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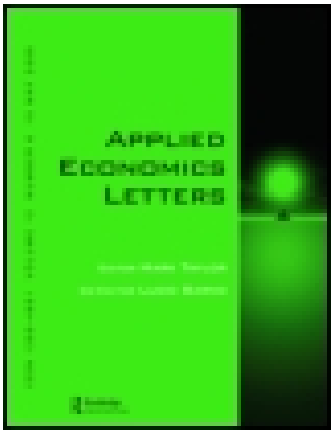

Applied Economics Letters
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rael20

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Published online: 05 Oct 2010.

To cite this article: Marybeth F. Charters & Paul W. Grimes (1997) Technology and librarianship: a test of the human capital model of occupational segregation, Applied Economics Letters, 4:7, 403-406, DOI: 10.1080/135048597355131

To link to this article: http://dx.doi.org/10.1080/135048597355131

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Applied Economics Letters, 1997, **4**, 403–406

Technology and librarianship: a test of the human capital model of occupational segregation

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Received 10 June 1996

An empirical test of the human capital model of occupational segregation is undertaken by analysing the gender ratio of new entrants into a traditional female occupation over a period of time characterized by significant technological change. Specifically, the relative number of females receiving the terminal professional degree in librarianship is examined over the 1968–92 period using regression analysis. The results indicate that a statistically significant decline in the relative number of new female entrants occurred over this period, *ceteris paribus*. Thus, the human capital model cannot be rejected in this case.

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I. INTRODUCTION

The human capital model is perhaps the most widely accepted, yet controversial, explanation for the persistence of occupational segregation by gender in the modern economy. The human capital model is based on the empirical observation that women in the aggregate have a greater probability of more frequent, and longer, interruptions in their lifetime labour market activities than men. These interruptions are assumed to affect the occupational choices made by women and the hiring decisions of firms. During periods of non-participation in the labour force, a worker's acquired human capital depreciates and opportunities for on-the-job training are forfeited; therefore, earning power is diminished. The potential earnings loss is significant for many women as the timing of career interruptions for family formation and child bearing often corresponds to the period when workers are most likely to receive on-the-job-training (Kaufman, 1994). Thus, according to the human capital model, women on average have an economic incentive to choose occupations in which their earnings loss from non-participation is the smallest. Furthermore, employers of occupations which require frequent updating of specific human capital through training, have a disincentive to hire female workers. (Such employer behaviour may result in 'statistical discrimination' against women with strong attachments to the labour force (Ehrenberg and Smith, 1994).)

Polachek (1979) has noted that many of the traditional 'female' occupations, such as school teacher, are those where the opportunity costs of career interruptions are relatively low. These occupations require job skills that do not rapidly depreciate or become obsolete over extended periods of time. Another important characteristic is that they are generally less affected by technological and structural change. Occupations that undergo significant advances in technology require more frequent training and new investment in human capital on the part of the worker and employer. Thus the human capital model predicts that women may avoid highly technical occupations which require frequent updating of professional skills. Likewise, the model suggests that employers in technically advanced occupations who provide and pay for specific on-the-job-training have economic incentives to hire predominant male workforces.

This paper provides a test of the human capital model of occupational segregation by analysing the gender ratio of new entrants into a traditional female occupation over a period of time characterized by significant technological change. Specifically, the relative number of women receiving the terminal professional degree in library science is examined over a 25-year period which included a revolution in the fundamental skills necessary for occupational success.

II. TECHNOLOGY AND LIBRARIANSHIP

Throughout most of the twentieth century, librarianship has been a female dominated occupation in the US. The characteristics of the traditional occupational structure closely

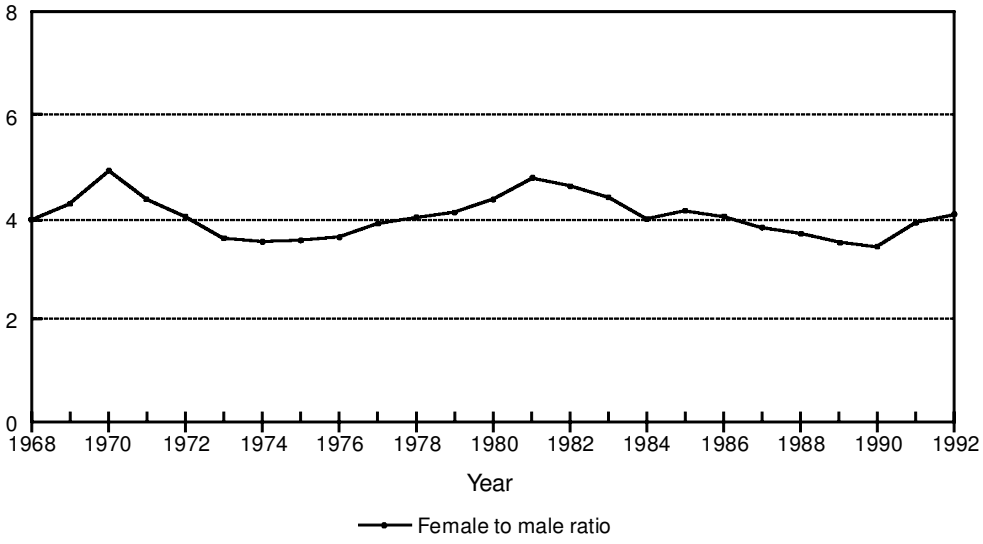

Fig. 1 NEW ENTRANTS *Female to male ratio in the period 1968–1992.*

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paralleled those suggested by the human capital model. Specifically, librarians acquired general training in skills such as cataloguing, collection development and preservation that were easily transferable between employers and were not subject to obsolescence during periods of non-participation. Training ladders and internal job hierarchies were relatively short within most libraries; therefore, the wages and salaries of librarians remained relatively low.

Librarianship has undergone a revolution during the past 30 years, driven by the tremendous advances in information technology. Today, a librarian is not just a housekeeper of books, but is a manager of information delivery systems. The advent of the modern computer has rewritten the job description for every professional librarian. Along with the technological change, the skill requirements for all aspects of librarianship have become more advanced and more specific. Librarians must use, manage and maintain complex systems of information storage and retrieval.

Modern information technology has spread relatively quickly and comprehensively throughout the profession. Although a few farsighted pioneers began experimenting with computerized information storage during the 1950s and 1960s, it was not until 1974 that a library patron could sit down and browse an online card catalogue (Su, 1994). In that year, three major universities installed the first online public access catalogues (OPACs). By 1994, more than eight out of ten US libraries reported using computer based network capabilities with online catalogues, access to the Internet, and online external CD-ROM resources (Corporation for Public Broadcasting, 1994).

Unquestionably, the technological revolution has changed librarians' skill requirements by demanding that training become more specific and more frequent. An entire industry has developed to provide training workshops and skill development classes for librarians. Within the context of the human capital model, these structural changes have raised the opportunity cost for women to enter librarianship. More specific and more frequent training requirements imply that occupational skills now depreciate and become obsolete at a faster rate. Thus the technological revolution has increased the cost of career interruptions for female librarians. The logical extension of this conclusion is that the relative number of new female entrants into the occupation should decline in response to the structural changes brought about by modern technology. This hypothesis is empirically examined in the next section.

III. REGRESSION MODEL

Today more than 80% of all librarians employed in the US are female (United States Department of Commerce, 1995). However, as discussed above, the human capital model of occupational segregation suggests that structural changes brought about by technological advancement should reduce the relative number of new female entrants. To test this hypothesis, the following regression model is posited and estimated by OLS for the 1968–92 period:

$$NEW\ ENTRANTS_t = \alpha + \beta_1 TREND_t + \beta_2 OPAC\ ERA_t + \beta_3 SALARY_t + \beta_4 \%\Delta GDP_t + \beta_5 PARTICIPATION_t + \epsilon \quad (1)$$

The dependent variable, $NEW\ ENTRANTS_t$, is defined as the ratio of female to male recipients of the Master of Library Science (MLS) degree, or equivalent, in year t, and proxies the relative flow of new librarians, by gender, into the profession. The MLS degree is generally accepted as the terminal professional degree for practising librarians. (Professional standards and accreditation bodies treat the MLS as an occupational licence.) As specified, the variable captures

Fig. 2 *Trend in* SALARY *over the 1968–1992 period.*

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the *potential* number of new female librarians relative to the *potential* number of new male librarians. Data that capture the actual number of new librarians employed do not exist. Fig. 1 plots the value of *NEW ENTRANTS* over the 1968–92 time span. Clearly, librarianship remains a predominant female occupation as the ratio of new female entrants to new male entrants has averaged about 4:1 over this 25 year time span.

The independent variables *TREND* and *OPAC ERA* are included to capture the effect of technological advancement on the relative flow of new entrants into the profession. *TREND* is an arithmetic counter-variable running from 1 in 1968 to 25 in 1992. This specification captures the long-run trend in *NEW ENTRANTS* over the sample period. *OPAC ERA* is a categorical variable equal to 0 for years before 1974 and equal to 1 for 1974 and after, and is designed to capture any shift in the *NEW ENTRANT* trend due to the technological introduction of the *OPAC* and other advanced technologies beginning in the mid-1970s. According to the human capital model, the *TREND* and *OPAC ERA* variables are expected to have negative coefficients. As technological advancement increases the human capital requirements of librarianship, the opportunity costs of career interruptions rise and fewer women are attracted to the field. Likewise, libraries will have an incentive to hire relatively more men. These effects are expected to reduce the ratio of new female to new male entrants.

SALARY is defined as the average real annual salary (in thousands of 1991 dollars) offered to beginning librarians by major universities (Association of Research Libraries, 1974–94). Fig. 2 depicts the trend in *SALARY* over the 1968–92 time frame. Because university libraries have been shown to pay relatively larger salaries than other libraries (Van House, 1986; 1987), *SALARY* reflects the *potential* first-year return to an MLS graduate. Again, comparable time-series data do not exist for all new librarians. *A priori*, the expected sign for *SALARY* is negative. Over time, real increases in the wages of a segregated occupation without major barriers will attract outside entrants, *ceteris paribus*.[1]

The independent variables $\%\Delta GDP$ and *PARTICIPATION* are included to control for market effects on the relative mix of new entrants. $\%\Delta GDP$ is specified as the annual percentage change in gross domestic product and controls for overall labour market conditions. *PARTICIPATION* is specified as the ratio of the overall female labour force participation rate to the overall male labour force participation rate. As the relative number of women in the labour force increases, the ratio of new entrants into a traditional female occupation, such as librarianship, is expected to increase. Thus, the estimated coefficient for *PARTICIPATION* is expected to have a positive sign.

IV. RESULTS AND CONCLUSIONS

The results of the regression estimation are reported in Table 1. The diagnostic statistics reveal that the equation is statistically fairly large and explains a significant portion of the variation observed in the dependent variable. Furthermore,

[1] The possibility that the entry of workers with non-traditional characteristics into an occupation may have an independent effect on wages cannot be dismissed. In this case, if men are attracted into librarianship due to the higher training requirements brought about by technological change, *SALARY* may reflect the level of human capital that they bring to the profession. The current data preclude the ability to test for such independent effects or the simultaneity of *NEW ENTRANTS* and *SALARY*.

Table 1. *Regression results – dependent variable:* NEW ENTRANTS

Variable	Coefficient	*t*-value
CONSTANT	1.164	1.229
TREND	−0.182	2.164**
OPAC ERA	−0.692	2.585**
SALARY	−0.121	1.893*
$\%\Delta GDP$	−0.061	2.409**
PARTICIPATION	13.967	1.855*
F-statistic = 6.691		
Adjusted R^2 = 0.542		

** Statistically significant at the 0.05 level, two-tailed test.
* Statistically significant at the 0.10 level, two-tailed test.

all the independent variable coefficients are statistically significant and carry the expected sign. A number of empirical tests, not reported here, were conducted to ensure the stability of the regression specification.

The negative *SALARY* coefficient indicates that an increase in the real starting salary of librarians is associated with a relative decline in the number of females entering the profession. This suggests that men may be responsive to positive wage differentials in a traditionally female occupation. Furthermore, technological change may also reduce perceived occupational role barriers for men entering librarianship.[2] The negative coefficient for $\%\Delta GDP$ suggests that the relative number of men entering librarianship increases when the economy expands. Tighter labour markets in a growing economy may force some men to pursue less traditional occupations. The positive *PARTICIPATION* coefficient indicates that as the relative labour force participation rate for females rises, so too does the relative number of new female entrants into librarianship. New female participants in the labour market have not abandoned traditional female occupations.

Both of the variables designed to capture the effect of the trend of technological change on the gender mix of new entrants into librarianship have negative and statistically significant coefficients. Though not obviously apparent in Fig. 1, the long-run *TREND* in the female to male ratio of *NEW ENTRANTS* is negative over the 1968–92 period, *ceteris paribus*. As noted above, this was a period of great technological change for libraries. The technological revolution swung into high gear with the advent of the modern OPAC in 1974. The negative and significant *OPAC ERA* coefficient suggests that the ongoing downward trend in the relative number of new female librarians shifted down further after the introduction of user-accessible online catalogues. (A specification test indicated that an interaction effect of the *TREND* and *OPAC ERA* variables was HARDLY significant. Thus after 1974 the function shifted downward but did not change in degree.)

These results indicate that the human capital model of occupational segregation cannot be rejected in the case of librarianship. Technological advancement and the accompanying structural change in the profession were associated with a statistically significant decline in the relative number of new female librarians, *ceteris paribus*. Empirical tests such as the one presented here do not exclude alternative explanations and hypotheses. Furthermore, would the same results be found for other traditionally female occupations which have undergone similar structural changes? Additional research with richer and more complete data is required to answer fully the continuing puzzle of occupational segregation by gender.

ACKNOWLEDGMENTS

The authors wish to thank the following librarians for their helpful suggestions and comments: John Cruickshank, Susan Hall, Debra Lee, David Nowak, Randy Rafferty and Suzy Turner. The authors also benefited from the input provided by the following economists: George Chressanthis, Charles Register and George Verrall.

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[2] Alternatively, it can be argued that *SALARY* is actually an endogenous variable and that the relative number of men entering librarianship is responsible for the observed wage gains. Studies of comparable worth indicate that the earnings and gender composition of an occupation may be simultaneously determined (Williams and Register, 1986). Limitations of the data used in this analysis prevent investigation of this hypothesis.

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