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Speed of Reproduction

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Speed of Reproduction

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FIGURES

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1 Introduction

The central importance of the demographic dimensions of fertility has long been recognized. Investigation of the patterns of fertility variation by age, duration of marriage, age at marriage, historical period, and birth and marriage cohort has formed the essential core of fertility research since its inception. Analyses of fertility variation along other dimensions – socio-economic, spatial – typically employ controls or adjustments for the demographic dimensions, and in so doing rely on explicit or implicit assumptions about the nature of the effects of the demographic dimensions.

Despite general agreement about their fundamental significance, there has been little systematic consideration of the relative strengths of the full set of demographic dimensions or systematic consideration of relationships among them. It is only recently, for example, that demographers have begun to investigate the cluster of variables, age, period and birth cohort, although theoretical and non-rigorous examinations of the relative merits of period and cohort perspectives abound (Hobcraft *et al* 1982b). Research in this area, moreover, customarily uses data from developed societies because the required information is seldom available in convenient form for less developed societies.

It is only recently that independent influences on fertility rates of both age and duration of marriage have been demonstrated (Page 1977, Gilks 1979), but this work too has yet to be extended to studies of fertility in less developed societies. On the contrary, it is still common for one but not both dimensions (age and marriage duration) to be chosen as the sole demographic control in analyses which focus on the fertility effects of other variables, such as socio-economic variables. Failure to incorporate both age and duration as controls in research on socio-economic effects is unwise however, since both show substantial independent effects on reproductive timing in widely differing demographic settings. Omission of one of these two dimensions is certainly a serious shortcoming in efforts to assess the significance of any of the other demographic dimensions. Here, mention may be made of research on the effects of age at marriage, where age or marriage duration, but never both, have been employed as demographic controls. Both are essential, the analytic complexities of examining effects of age, marital duration, and age at marriage simultaneously notwithstanding. We give attention to the age at marriage dimension and related analytic problems below. A similar set of observations applies to the investigation of the influence of historical period and of cohort (birth and marriage) membership: in most circumstances the analysis is deficient unless both are considered simultaneously, with controls for age and duration, despite the difficulties involved.

The aim of the research presented in this paper is to examine with data from less developed societies fertility variation in what we identify as the six basic demographic dimensions: age, duration, historical period, age at entry, birth cohort, and entry cohort. We refer here to 'age at entry' and 'entry cohort' because in the analysis women are classified alternatively by the timing of the events of marriage or first birth (or 'motherhood'); that is, women are characterized by an age at marriage and an age at motherhood and are members of a marriage cohort and a motherhood cohort. Similarly 'duration' is left non-specific as it may refer to duration of marriage or of motherhood.

The subject of our analysis is variation in fertility rates. This means that, in conventional language, our analyses consider the influence of the six demographic dimensions on the tempo of childbearing, and the findings reflect only indirectly on the quantum aspect. A more complete analysis of fertility which would include the quantum aspect as well as the tempo aspect requires explicit consideration of the influence of the appropriate demographic dimensions (age, period, birth cohort) on the timing of entry to first marriage or motherhood, but such analysis is not attempted in this paper.

The fertility data examined are from nine less developed countries which have participated in the World Fertility Survey (WFS) programme, namely Bangladesh, Colombia, Indonesia, Jamaica, Jordan, Kenya, Korea, Mexico, and Sri Lanka. The nine countries were selected in order to present diversity in demographic, as well as other, characteristics.

The paper is organized as follows. In the next section, we discuss key features of the analytic approach adopted. As systematic investigation of the six demographic dimensions has not, to our knowledge, been attempted previously, we discuss several theoretical and practical problems. We also note several matters pertaining to data manipulation, estimation of models, and interpretation of results. Before launching into these methodological issues, we begin the section with a review of the hypothesized nature of the effects of each of the demographic dimensions. The section also includes a discussion of the relative merits of indexing fertility rates by marriage and motherhood.

In the subsequent section, the findings are presented. For convenience this presentation is divided into four parts. First, we describe our efforts to identify a parsimonious model of the influences of the demographic dimensions on reproductive timing. Secondly, we examine the nature of the estimated effects of each term in our preferred model. Thirdly, we focus on those dimensions whose importance is problematic – specifically, the cohort and age at entry dimensions – and consider how their influence on fertility tempo is affected by inclusion in the analysis of an important socio-economic characteristic with which these dimensions are typically closely associated, namely level of educational attainment. We also pause for a brief look at the role of education itself *vis-à-vis* the demographic variables and at the nature of the education effects. Fourthly, we present analysis limited to never users of contraception, in an attempt to ascertain whether the demographic dimensions of their speed of reproduction can be captured by models of simpler structure. In a final section of the paper, we summarize our findings and discuss their significance.

2 Examining the Demographic Dimensions of Fertility with Survey Data

2.1 THE SIX DEMOGRAPHIC 'DIMENSIONS'

There is at least a *prima facie* case for the existence of effects on fertility for each of the six dimensions identified above, though with each it is plausible to argue that the dimension is acting as a surrogate or proxy for non-demographic components of reproduction. The presumed sources of each effect are for the most part familiar to demographers, but a brief review here will provide a useful context for the subsequent analysis as well as enabling us to define the terms used in the discussion. We stress from the outset that there are not six true dimensions, due to interdependencies among the six variables considered. Nevertheless, we use the term dimension throughout the paper in a looser sense.

It is well established that age (AGE) is closely associated with the physical capacity to reproduce and, arguably, pure age effects would only include a physiological or natural fertility component (see Rindfuss and Bumpass 1978 for a discussion of age effects which are not purely physiological). Period (PER) effects are surrogates for a whole set of contemporaneous influences, including economic circumstances, availability and acceptability of contraception and abortion, and societal or normative pressures. Time or duration since entry (MDR: we use MRDR for duration of marriage and MODR for duration of motherhood) is largely a measure of total period of exposure to childbearing and is at least partly a substitute for achieved parity. It may also capture shifts in fertility-related behaviour which are associated with the lengthening of time in a union *per se* (for example, coital frequency). The reproductive consequences of age at entry (AGM: AGMR for first marriage and AGMO for first birth or motherhood) include the so-called 'catch-up' effect of more rapid childbearing among women with later ages at entry (Kendall 1979; McDonald *et al* 1981; Freedman and Casterline 1982). Socio-economic correlates of age at entry (most notably level of educational attainment) are likely to produce fertility differentials, which may be expressed as age at entry effects in a purely demographic analysis (Rindfuss *et al* 1980 show that in USA educational effects on fertility depend upon educational effects on age at motherhood). Conceptual distinction between possible effects of birth cohort (BCO or BRCO) and marriage or motherhood cohort (MRCO and MOCO respectively; MCO inclusively) is by no means easy. Either cohort measure may capture cumulative effects of the cultural environment in which the individual grew up. Attitudes or norms about reproduction may be more closely associated with one or the other, to the extent that these are determined by common experiences of women at particular ages or particular stages in their reproductive careers, and these common experiences vary across cohorts. For example, in those societies where the average levels of educational attainment have been rapidly changing, birth cohort effects on fertility may be a proxy for the effects of the educational changes. In those societies where contraceptive availability and use have increased, entry cohort (marriage or motherhood) effects may reflect the effects of differing contraceptive contexts across cohorts at specific stages of the reproductive career. Note that a conceptual distinction between cohort and period effects is not always easily maintained; indeed, in circumstances where period effects do not operate, cohort effects are difficult to imagine. Following Ryder (1965), one may understand the special nature of cohort effects as the result of cohort experiences at one point in time leaving an imprint on all subsequent behaviour – persistent effects of past events which themselves must have cohort-specific impacts to be anything other than period effects. Contraceptive context might affect entry cohort behaviour in such a fashion. More generally, Hobcraft *et al* (1982b)[1] have proposed a set of 'cohort-inversion' models which posit mechanisms other than Ryder's through which cohort influences on fertility might arise. The models which Hobcraft *et al* describe posit cumulative effects of past reproductive behaviour on behaviour at any given time, and hence entry cohort (MCO) may be a better measure than birth cohort (BCO) for use in the investigation of these models.

While each of these six dimensions possesses conceptual appeal, models including all six are complicated by the non-independence of the six identifiers. For example, as is well known, in the subset age, period, and birth cohort, information on the values of any two is sufficient to determine the value of the third. A similar situation obtains among other subsets of three or more dimensions. We elaborate on this below. As a consequence, having set out to assess the relative importance of the six dimensions, the analytic chore remains by no means straightforward. For this reason we consider issues which inevitably emerge in an investigation of these dimensions.

When working with survey data it is convenient to identify cohorts by age or duration at the survey rather than by year of birth or year of entry. Similarly, we index period backwards in time, using years prior to the survey as the indicator. Knowledge of a woman's duration (of marriage or motherhood) at the survey and of the number of years prior to the survey at which a birth occurred allows unequivocal determination of the woman's duration (of marriage and motherhood) at the time of the birth (MDR = MCO – PER, in our notation), just as knowledge of age at survey (birth cohort) and period (number of years prior to the survey) allows determination of age at event (AGE = BCO – PER). In fact, six such 'triangular equalities' exist among the six demographic dimensions. The six equalities

[1] Subsequently, it has been suggested that the term 'cohort-experience' is preferable to 'cohort-inversion' as it is less restrictive. See Hobcraft and Gilks, forthcoming.

Table 1 The six demographic 'dimensions' of fertility and their interrelationships

The Dimensions	
AGE:	age at a particular time of exposure
PER:	period of exposure (years before survey)
BCO:	age at survey (birth cohort)
MCO:	duration at survey (first marriage or motherhood cohort)
AGM:	age at first entry to marriage or motherhood
MDR:	time since first marriage or first birth (duration of marriage or motherhood)
Triangular equalities	
AGE = BCO − PER = AGM + MDR (omits MCO)	
PER = BCO − AGE = MCO − MDR (omits AGM)	
BCO = AGE + PER = MCO + AGM (omits MDR)	
MCO = BCO − AGM = PER + MDR (omits AGE)	
AGM = BCO − MCO = AGE − MDR (omits PER)	
MDR = AGE − AGM = MCO − PER (omits BCO)	
The four reasonable three-way tabulation formats	
AGE by BCO by AGM	
AGE by PER by MDR	
PER by BCO by MCO	
MDR by MCO by AGM	

are specified in table 1. (Notice that indexing in terms of age and duration at survey and years before survey changes the signs in several of these equalities from the way they are usually written.)

It follows from these equalities that a cross-tabulation of rates by, say, age and period contains birth cohort as a latent dimension: rates for a birth cohort fall on a diagonal of the table. Thus a birth cohort effect can be regarded as a restricted form of age–period interaction. Alternatively, a table of rates by age and birth cohort contains period as a latent dimension, and period effects in this instance are a restricted form of age–birth cohort interaction. In general, the same circumstance obtains when a table is dimensioned on any two of the three terms in each of the six triangular equalities: the third term is always present as a latent dimension.[2] This fact is of no small consequence when models are fitted to such three-dimensional tables within the framework of general linear models. To begin with, the existence of the equality causes minor difficulties in fitting, as an additional identification constraint is required. This in turn creates substantial difficulties in interpretation of parameter estimates, as only quadratic (rather than linear) contrasts are estimable (Fienberg and Mason 1979; Pullum 1980). Interpretation can be particularly misleading if the unwary analyst treats the parameter estimates as if they were main effect estimates. It is meaningless, for example, to describe a cohort effect parameter as representing the effect of cohort membership holding both age and period constant: such an interpretation does not acknowledge that cohort membership is part of the interaction between age and period, in a statistical if not a conceptual sense (see Goldstein 1979 and Gilks 1981 for a further discussion of these issues). There are no obstacles to the fitting of general linear models which include a full set of terms in a triangular equality, however, provided sufficient additional identification constraints are imposed.

Among the possible two-way combinations of the six dimensions, there are three rather meaningless ones which do not contain a latent dimension, namely age by entry cohort (AGE and MCO), period by age at entry (PER and AGM), and birth cohort by duration (BCO and MDR). Avoidance of these combinations leads to four three-way tabulation schemes, each of which includes all three remaining indicators as latent dimensions in the two-dimensional margins. These four tabulation schemes are shown in table 1.

Choice among the possible table layouts is at least partly a matter of taste, but research focus and computational ease also inform the decision. When dimensions are defined in terms of broad intervals – say, five-year segments, as is usual in the analysis of data from moderate-sized sample surveys – the latent dimensions are measured less precisely than the explicit table dimensions. For example, when age at entry is measured as AGM = AGE − MDR and AGE and MDR are grouped into five-year categories, each age at entry category will refer to a ten-year span and these categories will overlap. The majority of the experience represented by a set of such AGM categories, however, will generally fall in the five years surrounding the mid-point of the ten-year span. Thus, the analyst may opt for explicit dimensions which, on the basis of *a priori* reasoning, would seem to require more precise measurement to capture the pattern of their effects on fertility or which are of greater interest in the research and thus merit more sharply focussed attention.

With retrospective fertility survey data, indexing rates by age at event (AGE), duration at event (MDR), or period of event (PER) is computationally inconvenient relative to indexing by birth cohort (BCO), entry cohort (MCO), or age at entry (AGM), because the latter are fixed characteristics of the survey respondents which do not vary among their births. A layout involving more than one of the set AGE, MDR, and PER is especially inconvenient, and this discourages use of the AGE by PER by MDR scheme. The analysis presented in this paper was achieved using the PER by BCO by MCO layout, each dimension grouped into five-year length categories. This means that age at event (AGE), duration at event (MDR), and age at entry (AGM) are measured with relatively less precision, a matter to which we return when discussing the findings.

Whatever table layout is selected, the constructed tables are bound to be incomplete. In an AGE by PER by MDR layout, some combinations of high duration and young age are impossible and others are extremely unlikely to occur. Additional cells are empty due to the design of retrospective surveys: the censoring of experience by the interview and the truncation of experience resulting from the imposition of selection criteria for interview (upper age limits, in particular) exclude exposure and births which may be of some interest. The joint effects of censoring by interview and truncation by selection result in a triangular form for experience in, say, the age by period or duration by period dimensions (Verma 1980; Hobcraft *et al* 1982a). Incompleteness is inevitable in three-way tables and complicates

[2] We note that it is possible to introduce the third or latent dimension as an explicit dimension of the table by 'unfolding' the two-way table. Even so, it remains true that the third 'dimension' is equivalent to a restricted form of interaction between the other two. See S.E. Fienberg and W.M. Mason, 1979.

analysis (see Bishop *et al* 1975 and Haberman 1979 for a discussion of these problems).

A final general point to note, which may not be obvious, is that there are overwhelming advantages to maintaining the same and equal length cells in each of the dimensions used in the table layout. Unless this is done, incorporation of effects corresponding to the latent dimensions becomes extremely difficult, as the markers pertaining to differing length categories will not line up. Hence modelling of the full set of effects is difficult, if not impossible (see Fienberg and Mason 1979 for a discussion of this problem in the simpler context of age, period and birth cohort).

2.2 INDEXING BY MARRIAGE OR MOTHERHOOD

Thus far we have made no distinction between first marriage (or, more generally, first union) and motherhood (or first birth) as indexing events; the issues of analytic design remain essentially the same whichever is chosen. A choice will usually be made, however, since very seldom will a research problem encourage simultaneous use of both as indexing events. We discuss here the competing merits of selection. Because use of motherhood is rather recent and still uncommon, we stress its expected advantages over first union, which is the more frequent choice as the indexing event. Our choice is based mainly on the analytic and substantive arguments which follow, but we note a technical advantage with WFS data in that age at first birth is often more reliably reported than is age at first union (see for example O'Muircheartaigh and Marckwardt 1981).

In considering the implications of choosing first union or motherhood as the indexing event, it is helpful to classify the various relationships among the timing of first union, the timing of first birth, and the timing of subsequent fertility into three general groupings. In some societies the decision to marry is also regarded as a decision to begin childbearing; the marriage and motherhood decisions are effectively inseparable, joint decisions. If sanctioned exposure to risk does not begin until the union, and exposure to risk is rare before the union, then the timing of first union and first birth will be closely associated, and one may anticipate that the results of analysis of fertility rates by duration of motherhood will typically differ in only minor ways from analysis of rates by duration of union. One source of difference is that childless women enter into the latter but not the former.

In many societies, however, the commencement of reproduction is less closely linked to entry into first union. Such cases fall into two groups. In some societies, entry into union occurs at a very early age and is quite removed from entry into childbearing. This pattern typifies many South Asian societies, for example. In other societies, childbearing prior to first (stable) union is quite common. This is especially true in almost all Latin American, Caribbean, and tropical African societies, as well as some European societies.

In the analysis of fertility data from those societies where entry into marriage or union and entry into motherhood are not closely linked, there are persuasive reasons for indexing by duration of motherhood rather than duration of union. Although the analyst may employ either duration variable as a measure of the amount of exposure to risk of conception, the former can be misleading. In societies in which marriage takes place at very early ages, the marriage event is not a good marker of the beginning of exposure to risk. Consummation of the marriage may occur somewhat later, postponed until menarche, for example; and, even if information on the timing of consummation is also gathered, as is the case in some WFS surveys, adolescent sub-fecundity may effectively remove women from full risk. In these circumstances, duration of union is an imprecise measure of exposure period. And in societies where childbearing prior to first union is frequent, an analysis by duration of union either must exclude out-of-union births (a noticeable proportion of all births in some instances) or must awkwardly treat them as 'pre-marital' with exposure in that period left undefined. Thus, weighed against indexing by first union with its disadvantages, indexing by first birth possesses great appeal: inclusion in the analysis of all births is straightforward; furthermore, the first birth is unequivocal evidence of entry into reproduction, and hence subsequent births should occur in a more orderly fashion, at least at the aggregate level, than births indexed by first union. Women who remain childless although exposed to risk are ignored when indexing is done by motherhood, but such women are a negligible proportion of all women in most societies, especially developing societies.

Further advantages of motherhood in place of marriage deserve emphasis. In the preceding paragraph, we have in effect argued that, in practical terms, there are compelling reasons for indexing on a marker determined by some aspect of reproduction itself rather than on a marker determined by other social processes. There are related substantive considerations of some importance. We contend that, in many societies, the change of status with most significance for subsequent fertility decisions and behaviour and with most impact on many other adult roles and activities is motherhood, not marriage. We shall not take space to defend this position here (see Rindfuss *et al* 1980). For this reason, analysis of fertility by motherhood duration, in conjunction with analysis of the timing of first birth, seems to us the preferred strategy.

Thus far we have approached this matter from the standpoint of analysis of data for one society, but it is immediately apparent that the advantages of indexing by motherhood in cross-national fertility analysis are even more compelling. International variability in the relationship between entry to marriage and entry to motherhood can become a major factor in cross-national analysis. Fertility rates at the low and high durations are the principal concern; particularly at low marriage durations, rates vary enormously, in part because of differences in the relationship between the marriage event and effective exposure to risk. To be sure, the differences in this relationship are of great interest in themselves and will be evident in international variability in rates at low marriage duration. It is preferable, however, to examine these differences explicitly rather than allowing them to confound analysis of the pace of reproduction. Again, the strategy we recommend is analysis of fertility subsequent to motherhood, in conjunction with analysis of the timing of first births. One component of the latter analysis will often be examination of the relationship between first union and first birth.

In the cross-national analysis presented below, we index by both first union and first birth most of the time, in order to assess the impact on the findings of choosing one or the other event. Some of the results are shown for rates indexed on motherhood only, although the entire analysis has been performed with both.

2.3 DATA AND ESTIMATION OF MODELS

We analyse data from nine World Fertility Surveys: Bangladesh, Indonesia, Korea, and Sri Lanka in South and East Asia; Jordan in West Asia; Kenya in Africa; and Colombia, Jamaica, and Mexico in Latin America and the Caribbean. For detailed information on the design and the basic findings of each survey, the reader is directed to the First Country Report for each survey.[3]

Using the Standard Recode files for each survey, we generate counts of both the number of births and woman-years of exposure within each cell of our chosen table layout (PER x BCO x MCO). We count over six five-year segments of PER and MCO and seven five-year segments of BCO (age at survey, starting at age fifteen). Hence we exclude experience occurring more than thirty years prior to the survey, and all experience of women at marriage or motherhood durations of thirty years or more at the survey and of women under age fifteen at the survey. The resulting number of births and exposure years subjected to analysis are summarized in appendix table A1. Sampling weights are applied throughout.

Measurement of the PER dimension of our tables requires information of the timing of births, obtained in the maternity history section of the WFS interview. There is ample reason to be cautious about possible errors in the maternity histories. The most usual problems identified in maternity history data are omissions of early births by older women and mis-dating of reported births (Potter 1977; Brass and Rashad, forthcoming). WFS data are generally of fairly high quality compared with other survey data, but variations in accuracy of reporting associated with levels of development and education, for example, frequently occur.

In addition to heavy reliance on the birth history for dates of births (including the first birth, one of our MCO indexing variables as well as one of the AGM variables), we use both the woman's date of birth (or age at survey) and date of first marriage (or duration of marriage at survey) to measure the BCO and MCO dimensions. There is clear evidence of age misreporting in several of the surveys used here and some evidence that date (or age) at first marriage is unreliably reported. All these variables are central to our analysis, and reporting errors can easily distort results. In several instances in the discussion of our results we shall point to evidence of errors or distortions, which are sometimes made clearer as a result of pushing the data further than their quality warrants. The highlighting of certain error patterns is one benefit of the detailed analysis we undertake.

In view of the complexity of trying to assess relative magnitudes of any effects in the six demographic dimensions of interest, it is necessary to utilize a model-based approach in the analysis. An appropriate approach to data of this kind is through so-called 'rate models'. In this approach, multiplicative or log-linear models are fitted to the counts of events (births), using the amount of exposure as one of the multiplicative factors in the model. Thus, the model is effectively a log-linear model for the rates, but a Poisson error structure is assumed for the counts, with the inclusion of the exposure, treated as a known constant, as a preliminary adjustment factor in the model (Berry 1970; Osborne 1975, Andersen 1977). Our main reservation about this approach concerns treating the exposures as known constants. This is satisfactory for making inferences about the survey population but ignores the fact that the exposures are themselves subject to sampling variation, which leads to conceptual difficulties in making inferences to the sampled populations. A further issue pertains to the treatment of first births under this approach when indexing by duration of motherhood. Each woman must by definition have a first birth in the initial motherhood duration month and, as a consequence, fertility in the early motherhood durations will be relatively high if this first birth is counted. This invariability of experience in the first exposure period is not in harmony with the Poisson process assumed by our statistical model. Hence, when indexing by motherhood we exclude first births from the birth counts analysed.[4]

The models were all fitted using the GLIM (General Linear Interactive Modelling, see Nelder and Wedderburn 1972; Baker and Nelder 1978) software package, with a Poisson error structure and a logarithmic link function, taking the exposure as an offset and fitting models by iterative weighted least-squares to the counts of births.

In our analysis we do not take any specific action to adjust for the possible impact of complex sample designs. (All WFS surveys use stratified, clustered sample designs.) We make extensive use of chi-squared statistics. Results on chi-squared tests for relatively simple models using relatively simple sample designs suggest that chi-squared statistics are distributed approximately X^2_N/d, where N is the degrees of freedom and d is the average of the design effects for each cell of the table (see Rao and Scott 1981; Holt *et al* 1980). Research on design effects for World

[3] See *Bangladesh Fertility Survey, 1975–1976: First Report*, Ministry of Health and Population Control, Population Control and Family Planning Division, Dacca 1978; *Encuesta Nacional de Fecundidad, Colombia, 1976: Resultados Generales*, Corporación Centro Regional de Población, Bogotá 1977; *Indonesia Fertility Survey, 1976: Principal Report* (2 vols), Central Bureau of Statistics, Jakarta 1978; *Jamaica Fertility Survey, 1975–76: Country Report* (2 vols), Department of Statistics, Kingston 1979; *Jordan Fertility Survey, 1976: Principal Report* (2 vols), Department of Statistics, Amman 1979; *Kenya Fertility Survey, 1977–78: First Report* (2 vols), Central Bureau of Statistics, Ministry of Economic Planning and Development, Nairobi 1980; *The Korean National Fertility Survey, 1974: First Country Report*, National Bureau of Statistics of the Economic Planning Board, Seoul 1977; *Encuesta Mexicana de Fecundidad: Primer Informe* (2 vols) and *Informe Metodológico*, Secretaría de Programición y Presupuesto, Mexico, 1978–9; and *World Fertility Survey, Sri Lanka, 1975: First Report*, Department of Census and Statistics, Ministry of Plan Implementation, Colombo 1978. See also *WFS Comparative Studies* series.

[4] We have replicated all the analyses presented here with tables including the first birth when indexed by duration of motherhood and results are also more sensible when the first birth is excluded. We note also that we have not attempted to adjust the motherhood rates for the effective non-exposure to birth in the nine months following the first birth, as this seemed unnecessarily complex and not clearly justified.

Fertility Survey samples indicates that design effects on fertility measures are small, and, further, that the effects are substantially reduced for demographic sub-classes and even more so for cross-classes (Verma *et al* 1980; Verma 1981). Given the rather elaborate cross-classifications by demographic variables used throughout this analysis, it is likely that the average design effects are small and thus the results are little threatened by the departures from simple random sampling.

A few final comments about the interpretation of the results as presented in this paper are in order. Countries representing a diversity of demographic experience have been intentionally selected for analysis. Not surprisingly, the results of the model-fitting also vary in important respects across countries, although the similarity of results is also at times impressive, as we frequently note. In interpreting the results we attempt to formulate generalizations which hold across countries, at the expense of attention to the country-specific findings, however interesting these may be. Without wishing to slight the importance of within-country analysis, we are convinced that a great opportunity to detect commonalities in reproductive behaviour is afforded by replication of the same analysis across a set of surveys which have utilized similar instruments and field methods (see Hobcraft 1981 for further discussion of this issue). The effort to formulate cross-national generalizations affects our handling of the results: for example, we make no attempt to select a 'best-fitting model' for each country but instead attempt to identify parsimonious models which perform well in most countries. Success in identifying models which are applicable cross-nationally contributes to the building of a general understanding of the demographic dimensions of fertility. It can be added, conversely, that the application of general models discloses societal particularities which might not appear noteworthy otherwise. Our findings include several such instances.

3 Results

3.1 MODELLING THE DEMOGRAPHIC DIMENSIONS OF FERTILITY

We first consider a set of relatively simple models consisting of two or more of the six demographic dimensions. Tables 2A and 2B present the goodness-of-fit statistics for these models fitted to the fertility rates for each of the nine countries. The eight models shown are a subset of a much larger number of models fitted in the course of our work. For the purpose of perceiving common structure across countries, we regard indications of goodness of fit in terms of significance levels of the chi-squared statistics as purely descriptive measures.

It is evident that fertility rates vary most in the age and duration since entry dimensions, with variation in the period dimension smaller yet still of considerable importance. In both tables, Model (2) (AGE + MDR) explains much of the variation around the grand mean and in all instances represents a substantial improvement on the grand mean model or the models with only AGE or MDR main effects (not shown). Addition of the period term (Model (3)) effects a further substantial improvement in fit in all instances. If we take a chi-squared statistic within two standard deviations of the mean as indicating an acceptable fit, Model (3) provides a respectable overall fit in six countries when rates are indexed by marriage and in all countries but one when rates are indexed by motherhood. An acceptable fit is achieved in all countries if Model (3) is complicated by the addition of MCO (MRCO or MOCO), BRCO, or AGM (AGMR or AGMO), the cohort and age at entry characteristics which are fixed characteristics of the women (see Models (4), (5), and (6)). The improvement achieved with the addition of one or several of these terms indicates that, net of main effects of age, duration, and period, the fertility rates vary along these other dimensions in most countries in either or both the tables indexed by marriage or motherhood. We give more detailed attention to these dimensions below. At this point we wish to emphasize that, not denying the importance of the finding of significant cohort effects, the variation explained by the cohort, and especially the age at entry, dimensions is quite small relative to that accounted for by the age, duration, and period dimensions, which show dominant effects. This conclusion holds whatever selection of models, ordered from simple to complex, is fitted.

The outcome is hardly surprising. Several matters nevertheless bear further discussion. The finding of main effects of both age and duration is in agreement with Page's results for Western European populations. Page handles period variation in a fashion not represented by the models in tables 2A and 2B. But a simple main effect of period, as specified in Models (3) to (7), appears to capture the major influence of historical period in most countries considered here. The independent importance of both age and duration in determining the speed of reproduction in developing countries has not previously been so clearly confirmed. Indeed, as pointed out in the Introduction, analyses commonly control for one but not both of age and duration. The findings here demonstrate that models without both are seriously incomplete; furthermore, inclusion of period effects in the demographic model is also essential in most instances.

The strength of the finding of dominant age, duration, and period effects receives further emphasis when it is recalled that both age and duration are latent dimensions in the tables of rates analysed (PER × BCO × MCO tables) and hence are measured with less precision than the two cohort dimensions. Even so the rates vary much more along the age and duration dimensions as measured than along the cohort dimensions.

We draw brief attention to the final model presented in tables 2A and 2B, AGE + PER*MDR (Model 8)), which might be regarded as one relatively simple representation of variation in fertility rates in a setting where fertility has been declining. In those countries characterized by recent declines in marital fertility – notably Colombia and Korea, and, to a lesser extent, Sri Lanka – the results provide no basis for preferring the AGE + PER*MDR model over simpler models which add a cohort marker as a fourth main effect or, for that matter, over the basic AGE + PER + MDR model.

Finally, we note that an initial assessment of the merits of indexing by marriage or motherhood through a comparison of the goodness-of-fit statistics of tables 2A and 2B reveals little basis for preferring one over the other, although suggesting a simpler structure for rates indexed by motherhood duration in more countries.

3.2 THE AGE, DURATION AND PERIOD EFFECTS

The figures presented in tables 2A and 2B indicate that the AGE + PER + MDR model (Model 3)) fits the observed rates at a minimally acceptable level in a majority of the countries (it is least satisfactory for Korea). In every country, moreover, the three dimensions represented in this model clearly possess substantially more explanatory power than the remaining three dimensions. Thus it is appropriate to examine the parameter estimates for this relatively simple model. Interpretation of the parameter estimates is complex in those instances where a model which includes a cohort term (Models (4) and (5)) might be preferable to the AGE + PER + MDR model, because, in order to resolve the identification problem, additional parameter constraints have been imposed in the fitting of the models. Furthermore, apart from problems of interpretation, addition of the cohort terms causes instability in the parameter estimates for the basic three dimensions. For these reasons

Table 2A Chi-squared statistics for selected models, by country: rates indexed by marriage

Model[a]	Number of parameters	Country[b]								
		Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Total degrees of freedom in table		92	91	101	93	89	91	74	91	98
(1) Grand mean	1	1050	2113	2139	1127	968	938	3122	2770	3866
(2) AGE + MRDR	12	237	304	191	144	119	177	294	146	207
(3) AGE + PER + MRDR	17	43‡	100	102*	84**	66**	76**	146	88*	117
(4) AGE + PER + MRDR + MRCO	21	37‡	64**	79**	80**	51†	59**	43**	77**	87**
(5) AGE + PER + MRDR + BRCO	22	40‡	54†	81**	75**	43‡	69**	76	72**	99
(6) AGE + PER + MRDR + AGMR	21–24	38‡	94*	98*	74**	62**	71**	134	74**	106
(7) AGE + PER + MRDR + MRCO + BRCO + AGMR	30–33	31‡	40†	71**	64**	36‡	49†	34†	51**	74*
(8) AGE + PER*MRDR	27	35‡	60**	69**	75**	48†	52†	32†	76*	83**

*Denotes chi-squared figure between one and two standard deviations greater than the mean.
**Denotes chi-squared figure within one standard deviation of the mean.
†Denotes chi-squared figure more than one standard deviation below the mean.
‡Denotes chi-squared figure more than two standard deviations below the mean.
[a]The model terms signify the demographic dimensions as defined in the text.
[b]The countries are as follows: Bang: Bangladesh; Col: Colombia; Indo: Indonesia; Jam: Jamaica; Jord: Jordan; Ken: Kenya; Kor: Korea; Mex: Mexico; SL: Sri Lanka.

Table 2B Chi-squared statistics for selected models, by country: rates indexed by motherhood

Model[a]	Number of parameters	Country[b]								
		Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Total df in table		90	91	91	91	90	91	76	91	91
(1) Grand Mean	1	1727	1590	2473	952	1025	1137	2874	2012	3193
(2) AGE + MODR	12	311	347	163	146	65†	93*	246	144	218
(3) AGE + PER + MODR	17	86*	72**	93*	76**	46‡	56†	142	70**	85**
(4) AGE + PER + MODR + MOCO	21	70**	61**	82*	68**	44‡	52†	56**	69**	75**
(5) AGE + PER + MODR + BRCO	22	67**	54†	88*	60**	32‡	50†	83	65**	74**
(6) AGE + PER + MODR + AGMO	21–22	83**	60**	83*	70**	42‡	53†	134	61**	76**
(7) AGE + PER + MODR + MOCO + BRCO + AGMO	30–31	58**	39†	68**	40†	27‡	43†	47**	54**	59**
(8) AGE + PER*MODR	27	60**	57**	69**	66**	41†	44†	44**	66**	70**

NOTE: Notes to table 2A apply to this table.

we feel it would be unwise to struggle with the estimates for the more complex models when our first interest is the set of terms AGE, PER, and MDR.

Because our principal aim is to identify patterns in the parameter estimates which characterize the full set of countries, we choose to show the estimates graphically, as common structure is more readily apparent in this mode of presentation. (The actual parameter estimates are available from the authors.) In figures 1A to 3B the parameter estimates of the age, duration, and period effects are plotted, for rates indexed by duration of marriage (the 'A' series) and by duration of motherhood (the 'B' series). The parameters are estimated under the log-linear model

$$\mathrm{Ln}(B_{APD}) = \mathrm{Ln}(W_{APD}) + \mathrm{GM} + \mathrm{AGE} + \mathrm{PER} + \mathrm{MDR}$$

with an assumed Poisson error distribution, where AGE are effects of five-year age segments centred on A, PER are effects of five-year periods before the survey centred on P, MDR are effects of five-year duration (of marriage or of motherhood) segments centred on D, GM is the grand mean, $\mathrm{Ln}(W_{APD})$ is the natural logarithm of the woman-years of exposure in the cross-classification APD (the 'offset' in the model), and $\mathrm{Ln}(B_{APD})$ is the natural logarithm of the births falling in the cross-classification APD. The values are contrasts with the effects of the age-group centred on 25 years, the period 0–4 years prior to the survey, and the duration-group centred on 5 years, each of which is set to 0 (1.0 on the natural scale).

The age effects (figures 1A and 1B) rise from the youngest segment to the segments centred on age 20 or 25 and then fall off to the oldest segment. Jamaica (when rates are indexed by marriage) is an exception to the pattern of rising effects through the youngest ages; there are no exceptions to the pattern of a large decline after age 35. Although the overall pattern of age effects is similar across countries and similar whether rates are indexed using marriage or motherhood as the entry event, it is interesting to note that the sharpness of the fall-off with age shows some association with overall level of fertility and the known presence of extensive fertility control: the decline is most sharp for Korea in both figures 1A and 1B, while Kenya, Jordan, Bangladesh, and Indonesia show the most moderate declines. This suggests that the pattern of age effects is at least partly indicative of the level of active fertility control, as well as reflecting natural fertility factors.

The duration effects (figures 2A and 2B) corresponding to the low durations appear to differ when the rates are indexed by marriage and by motherhood, but this is the result of exclusion of first births from the rates indexed by motherhood. Taking this into account, the duration effects are similar for both sets of rates and across countries. We draw attention to the estimated effects for Mexico, which show less decline with increasing duration and indeed are essentially unchanging over the durations five to twenty years. This pattern is not very plausible in itself. It might be accepted, nevertheless, as a reasonable expression of uncontrolled fertility behaviour once age effects have been removed (through fitting the AGE + PER + MDR model) were the same pattern of duration effects evident for other high fertility countries. This is not the case, however (note the patterns for Bangladesh, Indonesia, Jordan, and Kenya), which suggests that the Mexican pattern requires further investigation.[5] The exceptional character of the Mexican duration pattern emerges from cross-national comparison and probably would not be noticed in an analysis of the Mexican data alone, providing a good illustration of the benefits of cross-national analysis. Finally, we note that, unlike the age effects, the duration effects show no clear ordering according to levels of fertility or fertility control of the nine countries.

The pattern of period effects (figures 3A and 3B) is intriguing, and it is tempting to devote some space to interpreting the patterns country-by-country by setting them in the context of the recent demographic history of each. We resist this and instead highlight common features. The figures show fertility (subsequent to marriage or motherhood) rising in the more distant past to a peak occurring roughly ten to fifteen years before the survey (five to ten years in Bangladesh and Indonesia) and then declining in the ten years prior to the survey. In our judgement the general nature of this finding demands a general explanation. It may be possible to select particular countries and argue for the validity of the historical trends shown here, but a more daring argument is needed to explain a pattern which typifies an entire set of countries which differ widely in culture, economy, and in absolute levels of basic demographic indices. The argument for historical validity must claim that in many scattered locations in the developing world marital fertility, or fertility subsequent to the first birth, declined from the mid-1960s to the mid- to late-1970s, after rising from the early 1950s to the mid-1960s.

The universality of this is especially difficult to accept, although it is true that this same period witnessed dramatic declines in infant and child mortality, certainly reflective of genuine improvements in health and sanitation services and possibly reflective of other changes in well-being which may have prompted a rise in fertility. We think a more plausible source of the common period patterns is the use in every country of the same means of measurement, namely retrospective reports of fertility gathered in a cross-sectional survey. The pattern of period effects is as expected if there were a tendency on the part of survey respondents to omit births more distant in time and to displace more distant births towards the survey date.[6]

From the parameter estimates shown in figures 1A to 3B we draw several general conclusions. We have already noted that the ordering of countries in terms of the relative decline of fertility with increasing age, as opposed to the ordering in terms of decline with lengthening duration, corresponds more closely with an ordering according to level of fertility or fertility control. This suggests that the age effects are more indicative of the extent of fertility control than the duration effects, an unanticipated finding.

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[5] An evaluation of the Mexico WFS data suggests no data quality problems directly relevant to this issue. See Ordorica and Potter 1981.

[6] It should be added that measurement problems of another kind affect the period estimates. As one proceeds further back in time from the survey, the estimates are increasingly based on a more limited range of ages and durations, due to the restricted age-range at interview. This has consequences for estimation procedures owing to the incompleteness of the tables. For this reason we advise against placing any weight upon the estimates for the period 25–30 years prior to the survey.

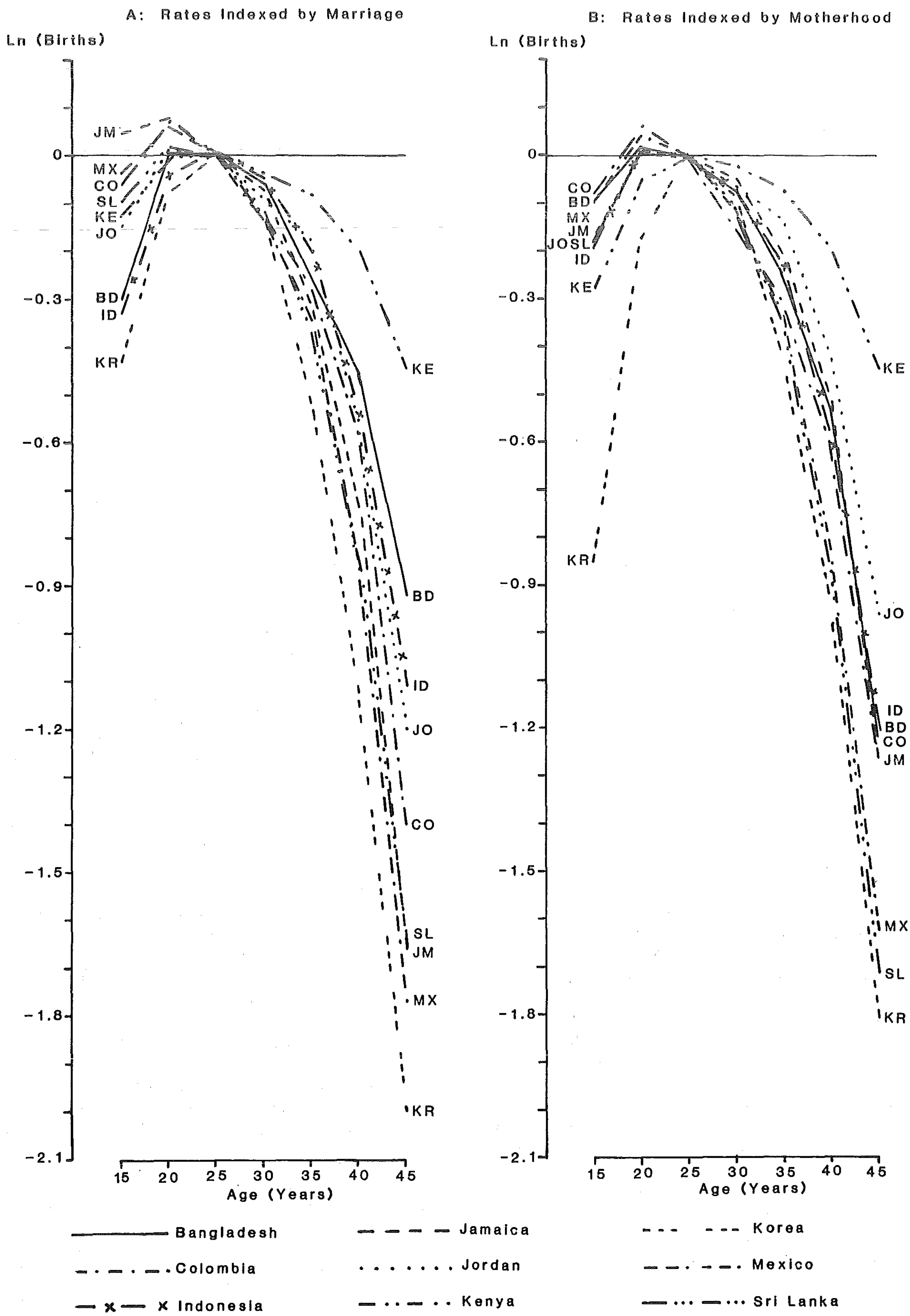

Figure 1 Estimates of age effects from AGE + PER + MDR model, by country

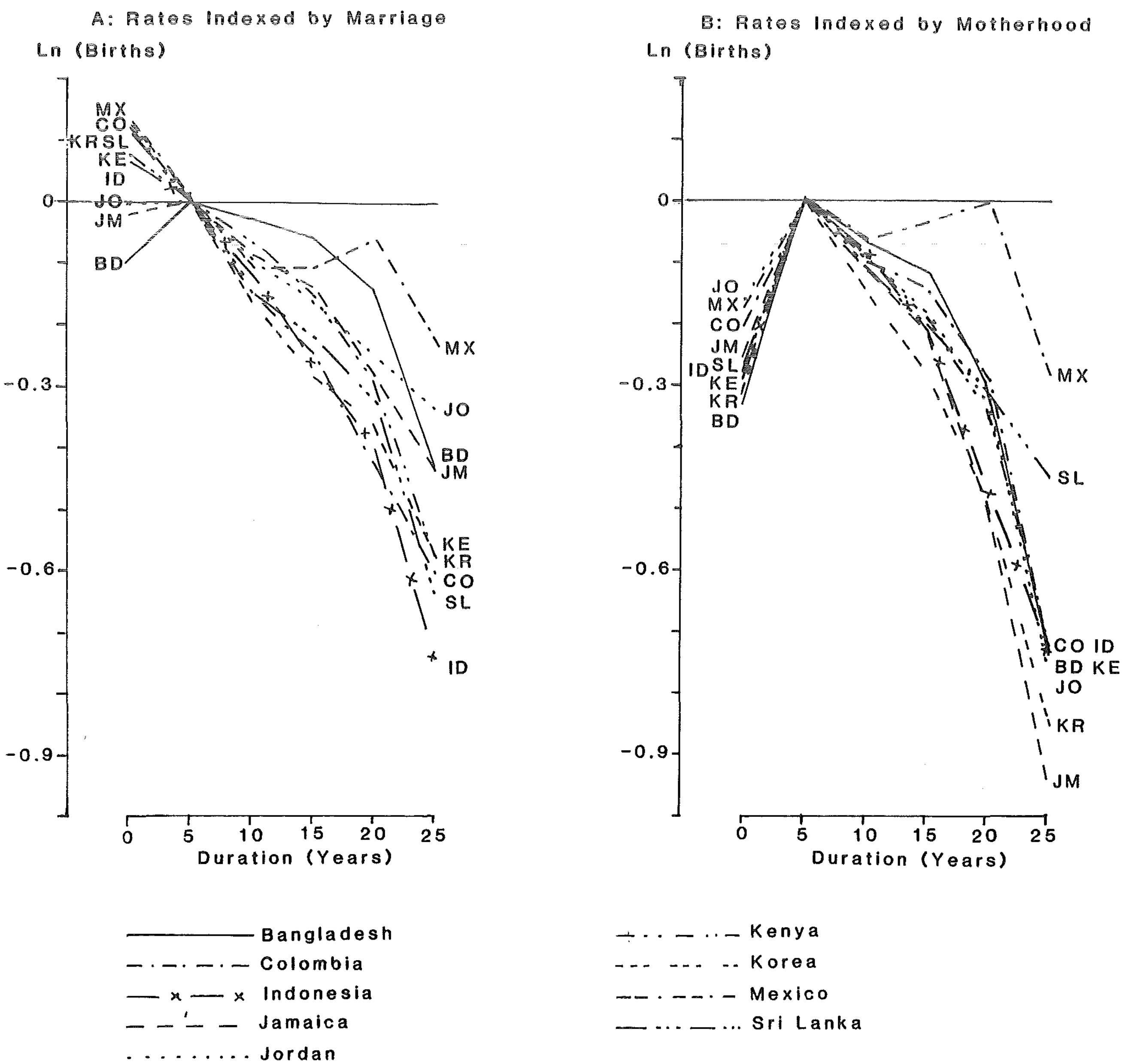

Figure 2 Estimates of duration effects from AGE + PER + MDR model, by country

It is also the case that the estimated age effects vary more across the countries. For example, if we calculate the mean relative deviation of the estimated parameter values from the mean parameter value for the nine countries (Mean ((Estimated value − Mean value)/Mean value)), the following figures are obtained:

Parameter	Rates indexed by marriage	Rates indexed by motherhood
Age	1.04	1.52
Duration	0.50	0.23

The greater relative cross-national heterogeneity of the age effects is further suggestive that voluntary fertility control is more closely related to age than to duration of marriage or motherhood.

The figures in the text table above also indicate that the patterns of duration effects are more similar when rates are indexed by motherhood than by marriage, while less similarity would appear to characterize the patterns of age effects when indexed by motherhood.[7] These findings are consistent with our expectations that fertility subsequent to the first birth would be more similar across countries than fertility subsequent to marriage. Associated with the greater homogeneity of duration effects in the duration of motherhood rates are larger differentials among countries in the pattern of age effects; but these would seem to be

[7] When Mexico, with its curious duration patterns, is excluded from the calculations, the greater homogeneity of the duration patterns based on motherhood becomes more apparent: the figures for the mean relative deviations become 0.61 for marriage rates and 0.21 for motherhood rates.

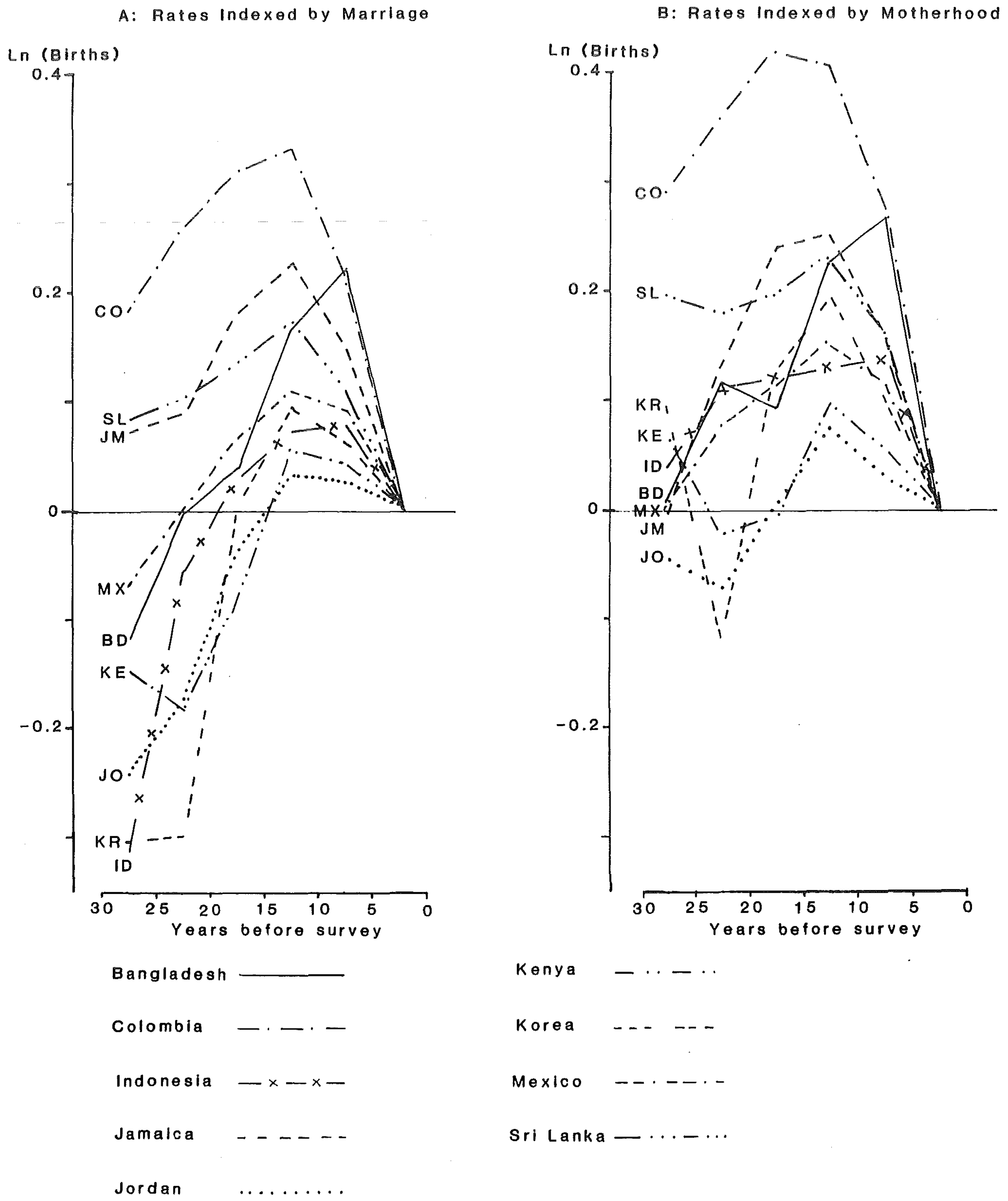

Figure 3 Estimates of period effects from AGE + PER + MDR model, by country

almost entirely a result of the exceptionally low value estimated for Korea at ages centred on 15 in the motherhood tables: when Korea is excluded from the calculations, the mean relative deviations for the age parameters are 0.57 and 0.49 for the marriage and motherhood estimates, respectively. Fewer than five per cent of the women in the Korea sample report a first birth by exact age 18 and hence the fertility rates for this youngest age group are based on a very small sub-group of the sample whose post-first-birth exposure in this age segment is likely to be on average very brief. We conclude that the duration patterns are more homogeneous across countries when rates are indexed by motherhood duration but that no firm conclusions can be drawn about which of the two indexing schemes yields more homogeneous age patterns.

Comparison of figures 3A and 3B provides a further reason for preferring motherhood to marriage as the entry event. Both figures show the pattern described above of fertility rising and then falling over the three decades prior to the survey. The apparent rise over the earlier time-periods is much less pronounced, however, when the rates are indexed by motherhood duration. The estimated values for the motherhood rates dip below zero (the normalized value for the most recent period) in only a few instances, whereas a majority of the estimated values for the marriage rates are negative for the time-periods more than twenty years prior to the survey. That is, the shape of the period effects in the motherhood rates is flatter over the years most distant from the survey, a shape we regard as more believable than the sharp rise indicated by the period effects in the marriage rates. The different trends are due chiefly to differences in experience in the short durations, because this is where rates indexed by marriage or motherhood are likely to vary the most and, further, because the experience available for more distant periods is more concentrated at these durations. At issue, in particular, is the interval between marriage and first birth and its impact on rates in the first marriage-duration segment. We note again that measurement by marriage duration relies on both the dating of first marriage (or union) and the dating of births. There has been little systematic investigation of the direction of biases in the reporting of dates of marriage. We suggest, nevertheless, that difficulties among older women in dating their first marriages, independently of their difficulties in dating births, poses an additional threat to the validity of the rates by marriage duration and may well account for the implausible period trends estimated from these rates. Because the motherhood duration rates do not require information beyond the maternity history data, they provide a sounder source for the assessment of fertility trends, a position which a comparison of figures 3A and 3B supports.

3.3 THE REMAINING DEMOGRAPHIC DIMENSIONS AND EDUCATIONAL ATTAINMENT

Birth and entry cohort effects

We observed in our discussion of the demographic models shown in tables 2A and 2B that the goodness-of-fit statistics indicate that in some countries statistically significant cohort effects exist. This matter is directly summarized in table 3, where we list the cohort terms which are significant on the basis of a comparison of Models (4) or (5) with Model (3) in tables 2A and 2B. In every country, one or both cohort terms is significant in either or both table 2A and 2B, but an examination of tables 2A and 2B reveals that the cohort terms tend to be of less importance in those countries where fertility after marriage or motherhood is thought to have been rather stable over time (Bangladesh, Indonesia, Jamaica, Jordan, Kenya) and of more importance in countries where marital fertility has been changing (especially Korea, but also Colombia, Sri Lanka, and, to a lesser extent, Mexico).

In a society where there have been secular increases in the average number of years of schooling completed, birth cohort or entry cohort may be suspected of acting as proxies in a purely demographic analysis for level of educational attainment. For this reason we extend our consideration of the cohort factors by analysing tables of fertility rates in which education is an explicit dimension and hence may be incorporated directly in the modeling as a control variable. The women are classified into three educational strata, with the exception of Bangladesh, where so few women are educated that we adopt a dichotomy. The strata are defined differently in each country, to allow reasonable sample sizes within each stratum, and thus the analysis is in terms of relative educational status within each country. The second educational category in each country consists of the following range of years of completed schooling:

Bangladesh	1 +	Jamaica	6	Korea	1–5
Colombia	3–5	Jordan	1–6	Mexico	3–6
Indonesia	1–5	Kenya	1–6	Sri Lanka	3–6

Table 3 Significant[a] cohort effects, by country

	Country[b]								
	Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Rates indexed by marriage duration (table 2A)	–	BRCO*	BRCO	–	BRCO*	–	BRCO	BRCO*	BRCO
	–	MRCO	MRCO*	–	MRCO	MRCO	MRCO*	MRCO	MRCO*
Rates indexed by motherhood duration (table 2B)	BRCO*	BRCO*	–	BRCO	BRCO	–	BRCO	–	–
	MOCO	MOCO	MOCO	–	–	–	MOCO*	–	MOCO

*Denotes stronger term where both cohort terms are significant.
[a]Significant at the .05 level.
[b]The countries are as listed in footnote b of table 2A.
NOTE: Based on tables 2A and 2B, Models (3), (4) and (5).

We construct the four-dimensional table PER x BCO x MCO x EDUC, which, as in the previous layout, contains latent dimensions corresponding to AGE, MDR, and AGM.

There are two types of cohort – birth and entry – and two sets of rates – by marriage duration and by motherhood duration – to consider, but we limit our presentation to an examination of entry cohort effects on rates indexed by marriage duration. Our conclusions would differ only slightly if another combination of cohort and indexing variable were examined. In table 4 selected goodness-of-fit statistics and significance tests are presented. (As table 3 indicates that MRCO is not significant in Bangladesh and Jamaica, we omit these two countries from table 4.) Of principal relevance here are the tests of the significance of the marriage cohort term as summarized in the second panel of the table. The first row in this panel simply confirms that the findings of table 3, based on fitting models to PER x BCO x MCO tables, are not altered when the analysis moves to the larger PER x BCO x MCO x EDUC table. The second row in this panel shows the effect of adding MRCO to our preferred model for this set of rates, AGE + PER + MRDR*EDUC (Model (10)). In three countries – Jordan, Kenya, and Mexico – the MRCO effect is no longer significant; these are countries where the effect was extremely weak in the first place (observe the chi-squared figures in the first panel of table 4). In the other four countries the marriage cohort term remains significant with the control for educational attainment and, indeed, the strength of the term is not greatly diminished (exceptive perhaps for Indonesia).

Particularly impressive are the powerful effects which are still evident in Colombia and, above all, in Korea. With the exception of Indonesia, these are countries where change in fertility within marriage and motherhood during the decade before the survey is well-documented and accepted. Our results indicate that in such a setting main effects of marriage cohort exist net of period and education effects. The same conclusion could also be drawn about birth cohort effects. In the final section of this paper, we make further comments about how this finding is to be interpreted. Our conclusion in an earlier section of the paper bears repeating here, however: the magnitude of the cohort effects is rather small compared to the age, duration and period effects.[8]

Age at entry effects

The existence and nature of age at entry effects have long been of special interest to demographers because age at entry is subject to choice more directly than the other demographic dimensions. Choice of an age at entry is also choice of an entry cohort, but it is not sensible in behavioural terms to think of an individual choosing an entry cohort *per se* and, in any case, the choice is realistically quite constrained. Likewise, the effects of age and duration, to the extent they reflect volitional fertility control, are influenced by individual decision, but values of age and duration are not selected in the same conscious manner as age at entry. In fact, choice of age at entry determines the combination of age and duration values which characterize each woman's fertility experience; this combination has great bearing on her fertility. Because age at entry is so directly subject to choice, as well as the influence of other factors, such as level of educational attainment, it is natural where there is concern about the level of fertility to regard age at entry as a potential target of public policies. Hence the question often arises of what changes in the distribution of age at entry would have a meaningful impact on aggregate fertility levels.

In the discussion of the effect of age at entry, we detect two distinct arguments, although they are not always distinguished. On the one hand, it is supposed that sufficient postponement of entry will lead to lower levels of completed fertility. This is essentially an issue of fertility quantum. On the other hand, some discussions of the so-called 'catch-up effect' imply age at entry effects on fertility tempo: those who enter marriage or motherhood later bear children more rapidly than would be expected on the basis of age and duration effects alone (McDonald *et al* 1981; Freedman and Casterline 1982). It is this second argument which we consider through analysis of fertility rates, although because of its importance we give some attention to the first argument, after examining age at entry effects on reproductive tempo.

We note before presenting our results that the design of our analysis handicaps a consideration of age at entry effects because our age at entry categories – ten-year age spans, concentrated in the five-year interval in the centre of the ten years, obtained as BCO–MCO, are rather broad in view of the concentration of the age at entry distributions in these countries (Smith 1980; Casterline and Trussell 1980). This measurement of age at entry does distinguish the tails of the distributions from the centre and in our judgment age at entry effects of relevance for fertility policy should be evident through the contrasts estimated.

In table 5 goodness-of-fit statistics are presented for models which permit testing for the presence of age at entry effects on fertility tempo. Model (3), we have maintained, is the preferred model for most of the countries. To this model we add an effect of age at entry in Model (6) and an interaction of age at entry and duration in Model (12). The latter represents an attempt to test for 'catch-up' effects – differing duration patterns for different age at entry strata. (Note that AGE is omitted from Model (12) as it is contained in the MDR*AGM interaction.) The results of the tests for age at entry effects are reported in the second half of each panel of table 5. Significant main effects of AGM (assessed by comparing the fit of Models (3) and (6)) are observed only in Korea and Mexico when rates are indexed by marriage (age at first union effects) and in Colombia when rates are indexed by motherhood (age at first birth effects). In each of these three instances, the improvement in fit, although statistically significant, is quite small. Significant effects of the MDR*AGM interaction (assessed by comparing the fit of Models (6) and (12)) are observed in Mexico and Sri Lanka when rates are indexed either by marriage or by motherhood. In the case

[8] We note that the 'main effect' of MRCO is a part of the PER*MRDR interaction. We have also fitted the model AGE + PER*MRDR + MRDR*EDUC and in no instance does it significantly improve the fit when compared with the simpler model AGE + PER + MRDR*EDUC + MRCO. We note also that the addition of MRCO in this latter model can only capture the non-linear components of the marriage cohort effects, as any linear component is already captured by the PER and MRDR main effects. See Hobcraft *et al* 1982b, especially the appendix.

Table 4 Testing for marriage cohort effects with controls for educational attainment: chi-squared statistics for selected models, by country (rates indexed by marriage)

Model[a]	Number of parameters	Country[b]						
		Col	Indo	Jord	Ken	Kor	Mex	SL
Total df in table		261	291	257	258	200	266	285
(1) Grand mean	1	2410	2463	1328	1204	3360	3207	4074
(3) AGE + PER + MRDR	17	433	448	437	347	416	569	350
(4) AGE + PER + MRDR + MRCO	21	397	425	421	330	314	559	320
(10) AGE + PER + MRDR*EDUC	29	251[**]	288[*]	176[‡]	190[†]	204[*]	231[**]	244[**]
(11) AGE + PER + MRDR*EDUC + MRCO	33	221[**]	270[**]	171[‡]	182[†]	132[†]	222[**]	226[†]
MRCO significant[c], *when added to:*								
Model (3)		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Model (10)		Yes	Yes	No	No	Yes	No	Yes

[*] Denotes chi-squared figure between one and two standard deviations greater than the mean.
[**] Denotes chi-squared figure within one standard deviation of the mean.
[†] Denotes chi-squared figure more than one standard deviation below the mean.
[‡] Denotes chi-squared figure more than two standard deviations below the mean.
[a] The model terms signify the demographic dimensions as defined in the text.
[b] The countries are as listed in footnote b of table 2A.
[c] Significant at the .05 level.

Table 5 Testing for age at entry effects: chi-squared statistics for selected models, by country

Model[a]	Number of parameters	Country[b] Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Rates indexed by marriage										
(3) AGE + PER + MRDR	17	43‡	100	102	84**	66**	76**	146	88*	117
(6) AGE + PER + MRDR + AGMR	21–24	38‡	94*	98*	74**	62**	71**	134	74**	106
(12) PER + MRDR*AGMR	36–41	29‡	80	87	59**	56**	56**	123	57**	68**
Significant[c] improvement in fit										
Model (6) – Model (3)		No	No	No	No	No	No	Yes	Yes	No
Model (12) – Model (3)		No	No	No	No	No	No	No	Yes	Yes
Rates indexed by motherhood										
(3) AGE + PER + MODR	17	86*	72**	93*	76**	46‡	56†	142	70**	85**
(6) AGE + PER + MODR + AGMO	21–22	83**	60**	83*	70**	42‡	53†	134	61**	76**
(12) PER + MODR*AGMO	31–36	66*	48**	73*	57**	37†	45**	121	40†	49**
Significant[c] improvement in fit										
Model (6) – Model (3)		No	Yes	No	No	No	No	No	No	No
Model (12) – Model (3)		No	No	No	No	No	No	No	Yes	Yes

*Denotes chi-squared figure between one and two standard deviations greater than the mean.
**Denotes chi-squared figure within one standard deviation of the mean.
†Denotes chi-squared figure more than one standard deviation below the mean.
‡Denotes chi-squared figure more than two standard deviations below the mean.
[a]The model terms signify the demographic dimensions as defined in the text.
[b]The countries are as listed in footnote b of table 2A.
[c]Significant at the .05 level.

Table 6 Completed fertility implied by parameter estimates, for most recent period, for AGE + PER + MDR model, by country

	Country[a]								
	Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Rates indexed by marriage									
(1) First marriage in age interval centred on 15 years	6.54	6.36	5.41	5.62	9.79	8.40	(5.85)	8.15	(6.06)
(2) First marriage in age interval centred on 20 years	5.97	5.56	5.05	4.71	8.67	8.05	5.20	6.76	5.22
(3) First marriage in age interval centred on 25 years	(4.72)	4.34	4.13	3.57	6.78	6.79	3.94	4.98	3.98
Rates indexed by motherhood									
(1) First birth in age interval centred on 15 years	6.96	6.61	5.97	6.07	10.03	8.67	(5.75)	8.54	(6.44)
(2) First birth in age interval centred on 20 years	6.26	5.89	5.46	5.58	9.27	8.47	5.41	7.27	5.64
(3) First birth in age interval centred on 25 years	5.14	4.77	4.54	3.70	7.72	7.38	4.40	5.59	4.48
(4) First birth in age interval centred on 30 years	(3.88)	3.63	3.51	3.64	5.93	5.92	3.20	3.98	3.29

[a]The countries are as listed in footnote b of table 2A.

NOTE: Figures in brackets refer to ages at marriage or first birth which occur very rarely in the country.

of Sri Lanka, this interaction term effects a marked improvement in fit, especially when rates are indexed by marriage.

Since level of educational attainment is closely associated with age at entry, we have pursued the analysis further, in those countries where significant age at entry effects emerged, by examining the effects with a control for education. As in the examination of cohort effects, we fit models to a PER x BCO x MCO x EDUC table of rates. Our preferred model is AGE + PER + MDR*EDUC, and hence we consider the improvement in fit when AGM and AGM*MDR are added to this model. The results are not shown here. We find main effects of age at entry disappearing in Korea but remaining in Mexico (rates indexed by marriage) and in Colombia (rates indexed by motherhood). The effects of the interaction of age at entry and duration disappear in all cases except Sri Lanka when rates are indexed by marriage, and in this case the reduction in chi-square, whilst still significant, is halved in comparison to testing without a control for education effects.

These results indicate that age at entry effects on reproductive timing are generally non-existent or very small, net of age and duration (and period) effects. Among the study countries, only Sri Lanka shows effects large enough to be of much interest; this case may be worth investigating further. In the other countries, the joint control for both age and duration is clearly of importance, for in an analysis with only one controlled – which is usual, as we noted in the introduction – something very much like age at entry effects on fertility tempo would seem evident. For example, those who enter later may show higher fertility in early durations. Our analysis demonstrates, however, that main effects of age and duration capture almost all of the apparent age at entry effects in the countries examined.

The choice of age at entry nevertheless has considerable influence on completed fertility, by determining at what ages each duration segment is experienced. The effect is principally one of defining the length of the exposure period, but the full effect is more complicated. Recall that the estimated age effects rise to ages 20–24 and then fall off (figures 1A and 1B), while the estimated duration effects decline from the earliest duration onward (figures 2A and 2B), imagining the first birth included in the rates for the first motherhood duration. Both sets of effects, especially the age effects, are non-linear, and hence the effect of a change in age at entry, which determines the pairings of age and duration categories, will not be the same through the whole range of typical ages at entry. In table 6 we present completed fertilities implied by the parameter estimates for the AGE + PER + MDR model under matchings of age and duration effects which correspond to ages at entry centred on ages 15, 20, 25, and 30 years. We exclude ages at marriage centred on 30 years, since for most of the countries such an average age is very remote from their present experience, and we bracket values for other ages at entry in specific countries where the ages characterize very few women. We emphasize that no direct estimates of age at entry effects have been incorporated in the calculation of these completed fertilities; rather, age at entry effects are specified in the form of particular pairings of main effects of age and duration.

A few comments about the calculation of these completed fertilities: women are allowed experience only through six five-year duration segments and through the age segment ending at 45–49 years. As a consequence of the duration constraint, women entering in the youngest age segment (centred on age 15) are allotted no experience in the oldest (seventh) age segment. As a consequence of the age constraint, women entering in the third and fourth age segment (centred on 25 and 30, respectively) are not allotted all six duration segments. In calculating the total fertility based on rates by duration of motherhood we have added in the first birth.

An examination of table 6 discloses that the differences in estimated completed fertilities are much smaller between ages at entry centred on 15 and 20 years than between subsequent ages (20 and 25, or 25 and 30). In fact, in those countries where early entry is most common – Bangladesh, Indonesia, Kenya – there is virtually no difference between the estimated completed fertilities for the first two age at entry categories. This comes about because of the negative effects estimated for ages centred on fifteen, reflecting no doubt teenage sub-fecundity, perhaps low coital frequency, or even non-consummation in the case of rates indexed by marriage. Clearly, the impact on completed fertility of entry centred on age 25 instead of age 20 is much greater in most countries than the impact of entry centred on age 20 instead of age 15. The small difference in some countries between the final fertility experience of those entering at 15 and 20 gives rise to the label 'catch-up' effect. We think this term misleading since as sometimes used it implies intentional behaviour affecting fertility tempo which is, in most instances, not suggested by the relevant data when they are subjected to the appropriate analysis (see table 5). There is a valid point to be made with respect to the quantum aspect of fertility: our results support the viewpoint that postponements of ages at entry through the teens (from, say, age 13 to 18) has little effect on total fertility levels in many countries.

Education effects

Although our results on the estimated effects of educational attainment on reproductive tempo add little to the work of others (for example, Hermalin and Mason 1981; Rodríguez and Cleland 1981), we feel a brief summary of the main features of this relationship which have emerged in the course of our work is in order, given the considerable interest in the relationship between education and fertility (for example, Cochrane 1979; Caldwell 1980).

First, our results leave little doubt that the effects of educational attainment on fertility tempo should be specified as interactive with the effects of duration (of marriage or motherhood). The goodness-of-fit statistics presented in table 7 make this emphatically clear. The significance tests reported in the lower half of each panel show that main effects of education (assessed by comparing the fit of Models (9) and (3)) are present in every country, with the exception of Sri Lanka when rates are indexed by marriage duration. Furthermore, additional effects of educational attainment interacting with duration (assessed by comparing the fit of Models (10) and (9)) are also evident in most countries, with the exceptions of Bangladesh and Jamaica; and Indonesia when rates are indexed by motherhood duration; in Kenya, the effect is also very weak for the rates by motherhood duration although it is significant. In these countries – notably Colombia, Jordan, Korea, Mexico, and Sri Lanka – failure to specify the interaction means neglecting a substantial portion of the total effect of education on the fertility rates. Specifying an effect in interaction with duration is, of course, a natural way to conceptualize educational effects. Especially in those countries (such as Colombia and Korea) where fertility control is widespread, it is differentials in voluntary curtailment of childbearing with increasing duration (itself perhaps largely a proxy for achieved parity) which distinguish the fertility experiences of the educational strata. Several authors have included this interaction

Table 7 Testing for education effects: chi-squared statistics for selected models, by country

Model[a]	Number of parameters	Country[b]								
		Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Rates indexed by marriage										
(3) AGE + PER + MRDR	17	100‡	433	448	228**	437	347	416	569	350
(9) AGE + PER + MRDR + EDUC	19[d]	89‡	355	340	216**	382	231**	376	401	345
(10) AGE + PER + MRDR*EDUC	29[e]	85‡	251**	288*	204**	176‡	190†	204*	231**	244**
Significant[c] improvement in fit										
Model (9) – Model (3)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Model (10) – Model (9)		No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Rates indexed by motherhood										
(3) AGE + PER + MODR	17	141**	455	341	216**	423	210†	455	510	332
(9) AGE + PER + MODR + EDUC	19[d]	136**	329	294	200†	297	192†	356	272*	311
(10) AGE + PER + MODR*EDUC	29[e]	133**	261*	278*	187†	167‡	172‡	223*	185‡	244**
Significant[c] improvement in fit										
Model (9) – Model (3)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Model (10) – Model (9)		No	Yes	No	No	Yes	Yes	Yes	Yes	Yes

*Denotes chi-squared figure between one and two standard deviations greater than the mean.
**Denotes chi-squared figure within one standard deviation of the mean.
†Denotes chi-squared figure more than one standard deviation below the mean.
‡Denotes chi-squared figure more than two standard deviations below the mean.
[a]The model terms signify the demographic dimensions as defined in the text.
[b]The countries are as listed in footnote b of table 2A.
[c]Significant at the .05 level.
[d]18 for Bangladesh.
[e]23 for Bangladesh.

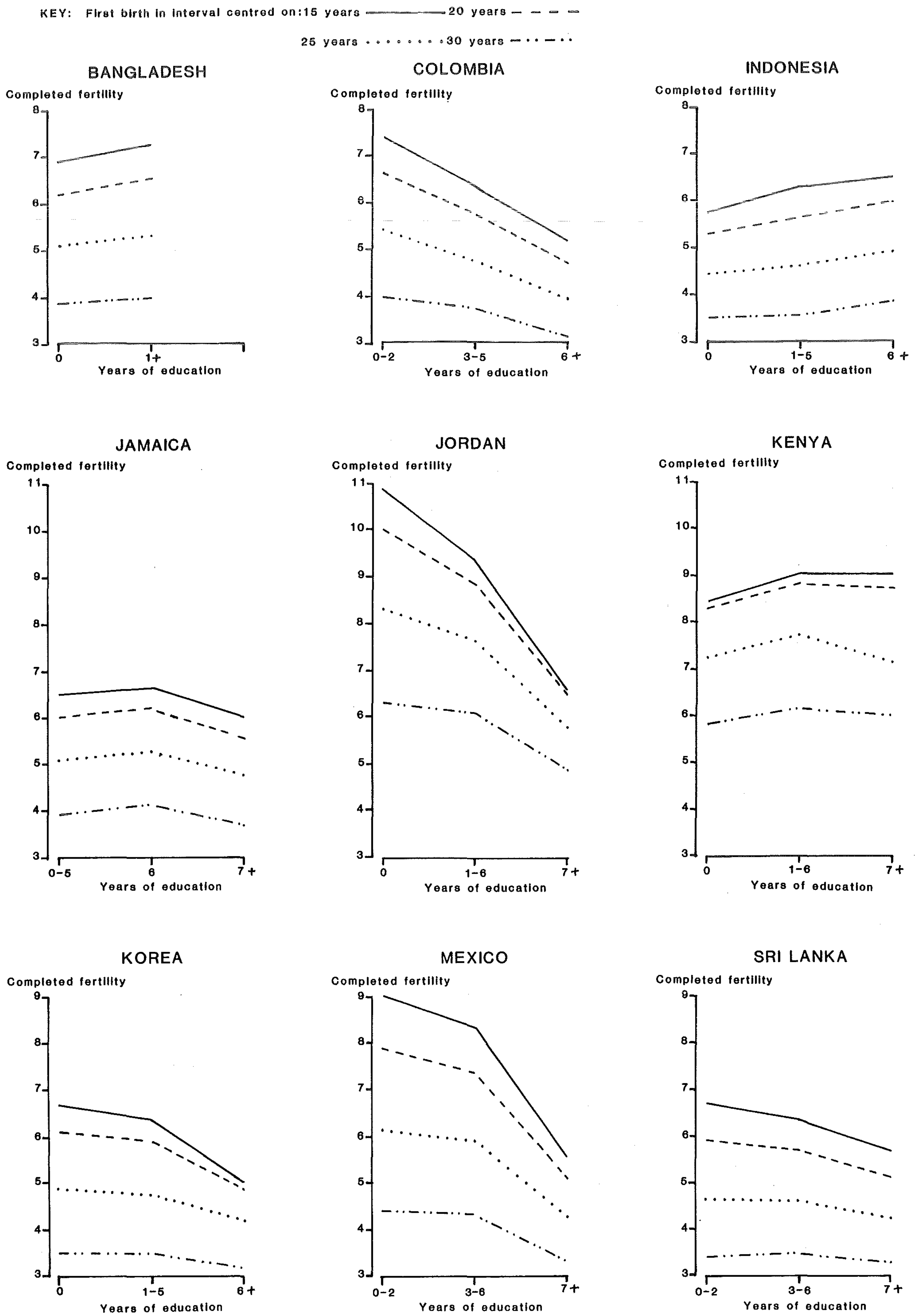

Figure 4 Completed fertility implied by parameter estimates for AGE + PER + MODR*EDUC model, for most recent period, by combinations of age at motherhood and education groupings, based on rates indexed by duration of motherhood

between education and marriage in recent work but do not explicitly examine the need for such a specification. Our results indicate that the interaction is indeed of fundamental importance if the full nature of educational effects is to be captured.

A second conclusion which emerges from our analysis is that the pattern of educational differentials differs markedly among countries. The completed fertilities are calculated assigning the same age at entry to each educational strata. Educational differentials in age at entry are large in most of these countries (McCarthy 1982). The differences in duration patterns by education result in part from differentials in age at entry. To the extent that these separate duration patterns do not represent the full effect of the age at entry differentials, the differentials in completed fertilities shown in table 8 and figure 4 summarize educational effects on fertility subsequent to marriage or motherhood rather than the total effect of education on fertility. Whilst a monotonic negative effect of increasing level of education is evident for the majority of countries, the relationship is curvilinear in Jamaica (and possibly Kenya) and positive in Bangladesh and Indonesia. In these latter two countries, increasing education is associated with more rapid childbearing; as these are also countries where the model fitting in table 7 indicates that the education effect is simply an additive main effect (that is, a constant proportionate effect of educational stratum on rates at all durations), it is plausible to interpret the effect as reflective of variations in effective fecundity; perhaps shorter breastfeeding durations among those with more education (Ferry and Smith 1983), rather than variation in patterns of intentional control by educational strata. Among countries showing the more usual inverse relationship between education and total fertility within marriage or motherhood, there are some differences in the relative level ('mid' or 'high') at which the suppressing effect is first strongly expressed, with 'high' education more often required for noticeably lower fertility to be observed. The relationship between education and fertility is without question powerful, but cross-nationally no simple generalizations describe it satisfactorily. We note, before concluding this section, that our findings are essentially in harmony with those of Rodríguez and Cleland (1981), who examine educational differentials with controls for several additional socio-economic variables.

3.4 NEVER USERS OF CONTRACEPTION

With some reservations, we posit that the fertility patterns of the subset of women who report never having used contraception should approximate natural fertility patterns. Hence fertility rates for these women should in theory exhibit no period effects. We also expect greater homogeneity across countries in the patterns of age and duration effects (since, from our analysis thus far, it seems that fertility control is expressed through both age and duration effects). Our reservations are based on our previous analysis and on consideration of the characteristics of never users. When discussing the period effects evident in the parameter estimates for rates for all women (ever users and never users combined), we concluded that reporting errors contributed heavily to the observed patterns. There is no reason to

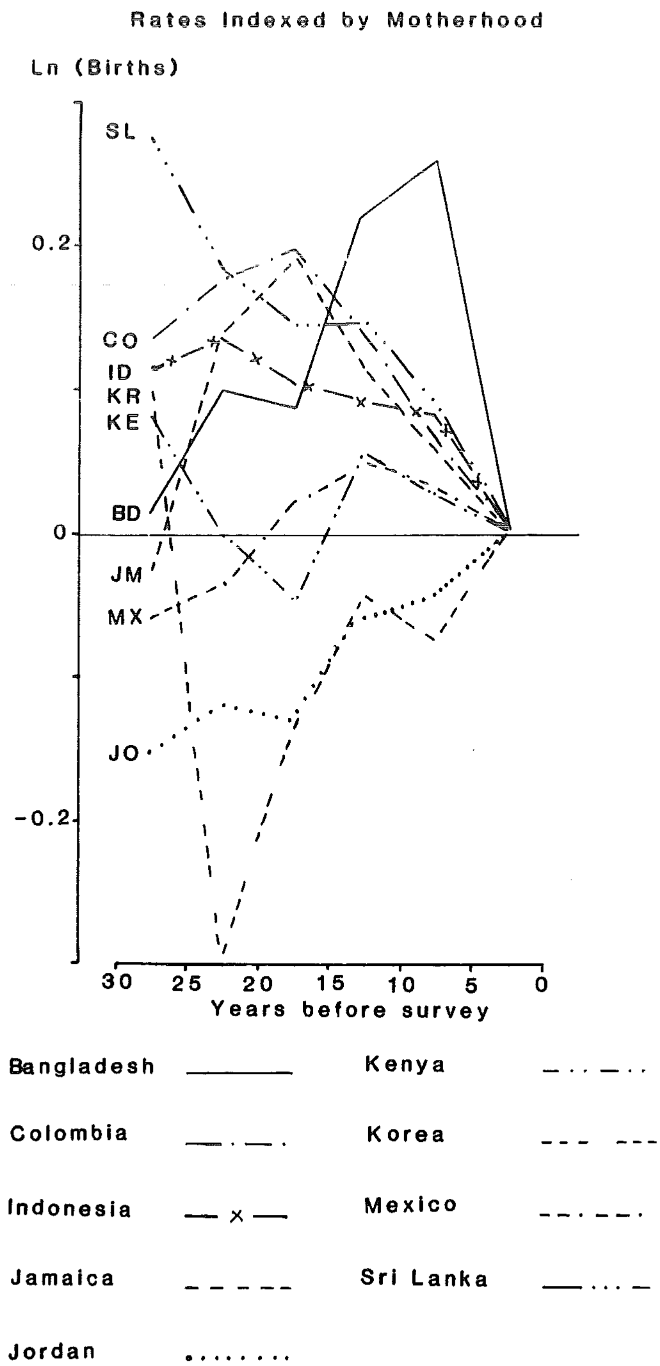

Figure 5 Estimates of period effects from AGE + PER + MODR model for never users of contraception, by country

think such errors will be absent among never users. Of more general concern is the selectivity associated with never use in countries with moderate or high levels of use. In these countries we might expect over-representation of relatively infecund women among the never users. Such selectivity might lead to the appearance of time or cohort trends in cases where levels of use have changed rapidly over time, as well as distorting the validity of the age and duration patterns as representative of a natural fertility population.

In table 9 goodness-of-fit statistics are presented for all women (upper panel) and for the subset of never users (lower panel), for three simple models, including AGE + PER + MODR, which is our preferred model for most of

Table 8 Completed fertility implied by parameter estimates for AGE + PER + MRDR*EDUC model for women married in age interval centred on 20 years by educational strata, most recent period, by country

		Country[a]								
		Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Rates indexed by marriage										
Educational attainment:	Low	5.91	6.24	4.83	5.04	9.24	7.57	5.68	7.33	5.39
	Mid	6.21	5.50	5.21	5.39	8.35	8.41	5.63	6.90	5.27
	High	–	4.30	5.66	4.75	6.37	8.05	4.81	4.80	4.78
Rates indexed by motherhood										
Educational attainment:	Low	6.20	6.62	5.32	6.04	10.03	8.28	6.12	7.86	5.88
	Mid	6.50	5.72	5.66	6.15	8.83	8.82	5.90	7.36	5.69
	High	–	4.68	5.96	6.57	6.42	8.71	4.91	5.09	5.12

[a]The countries are as listed in footnote b of table 2A.

Table 9 Chi-squared statistics for selected models, by country: rates indexed by motherhood: all women and never users

Model[a]	Number of parameters	Country[b]								
		Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
All women										
Total df in Table		90	91	91	91	90	91	76	91	91
(1) Grand mean	1	1727	1590	2473	952	1025	1137	2874	2012	3193
(2) AGE + MODR	12	311	347	163	146	65†	93*	246	144	218
(3) AGE + PER + MODR	17	86*	72**	93*	76**	46‡	56†	142	70**	85**
Never users										
Total df in Table		90	91	91	89	90	91	76	91	91
(1) Grand mean	1	1506	636	1866	314	475	771	1048	1178	1794
(2) AGE + MODR	12	262	73**	138	71**	67**	66†	81*	60†	115
(3) AGE + PER + MODR	17	81**	52†	117	62**	54†	52†	49**	57†	77**

*Denotes chi-squared figure between one and two standard deviations greater than the mean.
**Denotes chi-squared figure within one standard deviation of the mean.
†Denotes chi-squared figure more than one standard deviation below the mean.
‡Denotes chi-squared figure more than two standard deviations below the mean.
[a]The model terms signify the demographic dimensions as defined in the text.
[b]The countries are as listed in footnote b of table 2A.

the countries in the all-women analysis. The statistics pertain to models fitted to rates indexed by motherhood duration only; the results are in all important features the same for rates indexed by marriage duration.

A comparison of the upper and lower panels of table 9 reveals that, as hypothesized, a simpler structure characterizes the fertility patterns of the never users. Whereas for the sample of all women the model AGE + MODR (Model (2)) provides minimally acceptable fit for one or two countries (Jordan and perhaps Kenya), for never users the same model is satisfactory in five or six countries (Colombia, Jamaica, Jordan, Kenya, Mexico, and perhaps Korea). Only in the case of Indonesia do the goodness-of-fit statistics show worse fit (more complex structure) for never users (compare the two fits of Model (3)). At the same time, a comparison of the chi-squared figures for Models (2) and (3) indicates that the rates for never users vary along the PER dimension in every country except Jamaica and Mexico, even though the relative importance of this dimension (assessed by considering the magnitude of the chi-squared reduction upon addition of PER) is greatly attenuated in every country. The parameter estimates for PER are plotted in figure 5; they make plain that period variation remains, with the attenuation of the period effects evident when this figure is compared with figure 3B. Notice that the same overall pattern of PER effects remains when never users alone are examined: fertility falls in the two or three five-year periods prior to the survey, after rising in the earlier five-year periods. We view this as reflective of the types of reporting error described above. The less sharp decline in the two or three five-year periods immediately prior to the survey probably results in some countries from the exclusion of those women (ever users) whose fertility within motherhood has truly fallen in recent years; in particular, we point to Colombia, Korea, Mexico and Sri Lanka. The rising fertility over time estimated for never users in Jordan and Korea is curious and not readily explained, although we note the effect of the Korean War on early fertility rates for Korea.

4 Summary and Discussion

Our main findings can be summarized as follows:

(1) Age and duration since entry (to marriage or motherhood) are the dominant demographic dimensions in the fertility rates analyzed, with historical period of lesser but still considerable importance. The joint effects of these three dimensions can be expressed as a simple additive model within a log-linear framework.

(2) The patterns of age and duration effects are very similar across countries, with the age patterns more heterogeneous than the duration patterns. The results suggest that the age pattern is more reflective of the level of intentional fertility control than the duration pattern.

(3) The pattern of period effects varies more across countries than the age and duration patterns, in part, no doubt, the result of differences among countries in fertility trends in the years before the WFS survey. It is striking that, despite this variation, in all countries examined fertility rises and then falls over the time period considered, according to the estimated period effects. It is plausible that this common shape is a consequence of common reporting errors in the maternity history data from which the period trends for each country are estimated.

(4) Significant birth cohort or entry cohort effects on fertility tempo are evident together or separately for a majority of the countries, especially those in which reproductive behaviour has been in transition. The cohort effects are attenuated when level of educational attainment is controlled but remain significant in most instances.

(5) Direct effects of age at entry and interactive effects of age at entry and duration since entry are small or non-existent. Age at entry is nevertheless of profound importance in determining levels of completed fertility (fertility quantum) through its influence on the joint patterning of main effects of age and duration on fertility tempo. In this regard, in several societies examined, variation in age at entry under age 20 seems to be of little consequence; only with postponement of entry until after age 20 does noticeable impact on completed fertility become evident.

(6) Educational attainment affects reproductive timing in every country. Its full effect in most countries includes interaction with duration since entry; the means by which education affects the fertility rates is insufficiently captured by a simple additive main effect. The pattern of educational differentials shows substantial variation across countries with the association positive in a few countries where levels of fertility control are low.

(7) The fertility rates of never users present a simpler structure; in particular, for these women period effects are attenuated or absent altogether. But the persistence of some period effects gives reasons for concern about the selectivity of never users as a group and further supports the plausibility of certain hypothesized patterns of misreporting in the maternity history data.

The emergence of age and duration as the dominant demographic dimensions of reproduction is, in our view, the central finding of this analysis, although it may also be the least surprising. These two are clearly the dimensions in which fertility varies, generally in a rather simple and orderly fashion. It is worth emphasizing that the results are unambiguous about the existence of effects of age and duration net of each other, in societies where fertility is highly controlled as well as in those where there is thought to be little fertility control. The fact that both age and duration are required implies that the demographic dimensions are insufficiently controlled in most analyses. This point has previously been made by Page (1977) for a few developed societies, but the actual models used here are simpler in many respects.

More unexpected is the finding that cross-national variations in fertility control seem to be captured better by age than by duration. If it is reasonable to infer from this that control is more closely associated with age than duration, the implications of this finding are far reaching. Demographers (for example, Henry 1961; Leridon and Menken 1981) have become accustomed to conceptualizing intentional fertility control behaviour as parity-responsive, in particular control which is aimed at limiting family size. Ironically, many of the measures commonly employed to detect evidence of intentional fertility control in historical European fertility data are age-based rather than parity-based (Henry 1956; Wrigley 1966; Knodel 1978, 1979). Nevertheless the usual underlying assumption is that the changes detected by these measures reflect a shift to deliberate fertility control for the purpose of limiting family size, that is, 'stopping' behaviour, and that this new behaviour is parity dependent (Knodel 1977, 1979). If we assume that duration is principally a proxy for achieved parity, our results challenge this common working assumption and encourage further investigation of the connections between age and fertility control behaviour. In this context consideration of social norms and individual notions about 'appropriate' ages for childbearing would seem very much in order (Rindfuss and Bumpass 1978, Mineau *et al* 1979).

A close association of intentional fertility control with age as opposed to duration, itself proxying for parity, provides a reason to question some of the recent enthusiasm for parity-specific analysis, for example birth interval analysis. Such analysis inevitably tends to be more complex and detailed than analysis of fertility rates cross-classified by age, duration, and period, unless substantial proportions of the reported fertility experience are omitted from the birth interval analysis. The case for parity-specific analysis relies heavily on the assumption that fertility decisions and behaviour are fundamentally parity-responsive, above all when intentional fertility control is being exercised. Our results cast doubt on the correctness of this assumption, although we report that the strong effects of duration which we estimate do justify incorporation of duration (or its analogues) in an analysis in some fashion. A final implication is that when parity-specific analysis is performed, it is essential that age be incorporated as a control.

We should immediately caution against placing too much emphasis on the implications of the association between fertility control and age (rather than duration) discussed in the preceding paragraphs. That some caution is required, even in the face of fairly strong empirical evidence, is indicated by the need for interactions between duration and education rather than age and education in the models including education. If fertility control always operated largely through age this would not occur. In fact a model with an age by education interaction performs quite well in several countries but not as well overall as one with a duration by education interaction. A possibility exists that the apparent relation between age effects and fertility control is partly reflecting a correlation between fertility and age-misstatement. However, these reservations are not strong enough to undermine the discussion above.

The findings of significant non-linear effects of birth cohort and entry cohort in some of the countries are tantalizing, especially since the countries involved tend to be those among our selection of nine which are more actively experiencing fertility transition. This suggests that there are cohort dimensions to the fertility declines, net of the period dimensions. The latter, we emphasize, is of overwhelmingly greater importance than either cohort dimension (except possibly in Korea). Considerable attention has been given to the cohort dimension of fertility dynamics in developed countries (see, for example, Ryder 1980), but very little investigation of which we are aware has explicitly attempted to distinguish period and cohort components of fertility change in contemporary developing societies. We note again that the cohort effects are best understood as reflective of the effects of other variables which the cohort dimensions represent. (The same comment applies to the period effects as well.)

Our success in attenuating, or explaining away altogether, the cohort effects by addition of education to the analysis suggests that further efforts to identify the variables which the cohort markers proxy may well yield interesting insights about the nature of fertility variation in these countries. The overall small role of the cohort dimensions relative to the dominant dimensions, however, cautions against too much reliance on these dimensions. For example, the fitting of relational Gompertz models to birth cohort data as advocated by Brass and his associates (Booth 1979; Brass 1981) would seem misguided, since in most countries it appears that most of the distortions of rates in time occur equally across all ages and durations and are mainly determined by time prior to the survey (period).

Our analysis of the rates for never users of contraception, under the assumption that these women represent a natural fertility population, proved sobering in several respects. A simpler structure emerged as expected, but distinct period effects remained for most countries. The latter we view as indicative of reporting errors, similar to the errors we perceive in the rates for all women. These errors, along with the demonstrable selectivity of the never users render comparisons of never users with other subsets of women or with the entire sample both complex and easily subject to misleading interpretation.

It would be desirable for the comparative aspects of this work to be taken further. The work reported here falls into the category of replicated within country analysis (Hobcraft 1981). It would be of considerable interest to combine the tables for the separate countries and determine whether it were possible to place further parameter restrictions on the models. Thus, at the moment, the three-factor models with terms in age, duration, and period have been fitted separately for each country, in effect presuming a country by main effect interaction for all factors. The comparison of the duration since entry (especially since motherhood) parameter estimates across countries suggests that it may be possible to obtain a reasonable fit with a common duration since entry structure. We have not yet pursued this analysis. However, the identification of such commonalities among societies is a potentially enormous contribution which comparative analysis can make toward a better understanding of reproductive behaviour.[9]

[9] Since this work was completed, several aspects have been extended by W. Gilks, including more genuine comparative analysis and disaggregation by parity. See Gilks 1982.

References

Andersen, E.B. (1977). Multiplicative Poisson Models with Unequal Cell Rates. *Scandinavian Journal of Statistics, 4*: 153–8.

Baker, R.J. and J.A. Nelder (1978). *The GLIM System, Release 3: Manual*. Oxford: Numerical Algorithms Group.

Berry, G. (1970). Parametric Analysis of Disease Incidences in Multiway Tables. *Biometrics 26*: 572–8.

Bishop, Y.M.M., S.E. Fienberg and P.W. Holland (1975). *Discrete Multivariate Analysis: Theory and Practice*. Cambridge, Mass: MIT Press.

Booth, H. (1979). The Estimation of Fertility from Incomplete Cohort Data by Means of the Transformed Gompertz Model. Unpublished PhD thesis, University of London.

Brass, W. (1981). The Use of the Gompertz Relational Model to Estimate Fertility. In International Union for the Scientific Study of Population *International Population Conference, Manila, 1981 3*: 345–62. IUSSP, Liège.

Brass, W. and H. Rashad (forthcoming). Exploratory Demographic Analysis of Imperfect Maternity Histories to Determine Levels and Trends of Fertility. In W. Brass and A.G. Hill, eds *The Analysis of Maternity Histories*. Ordina Editions for IUSSP, Liège.

Caldwell, J. (1980). Mass Education as a Determinant of the Timing of Fertility Decline. *Population and Development Review 6*: 225–56.

Casterline, J.B. and J. Trussell (1980). Age at First Birth. *WFS Comparative Studies* no 15.

Cochrane, S. (1979). Fertility and Education: What Do We Really Know? *World Bank Staff Occasional Papers* no 26.

Ferry, B. and D.P. Smith (1983). Breastfeeding Differentials. *WFS Comparative Studies* no. 23.

Fienberg, S.E. and W.M. Mason (1979). Identification and Estimation of Age–Period–Cohort Models in the Analysis of Discrete Archival Data. In K.F. Schuessler, ed *Sociological Methodology, 1979*. San Francisco: Jossey-Bass.

Freedman, R. and J. Casterline (1982). Nuptiality and Fertility in Taiwan. In L.T. Ruzicka, ed *Nuptiality and Fertility*. Ordina Editions for IUSSP, Liège.

Gilks, W. (1979). The Examination of a Model of Marital Fertility Depending on both Age and Duration of Marriage. Unpublished MSc dissertation, Department of Social Statistics, University of Southampton.

Gilks, W.R. (1981). Age, Period, Cohort Models: Clarification, Verification and Identification. Unpublished paper, Department of Social Statistics, University of Southampton.

Gilks, W.R. (1982). The Relationship between Current Fertility and Birth History. Unpublished mimeograph, University of Southampton.

Goldstein, H. (1979). Age, Period and Cohort Effects – a Confounded Confusion. *Bulletin in Applied Statistics (Sheffield) 6*: 19–24.

Haberman, S. (1979). *Analysis of Qualitative Data* (2 vols). New York: Academic Press.

Henry, L. (1956). Anciennes familles Genevoises; étude démographique: 16e–20e Siècle. *INED Cahier* no 26.

Henry, L. (1961). Some Data on Natural Fertility. *Eugenics Quarterly*: 81–91.

Hermalin, A.I. and W. Mason (1981). A Strategy for the Comparative Analysis of WFS Data, with Illustrative Examples. In *The United Nations Programme for Comparative Analysis of World Fertility Survey Data*, UNFPA.

Hobcraft, J. (1981). Strategies for Comparative Analysis of WFS Data. *World Fertility Survey Conference 1980: Record of Proceedings, 3*: 509–74. Voorburg, Netherlands: International Statistical Institute.

Hobcraft, J. and W.R. Gilks (forthcoming). Age, Period and Cohort Analysis in Mortality Studies. In L. Heligman, J. Pollard and J. Vallin, eds *Methodology and Data Collection in Mortality Studies*. Ordina Editions for IUSSP, Liège.

Hobcraft, J., N. Goldman and V.C. Chidambaram (1982a). Advances in the P/F Ratio Method for the Analysis of Birth Histories. *Population Studies 36*: 291–316.

Hobcraft, J., J. Menken and S.H. Preston (1982b). Age, Period and Cohort Effects in Demography: a Review. *Population Index, 48*: 4–43.

Holt, D., A.J. Scott and P. Ewings (1980). Chi-squared Tests with Survey Data. *Journal of the Statistical Society, Series A, 143*: 303–20.

Kendall, M.G. (1979). The World Fertility Survey: Current Status and Findings. *Population Reports*, series M, no 3.

Knodel, J. (1977). Family Limitation and the Fertility Transition: Evidence from the Age Patterns of Fertility in Europe and Asia. *Population Studies 31*: 219–50.

Knodel, J. (1978). Natural Fertility in Pre-industrial Germany. *Population Studies 32*: 481–510.

Knodel, J. (1979). From Natural Fertility to Family Limitation: the Onset of Fertility Transition in a Sample of German Villages. *Demography 16*: 493–522.

Leridon, H. and J. Menken, eds (1981). *Natural Fertility*. Ordina Editions for IUSSP, Liège.

McCarthy, J. (1982). Differentials in Age at First Marriage. *WFS Comparative Studies* no 19.

McDonald, P.F., L.T. Ruzicka and J.C. Caldwell (1981). Interrelations between Nuptiality and Fertility: Evidence from the World Fertility Survey. *World Fertility Survey Conference 1980: Record of Proceedings, 2*: 77–137. Voorburg, Netherlands: International Statistical Institute.

Mineau, G.P., L.L. Bean and M. Skolnick (1979). Mormon Demographic History II: the Family Life-Cycle and Natural Fertility. *Population Studies 33*: 429–66.

Nelder, J.A. and D.W.M. Wedderburn (1972). Generalized Linear Models. *Journal of the Royal Statistical Society, Series A, 135*: 370–83.

O'Muircheartaigh, C.A. and A.M. Marckwardt (1981). An Assessment of the Reliability of WFS Data. *World Fertility Survey Conference 1980: Record of Proceedings, 3*: 313–79. Voorburg, Netherlands: International Statistical Institute.

Ordorica, M. and J.E. Potter (1981). Evaluation of the Mexican Fertility Survey 1976–77. *WFS Scientific Reports* no 21.

Osborne, J. (1975). A Multiplicative Model for the Analysis of Vital Statistics Rates. *Applied Statistics 24*: 75–84.

Page, H. (1977). Patterns Underlying Fertility Schedules: a Decomposition by both Age and Marriage Duration. *Population Studies 31*: 85–106.

Potter, J. (1977). Problems in Using Birth History Analysis to Estimate Trends in Fertility. *Population Studies 31*: 335–64.

Pullum, T.W. (1980). Separating Age, Period and Cohort Effects in White U.S. Fertility, 1920–70. *Social Science Research 9*: 225–44.

Rao, J.N.K. and A.J. Scott (1981). The Analysis of Categorical Data from Complex Sample Surveys: Chi-squared Tests for Goodness-of-fit and Independence in Two-way Tables. *Journal of the American Statistical Association 76*: 221–30.

Rindfuss, R.R. and L.L. Bumpass (1978). Age and the Sociology of Fertility: How Old is too Old? In K.E. Taeuber, L.L. Bumpass and J.A. Sweet, eds *Social Demography*. New York: Academic Press.

Rindfuss, R.R., L.L. Bumpass and C. St John (1980). Education and Fertility: Implications for the Roles Women Occupy. *American Sociological Review 45*: 431–47.

Rodríguez, G. and J. Cleland (1981). Socio-Economic Determinants of Marital Fertility in Twenty Countries: a Multivariate Analysis. *World Fertility Survey Conference 1980: Record of Proceedings, 3*: 337–425. Voorburg, Netherlands: International Statistical Institute.

Ryder, N.B. (1965). The Cohort as a Concept in the Study of Social Change. *American Sociological Review 30*: 843–61.

Ryder, N.B. (1980). Components of Temporal Variations in American Fertility. In R.W. Hiorns, ed *Demographic Patterns in Developed Societies*. London: Taylor and Francis.

Smith, D.P. (1980). Age at First Marriage. *WFS Comparative Studies* no 7.

Verma, V.K. (1980). Basic Fertility Measures from Retrospective Birth Histories. *WFS Technical Bulletins* no. 4.

Verma, V.K. (1981). Sampling for National Fertility Surveys. *World Fertility Survey Conference 1980: Record of Proceedings, 3*: 389–448. Voorburg, Netherlands: International Statistical Institute.

Verma, V.K., C. Scott and C.A. O'Muircheartaigh (1980). Sample Designs and Sampling Errors for the World Fertility Survey. *Journal of the Royal Statistical Society, Series A, 143*: 431–73.

Wrigley, E.A. (1966). Family Limitation in Pre-industrial England. *Economic History Review 19*: 82–109.

Appendix A – Characteristics of Subsamples Used in Analyses

Table A1 Characteristics of subsamples used in analyses (restricted to women of duration less than 30 years at survey, age greater than 14 years at survey, and births during 30 years prior to survey)

	Country[a]								
	Bang	Col	Indo	Jam	Jord	Ken	Kor	Mex	SL
Total respondents in survey	6513	5378	9155	3096	3610	8100	5430	7310	6810
Number of women									
< 30 years MRDR	5506	3203	8272	2678	3395	6001	5026	6012	6374
< 30 years MRDR, never users	4711	1283	5249	918	1812	4094	2056	3228	3535
< 30 years MODR	5307	3155	7663	2389	3222	6065	4983	5747	5992
< 30 years MODR, never users	4485	1280	4614	781	1627	4013	1995	3013	3133
Numbers of births to women[b]									
< 30 years MRDR	19484	12763	26589	8641	17288	26034	16926	25856	23622
< 30 years MRDR, never users	15889	5009	14370	2574	8289	17238	5594	13862	11656
< 30 years MODR	18491	10725	22271	7119	15099	23324	13887	21507	19047
< 30 years MODR, never users	15167	4439	12361	2167	7189	15266	4924	11826	9401
Average exposure per woman (years)									
< 30 years MRDR	12.4	12.3	13.7	12.6	12.9	12.7	12.8	12.5	13.4
< 30 years MRDR, never users	12.0	12.7	13.4	13.5	11.9	12.7	11.3	12.9	13.1
< 30 years MODR	12.4	11.9	13.1	12.3	12.4	11.9	12.6	12.0	13.1
< 30 years MODR, never users	12.2	12.7	13.6	13.6	11.7	12.0	12.3	12.8	13.3
Average births per woman[c]									
< 30 years MRDR	3.54	3.98	3.21	3.23	5.09	4.34	3.37	4.30	3.71
< 30 years MRDR, never users	3.37	3.90	2.74	2.80	4.57	4.21	2.71	4.29	3.30
< 30 years MODR	4.48	4.40	3.91	3.98	5.69	4.85	3.79	4.74	4.18
< 30 years MODR, never users	4.38	4.47	3.68	3.77	5.42	4.80	3.47	4.92	4.00
Births per year of exposure[b]									
< 30 years MRDR	0.286	0.325	0.235	0.256	0.394	0.343	0.263	0.345	0.276
< 30 years MRDR, never users	0.281	0.307	0.205	0.207	0.384	0.332	0.239	0.333	0.251
< 30 years MODR	0.281	0.286	0.222	0.242	0.378	0.322	0.221	0.311	0.243
< 30 years MODR, never users	0.276	0.274	0.196	0.203	0.378	0.317	0.201	0.308	0.225
Percentages of women									
Never users/all < 30 years MRDR	86	40	63	34	53	68	41	54	55
Never users/all < 30 years MODR	85	41	60	33	50	66	40	52	52

[a]The countries are as follows: Bang = Bangladesh; Col = Colombia; Indo = Indonesia; Jam = Jamaica; Jord = Jordan; Ken = Kenya; Kor = Korea; Mex = Mexico; SL = Sri Lanka.
[b]MODR numbers *exclude* first births.
[c]MODR numbers *include* first births.
NOTE: All numbers are weighted. MRDR ≡ marriage duration; MODR ≡ motherhood duration.