. = 0). Values are parameter estimates from this saturated model. Closed-form equations are as shown in Table 1 (note b), but with *j* here denoting fields rather than levels.

cieties than are ideologies justifying gender-differentiated status hierarchies (hence the profusion of literature examining the glass ceiling phenomenon in labor market research).

With regard to cross-national variability, however, these summary index scores must be regarded as incomplete measures because they capture differences only in *degrees* of sex segregation. As can be seen in the preceding columns of both tables, distributional *patterns* also vary strongly (e.g., compare Austria and Canada in Table 1, Italy and Sweden in Table 2). This evidence of qualitative variability confirms our prior arguments regarding the importance of preserving information on the level- and field-specific contours of sex segregation.

Finally, note that the indices of vertical and horizontal sex segregation shown in Tables 1 and 2 correlate only weakly with one another.[12] This further supports our multidimensional conceptualization of tertiary gender stratification. Accordingly, we distinguish between these two forms of sex segregation in our explanatory analyses.

SUMMARY

Vertical and horizontal sex segregation constitute distinct dimensions of gender stratification in higher education. Results of the foregoing descriptive analyses reveal substantial international variability in levels and patterns of sex segregation along both dimensions. In the remainder of this paper, we attempt to account for this variability, first with respect to segregation across tertiary education levels, then with respect to segregation across fields of study.

EXPLAINING CROSS-NATIONAL VARIABILITY IN GENDER DISTRIBUTIONS

SEX SEGREGATION BY TERTIARY LEVEL

Our first set of explanatory analyses aims to account for the cross-national variability in men's and women's distributions across tertiary levels that was revealed in Table 1. The general explanatory model can be expressed as follows:

$$m_{ijk} = \alpha_k \beta_{ik} \gamma_{jk} \delta_{ijk}, \quad (3)$$

with the *sex* × *level* interaction terms (δ_{ijk}) constrained to be linear functions of the country-level explanatory variables:

$$\delta_{ijk} = a_j + \mathbf{b}_j \mathbf{X}. \quad (4)$$

In equation 4, α_j is the intercept for the j^{th} level, $\mathbf{b}_j\mathbf{X}$ is a vector of country-level covariates and their slopes, and all other terms are defined as above (for similar models of occupational sex segregation, see Charles 1992, 1998; also see Grusky and Hauser 1984). To identify the models, the δ_{ijk} terms were constrained to sum to zero within each country. Parameter estimates from the δ_{ijk} interaction terms specify the relationship between the independent variables and the mean female-to-male sex ratio for each level.

We assess the fit of nested hierarchical models using the likelihood-ratio chi-square statistic (L^2), which indicates how well a given model reproduces observed cell counts. The power of explanatory variables to account for international differences in the structure of sex segregation is assessed by comparing the fit of the explanatory model to that of Model L1, which constrains gender distributions across levels to be identical in all countries. The relative explanatory power of each covariate can then be determined through a process of "backward deletion," whereby the L^2 statistics for models with individual variables omitted are compared with that for the full model. Equations are estimated using a maximum likelihood procedure.

Because our analyses are based on population data, we do not use traditional tests of statistical significance to assess model fit.[13]

[12] The zero-order correlation is only .11, excluding Japan, which is a positive outlier on both measures.

[13] Given our sample size of over 5 million cases (graduates), it is extremely unlikely that any model, save the saturated one, will fit the data (i.e., will yield a statistically nonsignificant chi-square or a negative BIC statistic). We thus base our model selection on relative, not absolute, criteria. It is the level-specific parameter estimates that are of substantive interest here.

Instead we attempt to balance considerations of parsimony and explanatory power by considering each covariate's relative contribution to model fit, as well as the robustness of observed effects across model specifications and samples.

Recall that a model specifying cross-national invariance in gender distributions across levels (Model L1 in Table 1) yields a likelihood ratio statistic of 113,940. The object of our explanatory analyses is to improve the fit of this model by accounting for cross-national variability. We do so by adding national-level covariates to Model L1. Based on the arguments outlined above, our full explanatory model includes indicators of gender-egalitarianism, structural diversification, tertiary system size, female tertiary participation, and female labor force participation (all defined in Appendix A).

Descriptive statistics for the explanatory variables are shown in Appendix C. The *gender egalitarianism* variable has been defined and discussed above. As expected, country scores range widely, with Japan and Austria showing the lowest values, and Sweden, Norway, and Canada the highest. Cross-national variability in *female tertiary participation*, measured as women's share of tertiary graduates, is minimal, however. While countries differ a great deal in the *modes* of women's tertiary incorporation, women's overall share is remarkably close to 50 percent in all countries (e.g., see standard deviation of 4.1).

Structural diversification is operationalized as the proportion of tertiary graduates with degrees from nonuniversity tertiary programs. The largest shares of nonuniversity graduates are found in Japan, Canada, and Norway, while the Spanish system shows by far the smallest share.[14] We measure *tertiary system size* with reference to total tertiary enrollment rates (as a percentage of the relevant population age group). Not surprisingly, the United States and Canada rank at the top on this indicator. *Female labor force participation* is measured using overall activity rates for 1990. We use 1990 figures because we expect effects to be lagged; nearly identical results are obtained using 1980 figures. Disparities in years represented by particular variables are unavoidable, given the difficulties involved in obtaining cross-nationally comparable data for a fixed set of 12 countries, and given historical changes in the definition of tertiary education and in the classification of educational levels in some countries. We have, however, verified our results using data for different time points, as available. The general pattern of results reported here is quite robust.

Table 3a shows fit statistics from a series of explanatory models. Our full model (Model L2) accounts for nearly 98 percent of international variability in vertical sex segregation while expending nearly half of the available degrees of freedom. The second panel of Table 3a provides information on the relative contribution to model fit of each of the five explanatory variables. Those with least explanatory power, female labor force participation, system size, and female tertiary participation, together account for little more than 3.6 percent of variability.[15] Additional analyses (not shown) indicate that parameters associated with these three variables are quite sensitive to changes in model specification, sample weighting, and sample composition. Under all specifications, their omission had at most only small effects on other parameters. Effects of gender egalitarianism and structural diversification are, in contrast, very stable across the models. The final explanatory model (Model L3) includes only these two variables. Gains in parsimony, it appears, cost little in the way of explanatory power: Model L3 accounts for 95 percent of cross-national variability in vertical sex segregation, while expending only 4 degrees of freedom. By far

[14] Structural diversification and female tertiary participation are measured using data on *graduates* because we have less confidence in the cross-national comparability of *student* breakdowns. Using the available student data yields similar results, however.

[15] Contradictory pressures associated with female tertiary participation may account for the absence of a clear effect here. In other words, it may be that we find no clear relationship because *two* influences are in fact operating, with a negative "accommodation" effect offsetting a positive "empowerment" effect of this variable (see preceding discussion).

Table 3a. Gender Distributions across Tertiary Education Levels in 12 Industrial Countries: Results from Nested Log-Linear Models

Model	L^2	Degrees of Freedom	L^2/L^2_t (×100)
Model L1 as Baseline			
Model L1: Constant Sex Segregation [a]			
Total variation	113,940	22	100.0%
Model L2: Initial Model [b]			
Unexplained variation (Model L2)	2,739	12	2.4%
Explained variation (Model L1 – Model L2)	111,201	10	97.6%
Model L3: Final Model [c]			
Unexplained variation (Model L3)	5,547	18	4.9%
Explained variation (Model L1 – Model L3)	108,393	4	95.1%
Model L2 as Baseline			
Gender egalitarianism deleted	16,386	14	12.0%
Effect	13,647	2	
Structural diversification deleted	7,276	14	4.0%
Effect	4,537	2	
Female labor force participation deleted	4,037	14	2.4%
Effect	2,739	2	
Tertiary system size deleted	3,775	14	1.2%
Effect	1,036	2	
Female tertiary participation deleted	2,789	14	0%
Effect	50	2	
Model L3 as Baseline			
Gender egalitarianism deleted	100,320	20	83.2%
Effect	94,773	2	
Structural diversification deleted	18,352	20	11.2%
Effect	12,805	2	

Note: L^2_t refers to the likelihood-ratio chi-square statistic for total cross-national variation in sex segregation across levels (Model L1). Data are for 1997 or as close thereto as possible (see Appendix A).

[a] See Table 1 for model definition.

[b] The initial model is defined as: (Model L1) + [*sex* × *level* × (*gender egalitarianism* + *structural diversification* + *female tertiary participation* + *tertiary system size* + *female labor force participation*)].

[c] The final model is defined as: (Model L1) + [*sex* × *level* × (*gender egalitarianism* + *structural diversification*)].

Table 3b. Gender Distributions across Tertiary Education Levels in 12 Industrial Countries: Parameter Estimates from Model L3 [a]

		University Level	
Independent Variable	Nonuniversity Level	First Degree	Postgraduate
Gender egalitarianism	–.040	.013	.027
Structural diversification	.014	–.002	–.012

[a] Parameter estimates from Model L2 are presented in Appendix D.

the largest of the covariate effects is for gender egalitarianism, which itself accounts for 83 percent of explained variability (compared with 11 percent for the structural diversification measure).

Level-specific parameter estimates for Model L3 are shown in Table 3b.[16] These provide information on the strength and direction of the relationship between the respective covariate and female representation in each tertiary level. For example, the value –.040 in the first column, first row indicates a net negative relationship between gender-egalitarian cultural norms and women's representation at the nonuniversity level. Taking the exponent (exp[–.040] = .96), we find that (controlling for structural diversification) a one-point increase in the percentage of the national population expressing gender-egalitarian views is associated with a 4 percent decrease in women's nonuniversity representation. In contrast, we find greater female presence in universities, and especially in postgraduate institutions, in more gender-egalitarian contexts.

The effects of gender egalitarianism are remarkably insensitive to changes in the particular indicator employed. In supplemental models, we replaced our attitudinal variable with a variety of structurally based indicators, including a measure of family policy support for gender equality constructed by Siaroff (1994), and composite indices of "legal egalitarianism" constructed by Charles (1998) and Chang (2000).[17] Such legal, social, and economic indicators of female status have been used in previous cross-national studies as indirect proxies for cultural gender attitudes (e.g., Chang 2000; Charles 1992, 1998; Ramirez and McEneaney 1997). Our supplemental models yielded parameter estimates similar to those reported in Table 3, with a stronger female presence at high tertiary levels in more legally or structurally egalitarian contexts. The total effects of these alternative measures were, however, weaker than those found for our direct attitudinal measure.[18] While structural and cultural forms of gender egalitarianism are no doubt reciprocally related, gender-egalitarian cultural norms appear to more directly undermine vertical gender inequalities in higher education.

Results in the second row of Table 3b, however, suggest that another feature common to advanced industrial countries—structural diversification—may be associated with *greater* sex segregation across levels. Net of gender egalitarianism, women tend to be more strongly concentrated at the nonuniversity level in countries where the nonuniversity sector is larger. In particular, we find (controlling for gender egalitarianism) that a 1 percentage-point increase in nonuniversity graduates' share of overall enrollment is associated with a 1-percent increase in female representation (i.e., the female-to-male ratio) in the nonuniversity sector (exp[.014] = 1.01). Japan is an obvious case in point, given its large and extremely female-dominated nonuniversity sector (see Table 1 and Appendix C). Yet the overall pattern of effects is identical if Japan is omitted.

The effect of structural diversification may be interpreted in two ways. First, the availability of nonuniversity institutions may provide tertiary *opportunities* for women who would not otherwise enroll in higher education (e.g., through expansion of female-dominated short-term vocational programs). The second interpretation follows from arguments, summarized above, positing a diversionary or "cooling out" effect of nonuniversity tertiary education. This interpretation suggests a zero-sum relationship between participation at the university and nonuniversity levels, with lower-tier institutions essentially siphoning off some of those who might have otherwise pursued a university degree. We have speculated that

[16] The corresponding parameters for Model L2 can be found in Appendix D, first panel. As can be seen, effects of gender egalitarianism and structural diversification are quite similar to those shown in Table 3.

[17] Indicators of legal egalitarianism considered in these studies include abortion rights, female suffrage, ratification of international gender-equality conventions, and national legislation on equal opportunity and affirmative action.

[18] Replacing our attitudinal measure with Chang's measure of legal egalitarianism increased the log-likelihood statistic (L^2) to 13,930 (from 5,547); using Charles' legal measure increased L^2 to 47,628; and using the family policy measure increased L^2 to 94,209.

women may be more susceptible to such diversionary effects because of a greater propensity for women—as well as women's parents, teachers, and academic counselors—to factor in potential work-family conflicts in making educational choices and recommendations, and because "normative alternatives" to demanding, education-intensive jobs are available to women. In addition, we have suggested that political pressures to integrate universities may be reduced when higher female tertiary enrollment rates are achieved through the enrollment of women in nonuniversity settings.

We suspect that both processes—expanded access and diversion—are at work simultaneously. And, indeed, the parameter estimates in Table 3b could by themselves support either thesis. Nonetheless, our examination of other available data leads us to give more weight to diversion. Among other things, we find a negative zero-order correlation of –.58 (–.46 omitting Japan) between women's share of nonuniversity (level 5) and university (level 6) graduates. In other words, women tend to be less well represented at universities when they make up a larger share of graduates from nonuniversity institutions.[19]

We tested the robustness of results by adding a series of macro-level controls to Model L3, including indicators of economic modernization, global linkage, economic structure, educational structure, and various demographic variables.[20] None resulted in changes that altered our substantive conclusions. Moreover, univariate models yielded very similar parameter estimates for gender egalitarianism and structural diversification.

Summary

These results are consistent with our argument suggesting partially countervailing cultural and structural effects on gender distributions in tertiary education. Egalitarian gender norms coincide with substantially greater female presence in more elite tertiary levels. But a particular form of structural diversification—a large nonuniversity sector—is associated with greater concentration of women in less elite tertiary institutions.

Sex Segregation by Field of Study

Table 4a shows fit statistics for a series of nested models predicting men's and women's distributions across seven fields of study. Data are pooled across tertiary levels for these analyses. With few exceptions (one is discussed below), our conclusions are unchanged when the analysis is confined to individuals graduating from universities and graduate schools.

Again, we attempt to account for cross-national variability not explained by the model of constant segregation (Model F1) by fitting a model that includes all five covariates. This full model (Model F2) accounts for 89 percent of cross-national variability in sex segregation by field (see Appendix D for parameter estimates). The second panel of Table 4a provides information on each covariate's contribution to model fit. As in the previous analyses, we find that gender egalitarianism and structural diversification exert the largest effects, accounting for 10 and 15 percent of cross-national variability, respectively. In addition, a sizeable effect (7 percent) is found for female labor force participation.

Based on two criteria, size of the effect and stability of parameter estimates, we have eliminated two variables from Model F2: tertiary system size and female tertiary participation.[21] Model F3 accounts for nearly 85

[19] This negative relationship between the number of women in nonuniversity programs and the number of women attending universities may be partly attributable to cross-national variability in the programmatic composition of the university and nonuniversity levels (e.g., variability in the location of programs in nursing and teaching). This implies that sex segregation by level may be both a cause and a consequence of sex segregation across fields of study. We will address this question more directly further on.

[20] Specifically, we tested the effects of occupational sex segregation, women's share of professional and managerial occupations, marriage and fertility patterns, patterns of economic and labor market growth, national memberships in international organizations, growth of higher education, government funding of higher education, female secondary enrollments, and the curricular structure of secondary education.

[21] Once again, substantive significance, not statistical significance provides our guideline for

Table 4a. Gender Distributions across Tertiary Education Fields in 12 Industrial Countries: Results from Nested Log-Linear Models

Model	L^2	Degrees of Freedom	L^2/L^2_t (×100)
Model F1 as Baseline			
Model F1: Constant Sex Segregation [a]			
Total variation	84,845	66	100.0%
Model F2: Initial Model [b]			
Unexplained variation (Model F2)	9,199	36	10.8%
Explained variation (Model F1 – Model F2)	75,646	30	89.2%
Model F3: Final Model [c]			
Unexplained variation (Model F3)	12,907	48	15.2%
Explained variation (Model F1 – Model F3)	71,938	18	84.8%
Model F2 as Baseline			
Structural diversification deleted	21,650	42	14.7%
Effect	12,451	6	
Gender egalitarianism deleted	17,303	42	9.6%
Effect	8,104	6	
Female labor force participation deleted	15,311	42	7.2%
Effect	6,112	6	
Tertiary system size deleted	11,694	42	2.9%
Effect	2,495	6	
Female tertiary participation deleted	10,367	42	1.4%
Effect	1,168	6	
Model F3 as Baseline			
Gender egalitarianism deleted	48,065	54	41.4%
Effect	35,158	6	
Structural diversification deleted	30,687	54	21.0%
Effect	17,780	6	
Female labor force participation deleted	21,953	54	10.7%
Effect	9,046	6	

Note: L^2_t refers to the likelihood-ratio chi-square statistic for total cross-national variation in sex segregation by field of study (Model F1). Data are for 1995 or as close thereto as possible (see Appendix A).

[a] See Table 2 for model definition.

[b] The initial model is defined as (Model F1) + [*sex* × *field* × (*gender egalitarianism* + *structural diversification* + *female tertiary participation* + *tertiary system size* + *female labor force participation*)].

[c] The final model is defined as (Model F1) + [*sex* × *field* × (*gender egalitarianism* + *structural diversification* + *female labor force participation*)].

Table 4b. Gender Distributions across Tertiary Education Fields in 12 Industrial Countries: Parameter Estimates from Model F3 [a]

Independent Variable	Education	Humanities	Social Science, Law, Business	Natural Science	Math, Computer Science	Medicine and Health	Engineering
Gender egalitarianism	–.022	–.046	.011	.028	–.009	.011	.028
Structural diversification	.013	.023	.002	–.013	.006	–.022	–.009
Female labor force participation	–.002	–.022	–.004	–.009	–.002	.045	–.005

[a] Parameter estimates from Model F2 are presented in Appendix D.

percent of cross-national variability in this form of sex segregation, while expending 12 fewer degrees of freedom than does the full model. As can be seen in the third panel of Table 4a, the strongest single effect is found for gender egalitarianism, which accounts for 41 percent of the model's explanatory power.[22] Structural diversification and female labor force participation account for 21 and 11 percent, respectively.

As expected, we are somewhat less successful in accounting for sex segregation across fields than across levels (e.g., compare the log-likelihood partitions for Models L3 and F3). This difference can be attributed to the weaker effect of gender egalitarianism in the field models. We have argued that the more purely hierarchical nature of tertiary levels makes this form of segregation more difficult to reconcile with egalitarian ideals. Gender-specific distributions across fields of study may be compatible with such ideals to the extent that such distributions are understood to represent "different but equal" choices and opportunity structures.

The field-specific parameter estimates for Model F3 are displayed in Table 4b. Figures in the first row indicate less gendered distributions across fields in more gender-egalitarian cultural contexts. Specifically, we find that gender-egalitarian attitudes are associated with lesser feminization of the education and humanities fields and a stronger female presence in two of the three male-dominated fields (natural sciences and engineering). The value .028 for engineering fields, for example, indicates that (net of structural diversification and female labor force participation) a 1 percentage-point increase in those espousing a gender-neutral division of family labor is associated with a 3-percent increase in women's representation in engineering fields (exp[.028] = 1.03).[23]

Again, distributional shifts associated with gender egalitarianism occur unevenly across fields. We suspect that field-specific effects are determined in part by the interaction of cultural ideals with idiosyncratic national characteristics and histories (e.g., country-specific patterns of educational and occupational expansion, labor market demand, social development). However, it is interesting that the strongest effects of gender egalitarianism are found for engineering (positive) and humanities (negative)—arguably the fields associated with the strongest and weakest economic returns, respectively (e.g., Jacobs 1995). In this instance, egalitarian cultural attitudes appear to coincide with better economic outcomes for women.

The second row of Table 4b shows parameter estimates for our structural diversification variable. Women's representation in the female-dominated education, humanities, and (to a lesser extent) social science fields is stronger in countries with larger nonuniversity sectors, and their representation in engineering and natural science in those countries is weaker. Results are thus consistent with arguments positing a generally segregative effect of structural diversification on gender distributions across fields. Findings from additional models (discussed below) suggest, however, that it may be *feminization of the nonuniversity level*, more than its relative size, that affects patterns of horizontal sex segregation in these countries.

Parameter estimates in the third row of Table 4b indicate that women's presence in health fields is most strongly affected by their market role—in particular, by national rates of female labor force participation: An increase of 1 percentage point in this rate is

model selection. A series of partitioning exercises with varying combinations of these and other variables indicated consistently small effects of system size and female tertiary participation. Furthermore, the field-specific parameter estimates associated with these variables were sensitive to changes in model specification, sample weighting and/or sample composition. We are therefore unable to discern any clear effects. Parameters for the other covariates were, in contrast, extremely robust.

[22] The increased size of this effect, relative to Model F2, can be attributed to the positive correlation of egalitarianism with the two omitted variables (see Appendix C).

[23] Again, supplemental models using alternative structural indicators of gender egalitarianism yielded weaker overall effects, but a similar pattern of parameter estimates to those shown here. The only exception is a positive effect for the field of education found for Siaroff's (1994) family policy indicator.

associated with a 5-percent increase in women's representation in medical/health fields (exp[.045] = 1.05), net of the other two variables.[24] This large effect may be attributable to the vocational nature of health-related programs and the strong concentration of women in many allied health professions (e.g., nurse, medical technician, dental hygienist). Past research has suggested that women are more likely to anticipate a future market role for themselves where female labor force participation rates are high. In this context, a degree in the field of health may be attractive because it represents a practical means of obtaining a market-relevant (and gender-appropriate) credential.

Since degrees in the field of education often constitute professional certification as well, it is surprising that we find no effect of female employment on the gender composition of this field.[25] One explanation may be that education programs, especially those at lower tertiary levels, appeal to women regardless of their market plans. (Pedagogic subject matter may, for example, be perceived as intrinsically interesting or as pertinent to the maternal role.) In contrast, most women who enroll in health or medical fields presumably expect to pursue work in the corresponding occupation (e.g., as nurse, medical technician, or dental hygienist).

Again, adding to Model F3 a series of control variables (pertaining to economic structure, family formation, educational structure, international linkages) did not affect the parameters in question.

SUMMARY

Gender-egalitarian norms are associated with substantially greater gender integration of some fields of study. But overall, this cultural effect appears to be weaker than that found for vertical distributions. Again, we found a generally segregative effect of tertiary diversification. In addition, female labor force participation is associated with greater female representation in health-related fields.

ON THE RELATIONSHIP BETWEEN VERTICAL AND HORIZONTAL SEX DISTRIBUTIONS

Thus far we have treated sex segregation across tertiary levels and tertiary fields as mutually independent. We will now briefly consider possible interactions between these variables.

Patterns of vertical sex segregation are likely affected by international differences in the institutional *locations* of specific credentialing programs. This is true to the extent that individuals seek to enroll in a specific field regardless of the type and level of institution offering that program of study. For example, women's concentration in nonuniversity institutions should be greater in countries where primary and preprimary teaching credentials are granted at that level. Policymakers' decisions to upgrade such programs from the nonuniversity to the university level (as recently occurred in Sweden) might then lead to decreased female representation at the nonuniversity level and increased female representation at the university level.

While such effects are certainly important within specific national contexts, examination of available data suggests that cross-national variability in vertical sex segregation cannot be attributed to simple differences in the level-specific locations of particular programs. In Japan, for example, women's overrepresentation in nonuniversity institutions occurs through female concentration in humanities and social science programs; in Germany it occurs largely through female concentration in health-related programs; and in Austria it occurs through strong female concentration in education programs. We formally explored effects of programmatic composition by adding to our level model (Model L3) variables indexing the relative sizes of various female-dominated fields at the nonuniversity level (e.g., health,

[24] We found no comparable effect for other economic variables (e.g., women's occupational distributions, industrial structure, economic growth, economic modernization).

[25] We did find a weak positive effect when analysis was restricted to the university and postgraduate levels of study—perhaps because the credentials required to teach professionally are today generally obtained in universities rather than in two-year institutions.

education, humanities).[26] Net effects were small and did not alter the results presented above.

Although we find no evidence that our results are driven by simple compositional effects, it is possible that horizontal and vertical distributions are related in a more substantive sense. For example, female tertiary participation that is limited to a narrow range of fields (or levels) may promote vertical (or horizontal) sex segregation by reinforcing gender distinctions in the minds of educational policymakers and prospective students. In other words, sex segregation along one dimension may contribute to gender-differentiated conceptualizations of higher education in general, and thus support sex segregation along other tertiary dimensions.

We begin to explore this possibility by adding to our final model of distributions across levels (Model L3) a variable indexing the overall amount of horizontal sex segregation in each country (values of *A* in Table 2), and by adding to our final model of distributions across fields (Model F3) a variable indexing the overall amount of vertical sex segregation (i.e., values of *A* in Table 1). Of course, these index scores must be regarded as incomplete measures of distributional inequality because they allow countries to be compared only with respect to amount, not pattern, of sex segregation. Nonetheless, to the extent that more sex segregation is associated with more gender-differentiated conceptualizations of higher education, larger index scores should be associated with more sex typing of some categories, and inclusion of these terms should result in attenuation of the gender-egalitarianism effects.

Results, shown in Table 5, suggest a positive association between vertical and horizontal sex segregation, *net of the other covariates*. Women tend to be more strongly concentrated in nonuniversity institutions in countries where sex segregation by field of study is more pronounced.[27] Moreover, female representation in all female-typed programs is greater in countries with more sex segregation across levels, and their representation in two of the three male-dominated fields—natural science and math/computer science—is weaker. Results of partitioning exercises (reported in footnotes to the respective tables) indicate sizeable effects of both segregation variables.

Also of interest is how the addition of these segregation terms affects other parameter estimates. Turning first to our model of distributions across levels (Table 5a), we find that the direction and pattern of covariate effects are largely unchanged from Table 3. Gender egalitarianism remains the variable with greatest overall explanatory power, although partitioning results indicate that horizontal sex segregation does absorb some of its effect.

Adding an indicator for vertical sex segregation to our field model effects more substantial changes (Table 5b). Most important, the overall explanatory power of gender egalitarianism is strongly attenuated (see note to Table 5b), due to the elimination of its negative effect for education programs and the weakening of its positive effect for natural sciences. This attenuation suggests that some of the cultural effects identified in Model F3 may be indirect (i.e., they may occur through an integrative influence of gender-egalitarian cultural norms on distributions across tertiary levels). These results are consistent with our arguments suggesting that gender-egalitarian cultural norms do more to undermine vertical than horizontal inequalities, and they help account for the persistence of extreme segregation by field of study in even the most gender-egalitarian of contexts. It is noteworthy, however, that the feminizing influence of gender egalitarianism on engineering programs remains large. Given the high pay and steep opportunity structures associated with engineering occupations (see Jacobs 1995 on economic returns to college majors; also see National Science Foundation 2000), a strong argument certainly could be made for treating female

[26] To avoid confounding the dependent and independent variables, field size was measured with respect to *male* graduates only.

[27] For example, a 1-point increase in the index of horizontal sex segregation is associated with a net increase of 39 percent in women's representation at the nonuniversity level (exp[.330] = 1.39).

Table 5a. Parameter Estimates after Addition of Sex Segregation Indicators: Model Predicting Sex Segregation by Tertiary Education Level, 12 Industrial Countries

Independent Variable	Nonuniversity Level	University Level	
		First Degree	Postgraduate
Gender egalitarianism	–.021	.014	.007
Structural diversification	.006	–.001	–.005
Horizontal sex segregation [a]	.330	.015	–.345

Note: L^2 = 3,751, d.f. = 16. Omission of individual variables resulted in the following L^2 values (d.f. = 18): Gender egalitarianism deleted = 6,068; structural diversification deleted = 4,465; horizontal sex segregation deleted = 5,547. Zero–order correlations with horizontal sex segregation: Gender egalitarianism = –.51; structural diversification = –.05.

[a] Refers to the value of the *A* index for gender distributions across fields of study (see Table 2).

Table 5b. Parameter Estimates after Addition of Sex Segregation Indicators: Model Predicting Sex Segregation by Tertiary Field of Study, 12 Industrial Countries

Independent Variable	Education	Humanities	Social Science, Law, Business	Natural Science	Math, Computer Science	Medicine and Health	Engineering
Gender egalitarianism	.000	–.016	.010	.001	–.039	.012	.032
Structural diversification	.002	.006	.003	.001	.022	–.023	–.011
Female labor force participation	.004	–.013	–.005	–.015	–.013	.045	–.004
Vertical sex segregation [a]	.626	.788	.036	–.730	–.976	.087	.169

Note: L^2 = 9,828, d.f. = 42. Omission of individual variables resulted in the following L^2 values (d.f. = 48): Gender egalitarianism deleted = 11,844; structural diversification deleted = 12,491; female labor force participation deleted = 16,733; vertical sex segregation deleted = 12,907. Zero–order correlations with vertical sex segregation: Gender egalitarianism = –.69; structural diversification = –.14; female labor force participation = .10.

[a] Refers to the value of the *A* index for gender distributions across tertiary levels (see Table 1).

underrepresentation in this field as a form of vertical inequality as well.

We also find marked changes in the effects of structural diversification on field-specific distributions—most notably a stronger positive effect on female representation in math/computer science and weaker positive effects in education and humanities. This suggests that it is the gender-specific way in which structural diversification occurs (i.e., through concentration of women in less prestigious vocational institutions and two-year colleges), rather than structural diversification per se, that increases sex segregation across fields of study.

Given that the vertical sex segregation variable absorbs some of the egalitarianism and diversification effects reported earlier, it is not surprising that female labor force participation now exerts the strongest independent influence on sex segregation across fields (see note to Table 5b). The nature of this relationship is largely unchanged from that reported in Table 4: High rates of female employment are associated with much greater concentration of women in health-related fields of study. In addition, we now find a weak positive effect of this variable on women's representation in the field of education. This is consistent with the argument that women who foresee longer and more continuous labor force careers more often choose fields of study that are linked to specific occupations. Notably, though, they do not appear more likely to invest in engineering programs, despite the high market value of such credentials. High rates of

female labor force participation alone thus do not appear to increase the likelihood that women will transgress occupational gender boundaries.

Effects of vertical segregation on field-specific gender distributions are not confined to the nonuniversity level. When attention is restricted to distributions at the university and postgraduate levels, parameter estimates are similar to those shown in Table 5b. Vertical sex segregation thus appears to effect diffuse changes in the symbolic meaning of higher education, thereby contributing to shifts in the identities and dispositions of tertiary students at all levels.

Despite these interrelationships, zero-order correlations between indices of horizontal and vertical sex segregation are low, because each of the underlying distributions is shaped by its own set of causal variables and by country- and period-specific institutional pressures (e.g., unique trajectories of national development, educational expansion, tertiary restructuring).

SUMMARY

Results suggest reciprocal relationships between horizontal and vertical sex segregation. The effect of gender egalitarianism on women's distribution across fields is strongly attenuated when the effect of sex segregation by level is taken into account. This reinforces our contention that egalitarian ideals more directly erode vertical inequalities than horizontal inequalities.

CONCLUSION

A unidimensional conceptualization of gender stratification is implicit in much theoretical and empirical work in this field. This tendency is exemplified by frequent references to trends in women's "status" (e.g., Blumberg 1984; Goode 1963; Jackson 1998; Ramirez 1987) and by the large body of literature that relies on summary indices to assess historical and cross-national variability in sex segregation.[28] Our results suggest, however, that national educational systems differ greatly in their *patterns* of gender inequality, and that this variability cannot be summarized with respect to differences in the overall "amount" of sex segregation. Although a multidimensional approach to understanding women's status has been advocated before (e.g., Bradley and Khor 1993; Collins et al. 1993; Seager 1997; Young, Fort, and Danner 1994), our analyses confirm the *empirical validity* of such an approach.

We have suggested two reasons for the complex, sometimes counterintuitive, patterns of variability in tertiary gender segregation revealed here and elsewhere. First, the impact of gender-egalitarian cultural norms is uneven. This is true, most importantly, because universalistic mandates more directly undermine vertical than horizontal inequalities. Sex segregation across fields of study, for example, can be more easily reconciled with "equal but different" cultural principles (espoused even by some feminists) than can segregation across a hierarchy of tertiary levels. Even in the most egalitarian of cultural contexts, men's and women's distributions across fields of study are highly gendered. The extent to which these distributional differences reflect anticipated work/family conflicts, taken-for-granted gender labels, or deeply rooted curricular preferences has not yet been empirically resolved.

Second, our findings suggest that structural features associated with economic and social modernization—in particular, diversified tertiary systems and high rates of female employment—exacerbate some forms of sex segregation in higher education and partially offset equalizing effects of egalitarian ideals. Results are reminiscent of those from recent comparative analyses of occupational sex segregation, which have also pointed to the operation of partially countervailing cultural and structural pressures (Charles 1992, 1998; Charles and Grusky forthcoming). Patterns of cross-national variability in tertiary sex segregation can likewise be attributed to the independent influences of multiple structural and cultural variables—each of which impacts women's representation in level- and/or field-specific ways.

[28] Grusky and Charles (1998) suggest that index-based measurement may represent both a cause and a consequence of unidimensional conceptualization.

Interestingly, we find no direct effects of either female tertiary participation rates or tertiary system size on gender distributions. It appears that the "massification" and feminization of higher education are themselves less relevant to the structure of tertiary sex segregation than are the specific *forms* that these trends take. Sex segregation will generally be more extreme where large size is achieved through disproportionate growth of nonuniversity institutions and where female "access" is achieved through women's concentration in vocational colleges or stereotypically female fields of study.

The strong cultural effects that we find provide support for evolutionary models that emphasize the *importance of universalistic norms and attitudes* in opening up elite male-dominated domains to women (Goode 1963; Jackson 1998; Ramirez 1987; Ramirez and Wotipka 2001). However, the unevenness of cultural effects and the weak covariation among common indicators of women's tertiary status suggest that gender egalitarianism undermines some forms of tertiary gender stratification more than others. Neoinstitutionalist scholars have rightly directed attention to the equalizing influence of universalistic cultural ideals on modern educational systems. What is needed now is a greater appreciation for the multidimensionality of gender stratification within higher education and for the uneven, multifarious process by which sex segregation is generated and maintained. Cross-national differences in tertiary sex segregation cannot be understood as a simple function of the "status of women" or the level of modernity in any given national or historical context.

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APPENDIX A

Variable Definitions, Data, and Sources

TERTIARY LEVELS

Levels are defined according to UNESCO's "International Standard Classification of Education" (ISCED), as follows:

LEVEL 5 (NONUNIVERSITY). "Diplomas and certificates not equivalent to a first university degree awarded after higher studies which last generally less than three years."

LEVEL 6 (UNIVERSITY, FIRST DEGREE). "First university degrees or equivalent qualifications represent higher studies of three to five years duration which lead to qualifications such as a Bachelor's degree."

LEVEL 7 (UNIVERSITY, POSTGRADUATE). "Post-graduate university degrees or equivalent qualifications, which persons who already possess a first university degree (or equivalent qualification) can obtain by continuing their studies; for example, the Master's degree or the various types of Doctorates."

Breakdowns by level are for 1997 graduates (1996 for Canada, Germany, Italy, and Japan; 1995 for Spain and USA) (UNESCO 1999, table II.15, and pp. 373–74).

TERTIARY FIELDS OF STUDY

Fields are defined according to UNESCO's classification (e.g., see UNESCO 1997). Some categories were combined in order to improve cross-national consistency and/or enhance country coverage: UNESCO fields 2 and 3 were combined to form our "Humanities and Arts" category, and UNESCO fields 4,5,6,7,8, and 9 were combined into "Social Science, Business and Law." Fields 14–17 were combined with UNESCO's "Other" category, which was eliminated due to cross-national inconsistencies. In Japan, the "Engineering" category includes some "Trade and Craft" programs. Data include graduates of level 5, 6, and 7 institutions (see above), and pertain to 1995 graduates (1992 for Japan; 1996 for Canada and Ireland) (UNESCO 1996, 1997, 1998, table 3.12).

EXPLANATORY VARIABLES

GENDER EGALITARIANISM. Percentage of respondents "disagreeing" or "strongly disagreeing" with the statement that "a man's job is to earn money; a woman's job is to look after the home and family." (*International Social Survey Program (ISSP)*, Zentralarchiv für Empirische Sozialforschung 1994).

STRUCTURAL DIVERSIFICATION. Level 5 (i.e., nonuniversity) graduates as percentage of all tertiary graduates in 1997 (1996 for Canada, Germany, Italy, and Japan; 1995 for Spain and USA) (UNESCO 1999; table II.15).

SIZE OF TERTIARY SYSTEM. Gross enrollment rate, 1995. Total enrollment in tertiary education, regardless of age, expressed as a percentage of the population of the five-year age-group following on from the secondary-school leaving age. Japanese data are for 1992 (UNESCO 1999, table II.8).

FEMALE TERTIARY PARTICIPATION. Women's percentage of tertiary graduates, 1995 (1992 for Japan; 1996 for Canada and Ireland) (UNESCO 1996, 1997, 1998, table 3.12).

FEMALE LABOR FORCE PARTICIPATION, 1990. Percentage economically active among women aged 15 years and over (United Nations 1991, table 8).

APPENDIX B

Validity and Generalizability

THE COUNTRY SAMPLE

Twelve advanced market economies are included in our analyses: Austria, Canada, Germany, Ireland, Italy, Japan, New Zealand, Norway, Spain, Sweden, United Kingdom, and United States. Selection of sample countries proceeded as follows:

(1) We identified countries with comparable data on postsecondary graduates differentiated by field of study, tertiary level, and sex. Collapsing fields from 18 to 7 categories (see Appendix A) allowed us to retain nearly all advanced industrialized countries. Level-specific breakdowns proved to be more difficult to reconcile cross-nationally, however. *France* was dropped because of missing data on tertiary education levels and because French reporting on fields of study does not conform to UNESCO standards. Despite our best efforts (which included examination of national data and personal communications with French officials), we could find no way of rendering the French reporting scheme compatible with the UNESCO classification. *Australia, Israel*, and the *Netherlands* were omitted because of various idiosyncrasies in their definition or reporting on levels. *Switzerland* was dropped because of an apparent change in the classification of tertiary levels between 1993 and 1996. This resulted in great inconsistencies between figures reported in the "field" and "level" tables from which we took our data. These countries were eliminated across the board (i.e., for all analyses) because we suspected that discrepancies in the definition of levels could adversely affect comparability of field-specific distributions.

(2) We examined several international attitudinal surveys and selected the measure of cultural gender norms that allowed us to retain the largest and most regionally representative sample of advanced market economies while remaining true to our conceptualization of gender egalitarianism. *Belgium, Denmark*, and *Finland* were dropped because of missing values on the selected attitudinal measure. (Data on all other exogenous variables were readily available for the countries in question.)

REPRESENTATIVENESS AND GENERALIZABILITY

We have conducted extensive tests to verify the representativeness of our sample and the generalizability of our explanatory results. By relaxing requirements for complete field and level breakdowns and by focusing on specific, elite educational categories (i.e., the "post-graduate" level and the "engineering" field), we were able to increase our sample sizes for the purpose of validity checks. In addition, we increased country coverage by imputing missing values on the gender-egalitarian variable (accomplished by regressing the original gender-egalitarianism values on a factor score comprised of three "structural" measures of egalitarianism: years since women obtained the franchise, legislative provisions for female equality, and legality of abortion on request). We also carried out tests using an alternative attitudinal indicator, indexing the percentage of the national population disagreeing with the statement that "when jobs are scarce, men should have more right to a job than women." This survey item, taken from the 1990 World Values Survey, was available for a different (partially overlapping) set of countries.

Test results show a high degree of consistency across samples and indicators, suggesting that our most important results (i.e., those pertaining to gender egalitarianism and structural diversification) are generalizable to "advanced industrialized countries" as a group. Results of some validity tests are reported in the text; others are available from the authors on request.

APPENDIX C

Descriptive Statistics

Variable/Statistic	Gender Egalitarianism	Structural Diversification	Tertiary System Size	Female Tertiary Participation	1990 Female Labor Force Participation
Country					
Austria	36.3	24.9	47	51.8	44
Canada	77.4	60.3	88	51.4	49
Germany	47.7	29.6	46	45.3	41
Ireland	53.2	37.5	40	48.6	32
taly	49.5	18.0	42	56.2	30
Japan	39.9	48.9	31	47.8	46
New Zealand	59.5	26.3	60	57.6	40
Norway	69.7	56.8	59	54.4	50
Spain	53.6	7.3	48	57.0	22
Sweden	69.6	10.2	47	57.3	55
United Kingdom	57.0	19.1	50	53.6	46
United States	59.4	31.6	81	55.2	50
Mean	56.1	30.9	53.3	53.0	42.1
Standard deviation	12.2	17.2	16.6	4.1	9.7
Correlations					
Gender egalitarianism	1.00	—	—	—	—
Structural diversification	.28	1.00	—	—	—
Tertiary system size	.68	.37	1.00	—	—
Female tertiary participation	.41	–.48	.27	1.00	—
Female labor force participation, 1990	.40	.40	.39	–.05	1.00

APPENDIX D

D-1. Parameter Estimates from Full Models: Vertical Sex Segregation (Tertiary Education Level)

Independent Variable	Nonuniversity Level	University Level	
		First Degree	Postgraduate
Gender egalitarianism	–.034	.017	.017
Structural diversification	.013	.000	–.013
Female labor force participation	.011	–.010	.000
Tertiary system size	–.005	–.001	.006
Female tertiary participation	.006	.001	–.007

Note: Values are parameter estimates taken from Model L2 (see Table 3a). Variables are listed in order of importance (i.e., their contribution to model fit).

D-2. Parameter Estimates from Full Models: Horizontal Sex Segregation (Tertiary Field of Study)

Independent Variable	Education	Humanities	Social Science, Law, Business	Natural Science	Math, Computer Science	Medicine and Health	Engineering
Gender egalitarianism	–.017	–.032	.009	.023	–.027	.019	.027
Structural diversification	.016	.023	.002	–.012	.008	–.029	–.008
Female labor force participation	.001	–.008	–.007	–.012	–.015	.046	–.005
Tertiary system size	–.006	–.012	.002	.003	.012	.001	.000
Female tertiary participation	.018	.023	–.011	–.001	.010	–.041	.002

Note: Values are covariate effects taken from Model F2 (see Table 4a). Variables are listed in order of importance (i.e., their contribution to model fit).

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