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DETERMINING THE IMPACT OF SEX PREFERENCES ON FERTILITY: A CONSIDERATION OF PARITY PROGRESSION RATIO, DOMINANCE, AND STOPPING RULE MEASURES

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Abstract—The two methods commonly used to assess the effect of sex preferences on fertility are inadequate to the task. Parity progression ratio analyses suffer from logical problems stemming from the heterogeneity of sex preferences and the riskiness of fertility decisions. While conjoint measurement-dominance procedures overcome these logical problems, they cannot yield quantitative estimates of the impact of sex preferences on fertility. A stopping rule measure which overcomes these limitations is proposed and described and its potential for determining the effect of sex predetermination methods on population is discussed.

That couples may prefer children of one sex to those of the other, or equal numbers of both sexes, is well established. (See Williamson, 1976, for a review of the sex-preference literature.) The existence of sex preferences leads naturally to the question of to what degree such preferences affect fertility, a question central to understanding both the fertility decision-making process and the potential effects of use of sex predetermination methods. Viable methods of sex predetermination seem ever more likely, and Markle and Nam (1971), Rosenzweig and Adelman (1976), and Westoff and Rindfuss (1974) have found that substantial numbers of the respondents (26 percent, 60 percent, and 38.8 percent, respectively) in their samples would use such methods if they were available. Thus, an assessment of the actual impact on fertility to be expected from sex predetermination is of interest. This paper reviews two methods commonly used to assess the effects of sex preferences on fertility, parity progression ratio analyses and conjoint measurement-dominance methods, and points out major shortcomings of each. A new method based on direct measurement of individuals' intended stopping rules is proposed.

PARITY PROGRESSION RATIO ANALYSES

Most studies attempting to assess empirically the impact of sex preferences on fertility have examined parity progression ratios or transition probabilities as a function of the existing sex composition of the family. The basic argument is that if sex preferences influence fertility decisions, then at any parity those couples with undesirable sex compositions should be more likely to have another child than those who already have desirable sex compositions. Whether used to predict the effects of sex control techniques on fertility (Ben-Porath and Welch, 1976; Cutright, Belt, and Scanzoni, 1974; Dawes, 1970; Pohlman, 1967) or to derive general sex preference-fertility relationships (Williamson, 1976), parity progression ratio analyses have yielded markedly inconsistent results. Although the effects of cultural, demographic, and time differences can be invoked to explain the inconsistencies (Williamson, 1976), another response is to question the validity of the method. One purpose of this paper is to argue that parity progression ratio methods are inherently incapable of adequately measuring the influence of sex preferences on fertility decisions. There are two logical problems in using the parity progression ratio method to assess the sex preference-fertility behavior relationship. These problems, which hinge on the heterogeneity of sex preferences and the riskiness of the fertility decision, lead to gross underestimates of the impact of sex preferences on fertility. Each is considered below.

Heterogeneity of Sex Preferences

Parity progression studies are inherently restricted to the use of aggregate data. That is, a pattern can be detected only after the intended or actual fertility decisions of many couples are accumulated and classified. With this limitation, a relationship between sex preferences and fertility can be detected only if a great majority of the population has the *same* sex preference. Individual differences in sex preferences will cancel to produce no differential in progression rates as a function of sex composition *even if* fertility decisions are heavily influenced by sex preferences. There is ample evidence of such individual differences in countries as diverse as Thailand and the United States (L. Coombs, 1976; C. Coombs, L. Coombs, and McClelland, 1975; Prachuabmoh, Knodel, and Alers, 1974).

It is instructive to consider the logic of the aggregate studies in a hypothetical case. In this example, the sex-preference percentages from a Thai study (Prachuabmoh et al., 1974) are combined with the extreme assumption that sex preference *perfectly determines* fertility decisions at parity two and after. In other words, assume those who want more boys than girls stop if they have two boys and continue otherwise, those who want equal numbers stop only if they have one boy and one girl, and those who want more girls than boys stop only if they have two girls. Assuming equal probabilities of male and female births for simplicity, a hypothetical sample of 400 couples is cross-tabulated according to original desire and actual composition; the results are shown in Table 1.

The starred cells represent the portion of the sample that would be "satisfied": their desires would match their outcomes at parity two. The last row of the table gives the percentage of "dissatisfied" couples—those who would move to higher parities under the assumption of a perfect relationship between sex preferences and fertility behavior. If these percentages had been obtained in a parity progression study, it would have been concluded that this population had a slight boy bias because a higher percentage of the girl-girl and boy-girl families progress to higher parities than do boy-boy families. However, the differences in parity progression ratios are not significant ($\chi^2 = 3.1$, df $= 2$) and so the relationship between sex preferences and fertility would be considered weak at best. Because the hypothetical data were constructed under the assumption of a *perfect* relationship, not a "weak" one, Table 1 provides a counterexample to the logic of all parity progression by sex composition studies in populations with heterogeneous sex preferences. The absence of an aggregate effect does not therefore imply the absence of pervasive, diverse individual effects. Although parity progression ratio analyses can and do obtain aggregate effects, they invariably underestimate the impact of sex preferences on individual fertility decisions.

Riskiness of the Fertility Decision

A second logical objection to the parity progression studies is that they assume that sex preferences can only influence fertility by causing *additional* births. The basic assumption is that if a couple has a family with a sex composition which is undesirable for them, then they should be motivated to have another child to attempt to improve the sex composition. Prachuabmoh et al. (1974, p. 606) give a

Table 1.—Hypothetical Progression Ratios at Parity Two Assuming Complete Determination of Fertility by Sex Preferences

		Actual Family Composition		
		BB	GG	BG
Desired	BB	39*	39	78
family	GG	32	32*	64
composition	BG	29	29	58*
Total number		100	100	200
Number satisfied and stopping at parity two		39	32	58
Number dissatisfied and progressing to parity three		61	68	142
Parity progression probabilities		.61	.68	.71

Marginal preference distribution based on data from Prachuabmoh, Knodel and Alers, 1974.

*Desired composition achieved.

particularly clear statement of this assumption:

> If son preference affects the desire for additional children then for any given number of living children, women who have no sons should be more likely to want an additional child than women with at least one son and these women in turn should be more likely to want an additional child than women who already have more than one male child.

However, this assumption ignores the possibility that sex preferences might cause people to decide *not* to have additional children even though they have an undesirable sex composition. This possibility is reviewed in the remainder of this section.

An example can be easily constructed in which a couple has a strong preference for one sex and a relatively small family composed entirely of the other sex and yet still is rational in deciding not to have any more children. For example, consider a couple most preferring to have two boys and one girl but currently with no boys and two girls. In deciding whether to have another child, they must decide whether the 50 percent chance of obtaining a more desirable outcome (one boy and two girls) than the status quo outweighs the 50 percent chance of obtaining an even less desirable family composition (three girls and no boys). The perceived psychological disadvantages and/or the monetary costs of having a third girl might outweigh the perceived benefits of finally having a boy. If so, then this couple would decide to stop at their present parity because of their sex preferences, or, rather, because of their fear of obtaining a less desirable sex composition. Note that if they decide to stop, this couple will have stopped at a parity (two) lower than their most preferred parity (three). This example demonstrates that couples can behave consistently with both their sex and family size preferences by *not* having additional children even when their current sex composition and family size are not most preferred.

The example above, analyses by Ben-Porath and Welch (1976) and Goodman (1961), and data from Flanagan (1942) and McClelland and Hackenberg (1978) all demonstrate that a basic presumption of the parity progression studies—that those couples with less desirable family sex compositions will be more likely to move to higher parities—is untenable. Thus, without additional information the meaning of the decision of a couple to have or not have another child is ambiguous. A couple may decide not to have additional children because (a) sex preferences are unimportant relative to total number, and ideal family size has been reached; (b) both sex composition and number are important, and ideals of each have been achieved; (c) having an additional child could result in a more or a less desirable family composition than the current one, and the risk of having the undesirable alternative is not judged worth taking; (d) having an additional child can only result in a less desirable family composition, even though the current one is not ideal. Only in the first instance (a) is the fertility decision uninfluenced by sex preferences. It is the third instance (c) which has been generally ignored in previous studies and which invalidates the parity progression methodology for measuring sex preferences at either the individual or aggregate level. The meaning of the decision to have more children is similarly ambiguous with respect to sex preferences. Therefore, it is logically impossible either to measure the existence of sex preferences or to infer their effect on fertility by observing either actual or intended parity progression ratios as a function of sex composition.

In summary, parity progression ratio measures of sex preference have two basic problems. Heterogeneity of sex preferences and the potential riskiness of the decision to have another child both cause parity progression studies inherently to underestimate the importance and prevalence of sex preferences in fertility decision making at the level of the individual couple.

CONJOINT MEASUREMENT AND DOMINANCE PROCEDURES

The analyses above place some obvious constraints on the types of measures that can be employed in lieu of parity progression ratios to measure sex preferences. The existence of heterogeneous sex preferences requires that any measure of those preferences be based on individual rather than aggregate data. The ambiguity (with respect to sex preferences) of the meaning of the decision not to have additional children means that the measures cannot be based on the actual fertility behavior alone. Thus, the measures must be primarily attitudinal; at most, measures of intended behavior may be used. A measurement procedure that meets these constraints and which is already in limited use is considered below—the conjoint measurement procedure and associated dominance measure proposed by Coombs et al. (1975).

The conjoint measurement procedure uses individual data and principles from unfolding theory (C. Coombs, 1964) and conjoint measurement (Krantz et al., 1971) to obtain measures of family size preference as well as family composition preferences. Each measure can be shown to be independent of the other in the sense that the index for each variable (family size or sex preferences) will be invariant over the levels of the other variable. One can obtain an index of preference for sex of children without having to specify the number of children preferred. For this method of measuring sex preferences the respondent rank orders or makes pair comparisons among a number of alternative family compositions (e.g., "Would you rather have 3 boys and 1 girl or 1 boy and 3 girls in your completed family?"). Based on the rankings each respondent is assigned to one of seven categories for each measure (see Coombs et al., 1975, for the tables necessary to make the assignment). This measurement procedure has been used successfully in a variety of cultures (see L. Coombs, 1976).

The index of sex preference from Coombs et al. (1975) does not have the problems associated with the parity progression ratio method and does have a strong measure-theoretic justification. However, it is still not particularly useful for answering the question which is the focus of this paper—do sex preferences affect fertility decisions? The sex preference index indicates a preference for a given ratio of children of one sex in the family, *not* the likelihood of the sex preference's determining fertility. As Coombs et al. (1975, p. 291) note, "The question of whether size or sex preference plays the greater role (in determining fertility decisions) is an exceedingly difficult question to answer on satisfactory theoretical grounds, yet practically it is a very important one." They suggest using the rank order matrix of alternative family compositions to calculate the relative "dominance" of size and sex bias (see also L. Coombs, 1976; L. Coombs and Sun, 1978).

Dominance is measured by noting what changes when the respondent moves from his or her first choice to second and from second to third. Three things can happen: the individual may (a) stay at the same size at the expense of settling for a less desirable sex composition; (b) preserve the sex composition at the expense of moving to a different (less desirable) family size; or (c) change both. Unless size dominates sex as in (a), sex preferences are likely to affect fertility decisions. The dominance measure of the influence of sex preferences on fertility does not suffer from the logical problems of the parity progression ratio method. However, it yields only a categorization of a population: it cannot be used to assess quantitatively the net effect of sex preferences on fertility or the potential effect of sex predetermination methods on fertility. A new method for measuring sex preferences which attempts to circumvent the limitations of the dominance measure is described in the following section.

A STOPPING RULE MEASURE

The proposed method is based on measuring an individual's (or couple's) preference order and intended fertility stopping rule—the family compositions at which no additional children would be desired. The method is free from the logical problems facing parity progression ratios as measures of the effect of sex preferences on fertility. Heterogeneity of sex preferences is not a problem because individual analyses are performed before aggregation, and the riskiness of the fertility decision is recognized and incorporated directly into the assessment. Furthermore, the stopping rule measure can, unlike the conjoint measurement-dominance procedure, both categorize the population and provide a quantitative estimate of the effect of sex preferences on fertility for each individual. It can, therefore, be used to derive an upper bound for the potential effect of sex predetermination methods on population fertility. Procedures for data collection, consistency checks, and complete analysis are described below.

Data Collection

For each of sixteen hypothetical family compositions, two items of information are collected: preference order and intention to stop. Methods for obtaining the preference order are described in Coombs et al. (1975). In brief, respondents are asked to order, by preference for completed family, sixteen cards displaying compositions with all possible combinations of 0–3 boys and 0–3 girls. A given composition is denoted B, G. For each composition, the respondent is then asked, "If you had B boys and G girls would you stop having children?" The preference ordering and stopping rule questions generate all necessary data. Data for three hypothetical respondents A, B, and C are shown in Table 2.

A standard method for discussion and display of the data is shown in Figure 1 for data from the three hypothetical respondents. Results of analyses are shown in Table 3. The preference order is used to construct a "tree" of family compositions. Composition 0,0 (0 boys, B; 0 girls, G) is at the top; having a girl moves a couple down and right; a boy, down and left. Note that all compositions except one-sex compositions can be reached by more than one path; for example, the family 1,2 can be reached by the paths B-G-G, G-B-G, or G-G-B. The preference order is superimposed on the tree so that the most preferred composition is labelled 1; least preferred, 16. Also marked on the tree are the minimal stopping points: that set of stopping points which can be reached by paths not passing through other stopping points. A stopping point is risky if (B+1, G) or (B, G+1), but not both, is preferred to (B, G); in other words, one outcome of having another child is more desirable than the status quo while the other outcome is less desirable. On the diagrams, risky decisions have one and only one ar-

Table 2.—Preference Orders and Stopping Rules for Hypothetical Respondents A, B, and C

Composition Boys, Girls	Preference order[a] A	Preference order[a] B,C	Stop here? A,B	Stop here? C
0,0	13	13	no	no
0,1	9	9	no	no
0,2	3	5	yes	no
0,3	7	7	yes	yes
1,0	8	8	no	no
1,1	1	1	yes	yes
1,2	5	3	yes	yes
1,3	12	12	yes	yes
2,0	2	4	yes	no
2,1	4	2	yes	yes
2,2	10	10	yes	yes
2,3	15	15	yes	yes
3,0	6	6	yes	yes
3,1	11	11	yes	yes
3,2	14	14	yes	yes
3,3	16	16	yes	yes

[a] 1 = most preferred, 16 = least preferred.

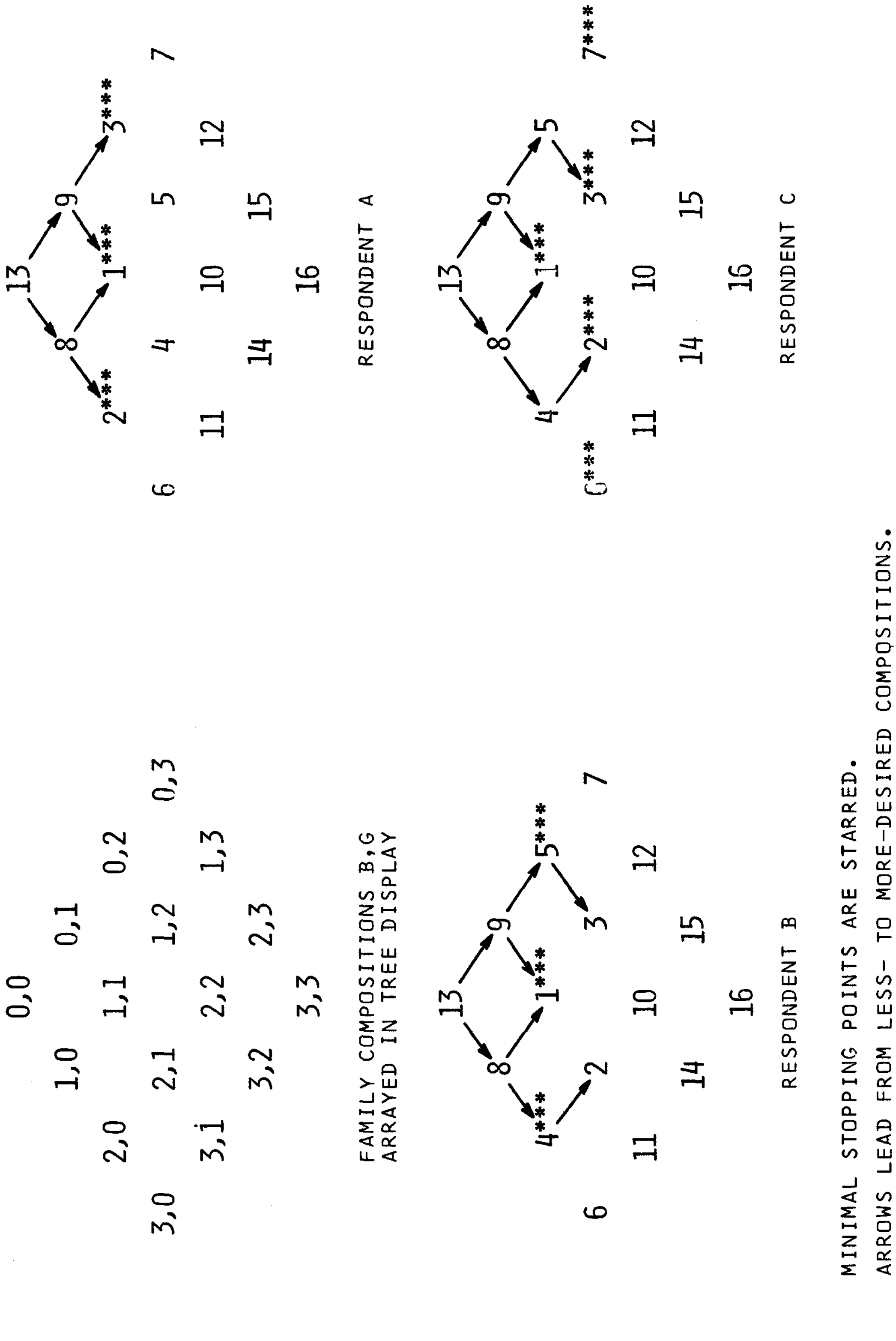

Figure 1.—Tree Displays of Preference Orders for Hypothetical Respondents A, B, and C

Table 3.—Data Analysis Results for Hypothetical Respondents A, B, and C

Measure	Respondent A	Respondent B	Respondent C
Most preferred composition	1,1	1,1	1,1
Minimal stopping points	2,0; 1,1; 0,2	2,0; 1,1; 0,2	3,0; 2,1; 1,1; 1,2; 0,3
Verbal stopping rule	Stop at 2	Stop at 2	Stop at 2 if 1,1; otherwise go to 3
Risky decision points	none	2,0; 0,2	2,0; 0,2
risk taken?	----	no	yes
Stopping rule classification	Fixed parity-no risk	Fixed parity with risk	Variable parity
IS (sex preference index)	5	5	5
interpretation	slight boy preference	slight boy preference	slight boy preference
IN (size preference index)	3	3	3
interpretation	small size bias	small size bias	small size bias
Expected family size	2	2	2.5
Difference between expected and most preferred number	0	0	.5

row leading from them. Such risky decisions can occur only in the presence of sex preferences.

Consistency Checks

An advantage of both the stopping rule procedure proposed here and the methods of Coombs et al. (1975) is that data for individual respondents can be checked for internal consistency. Data for a respondent are judged consistent if and only if:

(1) the preference ordering satisfies the conjoint measurement axioms of additivity and independence; see Coombs et al. (1975) for details;

(2) no compositions for which both (B+1, G) and (B, G+1) are preferred to (B,G) are stopping points;

(3) all compositions for which (B,G) is preferred to (B+1, G) and (B, G+1) are stopping points.

The decision of how much inconsistency to allow before a respondent is removed from further analyses is up to individual researchers; see Coombs et al. (1975) for further discussion.

Classification

Each respondent can be placed into one of three classifications:

(1) *fixed parity, no risk.* Hypothetical respondent A is an example. All the minimal stopping points are at the same family size, or parity, and none are risky decision points. Such a respondent could have a definite sex preference—respondent A consistently prefers balanced compositions, then boys to girls—but the preference does not affect intended fertility behavior.

(2) *fixed parity, with risk.* Respondent B is an example. All the minimal stopping points are at the same family size, in this case two children, but some are risky. The risk is due entirely to sex preference, which in this case does have an effect on fertility. For example, if respondent B's first two children were girls (fifth choice), having another child would increase the relative desirability of the family size and composition only if it were a boy (third choice) but would decrease desirability if it were a girl (seventh). Couples faced with such a risky decision might reasonably decide to avoid the risk by stopping at two, regardless of their sex composition. If so, then they would have a fixed-parity stopping rule because of, not in spite of, their sex preferences and associated fear of an undesirable sex composition. If the sex of the next child could be determined, they would surely go on to three if they had two children of the same sex. It is their fear of having another child of the same sex that would cause them to stop at two: a definite effect of sex preference on fertility.

(3) *Variable parity.* For respondent C, the minimal stopping points are not all at the same family size. Instead, the rule might be described as "Stop at two if have a boy and girl; otherwise go to three." Variable parity stopping rules clearly demonstrate the effect of sex preferences on fertility.

Note that classification does not depend upon preference ordering alone nor on the stopping rule alone. The preference orderings for hypothetical respondents B and C are identical and only slightly different from A's. The stopping rules for A and B are identical. When preference orderings and stopping rules are combined, however, all three fashions in which sex preferences might affect fertility are demonstrated.

IS, IN

The three-way classification described above differentiates respondents according to if and how their sex preferences affect fertility intentions. It does not indicate the nature of the sex preference: are boys preferred, or girls, or a balance of each? The IS or sex preference index developed by Coombs et al. (1975) can be derived from the preference order for this purpose. IN, the size preference index, can also be derived. The three preference orderings shown in Table 1 and Figure 1 are all classified as IN = 3 (preference for small family size) and IS = 5 (slight boy preference).

Expected Family Size

For respondents with fixed-parity stopping rules, expected family size is simply the number of children in the stopping point compositions. For respondents with variable parity rules, expected family size must be calculated using the probabilities for arriving at each stopping point. Consider, for example, respondent C's rule: "Stop at two if have one of each sex; otherwise go to three." The probability of having a boy and a girl in the first two births is one-half; thus, expected family size for C is $(1/2 \times 2) + (1/2 \times 3) = 2.5$. This is the expected average family size for a population of C's who all follow their stated intentions exactly (barring infertility, twins, etc.).

The expected family size for any variable parity stopping rule is calculated as

$$\sum (B + G)\, k_{B,G}\, p^B q^G$$

where

$\sum$ = summation over all compositions B,G in the minimal stopping points

p = probability of a male on any birth

q = probability of a female on any birth

$k_{B,G}$ = number of paths to B,G not passing through another stopping point.

Although this rule may appear complex, for most common preference order-stopping rule combinations, and given that p and q are approximated by one-half, the calculations are quite simple.

Quantitative Estimate

A quantitative estimate for the effect of sex preference on intended fertility is given by the difference between expected family size (as calculated above) and the number of children in the most preferred family composition. For respondents with fixed parity-no risk stopping rules, this difference is always zero. For those whose stopping rules are of the fixed parity with risk type, the difference is usually zero but can be negative if an individual stopped short of the most preferred composition because of fear of reaching an undesirable composition. For respondents with variable parity stopping rules, the difference can be positive (sex preference enhances fertility), negative (sex preference depresses fertility) or zero.

The differences between expected and most preferred family size for individual respondents can be aggregated over the population to indicate the net effect of sex preference on fertility. This value provides an upper bound for the effect of sex predetermination methods on aggregate fertility. If less than 100 percent of the population were to use the methods, and/or if they were not 100 percent reliable, the net effect would be lower.

Shortcuts

The only data actually used to classify respondents and compute expected family size are the minimal stopping points B,G and a preference ordering of the triple (B,G; B+1,G; B,G+1) for each. These could be elicited most efficiently by beginning with the respondent's most preferred composition and working out in the "tree" from there. Without computer-assisted stimuli presentation, however, such a procedure might place undue demands on the interviewer. Demands on the respondent would be more significantly reduced the less sex preference influenced fertility. The multitude of ways in which sex preferences may vary, and of the ways in which they can affect fertility decisions, preclude further abridgement of the data collection process. Certainly neither preference order alone (as in Coombs et al., 1975) nor stopping points alone (as in Schulz and Schulz, 1972) will suffice.

DISCUSSION

The stopping rule measure described above provides a logically consistent method for assessing the impact of sex preferences on individual fertility decisions. On theoretical grounds it is superior to both standard parity progression ratio analysis and the Coombs conjoint measurement-dominance index for measuring the effect of sex preferences. There is a price to be paid for this superiority, however: increased complexity both in the questions asked each respondent and in the analysis. Among the three available measures of the effect of sex preferences on fertility, there is a trade-off between practicality and logical consistency—no measure dominates the others on both dimensions.

Two points should be made concerning the procedural complexity of the stopping rule measure. First, there are undoubtedly many respondent characteristics in the class of attitudes, preferences, intentions, and beliefs for which simple but precise assessment procedures simply do not exist. Sex preference is therefore only an exemplar from a large class of influences on fertility for which relatively complex assessment procedures are required in order to provide a logically consistent, unambiguous index. The relatively poor track record of preference and attitudinal information in demographic studies to date might thus be attributed not to unimportance of such information, but rather to the use of simple, logically inconsistent measurement procedures.

Second, the stopping rule measure is not really very complex. While many data points are required from each respondent, the questions posed are simple, meaningful, and quick and easy to answer. The data reported in Coombs (1976) amply demonstrate that people in a variety of cultures can provide consistent answers to questions similar to those required for this measure. In fact, the stopping rule procedure requires only a few more questions than the complete matrix form of the family size-sex preference measure developed by Coombs et al. (1975). It is unfortunate, however, that a short form of the stopping rule procedure equivalent to the "diagonal" form of the Coombs measure does not seem possible.

As for the analysis, while it is somewhat awkward to implement computer algorithms to perform the tests outlined above, the tests themselves are conceptually quite simple and well defined. The consistency checks—an important advantage of the method—the classifications, and the computation of expected family size all have simple, intuitive, and precise interpretations. Analytical complexity is thus an insufficient reason for rejecting the proposed stopping rule measure.

When might use of the stopping rule measure be appropriate? Whenever accurate assessment is required of the impact of sex preferences on fertility decisions. As suggested above, measurement of the potential effect of sex predetermination methods on fertility might be such a case. Another instance might be the evaluation of an attitude change program designed to reduce sex preferences and hence fertility in a given population. By using the stopping rule measure prior to the program it would be possible, by comparing the first choice and expected family sizes, to estimate excess fertility caused by sex preferences—fertility potentially reducible by the attitude change program. The stopping rule measure could also be used in periodic surveys throughout the program to monitor changes in sex preference. A successful program to reduce sex preferences would result in the shift of people from the variable parity and fixed parity with risk categories to the fixed parity-no risk category. In this instance the extensive stopping rule measure would provide a logically valid index upon which program evaluation could be based.

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