Canadian Studies in Population, Vol. 14 (1), 1987, pp. 89-109

EDUCATION, AGE AT MARRIAGE OR FIRST BIRTH AND LABOUR FORCE PARTICIPATION AS PREDICTORS OF PARITY TRANSITIONS: AN APPLICATION OF DISCRETE MULTIVARIATE ANALYSIS TO THE STUDY OF CONDITIONAL LIFE TABLE PROBABILITIES

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Résumé – Nous examinons les probabilités d'agrandissement pour les femmes blanches aux Etats-Unis en utilisant l'education, l'âge au mariage ou à la première naissance et la participation dans la main d'oeuvre comme variables indépendantes. Nous séparons les femmes qui avaient moins de 30 ans en 1970 de celles que en avaient plus. Les résultats supportent l'hypothèse que les facteurs principaux varient selon la parité. Aussi, il y aurait des facteurs différents pour les deux cohortes. La variable de participation à la main d'oeuvre change de signe, indiquant que le rapport de cette variable avec la fécondité est complexe.

Abstract – Parity transition probabilities are examined for United States white women using female education, age at marriage or first birth and labour force participation as the independent variables. Two subgroups are considered: women who were 30 or less in 1970 and women who were more than 30. The findings support the proposition that different determinants come into prominence at different parities. Also, the patterns found are not uniform for the two groups of women, suggesting that cohort effects are important to consider. Sign reversals on the labour force participation variable underscore the complexity of the relationship between female work status and fertility.

Key Words – **Education, age at marriage, labour force participation, parity specific fertility, role conflict**

Introduction

The relationship between female labour force participation and completed family size has been extensively studied (Kasarda *et al.*, 1986). Likewise, parity specific models of fertility determinants have received wide theoretical support (Bulatao, 1981, Fried *et al.*, 1980; Goldberg, 1960; Hout, 1978; Lee and Khan, 1978; Mishler and Westoff, 1955; Namboodiri, 1972a, 1972b, 1974, 1981, 1983; Rosenzweig and Seiver, 1975; Rosenzweig, 1976; Snyder, 1978). Nevertheless, parity specific differences in the relationship between employment and fertility have been addressed in only a few studies (Jones, 1981; Lee and Khan, 1978).

Much importance has been attached to labour force participation as a determinant of fertility behaviour (Bulatao and Lee, 1983). It is therefore surprising to find that little attention has been paid to factors that interact with this variable. Furthermore, prior research has shown the importance of age, period and birth cohort in accounting for observed differences in family size (Ryder, 1965, 1980). Yet, few studies have incorporated such effects in their analysis of parity transitions (Namboodiri, 1981; Rindfuss and St. John, 1983). Given our limited understanding of the factors that enter into the individual decisions regarding family size, it appears that an examination of interaction effects associated with labour force participation and the variations in such effects over time would enhance our understanding of who stops at a given parity and who goes on to have additional children.

The purpose of this research is to demonstrate the appropriateness of focusing on interaction effects. The analysis is exploratory in nature and limited to variables with well established empirical effects: female education, female age at marriage or first birth, and female labour force participation. Models representing discrete stages in the family building process are identified to determine whether subgroups of women are similar or different with respect to the probability of making the transition to a successive parity.

Background Research

Since the 1960s, the relationship between female labour force participation and fertility has been extensively studied (Cochrane, 1979; Kupinsky, 1977). The theoretical justification for expecting a relationship between these variables is not well established (Kupinsky, 1977; Oppong, 1983; Standing, 1983). However, in the sociological literature the role conflict hypothesis speci-

fies the expected outcome (Davidson, 1973; Hass, 1972; Oppong, 1983; Smith, 1981; Weller, 1968).

Briefly stated, the role conflict hypothesis is based on the assumption that motherhood and employment do not always mix. Norms regarding expected behaviour account for much of this conflict. Another aspect is the actual time constraints experienced by the working mother. These factors by themselves and in combination create conflicts. When the two roles are incompatible, the obligations of one or the other role are reduced in order to minimize the conflict (Kupinsky, 1977). Given the opportunities, the income and the independence obtained through employment it is expected that childbearing is a less attractive alternative. In other words, employment is expected to reduce family size.

Employment is often conditional upon education. Education fosters awareness in the female of alternative roles and gives her an opportunity to acquire marketable skills. Women with more education also remain in the labour force longer because they are more likely to find jobs with financial rewards and prestige (Elizaga, 1975; Marini, 1978; Youssef, 1974). Similarly, the more educated women marry later and become mothers later than less educated women because they have alternatives to the roles of wife and mother; they are also more efficient users of birth control (Birdsall, 1974; Bloom and Trussell, 1983; Mueller, 1972; Rindfuss and St. John, 1983).

The role conflict hypothesis was developed to account for the relationship between completed family size and work (Stycos and Weller, 1967; Weller, 1968). However, its formulation can be extended to include parity specific considerations about the interaction of education, age at marriage or first birth and labour force participation. The more time and opportunity to accumulate conflicting role experiences, the lower the probability of making the transition to a parity of higher order. Thus, the more education, the older the age at marriage, and the more labour force participation, the lower the transition probability.

Furthermore, perceptions of role conflict may differ for women who belong to different cohorts. Cohort effects reflect the cultural conditions facing a generation as it matures (Ryder, 1965; 1980). For example, over the past decades a number of social, political and economic changes have altered female employment patterns. Such changes influence not only the way labour force participation interacts with other socioeconomic and demographic variables but also result in intergroup variations in fertility behaviour. It has become more acceptable for mothers, especially mothers with young children, to work outside the home (Smith, 1981; Waite, 1981). National time-use studies suggest that working women are spending less time in housework than previ-

ously and are giving housekeeping tasks lower priority (Stafford, 1977; Vanek, 1980). Thus, it is the expectation that younger working women experience less role conflict than older working women. For the younger women, work is more compatible with fertility.

Data and Methods

Data

The data for this study were obtained from the 1970 U.S. National Fertility Study. A total number of 4,398 cases are used in the analysis, representing a selection of currently married white non-Catholic women in their first marriage.

Dependent Variable

The dependent variable in this analysis is the conditional probability of making the transition from parity n to parity $n+1$. In order to ensure homogeneity in the sample, a life table procedure was used to compute the probability of the occurrence of these transitions over a specified time period (Suchindran *et al.*, 1979). Given the child-spacing pattern observed in the data, the women in the sample were allowed a four-year period to make the transition from one parity to the next (see Appendix A). The sample contained only a few mothers making the transition to parity five before age 30. Thus, only the first four parity transitions were considered.

Independent Variables

Education. The selected sample includes only women without changes in education from the time of marriage to the time of interview. Education is trichotomized into three categories: less than high school, high school completed and college education.

Age at marriage. For the transitions from parity zero to parity one age at marriage is utilized as an independent variable. For subsequent transitions, age at first birth is considered the more relevant determinant (Ford, 1981; Millman and Hendershot, 1980). Age at marriage and age at first birth are dichotomized, with age 20 being found to be the most appropriate cutting point.

Labour force participation. Employment status prior to each event was constructed from the knowledge of employment data and the dates of birth of chil-

dren. This information is dichotomized using the categories: working prior to the event and not working prior to the event. It is the assumption that women do not withdraw from the labour force for a short period of time, i.e., that they are stable in their labour force participation in given intervals between childbearing.

Age. The interaction effects are examined for two population subgroups: women who were 30 or less in 1970 and women who were older than 30 in 1970. For the latter group of women, the prime reproductive years fell in the baby-boom period, after the recession in the 1930s and before the fertility decline in 1957. For the young women, the childbearing occurred between 1957 and 1970, a period with declining birth rates (Rindfuss and Sweet, 1977).

Methodology

The analysis focuses on the interaction effects of education, age at marriage or at first birth and labour force participation on parity transition probabilities. In order to facilitate the interpretation of the observed effects, a conditional design matrix approach is adopted (Evers and Namboodiri, 1979). The models to be tested include the effects of education, age at marriage or at first birth and labour force participation. The effect of age at marriage or at first birth is treated as conditional upon educational attainment. The labour force participation effect is analyzed as nested within categories of age at marriage and education.

The transition probabilities are investigated using the Grizzle, Starmer and Koch (1968) technique for multivariate analysis of dichotomous dependent variables. This method is based on linear regression models and weighted least squares. It involves fitting simplified models to multidimensional contingency tables.

The weighted least squares method of estimation starts by superimposing an experimental design on the data. The design matrix for the saturated model is specified to reflect the conditional effects of one variable within levels of another variable (Evers and Namboodiri, 1979). An illustration of the application of the conditional effects design matrix to the data employed in this analysis is presented in Appendix B.

Once the saturated model has been specified, the next step in the analysis is to specify a reduced form model that fits the data. The objective is to find a model which has as few parameters as possible but still accounts for most of the variation among the four-year transition probabilities. Several guidelines have been offered to aid the search for a reduced or unsaturated model

(Johnson and Koch, 1971; Koch *et al.*, 1972). Most research has been based on the following rules: (1) the goodness of fit test statistic for the excluded degrees of freedom should not exceed 3.84, i.e., the 5 per cent critical value of the chi-square distribution with one degree of freedom and (2) only significant parameters should be included in the model. In many applications these rules cannot be satisfied. In addition, strict adherence to these rules might result in overfitting the data. Separate analyses have shown that the risk of overfitting can be reduced if the first rule is modified, employing instead the 5 per cent critical value of the chi-square distribution with v-u degrees of freedom, where v and u stand for the number of rows and columns, respectively, of the design matrix. The second rule remains unchanged (Namboodiri and West, 1978). These suggested modifications have been adopted in this research.

Analytical Results

The probabilities of making the transition from parity n to parity $n+1$, as estimated by the four-year life table probabilities, are presented in Tables 1 and 2. For both young and older women, the highest probabilities of making the transition from parity zero to parity one appear for women who marry young and are not in the labour force, regardless of educational status. Nonworking women with less than high school education and age at marriage more than 20 is an exception to this pattern. This category of women has a transition probability higher than any other group (.9322). This finding may, however, result from the small sample size involved (n=30).

Among the younger women in the sample, the effect of labour force participation appears to change at the transition from parity one to parity two. Among women who marry young and have less than a college education, working women have a higher probability of making this and subsequent transitions than nonworking women (.7519 for less than high school and .7311 for high school). Among college-educated women, working appears to have the expected negative suppressing effect on the transition probabilities (.6667 versus .7101 and .4171 versus .4327). Overall, we observe a negative impact of education: the lower the education the higher the probability of making the transition to the next parity (Table 1).

Among the older women in the sample, the pattern observed for the first parity transition is repeated for all subsequent parity transitions: women who are 20 or less at the time of the first birth and not in the labour force prior to the event have a higher probability of making the transition than women who are more than 20 at the time of the first birth and in the labour force.

TABLE 1. TRANSITION PROBABILITIES BY PARITY, EDUCATION, AGE AT MARRIAGE OR FIRST BIRTH AND LABOUR FORCE PARTICIPATION FOR YOUNGER WOMEN

Education	Age at Marriage or First Birth	Labor Force Participation	Parity Transition 0-1 (N)	1-2 (N)	2-3 (N)	3-4 (N)
<HS	≤20	Working	.8153 (128)	.7519 (124)	.4956 (114)	.6245 (62)
<HS	≤20	Not-Working	.8254 (375)	.6996 (313)	.3957 (241)	.3735 (134)
<HS	>20	Working	.7014 (19)	.3363 (19)	.5929 (11)	1.000 (2)
<HS	>20	Not-Working	.9322 (30)	.4920 (77)	.2615 (47)	.4455 (18)
HS	≤20	Working	.6662 (191)	.7311 (74)	.3848 (71)	.5066 (23)
HS	≤20	Not-Working	.8039 (357)	.5663 (203)	.2820 (178)	.1779 (77)
HS	>20	Working	.4128 (120)	.3053 (86)	.3463 (50)	.6550 (17)
HS	>20	Not-Working	.6229 (231)	.4438 (412)	.2291 (268)	.2313 (82)
>HS	≤20	Working	.5689 (56)	.6667 (7)	.3519 (6)	.5000 (2)
>HS	≤20	Not-Working	.7398 (85)	.7101 (25)	.3810 (22)	.4042 (9)
>HS	>20	Working	.3774 (161)	.4171 (98)	.2245 (46)	.5826 (12)
>HS	>20	Not-Working	.4446 (291)	.4327 (280)	.2137 (160)	.2385 (56)

The educational effect appears to be curvilinear, with low probabilities in the high school categories and higher probabilities in the categories less than and more than high school (Table 2).

The significance of the patterns observed in these transition probabilities is examined by looking at the statistical estimates of the effect parameters. Summary tables have been prepared facilitating comparisons of the probabilities (Tables 3 and 4).

In Table 3, we find that among young women making the transition from parity zero to parity one, education is the most important determinant, but age at marriage and labour force participation are also important. The signs on all the parameters are in the directions observed in Table 1: low education, young age at marriage and not employed are associated with the highest tran-

TABLE 2. TRANSITION PROBABILITIES BY PARITY, EDUCATION, AGE AT MARRIAGE OR FIRST BIRTH AND LABOUR FORCE PARTICIPATION FOR OLDER WOMEN

Education	Age at Marriage or First Birth	Labor Force Participation	Parity Transition 0-1 (N)	1-2 (N)	2-3 (N)	3-4 (N)
<HS	≤20	Working	.7770 (251)	.5934 (150)	.7683 (170)	.4289 (135)
<HS	≤20	Not-Working	.8921 (315)	.6360 (240)	.7610 (204)	.4955 (227)
<HS	>20	Working	.7211 (73)	.4718 (69)	.6673 (101)	.3838 (52)
<HS	>20	Not-Working	.7083 (96)	.4837 (161)	.6685 (133)	.4236 (121)
HS	≤20	Working	.8068 (260)	.4794 (74)	.6821 (124)	.2227 (59)
HS	≤20	Not-Working	.9291 (254)	.5667 (161)	.7719 (101)	.4463 (138)
HS	>20	Working	.6799 (199)	.3964 (219)	.6936 (256)	.3197 (107)
HS	>20	Not-Working	.7476 (310)	.4393 (566)	.6899 (466)	.3195 (395)
>HS	≤20	Working	.7407 (54)	.6614 (9)	.9451 (14)	.4000 (9)
>HS	≤20	Not-Working	.8472 (72)	.7857 (14)	.6250 (18)	.4883 (13)
>HS	>20	Working	.5982 (189)	.4191 (126)	.7321 (163)	.3180 (73)
>HS	>20	Not-Working	.7408 (289)	.4726 (423)	.7676 (320)	.3054 (283)

sition probabilities. The goodness of fit statistics indicate that this model has an acceptable fit ($X^2=11.95$, $df=5$, $p=.7245$).

At the transition to parity two, age at first birth is the most important determinant, significant for all categories of education and in the expected direction. No effects are found for education by itself. Employment is important only among women with high school education who have a child at or before age 20. Working women have a higher probability of making the transition than nonworking women. A lower probability was expected. This model does not capture all the variations in the data ($X^2=7.24$, $df=7$, $p=.4039$).

A satisfactory model for the transition to parity three could not be obtained ($X^2=13.29$, $df=9$, $p=.0990$). In the model including only significant parameters, education is an important determinant. Also, the effect of labour

TABLE 3. ESTIMATES OF PARSIMONIOUS MODELS FITTED TO DATA FOR YOUNG WHITE NON-CATHOLIC WOMEN PRESENTED IN TABLE 1

Category [a]	Parameter Effects Parity Transition			
	0 to 1	1 to 2	2 to 3	3 to 4
Mean	.6623	.5562	.3000	.4499
Educ1	.1568	-	.1068	-
Educ2	-b	-	-	-
Age1	-	.1477	-	-
Age2	.0978	.1177	-	-
Age3	.1006	.1286	-	-
LFP1	-	-	-	.1037
LFP2	-	-	.1529	-
LFP3	-.0563	.0836	-	.2410
LFP4	-.0862	-	-	.2174
LFP5	-.1049	-	-	-
LFP6	-	-	-	.2030
X^2	11.95	7.24	13.29	4.99
df	5	7	9	7
p	.7245	.4039	.0990	.6607

b--indicates that the parameter was not significant and therefore not included in the parsimonious model

[a] The categorical predictors presented in the table are abbreviated as follows:

EDUC1 = linear effect of education (<hs vs>hs)
EDUC2 = linear effect of education (hs vs>hs)
AGE1 = linear effect of age at marriage or first birth within less than high school education
AGE2 = linear effect of age at marriage or first birth within high school education
AGE3 = linear effect of age at marriage or first birth within more than high school education
LFP1 = linear effect of employment within age 20 or less within less than high school education
LFP2 = linear effect of employment within more than age 20 within less than high school education
LFP3 = linear effect of employment within age 20 or less within high school education
LFP4 = linear effect of employment within age more than 20 within high school education
LFP5 = linear effect of employment within age 20 or less within more than high school education
LFP6 = linear effect of employment within more than age 20 within more than high school education

force participation is prominent among women with less than high school education who have a child at or before age 20. The sign on this parameter is positive, indicating that working women have a higher probability of making the transition than nonworking women.

Finally, at the last parity transition four labour force participation parameters are significant. These parameters account for almost all the variation in the data ($X^2=4.99$, $df=7$, $p=.6607$). Again, regardless of age at marriage and the level of education, nonworking women are found to have a lower probability of making the transition than working women.

Table 4 shows the estimated parsimonious models for the older women in the sample. Education is a weak, but significant determinant of the first

TABLE 4. ESTIMATES OF PARSIMINIOUS MODELS FITTED TO DATA FOR OLDER WHITE NON-CATHOLIC WOMEN PRESENTED IN TABLE 2

Category [a]	Parameter Effects Parity Transition			
	0 to 1	1 to 2	2 to 3	3 to 4
Mean	.7710	.7253	.5355	.3655
Educ1	-b	-	-	-
Educ2	-.0124	-	-.0230	-.0220
Age1	.0707	.0449	.0655	-
Age2	.0721	-	.0616	-
Age3	.0785	-	.1027	-
LFP1	-.0597	-	-	-.0566
LFP2	-	-	-	-
LFP3	-.0612	-.0465	-	-.1095
LFP4	-	-	-	-
LFP5	-	.1756	-	-
LFP6	-.0681	-	-	-
X^2	6.25	2.06	4.22	15.04
df	4	8	7	8
p	.1811	.9562	.7537	.1307

b--indicates that the parameter was not significant and therefore not included in the parsimonious model

[a] Refer to Table 3 for explanations of abbreviations

parity transition. High school-educated women have a lower probability of making the transition than college-educated women. Age at marriage is significant within all education categories and in the expected direction. Employment is a significant determinant among women with less than high school and high school education who marry young, and college-educated women who marry after age 20. As expected, in all instances, working women have a lower probability of making the transition than nonworking women. The fit of the model is poor, however ($X^2=6.25$, $df=4$, $p=.1811$).

At the transition to parity two, one parameter accounts for almost all the variation in the data – the employment status of college-educated women who have a child at or before age 20. Working women in this category have a higher probability of making the transition than nonworking women. Among high school-educated women who have a child at a young age, employment has a small but significant effect. The effect is in the expected direction, i.e., no sign change is observed. Age at first birth is significant though small within the less than high school-educated category. With a chi-square value of 2.08 and eight degrees of freedom, the fit of this model is excellent ($p=.9562$).

For the transition to parity three, a reasonable fit was obtained once again ($X^2=4.22$, $df=7$, $p=.7537$). Age at first birth is the most important determinant of the transition probabilities. The effect is present for all education categories. Education has a small but significant effect, with high school-educated women having a lower probability of making the transition than college-educated women.

This small education effect is present again at the transition to parity four. However, it is labour force participation among less than high school- and high school-educated women who have a child at a young age that accounts for most of the observed variation. As it was observed for the first parity transition, working women have a lower probability of making the transition than nonworking women. The fit of this model is not good ($X^2=15.04$, $df=8$, $p=.1307$).

Discussion and Conclusion

In this study, we have focused on four determinants of fertility: education, age at marriage or first birth, and labour force participation. Education was examined as a main effect. Age at marriage and age at first birth were examined as conditional upon education, and labour force participation was examined finally within categories of age at marriage or first birth and education.

Parsimonious models, representing these determinants, were fitted to life table estimates of the probability of making the transition from parity n to parity $n+1$.

The findings associated with education are discussed first. For the younger women in the sample who represent childbearing experiences in the post baby-boom years between 1957 and 1970, education is one of the factors determining the probability of starting a family. Less than high school education results in a higher probability than college education. Though this finding is inconsistent with Rosenzweig and Seiver (1975), who reported a positive education effect at parities lower than two, it is consistent with the role conflict hypothesis.

Education is not a significant parameter at the transition to parity two. However, education makes a difference in determining who goes beyond a family size of two. Again, less education implies a higher parity transition probability. This finding was also reported by Rosenzweig and Seiver (1975). Several researchers have suggested that in our culture, the normatively prescribed family size is two children (Hout, 1978; McLaughlin, 1982; Namboodiri, 1974). This would account for the absence of any significant educational effects at the transition from parity one to parity two. In other words, the role conflict is felt most keenly at the first (zero to one) and the third (two to three) parity transitions because these are turning points in the family building process. Education influences who stops at the normatively prescribed family size.

For the older women in the sample, education has a small but significant impact when comparing women with high school education and women with college education. High-school educated women have lower parity transition probabilities than college-educated women. This is not consistent with the role conflict hypothesis but supports the finding that the education-fertility relationship is curvilinear (Cochrane, 1979; Mason *et al.*, 1971).

Age at marriage and age at first birth were examined within different levels of education. The age at marriage effect is present for both subgroups of women and all education categories, with the exception of young women with less than high school education. The effect suggests that women who marry young have a higher probability of starting a family at a young age, i.e., within four years after marriage than women who are older at time of marriage. This finding supports the role conflict hypothesis. The younger a woman when she marries, the less chance she has to become acquainted with nonfamilial adult roles and to have started on a career path. Consequently, with no other roles to compete with the role of motherhood, a woman who marries at a young age will be more likely to produce a larger family (Bumpass, 1969; Bumpass and Mburugu, 1977; Presser, 1971).

For the young women, age at first birth is an important determinant at the transition from parity one to parity two. For the older women, age at first birth is important at the transition from parity two to parity three. In both instances, the younger a woman is at first birth the higher the transition probability. Changing ideal family size may account for some of this difference. The older women in the sample represent a time period when a family size of three was not uncommon. On the other hand, the younger women in the sample represent a period of declining fertility where two children were considered ideal. In other words, age at first birth makes a difference in who goes on to have another child only within the normatively acceptable family size. In order to test this hypothesis, the parity specific impact of age at first birth needs to be examined for different cohorts of women.

Finally, the interaction of these variables with the labour force participation effects was examined. In this analysis, these effects are significant at several parity transitions. Furthermore, the nature of the effect changes at the transitions to parities higher than one. It was the expectation that labour force participation would be associated with a suppressing effect on fertility, though less so for the younger than the older women in the sample. However, for the young women in our sample, work outside the home implies a higher probability of making the transition to parities higher than one. For older women, this effect appears for college-educated women who marry young. This pattern suggests that the role conflict hypothesis does not adequately account for the relationship between labour force participation and fertility.

We speculate that norms concerning work and childrearing have changed. Employment outside the home is no longer acting as a strong deterrent to a large family size. Furthermore, the cost of raising a child may have become a factor of increasing importance (Espenshade, 1978). The labour force participation effect is particularly dominant in accounting for the variation observed at the transition to parity four. Given that all the women in our sample are currently married, we speculate that the working mother with three children might be in a better position financially to make the transition to parity four than the nonworking mother with the same family size. Further research on the effect of labour force participation on parity transitions should examine this issue.

In conclusion, the findings of this study reiterate that factors affecting family size vary from one parity to the next. The combined effects of education, age at marriage or first birth and labour force participation take on different importance at different parities, and also the effects are not always in the expected directions. Furthermore, the findings indicate different outcomes for

subgroups in the population, suggesting that the impact of the interaction effects is not uniform over time.

Acknowledgments

This research was done while the author was affiliated with the University of Maryland Baltimore County. Computer time for this project was supported through the facilities of their Computer Science Centre.

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Received October 1985; revised April 1986.

APPENDIX A

The focus of the analysis is on the conditional probabilities of making the transition from parity n to parity $n+1$. In order to ensure homogeneity, the women in the sample were given a four-year exposure period, i.e., they were exposed to the risk of making the transition from one parity to the next for four years. In reality, however, not all women were given this opportunity. Due to the nature of the data, a cross-sectional sample survey of women of childbearing ages, we only had information until the date of interview. In other words, in some cases, the exposure period was truncated by the interview date. Since the transition probabilities of these cases remain unknown after the date of interview, the effective number of women exposed to the risk of making the transition in the specified time period cannot be computed with accuracy. If such women are excluded from the analysis, an underestimate of the transition probabilities might result. This problem can be overcome by applying the life table procedures to compute the probabilities of the occurrence of the transition over a four-year period.

The life table procedure combines complete and incomplete histories in one analysis. In our analysis, three histories or outcomes are combined: cases experiencing a specific event, i.e., making the transition from parity n to parity $n+1$; cases that are censored because of the survey cutoff date; and cases that complete the four year interval without experiencing the specified event, i.e., without making the transition to parity $n+1$.

An illustration of the data arranged in the life table format is presented below:

Illustration of the calculation of parity transition probabilities

1	2	3	4	5	6	7	8
x	N_x^i	D_x^i	W_x^i	q_x^i	p_x^i	P_x^i	s.e.
0-1	128	62	5	.4940	.5060	1.0000	.0000
1-2	61	27	1	.4463	.5537	.5060	.0446
2-3	33	10	1	.3077	.6923	.2802	.0407
3-4	22	1	2	.0476	.9524	.1940	.0362
4-	19	7	12	.5285	.4615	.1847	.0356

To facilitate a formal description of the relationships between the figures presented in the life table, the following notations are introduced:

N_x^i = number of women at parity i at the completion of x years after marriage (e.g., $N_1^o = 128$)

D_x^i = number of women who move from parity i to parity $i+1$ during the xth year after marriage (e.g., $D_1^o = 62$)

W_x^i = number of women who are reported to be at parity i and have been married for only x years as of the survey date (i.e., $W_1^o = 5$)

It can be seen that the following relationship prevails betwen the figures in Columns 2, 3 and 4 of the table presented above:

$$N_x^o = N_{x-1}^o - D_{x-1}^o - W_{x-1}^o \tag{1}$$

Thus, for $x=2$, $61=128-62-5$, i.e., 61 women were at parity i at the beginning of the year.

The conditional probability of moving from parity zero to parity one (i.e., of having the first birth), in the xth year after marriage is calculated based on the number of women at risk. This is estimated by:

$$q_x^o = D_x^o / (N_x^o - 1/2\ W_x^o) \tag{2}$$

and in general

$$q_x^i = D_x^i / (N_x^i - 1/2\ W_x^i) \tag{3}$$

Implicit in this calculation is the assumption that withdrawn observations occur randomly from a uniform distribution in the interval. Therefore, women who withdraw are considered to be at risk for half of the interval. Similarly, it is assumed that the women who make the transition during a given year are exposed one half year, on the average, to the risk of having an ith birth.

The conditional probability of not moving from parity i to parity $i+1$ can be calculated as:

$$p_x^i = (1 - q_x^i) \tag{4}$$

Once the conditional probability of not moving from parity i to parity $i+1$ has been obtained, the cumulative "survival" function, P_x^i, can be calculated. P_x^i is shown in Column 7. This is the estimate of the cumulated proportion not making the transition before the beginning of the ith interval defined as

$$P_x^i = (p_{x-1}^i)\ (P_{x-1}^i) \tag{5}$$

where $P_1^o = 1.000$

The estimate, P_x^i, is based on the observation that survival to the ith interval requires that one survives to the $(i-1)$st, where survival indicates that no parity transition occurs. This is the usual life table estimate. Correspondingly, the cumulative proportion making the transition, Q_x^i, can be defined as

$$Q_x^i = (1 - P_x^i) \tag{6}$$

In our illustration, the four-year transition rate is thus equivalent to $1.000 = .1847 = .8153$.

The standard error of this function is defined as

$$s.e.\ (p_x^i) \simeq p_x^i \left\{ \sum_{j=1}^{i=1} q_j / (N_j^i - 1/2W_j^i)P_j \right\}^{1/2} \tag{7}$$

For a detailed discussion of survival distributions based on the actuarial life table, reference can be made to Cutler and Ederer (1958).

APPENDIX B

Design Matrix for the Data

1	2	3	4	5	6	7	8	9	10	11	12
	EDUC1	EDUC2	AGE1	AGE2	AGE3	LFP1	LFP2	LFP2	LFP4	LFP5	LFP6
1	1	0	1	0	0	1	0	0	0	0	0
1	1	0	1	0	0	-1	0	0	0	0	0
1	1	0	-1	0	0	0	1	0	0	0	0
1	1	0	-1	0	0	0	-1	0	0	0	0
1	0	1	0	1	0	0	0	1	0	0	0
1	0	1	0	1	0	0	0	-1	0	0	0
1	0	1	0	-1	0	0	0	0	1	0	0
1	0	1	0	-1	0	0	0	0	-1	0	0
1	-1	-1	0	0	1	0	0	0	0	1	0
1	-1	-1	0	0	1	0	0	0	0	-1	0
1	-1	-1	0	0	-1	0	0	0	0	0	1
1	-1	-1	0	0	-1	0	0	0	0	0	-1

The overall mean effect of the three parameters is specified in Column 1. Columns 2 and 3 specify the main effect for education. In Column 2, less than high school education is contrasted with more than high school education. Similarly, in Column 3, high school education is contrasted with more than high school education. Columns 4, 5 and 6 specify the age at marriage or age at first birth effect. Age at marriage or first birth have no main effects. Similarly, no interaction terms are specified. Instead, age at marriage or first birth is represented by three effects, each conditional upon a category of education: age at marriage within less than high school, age at marriage within high school, and age at marriage within more than high school. The same interpretation pertains to the age at first birth effects. Six effects are specified for labour force participation status (Columns 6-12). Each effect shows the effect of labour force participation status conditional on age at marriage or first birth and education. For example, in Columns 7 and 8, we have labour force participation within age twenty or less at marriage within less than high school, and labour force participation within age more than twenty at marriage within less than high school.